

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

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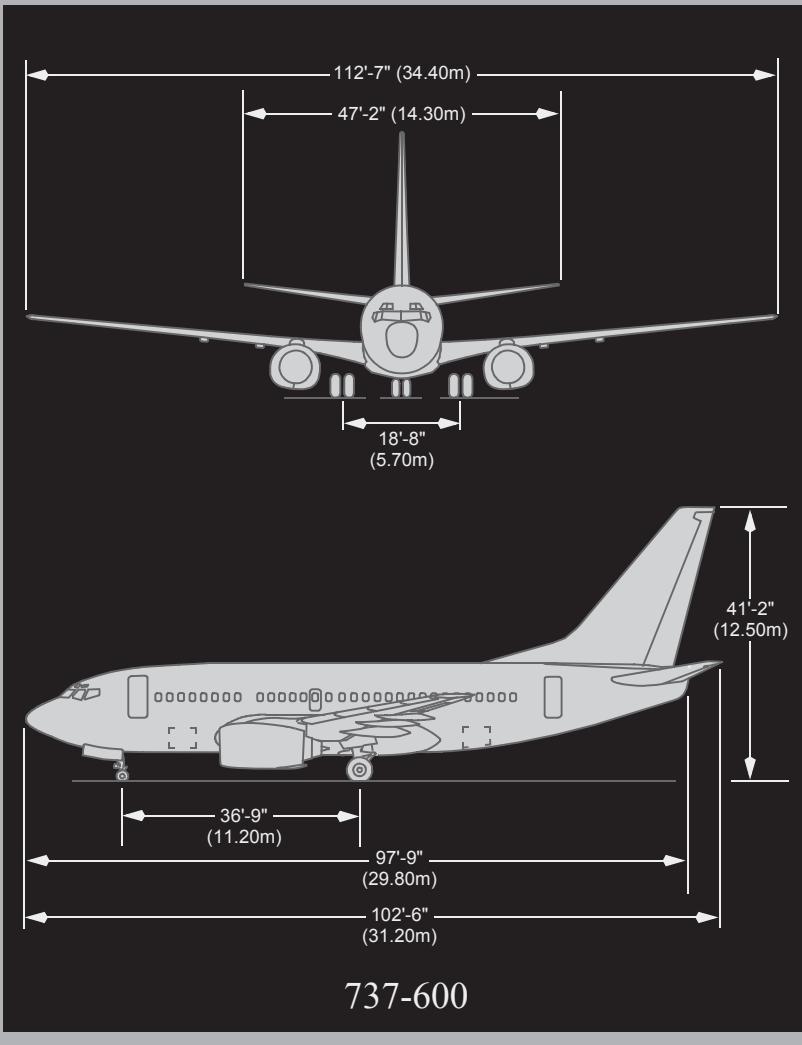
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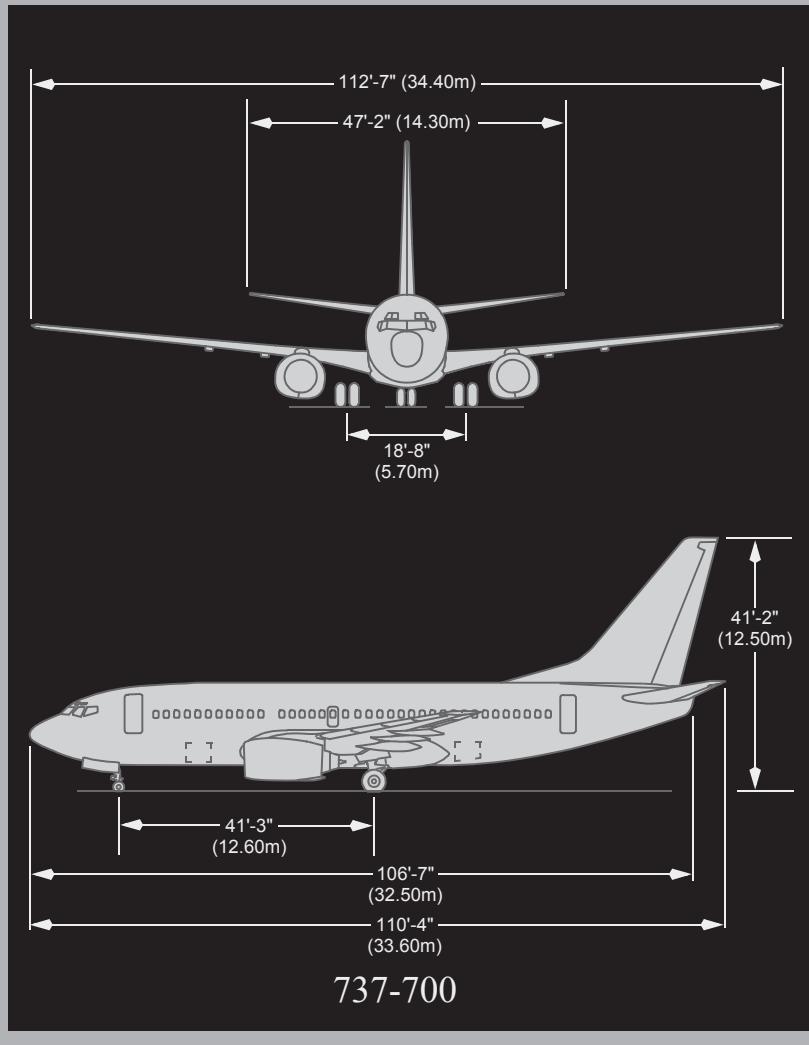
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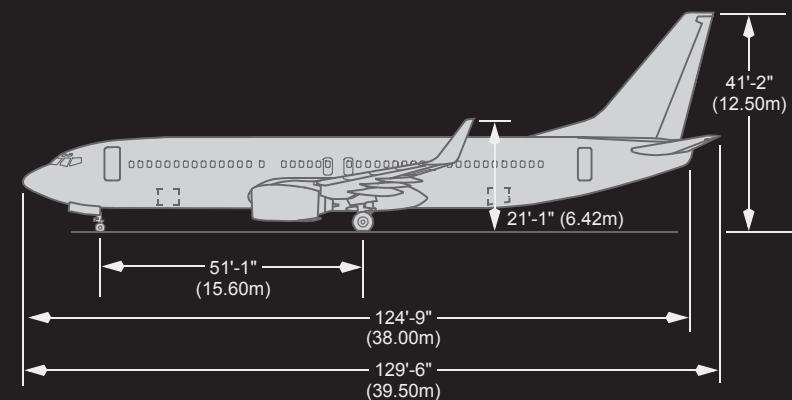
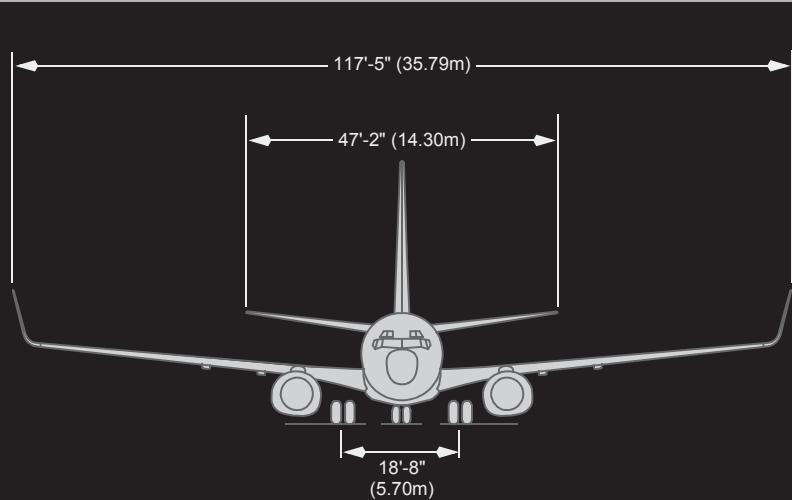
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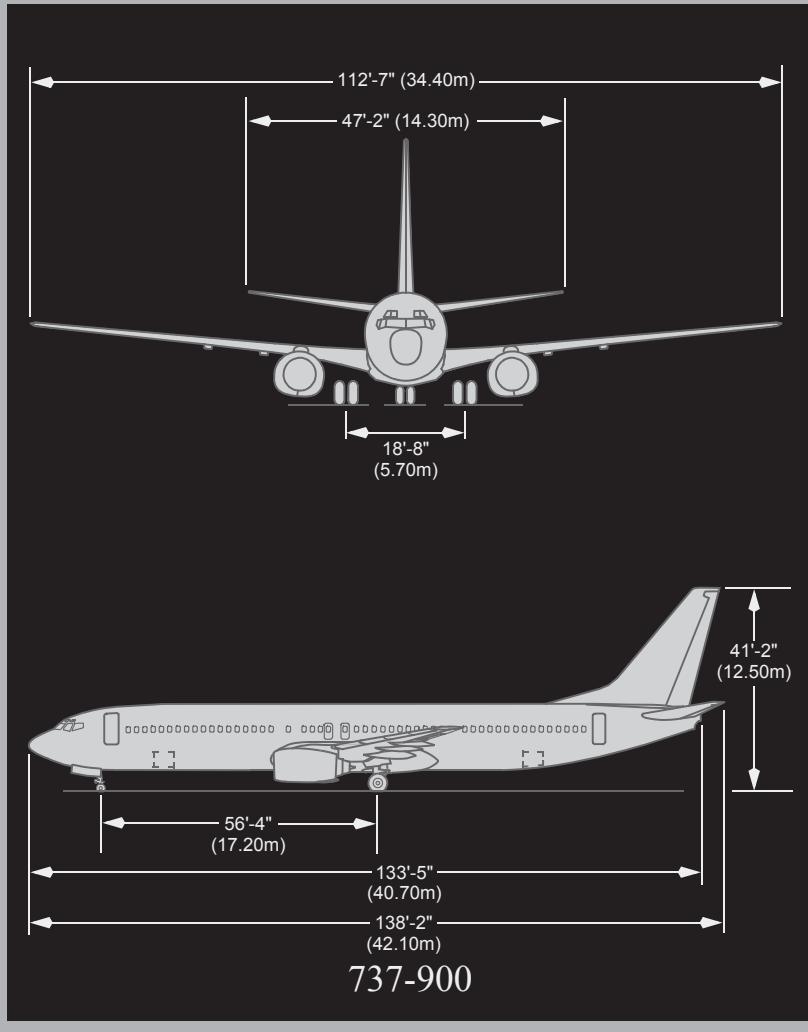
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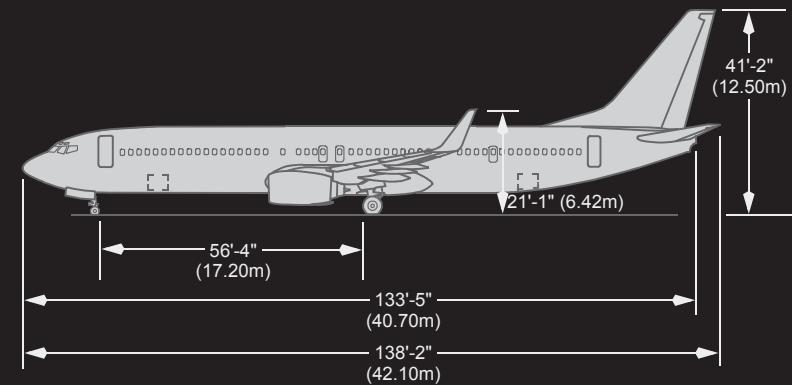
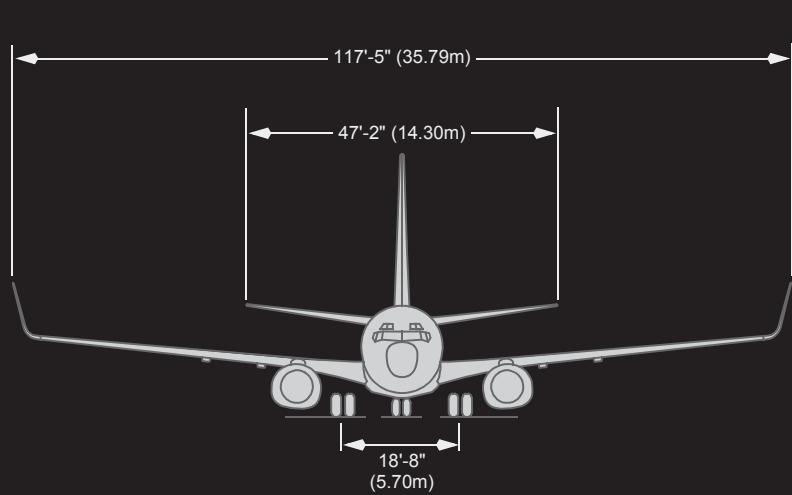
**Airplane General, Emergency  
Equipment, Doors, Windows  
Dimensions****Chapter 1**  
**Section 10****Principal Dimensions**





**737-800 With Winglets**





737-900ER With Winglets

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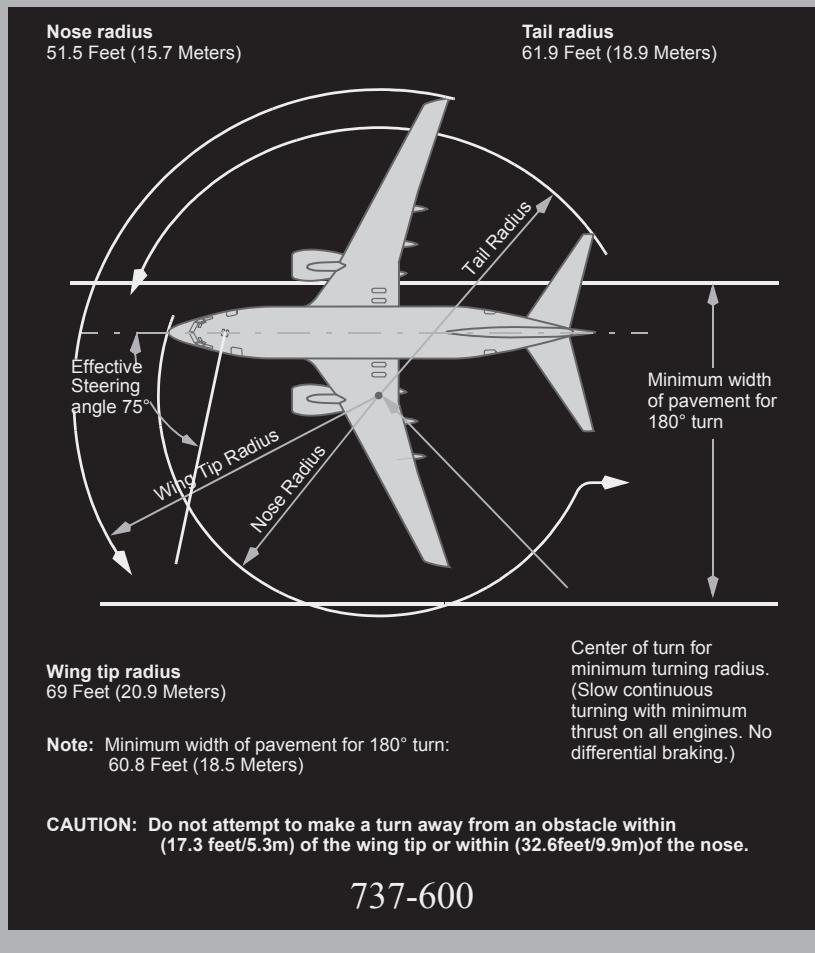
## Turning Radius

[Option: 737-600 without Winglets or 737-700 or 737-800 with Winglets]

The wingtip swings the largest arc while turning and determines the minimum obstruction clearance path. All other portions of the airplane structure remain within this arc.

[Option: 737-800 without Winglets or 737-900/737-900ER with winglets]

The tail swings the largest arc while turning and determines the minimum obstruction clearance path. All other portions of the airplane remain within this arc.

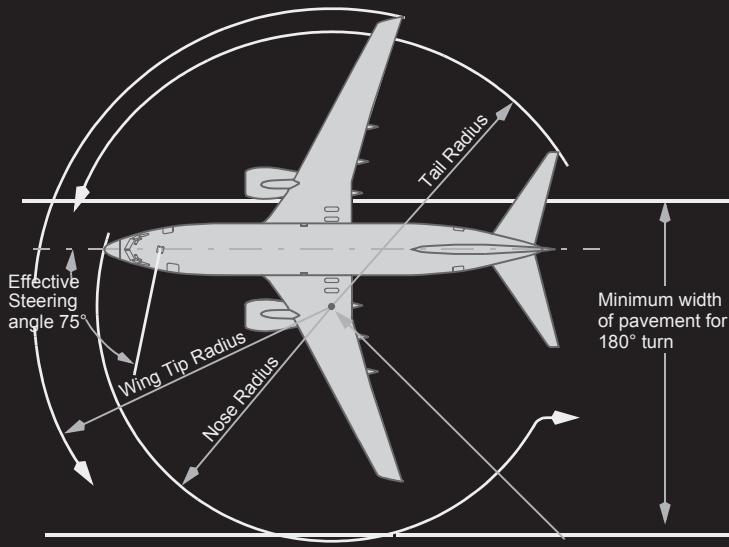


Nose radius

55.9 Feet (17.0 Meters)

Tail radius

65.5 Feet (20.0 Meters)



Wing tip radius

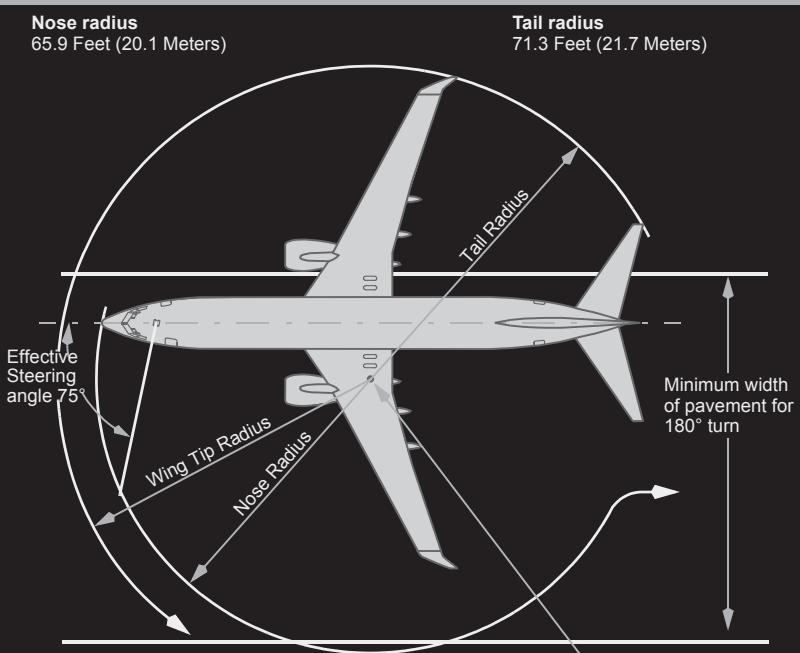
69.6 Feet (21.2 Meters)

**Note:** Minimum width of pavement for 180° turn:  
66.4 Feet (20.2 Meters)

Center of turn for  
minimum turning radius.  
(Slow continuous  
turning with minimum  
thrust on all engines. No  
differential braking.)

**CAUTION: Do not attempt to make a turn away from an obstacle within  
(17.2 feet/5.2m) of the wing tip or within (29.0feet/8.8m)of the nose.**

**737-700**



**Note:** Minimum width of pavement for 180° turn:  
 79.1 Feet (24.1 Meters)

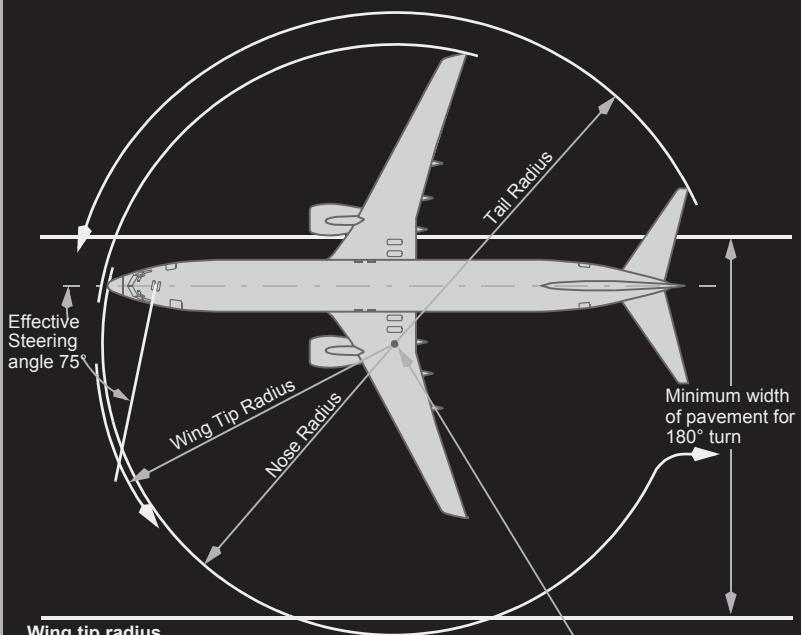
Center of turn for  
 minimum turning radius.  
 (Slow continuous  
 turning with minimum  
 thrust on all engines. No  
 differential braking.)

**CAUTION:** Do not attempt to make a turn away from an obstacle within  
 (17.8 feet/5.4m) of the wing tip or within (24.3feet/7.4m)of the nose.

## 737-800 With Winglets

Nose radius  
74.9 Feet (22.8 Meters)

Tail radius  
78.0 Feet (23.8 Meters)



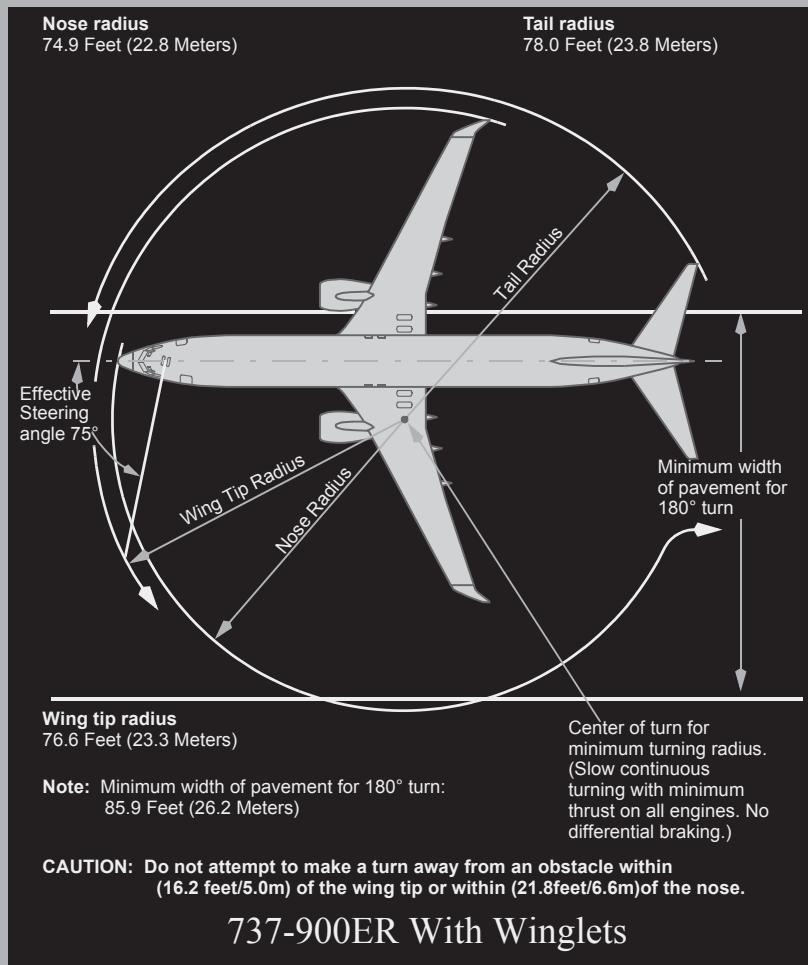
Wing tip radius  
73.5 Feet (22.4 Meters)

Center of turn for  
minimum turning radius.  
(Slow continuous  
turning with minimum  
thrust on all engines. No  
differential braking.)

**Note:** Minimum width of pavement for 180° turn:  
85.9 Feet (26.2 Meters)

**CAUTION:** Do not attempt to make a turn away from an obstacle within  
(19.5 feet/5.9m) of the wing tip or within (21.8feet/6.6m)of the nose.

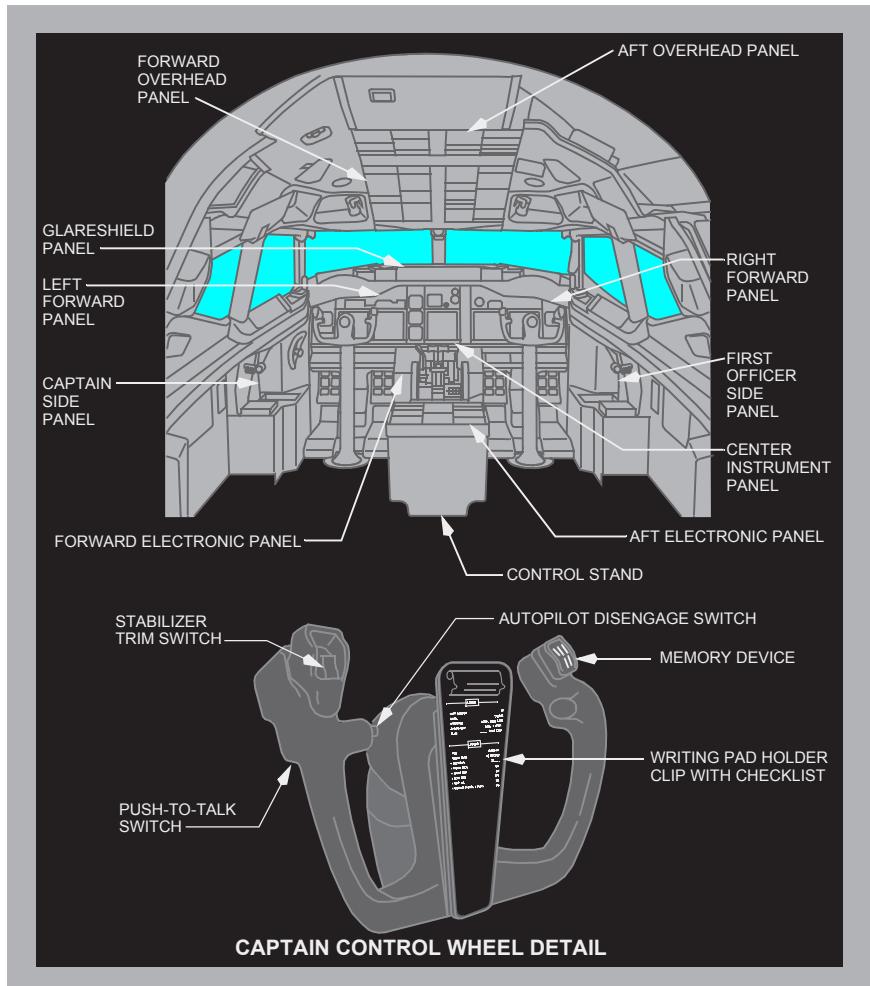
737-900



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Airplane General, Emergency Equipment, Doors, Windows  
Instrument PanelsChapter 1  
Section 20

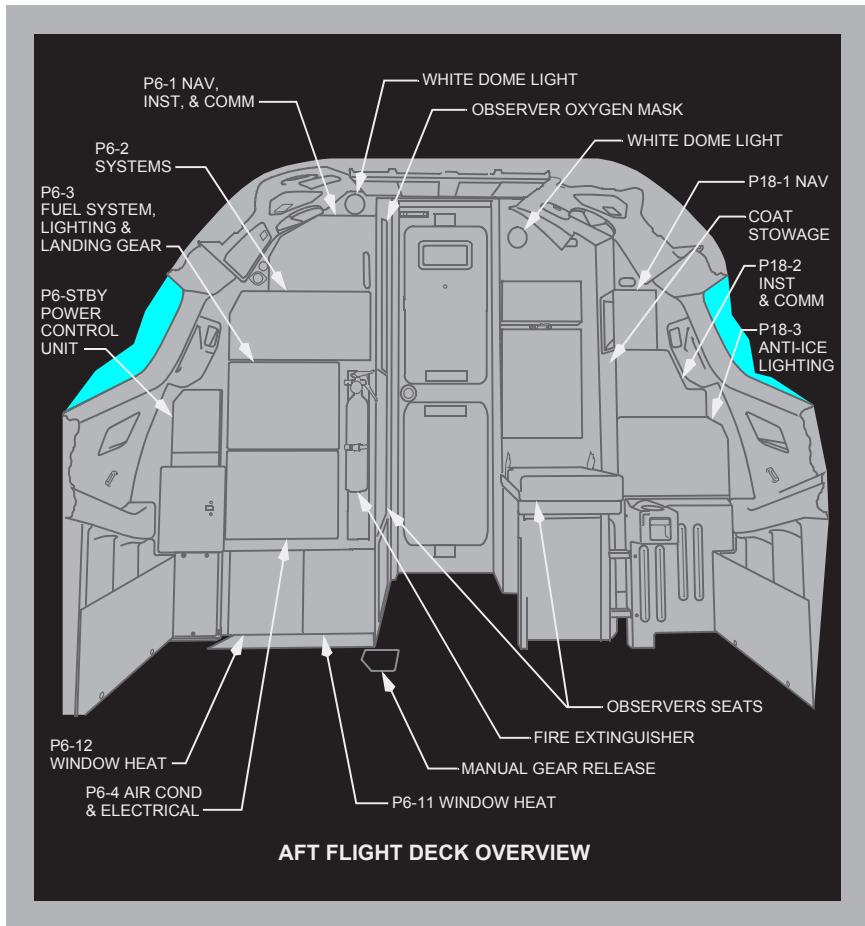
## Panel Arrangement



On the following pages, circled numbers refer to chapters where information on the item may be found.

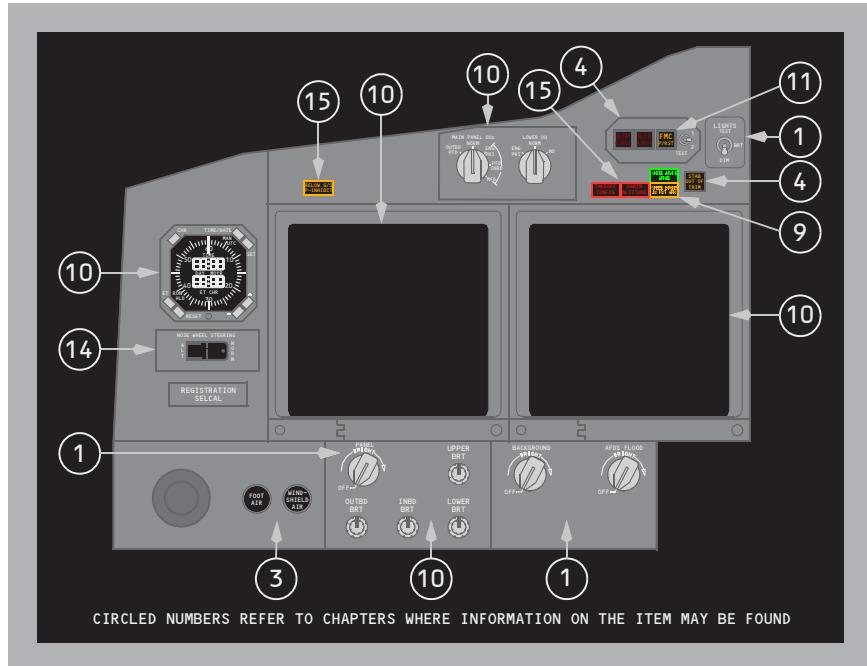
The panels, controls, and indicators shown in this chapter are representative of installed units and may not exactly match the latest configuration. Refer to the appropriate chapter system descriptions for current information.

## Aft Flight Deck Overview



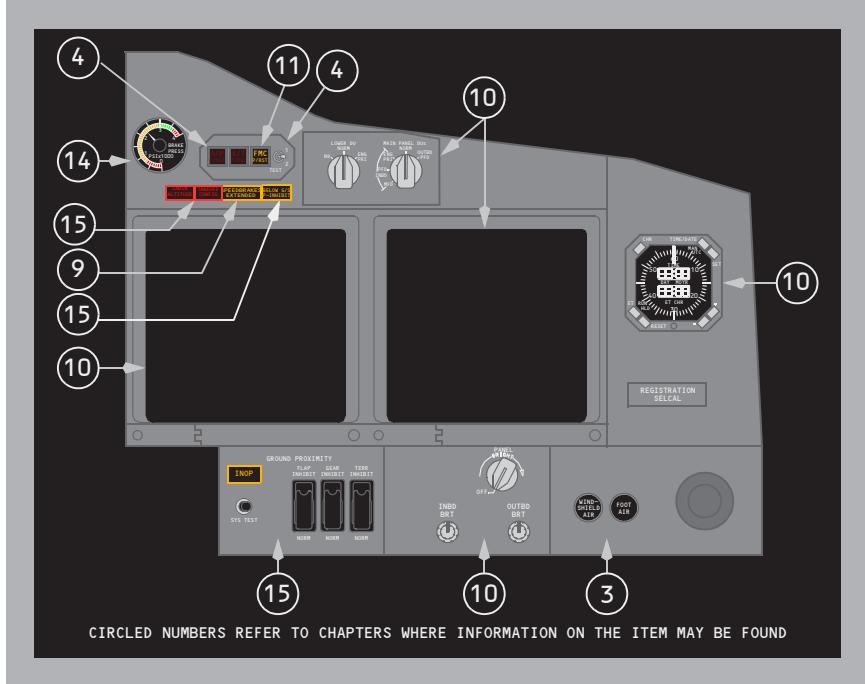
## Left Forward Panel

[Option - Typical]



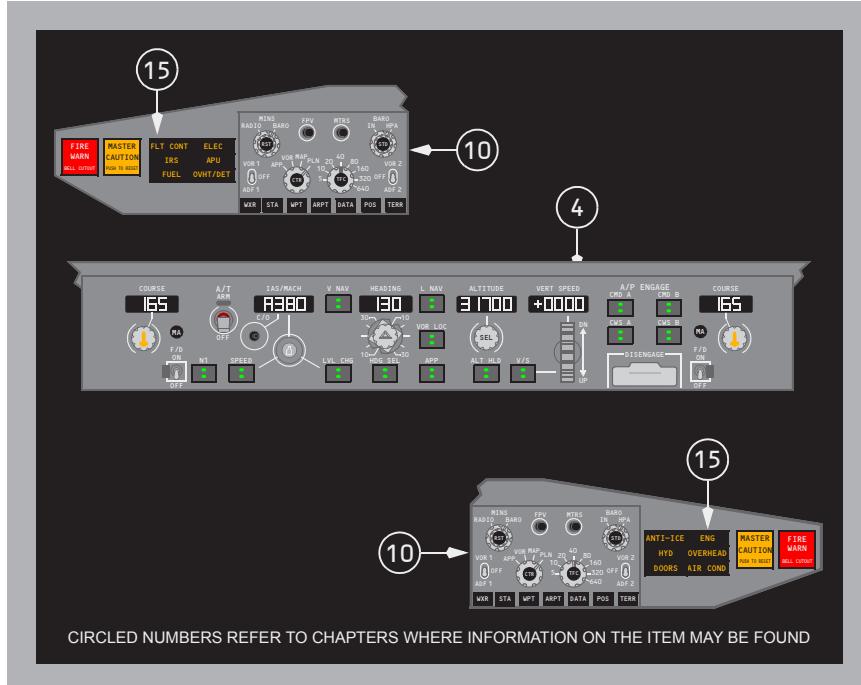
## Right Forward Panel

[Option - Typical]

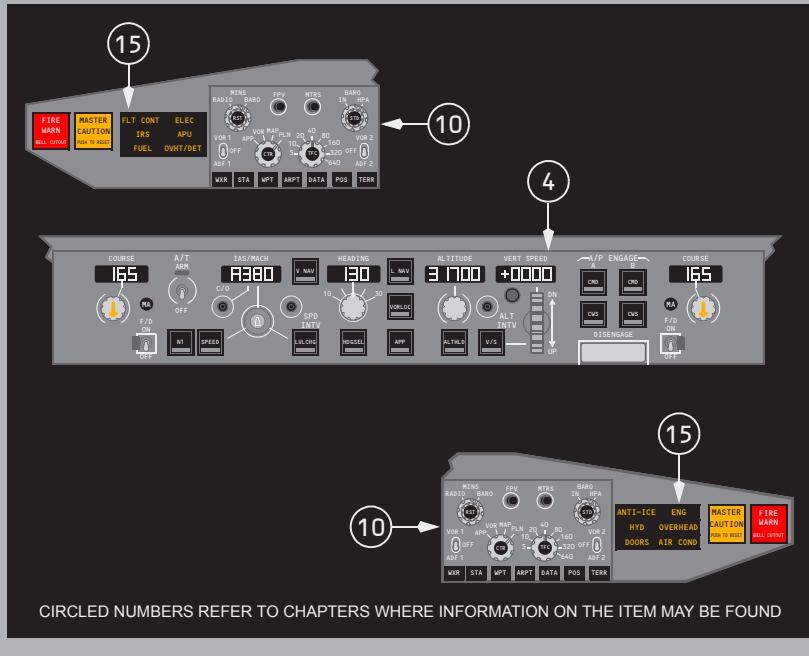


## Glareshield Panel

[Option - Honeywell mode control panel without speed and altitude intervention]

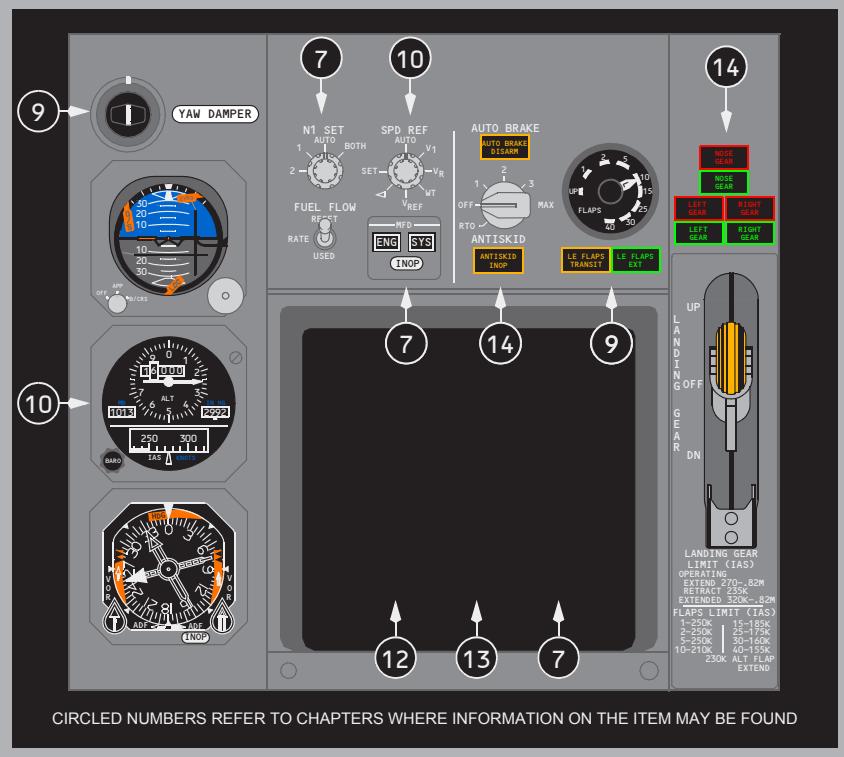


[Option - Collins mode control panel with speed and altitude intervention]

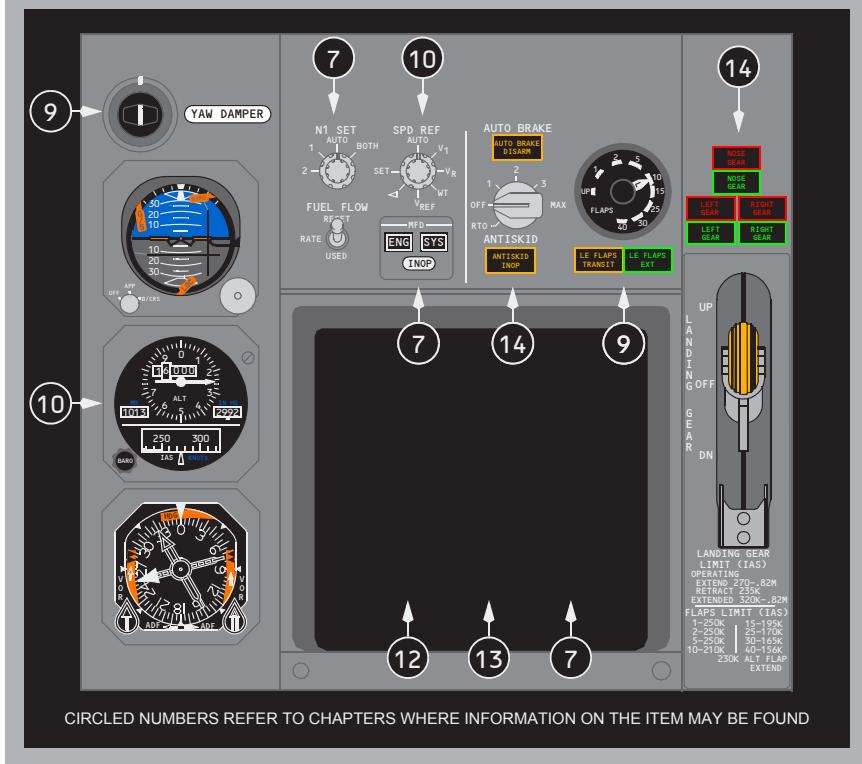


## Center Forward Panel

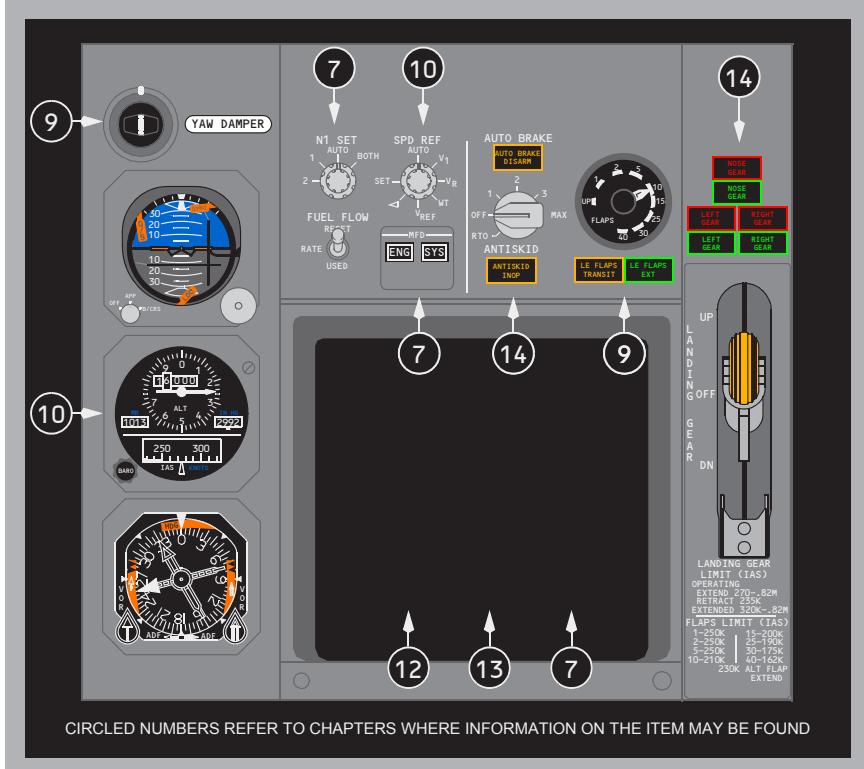
[Option - Typical 737-600 with EFIS/MAP displays]



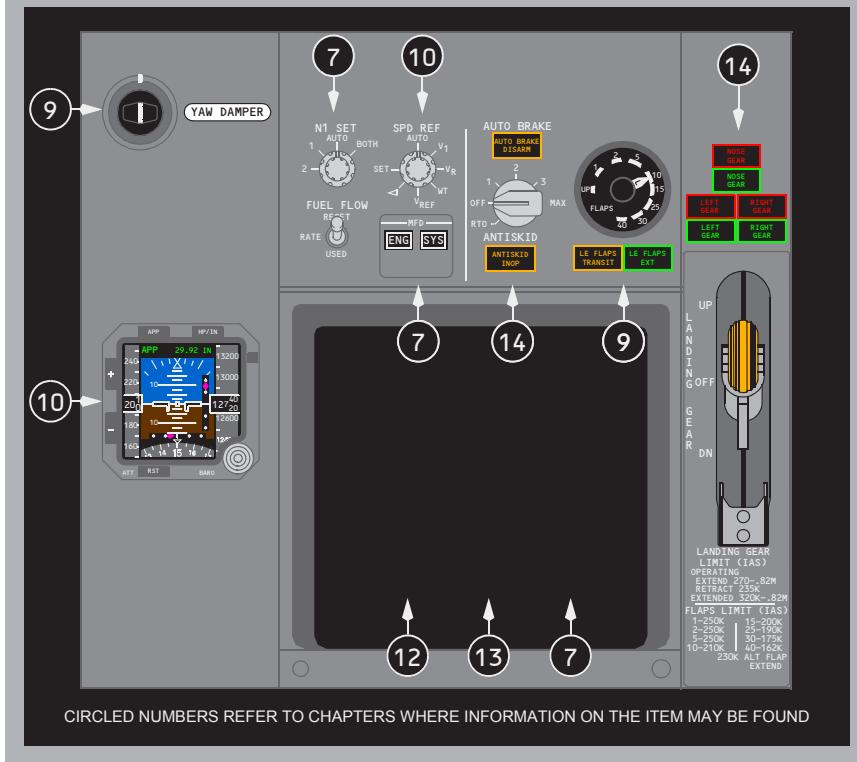
[Option - Typical 737-700 with EFIS/MAP displays]



[Option - Typical 737-800/900 with PFD/ND displays]



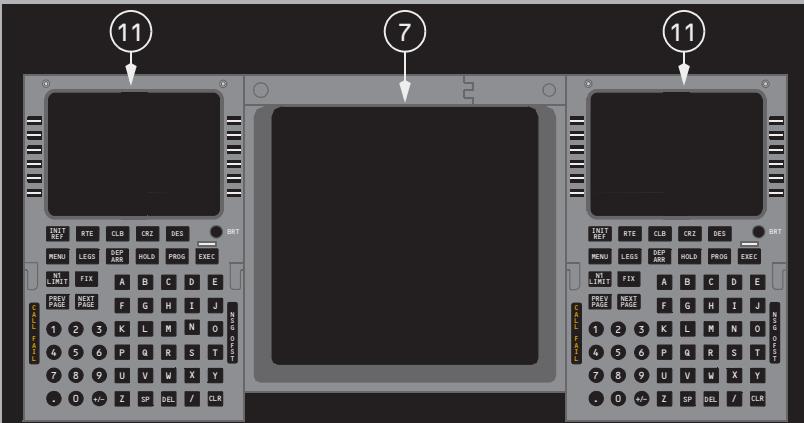
[Option - Typical 737-900 with Integrated Standby Flight Display and PFD/ND]



CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

## Forward Aisle Stand

[Option - Typical Liquid Crystal Display MCDU]

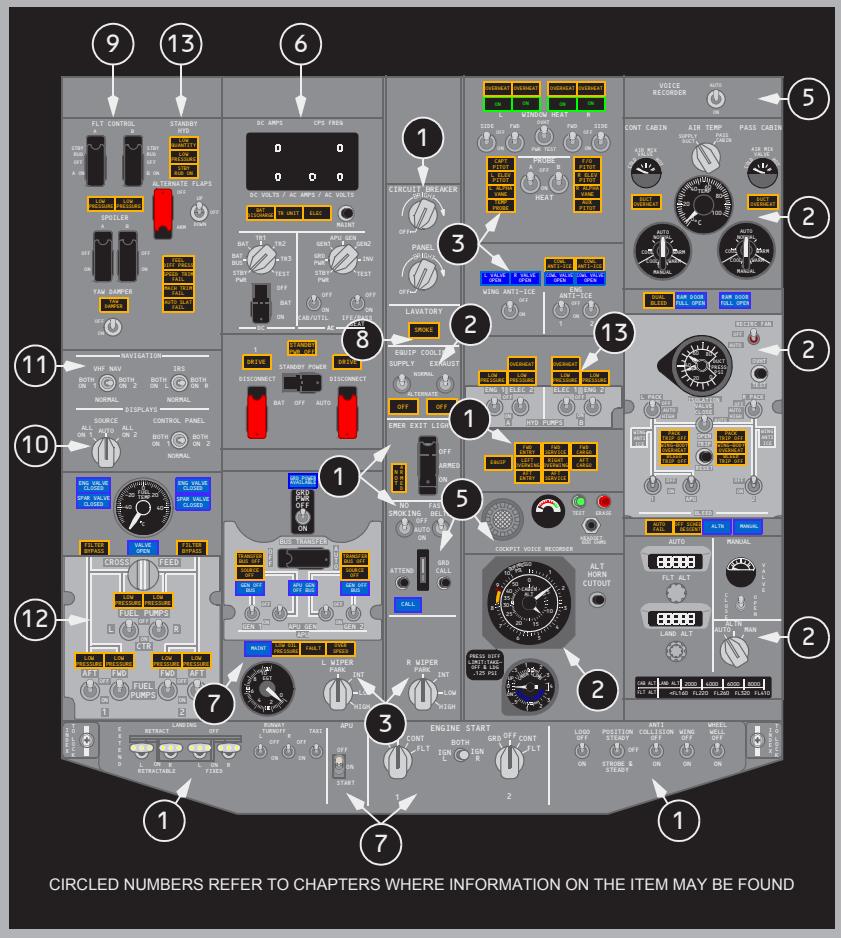


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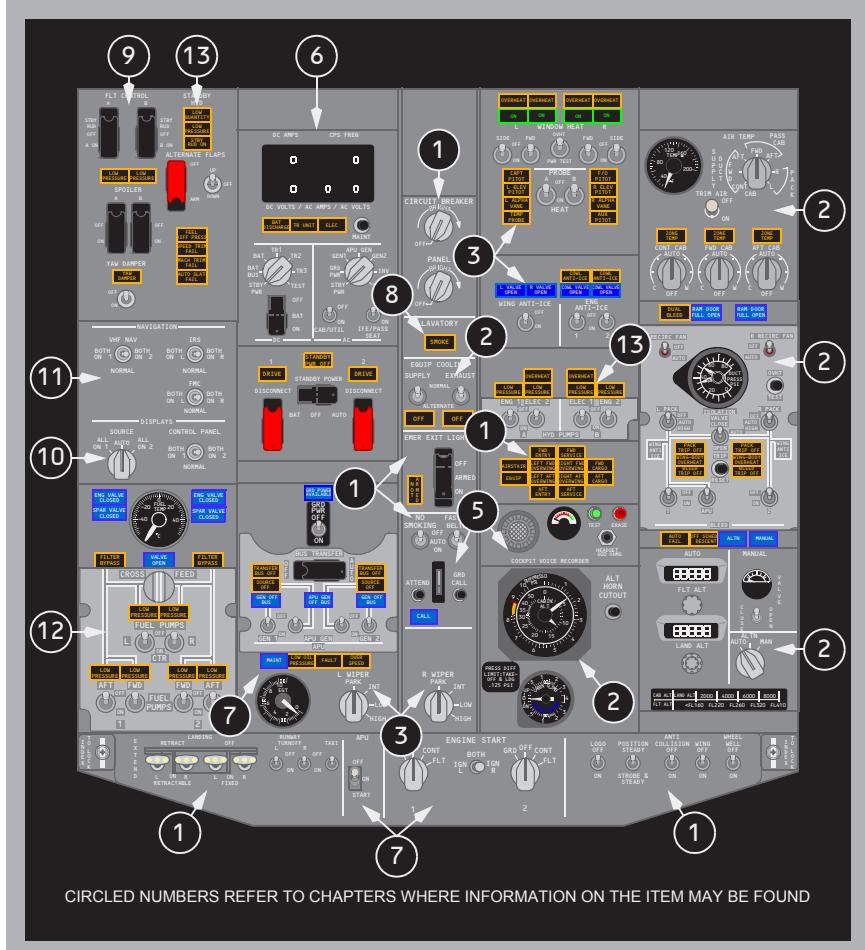
## 737-600/700 Forward Overhead Panel

[Option - Typical 737-600/700 Forward Overhead Panel]



## 737-800/900 Forward Overhead Panel

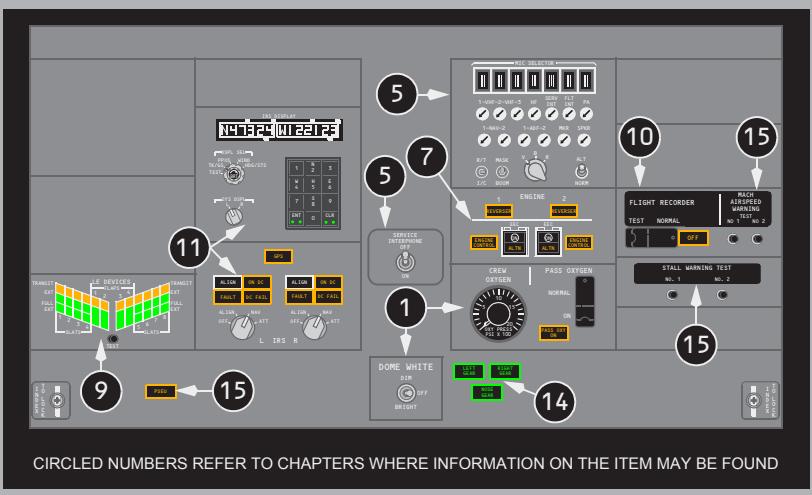
[Option - Typical 737-800/900 Forward Overhead Panel]



CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

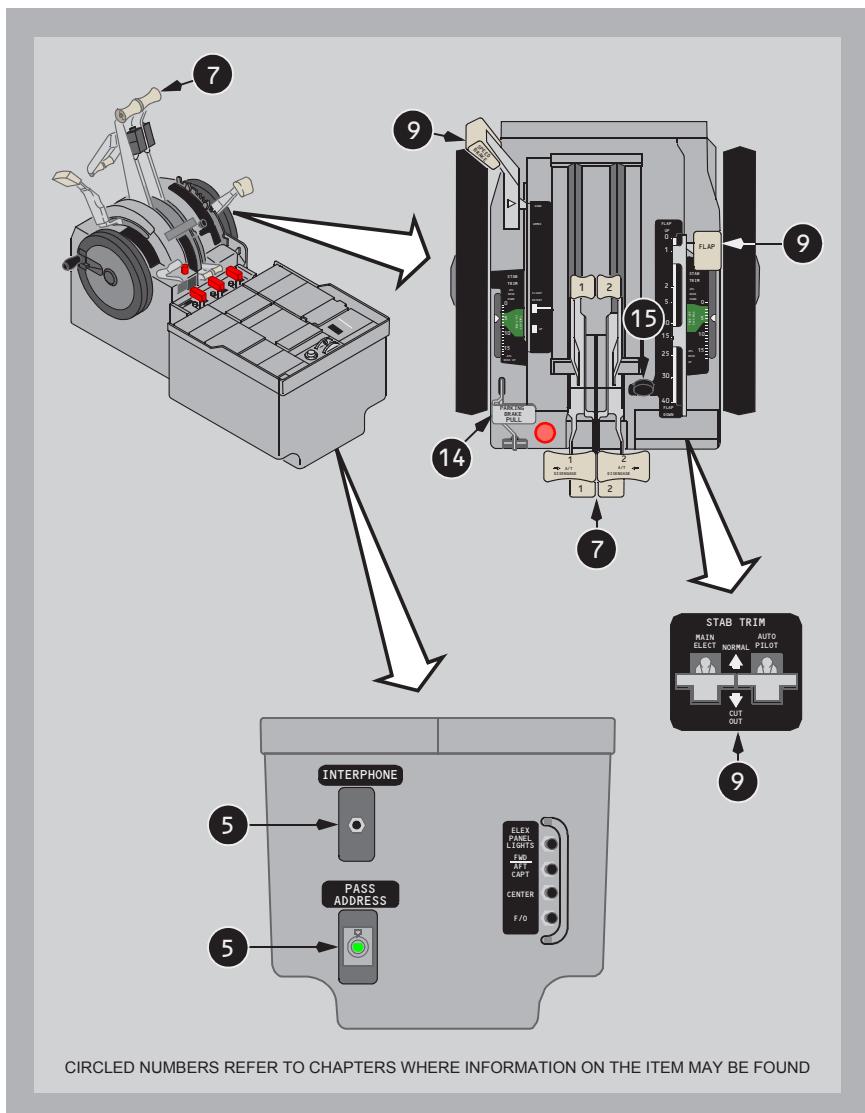
## Aft Overhead Panel

[Option - Typical Aft Overhead Panel]



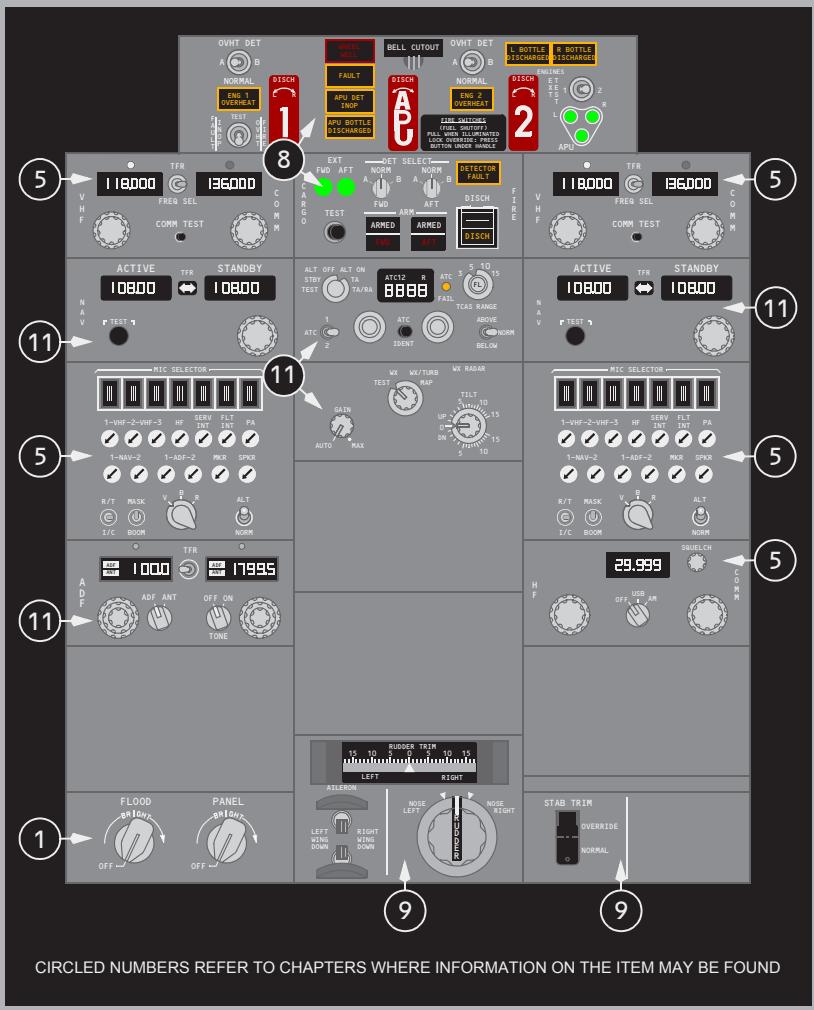
## Control Stand

[Option - Typical Control Stand]



## Aft Electronic Panel

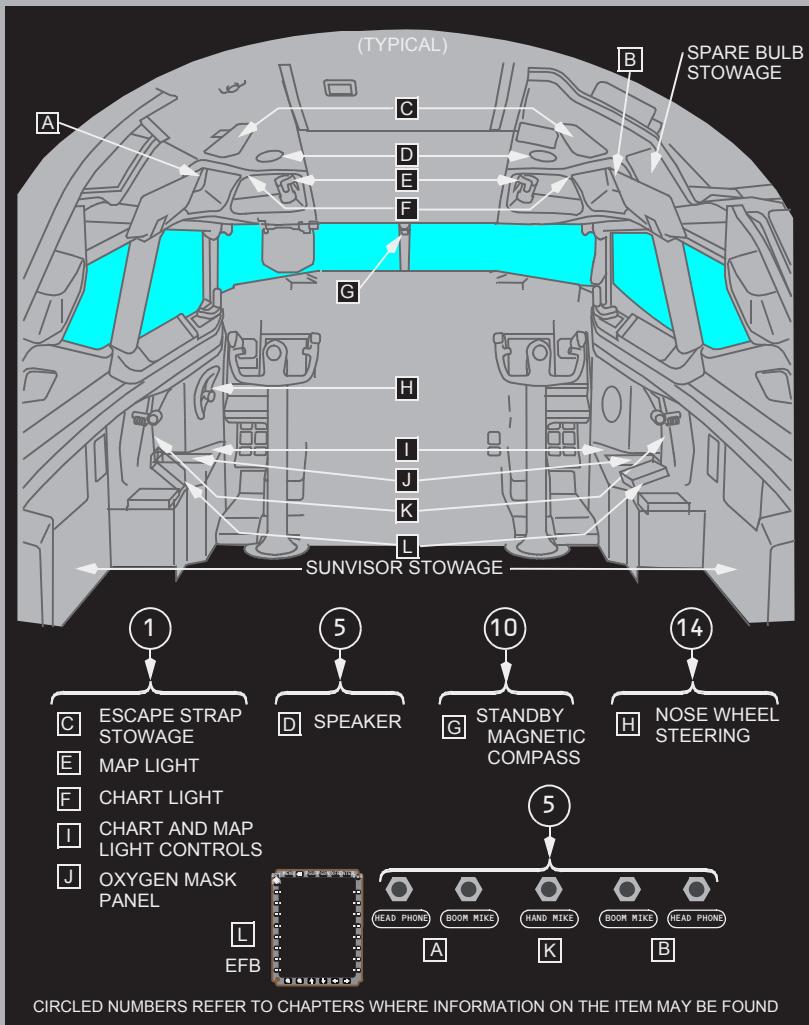
[Option - Typical Aft Electronic Panel]



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## Auxiliary Panels

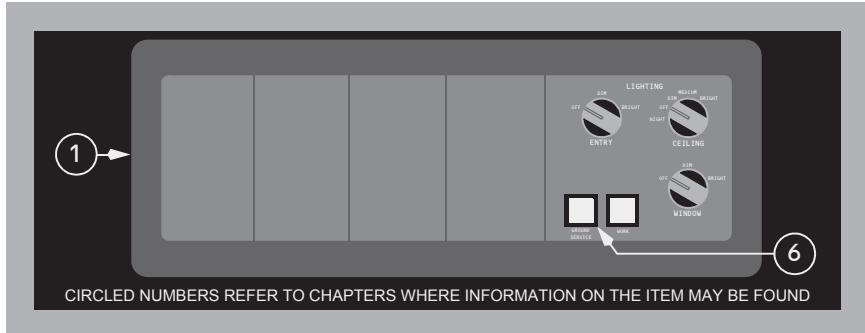
[Option - Typical with HUD and EFB installed]



## Attendant Panels

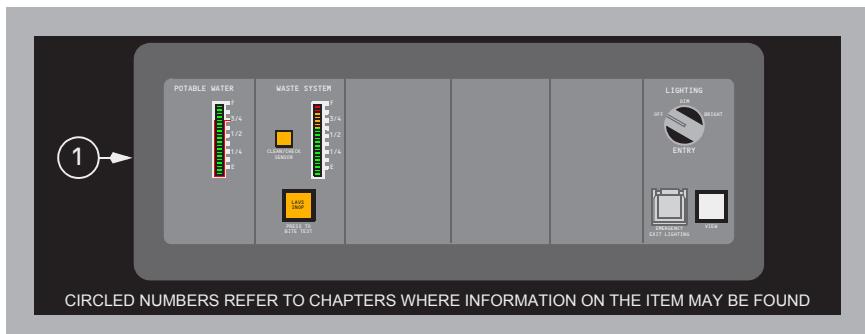
### Forward Attendant Panel

[Option - Typical]



### Aft Attendant Panel

[Option - Typical]



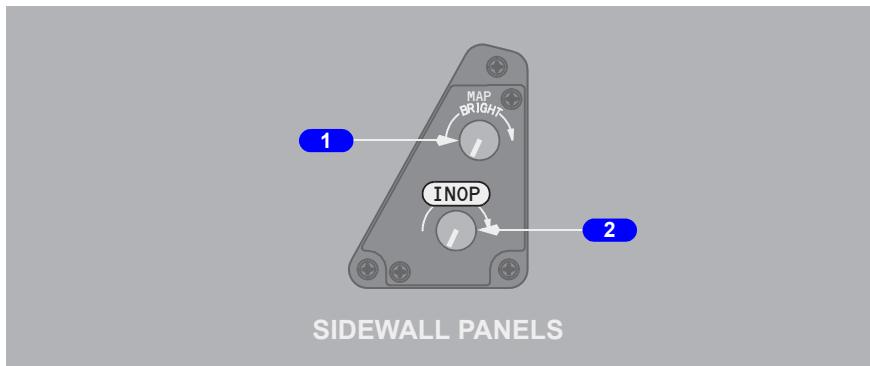
## Attendant Handset

[Option - Typical]



CIRCLED NUMBERS REFER TO CHAPTERS WHERE INFORMATION ON THE ITEM MAY BE FOUND

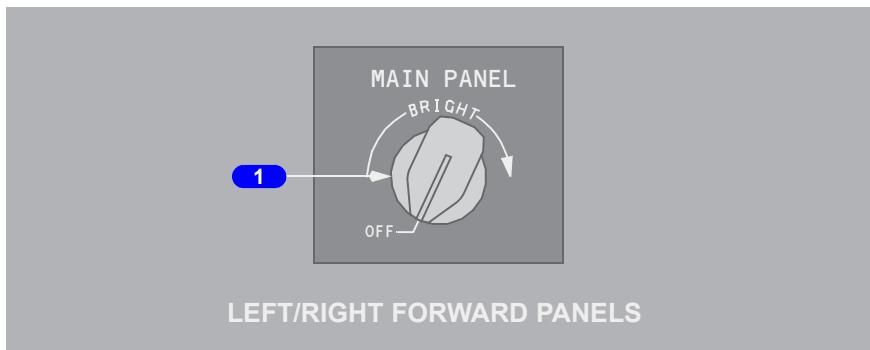
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**Airplane General, Emergency  
Equipment, Doors, Windows  
Controls and Indicators****Chapter 1**  
**Section 30****Flight Deck Lighting****Map and Chart Light Controls****1 MAP Light Control**

Rotate – adjusts brightness of Captain/First Officer map lights

**2 CHART Light Control**

Rotate – adjusts brightness of Captain/First Officer chart lights

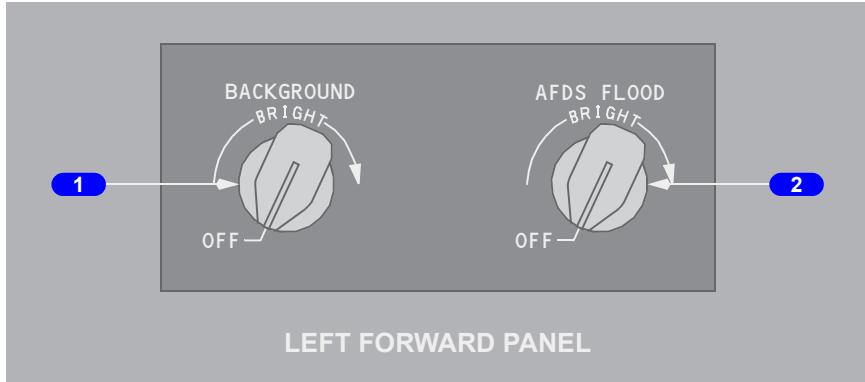
**Main Panel Lighting**

## 1 MAIN PANEL Light Control

Rotate –

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

## Background and AFDS Flood Light Control



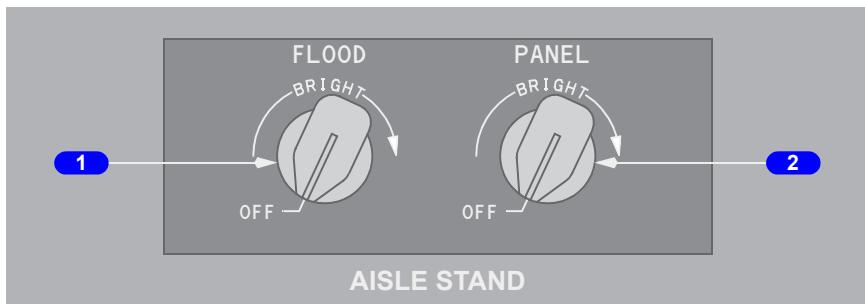
### 1 BACKGROUND Light Control

Rotate – controls incandescent lighting brightness for Captain's panel, First Officer's panel, and center panel.

### 2 AFDS FLOOD Light Control

Rotate – controls brightness of lighting directed at AFDS panel.

## Flood and Aft Electronics Lights Controls



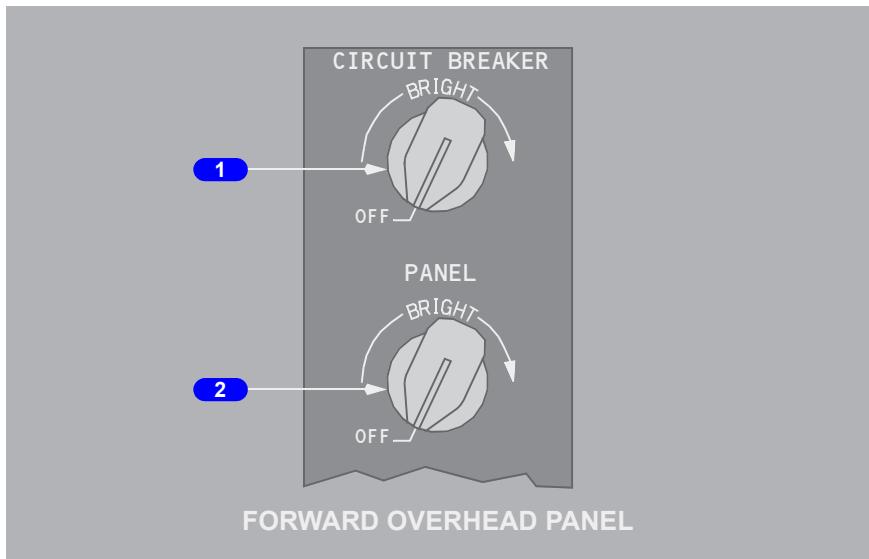
### 1 FLOOD Light Control

Rotate – controls overhead spotlight brightness directed at thrust lever quadrant.

## 2 PANEL Light Control

Rotate – controls forward and aft electronic control panel lights brightness.

### Overhead/Circuit Breaker Panel Light Controls



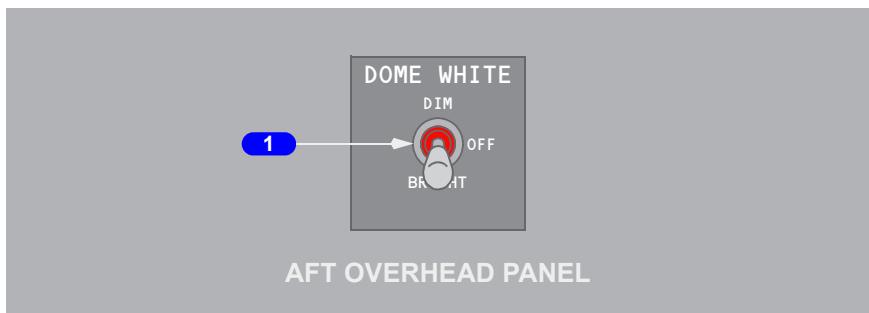
## 1 CIRCUIT BREAKER Light Control

Rotate – controls P-6 and P-18 circuit breaker panels light brightness.

## 2 PANEL Light Control

Rotate – controls forward and aft overhead panel lights brightness.

### Dome Light Control



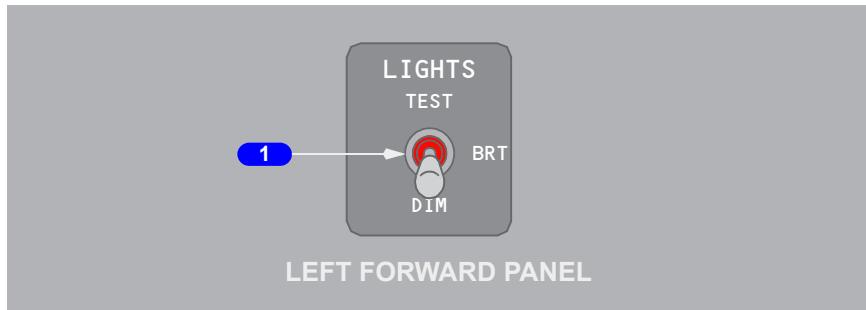
## 1 DOME Light Control

DIM – sets overhead dome lights to low brightness.

OFF – overhead dome lights are extinguished.

BRIGHT – sets overhead dome lights to full brightness.

## Master Lights Test and Dim Switch



### 1 Master LIGHTS TEST and DIM SWITCH

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

BRT (bright) – sets all system lights on forward and aft overhead panels, and some lights on Captain and First Officer panels to full brightness.

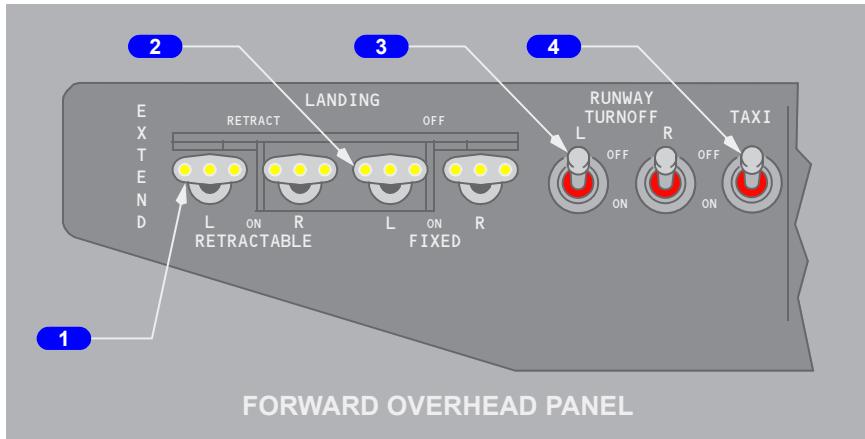
DIM – sets all system lights on forward and aft overhead panels, and some lights on Captain and First Officer panels to low brightness.

**Note:** Placing the Master Lights Test and Dim Switch in the TEST position will result in a master caution recall and any stored fault will cause the associated light to remain illuminated when the switch is released.

## Exterior Lighting

### Landing, Runway Turnoff and Taxi Lights

[Option - Typical]



#### **1 RETRACTABLE LANDING Light Switch**

RETRACT – retractable landing lights are retracted and extinguished

EXTEND – retractable landing lights are extended and extinguished

ON – retractable landing lights are extended and illuminated.

#### **2 FIXED LANDING Light Switch**

OFF – fixed landing lights are extinguished.

ON – fixed 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.

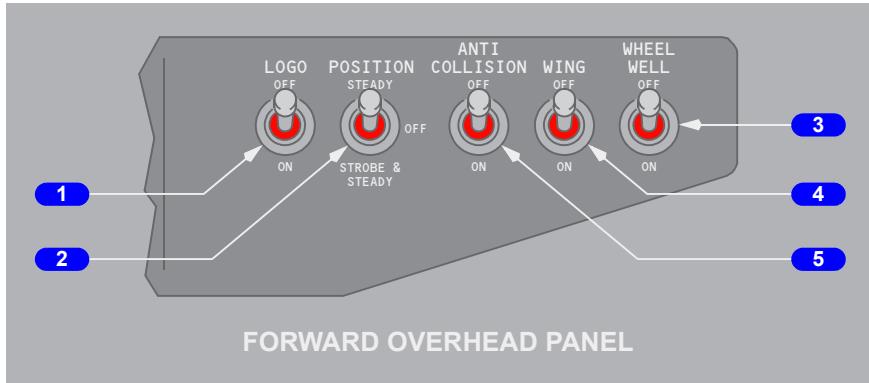
#### **4 TAXI Light Switch**

OFF – nose wheel well taxi light extinguished.

ON – nose wheel well taxi light illuminated.

## Miscellaneous Exterior Lights

[Option - Typical]



### **1 LOGO Light Switch**

OFF – logo lights on each side of vertical fin extinguished.

ON – logo lights illuminated.

### **2 POSITION Light Switch**

STROBE & STEADY – red and green wing-tip position lights, white trailing edge wing-tip lights and wing-tip and tail strobe lights illuminated.

OFF – red and green wing-tip position lights, white trailing edge wing-tip lights and wing-tip and tail strobe lights extinguished.

STEADY – red and green wing-tip position lights and white trailing edge wing-tip lights illuminated.

### **3 WHEEL WELL Light Switch**

OFF – three wheel well lights extinguished.

ON – wheel well lights illuminated.

### **4 WING Illumination Switch**

OFF – wing leading edge lights on fuselage forward of wing extinguished.

ON – wing leading edge lights illuminated.

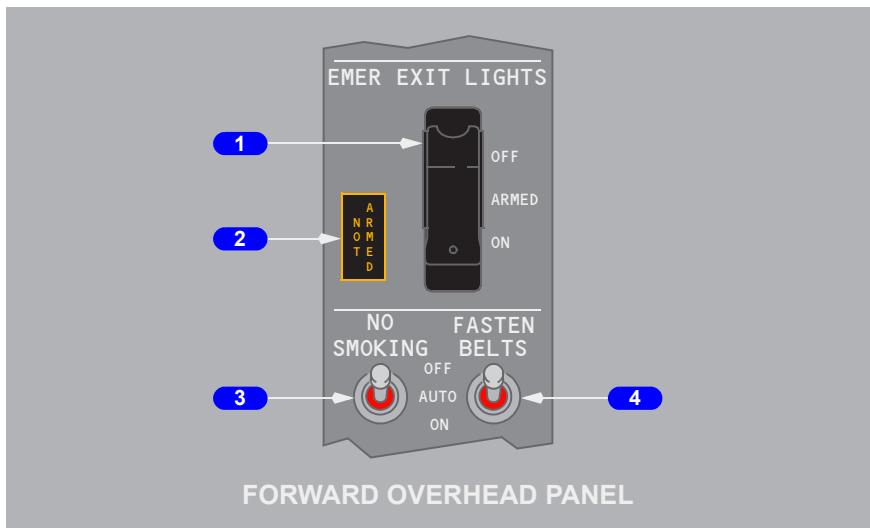
### **5 ANTI-COLLISION Light Switch**

OFF – red strobe/rotating beacon lights on upper and lower fuselage extinguished.

ON – red strobe/rotating beacon lights illuminated.

## Emergency Lighting and Passenger Signs

### Flight Deck



#### **1** Emergency (EMER) EXIT LIGHTS Switch

OFF – prevents emergency lights system operation if airplane electrical power fails or is turned off.

ARMED – (guarded position) 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 (EMER) EXIT LIGHTS NOT ARMED Light

Illuminated (amber) – EMER EXIT LIGHTS switch not in ARMED position.

#### **3** NO SMOKING 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.

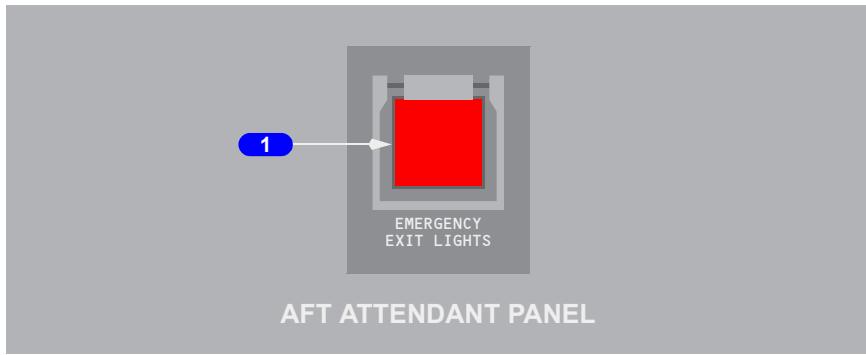
#### 4 FASTEN BELTS Switch

OFF – the FASTEN SEAT BELTS and RETURN TO SEAT signs are not illuminated.

AUTO – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated or extinguished automatically with reference to airplane configuration (refer to the Lighting System Description section).

ON – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated.

### Passenger Cabin



#### 1 Passenger Cabin Emergency Lights Switch (guarded)

On – illuminates all emergency lights and bypasses flight deck control.

### Emergency Locator Transmitter



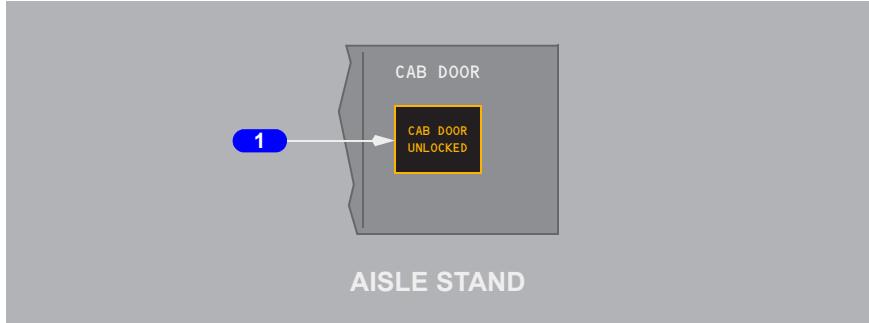
#### 1 Emergency Locator Transmitter Light

Illuminated (amber) – ELT has been activated and is simultaneously transmitting on 121.5, 243.0 and 406.0 mhz.

**2 Emergency Locator Transmitter Switch**

ARM – (guarded position) ELT transmits automatically when it reaches its preset G-Load limit.

ON – manually activates the ELT.

**Doors****Cabin Door****[Original Flight Deck Door]****1 Cabin Door (CAB DOOR) Lock Switch**

Illuminated (amber) – cabin door is unlocked.

Push – with DC power available, locks cabin door

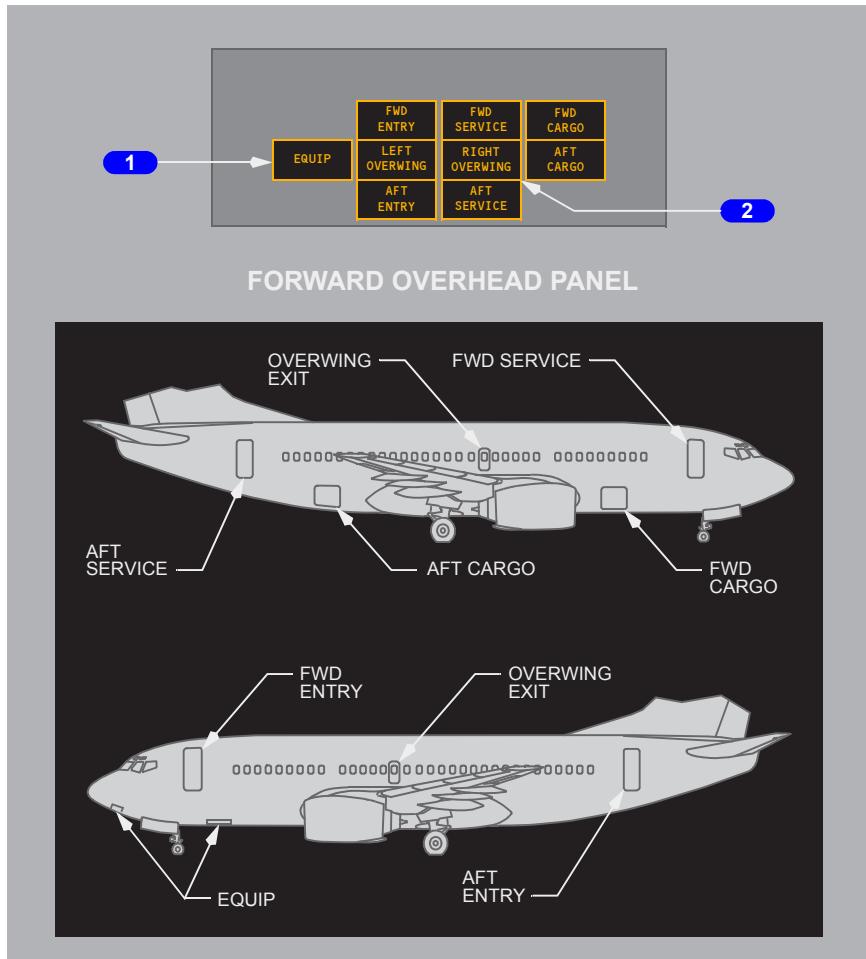
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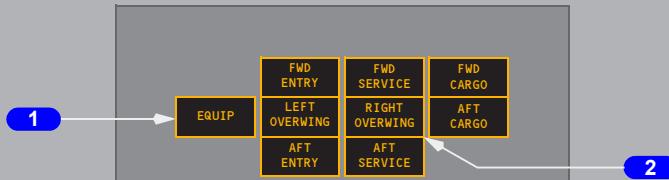
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## Exterior Door Annunciator Lights

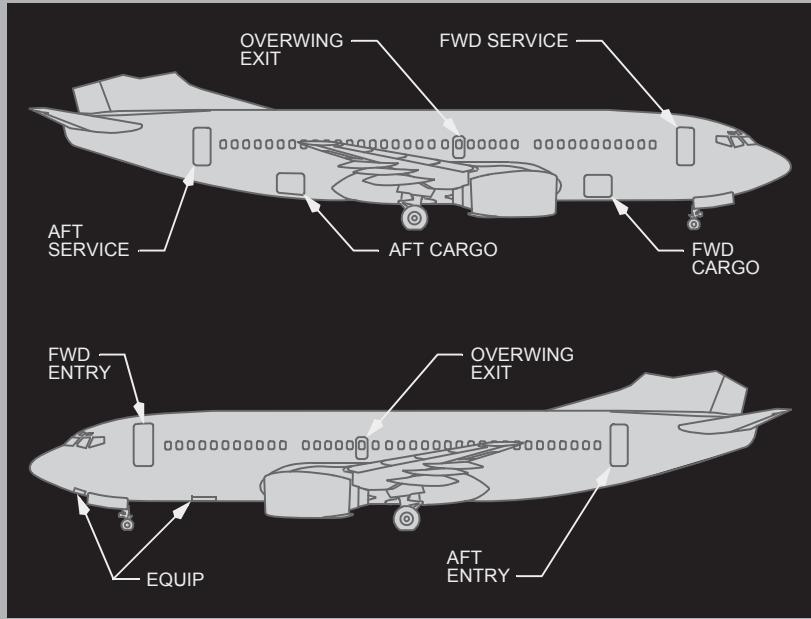
[Option - Typical 737-600 without airstairs]



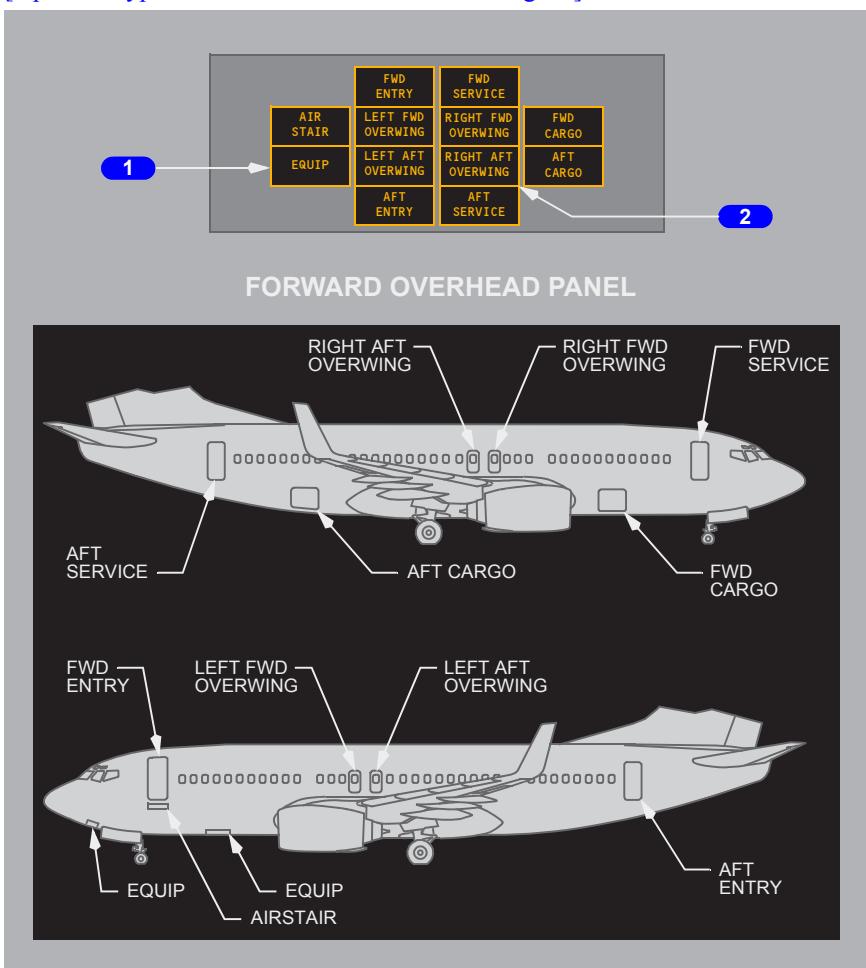
[Option - Typical 737-700 without airstairs]



### FORWARD OVERHEAD PANEL



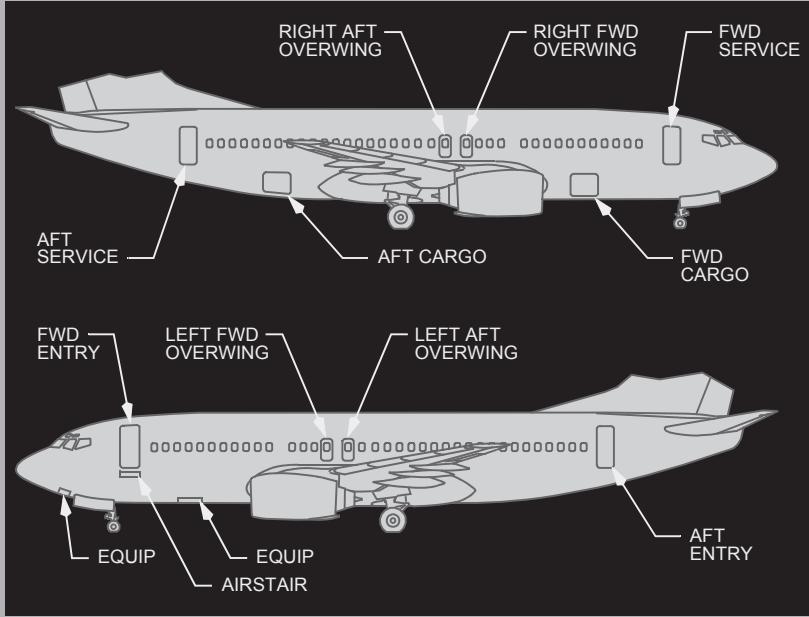
[Option - Typical 737-800 with airstairs and winglets]



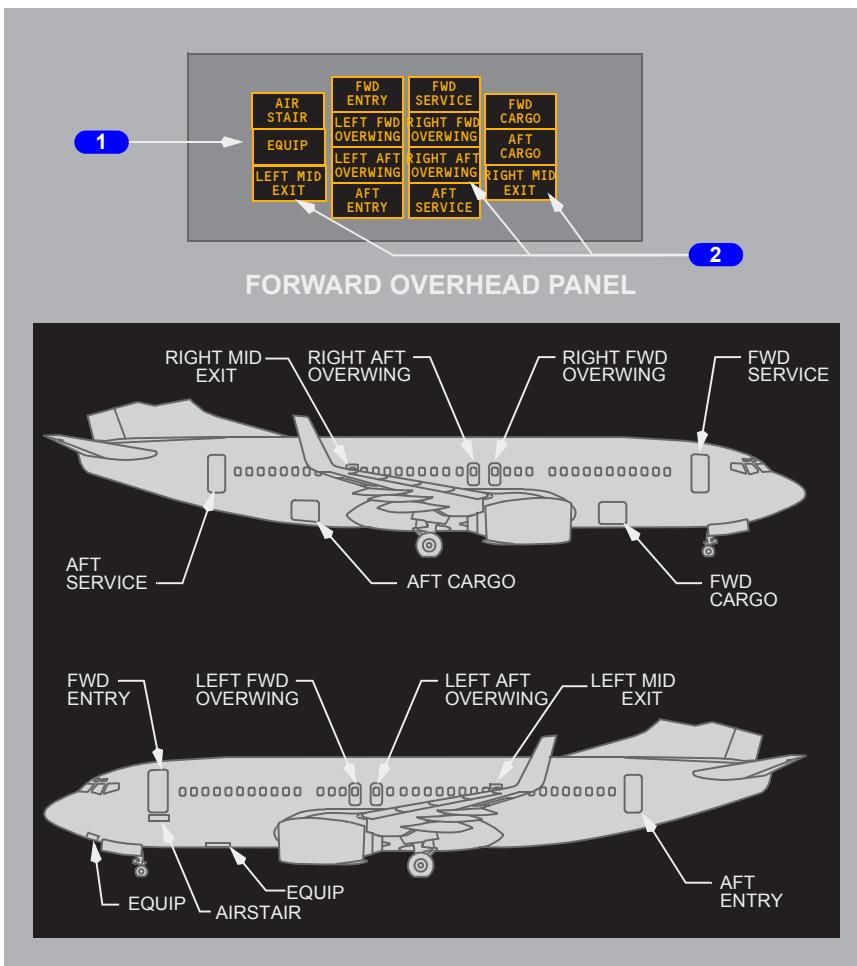
[Option - Typical 737-900 with airstairs]



### FORWARD OVERHEAD PANEL



[Option - Typical 737-900ER with airstairs]



### **1** Exterior Door Annunciations

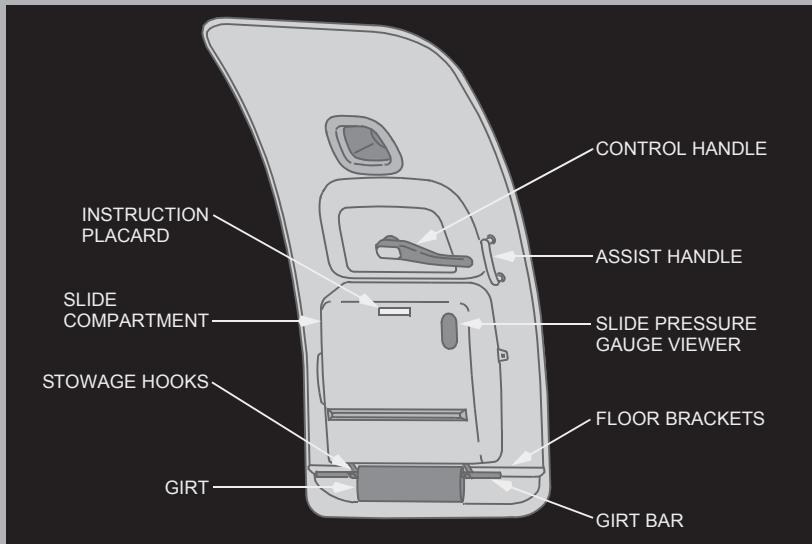
Illuminated (amber) – related door is not closed and locked.

### **2** Overwing Exit Annunciations

Illuminated (amber) –

- related overwing exit is not closed and locked
- related flight lock failed to engage when commanded locked.

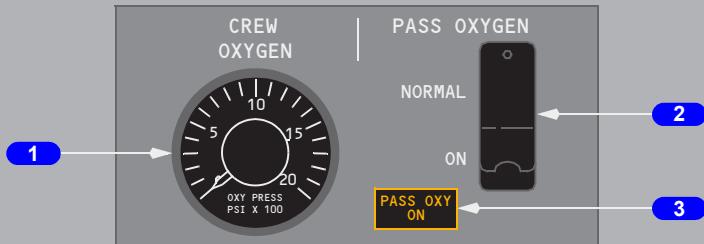
## Passenger Entry/Galley Service Doors



**PASSENGER CABIN**

## Oxygen

### Oxygen Panel



#### **1 Flight CREW OXYGEN Pressure Indicator**

Indicates pressure at the crew oxygen cylinder.

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

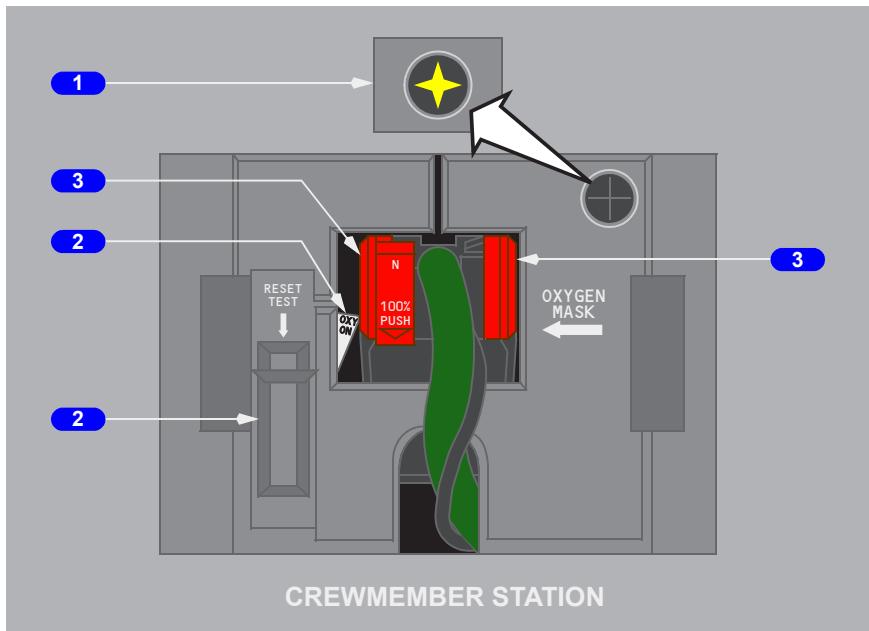
**NORMAL** – (guarded position) passenger masks drop and passenger oxygen system activated automatically if cabin altitude climbs to 14,000 feet

ON – activates system and drops masks if automatic function fails.

### **3 Passenger Oxygen On Light**

Illuminated (amber) – passenger oxygen system is operating and masks have dropped.

## Oxygen Mask Panel



### **1 Oxygen Flow Indicator**

Indicates a yellow cross when oxygen is flowing.

### **2 RESET/TEST Switch**

Push –

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

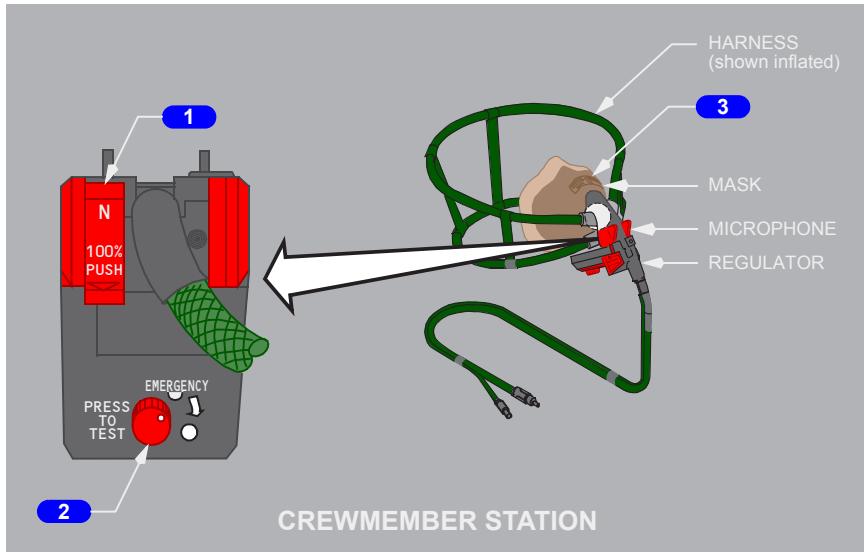
### **3 Oxygen Mask Release Lever**

Squeeze and pull up –

- releases mask from stowage box
- releases OXY ON flag when stowage box doors open

- initiates oxygen flow
- inflates mask harness when inflation lever is squeezed
- flow indicator shows a yellow cross momentarily as harness inflates.

## Oxygen Mask and Regulator



### 1 NORMAL/100% Switch

N (normal) – supplies air/oxygen mixture on demand (ratio depends on cabin altitude).

100% – supplies 100% oxygen on demand.

### 2 Oxygen Mask EMERGENCY/Test Selector (rotary)

Normal (non-emergency) position - supplies air/oxygen mixture or 100% oxygen on demand, depending upon the position of the Normal/100% switch.

Automatically supplies 100% oxygen under positive pressure when cabin altitude is above a preset value.

EMERGENCY position (rotate in the direction of the arrow) - supplies 100% oxygen under positive pressure at all cabin altitudes (protects against smoke and harmful vapors).

PRESS TO TEST – tests positive pressure supply to regulator.

### 3 Smoke Vent Valve Selector

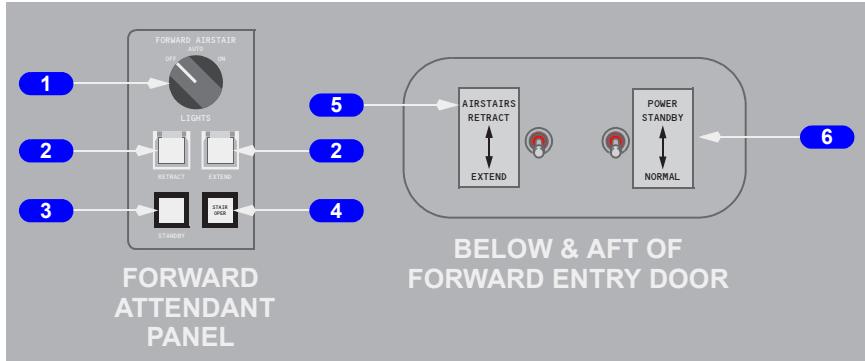
Up - vent valve closed.

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

## Forward Airstairs

### Interior and Exterior Controls

[Option - airstair]



#### 1 LIGHTS Switch

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

ON – illuminates the airstair tread lights.

#### 2 Normal Control Switches

**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 STANDBY Control Switch

**Note:** Switch must be held in while using EXTEND or RETRACT. Battery switch must be ON.

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.**

#### 4 STAIRS Operating (OPER) Light

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

#### 5 AIRSTAIRS Control Switch

EXTEND – extends the airstair.

RETRACT – retracts the airstair.

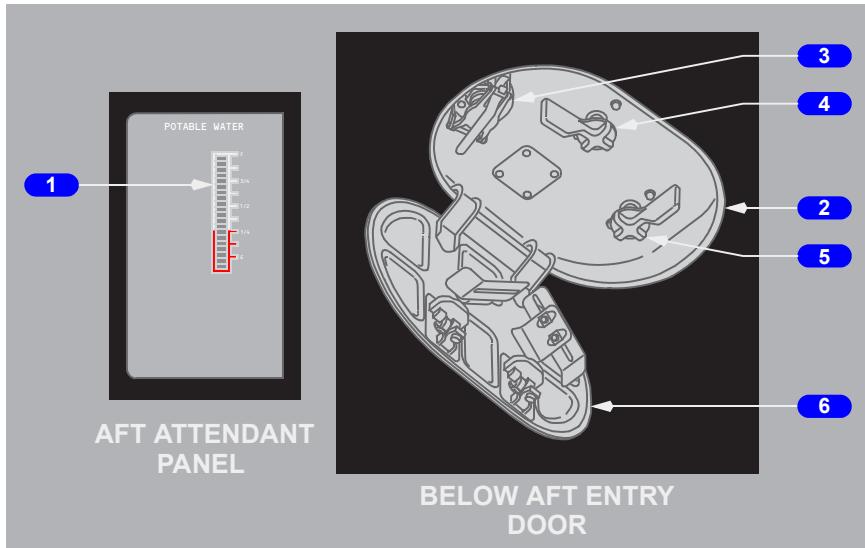
#### 6 POWER Switch

(spring-loaded to NORMAL)

NORMAL – requires both AC and DC power.

STANDBY – requires DC power.

### Water System Controls



#### 1 Water Quantity Indicator

Indicates quantity of water in reservoir.

#### 2 Water System Service Panel

#### 3 Fill Fitting

Used to fill tank.

#### **4 Fill and Overflow Valve Handle**

Open - enables filling or gravity draining water tank.

Closed - normal position.

#### **5 Tank Drain Valve Handle**

Open - drains water from tank.

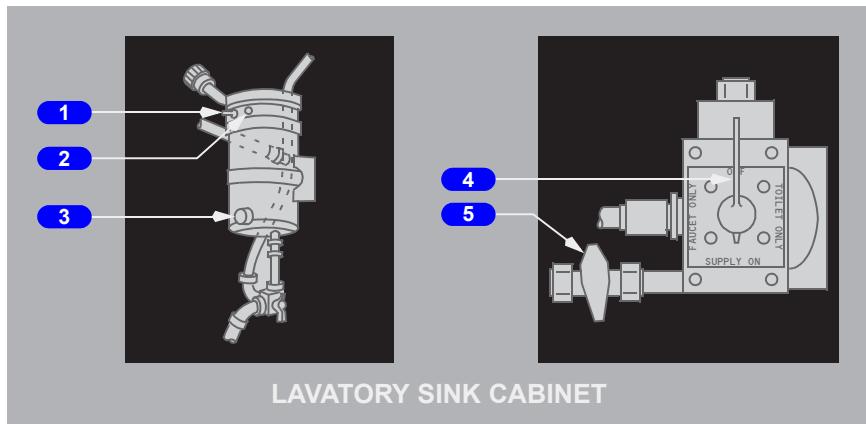
Closed - normal position.

#### **6 Access Panel**

Cannot be closed unless the Fill and Overflow Valve and Tank Drain Valve Handles are in the closed position.

### Lavatory Controls

[Option - Early Airplanes]



#### **1 Water Heater Switch**

On – activates the water heater.

#### **2 Water Heater Light**

Illuminated - heater operating.

#### **3 Temperature Control Switch**

#### **4 Water Supply Selector Valve**

SUPPLY ON – provides water to lavatory sink faucets and water heater (normal position).

FAUCET ONLY – water is supplied to faucet only.

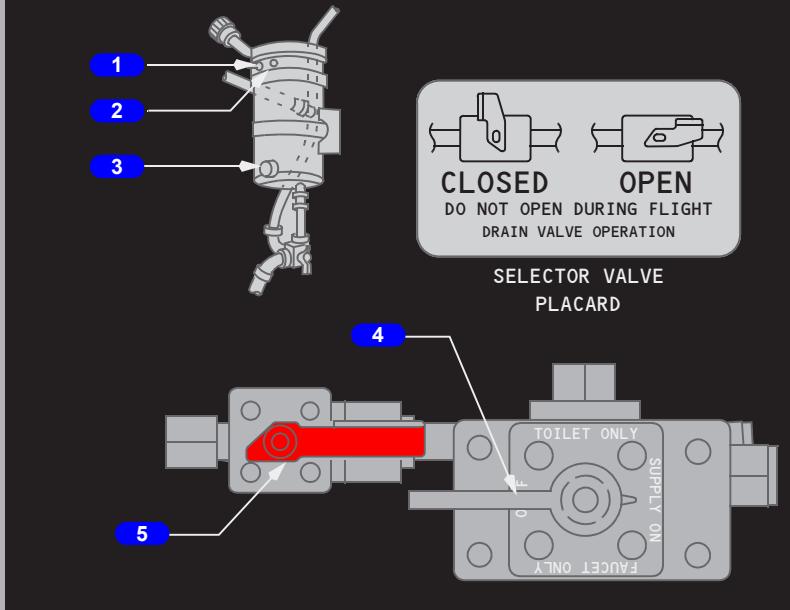
OFF – shuts off water to lavatory sink faucets and water heater.

TOILET ONLY – water is supplied to toilet only.

## 5 Drain Valve

Located in the forward lavatory.

[Newer airplanes]



## 1 Water Heater Switch

On – activates the water heater.

## 2 Water Heater Light

Illuminated - heater operating.

---

**3 Temperature Control Switch****4 Water Supply Selector Valve**

Each lavatory has a Water Supply Selector Valve. The Water Supply Selector Valve has four positions, and is located in the cabinet below the sink.

SUPPLY ON – Normal operating position. When the water system is depressurized, all lavatories except “A” will drain. In this lavatory, the drain valve must be opened to drain the lavatory

FAUCET ONLY – In this position, water is supplied to the faucet, but not to the toilet

TOILET ONLY – In this position, water is supplied to the toilet, but not to the faucet

OFF – No water is supplied to the lavatory.

**5 Drain Valve Handle (red)**

Located in the forward lavatory only.

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# Airplane General, Emergency Equipment, Doors, Windows Systems Description

## Chapter 1 Section 40

### Introduction

#### [Option - airstairs installed]

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.

### Retractable Landing Lights

Retractable landing lights are installed in the lower airplane fuselage. The lights are designed to extend and shine forward, parallel to the waterline of the airplane. The lights may be extended at any speed.

### Fixed Landing Lights

Two fixed 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.

## Logo Lights

Logo lights are located on the top of each horizontal stabilizer surface to point light on both sides of the vertical stabilizer.

## Position Lights

### [Option - non-winglet airplanes]

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

### [Option - winglets]

The navigation lights are the standard red (left forward, at the base of the winglet), green (right forward, at the base of the winglet), and white (trailing edge, at the base of both winglets).

## Strobe Lights

### [Option - no winglets]

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

### [Option - winglets]

Three high intensity white strobe lights are installed on the left forward winglet, right forward winglet, 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

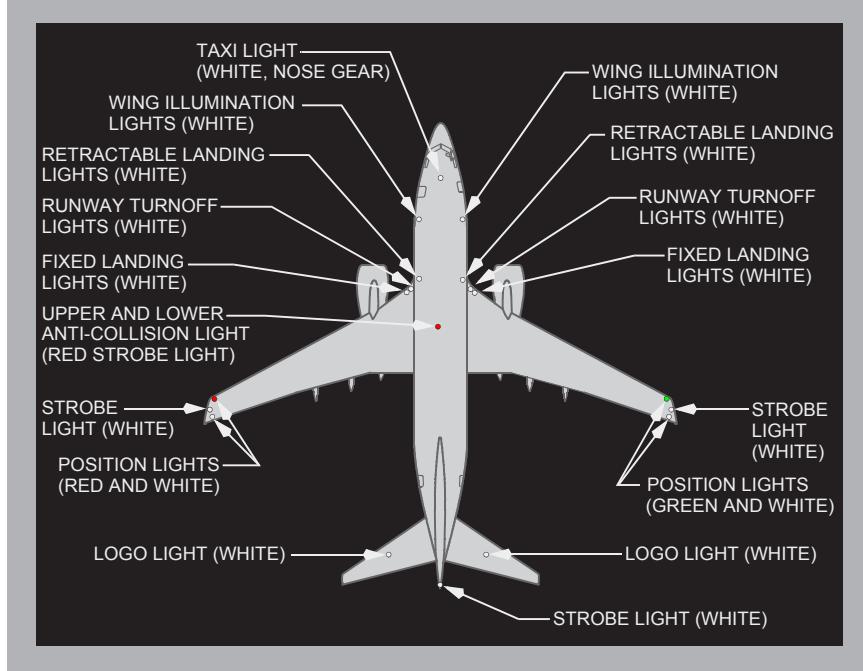
Wing lights are installed on the fuselage and illuminate the leading edge of the wing.

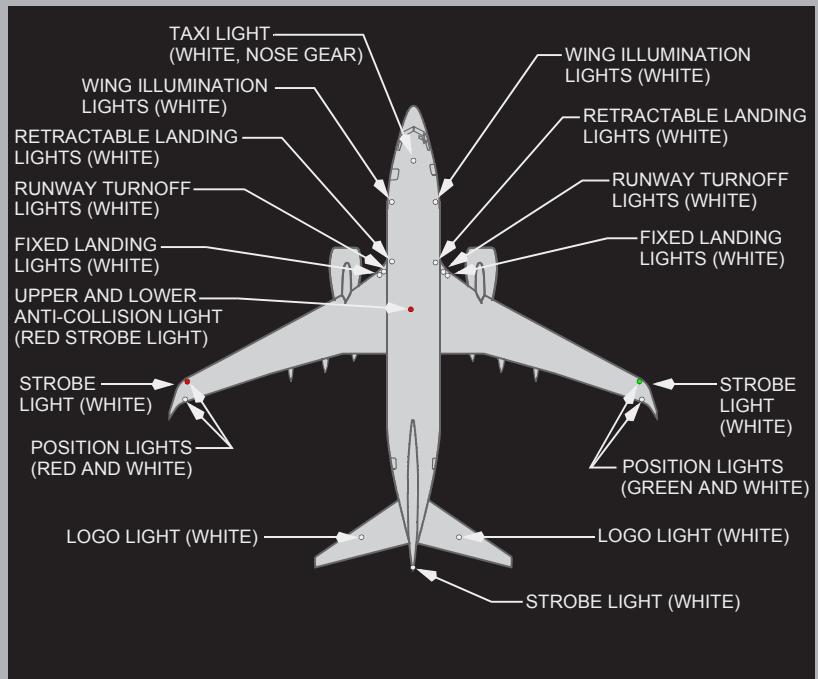
## Wheel Well Lights

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

## Exterior Lighting Locations

[Option - no winglets]



**[Option: winglets]**

## 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, chart 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 attendants 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 doors to indicate the door exits
- over the entry/service and overwing/mid-exit emergency doors to indicate the door 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 the aisle. Lighted EXIT indicators with arrows point to overwing exits. Lighted EXIT indicators without arrows are placed near each door. Escape path markings are provided for visual guidance for emergency cabin evacuation when other sources of cabin lighting are obscured.

## Interior Emergency Lighting

### [Option: Photoluminescent Lighting System]

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 doors to indicate the door 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.

A photoluminescent floor path marking system is installed along the cabin aisle. The photoluminescent material, when excited by light, will glow and provide exit path guidance. At the exit, electrically operated lights and markers provide exit identification.

The photoluminescent strips need to be properly charged. The table below contains charging information and can be used to determine how long the strips remain illuminated. For charging, the cabin ceiling, and sidewall lights need to be on at full intensity, and the strips should not be covered or blocked.

### Photoluminescent Lighting systems with strip colors other than blue.

| First Flight of the Day with Bin Doors Closed | Maximum Duration Allowed (Hours) | Additional Steps to Follow for charging credit                                    |
|---|----------------------------------|---|
| 5 minute charge                               | 4.25                             | a) Close overhead bin doors during charging.                                      |
| 10 minute charge                              | 8.0                              | b) Cabin activity is limited to minor aisle traffic or crew and personnel.        |
| 15 minute charge                              | 9.5                              | c) Passengers will shadow the system and are not allowed onboard during charging. |
| 30 minute charge                              | 14.0                             |   |
| 45 minute charge                              | 16.0                             |   |

|  |      |   |
|--|------|---|
| <b>First Flight of the Day with Bin Doors Open No Passengers</b> |      |   |
| 15 minute charge   | 4.25 | a) Close overhead bin doors during charging.<br><br>b) Cabin activity is limited to minor aisle traffic or crew and personnel.<br><br>c) Passengers will shadow the system and are not allowed onboard during charging. |
| 30 minute charge   | 8.0  |   |

|   |      |  |
|---|------|--|
| <b>In-Flight Charging* - All Phases</b> |      |  |
| 15 minute charge                        | 8.0  | Charging must begin prior to previous discharge duration ending. Strips are assumed to be shadowed during meal service by galley carts and flight attendants which are stationary for 5 minutes. |
| 30 minute charge                        | 11.5 |  |

|                                      |     |  |
|--------------------------------------|-----|--|
| <b>In-Flight Charging* - Descent</b> |     |  |
| 10 minute charge                     | 8.0 | Charging must begin prior to previous discharge duration ending. Reduced charge time allowed because passengers are seated, meal service ended and little aisle traffic. |

| <b>In-Flight Charging* - Double Charge at 4 Hours and 8 Hours</b> |      |   |
|---|------|---|
| 15 minute charge  | 9.5  |   |
| 30 minute charge  | 12.5 | Charging must begin prior to previous discharge duration ending. Strips are assumed to be shadowed during meal service by galley carts and flight attendants which are stationary for 5 minutes. In order to get double charging credit, strips must be charged for the first time 4 hours +/- 15 minutes after prior charge. The second charge must take place before 8 hours has elapsed from initial charge. |

|   |                                   |  |
|---|-----------------------------------|--|
| <b>Continuous Flight</b>                    | <b>No limit if lights stay on</b> | <b>Flight duration can be extended continuously by having ceiling lights on dim.</b> |
| *Taxi Time can be used for charging credit. |                                   |  |

| <b>Quick Turn with Bin Doors Open and Passengers in Seats</b> |      |   |
|---|------|---|
| 15 minute charge  | 6.75 | a) Charging must begin prior to previous discharge duration ending  |
| 30 minute charge  | 9.0  | b) Bin doors can be open during charging<br>c) Passenger loading and unloading periods can not be included in the charge time.<br>Passengers can be seated on the airplane. |

|  |      |  |
|--|------|--|
| <b>Quick Turn with Bin Doors Open and No Passengers in Seats</b> |      |  |
| 15 minute charge   | 7.5  | a) Close overhead bin doors during charging  |
| 30 minute charge   | 10.0 | b) Cabin activity is limited to minor aisle traffic or crew and personnel<br>c) Passengers will shadow the system and are not allowed onboard during charging. |

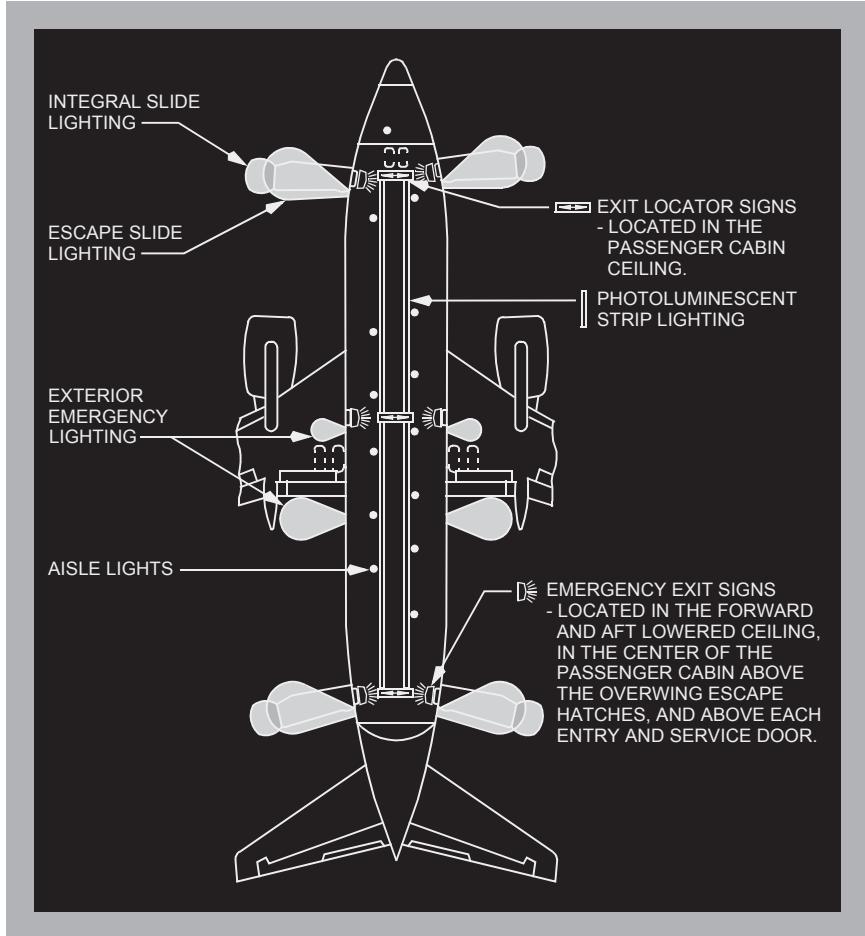
### Exterior Emergency Lighting

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

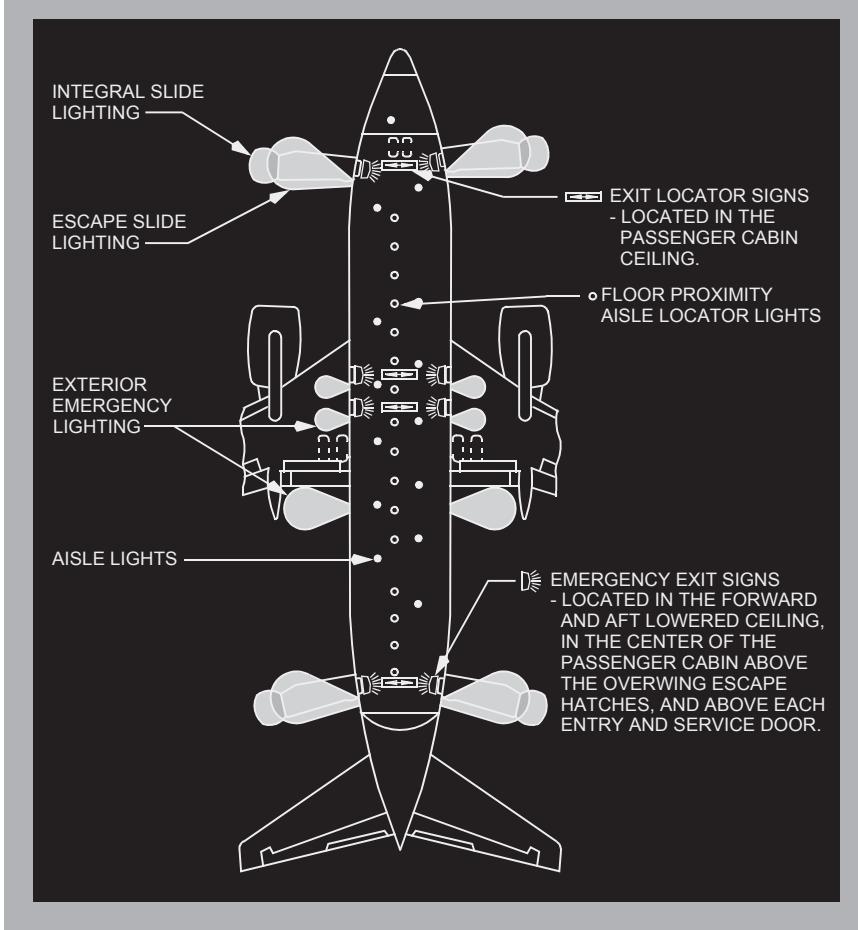
Exterior emergency lights illuminate the escape slides. The fuselage installed escape slide lights are adjacent to the forward and aft service and entry doors. Lights are also installed on the fuselage to illuminate the overwing and mid-exit escape routes and ground contact area.

## Emergency Exit Lighting

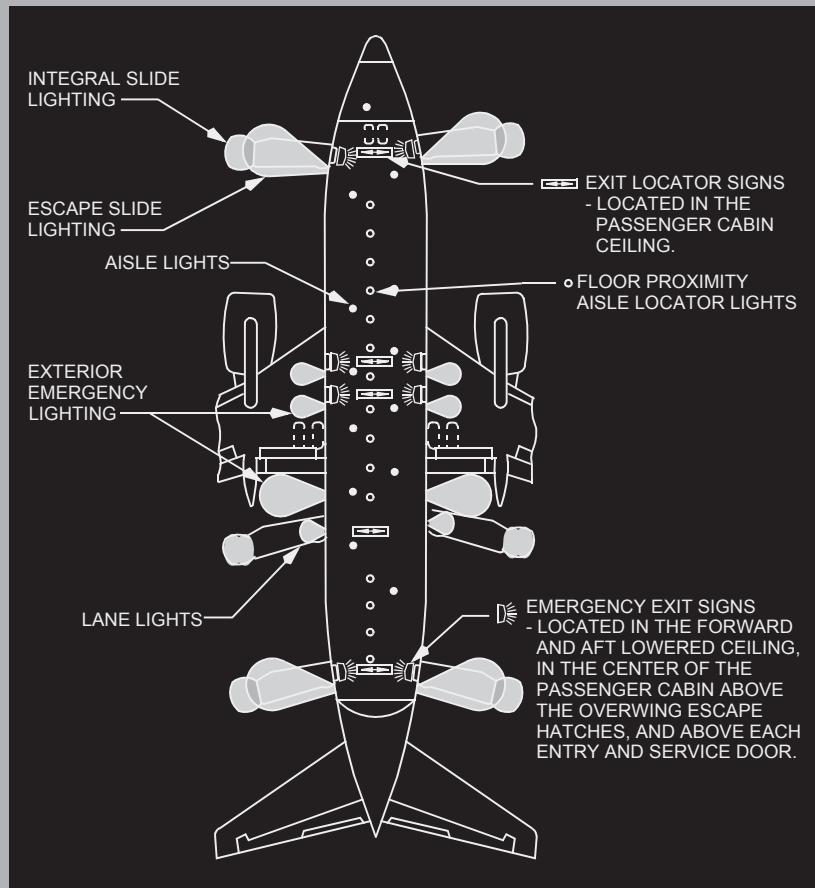
[Option - 737-600/700]



[Option - 737-800/900]



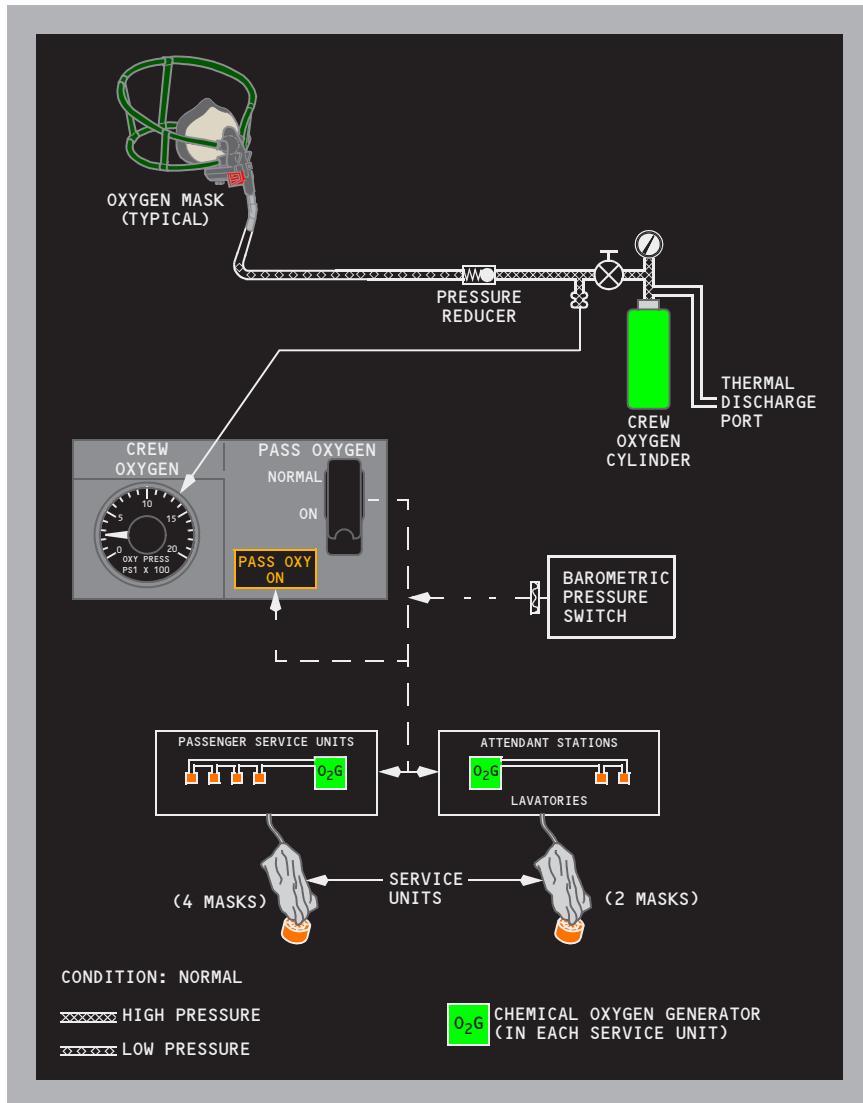
[Option - 737-900ER]



## Oxygen Systems

Two independent oxygen systems are provided, one for the flight crew and one for the passengers. Portable oxygen cylinders can be located throughout the airplane for emergency use. These cylinders are normally found in the forward and aft areas of the passenger cabin.

## 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 Oxygen Pressure indicator located on the aft overhead panel when the battery switch is ON. Oxygen flow is controlled through an in-line, pressure-reducing regulator to supply low-pressure oxygen to the regulator on the mask. System pressure may be as high as 1850 psi.

Oxygen flow is controlled by a regulator mounted on the oxygen mask. By pushing the NORMAL/100% control lever, the regulator is adjusted from the air/oxygen mixture to 100% oxygen. By rotating the EMERGENCY/PUSH TO TEST selector, the regulator is adjusted to supply oxygen under pressure.

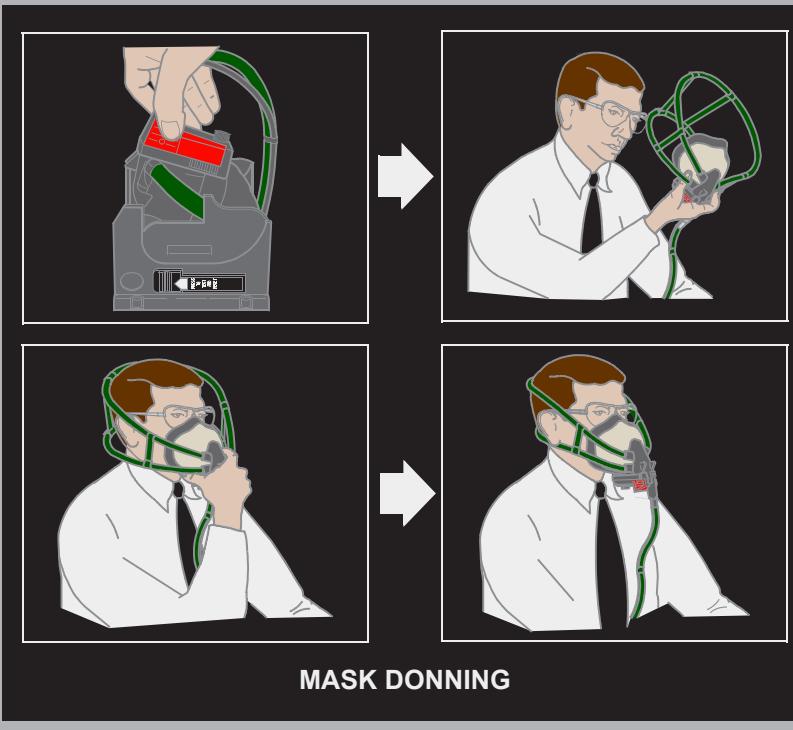
### Flight Crew Oxygen Mask Usage

#### Donning Instructions

To don the mask, grasp the regulator with the thumb and forefinger and remove from stowage. Squeezing the inflation levers and removing from the box:

- inflates the mask harness
- momentarily displays a colored oxygen flow indicator.
- Place the mask over the head and release the levers. The harness contracts to fit the mask to head and face.

The observer's oxygen mask, regulator, and harness unit is the same as the pilots'.



## 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) may be stowed throughout the airplane; however, they are normally found in the forward and aft sections of the passenger cabin. The device is placed over the head and, when activated, provides approximately 15 to over 20 minutes of oxygen depending upon the device used. Manufacturer's operating instructions are placarded on the container.

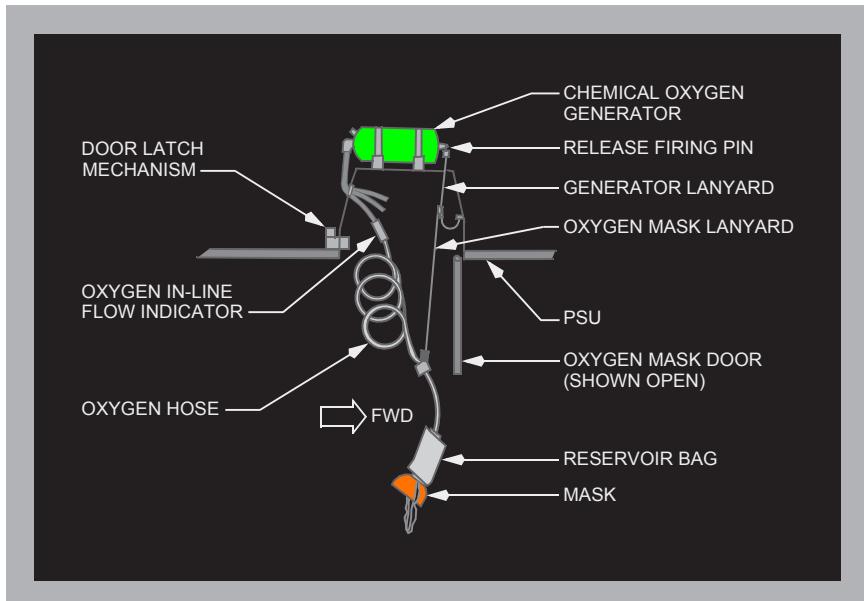
## Passenger Oxygen System

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 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



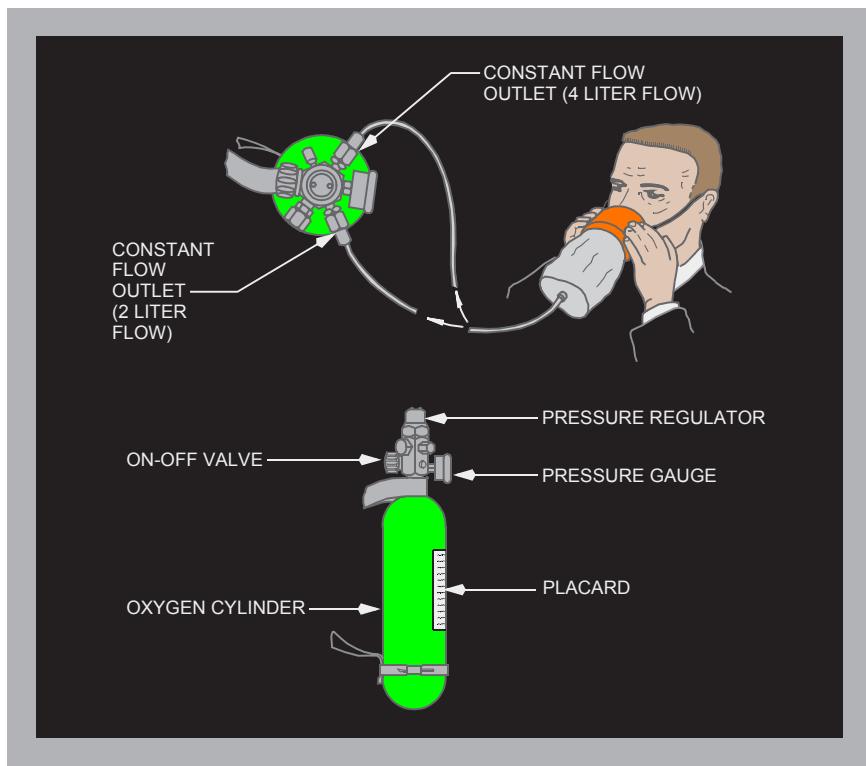
**WARNING:** When using passenger oxygen, the "NO SMOKING" sign should be strictly observed. Once the generator is activated, the flow of oxygen is constant, whether or not the mask is being worn.

## 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 gage, pressure regulator and on-off valve. The cylinders are pressurized to 1800 psi. At this pressure and a temperature of 70 degrees Fahrenheit, (21 degrees Celsius) the cylinders have a capacity of 4.25 cubic feet (120 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 (120 liters divided by 4 liters/minute = 30 minutes).

## Passenger Portable Oxygen Schematic



## Fire Extinguishers

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

## Water Fire Extinguishers

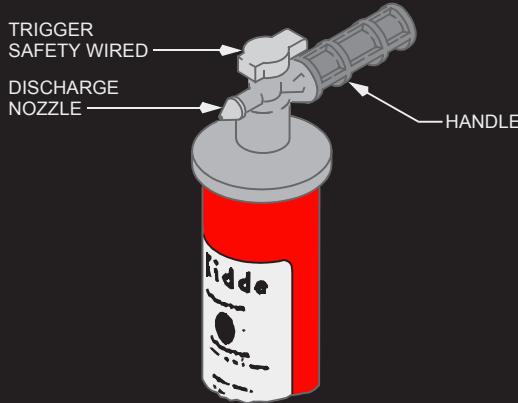
Water fire extinguishers contain a solution of water mixed with antifreeze. The container is pressurized by a CO<sub>2</sub> cartridge when the extinguisher handle is rotated fully clockwise. The extinguisher should be used on fabric, paper or wood fires only.

To use the water fire extinguisher:

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

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

### Water Fire Extinguisher



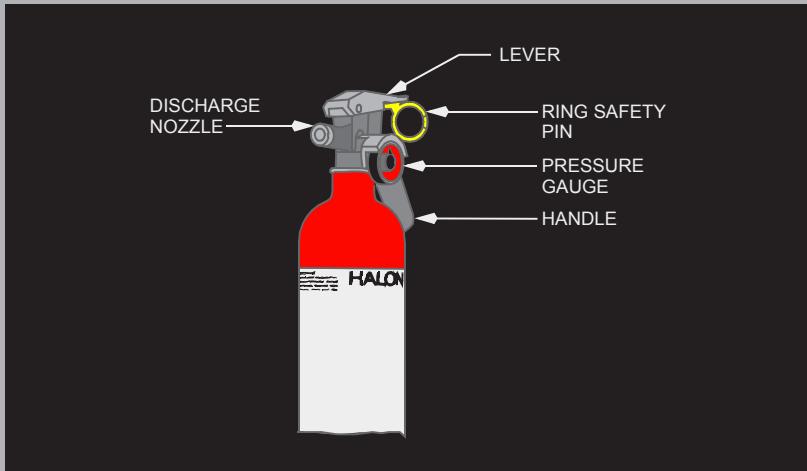
## Halon (BCF) Fire Extinguishers

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

To use the Halon fire extinguisher:

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

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

**BCF Fire Extinguisher (Halon 1211)****Fire Extinguisher Usage**

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

| UNITED STATES CLASS OF FIRES<br><b>There are three common classes of fire:</b>          |   | EXTINGUISHER TYPE   |
|---|---|---|
| CLASS  | <b>COMBUSTIBLE MATERIALS</b><br>paper, wood, fabric, rubber,<br>certain plastics, etc., where<br>quenching by water is effective.   | TYPE  Water (H <sub>2</sub> O)<br>saturates material<br>and prevents<br>rekindling |
| CLASS  | <b>FLAMMABLE LIQUIDS</b><br>gasoline, oils, greases, solvents,<br>paints, burning liquids, cooking<br>fats, etc., where smothering<br>action is required.   | TYPE  BCF (Halon 1211)   |
| CLASS  | <b>LIVE ELECTRICAL</b><br>fires started by short circuit or<br>faulty wiring in electrical,<br>electronic equipment or fires in<br>motors, switches, galley equipment,<br>etc., where a nonconducting<br>extinguisher agent is required.<br><br>NOTE: Whenever possible, electrical<br>equipment should be de-energized<br>before attacking a class C fire. | TYPE  BCF (Halon 1211)   |

**WARNING:** THE WRONG EXTINGUISHER ON A FIRE COULD DO MORE HARM THAN GOOD. FOR EXAMPLE,  
A  RATED EXTINGUISHER IS NOT AS EFFECTIVE AS H<sub>2</sub>O ON A CLASS  FIRE.  
WATER ON FLAMMABLE LIQUID FIRES SPREAD THE FIRE. WATER ON A LIVE  
ELECTRICAL FIRE COULD CAUSE SEVERE SHOCK OR DEATH.

| EUROPEAN/AUSTRALIAN CLASS OF FIRES<br>There are three common classes of fire:                    |   | EXTINGUISHER TYPE   |
|--|---|---|
| CLASS  <b>A</b> | COMBUSTIBLE MATERIALS<br>paper, wood, fabric, rubber, certain plastics, etc., where quenching by water is effective.  | TYPE  Water (H <sub>2</sub> O)<br>saturates material and prevents rekindling |
| CLASS  <b>B</b> | FLAMMABLE LIQUIDS<br>gasoline, oils, greases, solvents, paints, burning liquids, cooking fats, etc., where smothering action is required.   | TYPE  BCF (Halon 1211)   |
| CLASS  <b>E</b> | LIVE ELECTRICAL<br>fires started by short circuit or faulty wiring in electrical, electronic equipment or fires in motors, switches, galley equipment, etc., where a nonconducting extinguisher agent is required.<br><br>NOTE: Whenever possible, electrical equipment should be de-energized before attacking a class C fire. | TYPE  BCF (Halon 1211)   |

WARNING: THE WRONG EXTINGUISHER ON A FIRE COULD DO MORE HARM THAN GOOD. FOR EXAMPLE, A   RATED EXTINGUISHER IS NOT AS EFFECTIVE AS H<sub>2</sub>O ON A CLASS  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.**

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# Airplane General, Emergency Equipment, Doors, Windows Systems Description

## Chapter 1 Section 40

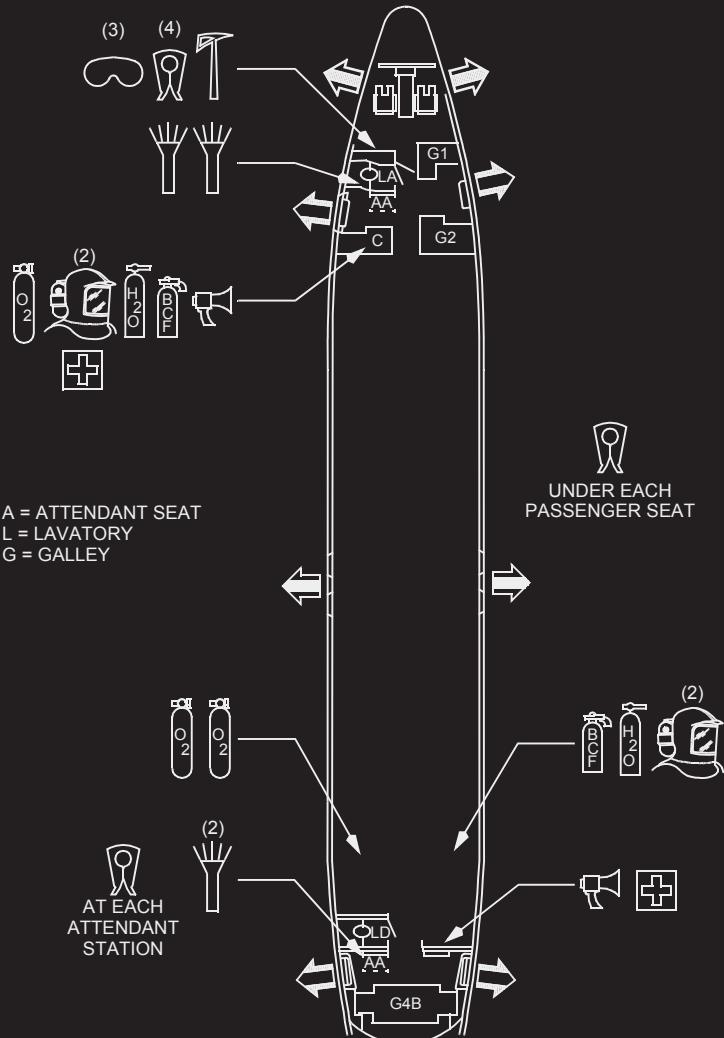
### Emergency Equipment Symbols



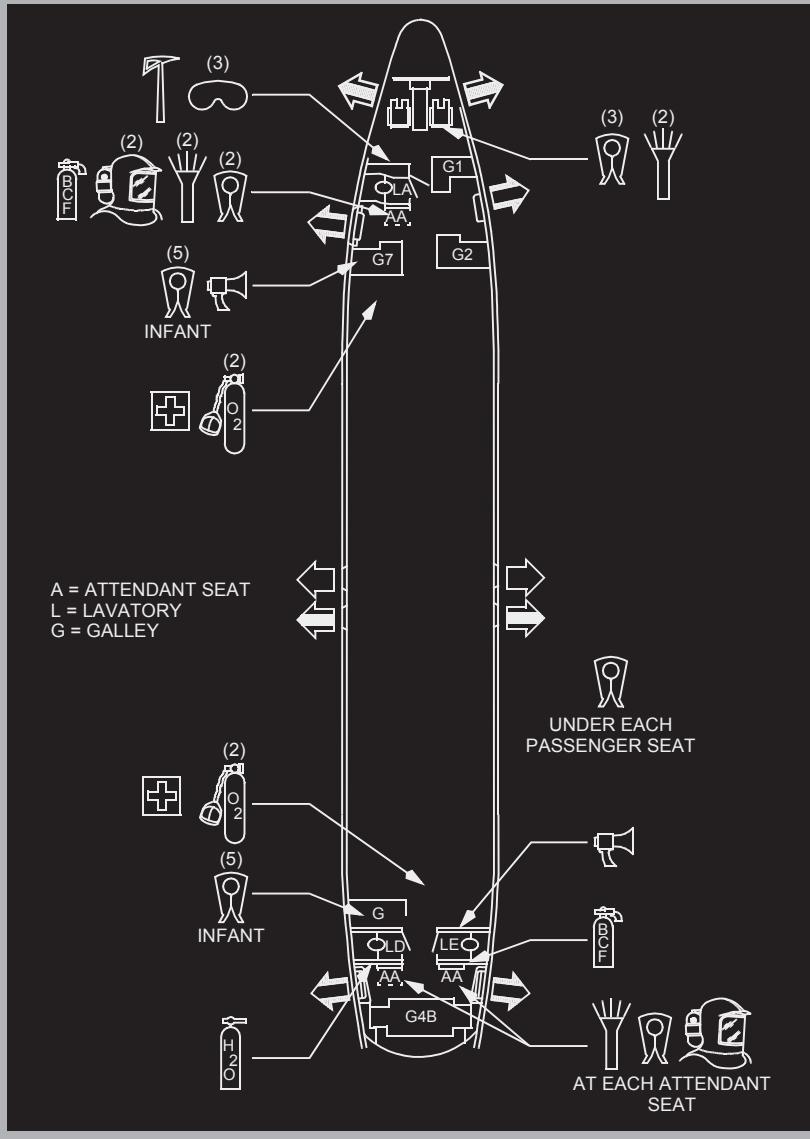
NOTE: SOME SYMBOLS DO NOT APPLY TO ALL CONFIGURATIONS.

## Emergency Equipment Locations

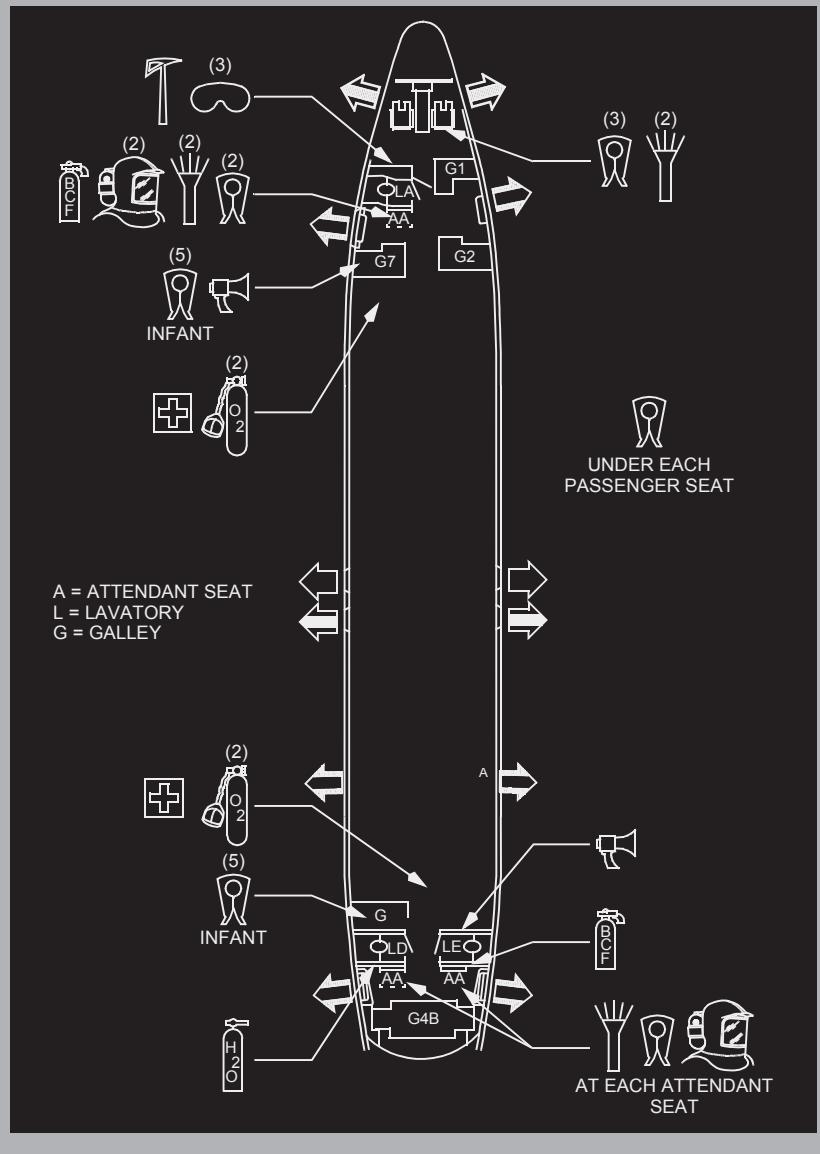
[Option - Typical 737-600/700 with optional emergency equipment]



[Option - 737-800/900 with optional emergency equipment]



[Option - 737-900ER with optional emergency equipment]



# Airplane General, Emergency Equipment, Doors, Windows Systems Description

## Chapter 1 Section 40

### 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.

#### [Option - 737-900ER]

The airplane has two passenger entry doors, one cabin door (the flight deck/passenger cabin entry), two service doors, two mid-exit 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.

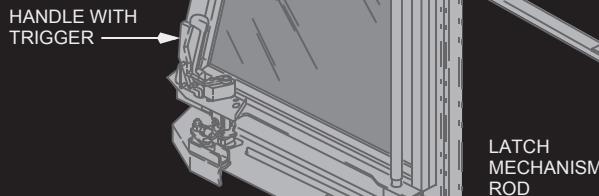
The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

**CAUTION: Do not operate the entry or cargo doors with winds at the door of more than 40 knots. Do not keep doors open when wind gusts are more than 65 knots. Strong winds can cause damage to the structure of the airplane.**

**INTENTIONALLY  
LEFT  
BLANK**

**INTENTIONALLY  
LEFT  
BLANK**

## Flight Deck Number Two Windows



CLOTHES  
GUARD  
PROTECTOR

LATCH  
MECHANISM  
ROD

**FLIGHT COMPARTMENT WINDOW NO. 2  
(RIGHT SIDE SHOWN)**

The flight deck number two windows can be opened on the ground or in flight and can be used for emergency evacuation. To open the window, depress the trigger and turn the handle back and inboard. After the window moves inboard, move it back until it locks in the open position.

To close the window, it must first be unlocked. Pull forward on the latch mechanism rod to unlock the window. Depress the trigger and move the window forward until the handle can be turned forward and outboard. When the trigger is released, the window latches.

Only the first officer's window number two window can be opened from outside the airplane.

## Lower Cargo Compartments

The lower cargo compartments are designed and constructed to satisfy FAA category Class C compartment requirements. This means the compartments are designed to completely confine a fire without endangering the safety of the airplane or its occupants. The compartments are sealed and pressurized but do not have fresh air circulation and temperature control as do the upper passenger 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 two 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. The door can be closed easily by pulling a lanyard attached to the door, 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
- emergency exit doors

## **Emergency Evacuation Routes**

### **[Option - 737-600/700]**

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

### **[Option - 737-800/900]**

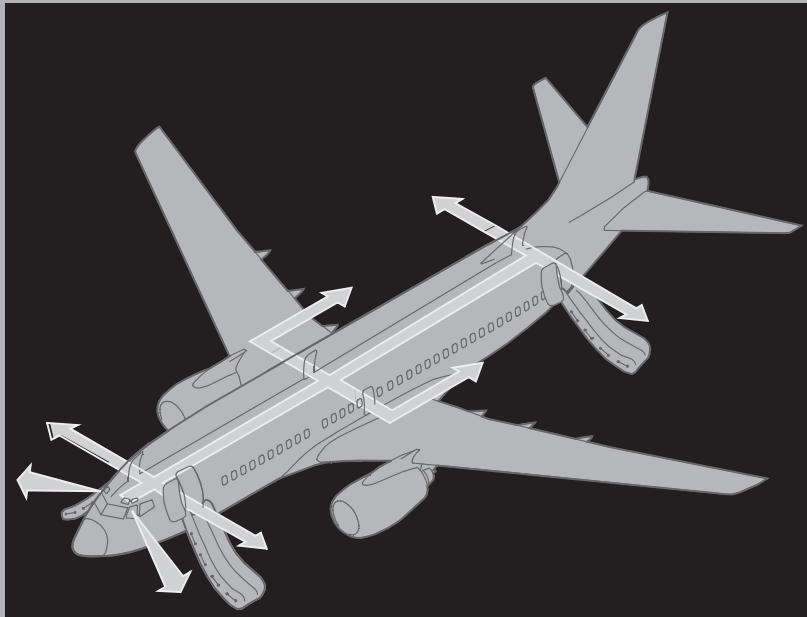
Emergency evacuation may be accomplished through four entry/service doors and four overwing escape hatches. Flight deck crew members may evacuate the airplane through two sliding flight deck windows.

### **[Option - 737-900ER]**

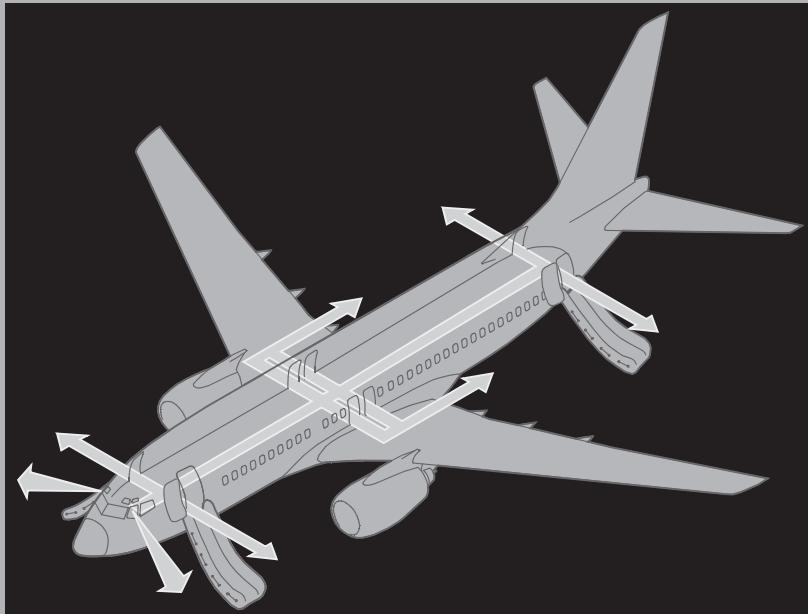
Emergency evacuation may be accomplished through four entry/service doors, four overwing escape hatches, and two mid-exit doors. Flight deck crew members may evacuate the airplane through two sliding flight deck windows.

## Emergency Evacuation Routes

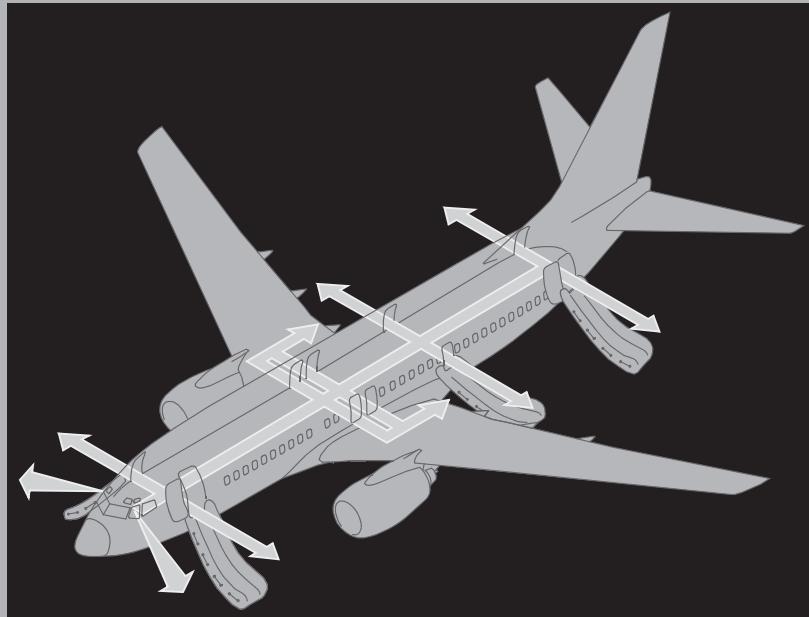
[Option - 737-600/700]



[Option - 737-800/900]



[Option - 737-900ER]

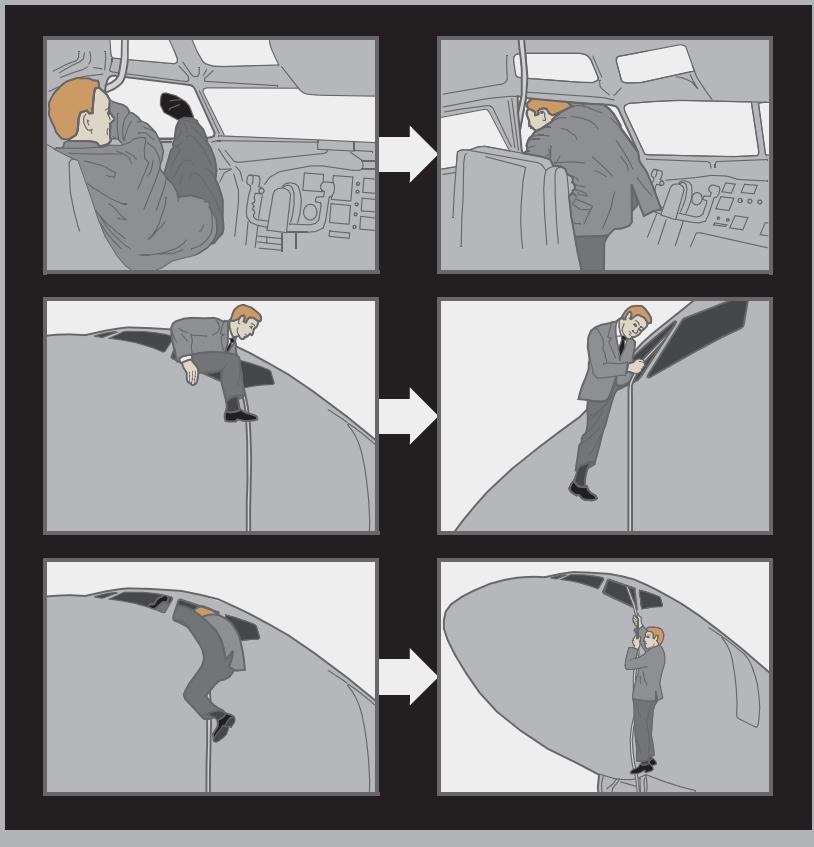


## Flight Deck Window Emergency Egress

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.**

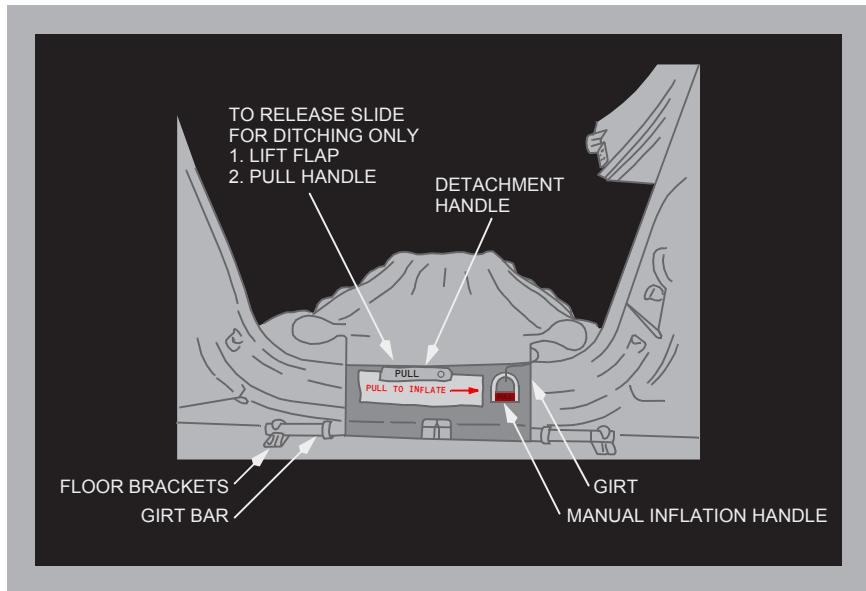


The above illustrated method of departure would probably be the easiest for most crewmembers. This technique is difficult and should be used only in extreme emergency.

### **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 detachment 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



## Escape Straps

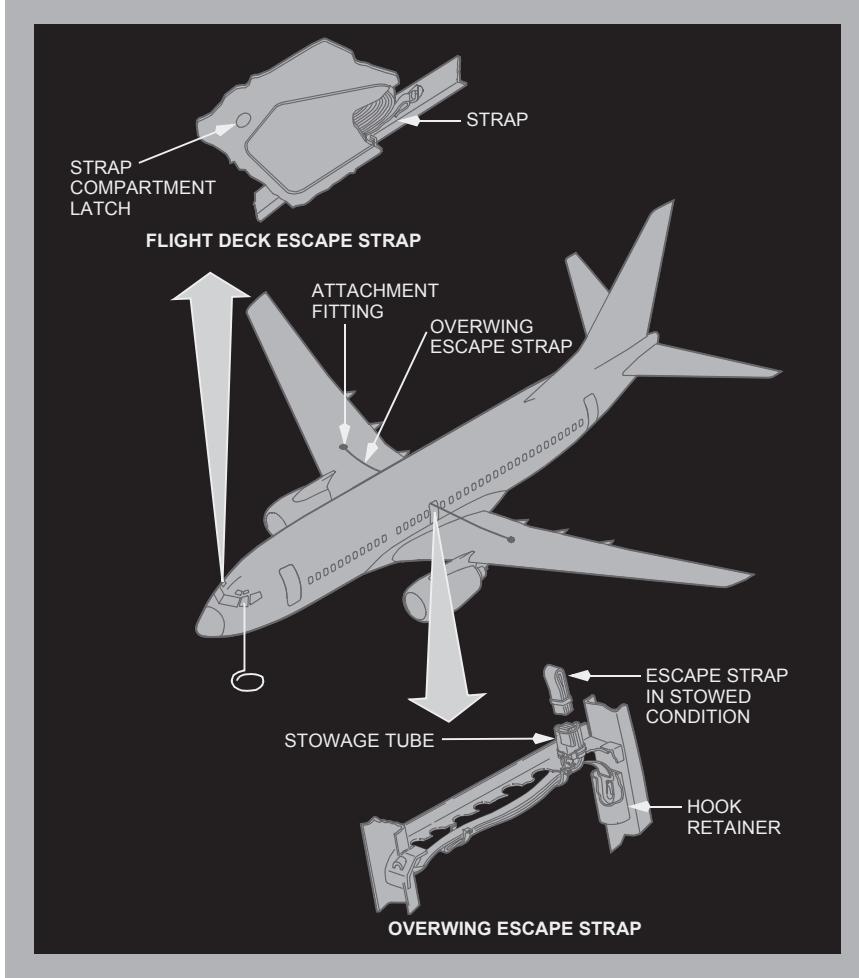
### [Option - 737-600/700]

Escape straps are installed above each emergency exit door frame. The escape doors must be opened to expose the straps. One end of the strap is attached to the door 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.

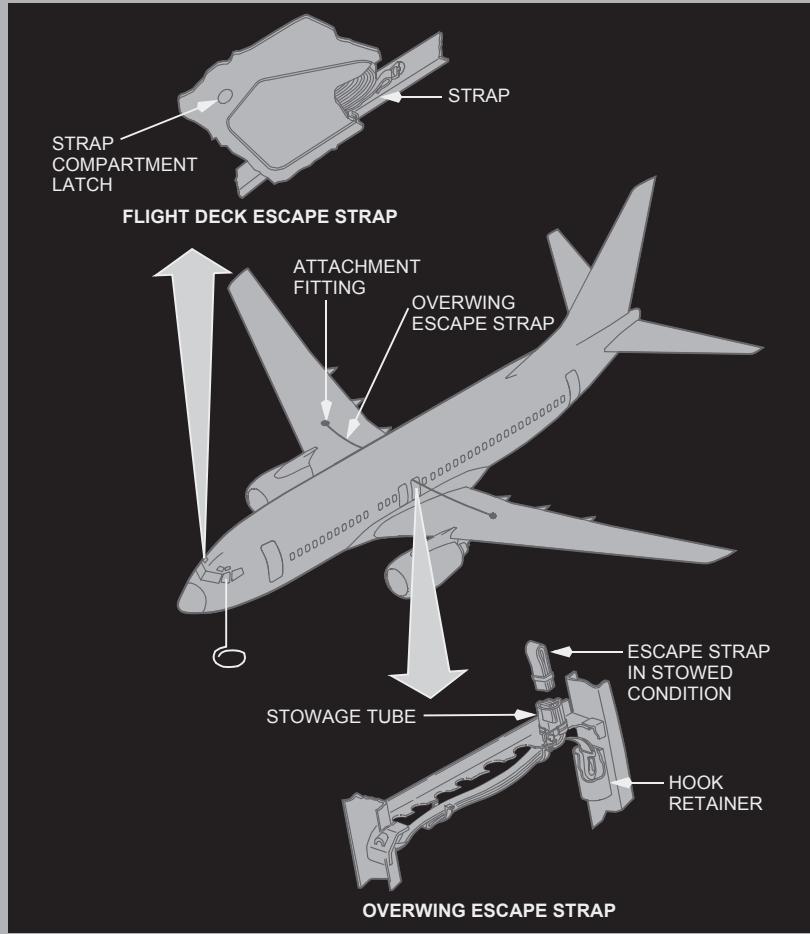
### [Option - 737-800/900/900ER]

Escape straps are installed above each aft emergency exit door frame. The escape doors must be opened to expose the straps. One end of the strap is attached to the door 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.

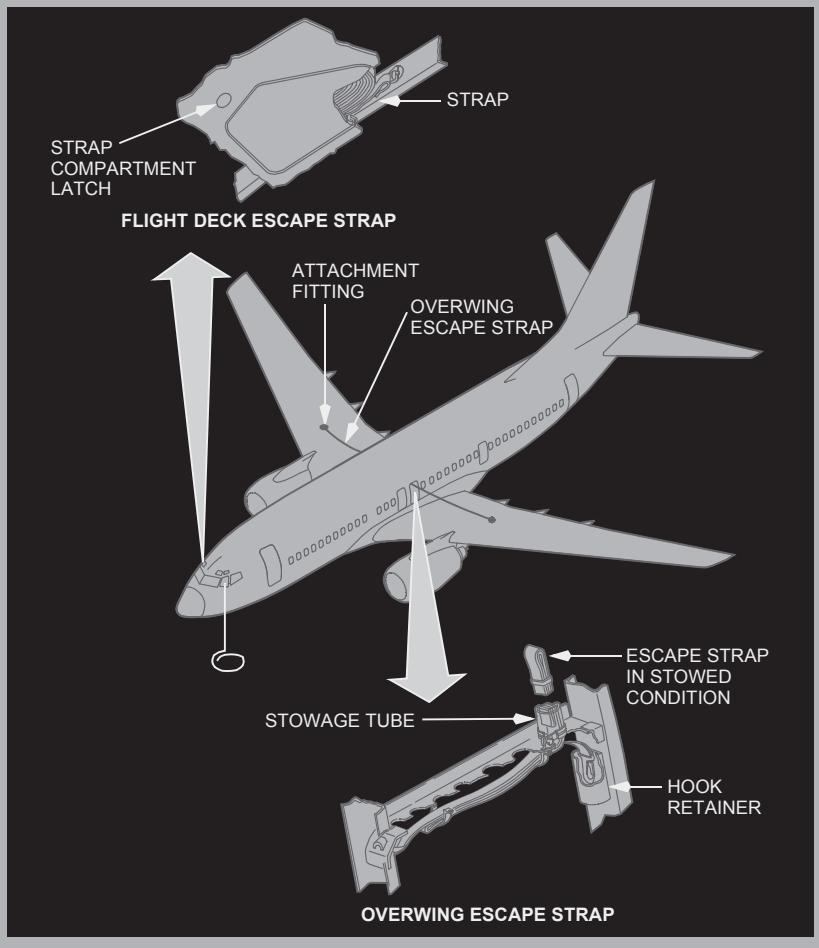
[Option - 737-600/700]



[Option - 737-800/900]



[Option - 737-900ER]



## Emergency Exit Doors

[Option - 737-600/700]

Two Type III emergency exits are located in the passenger cabin over the wings. These are canopy-type doors and are held in place by mechanical locks and airplane cabin pressure.

[Option - 737-800/900]

Four Type III emergency exits are located in the passenger cabin over the wings. These are canopy-type doors and are held in place by mechanical locks and airplane cabin pressure.

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[Option - 737-900ER]

Four Type III emergency exits are located in the passenger cabin over the wings. These are canopy-type doors and are held in place by mechanical locks and airplane cabin pressure. In addition, two Type II mid-exit doors are located aft of the wings.

The overwing exit doors can be opened from inside or outside of the airplane by a spring-loaded handle at the top of the door. The mid-exit doors are opened using the handles located on the side of the door. The 28 Volt DC flight lock system is designed to ensure that the flight lock will automatically lock during takeoff, in-flight, and landing and unlock on the ground to allow for opening of the door in emergency situations. Commands for the flight lock to lock and unlock are dependent upon engine speed, thrust lever position, air/ground mode status, and the open/closed status of the doors.

The overwing and mid-exit emergency exits lock when:

- three of the four Entry/Service doors are closed and
- either engine is running and
- the airplane air/ground logic indicates that the airplane is in the air or both thrust levers are advanced.

The overwing and mid-exit emergency exits unlock when any one of the above conditions is not met or DC power is lost.

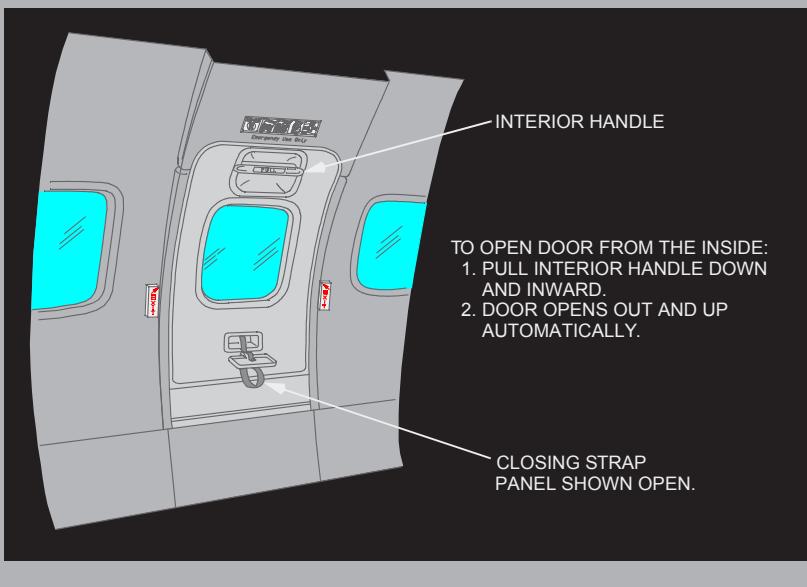
The LEFT OVERWING and/or RIGHT OVERWING warning lights, DOORS annunciator, and MASTER CAUTION light illuminate when an emergency exit door is not fully closed and locked or when the flight lock is not engaged, either during the takeoff roll or in-flight.

If a flight lock has failed locked or a fault is detected the PSEU light, the OVERHEAD annunciator, and the MASTER CAUTION lights illuminate. These indications are inhibited from takeoff until 30 seconds after the airplane is in the ground mode. When the doors are latched and locked and the flight lock is operating properly none of these lights will illuminate.

If a flight lock has failed locked or a fault is detected the PSEU light illuminates. If the SPSEU light illuminates there is a disagreement between flightlocks or there is an internal SPSEU failure. Illuminations of either of these lights will cause the OVERHEAD annunciator and the MASTER CAUTION lights to illuminate.

These indications are inhibited from takeoff until 30 seconds after the airplane is in the ground mode. When the doors are latched and locked and the flight lock is operating properly none of these lights will illuminate.

[Option - 737-600/700]



[Option - 737-800/900]

**EMERGENCY EXIT  
ONLY**

PUSH TO OPEN  
DOOR OPENS OUT AND UP  
AUTOMATICALLY

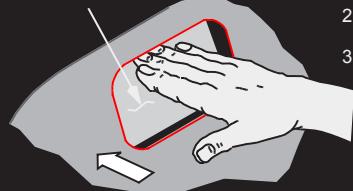
**WARNING**



DOOR SWINGS  
OUT AND UP  
HOLD YOUR  
KNEE AGAINST  
DOOR WHILE  
OPENING OR  
SERIOUS  
INJURY CAN  
OCCUR

**EXTERIOR PLACARDS**

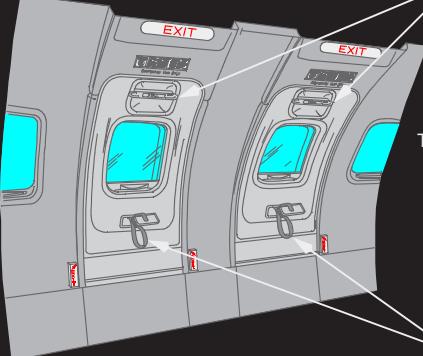
EXTERIOR OVERWING  
EMERGENCY EXIT  
PUSH PANEL



TO OPEN DOOR FROM THE OUTSIDE:

1. HOLD KNEE AGAINST LOWER PORTION OF DOOR.
2. PUSH IN EXTERIOR OVERWING EMERGENCY EXIT PUSH PANEL.
3. DOOR OPENS OUT AND UP AUTOMATICALLY.

INTERIOR HANDLE



TO OPEN DOOR FROM THE INSIDE:

1. PULL INTERIOR HANDLE DOWN AND INWARD.
2. DOOR OPENS OUT AND UP AUTOMATICALLY.

CLOSING STRAP  
PANEL SHOWN OPEN.

## Mid-Exit Doors

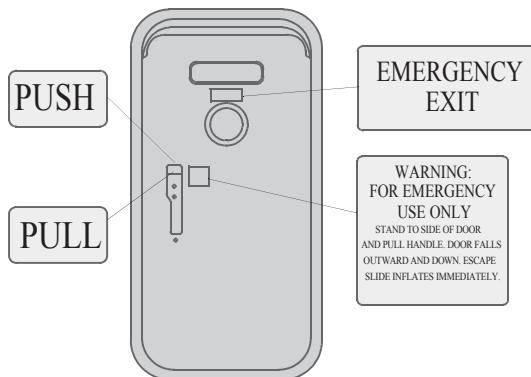
### [Option - 737-900ER]

An emergency door is located aft of the wing on each side of the airplane. This door is only used as an emergency exit. A slide bustle in the lower face of the door contains an evacuation slide. A window in the door allows observation outside of the airplane.

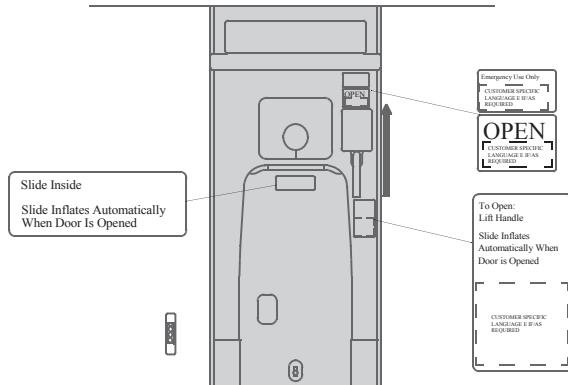
The emergency door is a plug-type door and is hinged on the bottom. Pulling the door operating handle up opens a pressure relief door and lifts the door inward and upward. The door can then be pushed out through the door frame and the slide automatically deploys and inflates.

A manual inflation handle can be pulled if the slide has not automatically inflated.

The emergency door evacuation slides are not configured as rafts, however they may be used as auxiliary flotation devices.



EXTERIOR PLACARDS



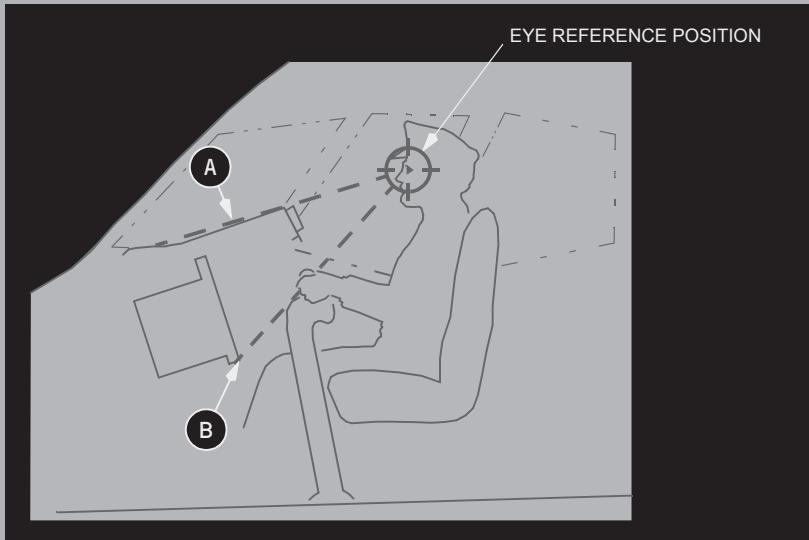
INTERIOR PLACARDS

## 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 over the control column (in the neutral position) until the bottom edge of the outboard display unit is visible (B).

## Pilot Seat Adjustment



## Galleys

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

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

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

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

## Electrical Power

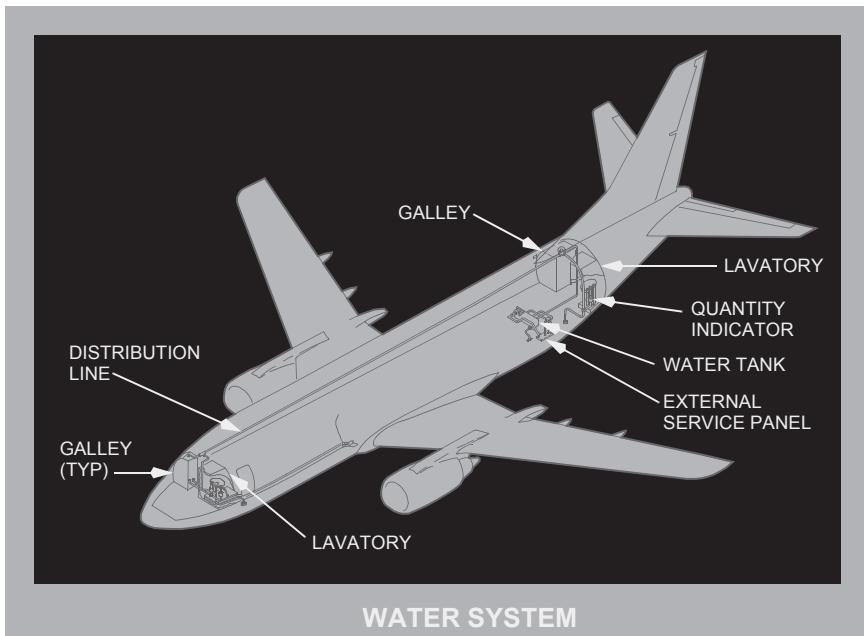
Electricity for the galleys is 115V AC supplied from the airplane transfer buses and controlled by a switch on the overhead panel. Circuit breakers are located in the lower E/E bay as part of the power distribution panels.

## Water Service

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

## Water System

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

## Servicing

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

---

## Forward Airstair

### [Option - Airstairs]

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.

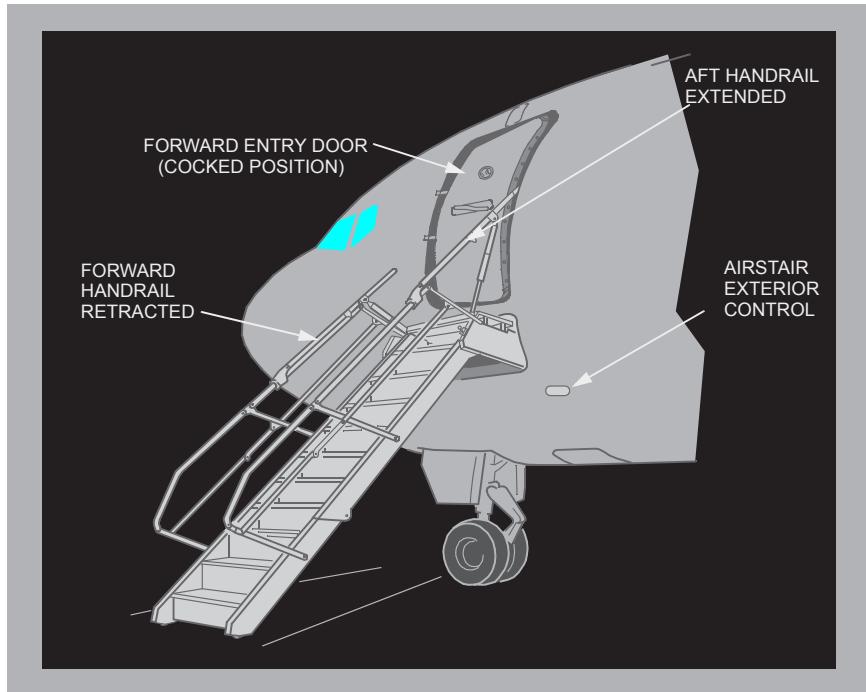
## Interior Control

The interior control panel is located on the forward attendant panel. A white STAIR OPER 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 Tread 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 115V AC while standby operation requires the battery switch to be ON. Both operating modes require the forward entry door to be partially open. During normal operation the momentary extend or retract switches are depressed to operate the stairs. To operate in the standby mode, the momentary standby switch must be depressed while the retract or extend switches are also depressed.

## Exterior Control

The exterior control is located to the right and below the airstair compartment. Operating instructions are located near the switches. When operating the airstair with the exterior control, the forward entry door need not be open. The exterior control switch by-passes the door-open requirement. A two-position switch, labeled NORMAL and STANDBY, is located in the exterior control 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 airstair control switch can be moved to extend or retract the airstair. The NORMAL and STANDBY systems are interlocked by the handrail switches to prevent the stair from being retracted with the handrail extended. Caution must be exercised when using the maintenance switch located under the airstair. 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. A white 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 DC bus 1 is not powered. The MASTER CAUTION and DOORS lights illuminate in normal or standby operation of the airstair.

## Airstairs



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

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## Air Systems

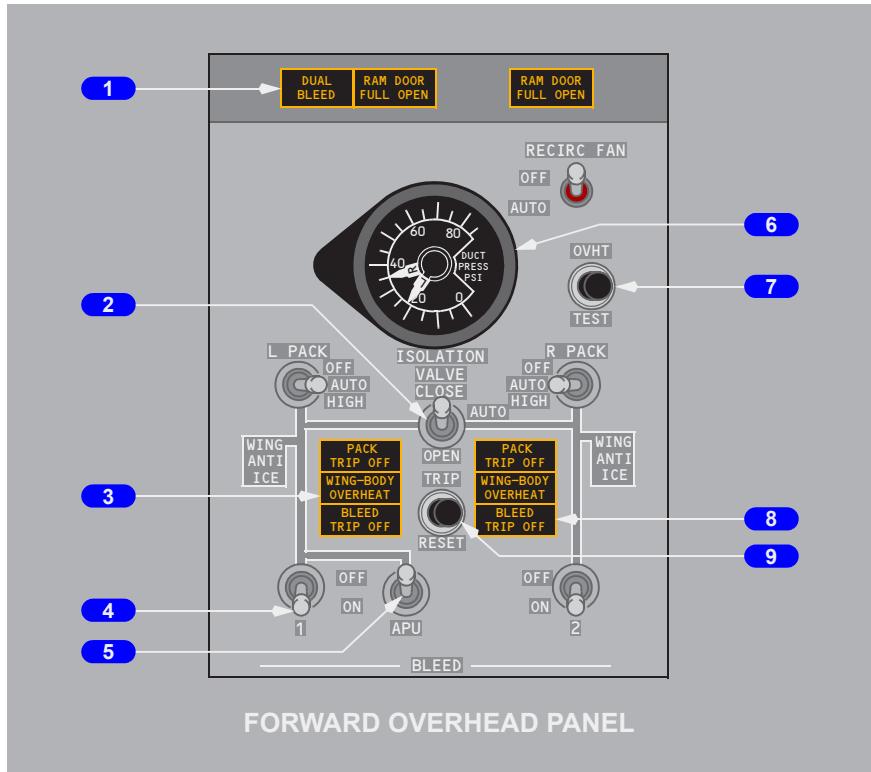
### Controls and Indicators

## Chapter 2

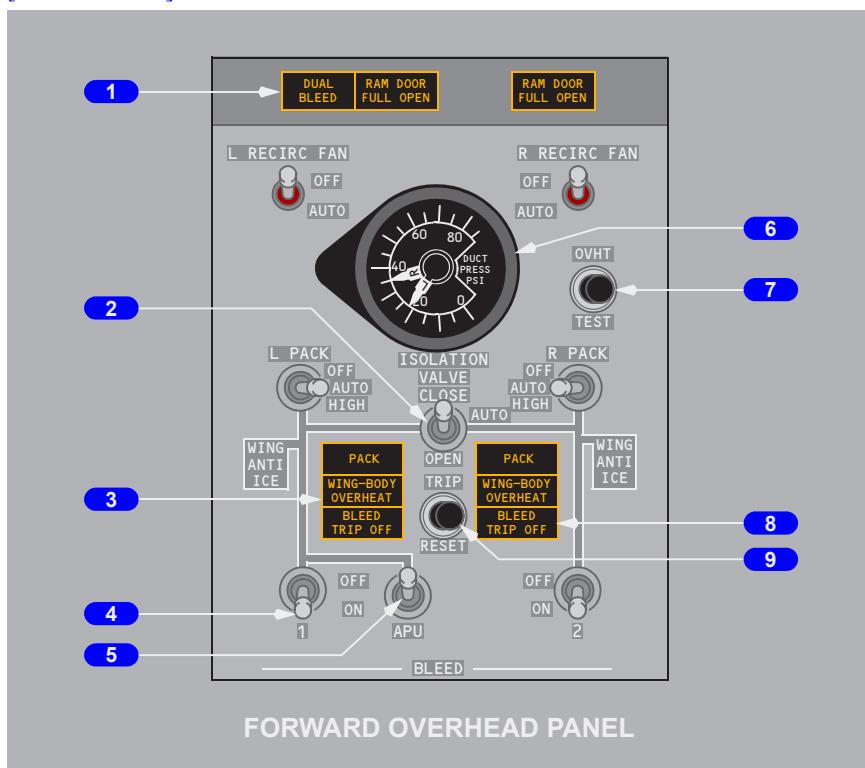
### Section 10

#### Bleed Air Controls and Indicators

[737 - 600/700]



[737 - 800/900]

**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 overheating 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 overheating 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****[737 - 600/700]**

Push (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights
- related engine bleed valve opens, or related pack valve opens, or related air mix valve opens
- lights remain illuminated until reset.

## 9 TRIP RESET Switch

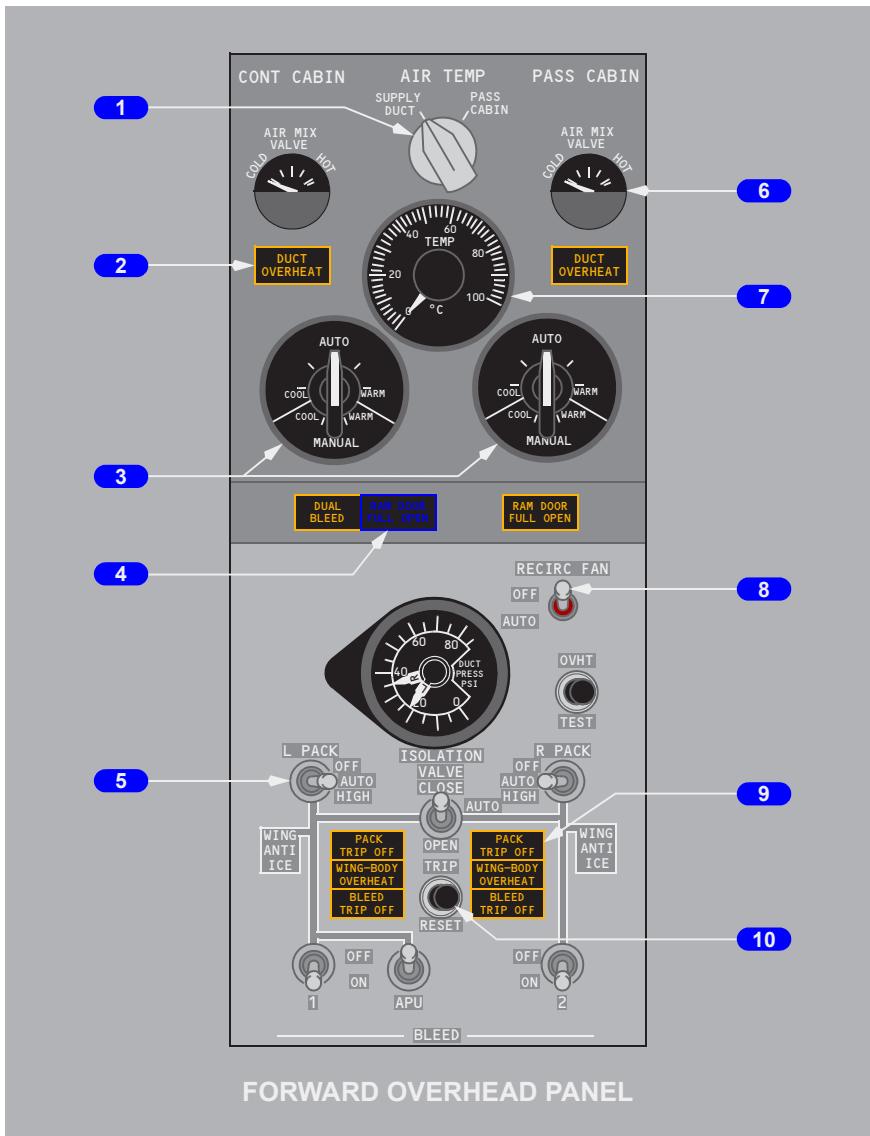
### [737 - 800/900]

Push (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK and ZONE TEMP lights
- related engine bleed valve opens, or related pack valve opens, or related air mix valve opens
- lights remain illuminated until reset.

## Air Conditioning Controls and Indicators

[737 - 600/700 and Air Temperature Indicator in degrees C]



### 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) –

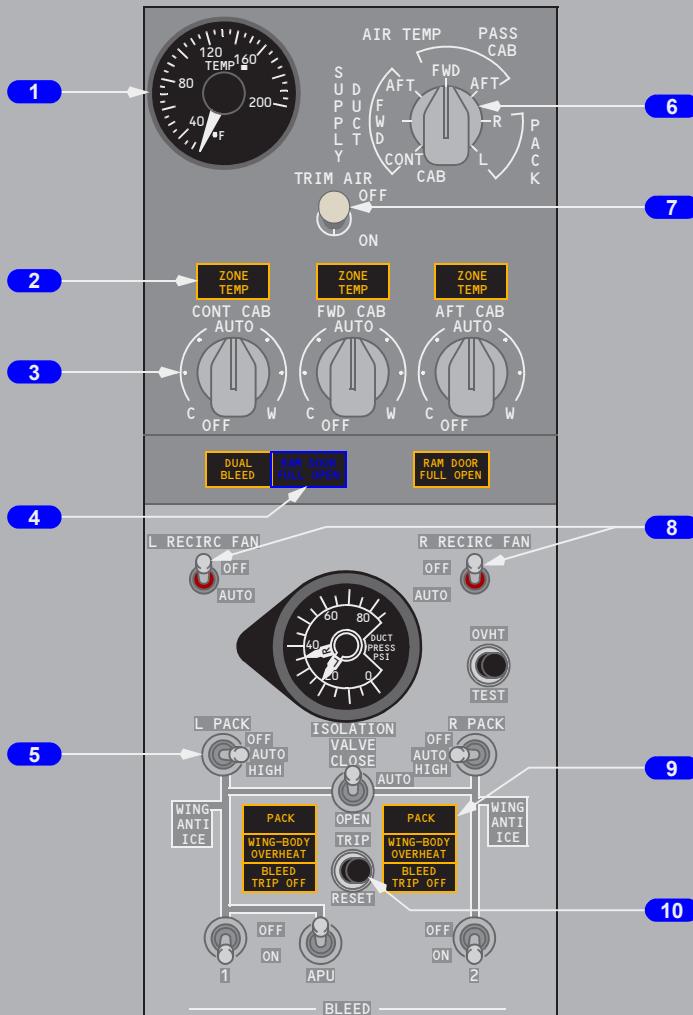
- indicates pack temperature has exceeded limits
- related pack valve automatically closes and mix valves drive full cold
- requires reset.

**10 TRIP RESET Switch**

Push (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights
- related engine bleed air valves open, or related pack valves open, or related air mix valves open
- lights remain illuminated until reset.

## [737 - 800/900 and Air Temperature Indicator in degrees F]

**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 control toward C (cool) or W (warm) manually 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 CAB – 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 Switches

OFF - fan signalled off.

AUTO –

- in-flight –
  - the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH
  - the right recirculation fan operates if both packs are operating unless both PACK switches are in HIGH.
- on the ground –
  - the left recirculation fan operates unless both PACK switches are in HIGH
  - the right recirculation fan operates even if both PACK switches are in HIGH.

## 9 PACK Light

Illuminated (amber) –

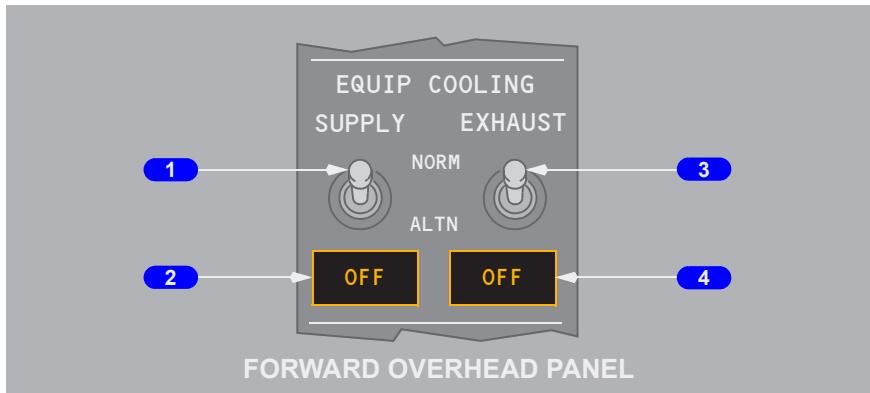
- indicates pack trip off or failure of both primary and standby pack controls
- during Master Caution recall, indicates failure of either primary or standby pack control. Extinguishes when Master Caution is reset

## 10 TRIP RESET Switch

Push (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK and ZONE TEMP lights
- related engine bleed air valves open, or related pack valves open, or related air mix valves open
- lights remain illuminated until reset.

## Equipment Cooling Panel



**1 Equipment (EQUIP) COOLING SUPPLY Switch**

NORM – normal cooling supply fan activated.

ALTN – 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**

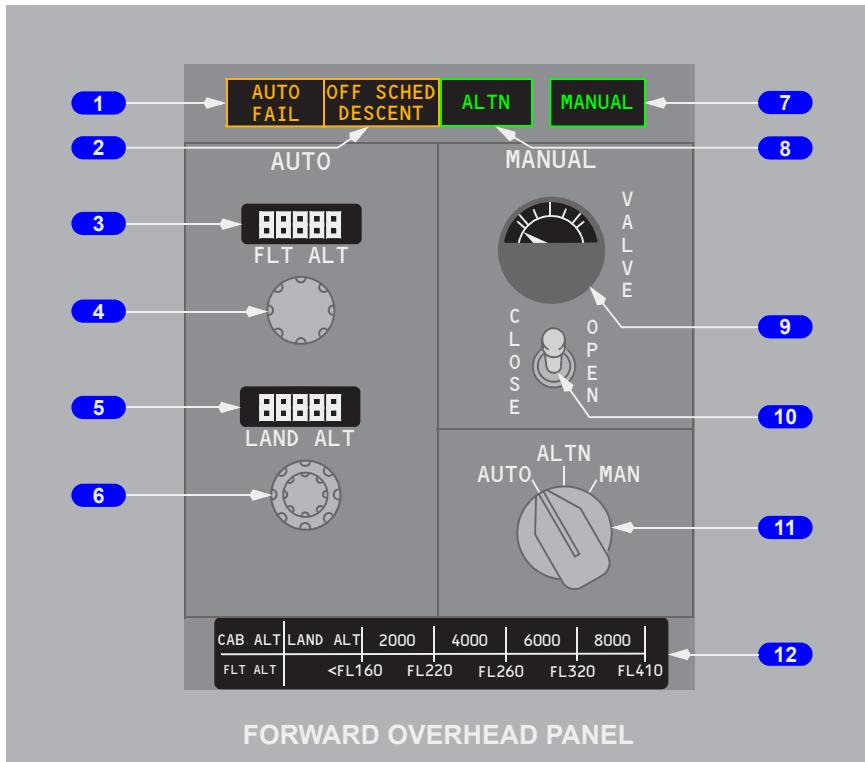
NORM – normal cooling exhaust fan activated.

ALTN – alternate cooling exhaust fan activated.

**4 Equipment Cooling Exhaust OFF Light**

Illuminated (amber) – no airflow from selected cooling exhaust fan.

## Cabin Pressurization Panel



### 1 AUTO FAIL Light

Illuminated (amber) – automatic pressurization system failure detected:

- indicates a single controller failure when ALTN light is also illuminated
- indicates a dual controller failure when illuminated alone.

### 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

Rotate – set planned cruise altitude. (-1,000 ft. to 42,000 ft. in 500 ft. increments).

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**5 Landing Altitude (LAND ALT) Indicator**

- indicates altitude of intended landing field
- set before takeoff.

**6 Landing Altitude Selector**

Rotate – select planned landing field altitude. (-1,000 ft. to 14,000 ft. in 50 ft. increments).

**7 MANUAL Light**

Illuminated (green) – pressurization system operating in the manual mode.

**8 Alternate (ALTN) Light**

Illuminated (green) – pressurization system operating in the alternate automatic mode:

- Illumination of both ALTN and AUTO FAIL lights indicates a single controller failure and automatic transfer to ALTN mode
- pressurization mode selector in ALTN position.

**9 Outflow VALVE Position Indicator**

- indicates position of outflow valve
- operates in all modes.

**10 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.

**11 Pressurization Mode Selector**

AUTO – pressurization system controlled automatically.

ALTN – pressurization system controlled automatically using ALTN controller.

MAN –

- pressurization system controlled manually by outflow valve switch
- both auto controllers bypassed.

**12 Cabin /Flight Altitude (CAB ALT)(FLT ALT) Placard**

Used to determine setting for cabin altitude when operating in manual mode.

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## Air Systems

### Bleed Air System Description

## Chapter 2

### Section 20

#### Introduction

Air for the bleed air system can be supplied by the engines, APU, or an external air cart/source. The APU or external cart supplies air to the bleed air duct prior to engine start. After engine start, air for the bleed air system is normally supplied by the engines.

The following systems rely on the bleed air system for operation:

- Air conditioning/pressurization
- Wing and engine thermal anti-icing
- Engine starting
- Hydraulic reservoirs pressurization
- Water tank pressurization

#### [Option - Aspirated TAT]

- 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. Differences between L and R duct pressure on the bleed air duct pressure indicator are considered normal as long as there is sufficient air for cabin pressurization.

## 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.

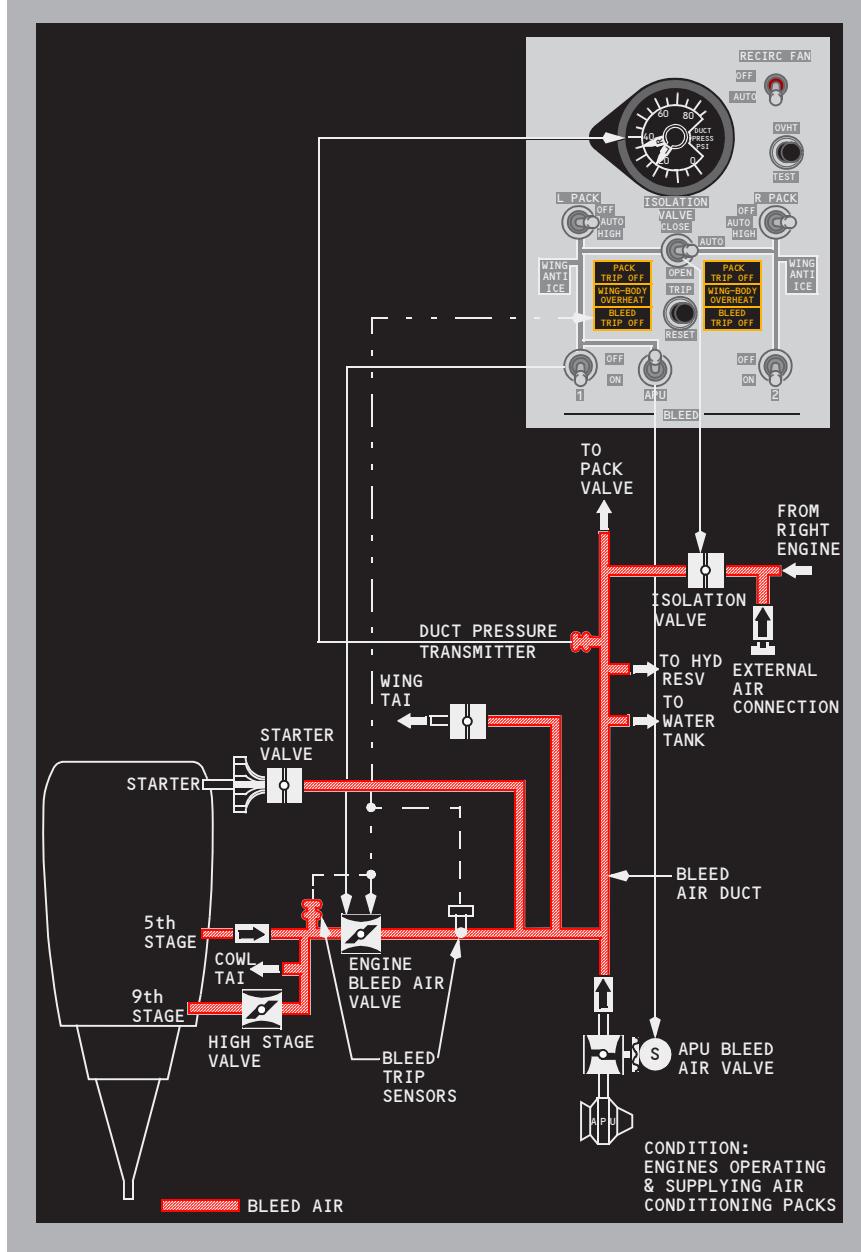
With both the APU and engine bleed air valves open, and the engines operating at idle thrust, there is a possibility of APU bleed air backpressuring the 9th stage modulating and shutoff valve. This would cause the 9th stage valve to close.

## DUAL BLEED Light

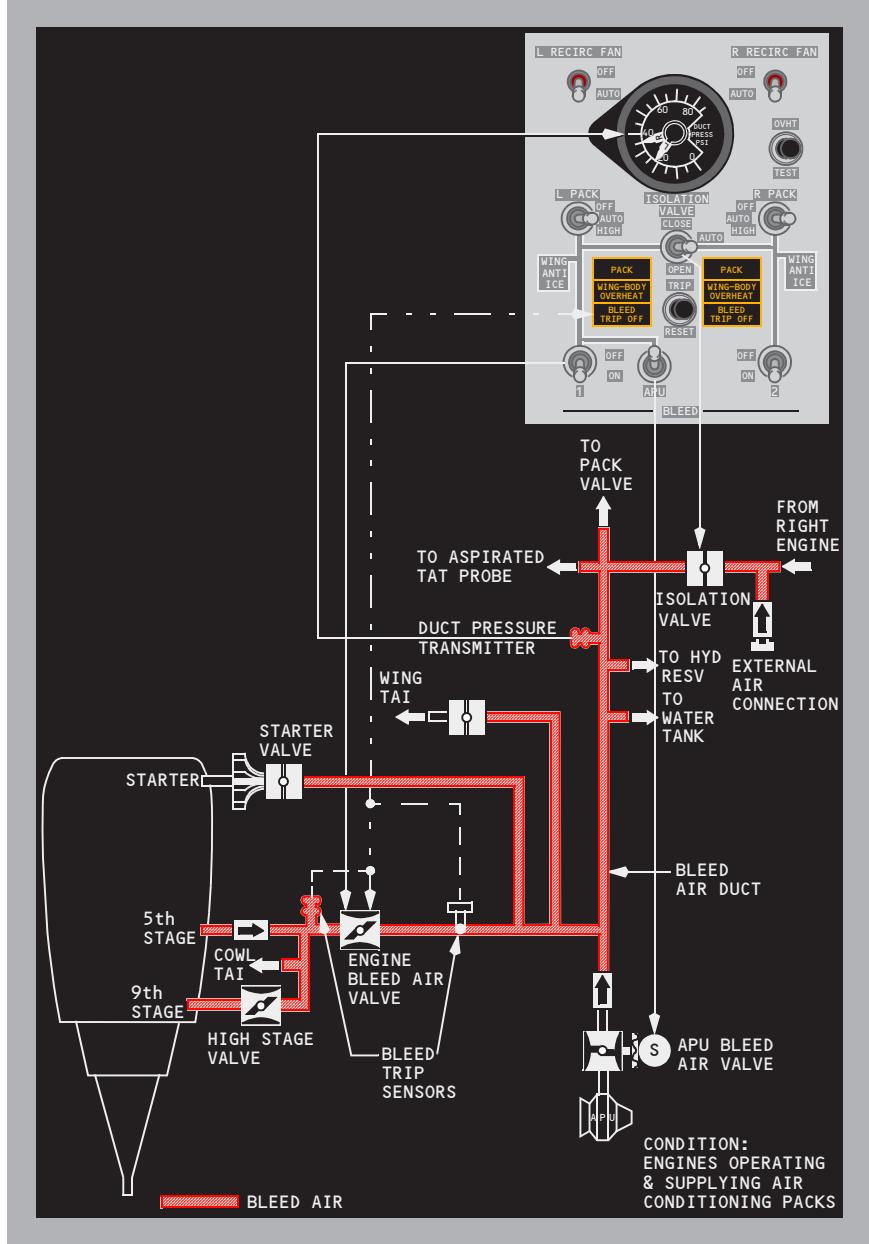
The DUAL BLEED light illuminates whenever the APU bleed air valve is open and the position of the engine bleed air switches and isolation valve would permit possible backpressure of the APU. Therefore, thrust must be limited to idle with the DUAL BLEED light illuminated.

## Bleed Air System Schematic

[737 - 600/700 with Non-Aspirated TAT or with Port-Capped TAT]



[737 - 800/900 with Aspirated TAT]

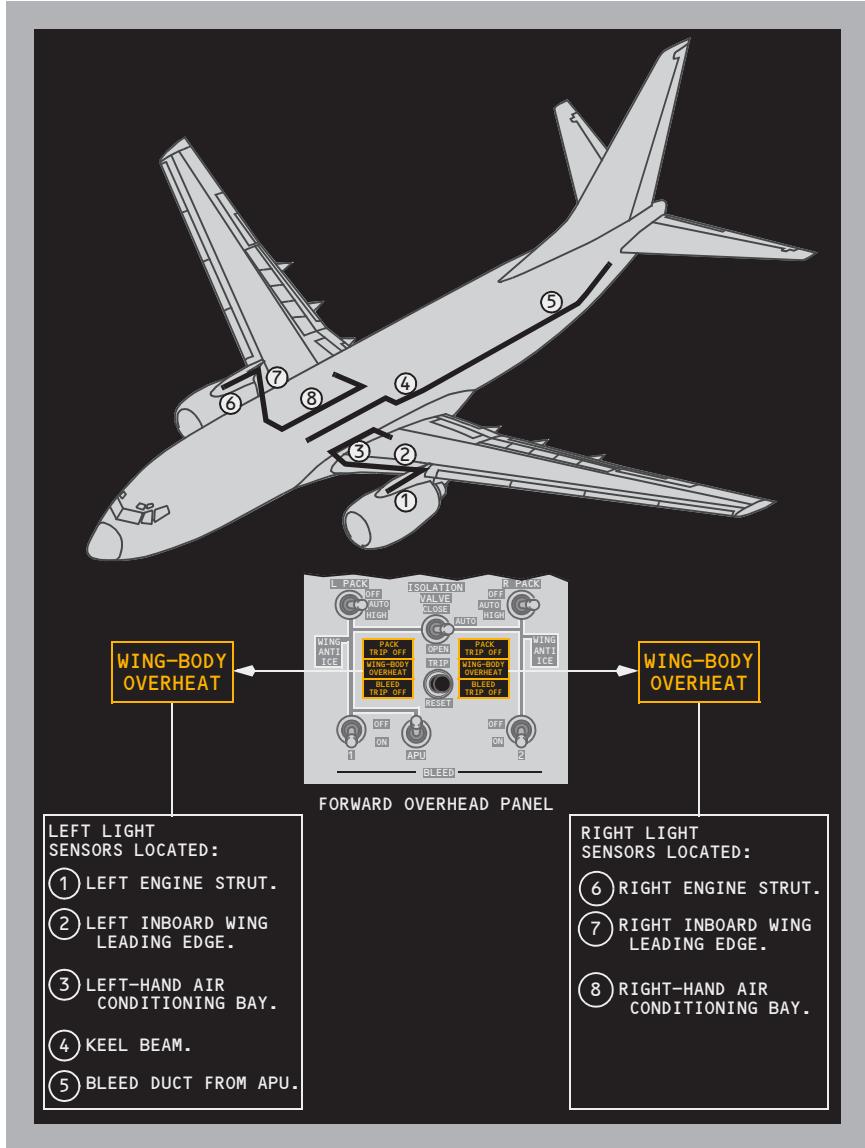


## Wing-Body Overheat

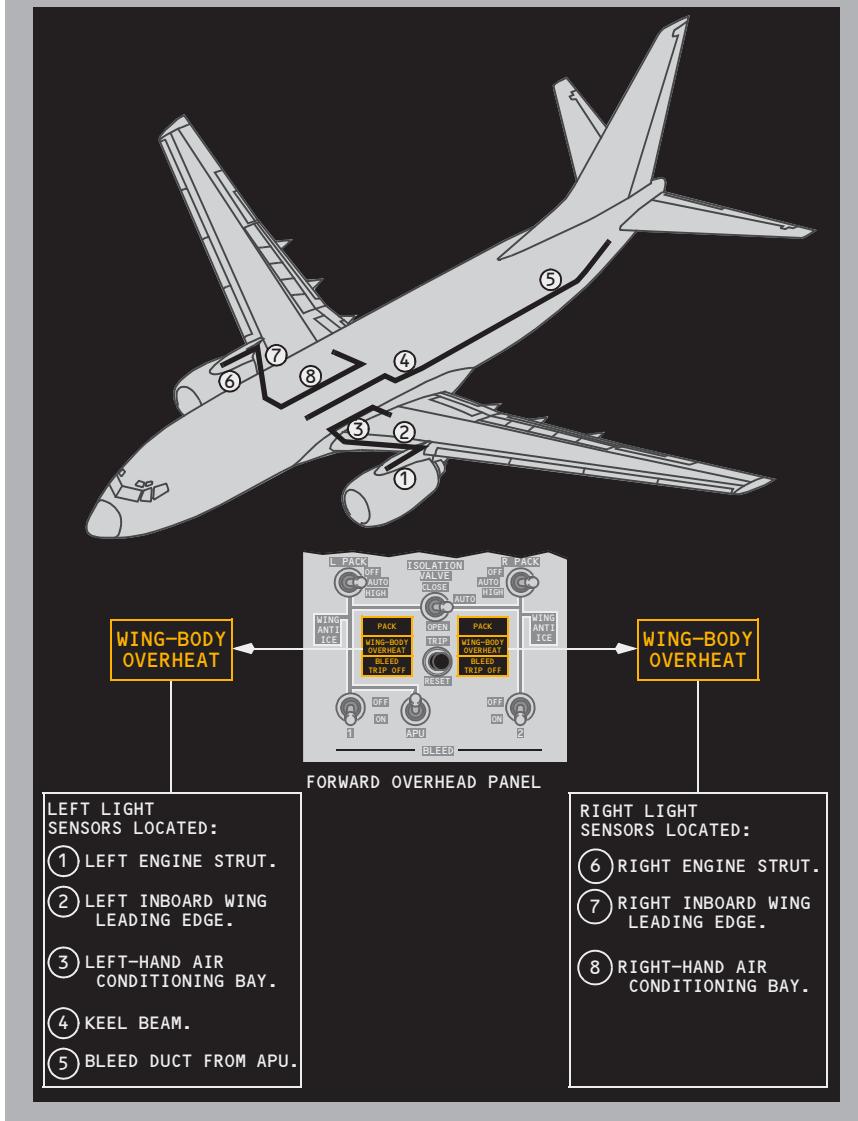
A wing-body overheating condition is caused by a bleed air duct leak. It is sensed by the overheating sensors located as shown.

## Wing-Body Overheat Ducts and Lights

[737 - 600/700]



[737 - 800/900]



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## Air Systems

### Air Conditioning System Description

## Chapter 2

### Section 30

[737-600/700]

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### 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 in high flow is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

The APU is capable of supplying bleed air for two packs on the ground, or one pack in flight. Most external air carts are capable of supplying adequate bleed air for two pack operation. Do not operate more than one pack from one engine at any time.

### 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 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. A RAM DOOR FULL OPEN light illuminates whenever a ram door is fully open.

Deflector doors are installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. Deflector doors extend 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.

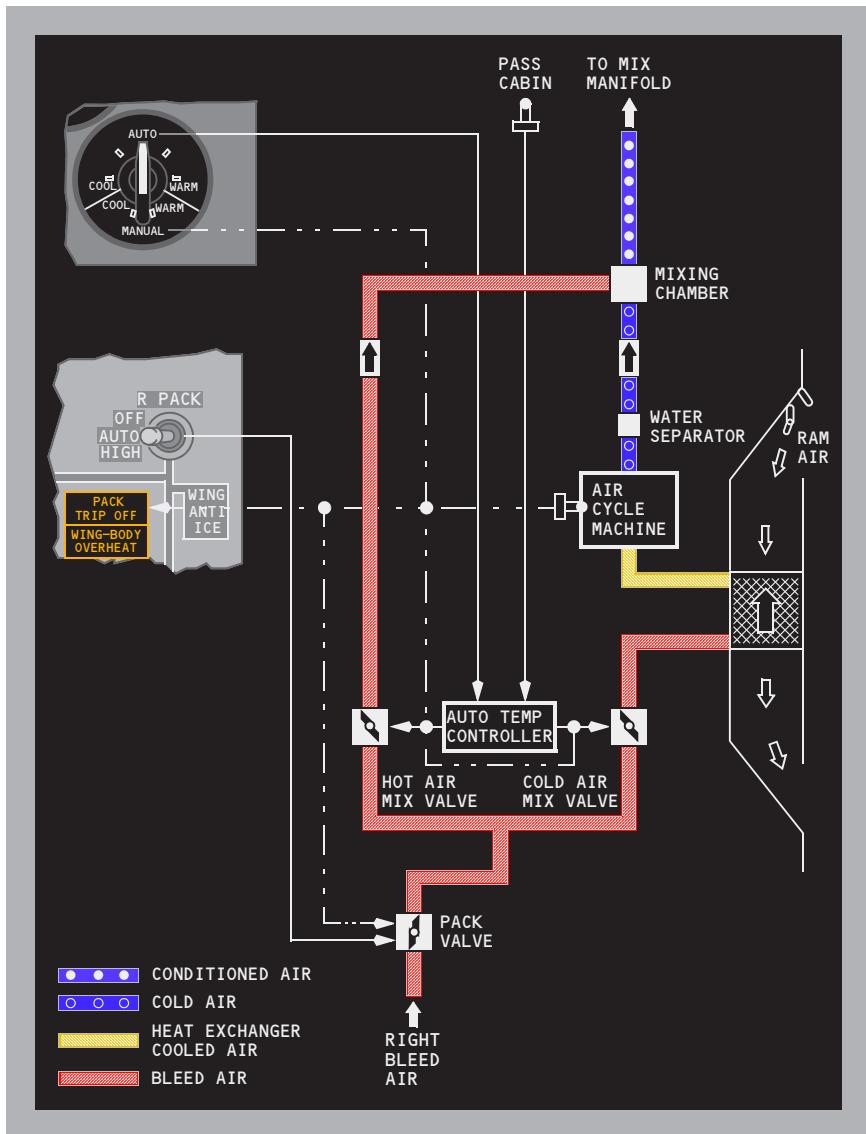
## Air Mix Valves

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 startup 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 recirc 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**

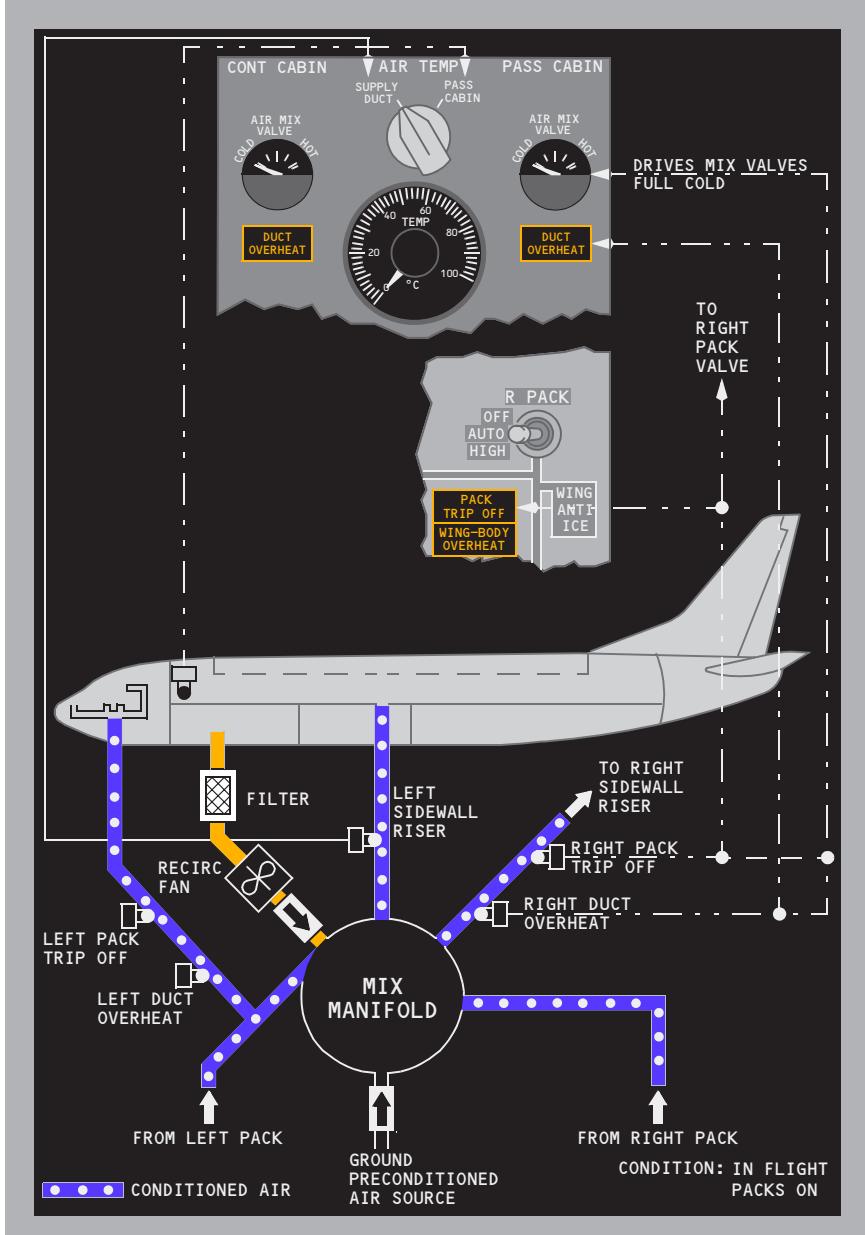
The recirculation fan system circulates air from the passenger cabin around the lining of the forward cargo compartment. When the overboard exhaust valve is closed, exhaust air from the equipment cooling system is also diffused to the lining of the forward cargo compartment for additional inflight heating.

## **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

[Option - Air Temperature Indicator in degrees C]



## Air Systems

### Air Conditioning System Description

## Chapter 2

### Section 31

[737-800/900]

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### 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 in high flow is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

The APU is capable of supplying bleed air for two packs on the ground, or one pack in flight. Most external air carts are capable of supplying adequate bleed air for two pack operation. Do not operate more than one pack from one engine at any time.

### 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 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. A RAM DOOR FULL OPEN light illuminates whenever a ram door is fully open.

Deflector doors are installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. Deflector doors extend when activated electrically by the air-ground safety sensor.

## Cooling Cycle

Flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration. The processed cold air is then combined with hot air which has bypassed the air cycle machine, then through a high pressure water separator which removes moisture. This conditioned air then flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK light to illuminate.

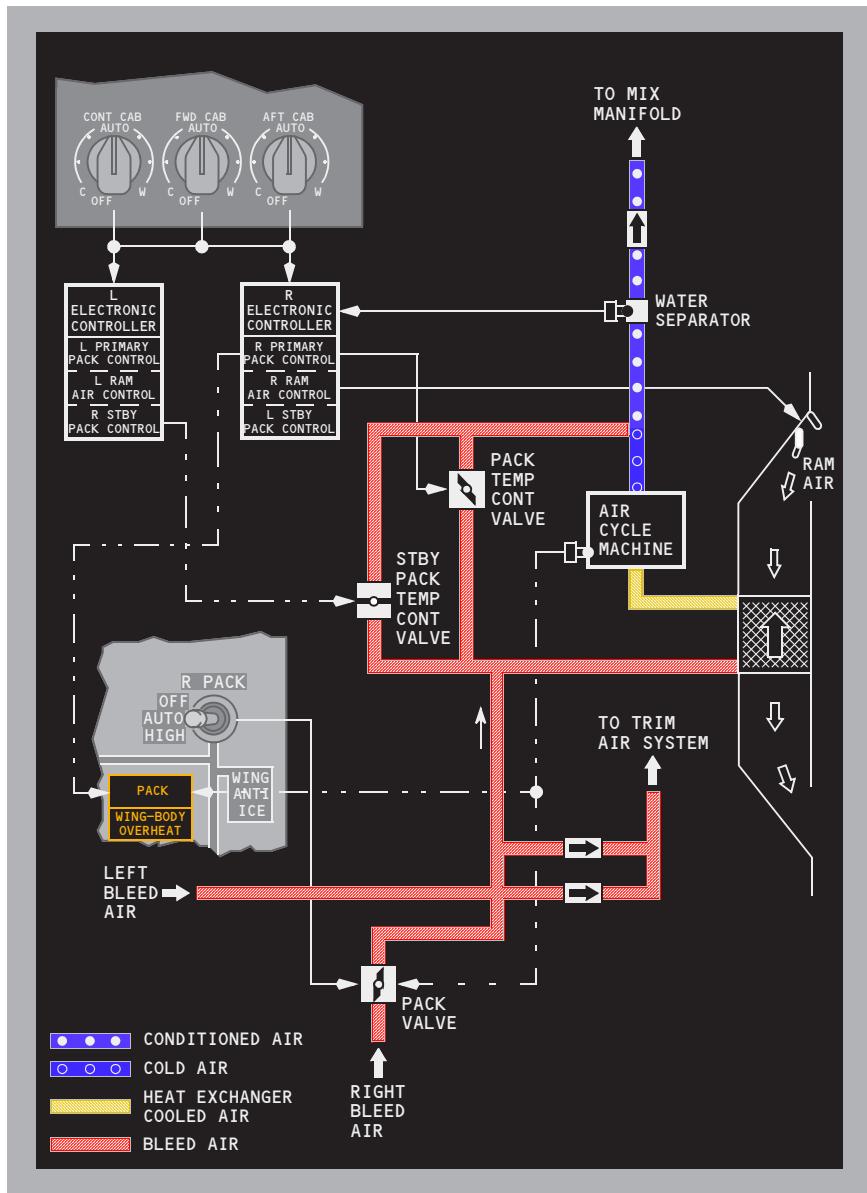
## Pack Temperature Control

Electronic controllers command the pack temperature control valve toward open or closed to satisfy pack discharge requirements.

If a primary pack control fails, the affected pack is controlled by the standby pack control in the opposite controller. A primary or standby pack control failure causes the PACK, MASTER CAUTION and AIR COND System Annunciator lights to illuminate during recall.

If both the primary and the standby pack controls fail for the same pack, the PACK, MASTER CAUTION, and AIR COND System Annunciator lights illuminate. The pack will continue to operate without control unless excessive temperatures cause the pack to trip off.

## Air Conditioning Pack Schematic



## Zone Temperature Control

There are three zones: flight deck, forward cabin and aft cabin. Desired zone temperature is set by adjusting the individual Temperature Selectors. The selector range is approximately 65°F (18°C) to 85°F (30°C).

The packs produce an air temperature that satisfies the zone which requires the most cooling. Zone temperature is controlled by introducing the proper amount of trim air to the zone supply ducts. The quantity of trim air is regulated by individual trim air modulating valves.

During single pack operation with the TRIM AIR selected ON, zone temperature is controlled the same as during two pack operation. During single pack operation with the TRIM AIR selected OFF, the pack attempts to produce an air temperature to satisfy the average temperature demands of all three zones.

If air in a zone supply duct overheats, the associated amber ZONE TEMP light illuminates, and the associated trim air modulating valve closes. The trim air modulating valve may be reopened after the duct has cooled by pushing the TRIP RESET Switch.

### Zone Temperature Control Modes

The left electronic controller controls the aft cabin zone and provides backup control for the flight deck. The right controller controls the forward cabin zone and provides primary control for the flight deck.

Failure of the primary flight deck temperature control will cause an automatic switch to the back up control and will illuminate the CONT CAB amber ZONE TEMP light upon Master Caution Recall. Failure of both the primary and standby controls will illuminate the lights automatically.

Failure of the forward or aft cabin temperature control will cause the associated trim air modulating valve to close. The Temperature Selectors operate normally, but the Temperature Selector settings of the two passenger cabin zones will be averaged. The amber ZONE TEMP light will illuminate upon Master Caution Recall to indicate failure of the associated zone control.

### Unbalanced Pack Temperature Control Mode

Any failure affecting the supply of trim air will cause the temperature control system to control both packs independently. If flight deck trim air is lost, the left pack will provide conditioned air to the flight deck at the selected temperature and the right pack will satisfy the demand of the passenger zone which requires the most cooling. If a passenger cabin zone trim air, or all trim air is lost, the forward and aft zone temperature demands will be averaged for control of the right pack.

If any individual zone is switched OFF, the Temperature Selector setting will be ignored by the temperature control system.

## Standby Pack Average Temperature

If all zone controls and primary pack controls fail, the standby pack controls command the packs to produce air temperatures which will satisfy the average temperature demand of the two cabin zones. The trim air modulating valves will close. The flight deck zone Temperature Selector will have no effect on the standby pack controls.

## Fixed Cabin Temperature

If all Temperature Selectors are positioned OFF, the pack controls will cause the left pack to maintain a fixed temperature of 75°F (24°C) and the right pack to maintain 65°F (18°C) as measured at the pack temperature sensor.

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## 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.

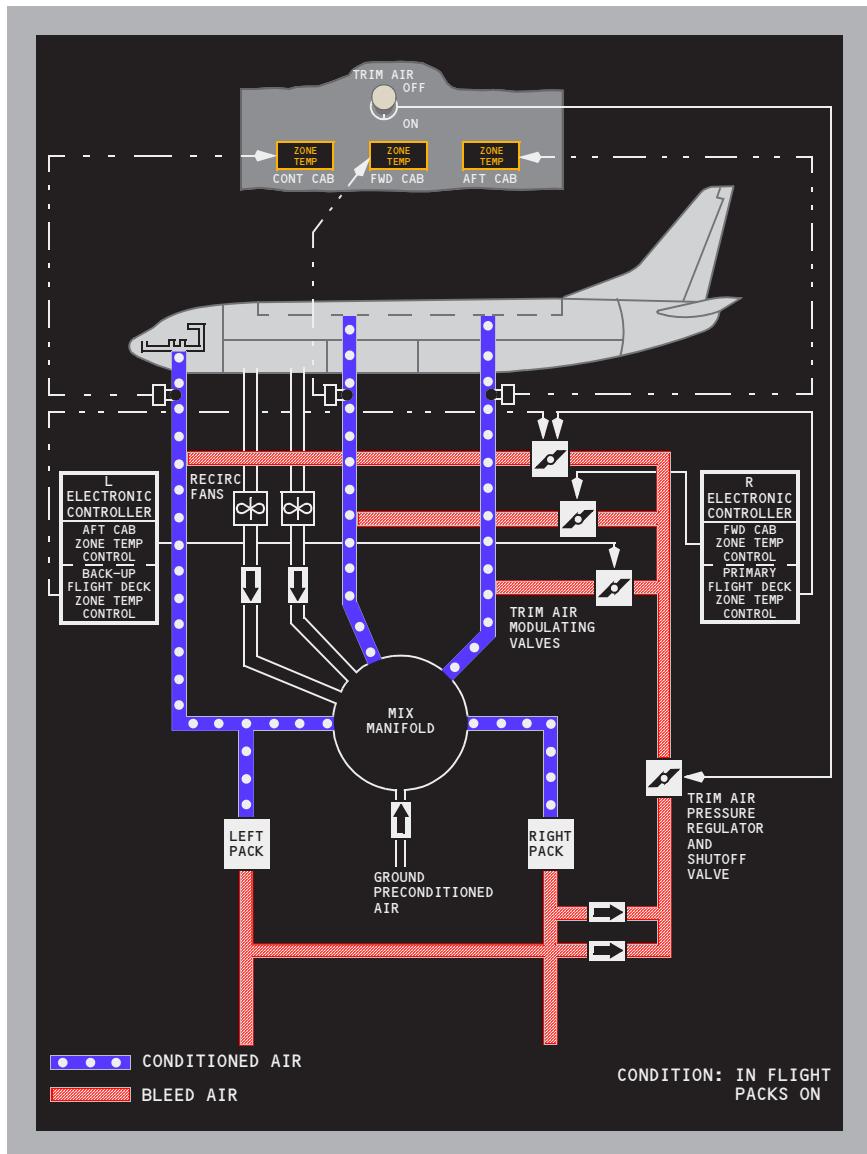
## Forward Cargo Compartment

The recirculation fan system circulates air from the passenger cabin around the lining of the forward cargo compartment. When the overboard exhaust valve is closed, exhaust air from the equipment cooling system is also diffused to the lining of the forward cargo compartment for additional inflight 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

### Pressurization System Description

## Chapter 2

### Section 40

---

#### Introduction

Cabin pressurization is controlled during all phases of airplane operation by the cabin pressure control system. The cabin pressure control system includes two identical automatic controllers available by selecting AUTO or ALTN and a manual (MAN) pilot-controlled mode.

The system uses bleed air supplied to and distributed by the air conditioning system. Pressurization and ventilation are controlled by modulating the outflow valve and the overboard exhaust valve.

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#### Pressure Relief Valves

Two pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum of 9.1 psi. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

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#### 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 41,000 feet.

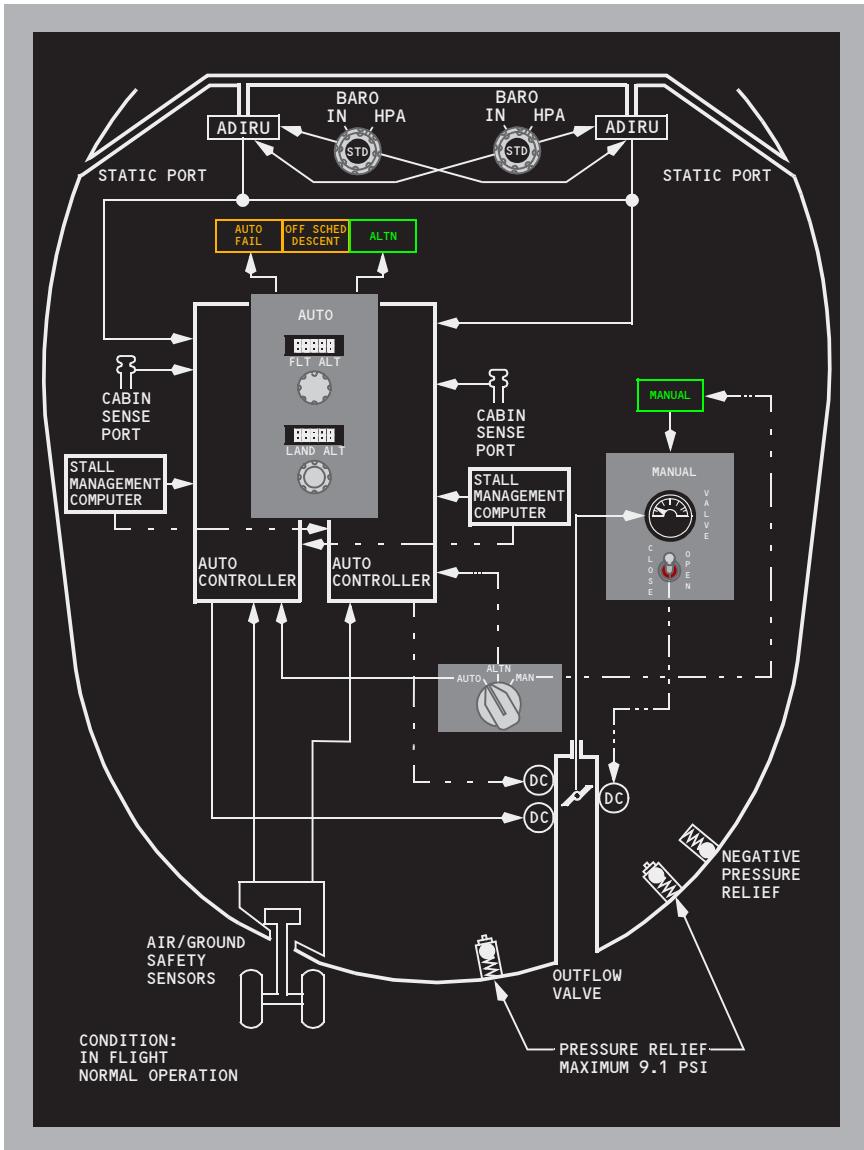
The cabin pressure controller controls cabin pressure in the following modes:

- AUTO – Automatic pressurization control; the normal mode of operation. Uses DC motor.
- ALTN – Automatic pressurization control; the alternate mode of operation. Uses DC motor.
- MAN – Manual control of the system using DC motor.

The air data inertial reference units (ADIRUs) provides ambient static pressure, baro corrected altitude, non corrected altitude and calibrated airspeed to both automatic controllers. The ADIRUs receive barometric corrections from the Captain's and First Officer's BARO reference selectors.

The automatic controllers also receive throttle position from both stall management computers and signals from the air/ground sensors.

## Cabin Pressure Control System Schematic



## Pressurization Outflow

Cabin air outflow is controlled by the outflow valve and the overboard exhaust valve. A small amount is also exhausted through toilet and galley vents, miscellaneous fixed vents, and by seal leakage.

## Outflow Valve

The 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 outflow valve.

## Overboard Exhaust Valve

On the ground and in flight with low differential pressure, the overboard exhaust valve is open and warm air from the E & E bay is discharged overboard. In flight, at higher cabin differential pressures, the overboard exhaust valve is normally closed and exhaust air is diffused to the lining of the forward cargo compartment.

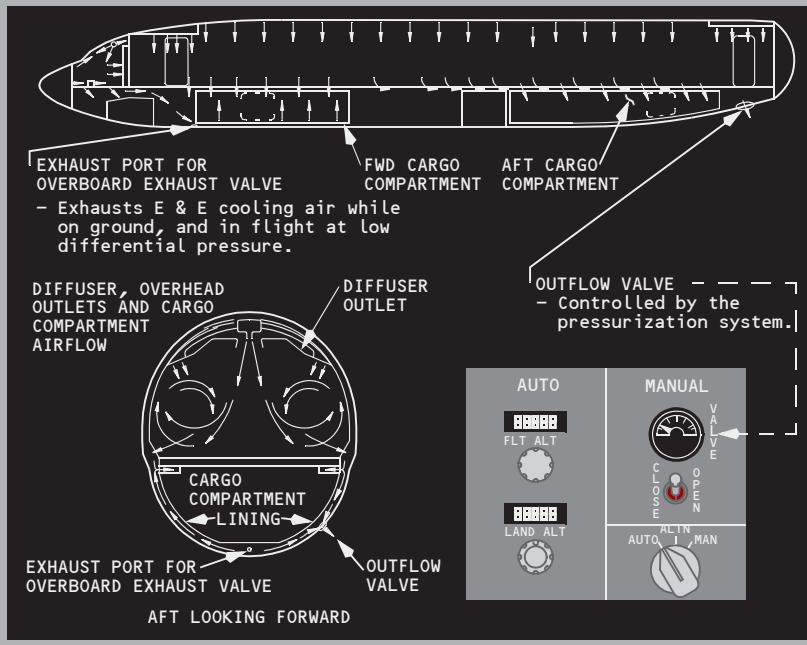
### [\[737-600 or 737-700\]](#)

However, the overboard exhaust valve is driven open if either pack switch is in high and the recirculation fan is off. This allows for increased ventilation in the smoke removal configuration.

### [\[737-800 or 737-900\]](#)

However, the overboard exhaust valve is driven open if either pack switch is in high and the right recirculation fan is off. This allows for increased ventilation in the smoke removal configuration.

## Pressurization Outflow Schematic



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## Auto Mode Operation

The AUTO system consists of two identical controllers, with one controller alternately sequenced as the primary operational controller for each new flight. The other automatic controller is immediately available as a backup.

In the AUTO or ALTN mode, the pressurization control panel is used to preset two altitudes into the auto controllers:

- FLT ALT (flight or cruise altitude).
- LAND ALT (landing or destination airport altitude).

Takeoff airport altitude (actually cabin altitude) is fed into the auto controllers 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 and at lower power settings, the cabin is depressurized by driving the outflow valve to the full open position.

The cabin begins to pressurize on the ground at higher power settings. The controller modulates the 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 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 8.35 psid above 37,000 feet, 7.80 psid with the FLT ALT between 28,000 and 37,000 feet, and 7.45 psid with FLT ALT less than 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 8.35 psid above 37,000 feet, 7.80 psid with the FLT ALT between 28,000 and 37,000 feet, and 7.45 psid with FLT ALT less than 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 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.

While taxiing in, the controller drives the outflow valve slowly to the full open position depressurizing the cabin.

An amber AUTO FAIL light illuminates if any of the following conditions occurs:

- Loss of DC power
- Controller fault
- Outflow valve control fault
- Excessive differential pressure ( $> 8.75$  psi)\*
- Excessive rate of cabin pressure change ( $\pm 2000$  sea level feet/minute)\*
- High cabin altitude (above 15,800 feet).\*

\*If controller is not responding properly

With illumination of the AUTO FAIL light, the pressure control automatically transfers to the other auto controller (ALTN mode).

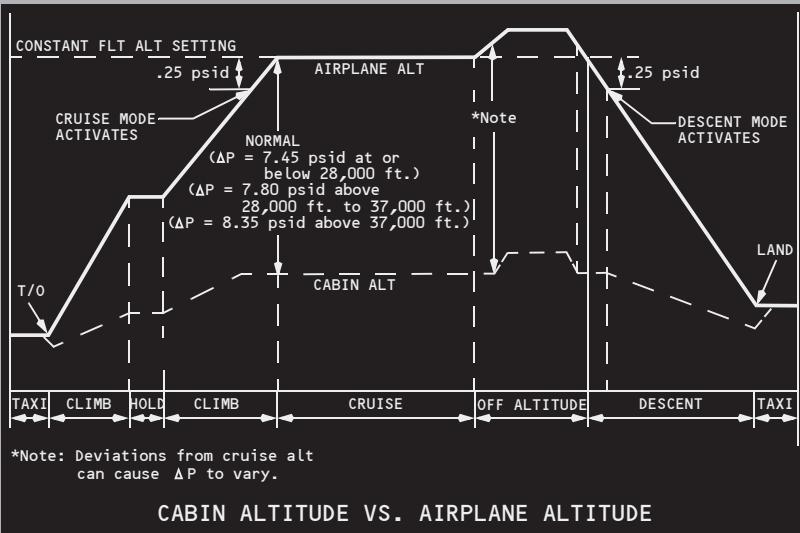
Moving the pressurization mode selector to the ALTN position extinguishes the AUTO FAIL light, however the ALTN light remains illuminated to indicate single channel operation.

## High Altitude Landing

### [Option - High Altitude Landing System]

When the high altitude landing system is engaged and the actual landing altitude is set, the controller brings the cabin altitude to the landing airport elevation when the descent mode is activated. Upon departure from a high altitude airport, the system returns to normal operation as the cabin descends through 8,000 feet.

## Flight Path Events – Auto Mode



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## Manual Mode Operation

A green MANUAL Light illuminates with the pressurization mode selector in the MAN position.

Manual control of the cabin altitude is used if both the AUTO and ALTN modes are inoperative. In the MAN mode, the outflow valve position switch is used to modulate the outflow valve by monitoring the cabin altitude panel and valve position on the outflow valve position indicator. A separate DC motor, powered by the DC standby system, drives the outflow valve at a slower rate than the automatic modes. Outflow valve full range of motion takes up to 20 seconds.

**Anti-Ice, Rain  
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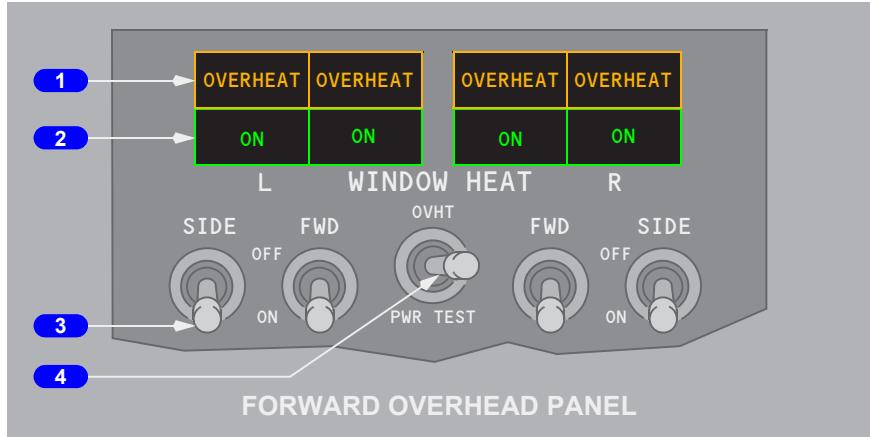
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## Anti-Ice, Rain Controls and Indicators

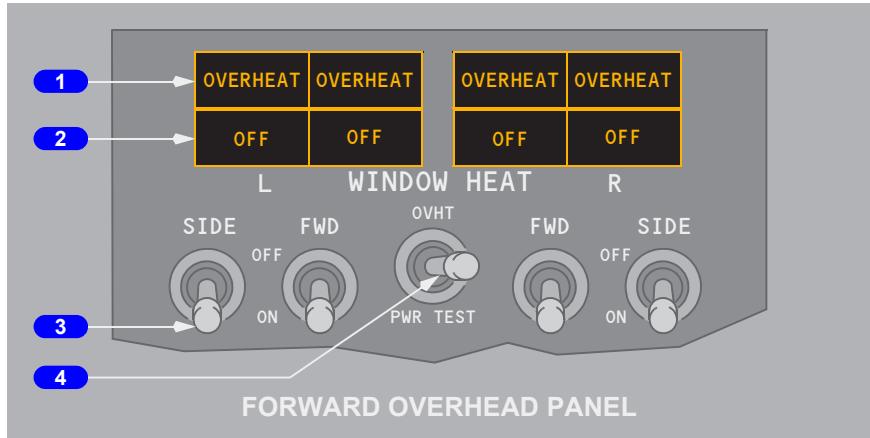
## Chapter 3 Section 10

### Window Heat Panel

[Option – Green ON Lights]



[Option – Amber OFF Lights]



#### 1 Window OVERHEAT Lights

Illuminated (amber) – overheat condition is detected.

**Note:** OVERHEAT lights also illuminate if electrical power to window(s) is interrupted.

## 2 Window Heat ON Lights

### [Option – Green ON Lights]

Illuminated (green) – window heat is being applied to selected window(s).

Extinguished –

- switch is OFF, or
- an overheat is detected, or
- a system failure has occurred
- system is at correct temperature.

## 2 Window Heat OFF Lights

### [Option – Amber OFF Lights]

Illuminated (amber) –

- switch is OFF, or
- an overheat is detected, or
- a system failure has occurred
- system is at correct temperature.

Extinguished – window heat is being applied to selected window(s).

## 3 WINDOW HEAT Switches

ON – window heat is applied to selected window(s).

OFF – window heat not in use.

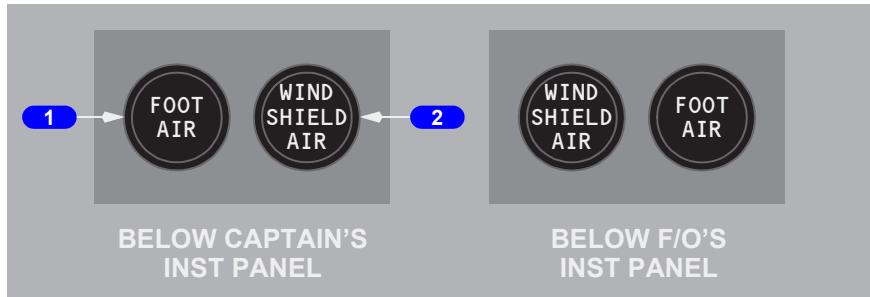
## 4 WINDOW HEAT Test Switch (spring-loaded to neutral)

OVHT – simulates an overheat condition.

PWR TEST – provides a confidence test.

**Note:** Refer to Supplementary Normal Procedures for Window Heat Test procedures.

## Windshield/Foot Air Controls



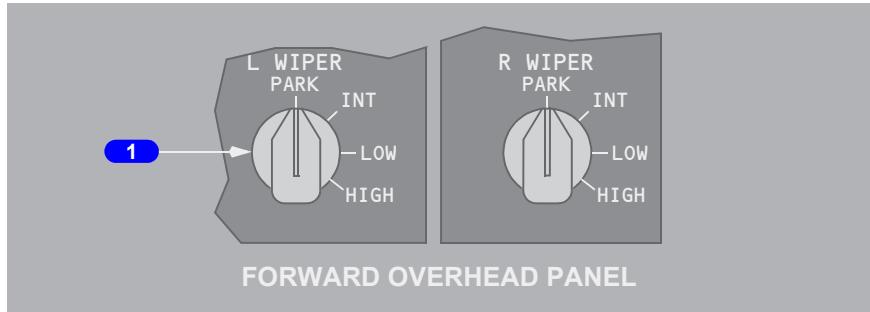
### 1 FOOT AIR Controls

PULL – supplies conditioned air to pilots' leg positions.

### 2 WINDSHIELD AIR Controls

PULL – supplies conditioned air to number 1 windows for defogging.

## Windshield Wiper Selector Panel



### 1 Windshield WIPER Selectors

PARK – turns off wiper motors and stows wiper blades.

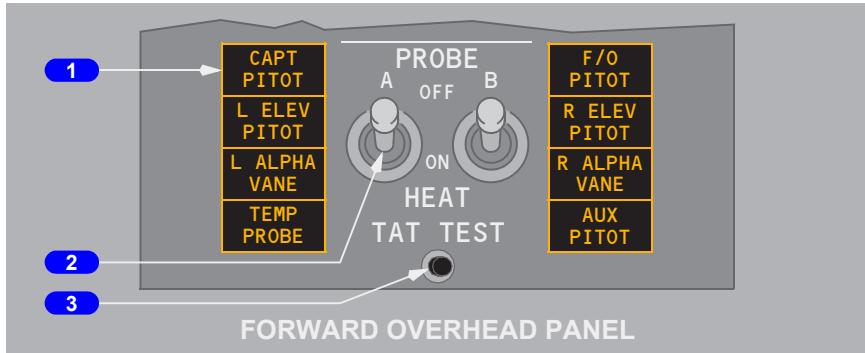
INT – seven second intermittent operation.

LOW – low speed operation.

HIGH – high speed operation.

## Probe Heat Panel

[Option - Aspirated TAT]



### 1 Probe Heat Lights

Illuminated (amber) – related probe not heated.

**Note:** If operating on standby power, probe heat lights do not indicate system status.

### 2 PROBE HEAT Switches

ON – power is supplied to heat related system.

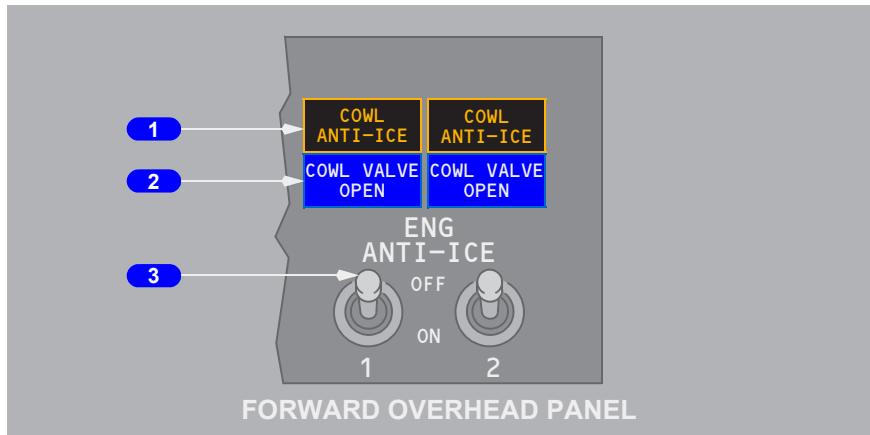
OFF – power off.

### 3 TAT TEST Switch

[Option - Aspirated TAT]

Push - Electrical power applied to TEMP PROBE on the ground.

## Engine Anti-Ice Panel



### 1 COWL ANTI-ICE Lights

Illuminated (amber) – indicates an overpressure 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 Switches

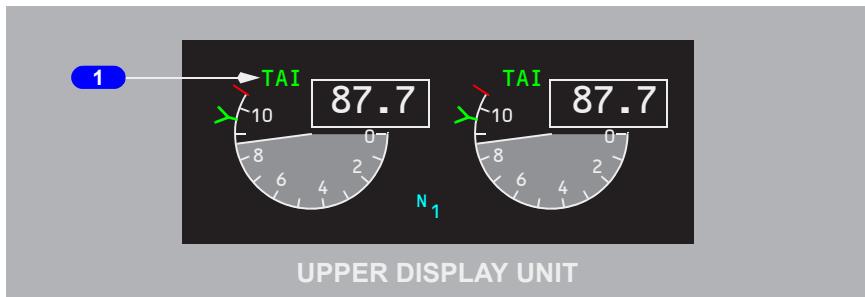
ON –

- related engine anti-ice valve is open
- stick shaker logic is set for icing conditions.

OFF –

- related engine anti-ice valve is closed
- stick shaker logic returns to normal if wing anti-ice has not been used in flight.

## Thermal Anti-Ice Indication



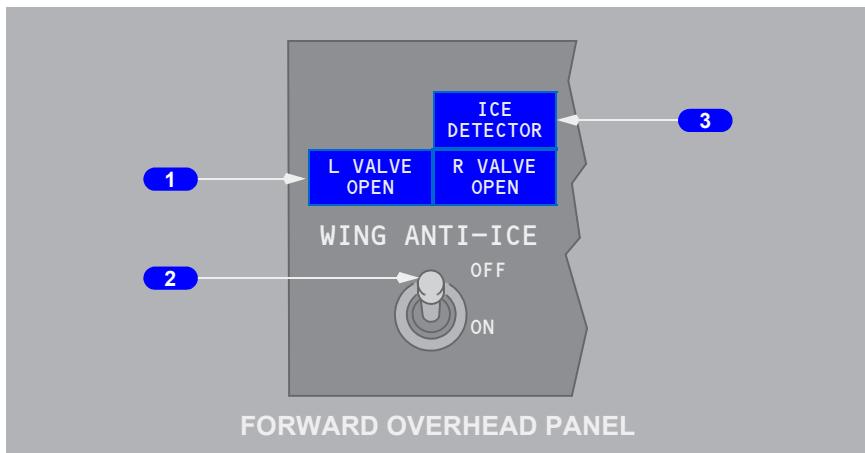
### 1 Thermal Anti-Ice Indications

Illuminated –

- Green – cowl anti-ice valve(s) open
- Amber – cowl anti-ice valve is not in position indicated by related engine anti-ice switch.

## Wing Anti-Ice Panel

[Option - ICE DETECTOR System]



### 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 are closed.

ON (in the air) –

- wing anti-ice control valves are open
- stick shaker logic is set for icing conditions.

**Note:** Stick shaker logic remains set for icing conditions for the remainder of the flight, regardless of subsequent WING ANTI-ICE switch position.

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.

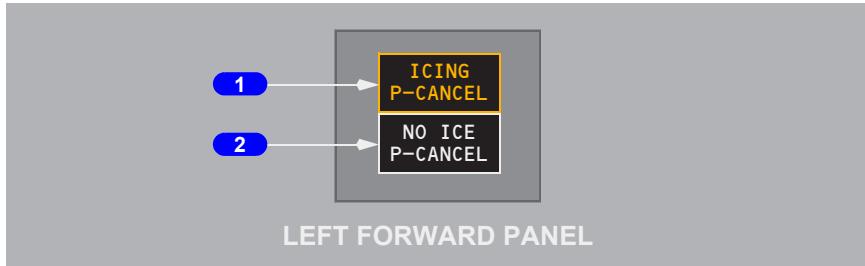
## 3 ICE DETECTOR Light

### [Option - ICE DETECTOR System]

Illuminated (amber) – Ice detector system has failed.

### Icing Advisory Lights

### [Option - Icing Detector System]



## 1 ICING Light

Illuminated (amber) –

- ice detector is detecting ice
- light is inhibited on the ground.

Press – extinguishes light, if illuminated.

## **2 NO ICE Light**

Illuminated (white) –

- ice detector is not detecting ice, and the ice detector probe had previously detected ice
- light is inhibited on the ground.

Press – extinguishes light, if illuminated.

## Anti-Ice, Rain System Description

## Chapter 3 Section 20

### Introduction

Thermal anti-icing (TAI), electrical anti-icing, and windshield wipers are the systems provided for ice and rain protection.

The anti-ice and rain systems include:

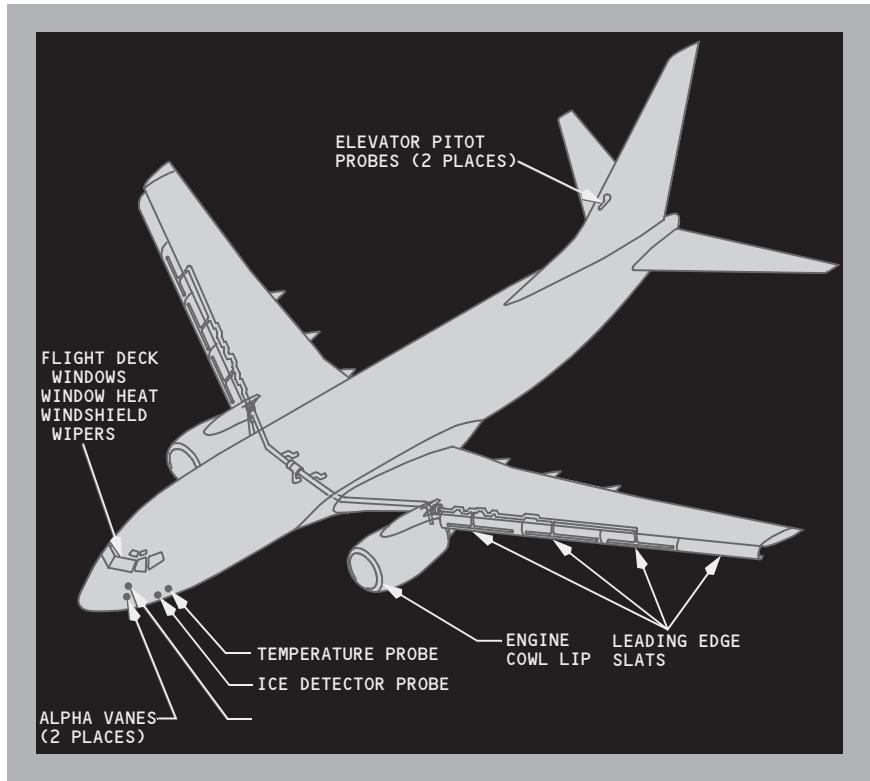
- Flight Deck Window Heat
- Windshield Wipers
- Probe and Sensor Heat
- Engine Anti-Ice System
- Wing Anti-Ice System

[Option]

- Ice Detection System

### Anti-Ice Components Diagram

[Option - Ice detector probe]



## Flight Deck Window Heat

### [Option – Window # 3 not heated]

Flight deck window numbers 1, 2, 4 and 5 consist of glass panes laminated to each side of a vinyl core. Flight deck window number 4 has an additional vinyl layer and acrylic sheet laminated to the inside surface. Flight deck window number 3 consists of two acrylic panes separated by an air space.

### [Option – Window # 3 not heated]

A conductive coating on the outer glass pane of window numbers 1 and 2 permits electrical heating to prevent ice build-up and fogging. A conductive coating on the inner glass pane of window numbers 4 and 5 permits electrical heating to prevent fogging. Window number 3 is not electrically heated.

### [Option – Window # 3 heated]

Flight deck windows consist of glass panes laminated to each side of a vinyl core. Flight deck window number 4 has an additional vinyl layer and acrylic sheet laminated to the inside surface.

### [Option – Window # 3 heated]

A conductive coating on the outer glass pane of window numbers 1 and 2 permits electrical heating to prevent ice build-up and fogging. A conductive coating on the inner glass pane of window numbers 3, 4 and 5 permits electrical heating to prevent fogging.

## Flight Deck Window Heat Operation

### [Option – Window # 3 not heated]

The FWD WINDOW HEAT switches control heat to window No. 1. The SIDE WINDOW HEAT switches control heat to window number 2, 4, and 5.

### [Option – Window # 3 not heated]

Temperature controllers maintain window numbers 1 and 2 at the correct temperature to ensure maximum strength of the windows in the event of bird impact. Power to window numbers 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 window numbers 4 and 5.

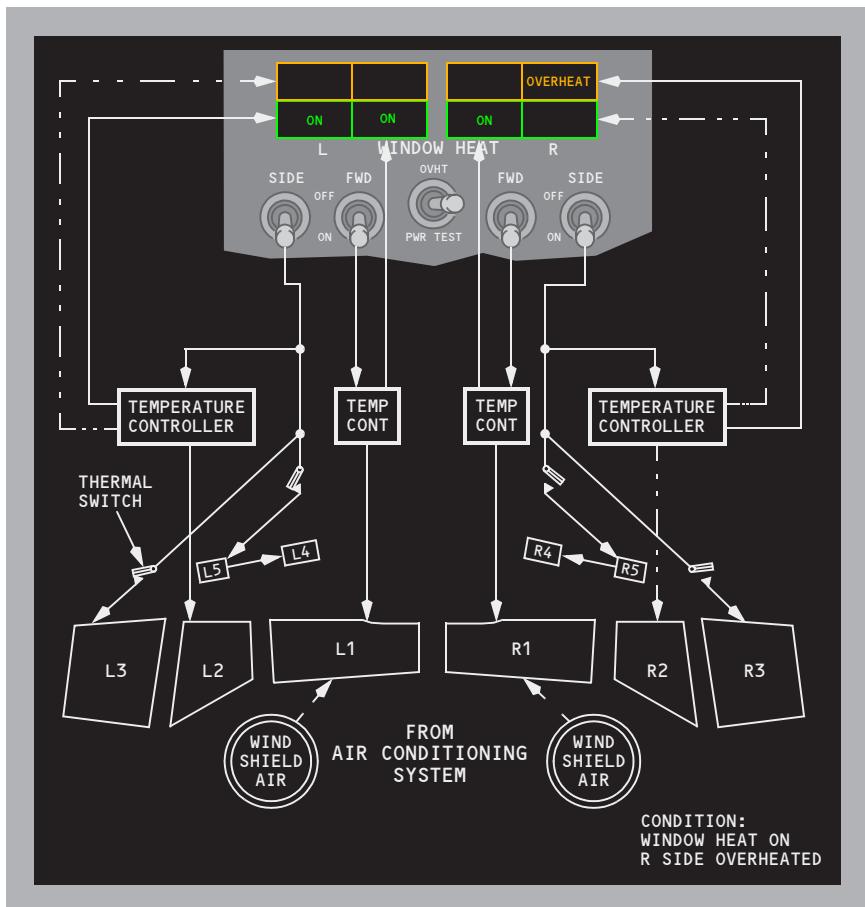
### [Option – Window # 3 heated]

The FWD WINDOW HEAT switches control heat to window number 1. The SIDE WINDOW HEAT switches control heat to window numbers 2, 3, 4 and 5.

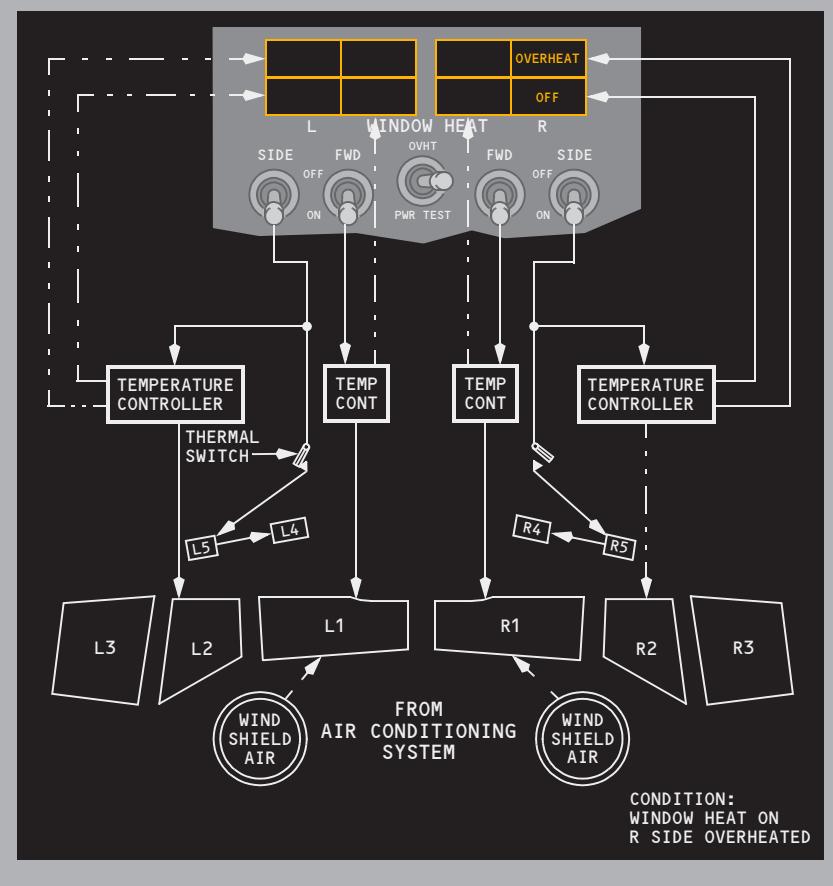
**[Option – Window # 3 heated]**

Temperature controllers maintain windows numbers 1 and 2 at the correct temperature to ensure maximum strength of the windows in the event of bird impact. Power to window numbers 1 and 2 is automatically removed if an overheat condition is detected. Thermal switches, located on window numbers 3 and 5, open and close to maintain the correct temperature of window numbers 3, 4, and 5.

## Flight Deck Window Heat Schematic

**[Option –Window # 3 heated and green ON lights]**


[Option –Window # 3 not heated and amber OFF lights]



## Windshield Wipers

The rain removal system for the forward windows consists of windshield wipers and a permanent rain repellent coating on the windows.

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

---

## Probe and Sensor Heat

### [Option - Captain's pitot probe on standby power]

Pitot probes, the total air temperature probe and the alpha vanes are electrically heated. Static ports are not heated. When operating on standby power, only the captain's pitot probe is heated, however, the CAPT PITOT light does not illuminate for a failure.

**Note:** The pitot probe for standby airspeed is not heated when the airplane is on standby power.

---

## Ice Detection System

### [Option]

An advisory only ice detection system detects airplane icing in flight. The system consists of a probe located on the forward left fuselage and advisory lights located on the left forward panel.

When the probe senses ice build-up inflight, the ICING light illuminates. When ice has previously been detected and the probe is no longer detecting ice, the ICING light will extinguish and the NO ICE light will illuminate. The ICING light and the NO ICE light do not illuminate simultaneously.

**Note:** Residual ice may remain on the window areas with the NO ICE light illuminated.

The ICE DETECTOR light, located on the forward overhead panel, will illuminate if the ice detection system fails. Illumination of the ICE DETECTOR light also illuminates the MASTER CAUTION and ANTI-ICE system annunciator lights.

---

## 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
- sets stall warning logic for icing conditions.

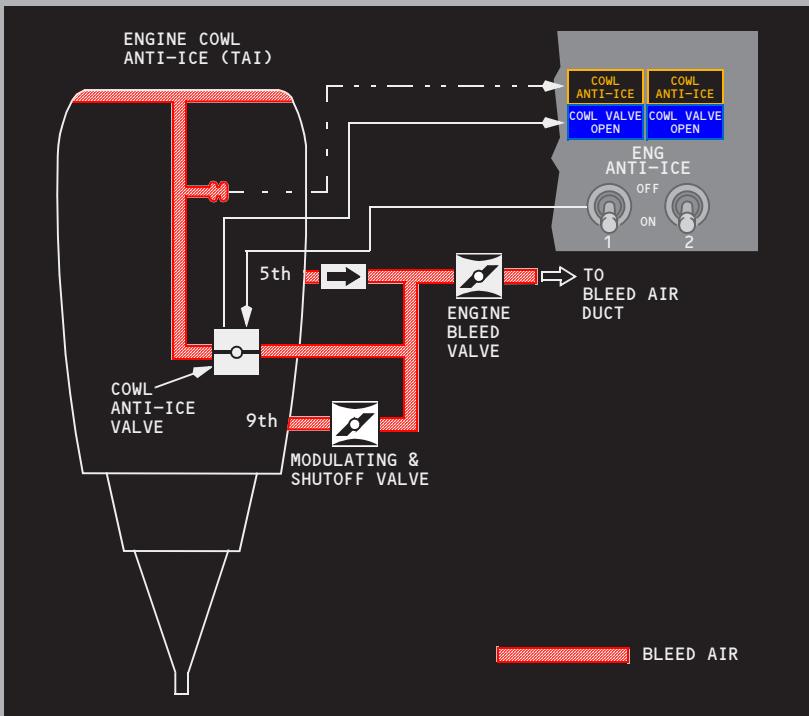
**Note:** Stall warning logic adjusts stick shaker and minimum maneuver speed bars on the airspeed indicator. FMC displayed VREF is not adjusted automatically.

**Note:** Stall warning logic, airspeed indications, and minimum maneuver speeds on the airspeed indicator return to normal when engine anti-ice is positioned OFF if wing anti-ice has not been used in flight.

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 and an amber TAI indication illuminates on the CDS after a short delay.

The amber COWL ANTI-ICE light illuminates due to excessive 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 three inboard leading edge slats by using bleed air. The wing anti-ice system does not include the leading edge flaps or the outboard leading edge slats.

The wing anti-ice control valves are AC motor-operated. With a valve open, bleed air flows to the three leading edge inboard slats, 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.

Positioning the WING ANTI-ICE switch to ON in flight:

- opens both control valves
- sets stall warning logic for icing conditions.

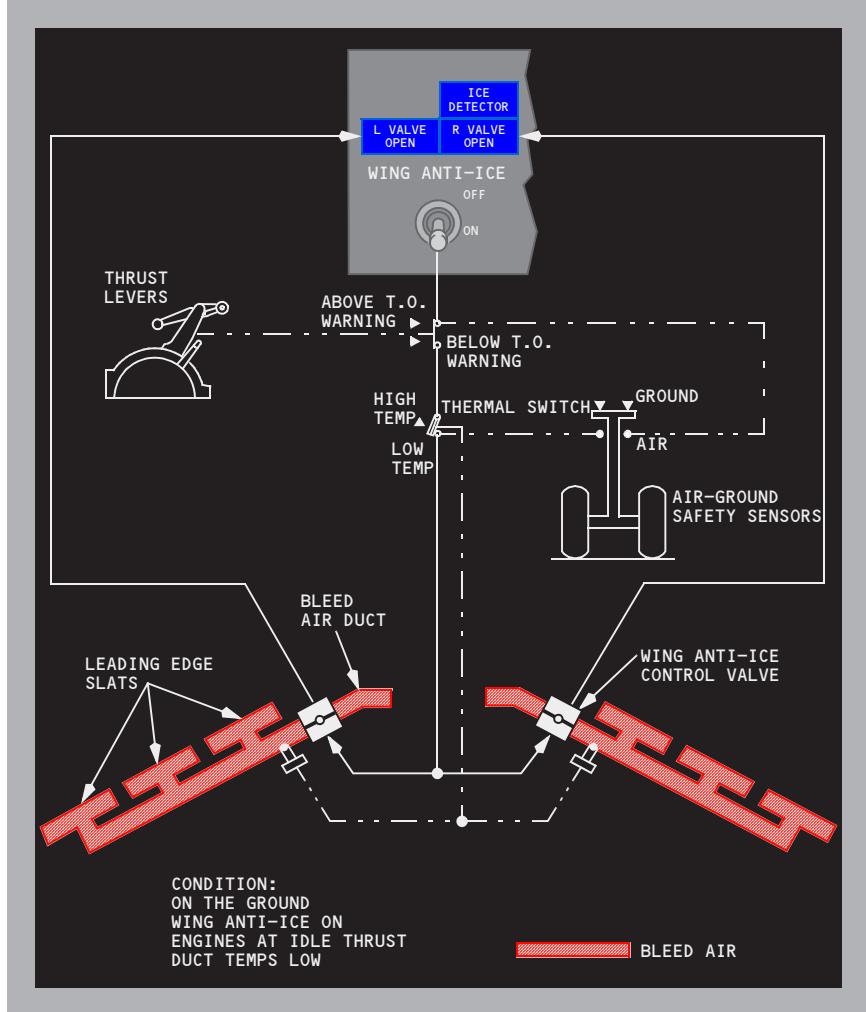
**Note:** Stall warning logic adjusts stick shaker and minimum maneuver speed bars on airspeed indications. FMC displayed VREF is not adjusted automatically.

**Note:** Stall warning logic remains set for icing conditions for the remainder of the flight, regardless of subsequent WING ANTI-ICE switch position.

Valve position is monitored by the blue VALVE OPEN lights. Duct temperature and thrust setting logic are disabled and have no affect on control valve operation in flight.

## Wing Anti-Ice System Schematic

[Option - ICE DETECTOR light]



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# Automatic Flight Controls and Indicators

# Chapter 4 Section 10

## Mode Control Panel (MCP)

[Option - Collins MCP with speed and altitude intervention]  
Below Vertical Speed window there is a white light sensor on all Collins MCP.

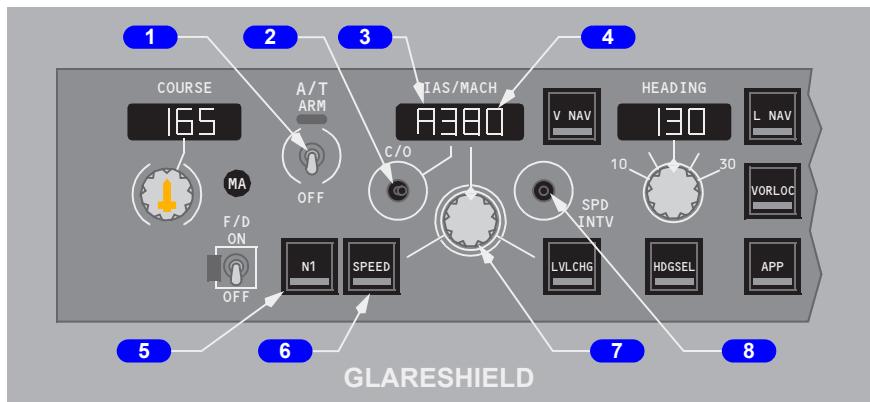


[Option - Honeywell MCP without speed and altitude intervention]

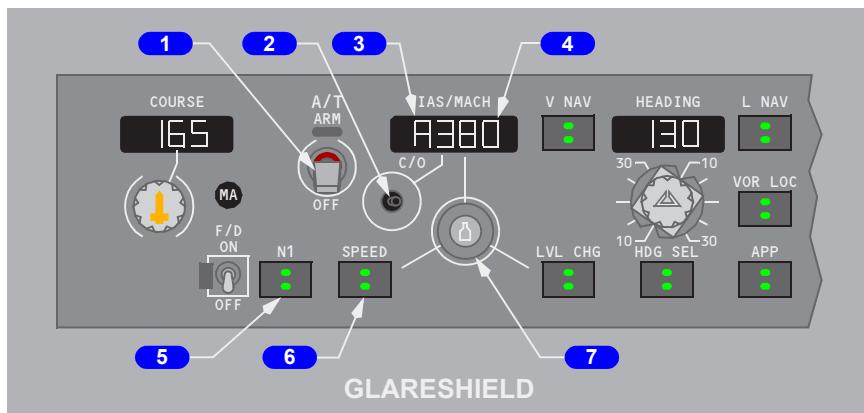


## Speed Controls

[Option - With speed and altitude intervention]



[Option - Without speed and altitude intervention]



### 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.

The indicator light illuminates green when A/T ARM switch is in the ARM position.

OFF – disengages A/T and prevents A/T engagement.

### 2 Changeover (C/O) Switch

Push –

- changes IAS/MACH display between IAS and MACH
- automatic changeover occurs at approximately FL260.

### 3 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.

#### **4 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 100 knots when power is first applied
- display range is:
  - 100 KIAS – Vmo in 1 knot increments
  - .60M – Mmo in .01M increments.

#### **5 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 inhibit period for 2 1/2 minutes after lift-off)
  - engaging VNAV in climb.

#### **6 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.

## 7 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.

## 8 Speed Intervention (SPD INTV) Switch

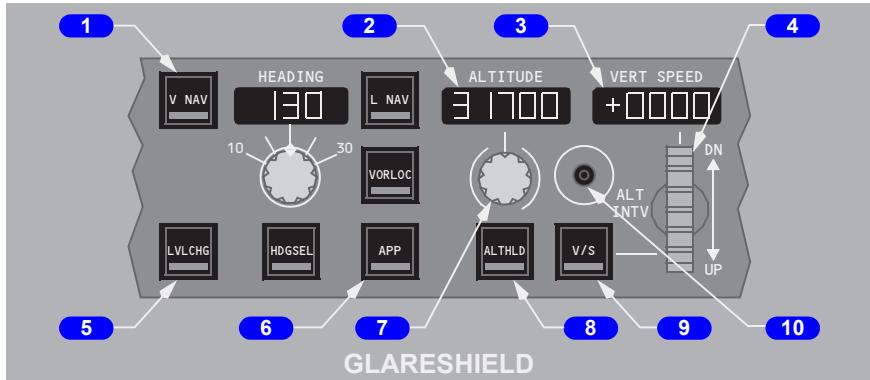
### [Option - With speed and altitude intervention]

Push (when VNAV engaged) –

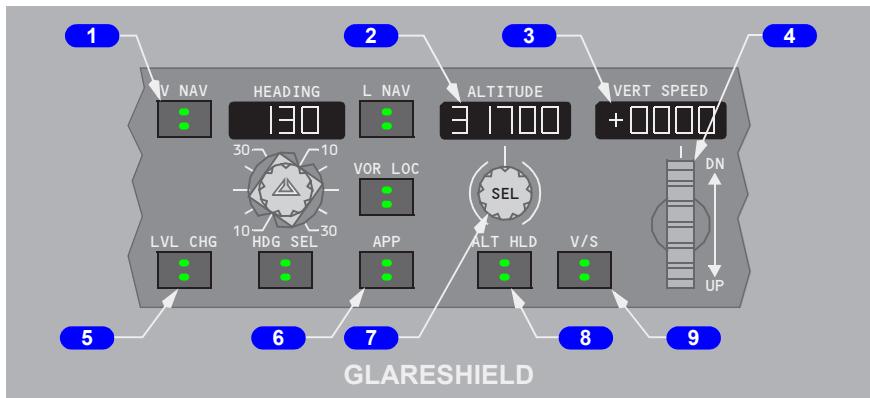
- IAS/MACH display alternately shows selected IAS/Mach and blanks
- when IAS/MACH display is unblanked, FMC speed intervention is active, FMC target speed is displayed, and IAS/MACH Selector may be used to set desired speed
- when IAS/MACH display is blank, FMC computed target speed is active and displayed on the airspeed indicator.

## Vertical Navigation

[Option - With speed and altitude intervention]



[Option - Without speed and altitude intervention]



### 1 VNAV Switch

Push –

- VNAV switch light illuminates

[Option - With VNAV ALT enabled]

- pitch mode annunciates VNAV SPD, VNAV PTH, or VNAV ALT
- 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.

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

[Option - With VNAV ALT enabled]

- MCP constrained altitude announces VNAV ALT
- VNAV constrained altitude announces VNAV PTH.

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 low to maintain FMC vertical path
  - AFDS tracks FMC descent path.
- automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
  - MCP constrained altitude announces VNAV ALT
  - VNAV constrained altitude announces 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
- reaching end of LNAV route

[Option - FMC update 10.3 and later]

- transition of glideslope intercept waypoint if G/S is armed

[Option - FMC update 10.3 and later]

- crosstrack deviation exceeds twice the RNP value during PTH descent for an active leg with a database vertical angle and LNAV not engaged

In the event of glideslope intercept waypoint transition, VNAV can be re-engaged.

**2 ALTITUDE Display**

Displays selected altitude

- displayed altitude is reference for altitude alerting and automatic level-offs

**[Option - ELS/EHS/ES]**

- with Mode S transponders installed, the displayed altitude is transmitted to ATC

**[Option - With 100 foot increments]**

- altitude range is 0 to 50,000 feet in 100 foot increments
- displays previously selected altitude when power first applied.

**3 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.

Display increments are:

- 50 fpm if V/S is less than 1000 fpm
- 100 fpm if V/S is 1000 fpm or greater.

**4 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.

**5 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.

## **6 Approach (APP) Switch**

(See Lateral Navigation)

## **7 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.

## **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 announces 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 announces 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
- announces 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 –

- announces 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
- glideslope captured in APP mode.

## **10 Altitude Intervention (ALT INTV) Switch**

### **[Option - With speed and altitude intervention]**

Allows manual deletion of next FMC altitude constraint via altitude SEL and ALT INTV switch.

Push – (during VNAV climb)

- lowest FMC altitude constraint below selected MCP altitude is deleted
- if airplane is currently at an FMC altitude constraint, deletion allows airplane to resume climb. MCP altitude must be set above current altitude
- for each press of switch, one deletion occurs
- if MCP altitude is set above current FMC altitude, FMC cruise altitude resets to MCP altitude. FMC cruise altitude cannot be decreased using ALT INTV switch.

Push – (during VNAV cruise)

- if MCP altitude is set above current FMC cruise altitude, FMC resets cruise altitude to MCP altitude and initiates a cruise climb
- if MCP altitude is set below current FMC cruise altitude, an early descent is initiated. Lower FMC cruise altitude cannot be entered using ALT INTV switch.

Push – (during VNAV descent)

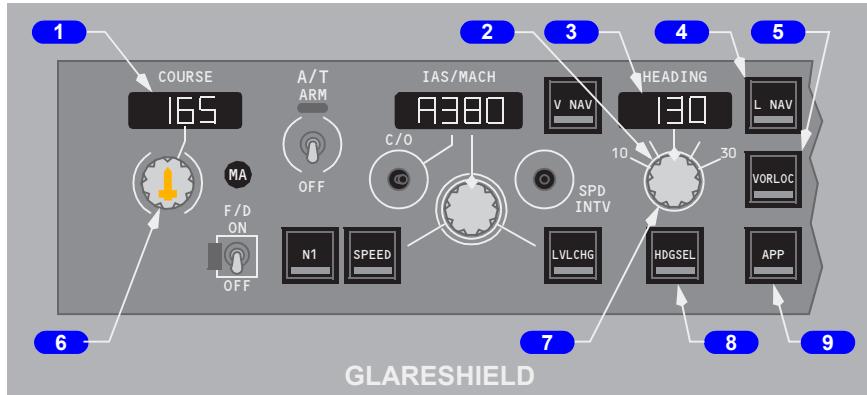
- the highest FMC altitude constraint above MCP altitude is deleted
- if airplane is currently at an FMC altitude constraint, deletion allows airplane to continue descent. MCP altitude must be set below current altitude

### **[Option - FMC U10.6 and above]**

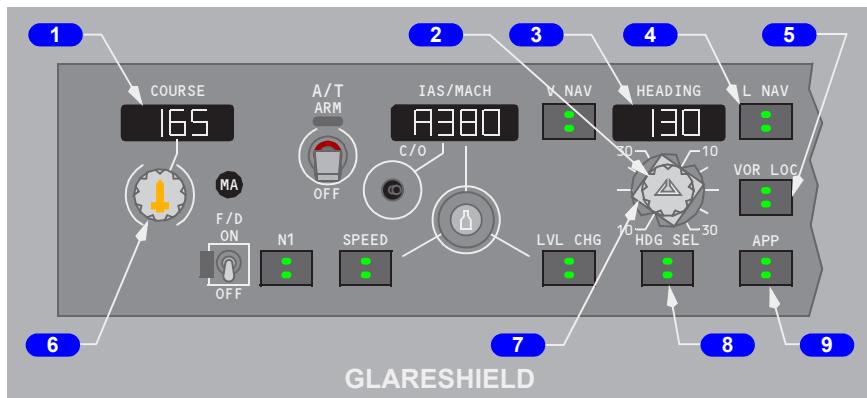
- if all FMC altitude constraints are deleted during VNAV path descent, an automatic transition to a VNAV speed descent is made.

## Lateral Navigation

[Option - With speed and altitude intervention]



[Option - Without speed and altitude intervention]



### 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 the DUs.

### **3 HEADING Display**

Displays selected heading.

### **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 arming criteria on the ground:

- origin runway in flight plan
- active route entered in FMC
- track of first leg within 5 degrees of runway heading
- LNAV selected prior to TO/GA.
  - LNAV guidance becomes active at 50 feet AGL

[Option - Bank angle limit is 30 degrees above 200 AGL]

[Option - Honeywell FCC -708 and on]

- bank angle is limited to 8 degrees below 200 feet and 30 degrees above 200 feet AGL.

LNAV engagement criteria in flight:

- 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 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 DU. 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 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 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 announces VOR/LOC armed
- pitch mode announces 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:

**[Option - G/S capture inhibited before LOC capture]**

- localizer must be captured prior to glideslope
- localizer can be intercepted in HDG SEL, LNAV, or CWS R

**[Option - EFIS/MAP]**

- 1 CH announces in A/P Status Display after localizer capture
  - for single autopilot approach, 1 CH remains announced for entire approach
  - for dual autopilot approach, 1 CH annunciation extinguishes when second autopilot engages and FLARE armed is announced

**[Option - PFD/ND]**

- SINGLE CH announces in A/P Status Display after localizer capture
  - for single autopilot approach, SINGLE CH remains announced for entire approach

**[Option - Fail-Operational Autoland]**

- for dual autopilot approach, SINGLE CH annunciation extinguishes when second autopilot engages and ROLLOUT armed and FLARE armed are announced
- for dual autopilot approach, SINGLE CH annunciation extinguishes when second autopilot engages and FLARE armed is announced
- 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:

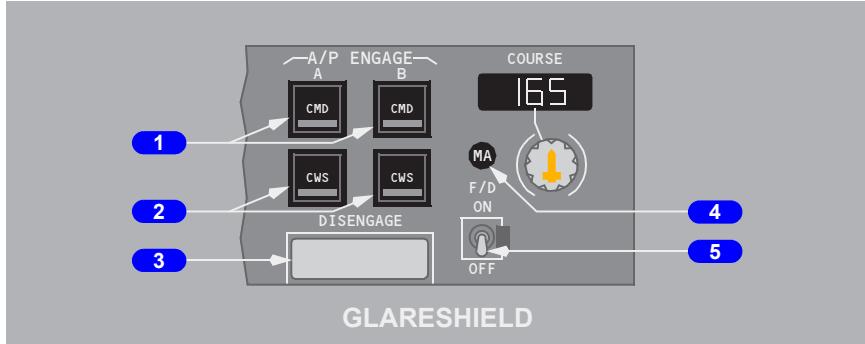
- the A autopilot and Captain's F/D use information from Captain's Course Selector and No. 1 VHF NAV receiver
- the B autopilot and First Officer's F/D use information from First Officer's Course Selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for the two VHF NAV receivers can cause disagreement between Captain's and First Officer's F/D displays and affect A/P operation.

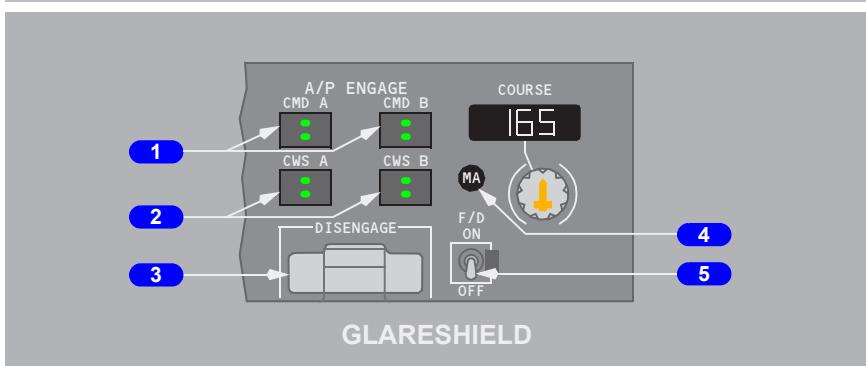
#### [Option - CWS deactivated on approach]

**Note:** After localizer and glideslope capture, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

## Autopilot / Flight Director

Pushing a CMD or CWS switch engages related A/P in CMD or CWS and illuminates switch lights. A/P can operate in CMD, CWS, or a combination of CMD and CWS.





### 1 Command Engage (CMD ENGAGE) Switch (A or B):

Push –

- engages A/P
- enables all command modes
- displays CMD in A/P status display
- pushing an engage switch for second A/P, while not in approach mode, engages second A/P and disengages first A/P
- enables CWS operation
- CWS engages if:
  - pitch or roll mode not selected
  - pitch or roll mode deselected
  - pitch or roll mode manually overridden with control column force.

#### [Option - CWS deactivated on approach]

**Note:** After localizer and glideslope capture during a dual autopilot approach, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

- CWS engaged displays:
  - CWS P and/or CWS R in A/P status display
  - blank in pitch and/or roll mode FMA
- when approaching a selected altitude in CWS P, the pitch mode engages in ALT ACQ and ALT HOLD when reaching selected altitude

- when approaching a selected radio course in CWS R with VOR/LOC or approach mode armed, VOR/LOC engages when course is intercepted
- if pitch is manually overridden while in ALT HOLD and control force is released within 250 feet of selected altitude, A/P pitch mode engages in ALT ACQ and returns to selected altitude in ALT HOLD mode.

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

## **2 Control Wheel Steering Engage (CWS ENGAGE) Switch (A or B):**

Push –

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

## **3 Autopilot Disengage (DISENGAGE) Bar**

Pull down –

- exposes yellow background
- disengages both A/Ps
- prevents A/P engagement.

Lift up –

- conceals yellow background
- enables A/P engagement.

## **4 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.

**5 Flight Director (F/D) Switch****[Option - Split Axis]**

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

**[Option - Integrated Cue]**

Left F/D switch activates the command bar on the Captain's attitude indicator.  
Right F/D switch activates the command bar on the First Officer's attitude indicator.

ON –

- 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
- displays FD in A/P status display if A/P is OFF or engaged in CWS
- enables command bar display on related pilot's attitude indicator

**[Option - Split Axis]**

- command bars are displayed if command pitch and/or roll modes are engaged

**[Option - Integrated Cue]**

- command bar is displayed if command pitch and roll modes are engaged

**[Option - Wings Level Takeoff Roll Mode ]**

- on ground, arms pitch and roll modes for engagement in TO/GA and wings level when TO/GA switch is pushed.

**[Option - Heading Select Takeoff Roll Mode ]**

- on ground, arms pitch and roll modes for engagement in TO/GA and HDG SEL when TO/GA switch is pushed.

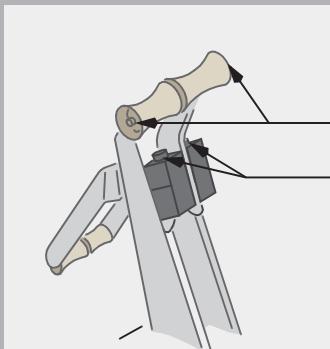
**[Option - Split Axis]**

OFF – command bars retract from related pilot's attitude indicator.

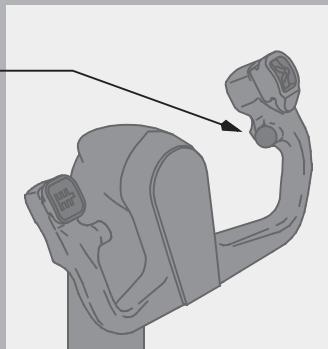
**[Option - Integrated Cue]**

OFF – command bar retracts from related pilot's attitude indicator.

## Autopilot / Autothrottle Controls



**CONTROL STAND**



**CONTROL WHEELS**

### **1 Autopilot Disengage Switch**

Push –

- disengages both autopilots
- A/P disengage lights flash
- A/P disengage warning tone sounds for a minimum of two seconds
- second push extinguishes disengage lights and silences disengage warning tone
- if autopilot automatically disengages, extinguishes A/P Disengage lights and silences A/P warning tone.

### **2 Autothrottle Disengage Switches**

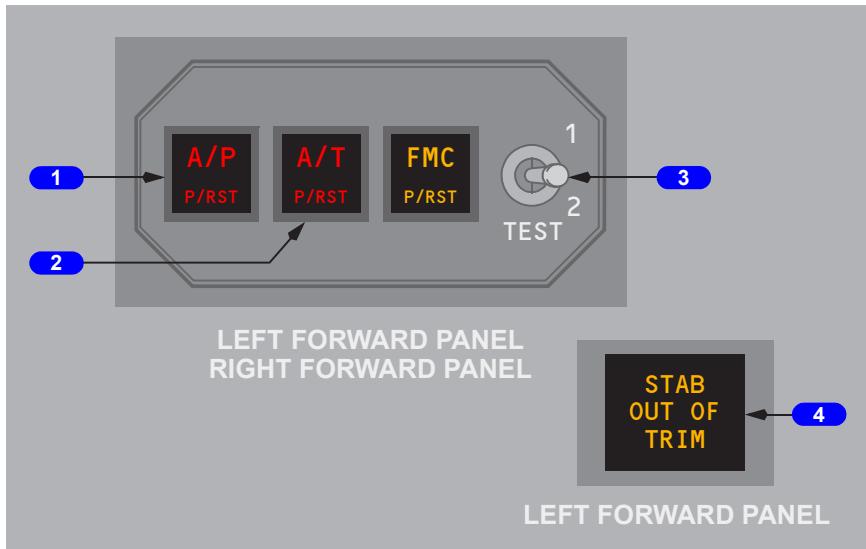
Push –

- disengages autothrottle
- A/T disengage lights flash
- A/T ARM switch trips OFF
- second press extinguishes A/T disengage lights
- extinguishes A/T disengage lights after automatic A/T disengagement.

### **3 Takeoff/Go-Around (TO/GA) Switches**

Push – engages AFDS and A/T in takeoff or go-around mode if previously armed.

## Autopilot / Autothrottle Indicators



### 1 Autopilot (A/P) Disengage Light

Illuminated (red) –

- flashes and tone sounds when autopilot has disengaged
- reset by pushing either disengage light or either A/P disengage switch
- steady for any of following conditions:
  - stabilizer out of trim below 800 feet RA on dual channel approach
  - ALT ACQ mode inhibited during A/P go-around if stabilizer not trimmed for single A/P operation
  - disengage light test switch held in position 2
  - automatic ground system tests fail.

Illuminated (amber) –

- steady – disengage light test switch held in position 1.

#### [Option - CWS warning activated]

- flashing – A/P automatically reverts to CWS pitch or roll while in CMD. Resets by pushing either light or selecting another mode.

#### [Option - Fail-Operational Autoland]

- steady – with disengage light test switch not held in position 1, indicates a downgrade in autoland capability.

## 2 Autothrottle (A/T) Disengage Light

Illuminated (red) –

- flashing – autothrottle has disengaged
- steady – disengage light test switch held in position 2.

Illuminated (amber) –

- steady – disengage light test switch held in position 1

### [Option - Airspeed deviation warning activated]

- flashing – indicates A/T airspeed error under following conditions:
  - inflight
  - flaps not up
  - airspeed differs from commanded value by +10 or -5 knots and is not approaching commanded value.

## 3 Disengage Light Test (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.

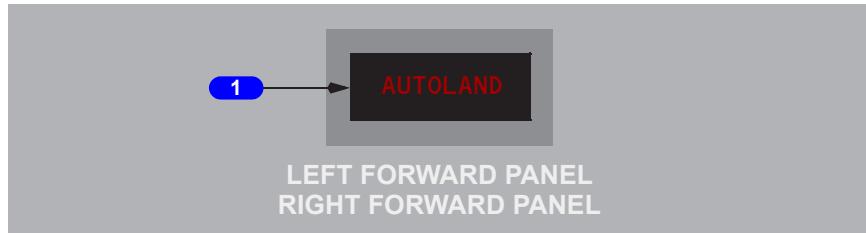
## 4 Stabilizer Out Of Trim (STAB OUT OF TRIM) Light

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

Illuminated (amber) – autopilot not trimming stabilizer properly.

## Autoland Warning

### [Option]



## 1 AUTOLAND Warning Light

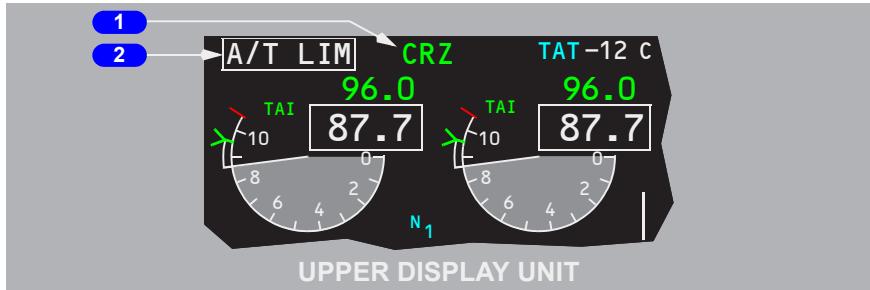
Armed during dual ILS A/P approach below 500 feet

Flashes (red) if:

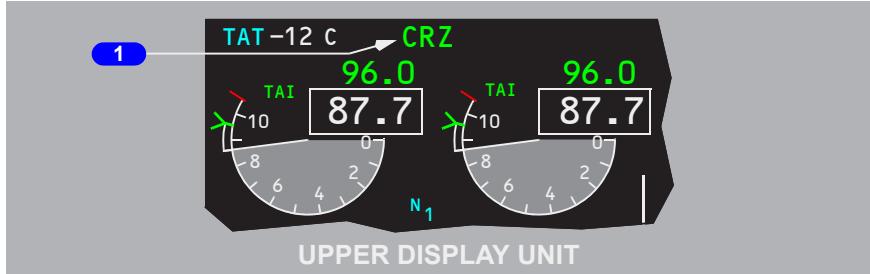
- A/P disengages
- stabilizer trim warning occurs
- ILS deviation occurs below 200 feet.

## Thrust Mode Display

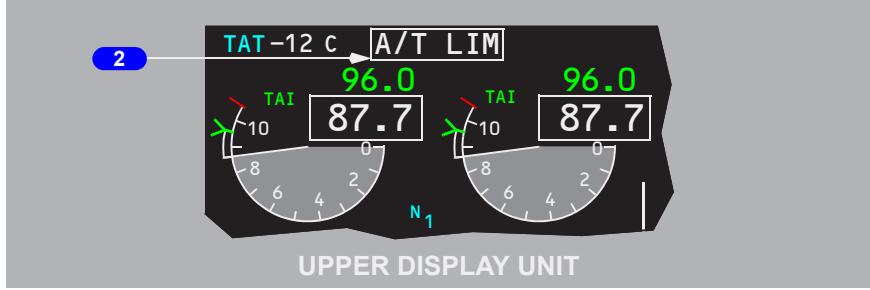
[Option - Side by side display]



[Option - Over/Under display]



[Option - Over/Under display]



### 1 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.

**[Option]**

Thrust mode display annunciations are:

- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff

**[Option]**

- TO B – takeoff bump thrust
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- G/A – go-around
- CON – continuous
- — – FMC not computing thrust limit.

Thrust mode display annunciations are:

- TO – takeoff
- R-TO – reduced takeoff
- R-CLB – reduced climb

**[Option]**

- TO B – takeoff bump thrust
- CLB – climb
- CRZ – cruise
- G/A – go-around
- CON – continuous
- — – FMC not computing thrust limit.

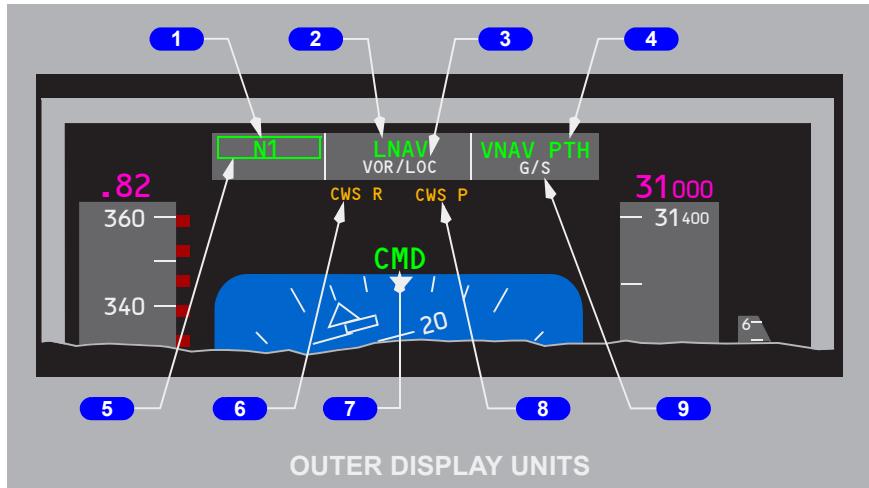
**Note:** R-TO does not indicate the type of reduced takeoff. The N1 limit may be reduced due to the entry of an assumed temperature, a takeoff thrust derate or a combination of both assumed temperature and takeoff thrust derate.

**2 Autothrottle Limit (A/T LIM) Indication**

Illuminated (white) – the FMC is not providing the A/T system with N1 limit values. The A/T is using a degraded N1 thrust limit from the related EEC.

## Flight Mode Annunciations (FMAs)

[Option – PFD/ND]



### 1 Autothrottle (A/T) Engaged Mode

- N1 (green)
- GA (green)
- Retard (green)
- FMC SPD (green)
- MCP SPD (green)
- THR HLD (green)
- ARM (white)

### 2 Roll Engaged Mode

- HDG SEL (green)
- VOR/LOC (green)

[Option – Integrated Approach Nav]

- FAC (green)

- LNAV (green)

[Option – Fail-Operational Autoland]

- ROLLOUT (green)

[Option – Integrated Approach Nav]

- B/CRS (green)

### 3 Roll Armed Mode

- VOR/LOC (white)

[Option – Integrated Approach Nav]

- B/CRS (white)

[Option – Fail-Operational Autoland]

- ROLLOUT (white)

[Option – Integrated Approach Nav]

- FAC (white)

#### 4 Pitch Engaged Mode

- TO/GA (green)
- V/S (green)
- MCP SPD (green)
- ALT/ACQ (green)
- ALT HOLD (green)

- G/S (green)
- FLARE (green)
- VNAV SPD (green)
- VNAV PTH (green)

[Option]

- VNAV ALT (green)

[Option – Integrated Approach Nav]

- G/P (green)

#### 5 Mode Highlight Change Symbol

A mode change highlight symbol (rectangle) is drawn around each pitch, roll, CWS, A/P status, and thrust engaged mode annunciation for a period of 10 seconds after each engagement.

#### 6 CWS Roll Engaged

- CWS R (amber)

#### 7 Autopilot Status

- CMD (green)
- FD (green)

[Option – Fail-Operational Autoland]

- ▷LAND 2◁ (green)
- LAND 3 (green)

[Option – Fail-Operational Autoland]

- SINGLE CH (amber)
- SINGLE CH (green-IAN)

[Option – Fail-Operational Autoland]

- NO AUTOLAND (amber)

[Option – Integrated Approach Nav]

- AUTOPILOT (amber)

#### 8 CWS Pitch Engaged

- CWS P (amber)

#### 9 Pitch Armed Mode

- G/S (white)
- V/S (white)
- FLARE (white)
- G/S V/S (white)

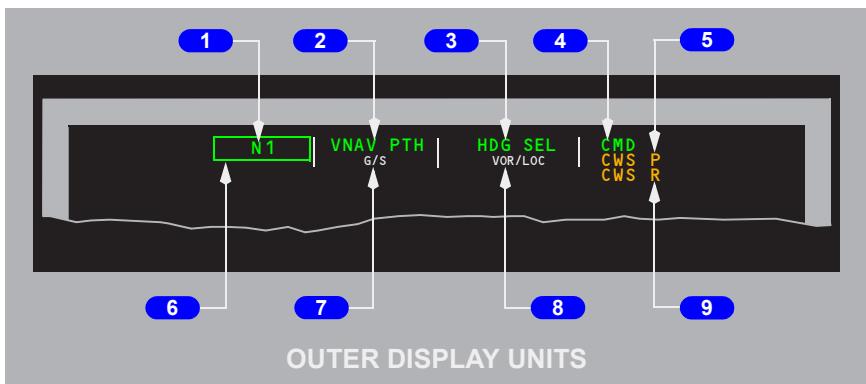
[Option – Integrated Approach Nav]

- G/P (white)

[Option – Integrated Approach Nav]

- G/P V/S (white)

**[Option – EFIS/MAP]**



**1 Autothrottle (A/T) Engaged Mode**

- N1 (green)
- GA (green)
- Retard (green)
- FMC SPD (green)
- MCP SPD (green)
- THR HLD (green)
- ARM (white)

**2 Pitch Engaged Mode**

- TO/GA (green)
- V/S (green)
- MCP SPD (green)
- ALT ACQ (green)
- ALT HOLD (green)
- G/S (green)
- FLARE (green)
- VNAV PTH (green)
- VNAV SPD (green)

**[Option]**

- VNAV ALT (green)

**3 Roll Engaged Mode**

- HDG SEL (green)
- VOR/LOC (green)
- LNAV (green)

**4 Autopilot Status**

- CMD (green)
- FD (green)

**[Option]**

- 1 CH (amber)

## 5 CWS Pitch Engaged

- CWS P (amber)

## 6 Mode Highlight Change Symbol

A mode change highlight symbol (rectangle) is drawn around each pitch, roll, CWS, A/P status, and thrust engaged mode annunciation for a period of 10 seconds after each engagement.

## 7 Pitch Armed Mode

- G/S (white)
- V/S (white)
- G/S V/S (white)
- FLARE (white)

## 8 Roll Armed Mode

- 
- [Option – BP\_04 or later Software Upgrade]
- LNAV VOR/LOC (white)

## 9 CWS Roll Engaged

- CWS R (amber)

## Automatic Flight System Description

## Chapter 4 Section 20

### General

The automatic flight system (AFS) consists of the autopilot flight director system (AFDS) and the autothrottle (A/T). The flight management computer (FMC) provides N1 limits and target N1 for the A/T and command airspeeds for the A/T and AFDS.

The AFDS and A/T are controlled using the AFDS mode control panel (MCP) and the FMC. Normally, the AFDS and A/T are controlled automatically by the FMC to fly an optimized lateral and vertical flight path through climb, cruise and descent.

AFS mode status is displayed on the flight mode annunciation on each pilot's primary display.

### Autopilot Flight Director System (AFDS)

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 attitude indicator.

### 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 pushing the switch again. While a mode is active, deselection can be automatically inhibited and is 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 by pushing a separate CMD or CWS engage switch. 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.

## 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 or,
  - with flaps not up or,
  - G/S engaged

[Option - A/P auto-disengages for TO/GA above 2000 feet RA]

[Option - Honeywell -708 FCC and on]

- pushing either Takeoff/Go-around (TO/GA) switch with a single A/P engaged in CWS or CMD above 2000 feet RA with flaps not up or G/S engaged.

[Option - Fail-Operational Autoland]

- pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD (except with LAND 3 or LAND 2 annunciated)
- pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD
- pushing an illuminated A/P ENGAGE switch
- pushing the A/P DISENGAGE bar down

[Option - Fail-Operational Autoland]

- activating either pilot's control wheel trim switch (except with LAND 3 or LAND 2 annunciated)
- activating either pilot's control wheel trim switch
- moving the STAB TRIM AUTOPILOT cutout switch to CUTOUT
- 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
- loss of respective hydraulic system pressure.

**Note:** Loss of the system A engine-driven hydraulic pump, and a heavy demand on system A, may cause A/P A to disengage.

#### [Option - Fail-Operational Autoland]

**Note:** During a fail-operational landing with LAND 3 or LAND 2 annunciated, pressing TO/GA after touchdown or activating the manual electric trim will not disconnect the autopilot and the rollout is not affected.

### 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 respective FCCs. With a radio altimeter inoperative, the autopilot will disconnect two seconds after LOC and GS capture.

### Flight Director Display

Turning a F/D switch ON displays command bars on the respective pilot's attitude indicator 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.
- During a Fail Operational autoland flare with Flare engaged and Land 3 annunciated, F/D command bars center.

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 pilots' F/D modes is controlled by the master FCC, and both FMA displays show the same mode status.

The master FCC is indicated by illumination of the respective 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 attitude indicators. 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 above the attitude indicator on the outboard display unit:

- 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)

### [Option - EFIS/MAP]

- 1 CH (for single A/P ILS approach, annunciates after localizer capture and remains on for entire approach. For dual A/P ILS approach, annunciates after localizer capture and extinguishes after pitch monitor confidence test is successfully completed).

### [Option - PFD/ND]

- SINGLE CH (for single A/P ILS approach, annunciates after localizer capture and remains on for entire approach. For dual A/P ILS approach, annunciates after localizer capture and extinguishes after pitch monitor confidence test is successfully completed).

## Fail-Operational Autoland Status Annunciations

### [Option - Fail-Operational Autoland]

The following annunciations provide the flight crew with autoland system mode and status:

- LAND 3 – two autopilots, three inertial sources, and the associated sensors are operating normally for an automatic landing and rollout.
- LAND 2 – a failure has occurred above Alert Height and redundancy is reduced; but the autoland system is still capable of making an automatic landing and rollout.
- NO AUTOLAND – the system is unable to make an automatic landing.

With a LAND 3 (fail-operational) indication, the autoland system level of redundancy is such that a single fault cannot prevent the autopilot system from making an automatic landing.

With a LAND 2 (fail passive) indication, the level of redundancy is such that a single fault cannot cause a significant deviation from the flight path.

The NO AUTOLAND status is annunciated if a system failure has occurred. FLARE and ROLLOUT will not arm when NO AUTOLAND is annunciated.

An advisory message is displayed on the Upper Engine Display for any fault which limits the capability of the automatic landing system. NO LAND 3 indicates the autoland system does not have the required redundancy for LAND 3 operations. NO AUTOLAND indicates autoland is not available.

Should any single failure occur below Alert Height and the system is still capable of continuing the autoland and rollout, LAND 3 will remain displayed and the airplane will land and roll out normally without failure annunciation. Failure or autoland downgrade annunciations will then be displayed when the airplane has decelerated below 40 kts and the autopilots have been disengaged.

## AFDS Flight Mode Annunciations

The flight mode annunciations are displayed just above the attitude indicator on the outboard display unit. The mode annunciations, from left to right, are:

### [Option - EFIS/MAP]

- autothrottle
- pitch
- roll.

### [Option - PFD/ND]

- autothrottle
- roll
- pitch.

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, including full go-around N1 limit
- GA – the autothrottle maintains thrust at reduced go-around setting
- 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. Minimum speed protection is provided

## Pitch Modes

- TO/GA – Takeoff

Engaged for takeoff by turning both F/D switches ON and pushing 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 2000 feet AGL and prior to 150 seconds after lift-off.

- TO/GA – Go-around

Engaged for go-around by pushing the TO/GA switch under the following conditions:

- inflight below 2000 feet radio altitude

[Option - A/P auto-disengages for TO/GA above 2000 feet RA]

[Option - Honeywell -708 FCC and on]

- inflight above 2000 feet radio altitude with flaps not up or G/S captured

- not in takeoff mode
- either F/D ON or OFF.

When engaged, the F/Ds command roll to hold the ground track, and 15 degrees nose up pitch. After reaching a programmed rate of climb, pitch commands the target airspeed for each flap setting based on maximum takeoff weight calculations.

- VNAV (engaged) – 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
  - VNAV SPD – the AFDS maintains the FMC speed displayed on the airspeed indicator and/or the CDU CLIMB or DESCENT pages
  - VNAV PTH – the AFDS maintains FMC altitude or descent path with pitch commands.
  - VNAV ALT – when a conflict occurs between the VNAV profile and the MCP altitude, the airplane levels at the MCP altitude and the pitch flight mode annunciation becomes VNAV ALT. VNAV ALT maintains altitude.
- V/S (armed) – V/S mode can be engaged by moving Vertical Speed thumbwheel
- V/S (engaged) – commands pitch to 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 – commands pitch to 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
- G/P (armed) – the AFDS is armed for G/P capture
- G/P (engaged) – the AFDS follows the IAN glidepath
- 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 (engaged) – 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.
- FAC (armed) – the AFDS is armed to capture the IAN final approach course
- FAC (engaged) – the AFDS tracks the IAN final approach course along the inbound course bearing.
- B/CRS (armed) – the AFDS is armed to capture the localizer final approach back course
- B/CRS (engaged) – the AFDS tracks the localizer final approach course along the inbound back course bearing.

#### [Option - Fail-Operational Autoland]

- ROLLOUT (armed) – annunciates below 1500 feet radio altitude.

#### [Option - Fail-Operational Autoland]

- ROLLOUT (engaged) – at touchdown the AFDS uses rudder and nose wheel steering to keep the airplane on the localizer centerline.

## Autopilot Control Wheel Steering

### CWS Engage Switch Selected

Pushing a CWS engage switch engages the A/P pitch and roll axes in the CWS mode and displays CWS P and CWS R on the FMAs.

With CWS engaged, the A/P maneuvers the airplane in response to control pressures applied by either pilot. The control pressure is similar to that required for manual flight. When control pressure is released, the A/P holds existing attitude.

If aileron pressure is released with 6 degrees or less bank, the A/P rolls the wings level and holds existing heading. This heading hold feature with bank less than 6 degrees is inhibited when any of the following conditions exists:

- below 1,500 feet RA with the landing gear down
- after F/D VOR capture with TAS 250 knots or less
- after F/D LOC capture in the APP mode.

---

## Pitch CWS with a CMD Engage 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. This manual roll override is inhibited in the APP mode with both A/Ps engaged.

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. 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 EECs ON or in ALTN. In either case, the A/T uses the FMC N1 limits. During A/T operation, it is recommended that both EECs be ON or both be in ALTN, as this produces minimum thrust lever separation.

## 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
- alpha floor automatically engages the A/T when armed.

## Autothrottle Disengagement

Any of the following conditions or actions disengages the A/T:

- moving the A/T Arm switch to OFF
- pushing either A/T Disengage switch
- an A/T system fault is detected
- two seconds have elapsed since landing touchdown

The autothrottle also disengages if it is engaged in a Speed mode, Retard for descent mode, or an N1 mode other than A/T GA mode AND;

[\[Option - Throttle Split Monitor, Honeywell MCP and Smiths A/T computer, with or without Quiet Climb\]](#)

- thrust levers become separated more than 10 degrees during a dual channel approach after FLARE armed is annunciated

[\[Option - Throttle Split Monitor, Collins MCP with integrated A/T, without Quiet Climb\]](#)

- thrust levers become separated more than 10 degrees

**[Option - Throttle Split Monitor, Collins MCP with integrated A/T, with Quiet Climb]**

- thrust levers become separated more than 10 degrees, except during takeoff, with a cutback N1 selected

**[Option - Thrust Split Monitor, Honeywell MCP and Smiths A/T computer]**

- significant thrust difference along with control wheel roll input of 10 degrees or more, and flap position up through 10

**[Option - Thrust Split Monitor, Collins MCP with integrated A/T, without Quiet Climb]**

- significant thrust difference along with control wheel roll input of 10 degrees or more at any point throughout the entire flight envelope

**[Option - Thrust Split Monitor, Collins MCP with integrated A/T, with Quiet Climb]**

- significant thrust difference along with control wheel roll input of 10 degrees or more throughout the entire flight envelope, except during takeoff, with a cutback N1 selected.

A/T disengagement is followed by A/T Arm switch releasing to OFF and flashing red A/T Disengage lights. The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.

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## 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.

**[Option - Flight director commands wings level on 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 pushing 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.

**[Option - Flight director commands HDG SEL on 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 pushing the TO/GA switch on either thrust lever. The FMAs display FD as the A/P status, TO/GA as the pitch mode, and HDG SEL as 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.

**[Option - Flight director commands wings level on takeoff]**

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.

**[Option - Flight director commands HDG SEL on takeoff]**

During takeoff, prior to 60 KIAS:

- the pitch command is 10 degrees nose down
- the roll command is HDG SEL
- 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 HDG SEL for the roll mode.

At 60 knots, the F/D pitch commands 15 degrees nose up.

At 84 knots, the A/T mode announces THR HLD.

At lift-off:

- the pitch command continues at 15 degrees until sufficient climb rate is acquired. Pitch then commands MCP speed (normally V2) plus 20 knots
- if an engine failure occurs during takeoff, the pitch command target speed is:
  - V2, if airspeed is below V2
  - existing speed, if airspeed is between V2 and V2 + 20
  - V2 + 20, if airspeed is above V2 + 20

**[Option - Flight director commands wings level on takeoff]**

- the roll command maintains wings level.

**[Option - Flight director commands HDG SEL on takeoff]**

- the roll command maintains HDG SEL. Bank angle is limited to 8 degrees below 400 feet, and 10–30 degrees selectable above 400 feet AGL.

After lift-off:

- the A/T remains in THR HLD until 800 feet RA. A/T annunciation then changes from THR HLD to ARM and reduction to climb thrust can be made by pushing the N1 switch

**[Option - Without automatic thrust reduction after takeoff]**

- 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

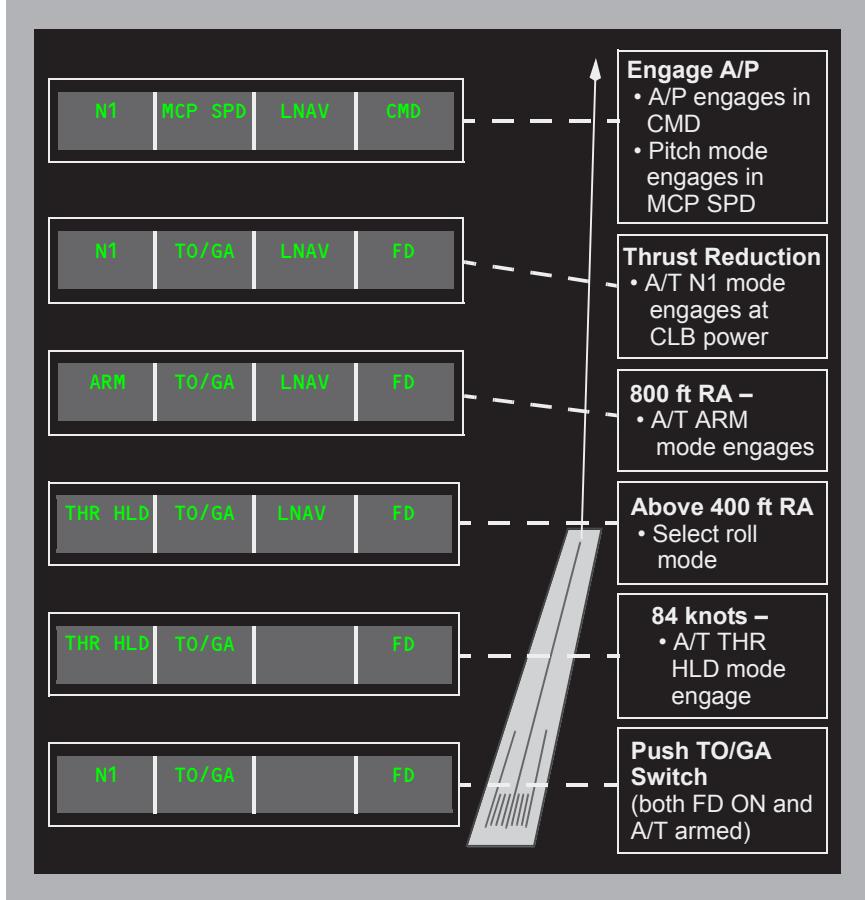
**[Option - Automatic thrust reduction after takeoff, FMC update 10.1 and later]**

- automatic reduction to climb thrust occurs upon reaching the selected thrust reduction altitude which is shown on the FMC CDU TAKEOFF REF page 2/2 during preflight, or when the airplane levels off in ALT HOLD or VNAV PTH. Pilot entries can be made to override the default value. Allowable entries are 800 feet to 9999 feet
- 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 unless another pitch mode has been selected
  - MCP IAS/Mach display and airspeed cursor change to V2 + 20 knots
  - roll mode engages in HDG SEL unless another roll mode has been selected.

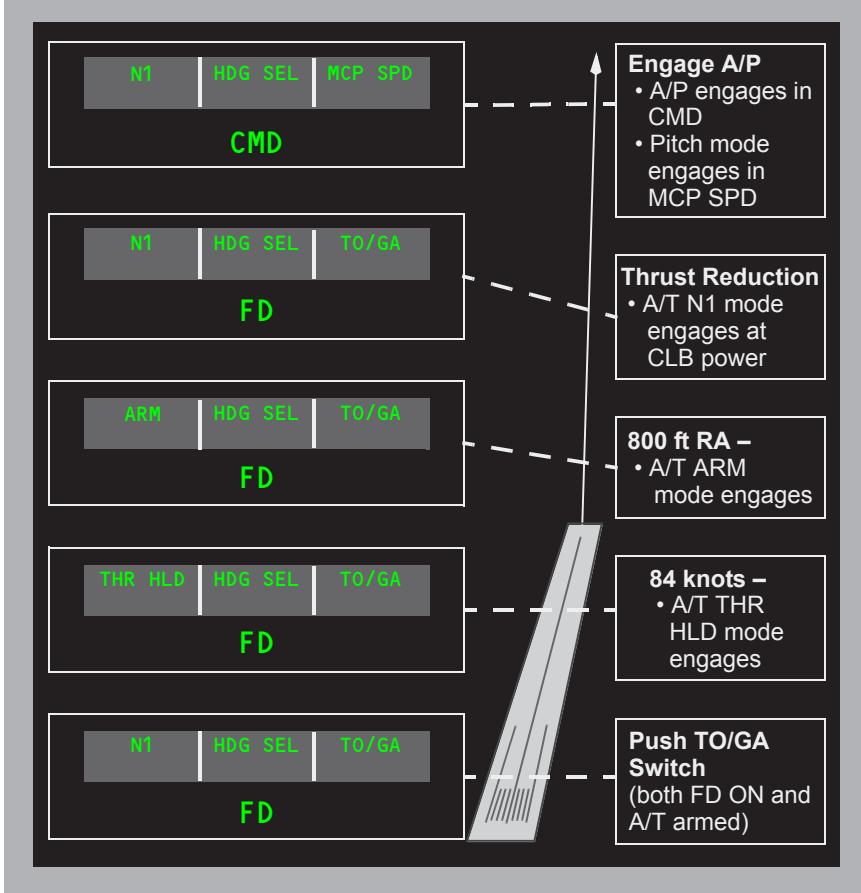
To terminate the takeoff mode below 400 feet RA, both F/D switches must be turned OFF. Above 400 feet RA, selection of another pitch mode or engaging an autopilot will terminate the takeoff mode; other F/D roll modes can be also selected.

## Automatic Flight Takeoff Profile

[Option - EFIS/MAP, flight director commands wings level on takeoff]



[Option - PFD/ND, flight director commands HDG SEL on takeoff]



## 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 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 glideslope.

### Approach (APP) Mode Dual A/Ps

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.

#### [Option - Fail-Operational Autoland]

Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides either fail-operational or fail-passive operation through landing flare, touchdown and rollout, or through an automatic go-around. If a failure is detected, 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 Glideslope Armed

After setting the localizer frequency and course, pushing 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.

#### [Option - G/S capture inhibited before LOC capture]

Glideslope (G/S) capture is inhibited prior to localizer capture.

## Localizer Capture

### [Option - EFIS/MAP]

The LOC capture point is variable and depends on intercept angle and rate of closure. Capture occurs no later than 1/2 dot. Upon LOC capture, VOR/LOC annunciates captured, 1 CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

### [Option - PFD/ND]

The LOC capture point is variable and depends on intercept angle and rate of closure. Capture occurs no later than 1/2 dot. Upon LOC capture, VOR/LOC annunciates captured, SINGLE CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

## Glideslope Capture

### [Option - G/S capture inhibited before LOC capture]

Glideslope capture is inhibited 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:

- pushing 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 LOC or 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 or LOC display turns amber and flashes
- test of autopilot rudder servo is performed
- FLARE armed is annunciated
- ROLLOUT armed is annunciated

### [Option - EFIS/MAP]

- the 1 CH annunciation extinguishes

**[Option - PFD/ND]**

- the SINGLE CH annunciation extinguishes
- A/P go-around mode arms but is not annunciated.

**[Option - CWS deactivated on approach]**

**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.

**500 Feet Radio Altitude**

**[Option – Fail-Operational Autoland]**

The pilot is required to check for the presence of LAND 3 or LAND 2 in order to continue the autoland.

If the second autopilot in CMD remains armed and does not engage, LAND 2 or LAND 3 does not annunciate. Instead, the amber NO AUTOLAND annunciation alerts the pilot that dual control has not been established and the autoland is to be discontinued.

**450 Feet Radio Altitude**

**[Option – Fail-Operational Autoland]**

The alignment mode is enabled which provides rudder compensation for the purpose of decreasing large crab angles produced by crosswinds, and to control the adverse moments caused by an engine failure. The automatic correction for aircraft crab angle due to crosswinds and engine failure enhances flight crew runway perspective and provides optimal aircraft position for initiation of rollout control. In a strong crosswind, the airplane does not fully align with the runway but lands in a slight crab. Sideslip is limited to 5 degrees. This mode is not annunciated.

**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.
- FLARE engaged is annunciated and with LAND 3 annunciated, F/D command bars center.
- 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.

## Rollout

### [Option - Fail-Operational Autoland]

ROLLOUT arms when LAND 2 or LAND 3 annunciates.

At approximately two feet radio altitude, rollout activates:

- ROLLOUT replaces the VOR/LOC roll flight mode annunciation
- the autopilot controls the rudder and nose wheel steering to keep the airplane on the localizer centerline.
- rollout guidance continues until a full stop or until the autopilots are disengaged.

### Approach (APP) Mode Single A/P

A single A/P ILS approach can be executed by engaging only one A/P in CMD after pushing the APP mode select switch. Single A/P approach operation is the same as dual, with the following exceptions:

- full automatic flare and touchdown capability is not available. FLARE is not annunciated and stabilizer trim bias is not applied

### [Option - EFIS/MAP]

- A/P status of 1 CH is annunciated for the entire approach after localizer capture

### [Option - PFD/ND]

- A/P status of SINGLE CH is annunciated for the entire approach after localizer capture
- an A/P go-around is not available.

## ILS Beam Anomaly

### [Option - Fail-Operational Autoland]

Prior to annunciation of LAND 3 or LAND 2, the autopilot will disconnect if a persistent localizer or glideslope beam anomaly is detected. If a beam anomaly is detected after annunciation of LAND 3 or LAND 2, the appropriate localizer or glideslope deviation scale will turn amber and the corresponding pointer will flash, a horizontal amber line will be drawn through the appropriate roll (VOR/LOC) or pitch (G/S) mode on the FMA, and the autopilot will disengage. For a single channel or F/D only approach, the autopilot will disconnect and/or the F/D bars will be removed.

In the event of a ground station failure, the appropriate localizer or glideslope deviation scale will blank, a horizontal amber line will be drawn through the appropriate roll (VOR/LOC) or pitch (G/S) mode on the FMA, but the autopilot will remain engaged.

## Single Engine Landing

### [Option – Fail-Operational Autoland]

If an engine fails and the APU is not used to provide a second electrical source, NO AUTOLAND is annunciated and autoland with rollout is prohibited. If an engine fails and the APU is used to provide a second electrical source prior to engagement of the second autopilot, a fail-passive autoland (LAND 2) with rollout may be flown. LAND 3 will be displayed, but fail-passive minimums must be used.

Automatic engine out rudder compensation is provided during A/P approach and landing.

In the event of a A/P go-around, the A/P will continue to compensate for asymmetric thrust until another roll mode is selected.

## Approach (APP) Mode Integrated Approach Navigation

### [Option – Integrated Approach Nav]

The Integrated Approach Navigation (IAN) modes are armed/engaged by selecting the APP button on the AFDS Mode Control Panel (MCP). Once armed, the autopilot/flight director will capture and track the localizer/final approach course and glide slope/glide path.

The following roll and pitch mode control annunciations of the FMA will be displayed:

- For an ILS approach, VOR/LOC and G/S will be the displayed roll and pitch modes
- For an FMC IAN approach, FAC and G/P will be the displayed roll and pitch modes

- For an ILS approach with G/S selected off or a localizer only approach, VOR/LOC and G/P will be the displayed roll and pitch modes
- For a backcourse localizer approach, B/CRS and G/P will be the displayed roll and pitch modes.

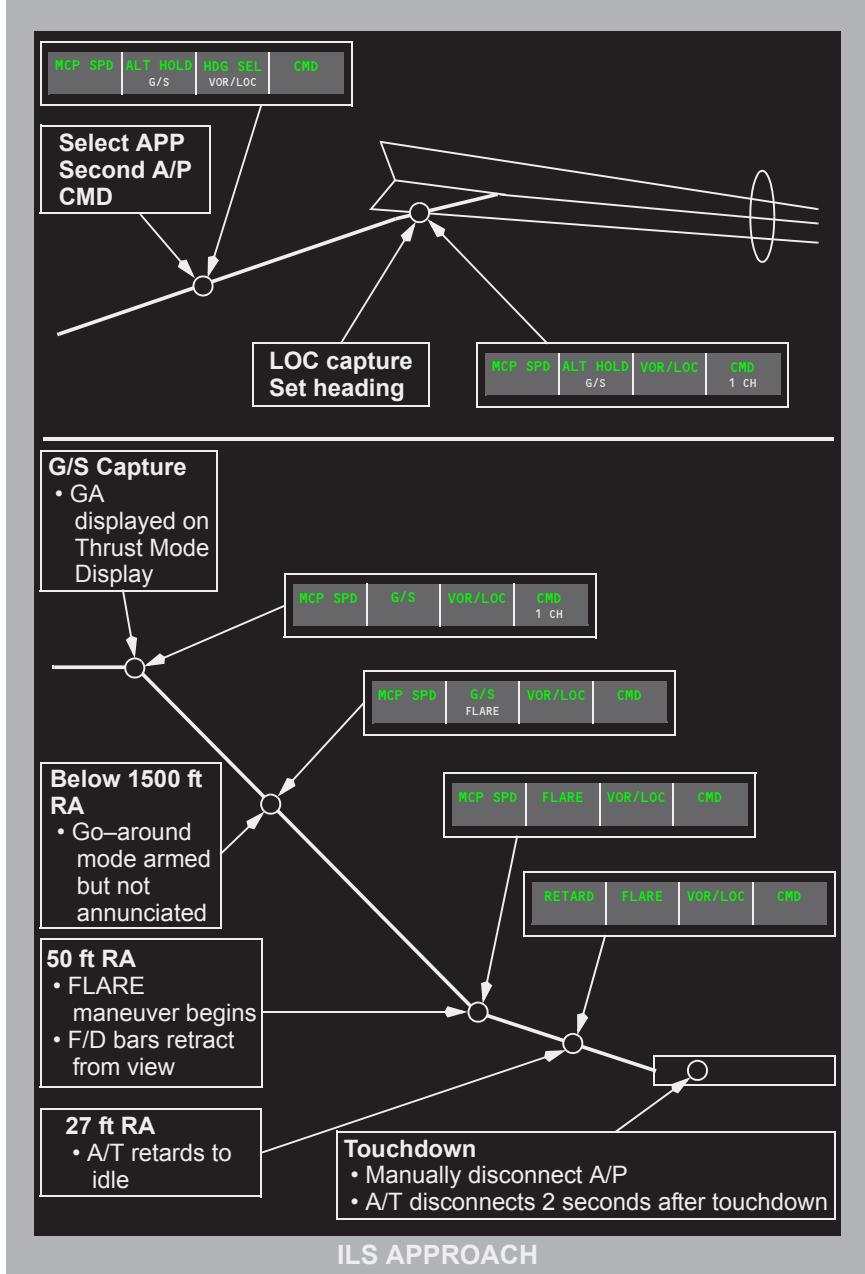
The armed and engaged states of FAC and G/P follow the established convention. The flight control system resets the FAC and G/P modes (the modes blank on the display) for the following cases:

- Loss of deviation signals
- Loss of validity
- Detection of a FAC or G/P failure

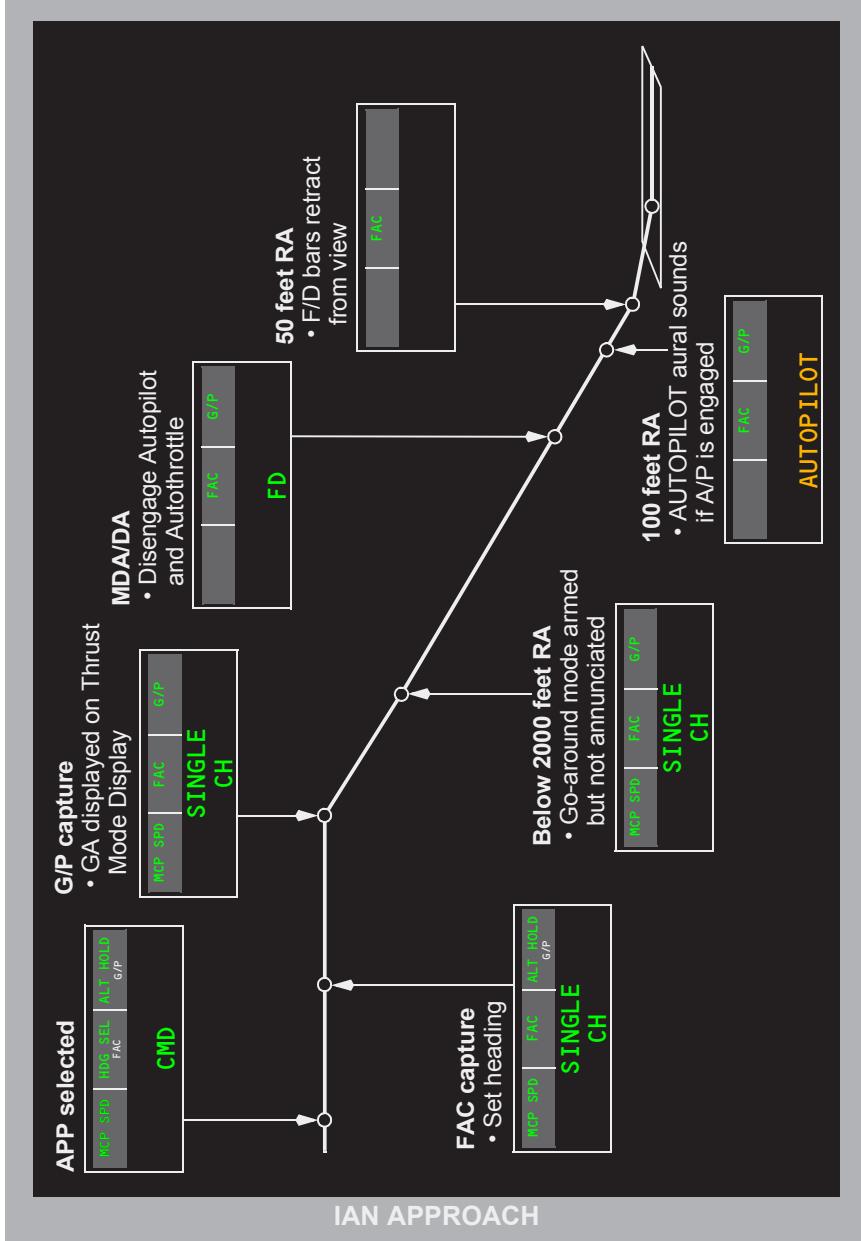
When the modes are reset, the FCC will remove (bias out of view) the F/D bars, and disconnect the A/P. These are analogous to the VOR/LOC and G/S reset modes.

## Automatic Flight Approach Profile

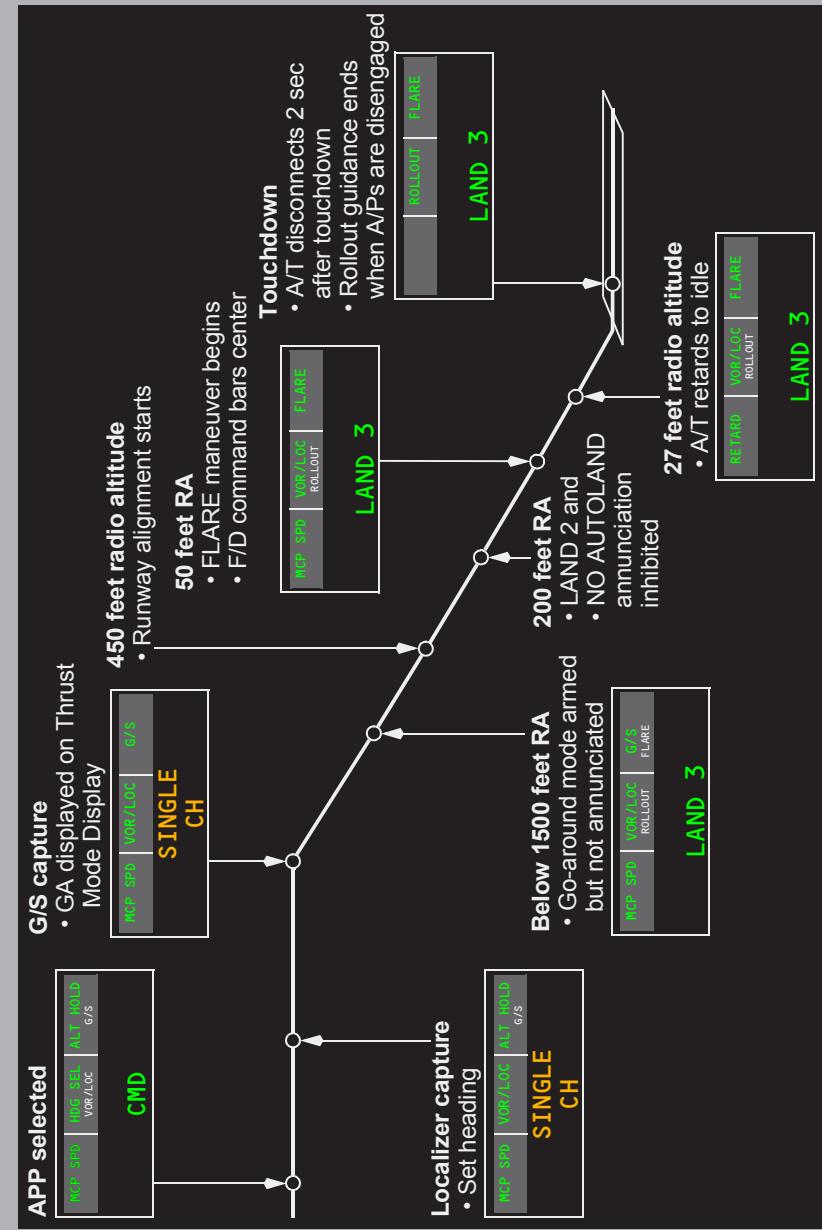
[Option - EFIS/MAP]



[Option - IAN]



[Option - Fail-Operational Autoland]



## 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

**[Option - A/P auto disengages for TO/GA above 2000 feet RA]**

**[Option - Honeywell -708 FCC and on]**

- when above 2000 feet RA with flaps not up or G/S captured
- with or without the AFDS engaged.

## 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 target airspeed for each flap setting based on maximum takeoff 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 command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff 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/T may command GA thrust.

**[Option - Fail-Operational Autoland]**

**Note:** During a fail-operational landing with LAND 3 or LAND 2 annunciated, pressing TO/GA after touchdown or activating the manual electric trim will not disconnect the autopilot and the rollout is not affected.

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.

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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

**[Option - Fail-Operational Autoland]**

- if the A/P is compensating for asymmetric thrust during the go-around, autopilot rudder control is disabled when a new pitch or roll mode is selected
- 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

[Option - A/P auto disengages for TO/GA above 2000 feet RA]

[Option - Honeywell -708 FCC and on]

- inflight above 2000 feet RA with flaps not up or G/S captured
- 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 target airspeed for each flap setting based on maximum takeoff 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 command airspeed cursor automatically moves to a target airspeed for the existing flap position based on maximum takeoff 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
    - F/D pitch mode remains in TO/GA.
  - if the pitch mode is changed first:
    - F/D pitch engages in the selected mode.
    - F/D roll mode automatically changes to HDG SEL
  - the A/T GA mode (if engaged) is terminated when:
    - another pitch mode is selected
    - ALT ACQ annunciates engaged.

**Note:** Engaging an A/P in CMD automatically engages the A/P and F/Ds in LVL CHG for pitch and HDG SEL for roll.

## Single Engine F/D Go-Around

With a push of either TO/GA switch:

- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- the F/D target speed is displayed on IAS/Mach display
- the F/D target speed is displayed on the airspeed cursor
- F/D pitch commands 13 degrees nose up. As climb rate increases, F/D pitch commands maintain a target speed.
  - if engine failure occurs prior to go-around engagement, then F/D target speed is the selected MCP speed.
  - if engine failure occurs after go-around engagement, then F/D target speed depends on whether ten seconds have elapsed since go-around engagement:
    - if prior to ten seconds, the MCP selected approach speed becomes target speed
    - if after ten seconds and the airspeed at engine failure is within five knots of the go-around engagement speed, the airspeed that existed at go-around engagement becomes target speed
    - if after ten seconds and the airspeed at engine failure is more than five knots above go-around engagement speed, then the current airspeed becomes target speed.

**Note:** The target speed is never less than V2 speed based on flap position unless in windshear conditions.

F/D commanded acceleration cannot occur until a higher speed is selected on the MCP IAS/Mach display.

## Go-Around Roll Mode – LNAV in Lieu of Track Hold

### [Option - TOGA to LNAV Go-Around Roll Mode]

When multiple arm modes such as LNAV and VOR/LOC are set, they will appear on the FMA side by side in white.

When a missed approach exists in the flight plan and the FCCs are capable of entering go-around, LNAV arm will be annunciated on the FMA. The roll go-around track hold mode will automatically transition to LNAV during a missed approach.

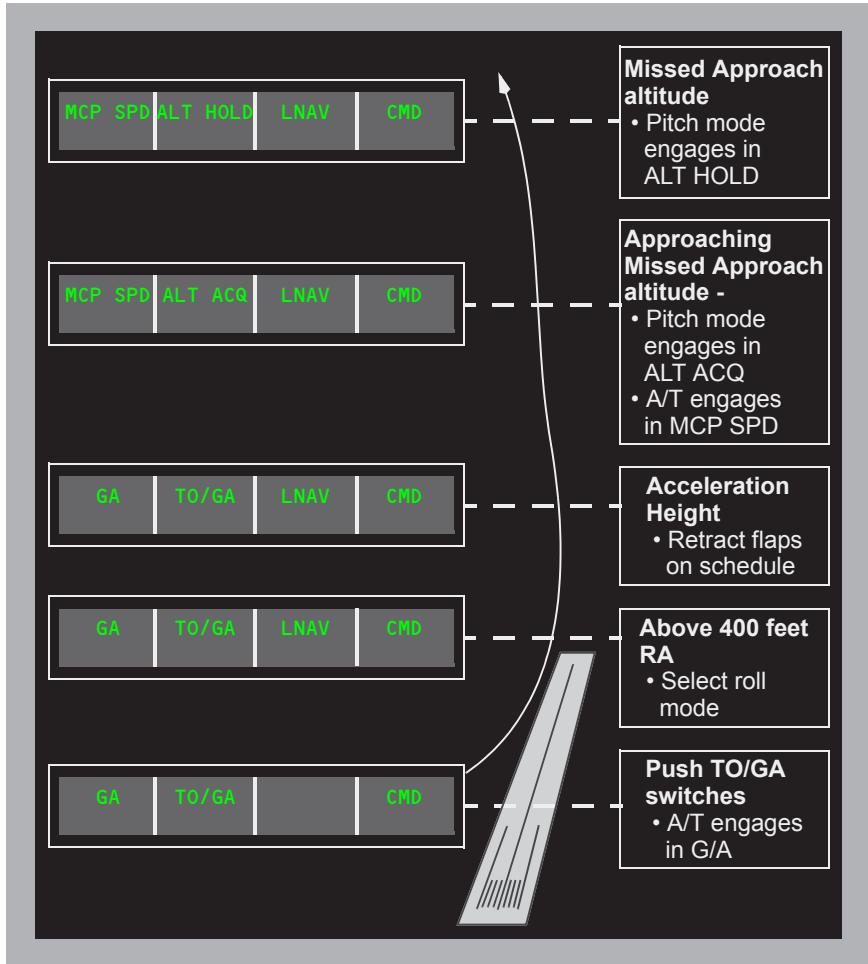
During autoland operations with FLARE arm or FLARE engage displayed, if TO/GA is pressed with LNAV arm annunciated on the FMA, then LNAV will engage when the airplane is above 400 feet. Below that altitude the roll mode will be track hold.

During an approach without FLARE arm or FLARE engage displayed, if TO/GA is pressed with LNAV arm annunciated on the FMA, the flight director LNAV mode will engage when the airplane is above 50 feet. Below that altitude the mode will be track hold.

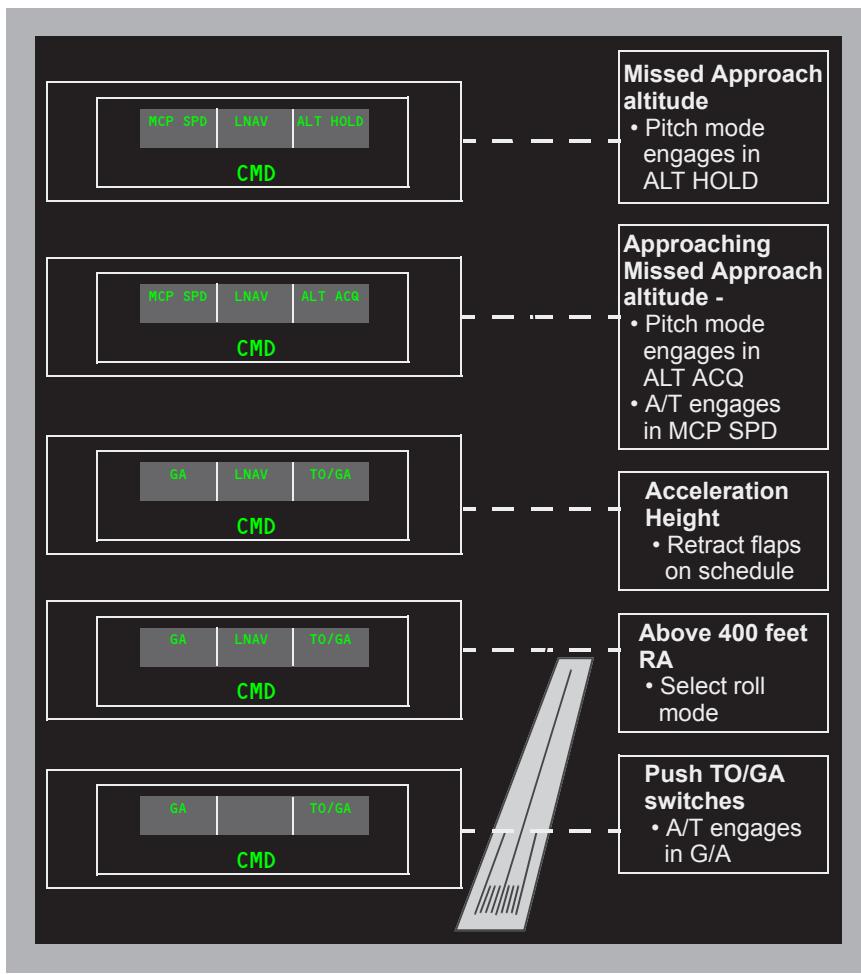
Single channel autopilot minimum engage and use heights are not affected. This feature is recommended to support RNP RNAV operations for terminal procedures requiring definitive course guidance.

## Automatic Flight Go-Around Profile

[Option - EFIS/MAP]



## [Option - PFD/ND]

**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 considers 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 pushing 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.

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## Command Speed Limiting and Reversion Modes

AFS command limiting and reversion operation is independent of the stall warning and mach warning systems.

### Command Speed Limiting

The AFS provides speed, pitch and thrust commands to avoid exceeding the following limit speeds:

- Vmo/Mmo
- wing flap placards
- landing gear placard
- minimum speed.

The commanded speed can be equal to, but does 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 knots 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 the AFDS is engaged but not in speed or CWS mode, and the A/T is armed but not in speed control, the A/T reverts to SPEED and controls speed to slightly below the placard limit
- if the AFDS or A/T is in speed control, speed is maintained slightly below the placard limit
- for VMO/MMO only, if the A/T is engaged in a speed mode and the thrust levers are at idle, the AFDS, if in a V/S mode, will automatically engage to LVL CHG mode.
- if the A/T is not available, no reversion response to gear or flap placard speeds is available. The AFDS reverts to speed control for Vmo/Mmo speed limiting.

## Minimum Speed Reversion

The AFDS and A/T do not control to a speed which is less than minimum speed for the current flap configuration. This speed is approximately 1.3 Vs. Minimum speed, FMC speed, or selected speed, whichever is higher, becomes the AFS commanded speed. If actual speed becomes equal to or slightly less than the minimum speed, the underspeed limiting symbol appears in the MCP IAS/Mach Display, and if operating in the V/S mode, the AFDS reverts to LVL CHG. The AFDS will also revert to LVL CHG from VNAV PTH, except when flying a level segment.

The AFS commands a speed 5 knots greater than minimum speed. Reaching a speed 5 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 5 knots greater than minimum speed, the underspeed limiting symbol disappears.

The A/P disengages and the F/D command bars retract when in a LVL CHG climb with a command speed equal to minimum speed and a minimum rate of climb cannot be maintained without decelerating.

Minimum speed reversion is not available when the A/T is OFF.

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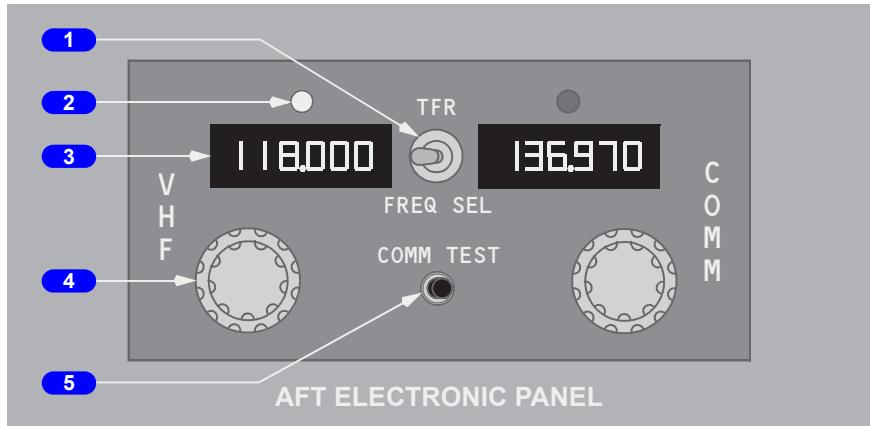
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**Communications****Controls and Indicators****Chapter 5****Section 10****VHF Communication Panel**

[Option - Typical VHF control panel with 8.33 khz frequency spacing]

**1 VHF Communications Transfer (TFR) Switch**

Left – selects left frequency as active for transceiver.

Right – selects right frequency as active for transceiver.

**2 Active Frequency Light**

Illuminated (white)– indicates the related frequency is selected.

**3 Frequency Indicator**

Indicates selected frequency.

**4 Frequency Selector**

Rotate – selects frequency in related indicator:

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

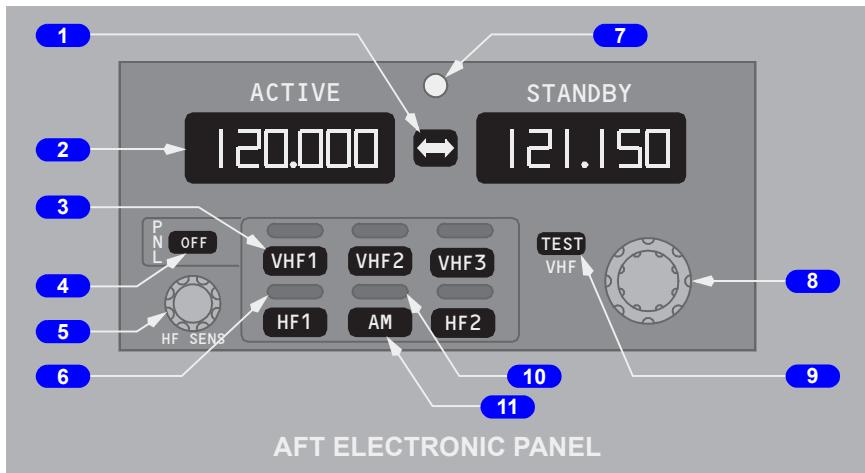
**5 Communication Test (COMM TEST) Switch**

Push –

- removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation
- improves reception of weak signals.

## Radio Tuning Panel

[Option -Typical radio tuning panel with 8.33 khz frequency spacing]



### 1 Frequency Transfer Switch

Push –

- transfers the STANDBY window frequency to the ACTIVE window and tunes the selected radio to the new active frequency
- transfers the ACTIVE window frequency to the STANDBY window.

### 2 Frequency Indicator

ACTIVE – displays the tuned frequency of the selected radio.

STANDBY – displays the preselected or previously tuned frequency of the selected radio

- displays DATA if the selected radio is in the data mode.
- displays six digit frequency in 8.33 KHz spacing.

**Note:** Illustration Typical

### 3 Radio Tuning Switch

Push –

- selects the VHF or HF radio to be tuned
- the tuned frequency is displayed in the ACTIVE frequency indicator
- the standby frequency is displayed in the STANDBY frequency indicator

**4 Radio Tuning Panel OFF Switch**

Push –

- disconnects the panel from the communication radios
- switch illuminates (white).

**5 HF Sensitivity Control**

Rotate – adjusts the sensitivity of the on-side HF receiver.

**6 Radio Tuning Light**

Illuminated (white) - indicates the selected radio.

**7 Offside Tuning Light**

Illuminated (white) –

- the radio normally associated with this panel is being tuned by another radio tuning panel, or
- the radio tuning panel is being used to tune a radio not normally associated with this radio tuning panel.

**8 Frequency Selector**

Rotate - selects frequency in the STANDBY frequency indicator:

- first digit is always 1
- outer selector changes second and third digits in 1 MHz increments
- inner selector changes fourth, fifth, and sixth digits in 8.33 KHz increments.
- For airplanes with ACARS, tuning above maximum or below minimum frequency displays DATA in Frequency Indicator.

**9 VHF TEST Switch**

Push –

- removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation
- improves reception of weak signals.

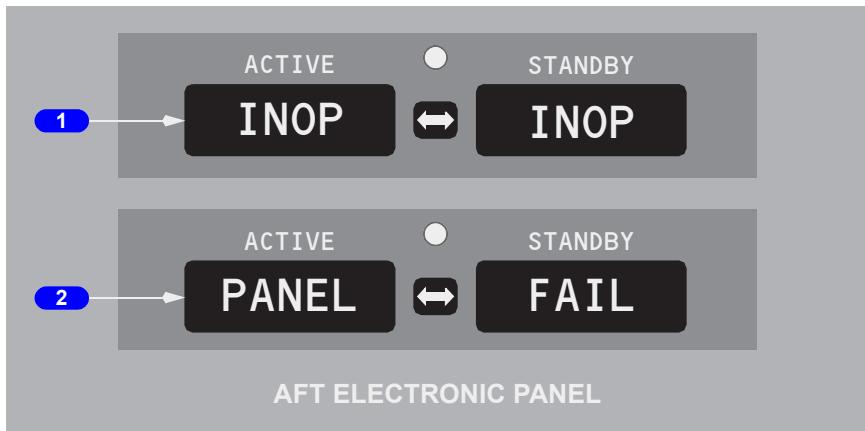
**10 AM Light**

Illuminated (white) – HF AM is selected.

Extinguished – HF USB is selected.

**11 AM Switch**

Push – sets the AM (amplitude modulation) or USB (upper side band) mode for the selected HF.

**Radio Tuning Panel Fail Modes****1 INOP Indication**

The selected radio is not available.

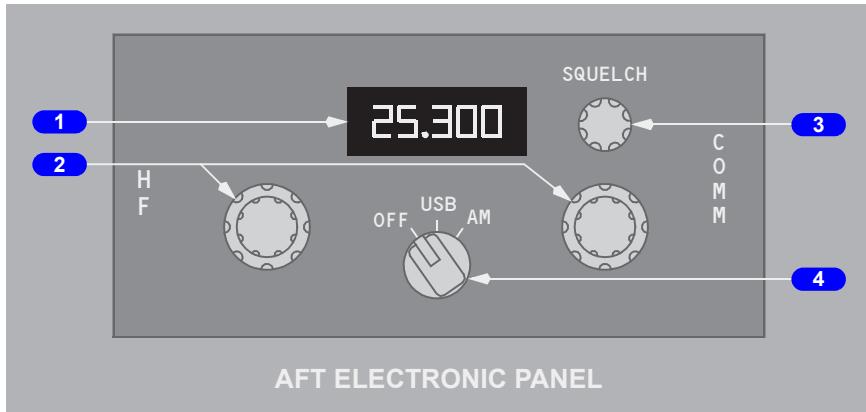
**2 PANEL FAIL**

The radio tuning panel has failed.

**Note:** The selected frequencies may continue to be displayed in the frequency indicator when the radio is not available.

## HF Communication Panel

[Option - Typical HF control panel]



### 1 Frequency Indicator

Displays tuned frequency

Frequency ranges from 2.000 to 29.999 megahertz.

### 2 Frequency Selectors

Rotate - selects desired frequency.

### 3 SQUELCH Control

Rotate - controls sensitivity of receiver

- clockwise increases sensitivity of weak or distant stations
- counterclockwise decreases sensitivity to reduce noise or static.

### 4 Mode Selector

OFF - removes power to transceiver

USB (Upper Sideband) - transmits and receives on the higher side of the frequency

AM (Amplitude Modulation) - transmits and receives on the selected frequency, accompanied by a carrier wave.

**Audio Control Panel (ACP)**

[Option - Typical audio control panel with MASK/BOOM and ALT/NORM switches]



### 1 Transmitter Selector (MIC SELECTOR) Switches

Illuminated – related switch is active

Push –

- selects related communication system for subsequent transmission
- only one switch may be selected at a time; pushing a second switch deselects first switch
- reception possible over selected system regardless of whether related receiver switch is on.

### 2 Receiver Switches

Illuminated (white) – related switch is active

Rotate – adjusts volume

Push –

- allows reception of 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 microphone for transmissions.

BOOM – selects boom microphone for transmissions.

**5 Speaker (SPKR) Switch**

Illuminated (white) – SPKR switch is active.

Push – audio from selected receiver is heard on overhead speaker.

Rotate – adjusts overhead speaker volume.

Push again – deselects audio from selected receiver to be heard on overhead speaker.

**6 Alternate-Normal (ALT-NORM) Switch**

NORM (Normal) – ACP operates normally.

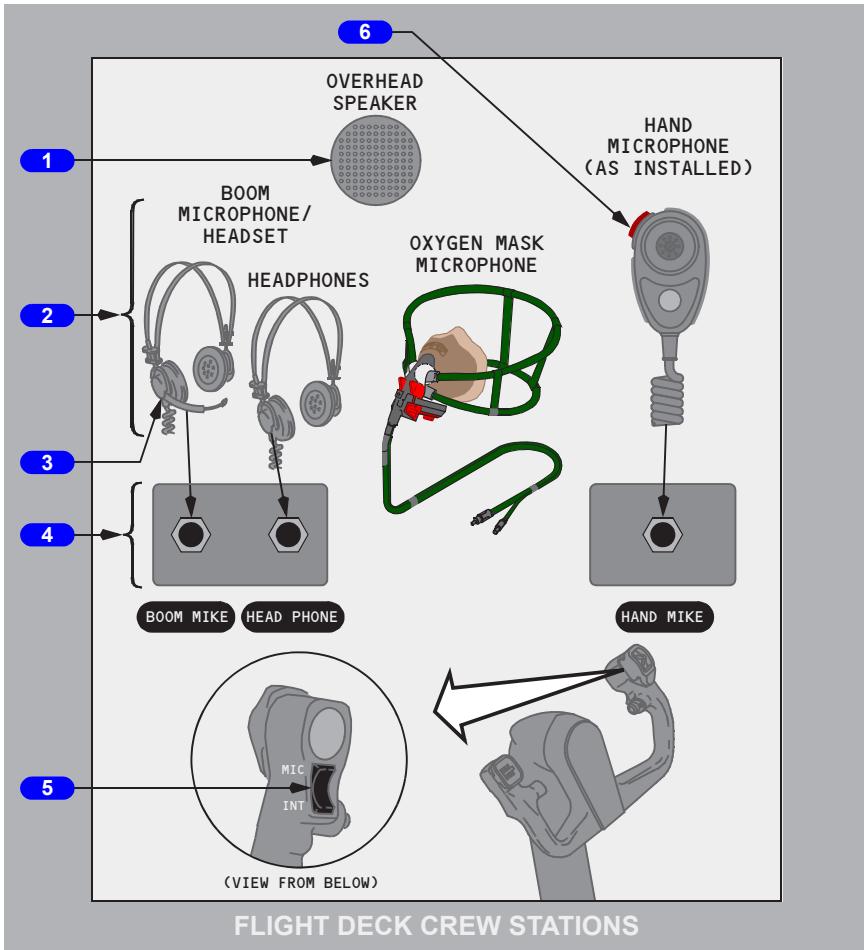
ALT (Alternate) – ACP operates in degraded mode.

**7 Filter Switch**

V (Voice) – receive NAV and ADF voice audio.

B (Both) – receive NAV and ADF voice and range audio.

R (Range) – receive NAV and ADF station identifier range (code) audio.

**Miscellaneous Communication Controls (Typical)****1 Overhead Speaker**

Monitors audio from related pilot's ACP.

**2 Headset or Headphones**

Monitors audio from related ACP.

**3 Standard Microphones**

Choose desired microphone for voice transmission through selected radio, interphone system, or passenger address (PA).

**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 ACP transmitter selector.
- same as using ACP PTT switch (R/T position).

OFF – center position.

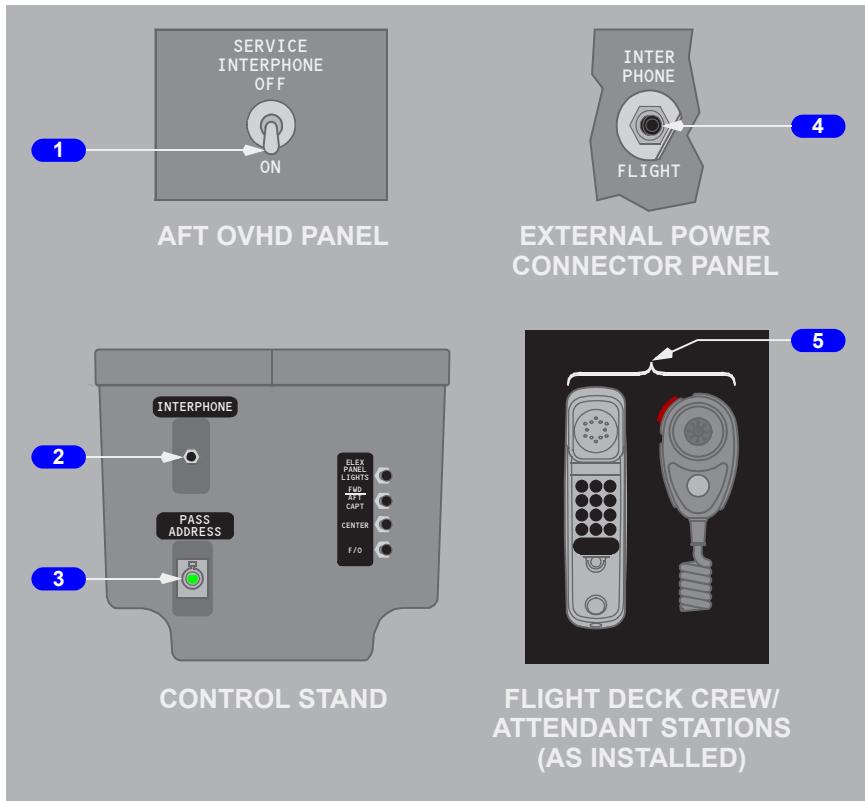
INT (interphone) –

- selects oxygen mask or boom microphone for direct transmission over flight interphone
- bypasses ACP transmitter selector
- same as using ACP PTT switch (I/C position)

**6 Push-To-Talk Switch**

Push – keys hand microphone for transmission, as selected by ACP transmitter 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 ACP.

### 3 Passenger Address (PASS ADDRESS) Hand Microphone Jack

With microphone installed:

- used to make PA announcements
- bypasses ACPs.

### 4 INTERPHONE FLIGHT Jack

Connects ground crew to flight interphone system.

### 5 Flight Deck / Attendant PA Hand Microphone

Used to make PA announcements.

## Cockpit Voice Recorder

[Option - Typical]



### 1 Area Microphone

Active anytime 115V AC is applied to airplane.

### 2 ERASE Switch (red)

Push (2 seconds) –

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

### 3 TEST Switch

Push – after a slight delay and no faults are detected:

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

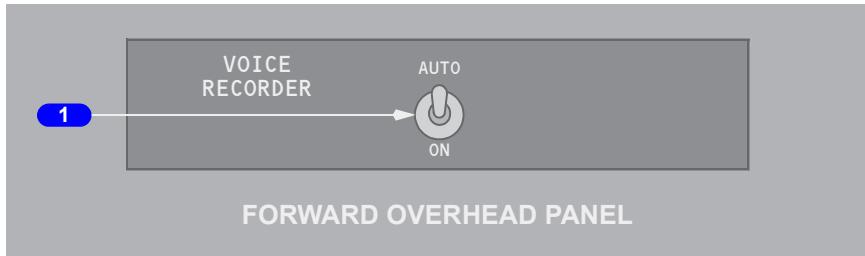
**4 HEADSET Jack**

Headset may be plugged into jack to monitor tone transmission during test, or to monitor playback of voice audio.

**5 Monitor Indicator**

Pointer deflection indicates:

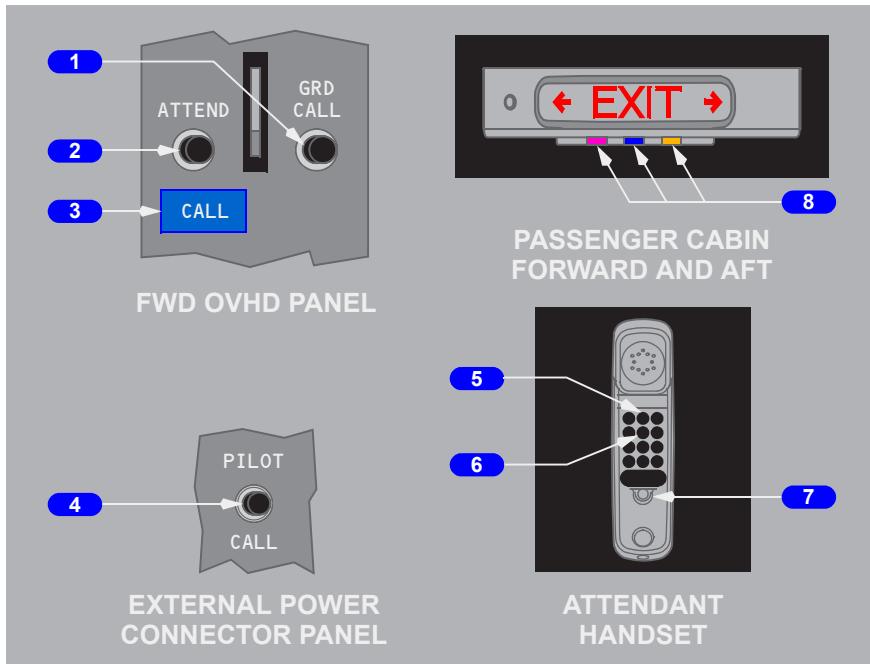
- during normal operation – system is recording
- during ERASE – erasure on all four channels  
(approximately a one second delay)
- during TEST – pointer rises into green band.

**Cockpit Voice Recorder Switch****[Option]****1 VOICE RECORDER Switch**

AUTO - powers the cockpit voice recorder from first engine start until 5 minutes after last engine shutdown

ON - powers the cockpit voice recorder until first engine start, then trips the switch to AUTO.

## Call System



### 1 Ground Call (GRD CALL) Switch

Push – sounds a horn in nose wheel well until released.

### 2 Attendant Call (ATTEND) Switch

Push –

- sounds a two-tone chime in 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.

### 4 PILOT CALL Switch

Push – sounds a single-tone chime in flight deck.

### 5 CAPTAIN Call Switch

Push – sounds a single-tone chime in flight deck.

## **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
- cancels call
- disconnects the handset from the public address system.

## **8 Master Call Lights**

Illuminated –

- amber – a lavatory call switch is activated or smoke is detected in a lavatory.
- pink – flight deck or other flight attendant station is calling.
- blue – a passenger seat call switch is activated.

## Communications System Description

## Chapter 5 Section 20

### Introduction

The communication system includes:

- radio communication system
- interphone communication system
- cockpit voice recorder system
- communication crew alerting system

The communication systems are controlled using the:

- audio control panels

#### [Option - Radio tuning panel]

- radio tuning panels

#### [Option - VHF or HF control panels]

- radio communication panels

---

## Audio Systems and Audio Control Panels

An ACP 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 ACP 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 ACP is monitored using a headset/headphones or the related pilot's speaker.

Audio warnings for altitude alert, ground proximity warning, collision avoidance, 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.

The MASK-BOOM switch allows selection of the oxygen mask microphone or the boom microphone. The MASK-BOOM switch does not affect the operation of the hand microphone.

Each hand microphone has a PTT switch to key the selected audio system. The PTT switches on the control wheel or ACP are used to key the oxygen mask or boom microphone, as selected by the R/T and I/C switch. The R/T and I/C 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 ACPs through digital or computerized control circuits.

---

## Degraded Audio System Operation

If the remote electronics unit or ACP malfunctions, the ACP 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 ACP at that station is inoperative and the crewmember can only communicate on one radio.

The ACP transmitter selectors are not functional. Any transmission from that station must be from 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 ACP 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 ACP 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 use the 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. Alternately, any crewmember with an ACP can transmit/receive over the flight interphone by using their related ACP 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 ACP 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 handset or by using any standard microphone and the related ACP. Flight Attendants make announcements using PA handset 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.

## Call System

The call system is used as a means for various crewmembers to gain the attention of other crewmembers and to indicate that interphone communication is desired. Attention is gained through the use of lights and aural signals (chimes or horn). The system can be activated from the flight deck, either flight attendant station, or from the external power receptacle. Passengers may also use the system to call an attendant, through the use of individual call switches at each seat.

The flight deck may be called from either flight attendant station or by the ground crew. The ground crew may only be called from the flight deck. Flight Attendants may be called from the flight deck, the other attendant station, or from any passenger seat or lavatory. Master call lights in the passenger cabin identify the source of incoming calls to the attendants.

Call system chime signals are audible in the passenger cabin through the PA system speakers. The PA speakers also provide an alerting chime signal whenever the NO SMOKING or FASTEN SEAT BELT signs illuminate or extinguish.

| Location of Call Originator    | Called Position   | Visual Signal at Called Position                           | Aural Signal at Called Position |
|--------------------------------|-------------------|--|---------------------------------|
| Flight deck                    | Attendant station | Pink master call light                                     | Two-tone chime                  |
| Flight deck                    | Nose wheel well   |  | Horn in nose wheel well         |
| Attendant station              | Flight deck       | Blue flight deck call light                                | Single high-tone chime          |
| External Power Connector Panel | Flight deck       | Blue flight deck call light                                | Single high-tone chime          |
| Flight deck                    | Passenger cabin   | NO SMOKING or FASTEN SEAT BELT signs illuminate/extinguish | Single low-tone chime           |

---

## VHF Communications

Primary short-range voice communications is provided in the VHF range by 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 ACP.

### [Option -Typical VHF control panel equipped airplanes]

VHF-1 control panel is located on the left side of the aft electronic panel, VHF-2 control panel is on the right and VHF-3 control panel is in the center. The VHF-2 and VHF-3 antennae are located on the lower fuselage, VHF-1 is on the upper fuselage.

### [Option - Typical for radio tuning panel equipped airplanes]

The VHF/HF RTP-1 is located on the forward left side of the aft electronic panel, VHF/HF RTP-2 is on the forward right side and VHF/HF RTP-3 is on the aft portion of the panel. The VHF-2 and VHF-3 antennae are located on the lower fuselage, VHF-1 is on the upper fuselage.

**Note:** VHF antennae located on the lower fuselage are susceptible to multipath interference from nearby structures or vehicles. This may disrupt VHF communications. VHF antennae located on the upper fuselage are not as susceptible to this interference.

---

## HF Communications

### [Option - Typical for radio tuning panel equipped airplanes]

The HF communication radio can be tuned by any radio tuning panel. HF radio sensitivity can only be set on the on-side radio tuning panel.

### [Option - Typical for HF control panel equipped airplanes]

The HF radio communications control panel allows for frequency selection and adjustment of radio sensitivity.

The audio control panels are used to control voice transmission and receiver monitoring. When an HF transmitter is keyed after a frequency change, the antenna tunes. A steady or intermittent tone may be heard through the audio system. While tuning, the tone can last as long as 7 seconds. If the system fails to tune, the tone will last more than 7 seconds, to a maximum of 15 seconds. The antenna is located in the vertical stabilizer.

## Cockpit Voice Recorder

The cockpit voice recorder uses four independent channels to record flight deck audio for 120 minutes. Recordings older than 120 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual ACP output (headset) audio and transmissions for the pilots and observer.

## ACARS System

The ARINC Communications 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 operation center utilizing an onboard VHF communications 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 in the E/E compartment, either a interactive display unit or multipurpose control display unit (MCDU), and frequently a printer. Data is entered and transmitted to the ground operations center.

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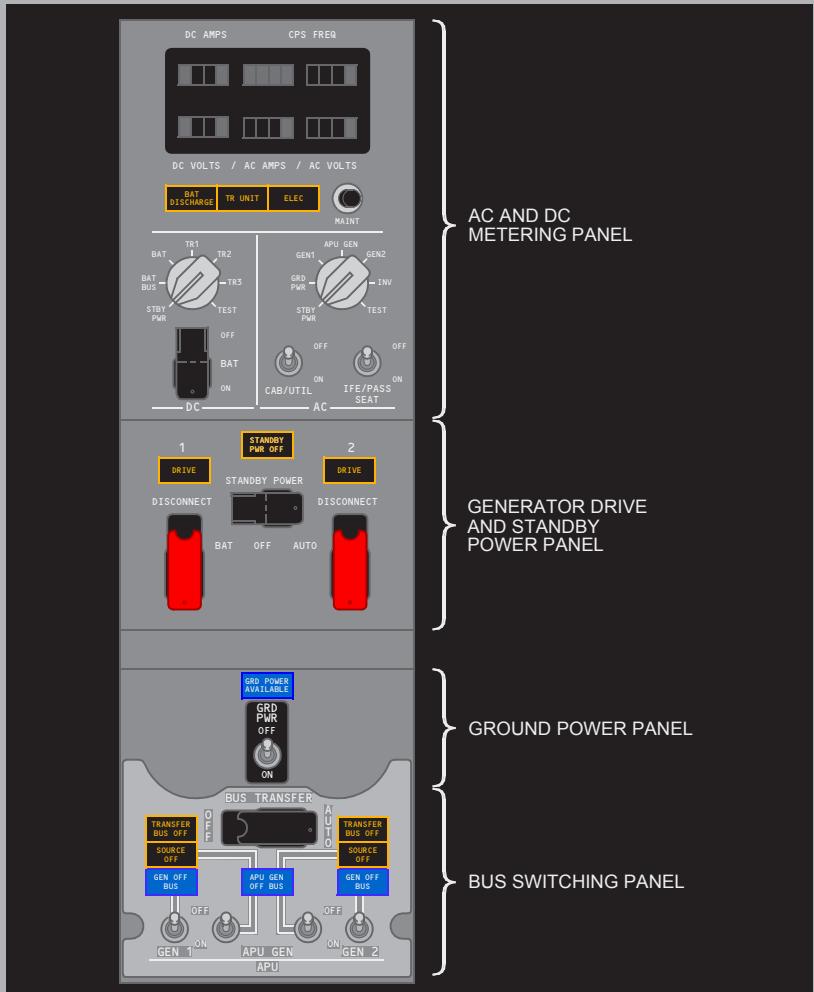
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# Electrical Controls and Indicators

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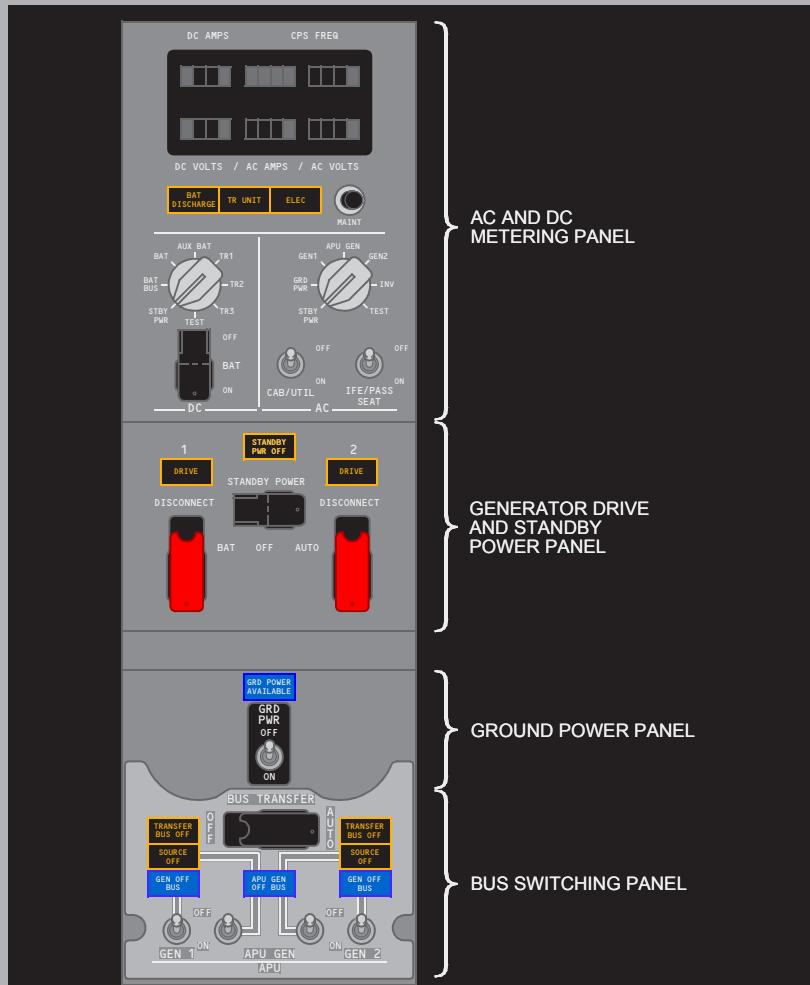
## Electrical Panel

[Option - Single battery with CAB/UTIL switch]



**FORWARD OVERHEAD PANEL**

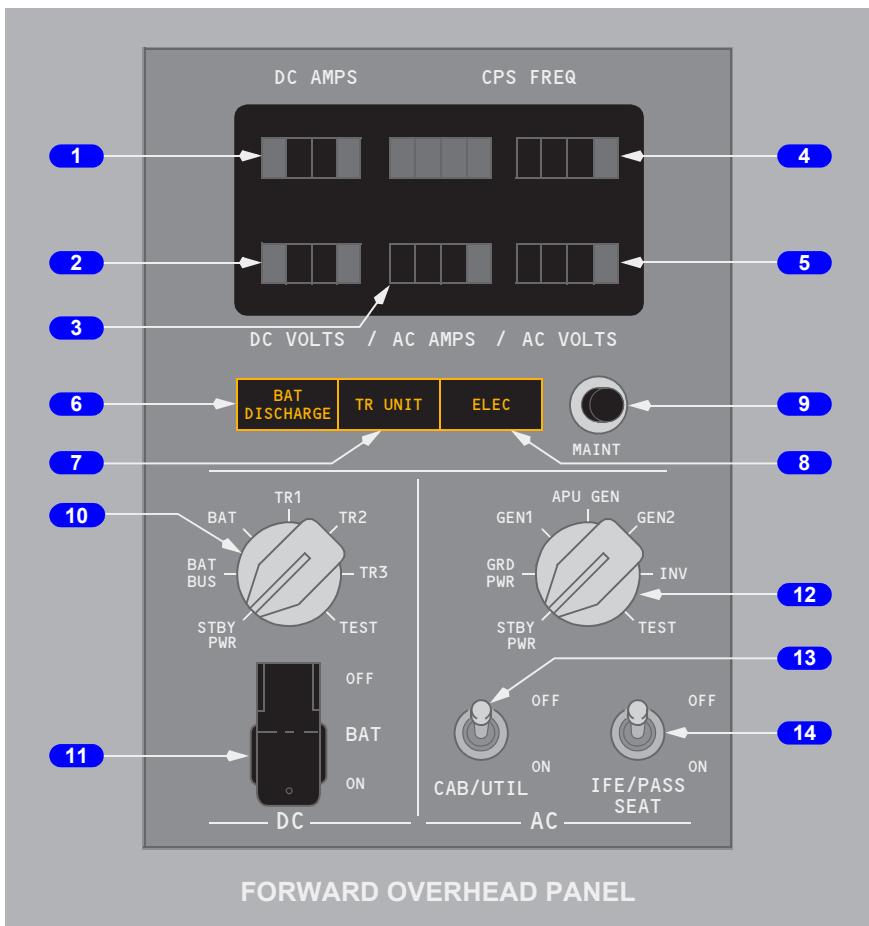
[Option - Dual battery with CAB/UTIL switch]



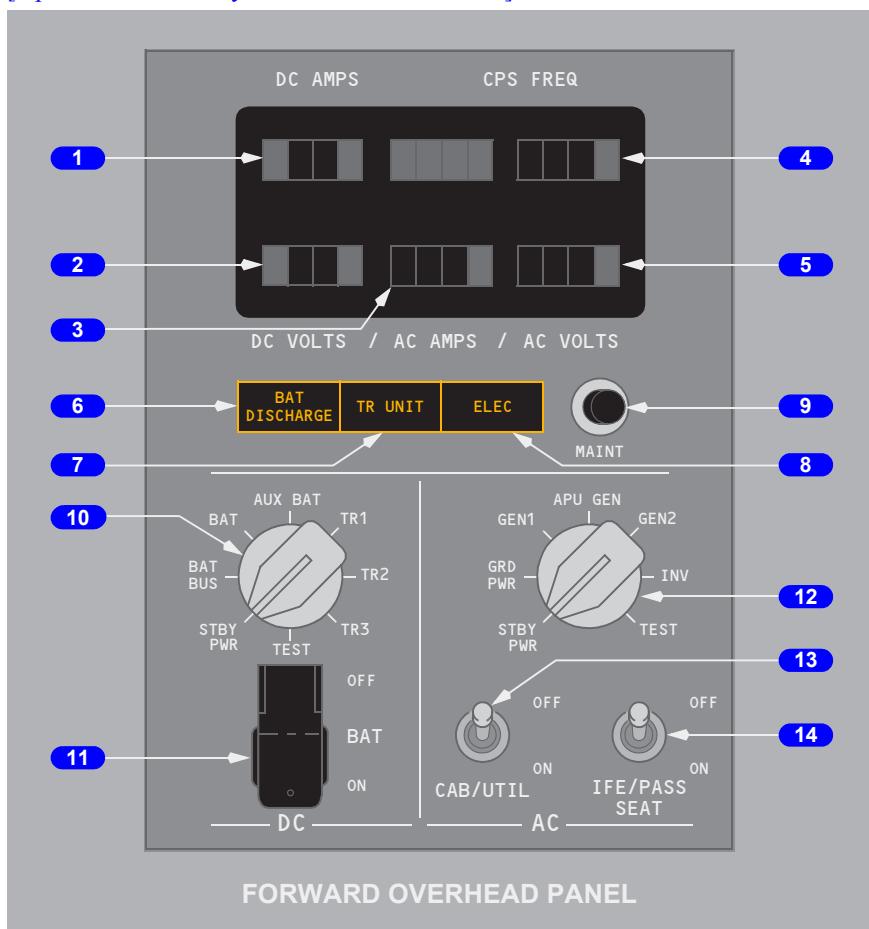
**FORWARD OVERHEAD PANEL**

## AC and DC Metering Panel

[Option - Single battery with CAB/UTIL switch]



## [Option - Dual battery with CAB/UTIL switch]



FORWARD OVERHEAD PANEL

**1 DC Ammeter**

Indicates amperage of source selected by DC meters selector.

**2 DC Voltmeter**

Indicates voltage of source selected by DC meters selector.

**3 AC Ammeter**

Indicates amperage of source selected by AC meters selector.

**4 Frequency Meter**

Indicates frequency of source selected by AC meters selector.

**5 AC Voltmeter**

Indicates voltage of source selected by AC meters selector.

**6 Battery Discharge (BAT DISCHARGE) Light**

Illuminated (amber) – with BAT switch ON, excessive battery discharge detected.

**7 TR UNIT Light**

Illuminated (amber) –

- on the ground – any TR has failed.
- in flight –
  - TR1 failed; or
  - TR2 and TR3 failed.

**8 Electrical (ELEC) Light**

Illuminated (amber) – a fault exists in DC power system or standby power system.

**Note:** Operates only with airplane on ground.

**9 Maintenance Test (MAINT) Switch**

Used by maintenance.

**10 DC Meters Selector**

Selects DC source for DC voltmeter and DC ammeter indications.

TEST – used by maintenance.

**11 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.

## **12 AC Meters Selector**

Selects AC source for AC voltmeter, AC ammeter and frequency meter indications

TEST – used by maintenance.

## **13 CAB/UTIL Switch**

OFF – removes electrical power from galley and cabin equipment systems including:

- all 115V AC galley busses

[737-600/700]

- cabin recirculation fan

[737-800/900]

- left & right recirculation fans
- fwd and aft door area heaters
- drain mast heaters
- lavatory water heaters
- logo lights
- potable water compressor
- 115V AC shaver outlets when installed

ON – supplies electrical power to galley and cabin equipment systems.

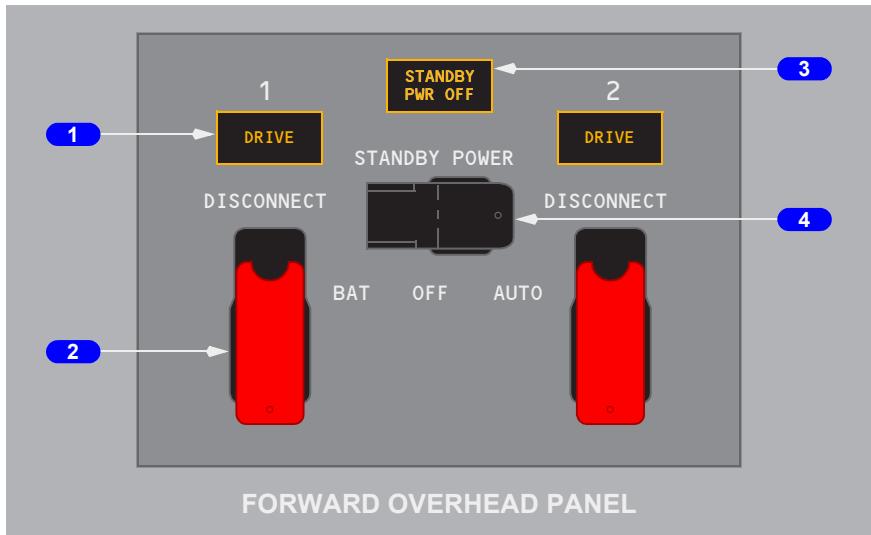
## **14 IFE/PASS SEAT Switch**

OFF – removes electrical power from installed components of the passenger seats, in-flight entertainment systems, and other power systems including:

- 115V AC audio entertainment equipment
- 115V AC video entertainment equipment
- cabin telephone equipment
- FAX machine
- 28V DC video equipment and passenger seat electronic outlets
- 115V AC flight deck auxiliary power outlets

ON – supplies electrical power to installed components of the passenger seats, in-flight entertainment systems, and other power systems.

## Generator Drive and Standby Power Panel



### 1 Generator Drive (DRIVE) Lights

Illuminated (amber) – Integrated drive generator (IDG) low oil pressure caused by one of the following:

- IDG failure
- engine shutdown
- IDG automatic disconnect due to high oil temperature
- IDG disconnected through generator drive DISCONNECT switch.

### 2 Generator Drive Disconnect (DISCONNECT) Switches (guarded)

Disconnects IDG if electrical power is available and engine start lever is in IDLE. IDG cannot be reconnected in the air.

### 3 STANDBY Power Off (PWR OFF) Light

Illuminated (amber) – one or more of the following busses are unpowered:

- AC standby bus
- DC standby bus
- battery bus.

**4 STANDBY POWER Switch**

AUTO (guarded position) –

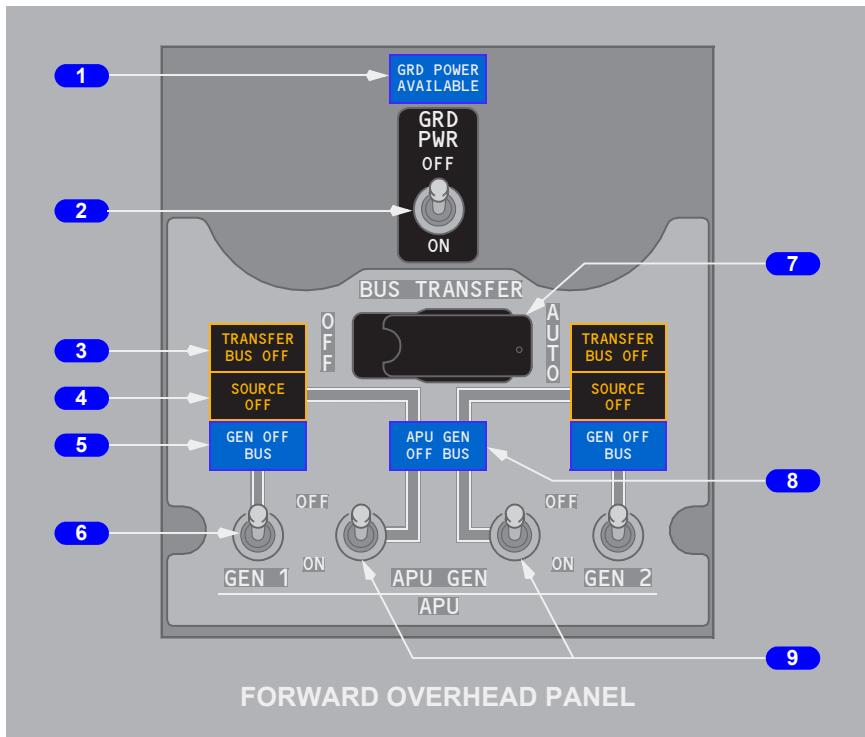
- In flight, or on the ground, and AC transfer busses powered:
  - AC standby bus is powered by AC transfer bus 1
  - DC standby bus is powered by TR1, TR2 and TR3
- In flight, or on the ground, loss of all AC power
  - AC standby bus is powered by battery through static inverter
  - DC standby bus is powered by battery
  - Battery bus is powered by battery.

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 battery through static inverter
- DC standby bus and battery bus are powered directly by battery.

**Ground Power Panel and Bus Switching Panel**

**1 Ground Power Available (GRD POWER AVAILABLE) Light**

Illuminated (blue) – ground power is connected and meets airplane power quality standards.

**2 Ground Power (GRD PWR) Switch**

Three position switch, spring-loaded to neutral

OFF – disconnects ground power from AC transfer busses.

ON – if momentarily moved to ON position and ground power is available:

- removes previously connected power from AC transfer busses
- connects ground power to AC transfer busses if power quality is correct.

**3 TRANSFER BUS OFF Lights**

Illuminated (amber) – related transfer bus is not powered.

**4 SOURCE OFF Lights**

Illuminated (amber) – no source has been manually selected to power the related transfer bus, or the manually selected source has been disconnected

- if a source has been selected to power the opposite transfer bus, both transfer busses are powered.

**5 Generator Off Bus (GEN OFF BUS) Lights**

Illuminated (blue) – IDG is not supplying power to the related transfer bus.

**6 Generator (GEN) Switches**

Three position switch, spring-loaded to neutral.

OFF – disconnects IDG from related AC transfer bus by opening generator circuit breaker.

ON – connects IDG to related AC transfer bus by disconnecting previous power source and closing generator circuit breaker,

**7 BUS TRANSFER Switch**

AUTO (guarded position) – BTBs operate automatically to maintain power to AC transfer busses from any operating generator or external power

- DC cross tie relay automatically provides normal or isolated operation as required.

OFF – isolates AC transfer bus 1 from AC transfer bus 2 if one IDG is supplying power to both AC transfer busses

- DC cross tie relay opens to isolate DC bus 1 from DC bus 2.

## **8 APU Generator Off Bus (GEN OFF BUS) Light**

Illuminated (blue) – APU is running and not powering a bus.

## **9 APU Generator (GEN) Switches**

Three position switch, spring-loaded to neutral.

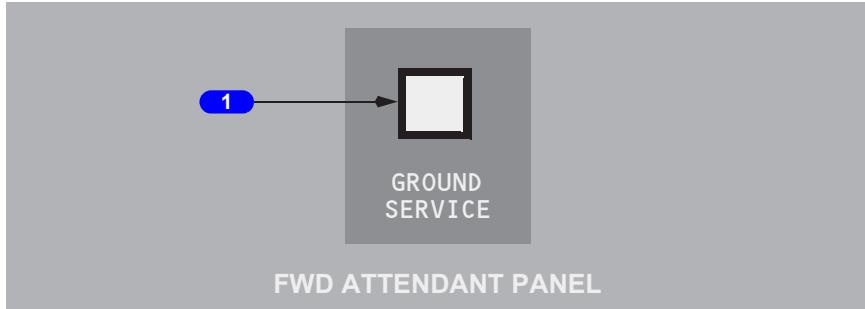
OFF –

- APU generator powering both AC transfer busses
  - moving a single APU GEN switch to OFF illuminates related SOURCE OFF light. APU continues to power AC transfer busses
  - subsequently moving other APU GEN switch to OFF disconnects APU generator from tie bus and removes APU power from AC transfer busses
- APU generator powering one AC transfer bus; IDG powering one AC transfer bus
  - moving related APU GEN switch to OFF disconnects APU generator from tie bus and AC transfer bus. IDG powers AC transfer busses.

ON –

- Neither AC transfer bus powered by IDG – moving a single APU GEN switch to ON:
  - connects both AC transfer busses to the APU generator
  - disconnects external power, if connected
  - opposite SOURCE OFF light illuminates until the other APU GEN switch is moved to ON.
- Both AC transfer busses powered by IDGs – moving an APU GEN switch ON:
  - powers the related AC transfer bus from the APU generator
  - other AC transfer bus continues to receive power from the IDG.

## **Ground Service Switch**



---

**1 GROUND SERVICE Switch**

Momentary push-button switch.

Provides manual control of ground service busses. Enables servicing airplane using external power without activating AC transfer busses.

Illuminated (white) –

- ON – connects external power to ground service busses
- OFF – disconnects external power from ground service busses.

Intentionally  
Blank

## Electrical System Description

## Chapter 6 Section 20

### Introduction

#### Single Battery

##### **[Option]**

Primary electrical power is provided by two engine integrated drive generators (IDGs) which supply three-phase, 115 volt, 400 cycle alternating current. Each IDG supplies its own bus system in normal operation and can also supply essential and non-essential loads of the opposite side bus system when one IDG is inoperative. Transformer rectifier (TR) units and a battery/battery charger supply DC power. The battery also provides backup power for the AC and DC standby system. The APU operates a generator and can supply power to both AC transfer busses on the ground or 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 transfer 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.

#### Dual Battery

##### **[Option]**

Primary electrical power is provided by two engine integrated drive generators (IDGs) which supply three-phase, 115 volt, 400 cycle alternating current. Each IDG supplies its own bus system in normal operation and can also supply essential and non-essential loads of the opposite side bus system when one IDG is inoperative. Transformer rectifier (TR) units and the main battery/battery charger supply DC power. The main and auxiliary batteries also provide backup power for the AC and DC standby system. The APU operates a generator and can supply power to both AC transfer busses on the ground or 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 transfer 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 IDGs. The IDG maintains a constant generator speed throughout the normal operating range of the engine. An integral electro-mechanical disconnect device provides for complete mechanical isolation of the IDG.

### APU Generator

The APU generator can supply power to both AC transfer busses on the ground or in flight. As the only power source, the APU generator can meet electrical power requirements for all ground conditions and most flight conditions.

### External Ground Power

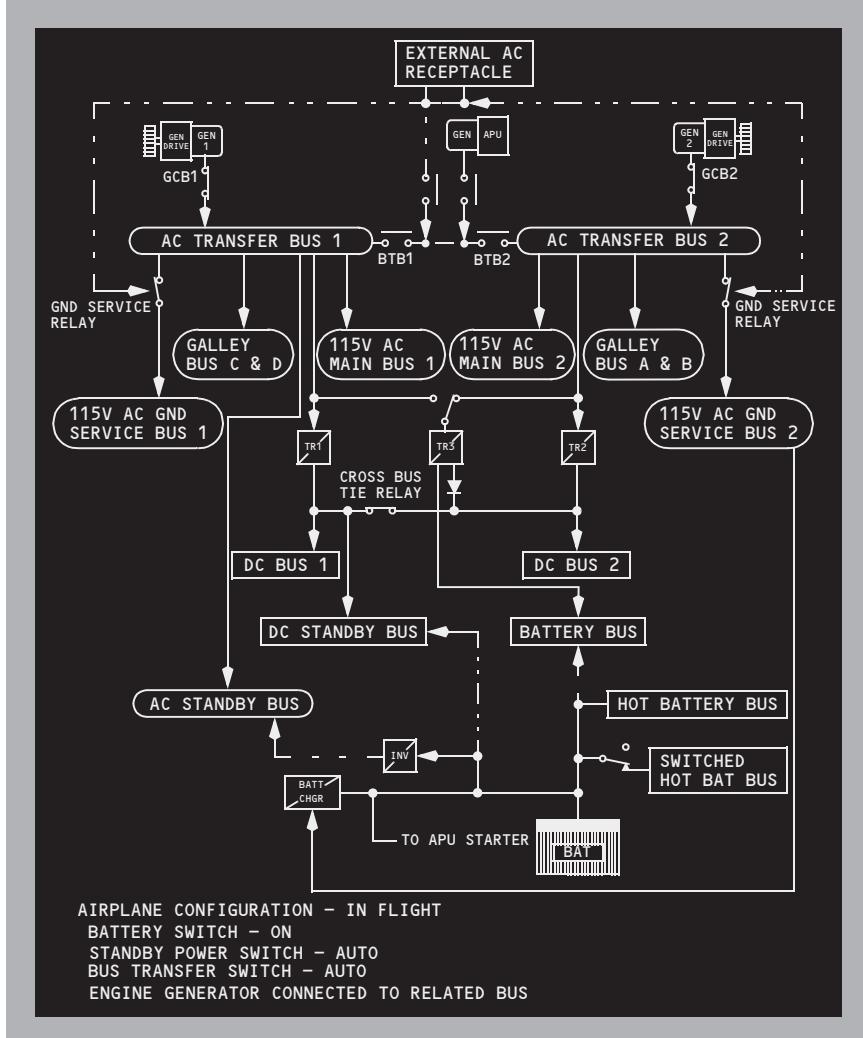
An external AC power receptacle located near the nose gear wheel well, on the lower right side of the fuselage, allows the use of an external power source. Status lights on a panel adjacent to the receptacle permit the ground crew to determine if external power is being used. When connected, external power can supply power to both transfer busses.

### Ground Service

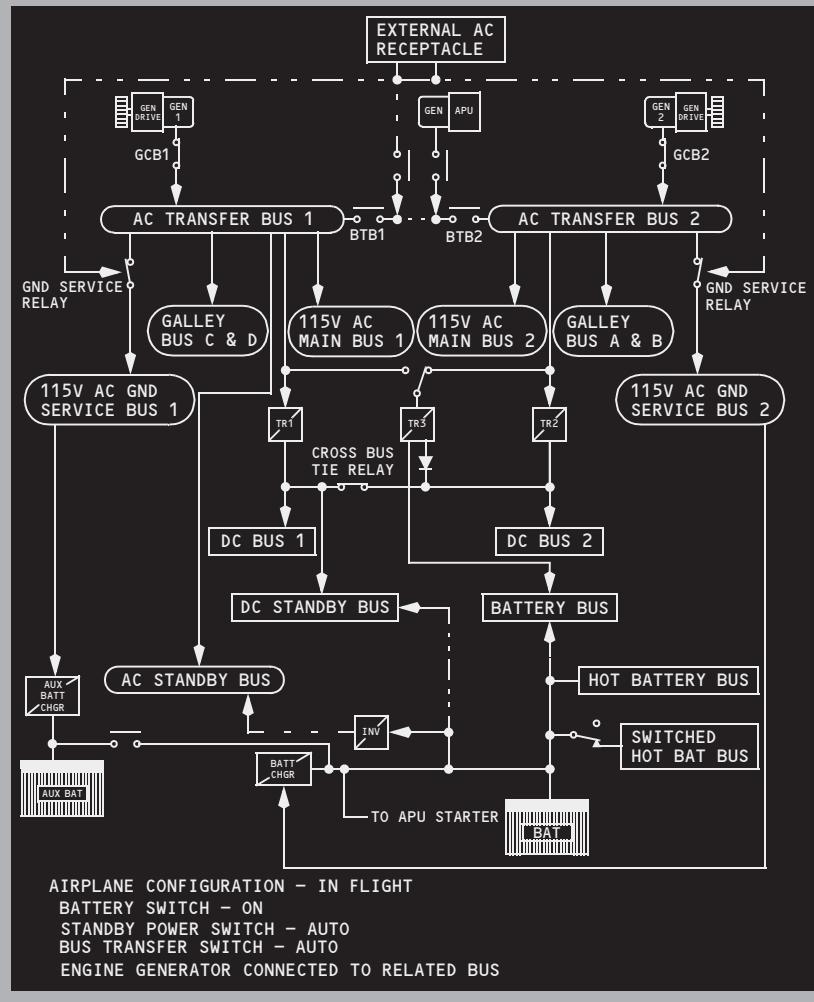
For ground servicing, a ground service switch is on the forward attendant's panel. The switch provides ground power directly to the AC ground service busses for utility outlets, cabin lighting and the battery charger without powering all airplane electrical busses. The ground service switch is a momentary push button and is overridden when both AC transfer busses are powered.

## Electrical Power Schematic

[Option - Single battery]



## [Option – Dual battery]

**AC Power System**

Each AC power system consists of a transfer bus, a main bus, two galley busses, and a ground service bus. Transfer bus 1 also supplies power to the AC standby bus. If the AC source powering either transfer bus fails or is disconnected, the transfer bus can be powered by any available source through the tie bus with the bus tie breakers (BTBs).

With the airplane on the ground and both generator control switches OFF, or with both engines shut down, selecting the GRD PWR switch ON connects external power to both transfer busses. Likewise, selecting either APU GEN switch ON connects APU power to both transfer busses. Whichever source is selected last powers both busses. It is not possible to power one transfer bus with external power and one transfer bus with APU power.

The transfer busses can be powered from the engine generators by momentarily positioning the related generator switch to ON. This closes the related generator circuit breaker (GCB) and connects the generator to the transfer bus. Whenever external power or APU is powering both transfer busses, and engine generator power is applied to its onside transfer bus, external power or APU continues to supply power to the remaining transfer bus.

In flight, each engine generator normally powers its own transfer bus. If an engine generator is no longer supplying power, the BTBs automatically close to allow the other engine generator to supply both transfer busses through the tie bus and BTBs. The APU can power either or both busses through the BTBs.

The system also incorporates an automatic generator on-line feature in case the airplane takes off with the APU powering both transfer busses. If the APU is either shut down or fails, the engine generators are automatically connected to their related transfer busses. This action occurs only once in flight and only under the circumstances described above.

## Bus Tie System

Either generator or the APU can supply power to both transfer busses. If the BUS TRANS switch is in the AUTO position and the source powering the transfer bus is disconnected or fails, the source powering the opposite transfer bus automatically picks up the unpowered transfer bus through the BTBs.

## Flight Deck Auxiliary Power System

The system is composed of a power converter and AC outlets on the P6 and P18 panels to provide power for Flight Deck Personal Electronic Devices (PEDs). A protective device is a part of the safety aspect of the outlets to prevent tampering with foreign objects. PEDs that are plugged into the Flight Deck Auxiliary Power outlets must be fully inserted into the outlet with the prongs of the plug inserted simultaneously to activate the protective device. If a plug is not inserted correctly, electrical power will not be present at the outlet and the plug will need to be removed and reinserted.

**Note:** Plugs installed before power up will need to be removed and reinserted to achieve electrical power.

## Automatic Load Shedding (Engine Generators)

### [Option - CAB/UTIL Power Switch]

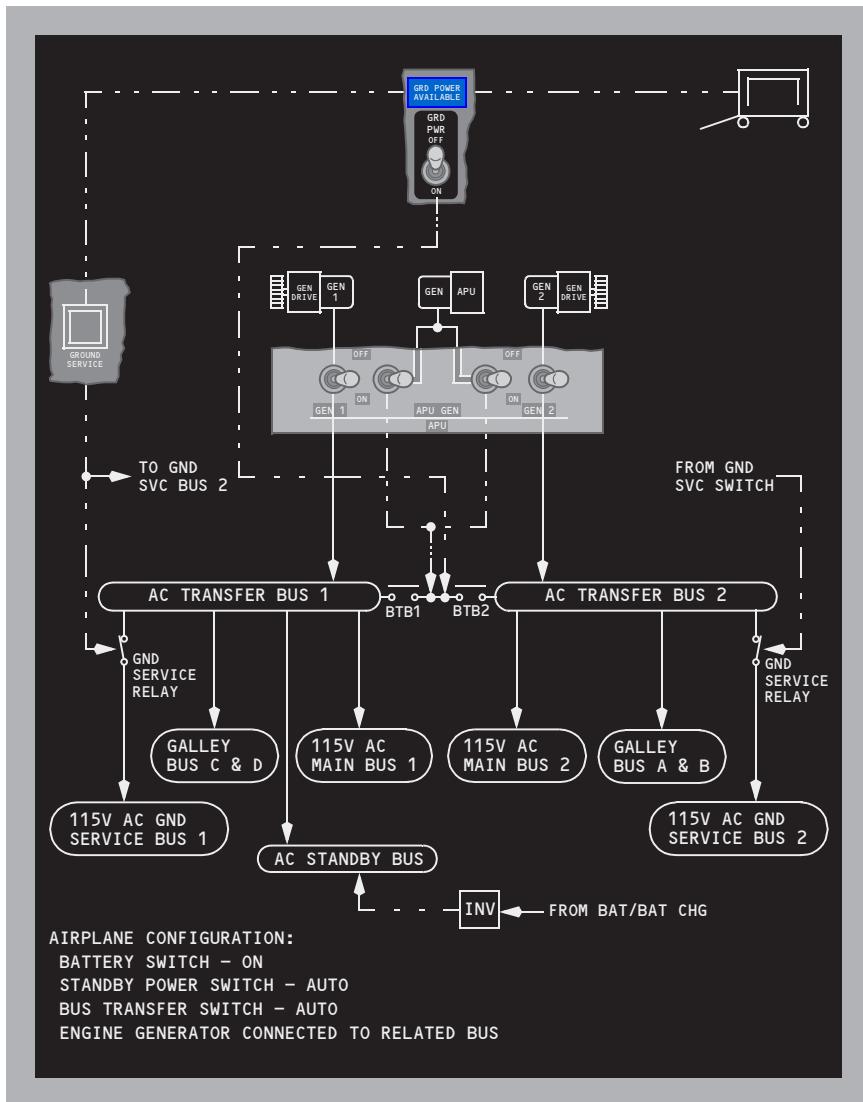
For single generator operation, the system is designed to shed electrical load incrementally based on actual load sensing. The galleys and main bus on transfer bus 2 are shed first; if an overload is still sensed, the galleys and main bus on transfer bus 1 are shed; if overload still exists, the IFE buses are shed. When configuration changes to more source capacity (two generator operation), automatic load restoration of the main busses, galley busses and IFE buses occurs; manual restoration of galley and main bus power can be attempted by moving the CAB/UTIL Power Switch to OFF, then back ON.

## APU Automatic Load Shedding

### [Option - CAB/UTIL Power Switch]

In flight, if the APU is the only source of electrical power, all galley busses and main buses are automatically shed. If electrical load still exceeds design limits, both IFE busses are also automatically shed. On the ground, the APU attempts to carry a full electrical load. If an overload condition is sensed, the APU sheds galley busses and main busses until the load is within limits. Manual restoration of galley and main bus power can be attempted by moving the CAB/UTIL Power Switch to OFF, then back ON.

## AC Power Schematic



## Electrical Power Controls and Monitoring

### Generator Drive

The IDGs contain the generator and drive in a common housing, and are lubricated and cooled by a self-contained oil system. An integral electro-mechanical disconnect device provides for complete mechanical isolation of the IDG.

The generator drive (DRIVE) amber caution light is illuminated when low oil is sensed in the IDG. IDG low oil pressure is caused by one of the following:

- IDG failure
- engine shutdown
- IDG automatic disconnect due to high oil temperature
- IDG disconnected through generator drive DISCONNECT switch.

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, Ammeter 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 IDGs and the APU generator may be read on the AC ammeter.

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

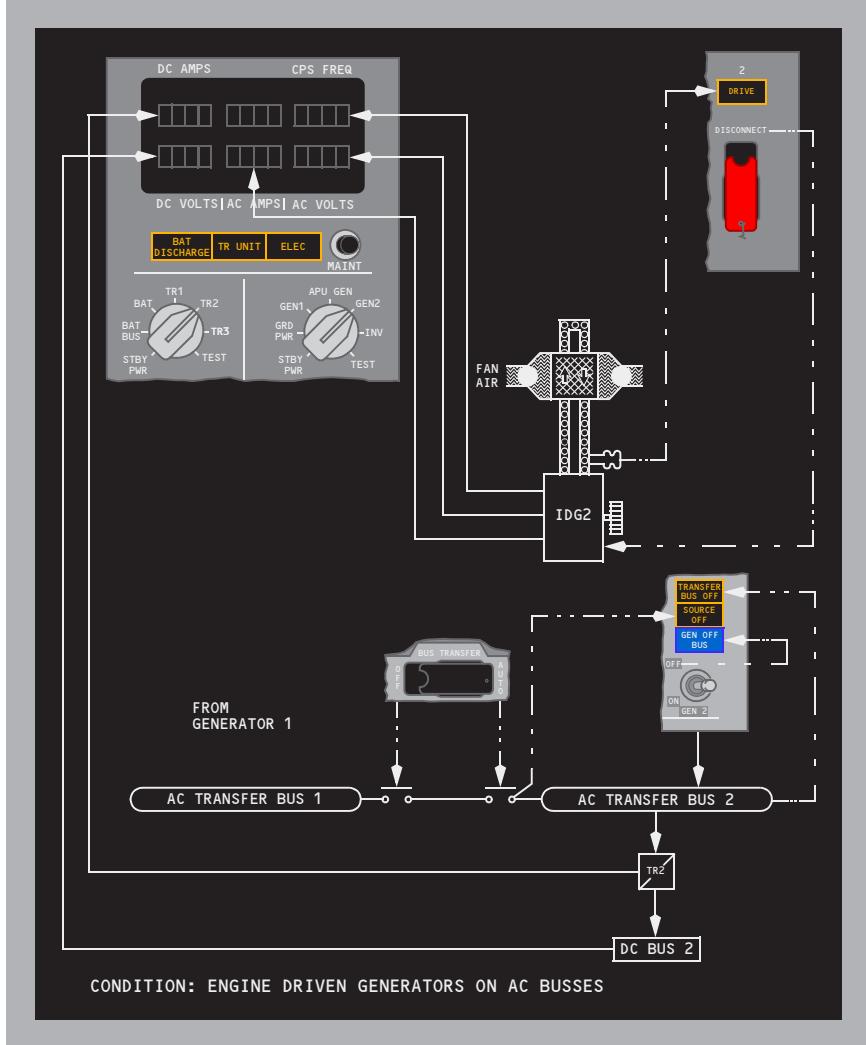
## **DC Voltmeter and Ammeter**

DC voltage and amperage may be read on the DC voltmeter and ammeter for the battery and each of the three TRs. The standby power and battery bus displays only DC voltage.

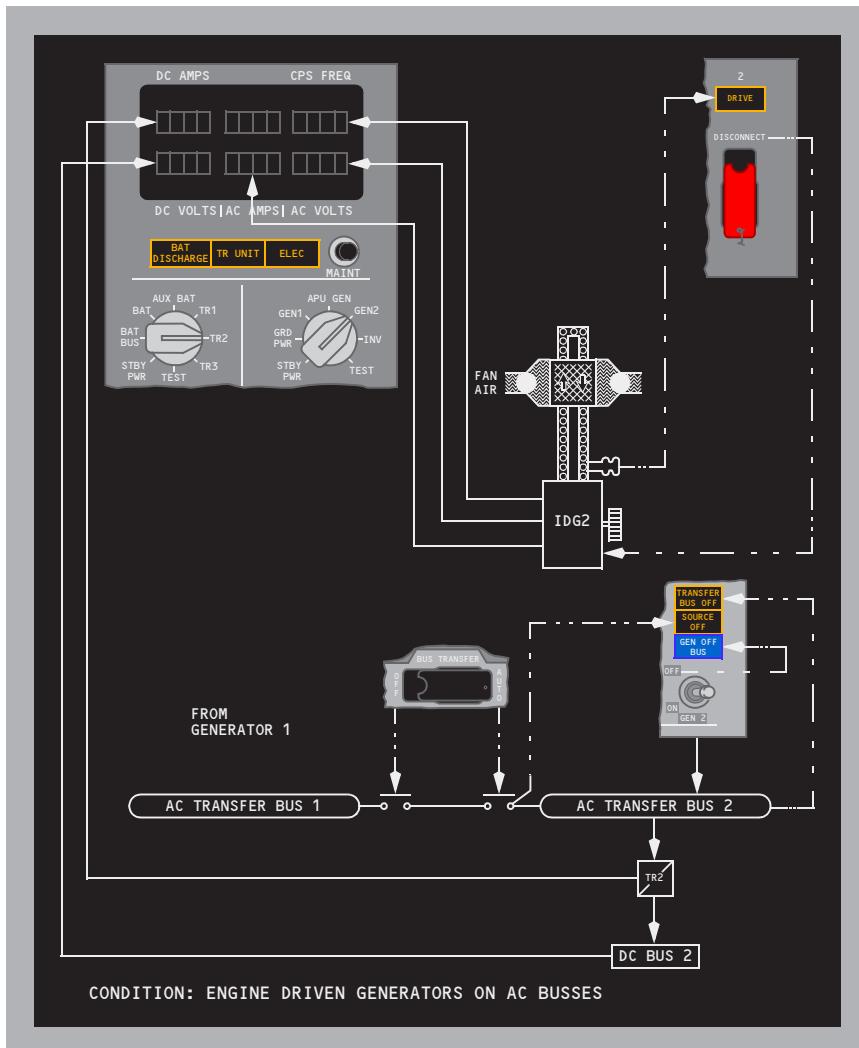
The TEST position is used by maintenance.

## Electrical Power Controls and Monitoring Schematic

[Option - Single battery]



## [Option – Dual battery]



## DC Power System

28 volt DC power is supplied by three TR units, which are energized from the AC transfer busses. The battery provides DC power to loads required to be operative when no other source is available.

On the ground, an amber ELEC light comes on to indicate that a fault exists in DC power system or standby power system. The ELEC light is inhibited in flight.

## Transformer Rectifier Units

The TRs convert 115 volt AC to 28 volt DC, and are identified as TR1, TR2, and TR3.

TR1 receives AC power from transfer bus 1. TR2 receives AC power from transfer bus 2. TR3 normally receives AC power from transfer bus 2 and has a backup source of AC power from transfer bus 1. Any two TRs are capable of supplying the total connected load.

Under normal conditions, DC bus 1, DC bus 2, and the DC standby bus are connected via the cross bus tie relay. In this condition, TR1 and TR2 are each powering DC bus 1, DC bus 2, and the DC standby bus. TR3 powers the battery bus and serves as a backup power source for TR1 and TR2.

The cross bus tie 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.

In-flight, an amber TR UNIT light illuminates if TR1, or TR2 and TR3 has failed.

On the ground, any TR fault causes the light to illuminate.

## Battery Power

### Single Battery

#### [Option]

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. An amber BAT DISCHARGE light comes on when excessive battery discharge is detected.

## Dual Battery

### [Option]

Two 24 volt nickel–cadmium batteries, main and auxiliary, are located in the electronics compartment. The batteries can supply part of the DC system. The auxiliary battery operates in parallel with the main battery when the battery is powering the standby system. At all other times, the auxiliary battery is isolated from the power distribution system. Battery charging is automatically controlled. Two fully charged batteries have sufficient capacity to provide standby power for a minimum of 60 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. An amber BAT DISCHARGE light comes on when excessive battery discharge is detected.

## Battery Charger Transformer/Rectifier

### Single Battery

### [Option]

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 2.

The battery charger provides a voltage output tailored to maximize the battery charge. Following completion of the primary charge cycle, the battery charger reverts to a constant voltage TR mode. In the TR mode, it powers loads connected to the hot battery bus and the switched hot battery bus. The battery charger TR also powers the battery bus if TR3 fails. With loss of AC transfer bus 1 or the source of power to DC bus 1, the AC and DC standby busses are powered by the battery/battery charger.

### Dual Battery

### [Option]

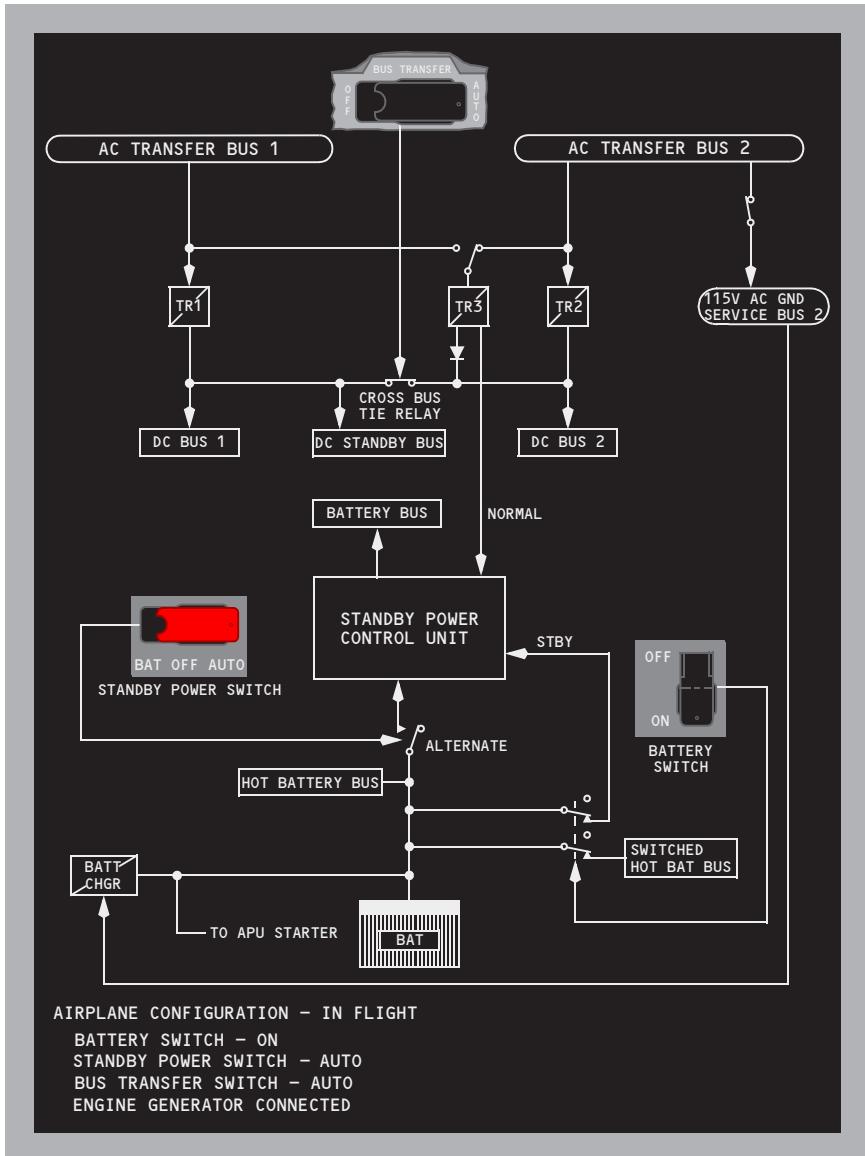
The purpose of the battery chargers is to restore and maintain the batteries at full electrical power. The main battery charger is powered through AC ground service bus 2. The auxiliary battery charger is powered through AC ground service bus 1.

The battery chargers provide a voltage output tailored to maximize the battery charge. Following completion of the primary charge cycle, the main battery charger reverts to a constant voltage TR mode. In the TR mode, it powers loads connected to the hot battery bus and the switched hot battery bus. The main battery charger TR also powers the battery bus if TR3 fails. With loss of AC transfer bus 1 or the source of power to DC bus 1, the AC and DC standby busses are powered by the main and auxiliary battery/battery chargers.

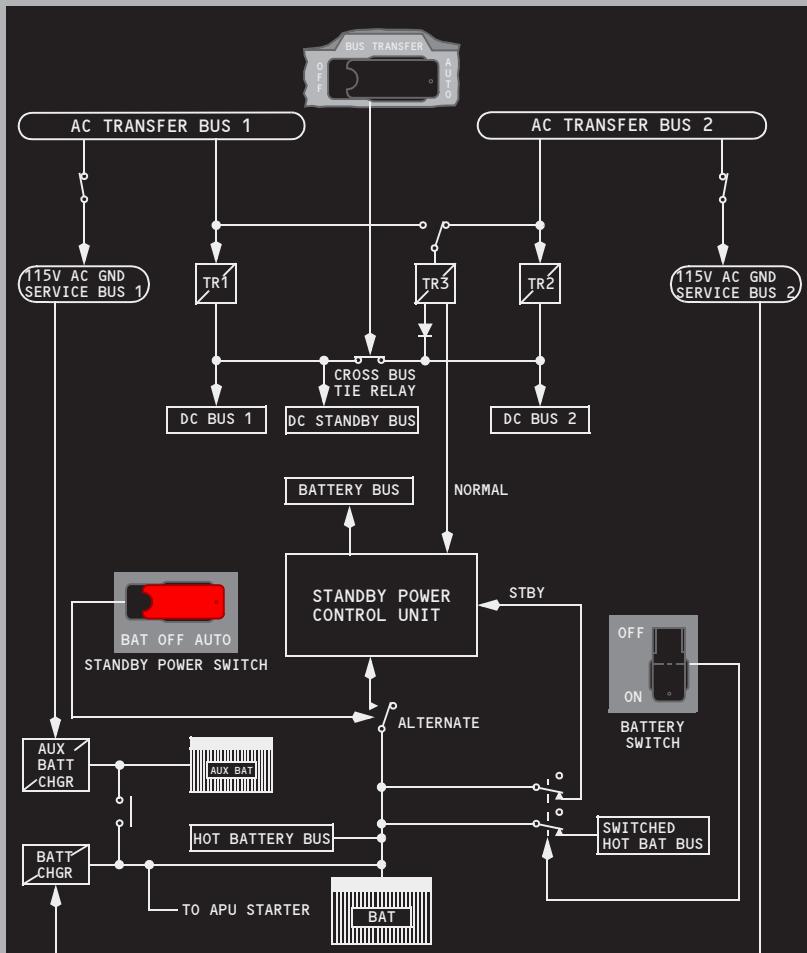
The auxiliary battery charger and battery are isolated from the power distribution system under normal operation. When the main battery is powering the standby system, the auxiliary battery is connected to operate in parallel with the main battery.

## DC Power System Schematic

[Option - Single battery]



## [Option – Dual battery]



## Standby Power System

### Normal Operation

The standby system provides 115V AC and 24V DC power to essential systems in the event of loss of all engine or APU–driven AC power. The standby power system consists of:

- static inverter
- AC standby bus
- DC standby bus
- battery bus
- hot battery bus
- switched hot battery bus
- main battery

#### [Option - Dual battery]

- auxiliary battery.

During normal operation the guarded standby power switch is in AUTO and the battery switch is ON. This configuration provides alternate power sources in case of partial power loss as well as complete transfer to battery power if all normal power is lost. Under normal conditions the AC standby bus is powered from AC transfer bus 1. The DC standby bus is powered by TR1, TR2, and TR3; the battery bus is powered by TR3; the hot battery bus and switched hot battery bus are powered by the battery/battery charger.

### Alternate Operation

#### Single Battery

#### [Option]

The alternate power source for standby power is the battery. With the standby power switch in the AUTO position, the loss of all engine or APU electrical power causes the battery to power the standby loads, both in the air and on the ground. The AC standby bus is powered from the battery via the static inverter. The DC standby bus, battery bus, hot battery bus, and switched hot battery bus are powered directly from the battery.

The standby power switch provides for automatic or manual control of power to the standby buses.

In the AUTO position, automatic switching from normal to alternate power occurs if power from either AC transfer bus 1 or DC bus 1 is lost.

Positioning the switch to BAT overrides automatic switching and places the AC standby bus, DC standby bus, and battery bus on battery power. The battery switch may be ON or OFF. If the battery switch is OFF, the switched hot battery bus is not powered.

Positioning the standby power switch to OFF de-energizes both the AC standby bus and the DC standby bus and illuminates the STANDBY PWR OFF light.

## Dual Battery

### [Option]

The alternate power sources for standby power are the main battery and auxiliary battery. With the standby power switch in the AUTO position, the loss of all engine or APU electrical power causes the batteries to power the standby loads, both in the air and on the ground. The AC standby bus is powered from the batteries via the static inverter. The DC standby bus, battery bus, hot battery bus, and switched hot battery bus are powered directly from the batteries.

The standby power switch provides for automatic or manual control of power to the standby buses.

In the AUTO position, automatic switching from normal to alternate power occurs if power from either AC transfer bus 1 or DC bus 1 is lost.

Positioning the switch to BAT overrides automatic switching and places the AC standby bus, DC standby bus, and battery bus on battery power. The battery switch may be ON or OFF. If the battery switch is OFF, the switched hot battery bus is not powered.

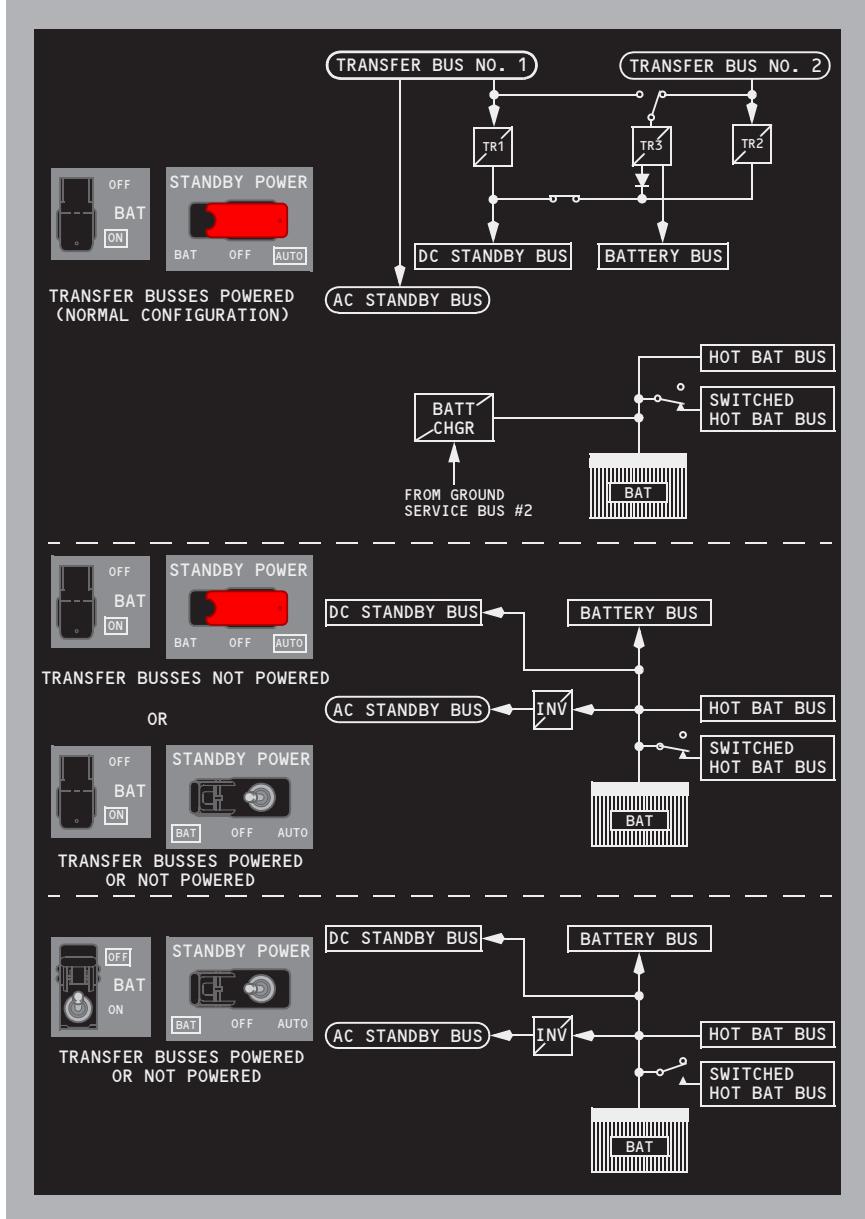
Positioning the standby power switch to OFF de-energizes both the AC standby bus and the DC standby bus and illuminates the STANDBY PWR OFF light.

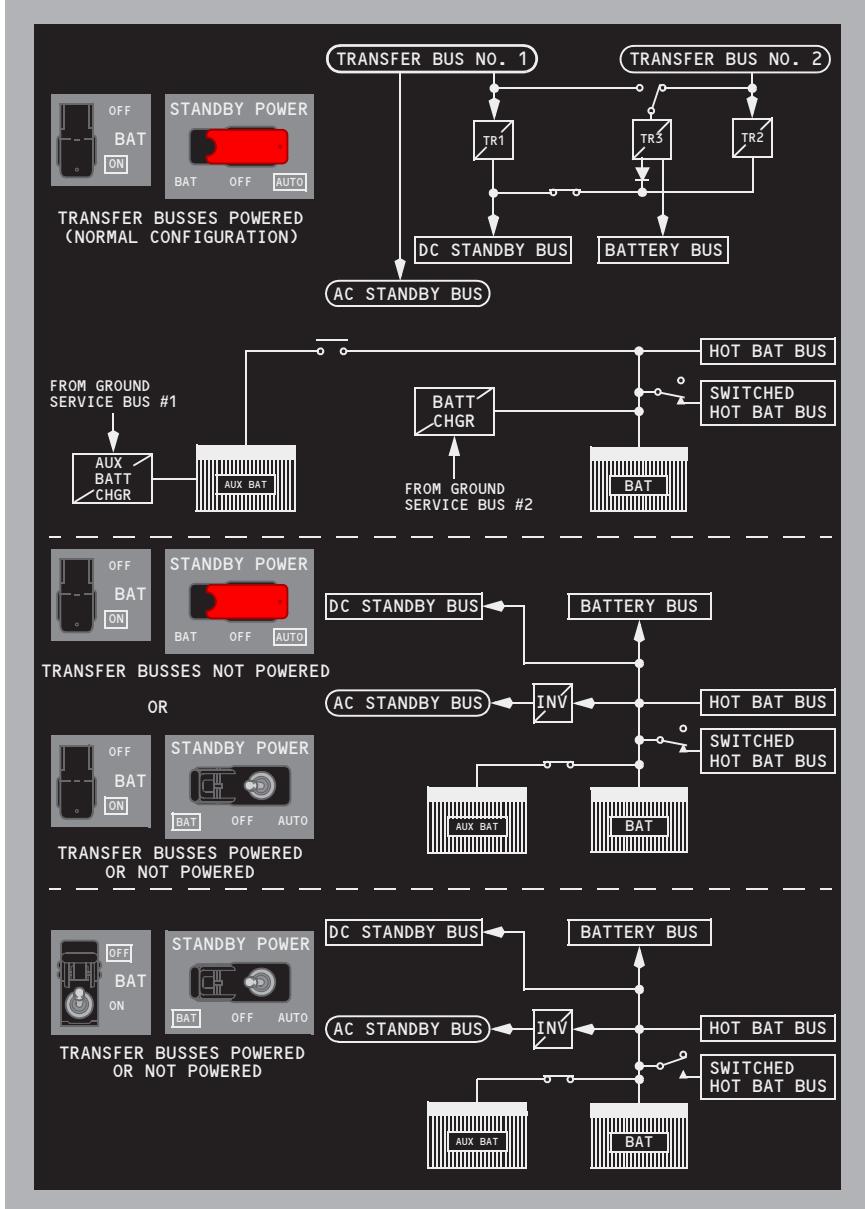
## Static Inverter

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

[Option - Single battery]



**[Option – Dual battery]**


## All Generators Inoperative

The following list identifies the significant equipment that operates when the main battery and the auxiliary battery are the only source of electrical power.

## Airplane General

- standby compass light
- white dome lights
- emergency instrument flood lights
- flight crew oxygen
- passenger oxygen

### [Option]

- standby forward airstair interior/exterior operation

## Air Systems

- A/C pack valves
- BLEED TRIP OFF lights
- manual pressurization control
- altitude warning horn

### [737-600/700]

- PACK TRIP OFF lights

### [737-800/900]

- PACK lights

## Anti-Ice

### [Option]

- Captain's pitot probe heat

## Communications

- flight interphone system
- service interphone system
- passenger address system
- VHF No. 1

## Electrical

- STANDBY POWER OFF light

## Engines, APU

- upper display unit  
N1, N2, fuel flow, EGT, fuel quantity, oil pressure, oil temperature, oil quantity
- upper display unit  
N1, N2, fuel flow, EGT, fuel quantity, oil pressure, oil temperature, oil quantity, hydraulic pressure, hydraulic quantity
- thrust reversers
- starter valves

- right igniters
- APU operation (start attempts not recommended above 25,000 feet)

## Fire Protection

- APU and engine fire extinguisher bottles
- APU and engine fire detection system
- Cargo fire extinguisher bottle

## Flight Instruments

- Captain's outboard display unit (compact EFIS or PFD format)

### [Option]

- Captain's outboard and inboard display units (EFIS/MAP or PFD/ND format)
- clocks
- left EFIS control panel
- Standby instruments
  - radio magnetic indicator (RMI), standby airspeed/altimeter, standby attitude indicator, standby magnetic compass

## Flight Management, Navigation

- FMC
- left CDU
- heading/track indications
- VHF NAV No. 1
- ILS No. 1
- left IRS
- left GPS
- marker beacon

### [Option]

- ADF No. 1

### [Option]

- IFF No. 1

### [Option]

- transponder No. 1

### [Option]

- DME No. 1

## Fuel

- crossfeed valve
- engine fuel shutoff valves
- spar fuel shutoff valve

- FUEL VALVE CLOSED lights
- fuel quantity indicators

### Hydraulic Power

- engine hydraulic shutoff valves
- standby rudder shutoff valves

### Landing Gear

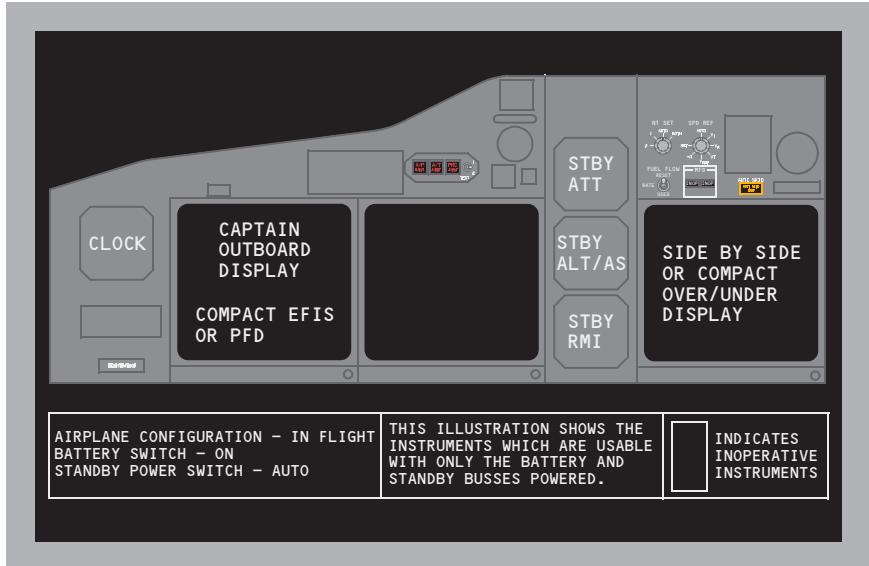
- inboard antiskid system
- ANTISKID INOP light
- parking brake
- air/ground system
- landing gear indicator lights

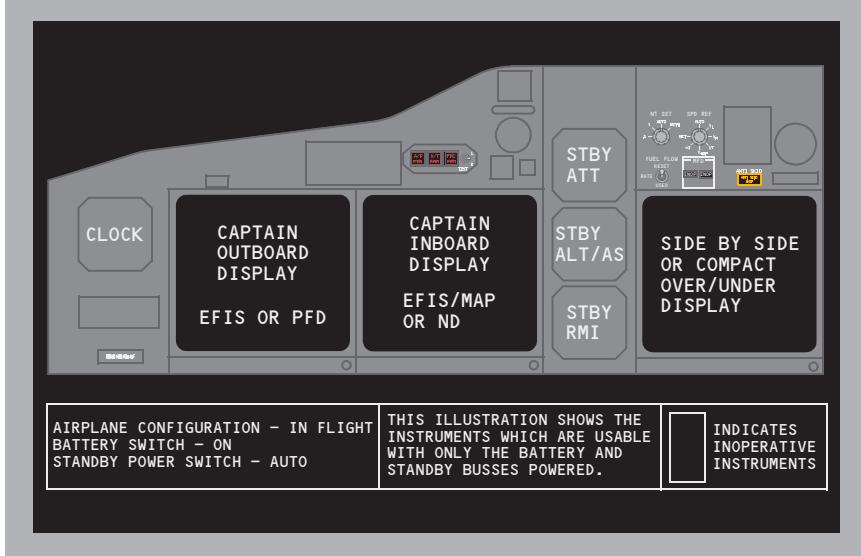
### Warnings

- stall warning system
- aural warnings
- master caution light recall

## Basic Equipment Operating – Captain Instrument Panel

The standby power system utilizes the battery as a source of power to supply the below depicted flight instruments. All of the Captain's instruments that are powered by standby power are integrally lighted on standby power



**[Option - Captain's Outboard and Inboard Display Units on Standby Power]**


## Basic Equipment Operating – First Officer Instrument Panel



FLIGHT DECK COMMUNICATION

AUDIO SELECTOR PANELS  
FLIGHT INTERPHONE  
PASSENGER ADDRESS SYSTEM

FLIGHT DECK 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 USABLE  
WITH ONLY THE BATTERIES AND  
STANDBY BUSSES POWERED.

INDICATES  
INOPERATIVE  
INSTRUMENTS

**Engines, APU****Table of Contents****Chapter 7****Section 0**

|   |             |
|---|-------------|
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## Engines, APU

### Side by Side – Displays

## Chapter 7

### Section 10

#### Primary and Secondary Engine Indications

[Option - Side by side display, lbs]



#### 1 Primary Engine Indications

#### 2 Fuel Quantity Indications

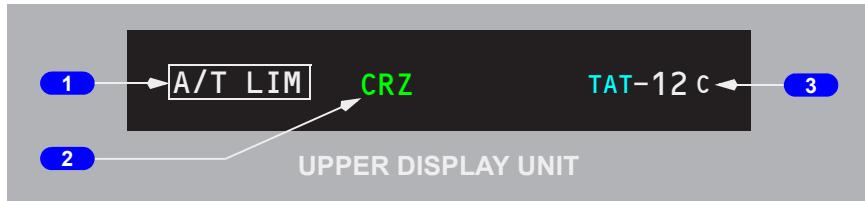
Refer to Chapter 12, Fuel.

#### 3 Secondary Engine Indications

#### 4 Hydraulic Indications

Refer to Chapter 13, Hydraulics.

## Autothrottle Limit, Thrust Mode Display and Total Air Temperature



### 1 Autothrottle Limit (A/T LIM) Indication

Illuminated (white) – The FMC is not providing the A/T system with N1 limit values. The A/T is using a degraded N1 thrust limit from the related EEC.

### 2 Thrust Mode Display

Displayed (green) – the active N1 limit reference mode.

With N1 Set Outer Knob (on engine display control panel) in AUTO, active N1 limit is displayed by reference N1 bugs.

With N1 Set Outer Knob (on engine display control panel) in either 1, 2 or BOTH (other than AUTO), the thrust mode display annunciation is MAN.

Active N1 limit is normally calculated by FMC.

#### [Option - Without double derate]

Thrust mode display annunciations are:

- R-TO – reduced takeoff
- R-CLB – reduced climb
- TO – takeoff

#### [Option]

- TO B – takeoff bump thrust
- CLB – climb
- CRZ – cruise
- G/A – go-around
- CON – continuous
- —— FMC not computing thrust limit.

**Note:** R-TO does not indicate the type of reduced takeoff. The N1 limit may be reduced due to the entry of an assumed temperature, a takeoff thrust derate or a combination of both assumed temperature and takeoff thrust derate.

**[Option - with Double Derate]**

Thrust mode display annunciations are:

- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff

**[Option]**

- TO B – takeoff bump thrust
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- G/A – go-around
- CON – continuous

**[Option]**

- Q-CLB – quiet climb
- — — FMC not computing thrust limit.

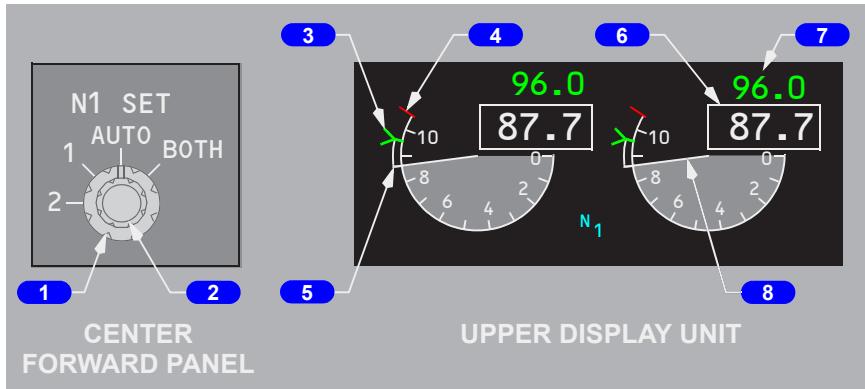
**Note:** In the “bump” configuration, the highest takeoff thrust level is an FMC selectable thrust bump and the use of assumed temperature method (ATM) thrust reduction is not allowed in combination with the bump rating..

**3 Total Air Temperature (TAT) Indication**

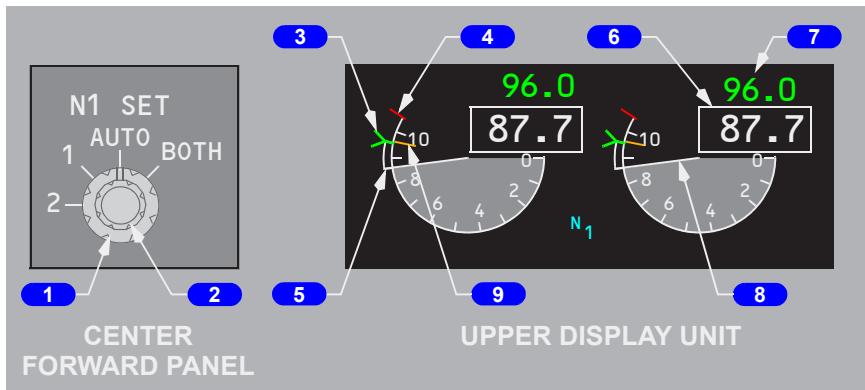
Displayed (label –cyan, temp – white) – total air temperature (degrees C).

## N1 Indications

[Option - without Double Derate]



[Option - with Double Derate]



### 1 N1 SET Outer Knob

AUTO –

- both reference N1 bugs set by FMC based on N1 limit page and takeoff reference page
- displays reference N1 bugs at active N1 limit for A/T.

BOTH –

- both reference N1 bugs and readouts manually set by turning N1 SET inner knob
- has no effect on A/T operation.

---

1 or 2 –

- respective N1 reference bug and readout manually set by turning N1 SET inner knob
- has no effect on A/T operation.

## **2 N1 SET Inner Knob (spring-loaded to center)**

Rotate – positions reference N1 bug(s) and readouts when N1 SET outer knob is set to BOTH, 1, or 2.

## **3 Reference N1 Bugs**

Displayed (green) – with N1 SET outer knob in AUTO, 1, 2 or BOTH position.

## **4 N1 Redlines**

Displayed (red) – N1% RPM operating limit

## **5 N1 Command Sectors**

Displayed (white) – momentary difference between actual N1 and value commanded by thrust lever position.

## **6 N1 RPM Readouts (digital)**

Displayed (white) – normal operating range.

Displayed (red) –

- operating limit exceeded
- on ground after engine shutdown, red box indicates an inflight exceedance has occurred.

## **7 Reference N1 Readouts**

Displayed (green) –

- manually set N1% RPM when N1 SET outer knob is in BOTH, 1, or 2 position
- —— when N1 SET outer knob is in AUTO position and FMC source invalid.

### **[Option - without Double Derate]**

YX800 - YX910

- blank when N1 SET outer knob is in AUTO position

### **[Option - with Double Derate]**

- when N1 SET outer knob is in AUTO position, may indicate fixed derate, assumed temperature derate, or a combination of fixed and assumed temperature derate

Not Displayed when Reverse Thrust is selected.

## 8 N1 RPM Indications

Displays N1% RPM:

- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

## 9 N1 Maximum Bug

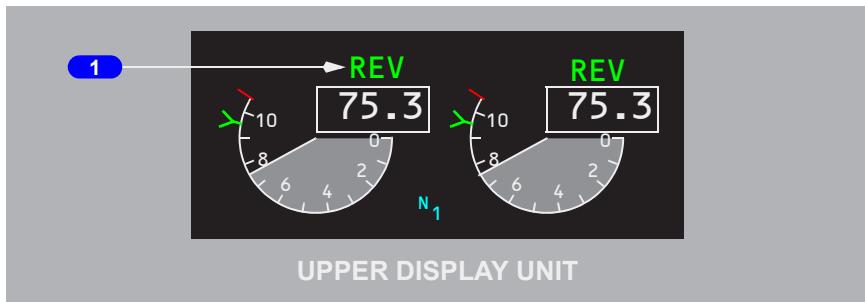
### [Option - Double Derate]

Displayed (amber) –

- N1 value for maximum rated thrust
- computed by the EEC through all phases of flight.

Not Displayed when Reverse Thrust is selected.

## Thrust Reverser Indications

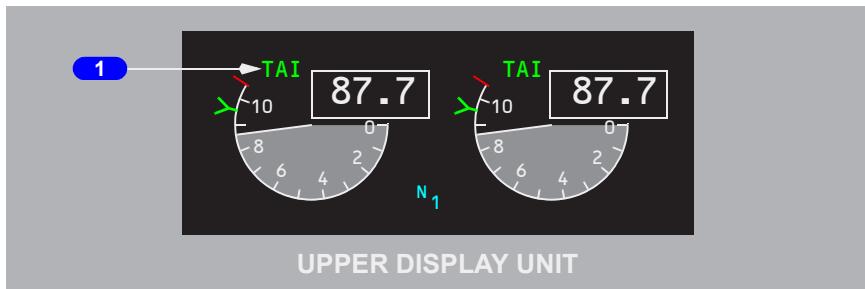


## 1 Thrust Reverser (REV) Indications

Displayed (amber) – thrust reverser is moved from stowed position.

Displayed (green) – thrust reverser is deployed.

## Thermal Anti-Ice Indication

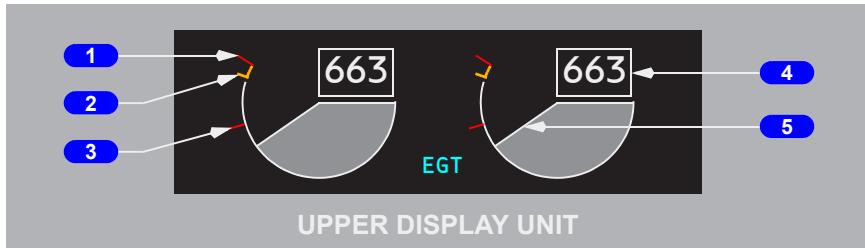


## 1 Thermal Anti-Ice (TAI) Indications

Displayed (green) – cowl anti-ice valve(s) open.

Displayed (amber) – cowl anti-ice valve is not in position indicated by related engine anti-ice switch.

## EGT Indications



### 1 Exhaust Gas Temperature (EGT) Redlines

Displayed (red) – maximum takeoff EGT limit.

### 2 Exhaust Gas Temperature (EGT) Amber Bands

Displayed (amber) – lower end of band displays maximum continuous EGT limit.

### 3 Exhaust Gas Temperature (EGT) Start Limit Lines

Displayed (red) – until the engine achieves stabilized idle (approximately 59% N2).

### 4 Exhaust Gas Temperature (EGT) Readouts (digital)

Displayed (white) – normal operating range (degrees C)

[Option - Color change inhibit 5 minutes]

Displayed (amber) – maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go-around

[Option - Color change inhibit 10 minutes]

Displayed (amber) – maximum continuous limit exceeded

- color change inhibited for up to 5 minutes during takeoff or go-around (normal operation)
- color change inhibited for up to 10 minutes during takeoff or go-around (when an engine out condition occurs within the first 5 minutes of the inhibit)

Displayed (red) – maximum takeoff limit or start limit exceeded

On ground, after both engines are shut down, red box indicates an exceedance has occurred

EEC senses conditions that may lead to hot start during ground starts (blinking white box).

## 5 Exhaust Gas Temperature (EGT) Indications

Displayed (white) – normal operating range.

### [Option - Color change inhibit 5 minutes]

Displayed (amber) – maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go-around

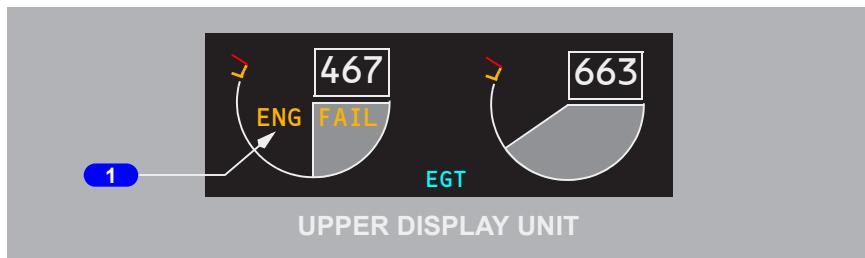
### [Option - Color change inhibit 10 minutes]

Displayed (amber) – maximum continuous limit exceeded

- color change inhibited for up to 5 minutes during takeoff or go-around (normal operation)
- color change inhibited for up to 10 minutes during takeoff or go-around (when an engine out condition occurs within the first 5 minutes of the inhibit)

Displayed (red) – maximum takeoff limit or start limit exceeded.

## Engine Fail Alert



## 1 Engine Fail (ENG FAIL) Alert

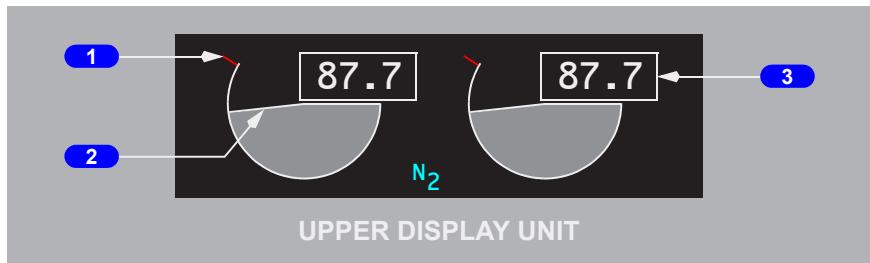
Displayed (amber) –

- engine N2 below sustainable idle (less than 50%); and
- engine start lever in IDLE position.

Alert remains until –

- engine N2 above sustainable idle (50% or greater); or
- start lever moved to CUTOFF; or
- engine fire warning switch pulled.

## N2 Indications



### 1 N2 Redlines

Displayed (red) – N2 % RPM operating limit.

### 2 N2 RPM Indications

Displays N2 % RPM

- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

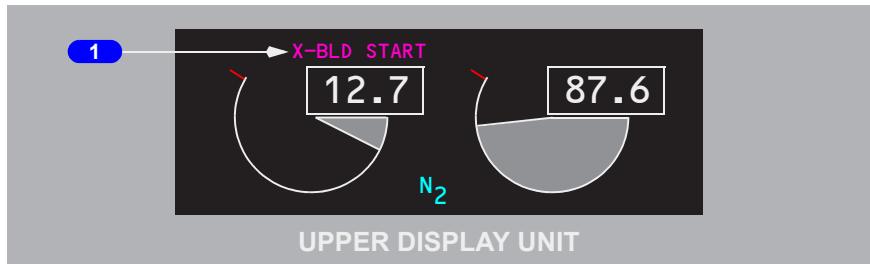
### 3 N2 Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) –

- operating limit exceeded
- on ground, after engine shutdown, red box indicates an inflight exceedance has occurred.

## Crossbleed Start Indication



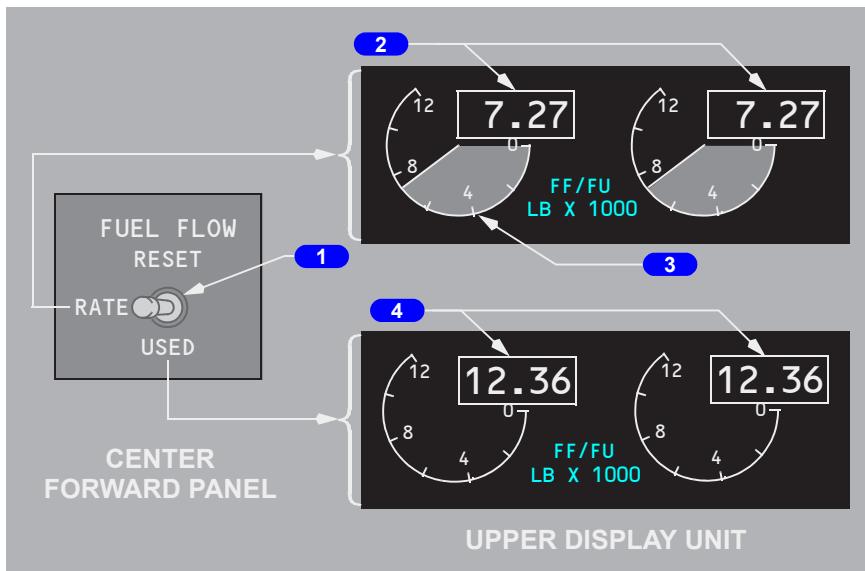
### 1 Crossbleed (X-BLD) START Indication

Displayed (magenta) – crossbleed air recommended for inflight start.

Displayed when airspeed is less than required for a windmilling start.

## Fuel Flow/Fuel Used Indications

[Option - lbs]



### 1 FUEL FLOW Switch (spring-loaded to RATE)

RATE – displays fuel flow to engine.

USED –

- pointer and shading are removed
- displays fuel used since last reset
- after 10 seconds, display automatically reverts to fuel flow.

RESET –

- pointer and shading are removed
- resets fuel used to zero
- displays fuel used momentarily, decreases to zero, then displays fuel flow.

### 2 Fuel Flow (FF) Readout (digital)

[Option - lbs]

Displayed (white) – fuel flow to engine with FUEL FLOW switch in RATE position (pounds per hour x 1000).

### 3 Fuel Flow (FF) Dial/ Index Markers & Digits (white)

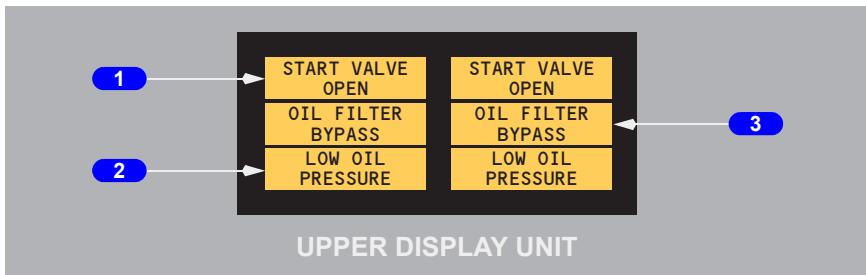
[Option - lbs]

Displayed (white) – fuel flow to engine with FUEL FLOW switch in RATE position (pounds per hour x 1000).

### 4 Fuel Used (FU) Readout (digital)

Displayed (white) – when FUEL FLOW switch moved to USED or RESET.

## Crew Alerts



#### 1 START VALVE OPEN Alert

Illuminated (amber) –

- steady – respective engine start valve open and air is supplied to starter
- blinking – uncommanded opening of start valve. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed (see Note).

#### 2 LOW OIL PRESSURE Alert

Illuminated (amber) –

- steady – oil pressure at or below red line
- blinking – with a condition of low oil pressure. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed (see Note).

### 3 OIL FILTER BYPASS Alert

Illuminated (amber) –

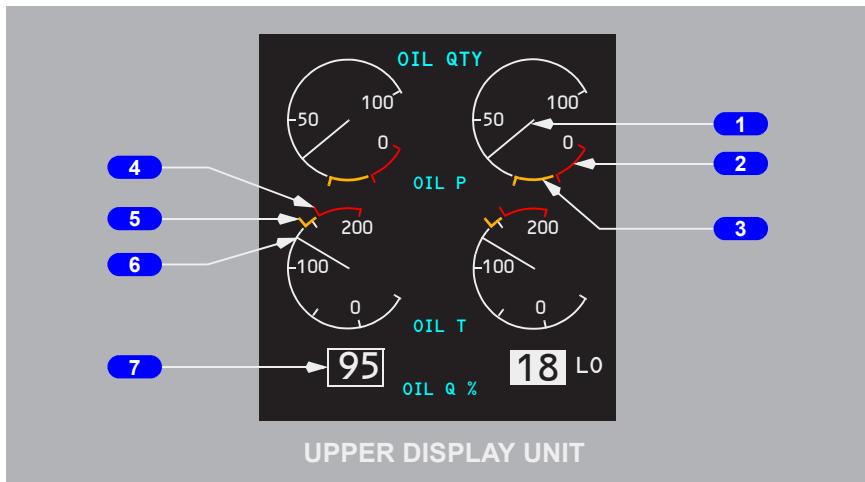
- steady – indicates an impending bypass of scavenged oil filter
- blinking – with an impending bypass. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed (see Note).

**Note:** Blinking is inhibited:

- during takeoff from 80 knots to 400 feet RA, or 30 seconds after reaching 80 knots, whichever occurs first
- during landing below 200 feet RA until 30 seconds after touchdown
- during periods when blinking is inhibited, alerts illuminate steady.

## Engine Oil Indications

[Option - Low oil quantity reverse video]



### 1 Oil Pressure (OIL P) Indication

Displays engine oil pressure (psi)

- displayed (white) – normal operating range
- displayed (amber) – caution range
- displayed (red) – operating limit reached.

### 2 Low Oil Pressure (OIL P) Redline

Displayed (red) – oil pressure operating limit.

### 3 Low Oil Pressure (OIL P) Amber Band

Displayed (amber) – low oil pressure caution range beginning at red line:

- variable depending on N2% RPM above 65% N2
- amber band not displayed below 65% N2.

### 4 High Oil Temperature (OIL T) Redline

Displayed (red) – oil temperature operating limit.

### 5 High Oil Temperature (OIL T) Amber Band

Displayed (amber) – oil temperature caution range.

### 6 Oil Temperature (OIL T) Indication

Displays oil temperature (degrees C):

- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

### 7 Oil Quantity (OIL Q)% Readout

Displays usable oil quantity as a percentage of full quantity.

#### [Option - Low oil quantity reverse video]

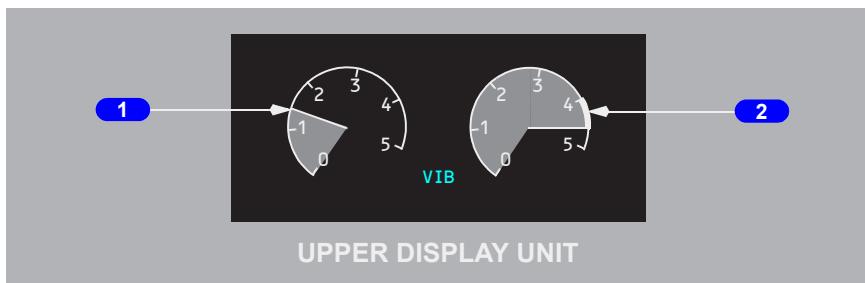
Video is reversed and LO (white) displayed for low oil quantity.

**Note:** Indicated oil quantity may decrease significantly during engine start, takeoff and climb out. If this occurs, engine operation is not impacted and the correct oil quantity should be indicated during level flight.

**Note:** An oil quantity indication as low as zero is normal if windmilling N2 RPM is below approximately 8%.

## Engine Vibration Indications

#### [Option - High vibration alert]



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**1 Vibration (VIB) Pointer**

Displayed (white) – engine vibration level.

**2 High Engine Vibration Indication**

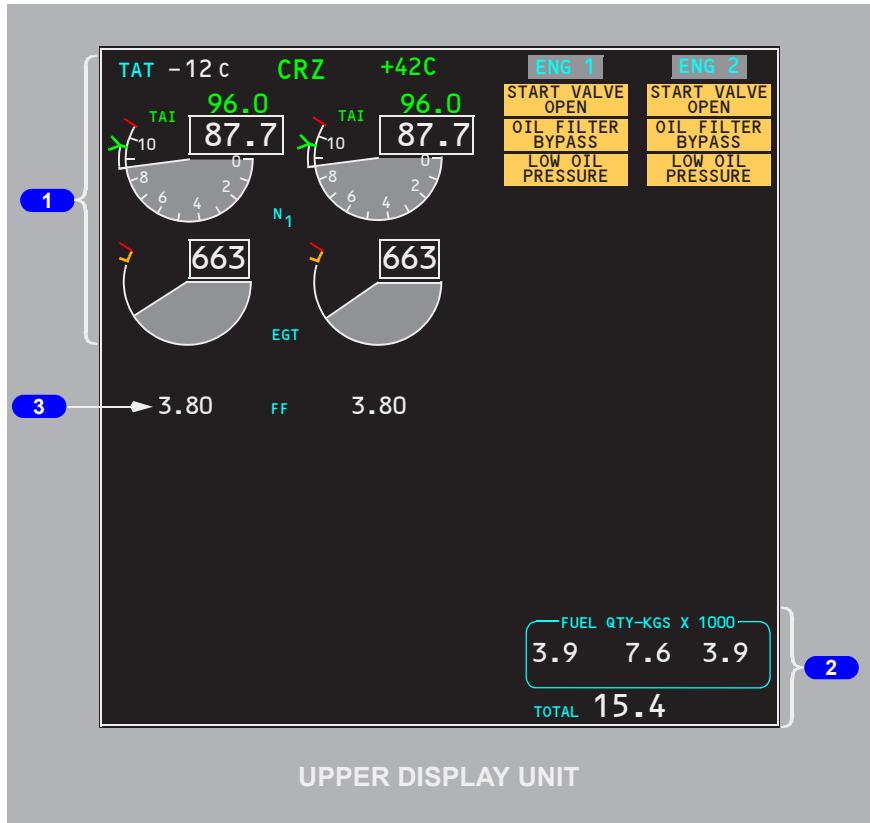
[Option - High vibration alert]

Displayed (white)

When engine vibration level is greater than four units, the portion of the dial arc between 4 units and the pointer, becomes bold.

**Engines, APU**
**Over/Under – Displays**
**Chapter 7**
**Section 11**
**Primary Engine Indications**

[Option - Over/Under display, kgs, fuel flow displayed full time]

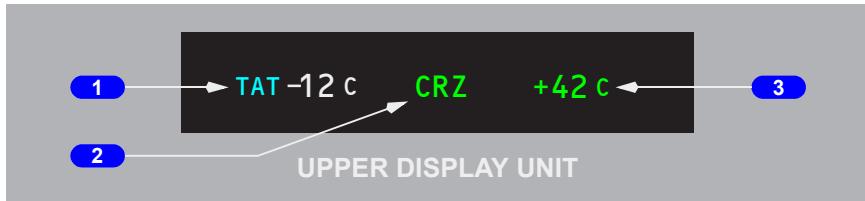

**1 Primary Engine Indications**
**2 Fuel Quantity Indications**

Refer to Chapter 12, Fuel

**3 Fuel Flow Indications**

[Option - Fuel flow displayed full time]

## Total Air Temperature, Thrust Mode Display, Selected Temperature and Autothrottle Limit



### 1 Total Air Temperature (TAT) Indication

Displayed (label – cyan, temp – white) – total air temperature (degrees C).

### 2 Thrust Mode Display

Displayed (green) – the active N1 limit reference mode.

With N1 Set Outer Knob (on engine display control panel) in AUTO, active N1 limit is displayed by reference N1 bugs.

With N1 Set Outer Knob (on engine display control panel) in either 1, 2 or BOTH (other than AUTO), the thrust mode display annunciation is MAN.

Active N1 limit is normally calculated by FMC.

#### [Option - without double derate]

Thrust mode display annunciations are:

- R-TO – reduced takeoff
- R-CLB – reduced climb
- TO – takeoff

#### [Option]

- TO B – takeoff bump thrust
- CLB – climb
- CRZ – cruise
- G/A – go-around

- CON – continuous
- —— FMC not computing thrust limit.

**Note:** R-TO does not indicate the type of reduced takeoff. The N1 limit may be reduced due to the entry of an assumed temperature, a takeoff thrust derate or a combination of both assumed temperature and takeoff thrust derate.

#### [Option - with double derate]

Thrust mode display annunciations are:

- TO – takeoff
- TO 1 – derated takeoff one
- TO 2 – derated takeoff two
- D-TO – assumed temperature reduced thrust takeoff
- D-TO 1 – derate one and assumed temperature reduced thrust takeoff
- D-TO 2 – derate two and assumed temperature reduced thrust takeoff

#### [Option]

- TO B – takeoff bump thrust
- CLB – climb
- CLB 1 – derated climb one
- CLB 2 – derated climb two
- CRZ – cruise
- G/A – go-around
- CON – continuous

#### [Option]

- Q-CLB – quiet climb
- —— FMC not computing thrust limit.

**Note:** In the “bump” configuration, the highest takeoff thrust level is an FMC selectable thrust bump and the use of assumed temperature method (ATM) thrust reduction is not allowed in combination with the bump rating.

### 3 Selected Temperature

Displayed (green) – selected assumed temperature (degrees C) for reduced thrust takeoff N1.

Repeats data selected on TAKEOFF REF page.

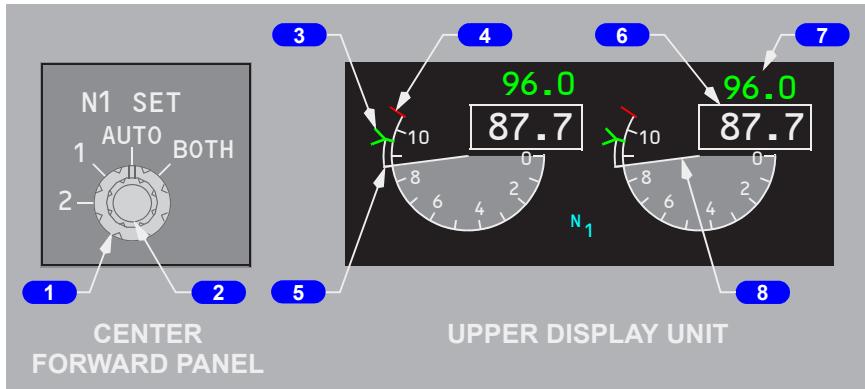
### 4 Autothrottle Limit (A/T LIM) Indication

Illuminated (white) – The FMC is not providing the A/T system with N1 limit values. The A/T is using a degraded N1 thrust limit from the related EEC.

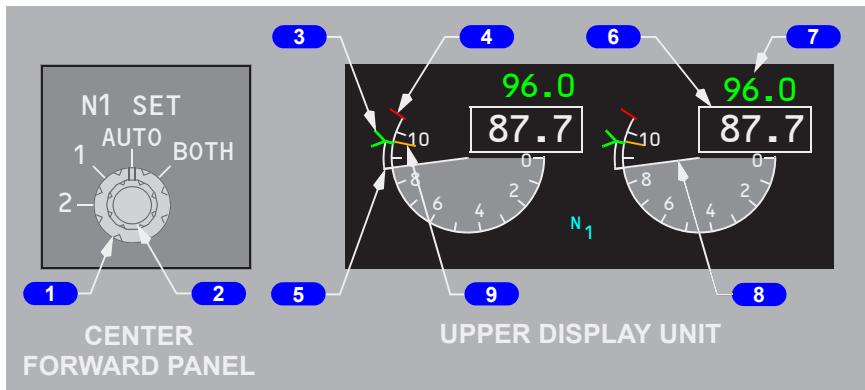
Replaces thrust mode display annunciation when illuminated.

## N1 Indications

[Option - without Double Derate]



[Option - with Double Derate]



### 1 N1 SET Outer Knob

AUTO –

- both reference N1 bugs set by FMC based on N1 limit page and takeoff reference page
- displays reference N1 bugs at active N1 limit for A/T.

BOTH –

- both reference N1 bugs and readouts manually set by turning N1 SET inner knob
- has no effect on A/T operation.

1 or 2 –

- respective N1 reference bug and readout manually set by turning N1 SET inner knob
- has no effect on A/T operation.

## **2 N1 SET Inner Knob (spring-loaded to center)**

Rotate – positions reference N1 bug(s) and readouts when N1 SET outer knob is set to BOTH, 1, or 2.

## **3 Reference N1 Bugs**

Displayed (green) – with N1 SET outer knob in AUTO, 1, 2 or BOTH position.

Position corresponds to digital value on the Reference N1 Readout.

## **4 N1 Redlines**

Displayed (red) – N1% RPM operating limit

## **5 N1 Command Sectors**

Displayed (white) – momentary difference between actual N1 and value commanded by thrust lever position.

## **6 N1 RPM Readouts (digital)**

Displayed (white) – normal operating range.

Displayed (red) –

- operating limit exceeded
- on ground after engine shutdown, red box indicates an inflight exceedance has occurred.

## **7 Reference N1 Readouts**

Displayed (green) –

- manually set N1% RPM when N1 SET outer knob is in BOTH, 1, or 2 position
- —— when N1 SET outer knob is in AUTO position and FMC source invalid.

### **[Option - without Double Derate]**

YX800 - YX910

- blank when N1 SET outer knob is in AUTO position

**[Option - with Double Derate]**

- when N1 SET outer knob is in AUTO position, may indicate fixed derate, assumed temperature derate, or a combination of fixed and assumed temperature derate

Not Displayed when Reverse Thrust is selected.

**8 N1 RPM Indications**

Displays N1% RPM:

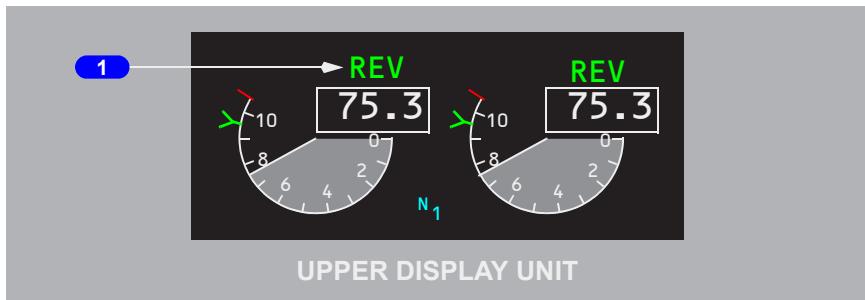
- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

**9 N1 Maximum Bug****[Option - with Double Derate]**

Displayed (amber) –

- N1 value for full rated thrust
- computed by the EEC through all phases of flight.
- upper limit for autothrottle operation.

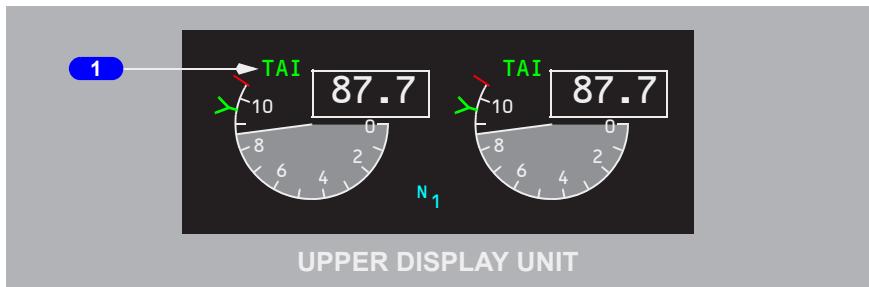
Not Displayed when Reverse Thrust is selected.

**Thrust Reverser Indications****1 Thrust Reverser (REV) Indications**

Displayed (amber) – thrust reverser is moved from stowed position.

Displayed (green) – thrust reverser is deployed.

## Thermal Anti–Ice Indication

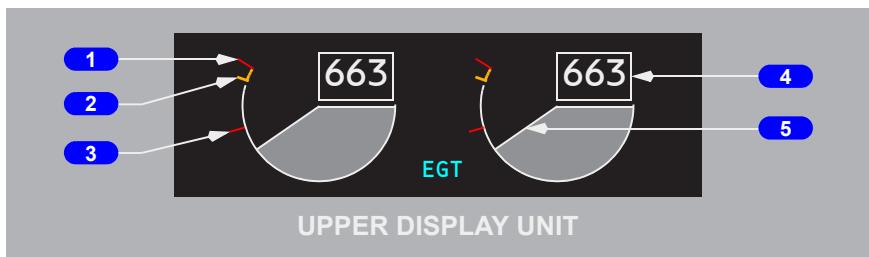


### 1 Thermal Anti–Ice (TAI) Indications

Displayed (green) – cowl anti–ice valve(s) open.

Displayed (amber) – cowl anti–ice valve is not in position indicated by related engine anti–ice switch.

## EGT Indications



### 1 Exhaust Gas Temperature (EGT) Redlines

Displayed (red) – maximum takeoff EGT limit.

### 2 Exhaust Gas Temperature (EGT) Amber Bands

Displayed (amber) – lower end of band displays maximum continuous EGT limit.

### 3 Exhaust Gas Temperature (EGT) Start Limit Lines

Displayed (red) – until the engine achieves stabilized idle (approximately 59% N2).

### 4 Exhaust Gas Temperature (EGT) Readouts (digital)

Displayed (white) – normal operating range (degrees C)

**[Option - Color change inhibit 5 minutes]**

Displayed (amber) – maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go-around

**[Option - Color change inhibit 10 minutes]**

Displayed (amber) – maximum continuous limit exceeded

- Color change inhibited for up to 5 minutes during takeoff or go-around (normal operation)
- color change inhibited for up to 10 minutes during takeoff or go-around (when an engine out condition occurs within the first 5 minutes of the inhibit)

Displayed (red) – maximum takeoff limit or start limit exceeded

On ground, after both engines are shut down, red box indicates an exceedance has occurred

Displayed (white-blinking) EEC senses conditions that may lead to hot start or stall during ground starting. Current versions of EEC software (7.B.Q and later) will automatically cut fuel for an impending hot start or stall during ground starting.

**5 Exhaust Gas Temperature (EGT) Indications**

Displayed (white) – normal operating range.

**[Option - Color change inhibit 5 minutes]**

Displayed (amber) – maximum continuous limit exceeded; color change inhibited for up to 5 minutes during takeoff or go-around

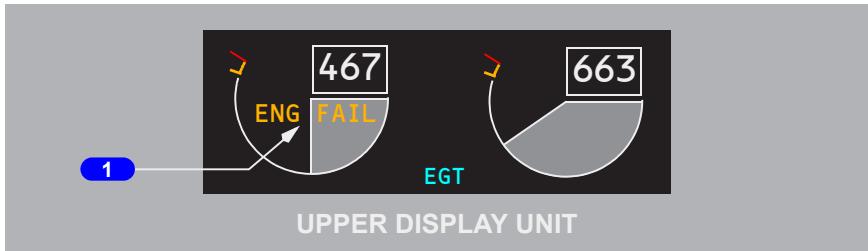
**[Option - Color change inhibit 10 minutes]**

Displayed (amber) – maximum continuous limit exceeded

- color change inhibited for up to 5 minutes during takeoff or go-around (normal operation)
- color change inhibited for up to 10 minutes during takeoff or go-around (when an engine out condition occurs within the first 5 minutes of the inhibit)

Displayed (red) – maximum takeoff limit or start limit exceeded.

## Engine Fail Alert



### 1 Engine Fail (ENG FAIL) Alert

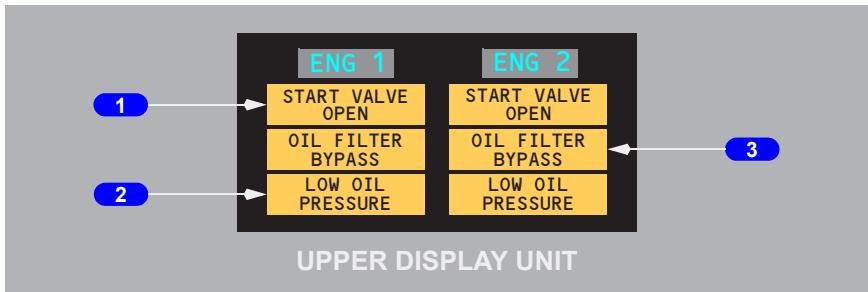
Displayed (amber) –

- engine operating below sustainable idle (less than 50% N2); and
- engine start lever in IDLE position.

Alert remains until –

- engine recovers; or
- start lever moved to CUTOFF; or
- engine fire warning switch pulled.

## Crew Alerts



### 1 START VALVE OPEN Alert

Illuminated (amber) –

- steady – respective engine start valve open and air is supplied to starter
- blinking – uncommanded opening of start valve. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed (see Note).

## **2 LOW OIL PRESSURE Alert**

Illuminated (amber) –

- steady – oil pressure at or below red line
- blinking – with a condition of low oil pressure. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed (see Note).

## **3 OIL FILTER BYPASS Alert**

Illuminated (amber) –

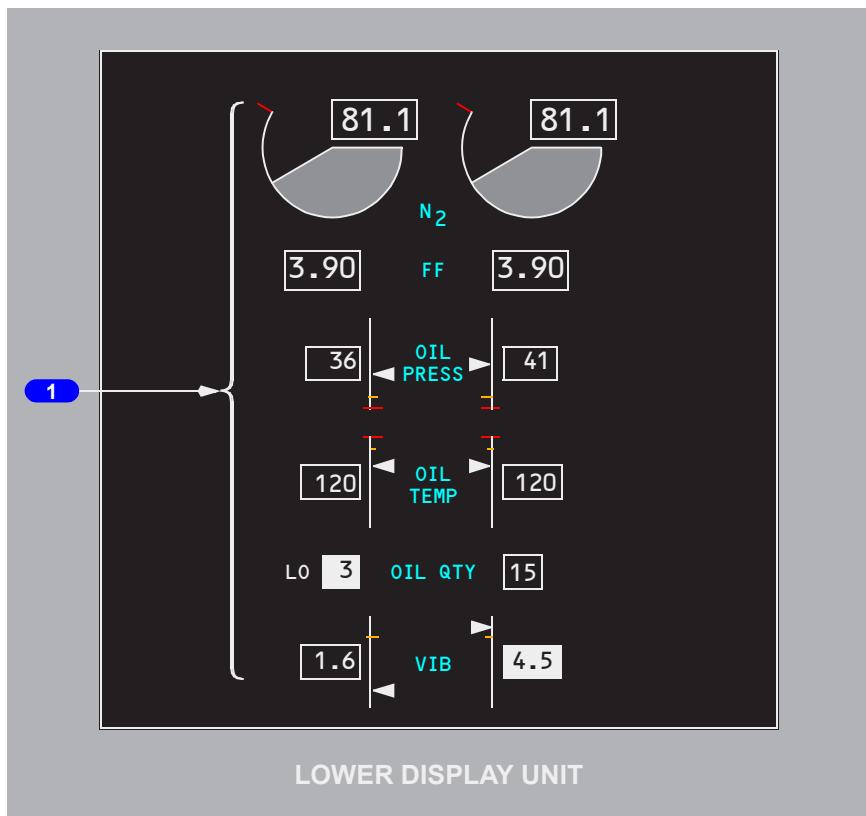
- steady – indicates an impending bypass of scavenge oil filter
- blinking – with an impending bypass. Alert is displayed and solid amber boxes are displayed in unannunciated positions for that engine. All three boxes blink for ten seconds, then alert remains on steady and solid amber boxes are removed (see Note).

**Note:** Blinking is inhibited:

- during takeoff from 80 knots to 400 feet RA, or 30 seconds after reaching 80 knots, whichever occurs first
- during landing below 200 feet RA until 30 seconds after touchdown
- during periods when blinking is inhibited, alerts illuminate steady.

## Secondary Engine Indications

[Option - Over/Under display, kgs]

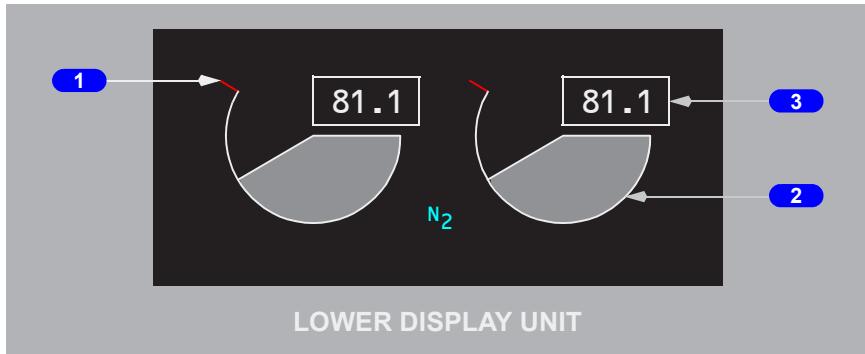


### 1 Secondary Engine Indications

Secondary engine indications are displayed:

- when CDS initially receives power
- when selected by the Multi-Function Display (MFD)
- in flight when an engine start lever moved to CUTOFF
- in flight when an engine fails
- when a secondary engine parameter exceeds normal operating range.

## N2 Indications



### 1 N2 Redlines

Displayed (red) – N2% RPM operating limit.

### 2 N2 RPM Indications

Displays N2% RPM

- displayed (white) – normal operating range
- displayed (red) – operating limit exceeded.

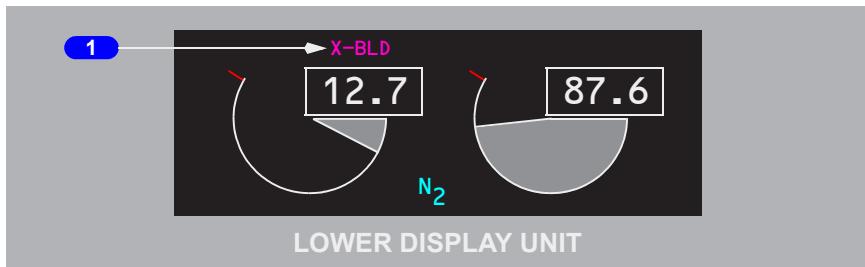
### 3 N2 Readouts (digital)

Displayed (white) – normal operating range.

Displayed (red) –

- operating limit exceeded
- on ground, after engine shutdown, red box indicates an inflight exceedance has occurred.

## Crossbleed Start Indication



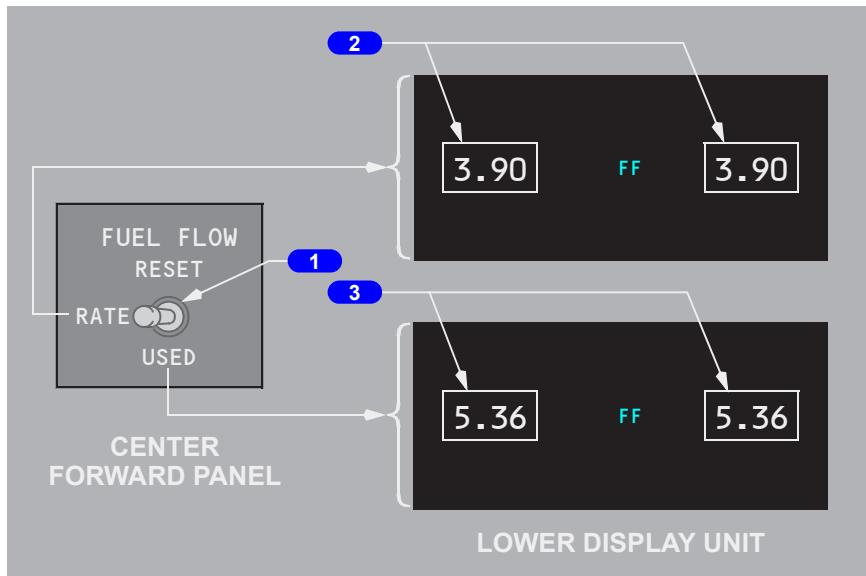
### 1 Crossbleed Start (X-BLD) Indication

Displayed (magenta) – crossbleed air recommended for inflight start.

Displayed when airspeed is less than required for a windmilling start.

## Fuel Flow/Fuel Used Indications

[Option - Over/Under display, kgs]



### 1 FUEL FLOW Switch (spring-loaded to RATE)

**RATE** – displays fuel flow to engine.

**USED** –

- displays fuel used since last reset
- after 10 seconds, display automatically reverts to fuel flow.

**RESET** –

- resets fuel used to zero
- displays fuel used for 1 second, decreases to zero, then displays fuel flow.

### 2 Fuel Flow (FF) Readout (digital)

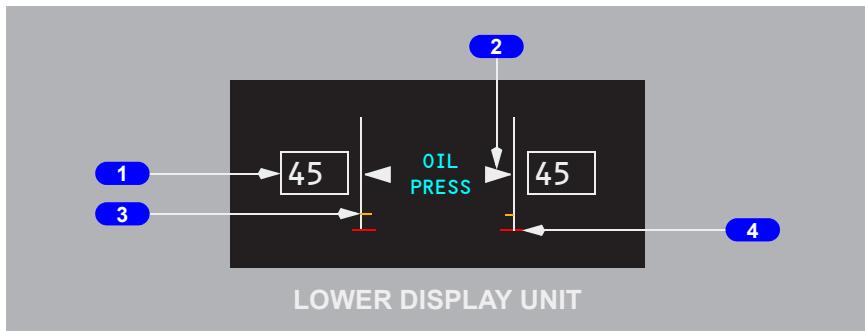
[Option - kgs]

Displayed (white) – fuel flow to engine with FUEL FLOW switch in RATE position (kilograms per hour x 1000).

### 3 Fuel Used Readout (digital)

Displayed (white) – when FUEL FLOW switch moved to USED or RESET.

## Oil Pressure Indications



### **1 Oil Pressure (OIL PRESS) Readout**

Displays engine oil pressure (psi)

- displayed (white) – normal operating range
- displayed (amber) – caution range
- displayed (red) – operating limit reached.

### **2 Oil Pressure (OIL PRESS) Pointer**

Displays engine oil pressure:

- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

### **3 Low Oil Pressure (OIL PRESS) Amber Band**

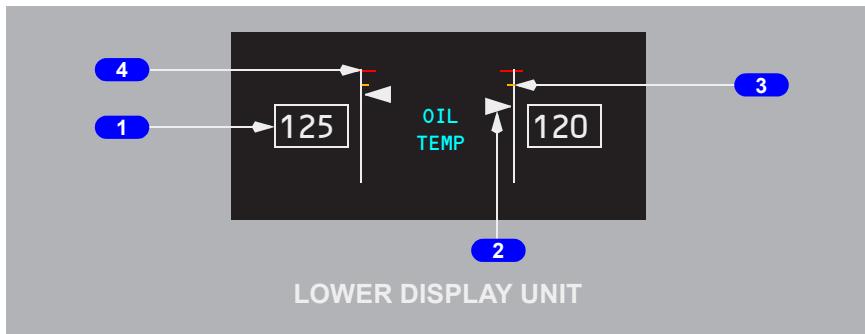
Displayed (amber) – low oil pressure caution range beginning at red line.:

- variable depending on N2% RPM above 65% N2
- amber band not displayed below 65% N2.

### **4 Low Oil Pressure (OIL PRESS) Redline**

Displayed (red) – oil pressure operating limit.

## Oil Temperature Indications



### 1 Oil Temperature (OIL TEMP) Readout

Displays oil temperature (degrees C):

- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

### 2 Oil Temperature (OIL TEMP) Pointer

Displays oil temperature (degrees C):

- displayed (white) – normal operating range
- displayed (amber) – caution range reached
- displayed (red) – operating limit reached.

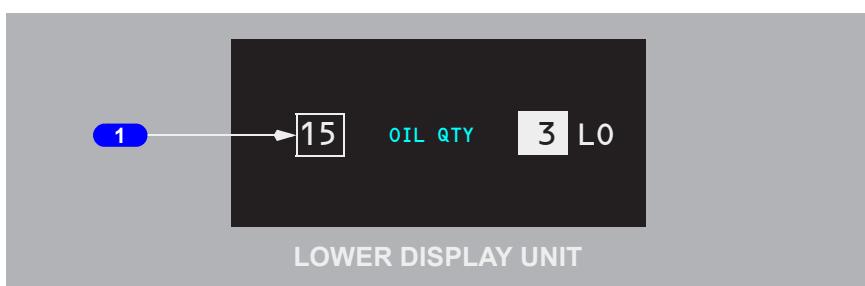
### 3 High Oil Temperature (OIL TEMP) Amber Band

Displayed (amber) – oil temperature caution range.

### 4 High Oil Temperature (OIL TEMP) Redline

Displayed (red) – oil temperature operating limit.

## Oil Quantity Indications



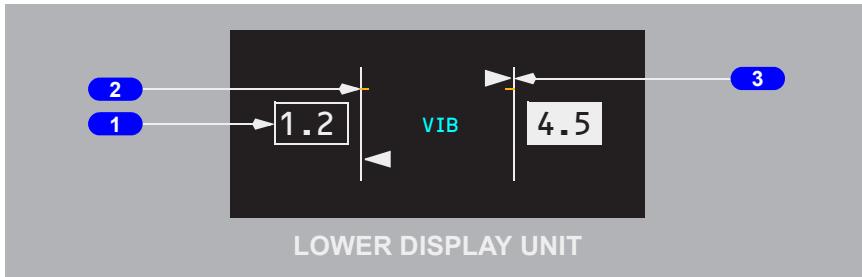
**1 Oil Quantity (OIL QTY) Readout****[Option - liters]**

Displays usable oil quantity in liters.

Video is reversed and LO (white) displayed for low oil quantity.

**Note:** Indicated oil quantity may decrease significantly during engine start, takeoff and climb out. If this occurs, engine operation is not impacted and the correct oil quantity should be indicated during level flight.

**Note:** An oil quantity indication as low as zero is normal if windmilling N2 RPM is below approximately 8%.

**Engine Vibration Indications****1 Vibration (VIB) Readout**

Displayed (white) – engine vibration level.

Video is reversed for high vibration.

**2 High Limit**

Displays tick mark and thick line.

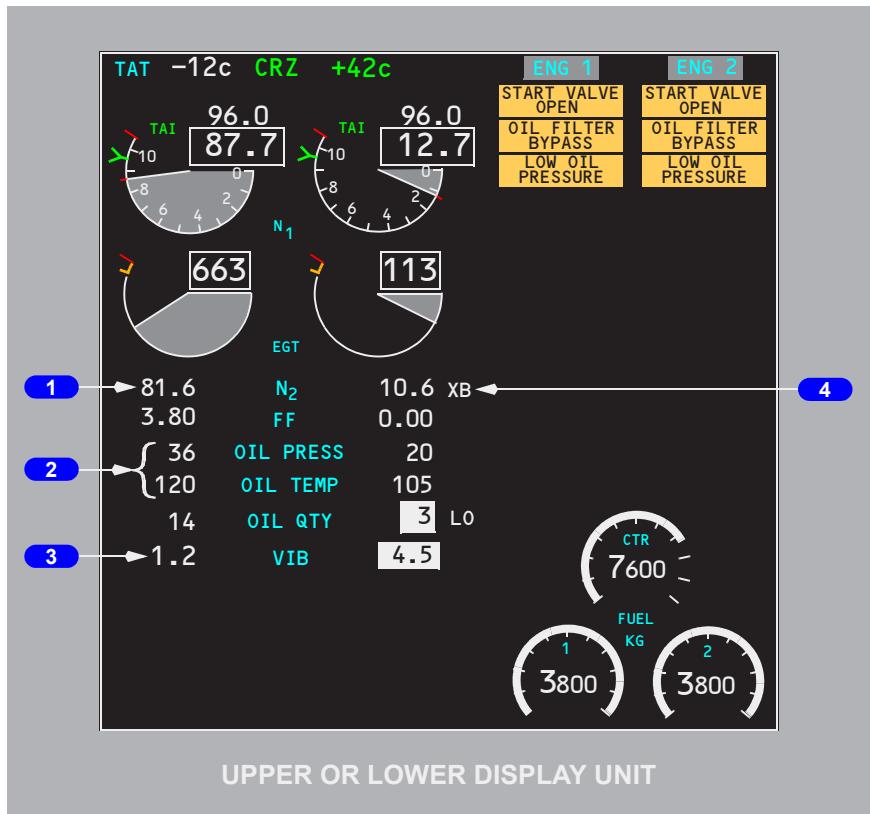
**3 Vibration (VIB) Pointer**

Displayed (white) – engine vibration level.

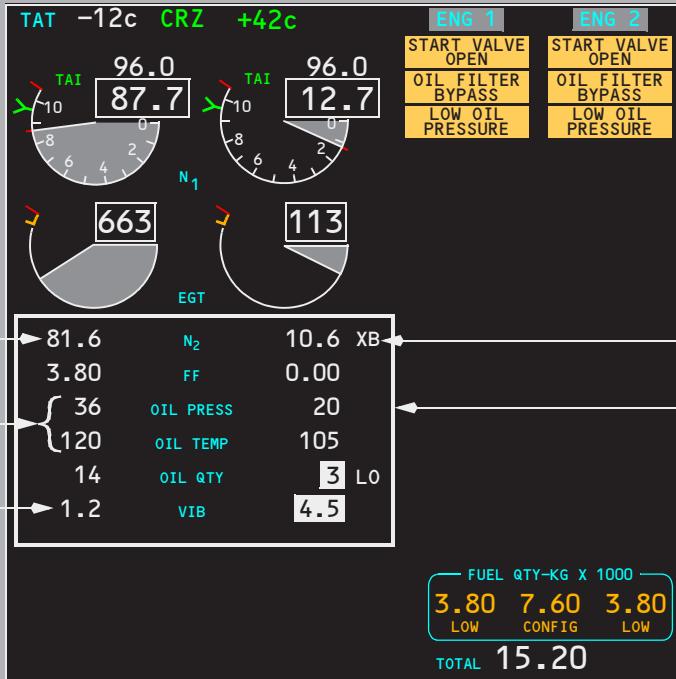
## Compact Engine Displays

The following changes occur to the secondary engine display in the compact engine displays.

[Option - kgs]



[Option - kgs with selectable compact display and total fuel]



UPPER OR LOWER DISPLAY UNIT

## 1 N2 RPM Indications

N2 changes from round dial display to a digital display.

The digital display is framed by a red box after engine shutdown on the ground if an inflight exceedance occurred.

## 2 OIL PRESS, OIL TEMP Indications

Displayed as digital readouts only

The digital readouts display amber or red if limits are exceeded.

## 3 Vibration (VIB) Indications

Displayed as digital readout only.

**4 Crossbleed Start (XB) Indications**

Displayed on the side of N2

**5 Exceedance Indication****[Option - Selectable Compact Display]**

Displayed as rectangular box outline around secondary engine parameters if limits are exceeded when compact display is selected.

The outline has thick lines and blinks for 10 seconds. After 10 seconds, the lines are thinner and do not blink.

The color of the outline matches the color of the exceedance - amber, red or white.

Intentionally  
Blank

## Engines, APU

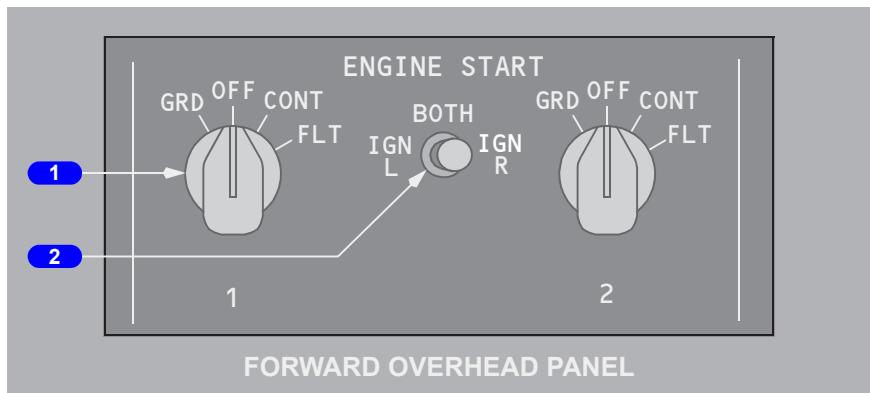
### General Controls and Indicators

## Chapter 7

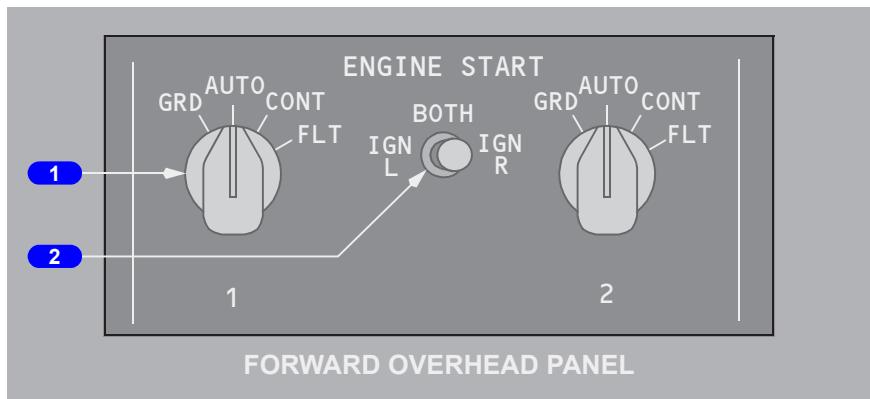
### Section 15

#### Engine Start Switches

[Option - Without automatic ignition]



[Option - With automatic ignition]



#### 1 ENGINE START Switches

GRD –

- opens start valve
- closes engine bleed valve
- for ground starts, arms selected igniter(s) to provide ignition when engine start lever is moved to IDLE
- for inflight starts, arms both igniters to provide ignition when engine start lever is moved to IDLE

[Option - Without automatic ignition]

- releases to OFF at start valve cutout.

[Option - With automatic ignition]

- releases to AUTO at start valve cutout.

[Option - Without automatic ignition]

OFF –

- ignition normally off
- both igniters are activated when engine start lever is in IDLE and:
  - an uncommanded rapid decrease in N2 occurs or,
  - N2 is between 57% and 50% or,
  - in flight - N2 is between idle and 5%.

[Option - With automatic ignition]

AUTO –

- ignition normally off
- both igniters are activated when engine start lever is in IDLE and:
  - an uncommanded rapid decrease in N2 occurs or,
  - N2 is between 57% and 50% or,
  - in flight - N2 is between idle and 5%.
- provides automatic ignition to selected igniters when:
  - engine is running and,
  - flaps are not up below 18000 feet altitude or,
  - engine anti-ice is selected to ON.

CONT –

- provides ignition to selected igniters when engine is operating and engine start lever is in IDLE
- in flight - provides ignition to both igniters when N2 is below idle and engine start lever is in IDLE.

FLT – provides ignition to both igniters when engine start lever is in IDLE.

## **2 Ignition Select Switch**

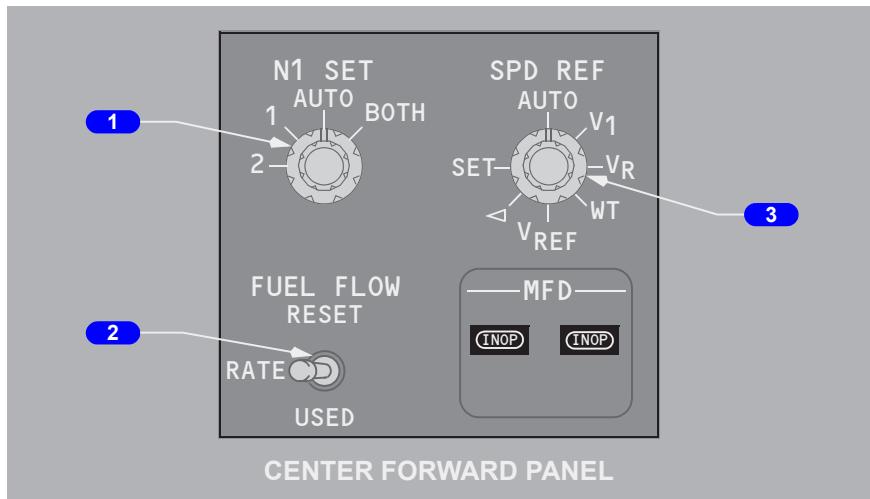
IGN L – selects the left igniter for use on both engines.

BOTH – selects both igniters for use on both engines.

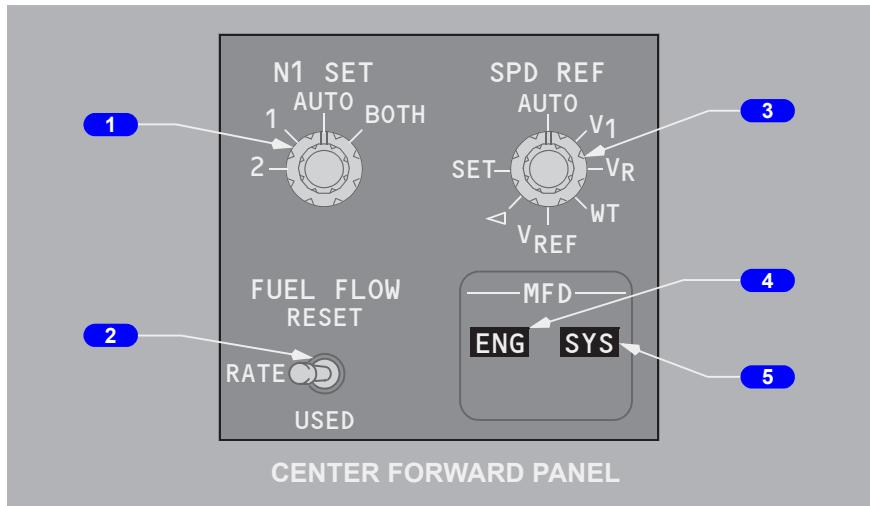
IGN R – selects the right igniter for use on both engines.

## Engine Display Control Panel

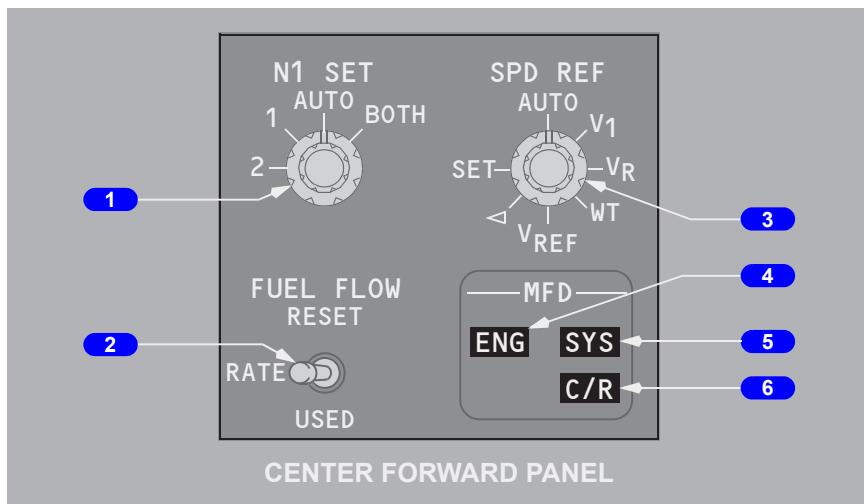
[Option - Side by side display]



[Option - Over/Under display]



[Option – MFD CANCEL/RECALL Switch]



**1 N1 SET Knob**

[Option - Side by side display]

Refer to section 10, Side by Side - Displays

[Option - Over/Under display]

Refer to section 11, Over/Under - Displays

**2 FUEL FLOW Switch**

[Option - Side by side display]

Refer to section 10, Side by Side - Displays

[Option - Over/Under display]

Refer to section 11, Over/Under - Displays

**3 Speed Reference Selector**

Refer to Chapter 10, Flight Instruments, Displays.

## 4 MFD Engine (ENG) Switch

### [Option - Over/Under display]

Push – ENG

- displays secondary engine indications on lower DU; or if the lower DU is unavailable, on upper or inboard DU based on the position of the display select panel selector
- second push blanks lower DU.

## 4 MFD Engine (ENG) Switch

### [Option - Selectable Compact Engine Display]

Refer to section 20, Engines, APU - Engine System Description

## 5 MFD System (SYS) Switch

Refer to:

- Chapter 13, Hydraulics

### [Option - Over/Under display with flight control surface position indicator]

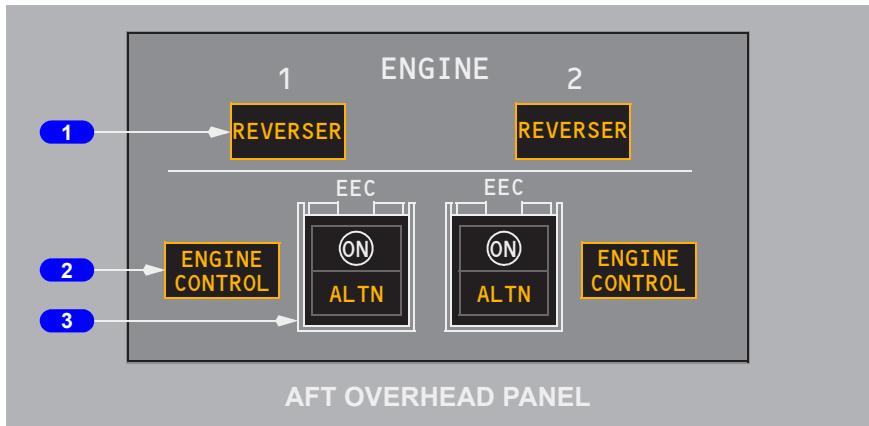
- Chapter 9, Flight Controls

## 6 MFD Cancel/Recall (C/R) Switch

Refer to Chapter 15, Warning Systems.

---

## Engine Panel



## 1 REVERSER Lights

Illuminated (amber) – one or more of following has occurred:

- isolation valve or thrust reverser control valve is not in commanded position
- one or more thrust reverser sleeves are not in commanded state
- auto-restow circuit has been activated
- a failure has been detected in synchronization shaft lock circuitry.

## 2 ENGINE CONTROL Lights

Illuminated (amber) – engine control system is not dispatchable due to faults in system.

Light operates when:

- engine is operating and,
- airplane on ground and:
  - below 80 kt prior to takeoff or,
  - approximately 30 seconds after touchdown.

## 3 Electronic Engine Control (EEC) Switches

ON – in view (white)

- indicates normal control mode is selected
- engine ratings calculated by EEC from sensed atmospheric conditions and bleed air demand
- when ON is not in view, the EEC has been manually selected to the alternate mode.

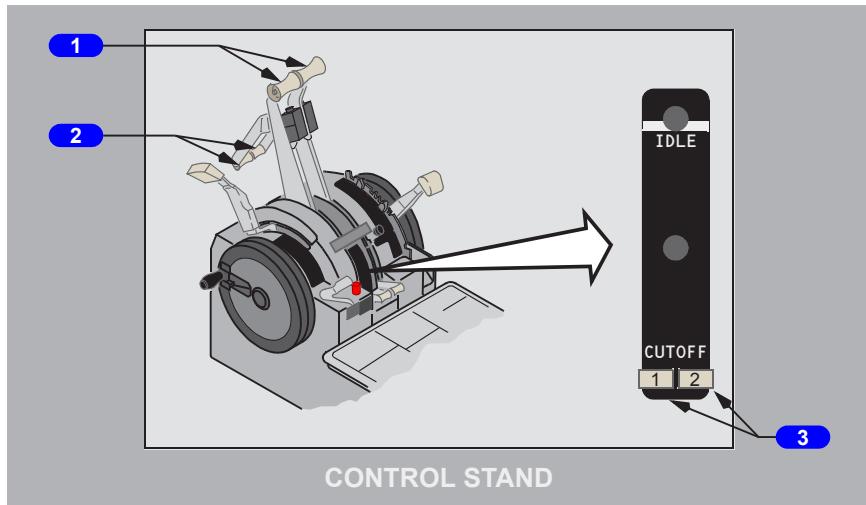
ALTN – in view (amber)

- indicated EEC has automatically switched to alternate control mode or it has been selected manually
- EEC provides rated thrust or higher.

**Note:** Both ON and ALTN may be in view if EEC has automatically switched to soft alternate mode.

**Note:** EGT limits must be observed in both normal and alternate control modes.

## Engine Controls



### 1 Forward Thrust Levers –

- controls engine thrust
- cannot be advanced if the reverse thrust lever is in the deployed position.

### 2 Reverse Thrust Levers –

- controls 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

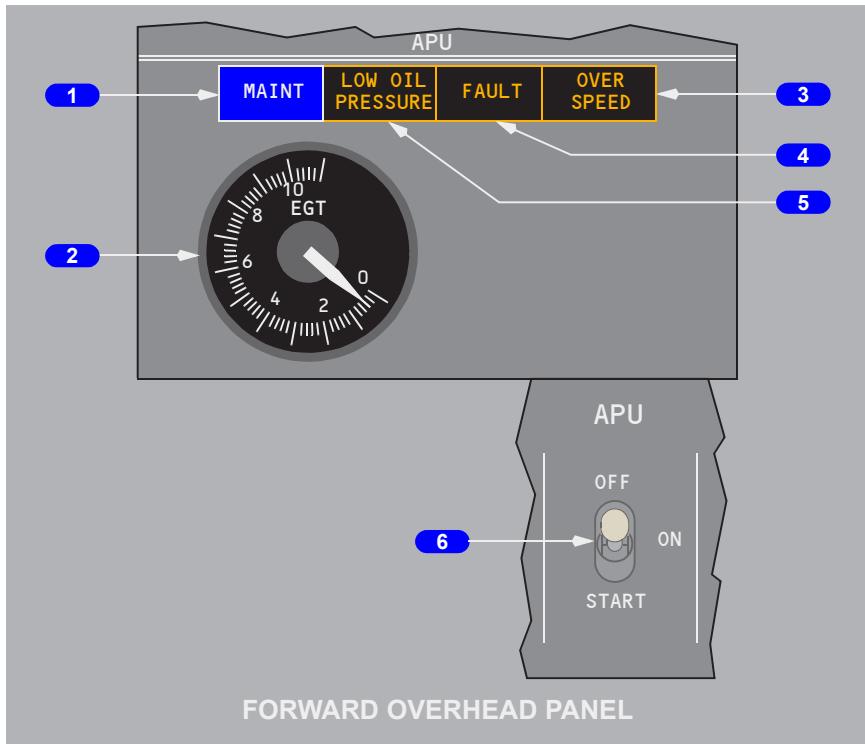
IDLE –

- energizes ignition system through EEC
- electrically opens spar fuel shutoff valve in the wing leading edge outboard of the pylon
- electrically opens engine-mounted fuel shutoff valve via the EEC.

CUTOFF –

- closes both spar and engine fuel shutoff valves
- de-energizes ignition system.

## APU



### 1 APU Maintenance (MAINT) Light

Illuminated (blue) – APU maintenance problem exists:

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

### 2 APU Exhaust Gas Temperature (EGT) Indicator

Displays APU EGT

EGT indicator remains powered for 5 minutes after shutdown.

### 3 APU OVERSPEED Light

Illuminated (amber) –

- APU RPM limit has been exceeded resulting in an automatic shutdown
- overspeed shutdown protection feature has failed a self-test during a normal APU shutdown

- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes
- light is disarmed when the APU switch is in OFF position.

**4 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 after 5 minutes
- light is disarmed when APU switch is in OFF position.

**5 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 in OFF position.

**6 APU Switch**

OFF – normal position when APU is not running

- positioning switch to OFF with APU running trips APU generator off the bus(es), if connected, and closes APU bleed air valve. APU continues to run for a 60 second cooling period
- APU air inlet door automatically closes after shutdown.

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.

Intentionally  
Blank

## Engines, APU

### Engine System Description

## Chapter 7

### Section 20

#### Introduction

The airplane is powered by two CFM56–7 engines. The engine is a dual–rotor, axial–flow turbofan. The N1 rotor consists of a fan, a low–pressure compressor and a 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.

A dual–channel electronic engine control (EEC) regulates each engine. The EEC monitors autothrottle and flight crew inputs to automatically set engine thrust.

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. If the EECs are in the alternate mode, advancing the thrust levers full forward provides some overboost and should be considered only during emergency situations when all other available actions have been taken and terrain contact is imminent. The reverse thrust levers control thrust from reverse idle to maximum reverse

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#### Engine Indications

##### **[Option - Side by side display]**

Engine indications are displayed on the center instrument panel upper display unit (DU). If a failure is detected on the upper DU, the engine indications automatically shift to the lower DU. The engine indications can also be manually selected to either the Captain's or First Officer's inboard DU, or the lower DU, using the respective display select panel.

N1, EGT, N2, and FF/FU are the primary indications and are displayed as both digital readouts and round dial/moving pointer indications. N1, EGT, and N2 have operating limits indicated by redlines. EGT also displays an amber caution limit. If one of these indications exceeds the red or amber line, the digital readout, box, pointer, and indicator change color to red or amber.

Oil pressure, oil temperature, oil quantity, and engine vibration are the secondary engine indications. Oil pressure and oil temperature indications are displayed with a round dial/moving pointer. Operating and caution ranges are displayed with red and amber lines. If the red or amber line is reached, the pointer changes color to red or amber for that indication. The oil quantity indicator displays a digital readout of quantity as a percent of full.

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Engine vibration indications are displayed with a round dial/moving pointer.

The EEC must receive electrical power to supply engine operating data to the flight deck engine indications. When the EEC is not powered, N1, N2, oil quantity and engine vibration are displayed directly from the engine sensors. Positioning the engine start switch to GRD supplies electrical power to the EEC and displays pointers/digits for all engine parameters.

During battery start with no power on the airplane, only N1, N2, and oil quantity are available. The EEC is not powered until the engine accelerates to a speed greater than 15% N2. At 15% N2, the EEC becomes energized and pointers/digits for all engine parameters are displayed.

An engine failure alert indication (ENG FAIL) is displayed in amber on the EGT indicator when the respective engine is operating at a condition below sustainable idle (50% N2) and the engine start lever is in the IDLE position. The alert remains until the engine recovers, the engine start lever is moved to CUTOFF, or the engine fire warning switch is pulled.

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## Engine Indications

### [Option - Over/Under display]

Primary and secondary engine indications are provided. Engine indications are displayed on the center forward panel upper display unit (DU), lower DU or the Captain's or First Officer's inboard DU.

## Primary Engine Indications

N1 and EGT are the primary engine indications. The primary engine indications are normally displayed on the center forward panel upper DU. If that unit fails, the display automatically moves to the lower DU. The primary engine indications can also be manually selected to either the Captain's or First Officer's inboard DU, or the lower DU, using the respective display select panel.

## Secondary Engine Indications

### [Option - Fuel flow displayed full time]

N2, fuel flow, oil pressure, oil temperature, oil quantity, and engine vibration are the secondary engine indications. The secondary engine indications, except for fuel flow, are manually selected to either the Captain's or First Officer's inboard DU, or the lower DU, using the respective display select panel and the ENG switch on the engine display control panel. Fuel flow is displayed full time on the upper display unit below the primary engine indications.

The secondary engine indications are automatically displayed when:

- the displays initially receive electrical power
- in flight when an engine start lever is moved to CUTOFF

- in flight when an engine N2 RPM is below idle
- a secondary engine parameter is exceeded.

When the secondary engine indications are automatically displayed, they cannot be cleared until the condition is no longer present.

## Normal Display Format

N1, EGT, and N2 are displayed as both digital readouts and round dial/moving pointer indications. The digital readouts display numerical values while the moving pointers indicate relative value.

Oil pressure, oil temperature, and engine vibration indications are both digital readouts and vertical indication/moving pointers. Fuel flow and oil quantity are digital readouts only. All digital readouts are enclosed by boxes.

The dials and vertical indications display the normal operating range, caution range, and operating limits.

Normal operating range is displayed on a dial or vertical indication in white.

N1, EGT, and N2 have operating limits indicated by redlines. EGT also displays an amber caution limit. If one of these indications exceeds the red or amber line, the digital readout, box, pointer, and indicator change color to red or amber.

The oil temperature and oil pressure vertical indications have a caution range and an operating limit redline. If the oil temperature or pressure reaches the caution range, the digital readout, digital readout box, and pointer all change color to amber. If one of these indications reach the operating limit, the digital readout, digital readout box, and pointer all change color to red.

The EEC must receive electrical power to supply engine operating data to the flight deck engine indications. When the EEC is not powered, N1, N2, oil quantity and engine vibration are displayed directly from the engine sensors. Positioning the engine start switch to GRD supplies electrical power to the EEC and displays pointers/digits for all engine parameters.

During battery start with no power on the airplane, only N1, N2, and oil quantity are available. The EEC is not powered until the engine accelerates to a speed greater than 15% N2. At 15% N2, the EEC becomes energized and pointers/digits for all engine parameters are displayed.

An engine failure alert indication (ENG FAIL) is displayed in amber on the EGT indicator when the respective engine is operating at a condition below sustainable idle (50% N2) and the engine start lever is in the IDLE position. The alert remains until the engine recovers, the engine start lever is moved to CUTOFF, or the engine fire warning switch is pulled.

## Compact Display

In compact format, the primary and secondary engine indications are combined on the same display. The N1 and EGT indications are displayed as they are normally. All other indications change to digital readouts only. N2, oil temperature, and oil pressure digital readouts turn red or amber if an exceedance occurs. The N2 digital display is framed with a red box after engine shutdown on the ground if an inflight exceedance occurred.

Primary and secondary engine indications are displayed in compact format on the upper DU when the secondary engine indications are selected for display (manually or automatically) and the lower DU is unavailable. Alternatively, the compacted indications are displayed on the lower DU if the upper DU is unavailable.

### Selectable Compact Engine Display

#### [Option - Selectable Compact Engine Display]

The compact engine format may also be selected by pushing the MFD ENG key on the Engine Display Control panel.

| Initial Formats<br>Displayed on<br>Center DUs<br>(Upper/Lower) | After<br>ENG Key<br>is Pushed | When<br>an Exceedance<br>Occurs | Exceedance is<br>Active &<br>ENG Key<br>isPushed |
|--|-------------------------------|---------------------------------|--|
| Primary Eng/Blank  | Primary Eng/<br>Secondary Eng | Primary Eng/<br>Secondary Eng   | Comp Eng/Blank                                   |
| Primary Eng/<br>Secondary Eng                                  | Comp Eng/Blank                | Comp Eng/Blank                  | Primary Eng/<br>Secondary Eng                    |
| Comp Eng/Blank   | Primary Eng/Blank             | Primary Eng/<br>Secondary Eng   | Comp Eng/Blank                                   |
| Primary Eng/Sys  | Primary Eng/<br>Secondary Eng | Primary Eng/<br>Secondary Eng   | Comp Eng/Blank                                   |
| Comp Eng/Sys   | Primary Eng/Sys               | Comp Eng/Sys                    | Primary Eng/<br>Secondary Eng                    |
| Primary ENG/ND   | Comp Eng/ND                   | Comp Eng/ND                     | Comp Eng/ND                                      |
| Comp Eng/ND  | Primary ENG/ND                | Comp Eng/ND                     | Comp Eng/ND                                      |

If the compact engine format is displayed, the subsequent exceedance of a secondary engine parameter will cause a rectangular box outline to appear around the secondary engine parameter. For the initial 10 seconds, the box outline is displayed with thick lines and the box blinks. After 10 seconds, thinner lines are used for the box, and the box stops blinking. The color of the box will match the color of the digits of the exceedance: amber box for an amber exceedance, red box for a red exceedance, and white box for an exceedance indicated by reverse video. Once all exceedances are removed, the box outline will be removed. For multiple exceedances, the color of the box color will match the worst case exceedance.

---

## Electronic Engine Control (EEC)

Each engine has a full authority digital EEC. Each EEC has two independent control channels, with automatic channel transfer if the operating channel fails. With each engine start or start attempt, the EEC alternates between control channels. The EEC uses thrust lever inputs to automatically control forward and reverse thrust. N1 is used by the EEC to set thrust in two control modes: normal and alternate. Manual selection of the control mode can be made with the EEC switches on engine panel.

### EEC Normal Mode

In the normal mode, the EEC uses sensed flight conditions and bleed air demand to calculate N1 thrust ratings. The EEC compares commanded N1 to actual N1 and adjusts fuel flow to achieve the commanded N1.

The full rated takeoff thrust for the installed engine is available at a thrust lever position less than the forward stop. Fixed or assumed temperature derated takeoff thrust ratings are set at thrust lever positions less than full rated takeoff. The maximum rated thrust is available at the forward stop. The EEC limits the maximum thrust according to the airplane model as follows:

- 737-600 – CFM56-7B22 rating
- 737-700 – CFM56-7B24 rating
- 737-800 – CFM56-7B27 rating
- 737-900 – CFM56-7B27 rating

### Takeoff Bump Thrust

#### [Option - Takeoff bump thrust]

Takeoff bump thrust is available when increased thrust is needed for takeoff, above the normal maximum takeoff thrust setting. When selected using the FMC N1 LIMIT page, takeoff thrust is increased by either the flight crew or the autothrottle positioning the thrust levers to set N1 to the reference N1 bug. Bump thrust applies only to the takeoff rating; maximum climb, maximum continuous and go-around thrust ratings are not affected.

Airplanes equipped with a takeoff thrust bump have a reserve thrust capability which is greater than the standard values listed under the EEC Normal Mode listed above. Use of this reserve thrust capability is intended for emergency use only in the event of wind shear or impending ground contact.

FMC selection of takeoff bump thrust can be configured as either “Bump Option” or a “Full-Rate Option.” When configured as a FMC “Bump Option”, the default takeoff rating is lower than takeoff bump, and the takeoff bump must be activated via the FMC-CDU. With this “Bump Option” configuration, assumed temperature engine derates are not available from the bump. When configured as a FMC “Full-Rate Option”, the default takeoff rating is the takeoff bump. With this full-rate option, the assumed temperature engine derate method may always be used. With this “Full-Rate Option” configuration, the ability to select the lowest normally offered takeoff fixed derate is lost.

## **EEC Alternate Mode**

The EEC can operate in either of two alternate modes, soft or hard. If required signals are not available to operate in the normal mode, the EEC automatically changes to the soft alternate mode. When this occurs, the ALTN switch illuminates and the ON indication remains visible. In the soft alternate mode, the EEC uses the last valid flight conditions to define engine parameters which allows the mode change to occur with no immediate change in engine thrust. Thrust rating shortfalls or exceedances may occur as flight conditions change. The soft alternate mode remains until the hard alternate mode is entered by either retarding the thrust lever to idle or manually selecting ALTN with the EEC switch on the aft overhead panel.

**Note:** Loss of either DEU results in a loss of signal to both EECs. The EEC ALTN lights illuminate and each EEC reverts to the alternate mode to prevent the engines from operating on a single source of data.

When the hard alternate mode is entered, the EEC reverts to the alternate mode thrust schedule. Hard alternate mode thrust is always equal to or greater than normal mode thrust for the same lever position. If the hard alternate mode is entered by reducing the thrust lever to idle while in the soft alternate mode, the ALTN switch remains illuminated and the ON indication remains visible. When ALTN is selected manually, the ON indication is blanked.

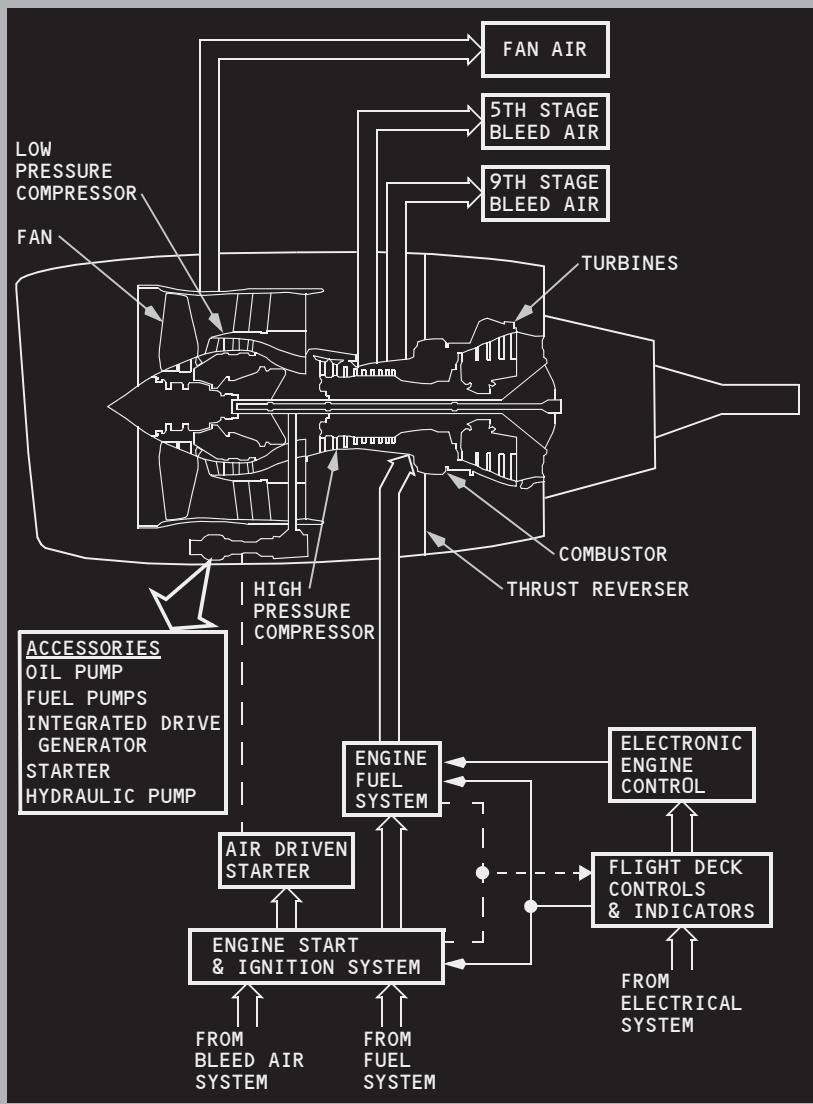
## **Structural Limit Protection**

The EEC provides N1 and N2 redline overspeed protection in both normal and alternate modes. The EGT limit must be observed by the crew because the EEC does not provide EGT redline exceedance protection.

## Idle Operation

The EEC automatically selects ground minimum idle, flight minimum idle, and approach idle. Ground minimum idle is selected for ground operations and flight minimum idle is selected for most phases of flight. Approach idle is selected in flight if flaps are in landing configuration or engine anti-ice is ON for either engine. At the same airspeed and altitude, N1 and N2% RPM will be higher for approach idle than for flight minimum idle. This higher% RPM improves engine acceleration time in the event of a go-around. Approach idle is maintained until after touchdown, when ground minimum idle is selected. In flight, if a fault prevents the EEC from receiving flap or anti-ice signals, approach idle schedule begins below 15,000 feet MSL.

## Power Plant Schematic



## Engine Fuel System

Fuel is delivered under pressure from fuel pumps located in the fuel tanks. The fuel flows through a fuel spar shutoff valve located at the engine mounting wing stations. The fuel passes through the first stage engine fuel pump where pressure is increased. It then passes through two fuel/oil heat exchangers where IDG oil and main engine oil heat 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 adds more pressure before the fuel reaches the hydro mechanical unit (HMU). To meet thrust requirements, the EEC meters fuel through the HMU.

The spar fuel shutoff valve and engine 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. Both valves close when either the start lever is in CUTOFF or the engine fire warning switch is out. SPAR VALVE CLOSED and ENG VALVE CLOSED lights located on the overhead panel indicate valve position.

Fuel flow is measured after passing through the engine fuel shutoff valve and is displayed on the display unit. Fuel flow information is also provided to the FMS.

## Engine Oil System

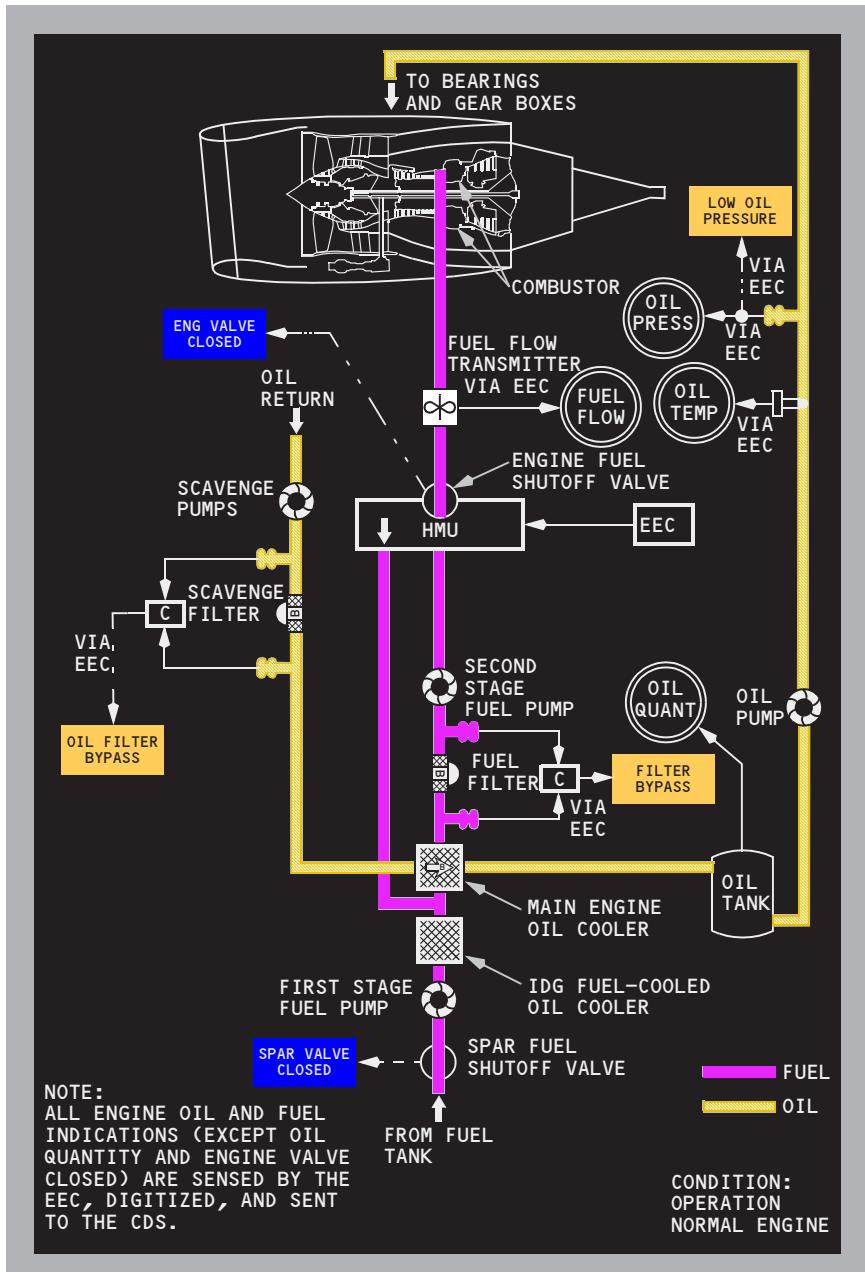
Oil from the individual engine tank is circulated under pressure, through the engine to lubricate the engine bearings and accessory gearbox. The oil quantity indicator, oil temperature indicator, oil pressure indicator and LOW OIL PRESSURE alert are all located on the display unit.

The oil system is pressurized by the engine driven oil pump. Oil from the pump, goes to the engine bearings and gearbox. Sensors for the oil temperature indicator, oil pressure indicator and LOW OIL PRESSURE alert are located downstream of the oil pump prior to engine lubrication.

Oil is returned to the oil tank by engine driven scavenging pumps. From the scavenging pumps oil passes through a scavenging filter. If the filter becomes saturated with contaminants, oil automatically bypasses the filter. Prior to the oil bypassing the scavenging filter, the OIL FILTER BYPASS alert illuminates on the upper display unit.

Prior to returning to the oil tank, the oil passes through the main engine oil cooler where it is cooled by engine fuel to maintain proper oil temperature.

## 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 battery power 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 alert is provided on the upper display unit. The starter rotates the N2 compressor through the accessory drive gear system. When the engine accelerates to the recommended value (25% N2 or max motoring), moving the engine start lever to the IDLE position opens the fuel valves on the wing spar and engine, and causes the EEC to supply fuel and ignition to the combustor where the fuel ignites. Initial fuel flow indications lag actual fuel flow by approximately two seconds, therefore, during engine start, an EGT rise may occur before fuel flow indication.

### [Option - Without automatic ignition]

At starter cutout speed (approximately 56% N2), power is removed from the 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.

### [Option - With automatic ignition]

At starter cutout speed (approximately 56% N2), power is removed from the start switch holding solenoid. The engine start switch returns to AUTO, the engine bleed air valve returns to the selected position, and the start valve closes.

## Abnormal Start Protection (Ground Starts Only)

During ground starts, the EEC monitors engine parameters to detect impending hot starts, engine stalls, EGT start limit exceedances, and wet starts. These protection features do not function during inflight starts.

If an impending hot start is detected by a rapid rise in EGT or EGT approaching the start limit, or a compressor stall occurs, the white box surrounding the EGT digital readout flashes white. The flashing white box resets when the start lever is moved to CUTOFF or the engine reaches idle N2. Current versions of EEC software (7.B.Q and later) automatically turn off the ignition and shuts off fuel to the engine for an impending hot start or stall.

If the EGT exceeds the starting limit, the EGT display, both box and dial, turn red. The EEC automatically turns off the ignition and shuts off fuel to the engine. The alert terminates and the display returns to white when EGT drops below the start limit. Following shutdown of both engines, the EGT box turns red to remind the crew of the exceedance.

A wet start occurs if the EGT does not rise after the start lever is moved to IDLE. If a wet start is detected, the EEC turns off the ignition and shuts off fuel to the engine 15 seconds after the start lever is moved to IDLE.

## Engine Ignition System

Each engine has two igniter plugs. The EEC arms the igniter plug(s) selected by the ignition select switch. The left igniter plug receives power from the associated AC transfer bus. The right igniter plug receives power from the AC standby bus.

### Auto-Relight

An auto-relight capability is provided for flameout protection. Whenever the EEC detects an engine flameout, both igniters are activated. A flameout is detected when an uncommanded rapid decrease in N2 occurs, or N2 is below idle RPM.

### Inflight Starting

Two methods of starting an engine inflight are available, windmill and crossbleed. None of the ground start protection features are functional during inflight start.

**Note:** At low N2 values, the oil scavenge pump may not provide enough pressure to return oil to the tank, causing a low oil quantity indication. Normal oil quantity should be indicated after start.

#### [Option - Side by side display]

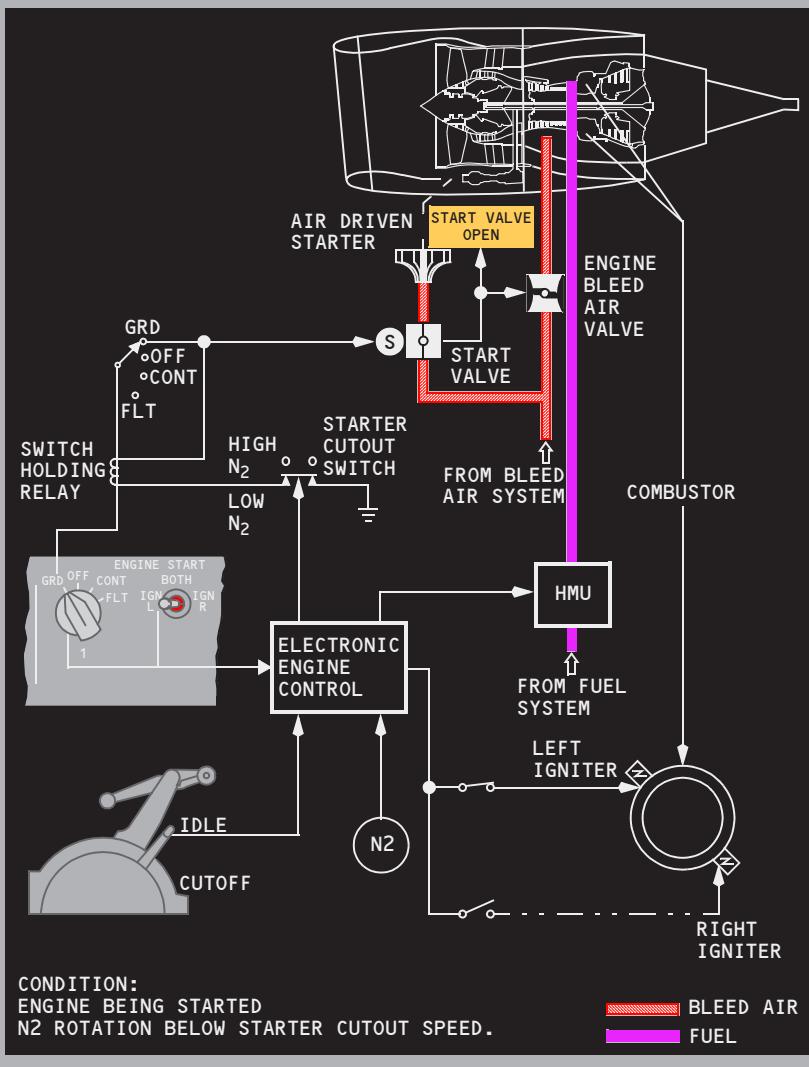
If crossbleed starting is required, the X-BLD START indication is displayed above the N2 dial. This indication is based on airplane altitude, airspeed and N2.

#### [Option - Over/Under display]

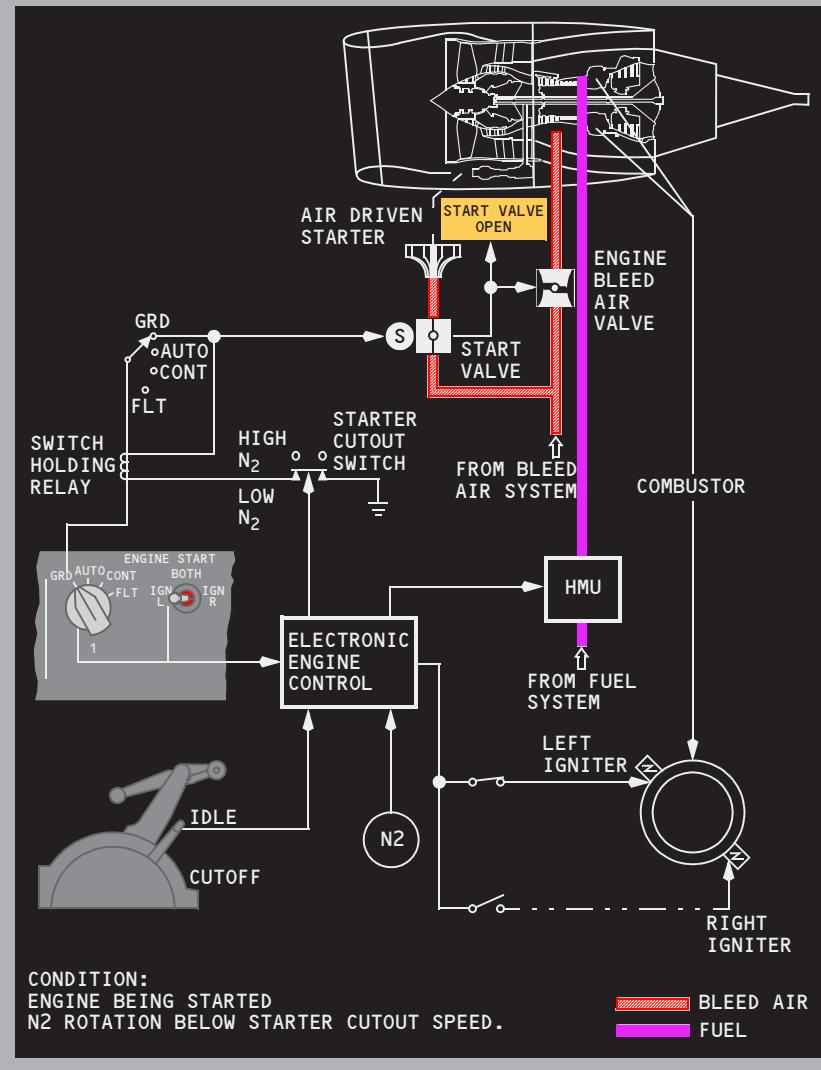
If crossbleed starting is required, the X-BLD indication (XB for the compact engine display) is displayed above the N2 dial. This indication is based on airplane altitude, airspeed and N2.

## Engine Start and Ignition System Schematic

[Option - Without automatic ignition]



[Option - With automatic ignition]



## 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 and/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, an electro-mechanical lock releases, 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 REV indication, located on the upper display unit, illuminates. As the thrust reverser reaches the deployed position, the REV indication illuminates green and 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 (reverse idle thrust) initiates the command to stow the reverser. When the lever reaches the full down position, 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 and the electro-mechanical lock engages.

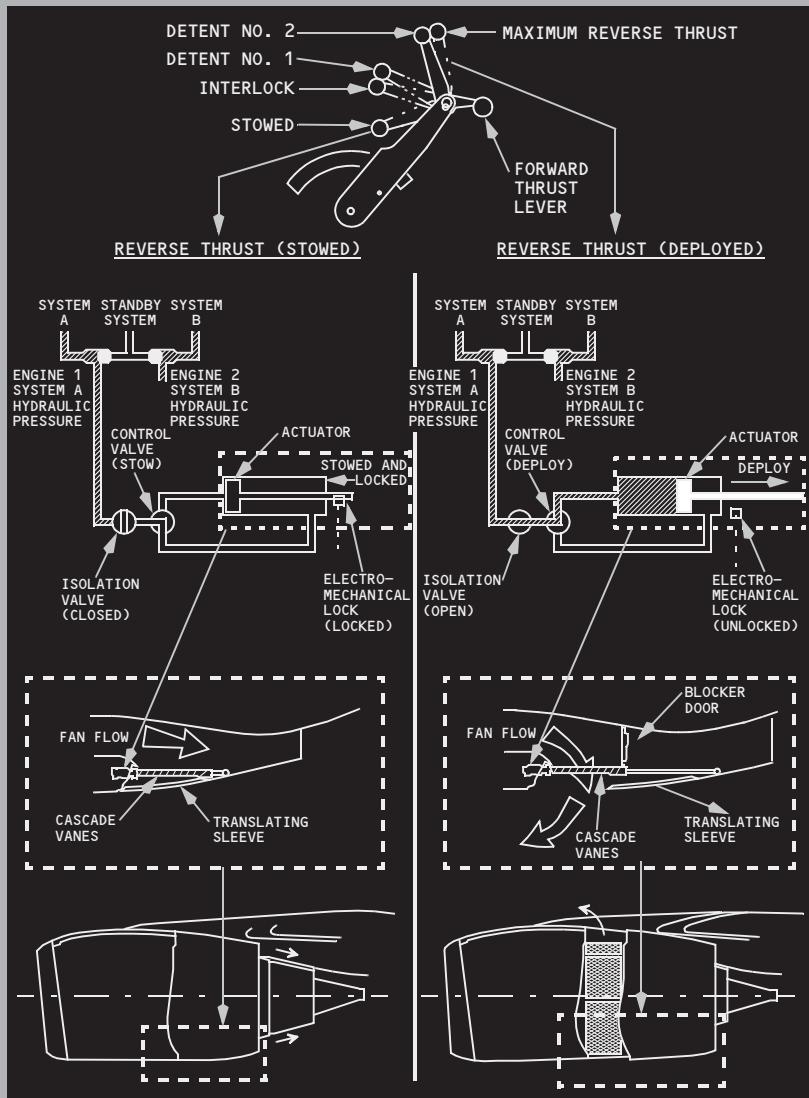
The REVERSER light, located on the aft overhead panel, illuminates when the thrust reverser is commanded to stow and extinguishes 10 seconds later when the isolation valve closes. Any time the REVERSER light illuminates for more than approximately 12 seconds, a malfunction has occurred and the MASTER CAUTION and ENG system annunciation lights illuminate.

**Note:** A pause in movement of the reverse thrust levers past detent No. 1 toward the stow position may cause MASTER CAUTION and ENG system annunciation lights to illuminate. A pause of approximately 18 seconds engages the electro-mechanical lock and prevents the thrust reverser sleeves from further movement. Cycling the thrust reversers may clear the fault and restore normal operation.

When the reverser sleeves are in the stow position, an electro-mechanical lock and a hydraulically operated locking actuator inhibit motion to each reverser sleeve until reverser extension is selected. Additionally, an auto-restow circuit compares the actual reverser sleeve position and the commanded reverser position. In the event of incomplete stowage or uncommanded movement of the reverser sleeves toward the deployed position, the auto-restow circuit opens the isolation valve and commands the control valve to the stow position directing hydraulic pressure to stow the reverser sleeves. Once the auto-restow circuit is activated, the isolation valve remains open and the control valve is held in the stowed position until the thrust reverser is commanded to deploy or until corrective maintenance action is taken.

**WARNING:** Actuation of the thrust reversers on the ground without suitable precautions is dangerous to ground personnel.

## Thrust Reverser Schematic

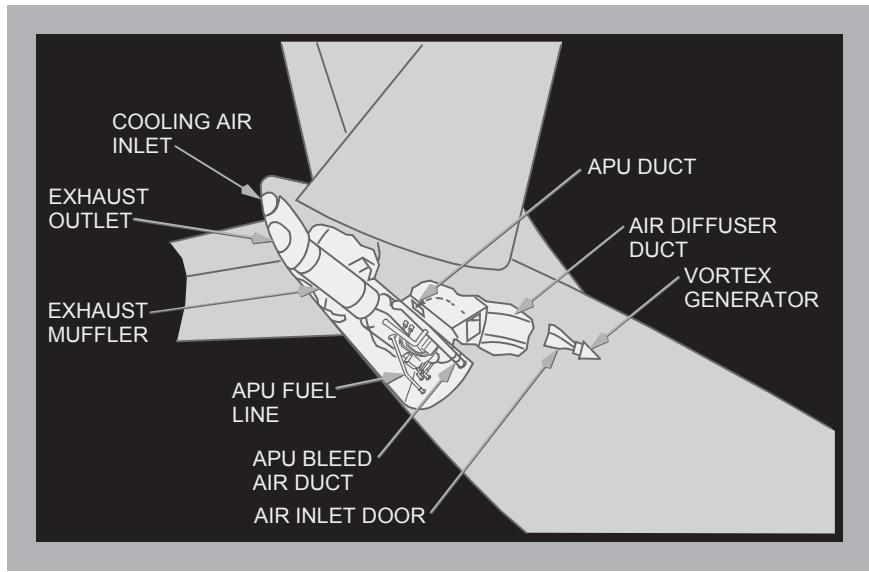


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**Engines, APU****APU System Description****Chapter 7****Section 30****Introduction**

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 starts and operates up to the airplane maximum certified altitude.

The APU supplies bleed air for both air conditioning packs on the ground or one pack in flight. Both transfer busses can be powered on the ground or in flight.

## APU Fuel Supply

### [Option - APU DC fuel boost pump]

Fuel to start and operate the APU comes from the left side of the fuel manifold when the AC fuel pumps are operating. A DC operated APU fuel boost pump is installed to ensure positive fuel pressure to the APU fuel control unit. During APU start and operation, the pump operates automatically when the APU fuel control unit senses low fuel pressure. The pump shuts off automatically when an AC fuel pump pressurizes the fuel manifold. If the AC and DC fuel pumps are not operating, fuel is suction fed from the No. 1 tank. During APU operation, fuel is automatically heated to prevent icing.

## APU Engine and Cooling Air

APU engine air routes to the APU through an automatically operated air inlet door located on the right side of the fuselage. APU exhaust gases discharge overboard through an exhaust muffler.

Air for APU cooling enters through a cooling air inlet above the APU exhaust outlet. This air circulates through the APU compartment, passes through the oil cooler and vents through the exhaust outlet.

## 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 No. 1 transfer bus or the airplane battery(ies). With AC power available, the starter generator uses AC power to start the APU. With no AC power, the starter generator uses battery power to start the APU.

Moving the battery switch to OFF on the ground or in the air automatically shuts down the APU because of power loss to the electronic control unit.

## 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.

**Note:** When the APU is started using battery power only, there is no indication on the electrical metering panel that the APU generator has come on line and is ready to be selected. Both the frequency and voltage readings are zero until the APU generator is placed on line.

**Note:** During the APU start cycle, the APU EGT indication may fluctuate from 0° to 1100° C prior to normal EGT rise and the LOW OIL PRESSURE light may cycle on and off several times. These indications have no adverse effect on starting the APU. It is not necessary to monitor EGT during start.

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 120 seconds. Automatic shutdown occurs in the event of EGT exceedance.

If the start fails or the APU GEN OFF BUS light fails to illuminate by the end of the start cycle, a system failure has occurred and the FAULT light illuminates.

Operate the APU for one full minute before using it as a bleed air source. This one minute stabilization is recommended to extend the service life of the APU.

## APU Shutdown

Operate the APU for one full minute with no bleed air load prior to shutdown. This cooling period is recommended to extend the service life of the APU. When the APU switch is moved to OFF, this time delay is met automatically.

Moving the APU switch to OFF trips the APU generator, closes the APU bleed air valve and extinguishes the APU GEN OFF BUS light. Shutdown occurs automatically after 60 seconds. When the APU speed decreases sufficiently during shutdown, the fuel valve and inlet door close. If the fuel valve does not close, the FAULT light will illuminate after approximately 30 seconds. An immediate shutdown can be accomplished by pulling the APU fire switch.

## Electronic Control Unit (ECU)

An electronic control unit (ECU) monitors and controls the APU. Automatic shutdown protection is provided for overspeed conditions, low oil pressure, high oil temperature, APU fire, fuel control unit failure, EGT exceedance, and other system faults monitored by the ECU.

The ECU automatically controls APU speed through the electronic fuel control. If speed or EGT exceed acceptable levels with the APU providing electrical load only, some electrical load is shed. When electrical load and air extraction raise the EGT above acceptable levels during engine starting, electrical load shedding occurs prior to reducing bleed air. When electrical load and air extraction raise the EGT above acceptable levels other than during engine starting, the inlet guide vanes move toward a closed position, reducing bleed air extraction while maintaining electrical load.

## **APU Automatic Load Shedding**

### **[Option - CAB/UTIL Power Switch]**

In flight, if the APU is the only source of electrical power, all galley busses and main buses are automatically shed. If electrical load still exceeds design limits, both IFE busses are also automatically shed. On the ground, the APU attempts to carry a full electrical load. If an overload condition is sensed, the APU sheds galley busses and main busses until the load is within limits. Manual restoration of galley and main bus power can be attempted by moving the CAB/UTIL Power Switch to OFF, then back ON.

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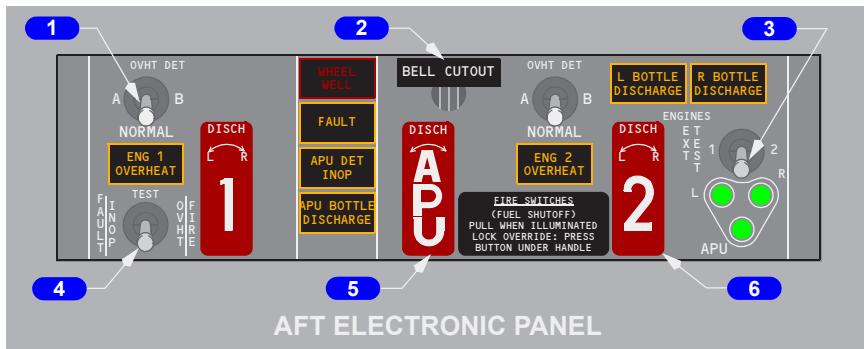
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## Fire Protection Controls and Indicators

## Chapter 8 Section 10

### Overheat/Fire Protection Panel Switches



#### 1 Overheat Detector (OVHT DET) Switch

NORMAL – detection loop A and loop B are active.

A – detection loop A is active.

B – detection loop B is active.

#### 2 Fire Warning BELL CUTOUT Switch

Push –

- extinguishes both master FIRE WARN lights
- silences the fire warning bell
- silences the remote APU fire warning horn (on the ground only)
- resets the system for additional warnings.

#### 3 Extinguisher (EXT) TEST Switch

(spring-loaded to center)

1 or 2 – tests bottle discharge circuits for all three extinguisher bottles.

#### 4 Fault/Inoperative (FAULT/INOP) and Overheat/Fire (OVHT/FIRE) TEST Switch

(spring-loaded to center)

FAULT/INOP – tests fault detection circuits for both engines and the APU.

OVHT/FIRE – tests overheat and fire detection loops on both engines and APU, and wheel well fire detector

**Note:** See Fire and Overheat Detection System Fault Test in Section 20.

## **5 APU Fire Switch**

Illuminated (red) –

- indicates fire in APU
- unlocks APU fire switch.

**Note:** Master FIRE WARN lights illuminate, fire warning bell sounds, and in the main wheel well the APU fire warning horn 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 fuel shutoff valve, APU bleed air valve, and APU inlet door
- trips generator control relay and breaker
- allows APU fire switch to rotate.

Rotate (left or right) –

- discharges APU fire bottle.

## **6 Engine Fire Switch**

Illuminated (red) –

- indicates fire in related engine
- unlocks related engine fire switch.

**Note:** Master FIRE WARN lights illuminate and fire warning bell sounds.

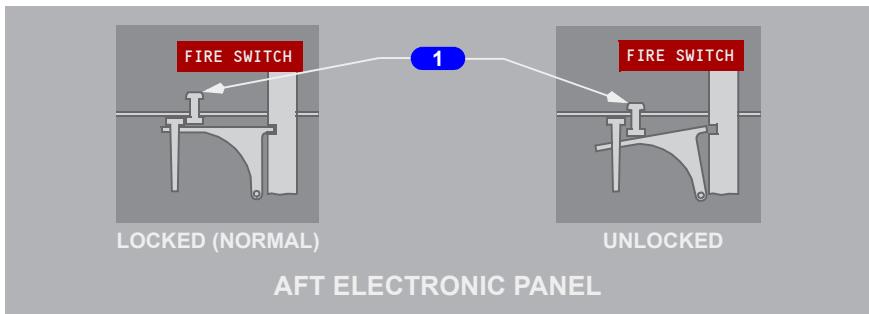
In – normal position, mechanically locked if no fire signal.

Up –

- arms one discharge squib on each engine fire extinguisher
- closes fuel, hydraulic shutoff and engine bleed air valves
- disables thrust reverser
- trips generator control relay and breaker
- deactivates engine driven hydraulic pump LOW PRESSURE light
- allows engine fire switch to rotate.

Rotate (left or right) – discharges related fire bottle.

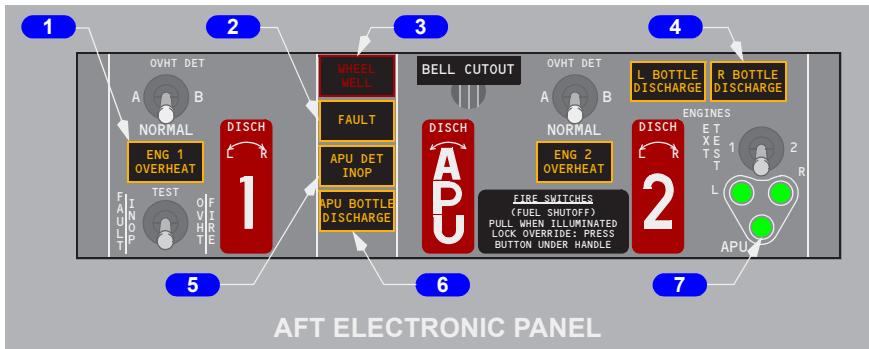
## Fire Switch Override



### 1 Fire Switch Override

Push – unlocks fire switch.

## Overheat/Fire Protection Panel Lights



### 1 Engine (ENG) OVERHEAT Light

Illuminated (amber) – indicates overheat in related engine.

**Note:** MASTER CAUTION and OVHT/DET system annunciation 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 annunciation lights do not illuminate.

**3 WHEEL WELL Fire Warning Light**

Illuminated (red) – indicates fire in main gear wheel well

**Note:** Master FIRE WARN lights illuminate and fire warning bell sounds.

**4 Engine BOTTLE DISCHARGE Light**

Illuminated (amber) – indicates related fire extinguisher bottle has discharged.

**5 APU Detector Inoperative (DET INOP) Light**

Illuminated (amber) – indicates APU detector loop has failed.

**Note:** MASTER CAUTION and OVHT/DET system annunciator lights illuminate.

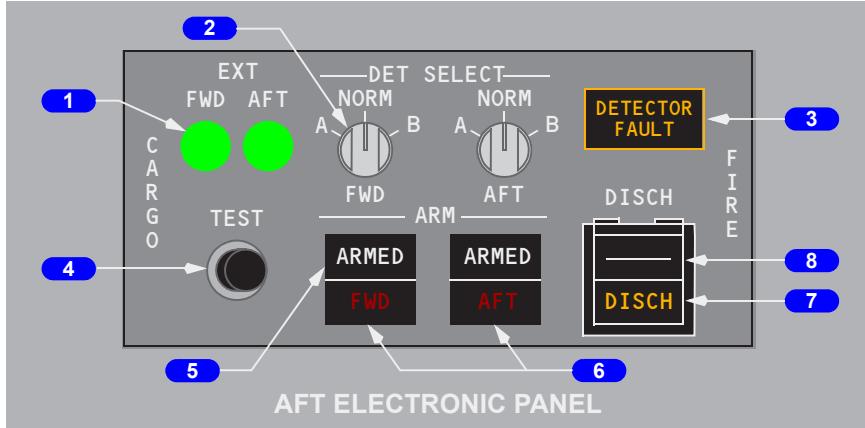
**6 APU BOTTLE DISCHARGE Light**

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****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 of the selected detector loop(s) in either cargo compartment 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 ARM Switches****[Option - Single Cargo Fire Extinguisher bottle]**

PUSH -

- FWD ARMED - extinguisher armed for the forward cargo compartment
- AFT ARMED - extinguisher armed for the aft cargo compartment.

**5 Cargo Fire ARM Switches****[Option - Dual Cargo Fire Extinguisher bottles]**

PUSH -

- FWD ARMED - extinguisher armed for the forward cargo compartment
- AFT ARMED - extinguisher armed for the aft cargo compartment.

**Note:** If the first bottle has discharged and the system remains armed, the second bottle discharge is inhibited upon landing. The second bottle discharge timer is disabled when the system is disarmed.

**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

### [Option - Single Cargo Fire Extinguisher bottle]

Illuminated (amber) - indicates the extinguisher bottle has discharged

## 7 Cargo Fire Bottle Discharge (DISCH) Light

### [Option - Dual Cargo Fire Extinguisher bottles]

Illuminated (amber) - indicates that either extinguisher bottle has discharged

## 8 Cargo Fire Discharge (DISCH) Switch

### [Option - Single Cargo Fire Extinguisher bottle]

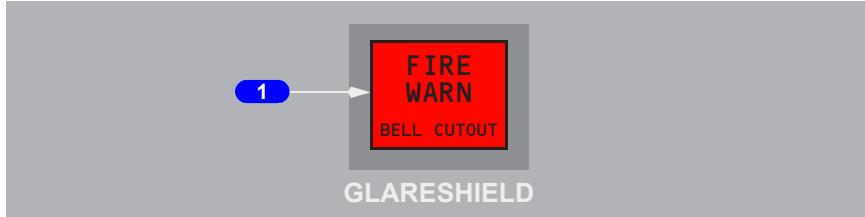
PUSH - if system is armed, discharges the extinguisher bottle.

## 8 Cargo Fire Discharge (DISCH) Switch

### [Option - Dual Cargo Fire Extinguisher bottles]

PUSH - if system is armed, discharges the first extinguisher bottle. The timer is set for 60 minutes to discharge the second extinguisher bottle.

## Master Fire Warning Light



## 1 Master Fire Warning (FIRE WARN) Lights

Illuminated (red) – indicates a fire warning (or system test) in engine, APU, main gear wheel well or cargo compartment

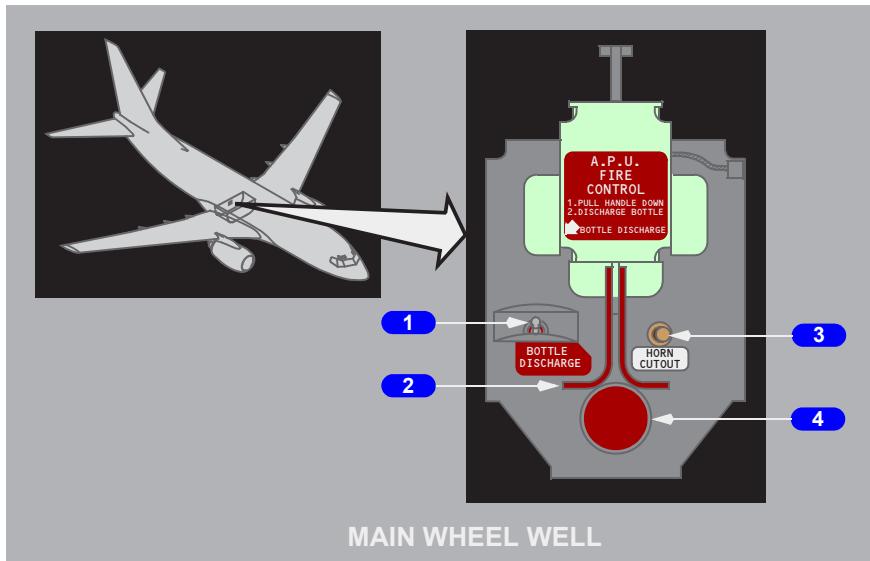
- fire warning bell sounds
- if on ground, remote APU fire warning horn sounds.

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.

## APU Ground Control Panel



### 1 APU BOTTLE DISCHARGE Switch

(spring-loaded to the right and safety wired.)

Left – discharges APU extinguisher.

**Note:** Armed only if APU fire control handle is pulled at this panel.

### 2 APU Fire Control Handle

Up – normal position.

Down –

- arms APU BOTTLE DISCHARGE switch (on this panel only)
- closes APU fuel shutoff, bleed air valve and APU inlet door
- trips generator control relay and breaker.

### 3 APU Fire Warning HORN CUTOUT Switch

Push –

- silences fire alarm bell
- silences APU fire warning horn
- causes APU fire warning light to stop flashing but remain illuminated.

#### 4 APU Fire Warning Light

Illuminated (red flashing) – indicates fire in APU.

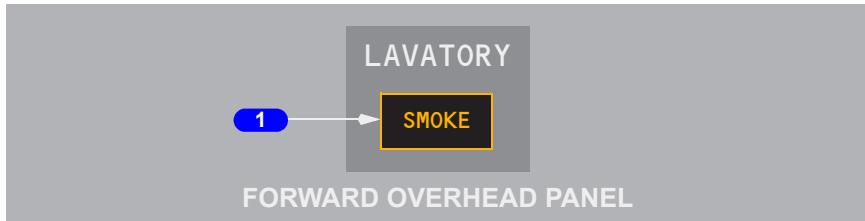
**Note:** Also, flight deck fire warning bell sounds and APU fire warning horn in main wheel well sounds.

Illuminated (red steady) – indicates APU fire warning HORN CUTOUT switch has been pushed following an APU fire indication.

### Lavatory Fire

#### Lavatory Smoke Detection

[Option - Lavatory Smoke Light]



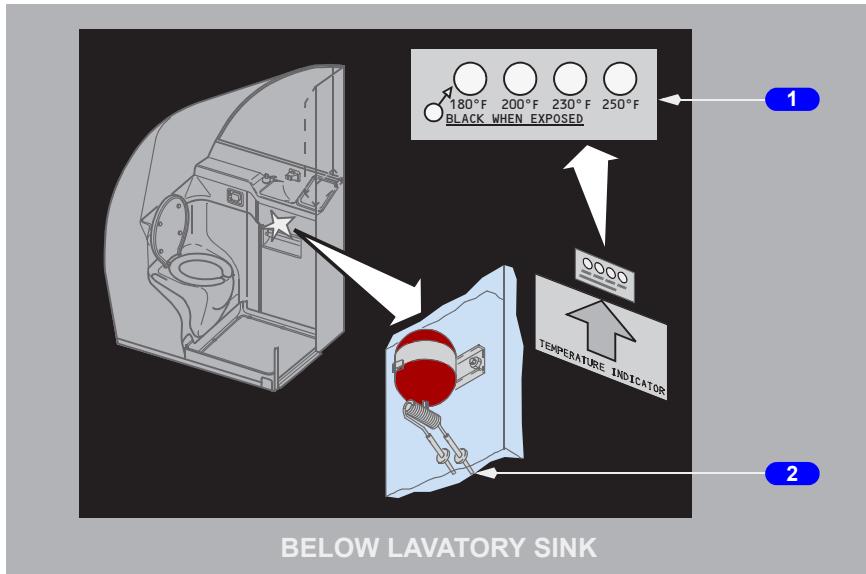
#### 1 LAVATORY SMOKE Light

Illuminated (amber) –

- smoke has been detected in a lavatory
- a test is being conducted.

**Note:** MASTER CAUTION and OVERHEAD system annunciator lights illuminate.

## Lavatory Fire Extinguisher



### **1 TEMPERATURE INDICATOR Placard**

White – normal condition.

Black – exposed to high temperatures.

### **2 Heat Activated Nozzles**

Flat black – normal condition.

Aluminum – indicates extinguisher has discharged.

Both nozzles discharge toward the towel disposal container.

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## Fire Protection System Description

## Chapter 8 Section 20

### Introduction

There are fire detection and extinguishing systems for:

- engines
- lavatories
- APU
- cargo compartments.

The engines also have overheat detection systems.

The main gear wheel well has a fire detection system, but no fire extinguishing system.

### Engine Fire Protection

Engine fire protection consists of these systems:

- engine overheat and fire detection powered by the battery bus
- engine fire extinguishing powered by the hot battery bus.

### Engine Overheat and Fire Detection

Each engine contains two overheat/fire detector loops. Each loop provides both fire and overheat detection. As the temperature of a detector increases to a predetermined limit, the detector senses an overheat condition. At higher temperatures, the detector senses a fire condition. Normally, both detector loops must sense a fire or overheat condition to cause an engine overheat or fire alert. The ENG OVERHEAT light or engine fire switch remains illuminated until the temperature drops below the onset temperature.

An OVHT DET switch for each engine, labeled A, B, and NORMAL, permits selection of either loop A or B, or both A and B, as the active detecting loops.

The system contains a fault monitoring circuit. If one loop fails with the OVHT DET switch in NORMAL, that loop is automatically deselected and the remaining loop functions as a single loop detector. There is no flight deck indication of single loop failure. If both loops fail on an engine, the FAULT light illuminates and the system is inoperative.

If the OVHT DET switch is positioned to A or B, the system operates as a single loop system. The non-selected loop is not monitored. If the selected loop fails, the FAULT light illuminates and the system is inoperative.

The indications of an engine overheat are:

- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the related ENG OVERHEAT light illuminates.

The indications of an engine fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the related engine fire switch illuminates
- all related engine overheat alert indications illuminate.

## Engine Fire Extinguishing

The engine fire extinguisher system consists of two engine fire extinguisher bottles, two engine fire switches, two BOTTLE DISCHARGE lights, and an EXT TEST switch. Either or both bottles can be discharged into either engine.

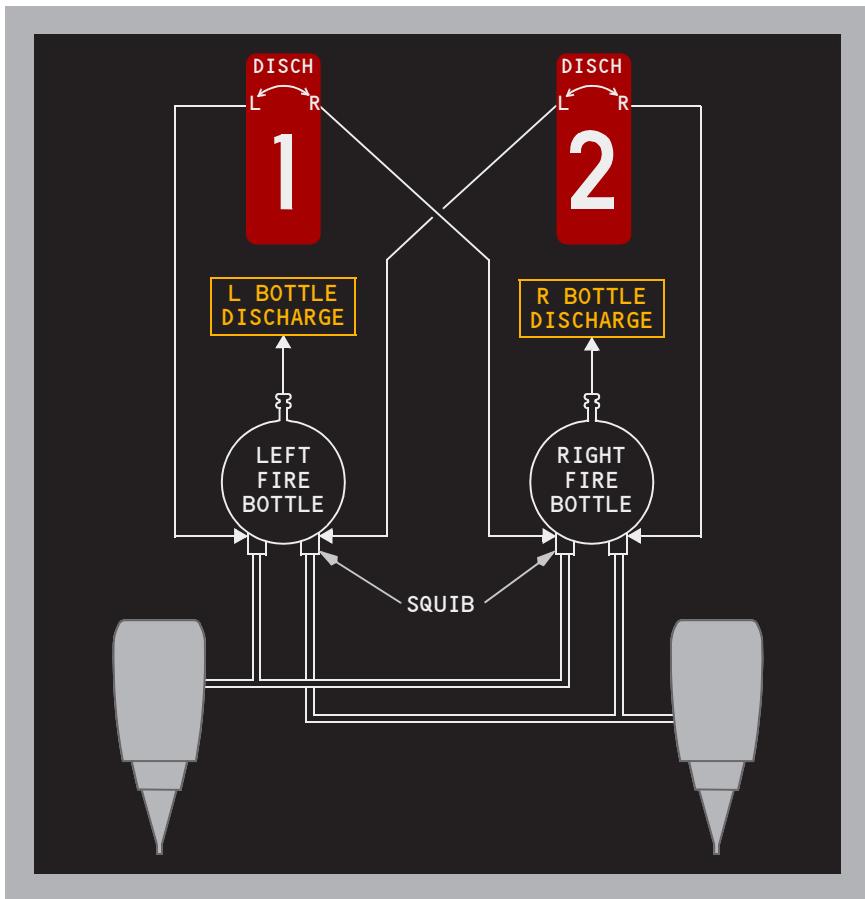
The engine fire switches are normally locked down to prevent inadvertent shutdown of an engine. Illumination of an engine fire switch or ENG OVERHEAT light unlocks the engine fire switch. The switches may also be unlocked manually.

Pulling the engine fire switch up:

- closes both the engine fuel shutoff valve and the spar fuel shutoff valve
- closes the engine bleed air valve resulting in loss of wing anti-ice to the affected wing and closure of bleed air operated pack valve
- trips the generator control relay and breaker
- closes the hydraulic fluid shutoff valve. The engine driven hydraulic pump LOW PRESSURE light is deactivated
- disables thrust reverser for the related engine.
- allows the engine fire switch to be rotated for discharge
- arms one discharge squib on each engine fire extinguisher bottle.

Rotating the engine fire switch electrically “fires” a squib, discharging the extinguishing agent into the related engine. Rotating the switch the other way discharges the remaining bottle.

The L or R BOTTLE DISCHARGE light illuminates a few seconds after the engine fire switch is rotated, indicating the bottle has discharged.

**Engine Fire Extinguisher Schematic**

## APU Fire Protection

APU fire protection consists of these systems:

- APU fire detection powered by the battery bus.
- APU fire extinguishing powered by the hot battery bus.

## APU Fire Detection

A single fire detection loop is installed on the APU. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The APU fire switch remains illuminated until the temperature of the detector has decreased below the onset temperature.

The system contains a fault monitoring circuit. If the loop fails, the APU DET INOP light illuminates indicating the APU fire detection system is inoperative.

The indications of an APU fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the APU fire switch illuminates
- the APU automatically shuts down
- the wheel well APU fire warning horn sounds, (on the ground only), and the wheel well APU fire warning light flashes.

## APU Fire Extinguishing

The APU fire extinguisher system consists of one APU fire extinguisher bottle, an APU fire switch, an APU BOTTLE DISCHARGE light, and an EXT TEST switch. The APU ground control panel located in the right main wheel well also contains an APU fire warning light, an APU BOTTLE DISCHARGE switch, an APU fire control handle and APU HORN CUTOUT switch.

The APU fire switch is normally locked down to prevent inadvertent shutdown of the APU. Illumination of the APU fire switch unlocks the switch. The switch may also be unlocked manually.

Pulling the APU Fire switch up:

- provides backup for the automatic shutdown feature
- deactivates the fuel solenoid and closes the APU fuel shutoff valve
- closes the APU bleed air valve
- closes the APU air inlet door
- trips the APU generator control relay and breaker
- allows the APU fire switch to be rotated for discharge
- arms the APU fire extinguisher bottle squib.

Rotating the APU fire switch in either direction electrically “fires” the squib discharging the extinguishing agent into the APU. The APU BOTTLE DISCHARGE light illuminates after a few seconds, indicating the bottle has discharged.

---

## Main Wheel Well Fire Protection

Main wheel well fire protection consists of fire detection powered by the No. 2 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 WHEEL WELL 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

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. In the event of a detector failure, the system can be manually converted to single-loop detection through the DETECT SELECT switch on the cargo fire control panel. In the event of a power failure in one loop the system automatically converts to single-loop detection.

## 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

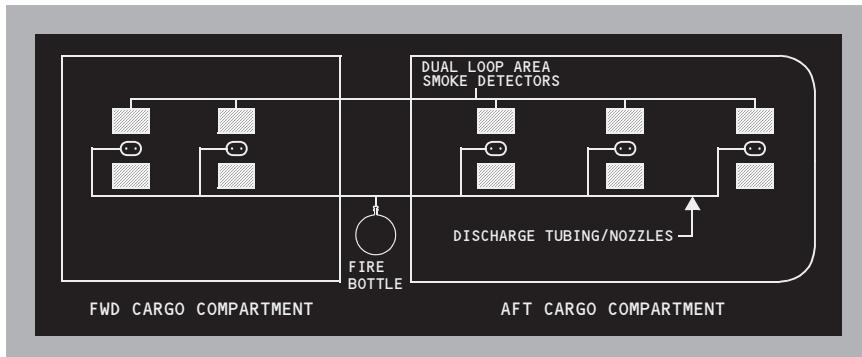
### [Option - Single cargo fire extinguisher bottle]

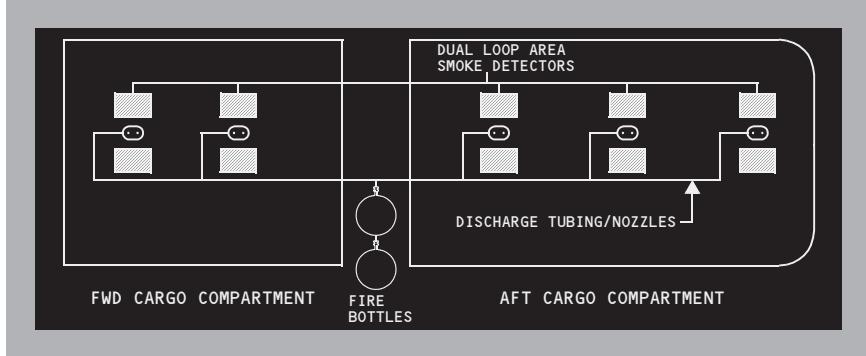
A single fire extinguisher bottle is installed in the air conditioning mix bay on the forward wing spar. Detection of a fire in either the forward or aft compartment will cause the FWD or AFT cargo fire warning light to illuminate. The extinguisher is armed by pushing the appropriate cargo fire ARMED 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.

### [Option - Dual cargo fire extinguisher bottles]

Two fire extinguisher bottles are 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 extinguishers are armed by pushing the appropriate cargo fire ARMED switch. Once armed, the first bottle is discharged by pushing the cargo fire DISCH switch. This results in the total discharge of the first bottle contents into the selected compartment. The second bottle discharge is metered to discharge at a reduced flow into the selected compartment. Discharge of the second bottle may be disabled if the system is disarmed. The cargo fire DISCH light illuminates when a bottle is discharged. It may take up to 30 seconds for the light to illuminate. On landing, if the first bottle was discharged and the system remains armed, the second bottle discharge is inhibited.

## 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
- the red alarm indicator light on the lavatory smoke detector panel illuminates and the appropriate amber lavatory call light will flash
- the amber lavatory SMOKE light on the forward overhead panel illuminates.

When smoke is no longer present the system automatically resets.

## Lavatory Fire Extinguisher System

A fire extinguisher system is located beneath the sink area in each lavatory. When a fire is detected:

- fire extinguisher operation is automatic
- flight deck has no indication of extinguisher discharge.

## Fire and Overheat System Tests

The fire and overheat detection systems can be tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch. Extinguisher continuity can be tested by pushing and holding the EXT TEST switch. All test indications clear when switches are released.

## FAULT/INOP Test Detection

The fault detection circuits for both the engines and the APU are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the FAULT/INOP position.

The indications for the FAULT/INOP test are:

- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the FAULT light illuminates
- the APU DET INOP light illuminates.

## OVERHEAT/FIRE Test Detection

The overheat and fire detection loops on both engines, the APU, and the fire detector in the wheel well are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the OVHT/FIRE position.

The indications for the OVHT/FIRE test are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- both engine fire switches illuminate
- the APU fire switch illuminates
- both ENG OVERHEAT lights illuminate
- the WHEEL WELL fire warning light illuminates if AC power is available
- on the ground, the wheel well APU fire warning horn sounds and the wheel well APU fire warning light flashes.

## Extinguisher Test

When the EXT TEST switch is positioned to 1 or 2, the green EXT TEST lights illuminate, verifying circuit continuity from the squib to the engine fire switch.

## Cargo Fire System Tests

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 loops (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, up to a four second delay may occur to allow all applicable indications to extinguish at the same time.

## Cargo Fire Extinguisher Test

When the Cargo Fire TEST button is pushed, the green EXT lights illuminate, verifying the fire bottle discharge squib circuit continuity is normal.

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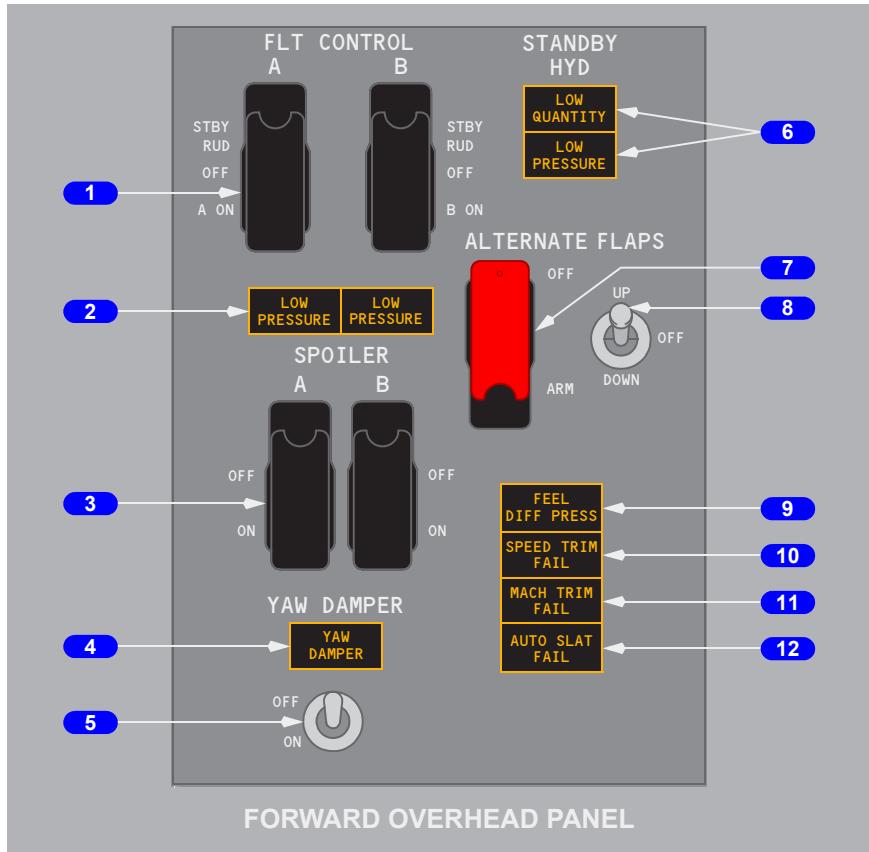
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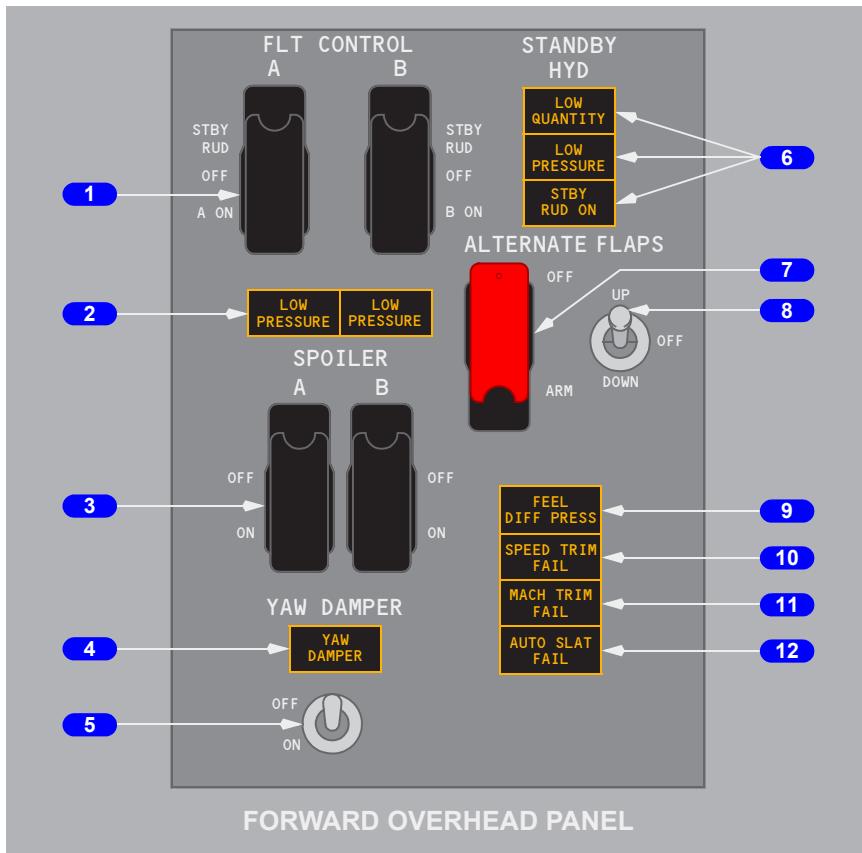
## Flight Controls Controls and Indicators

## Chapter 9 Section 10

### Flight Control Panel



[Flight Control Panel for 737 modified rudder system.]



## 1 FLIGHT CONTROL Switches

STBY RUD - activates standby hydraulic system 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.

**3 Flight SPOILER Switches**

ON (guarded position) – normal operating position.  
OFF – closes the respective flight spoiler shutoff valve.

**Note:** Used for maintenance purposes only.

**4 YAW DAMPER Light**

Illuminated (amber) – yaw damper is not engaged.

**5 YAW DAMPER Switch**

OFF – disengages yaw damper.

ON –

- engages main yaw damper to main rudder power control unit if the B FLT CONTROL switch is in the ON position
- engages standby yaw damper to standby rudder power control unit if both the A and B FLT CONTROL switches are in the STBY RUD position.

**6 STANDBY HYD Lights**

STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) -

- indicates low quantity in standby hydraulic reservoir
- always armed.

STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) -

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

STBY RUD ON Light

- Illuminated (amber) - indicates the standby rudder system is commanded on to pressurize the standby rudder power control unit.

**7 ALTERNATE FLAPS Master Switch**

OFF (guarded position) – normal operating position.

ARM – closes TE flap bypass valve, activates standby pump, and arms the ALTERNATE FLAPS position switch.

**8 ALTERNATE FLAPS Position Switch**

Functions only when the ALTERNATE FLAPS master switch is in ARM.

UP –

- electrically retracts TE flaps
- LE devices remain extended and cannot be retracted by the alternate flaps system.

OFF – normal operating position.

DOWN (spring loaded to OFF) –

- (momentary) fully extends LE devices using standby hydraulic pressure
- (hold) electrically extends TE flaps until released.

#### **9 Feel Differential Pressure (FEEL DIFF PRESS) Light**

Armed when the TE flaps are up or down.

Illuminated (amber) –

- indicates excessive differential pressure in the elevator feel computer.

**Note:** Excessive differential pressure can be caused by erroneous activation of the Elevator Feel Shift module.

#### **10 Speed Trim Failure (SPEED TRIM FAIL) Light**

Illuminated (amber) –

- indicates failure of the speed trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when Master Caution System is reset.

#### **11 Mach Trim Failure (MACH TRIM FAIL) Light**

Illuminated (amber) –

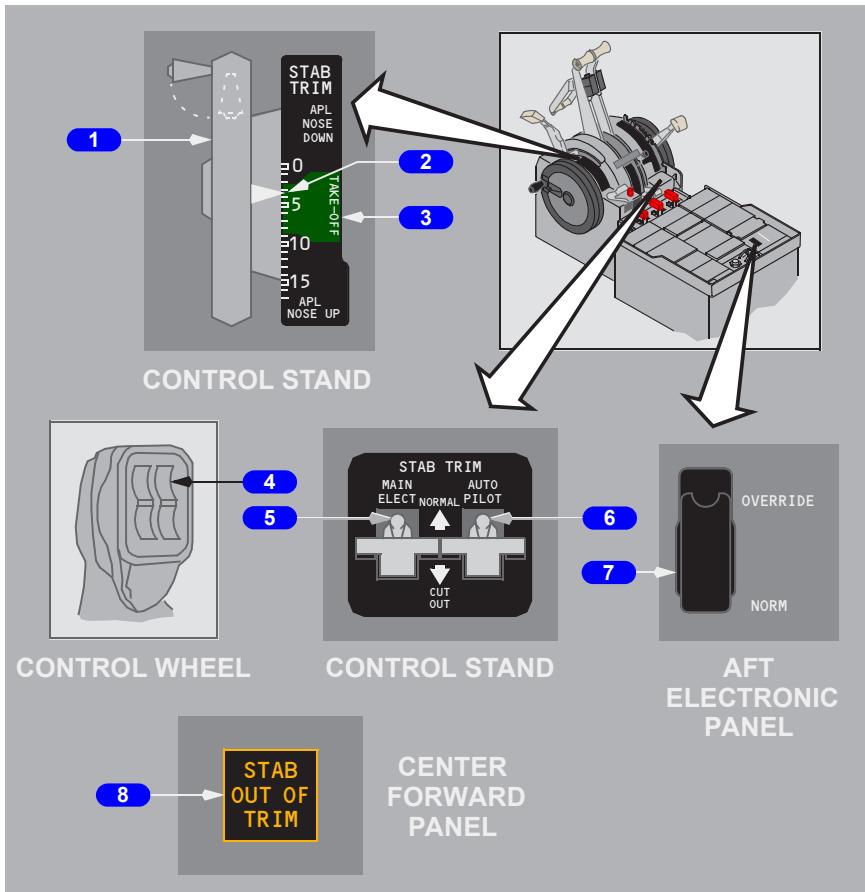
- indicates failure of the mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

#### **12 Automatic Slat Failure (AUTO SLAT FAIL) Light**

Illuminated (amber) –

- indicates failure of the auto slat system
- indicates failure of a single Stall Management/Yaw Damper (SMYD) computer when illuminated during MASTER CAUTION recall and extinguishes when master caution system is reset.

## Stabilizer



### 1 Stabilizer Trim Wheel

- provides for manual operation of stabilizer
- overrides any other stabilizer trim inputs
- rotates when stabilizer is in motion.

**Note:** Handle should be folded inside stabilizer trim wheel for normal operation

### 2 Stabilizer Trim Indicator

Indicates units of airplane trim on the adjacent scale.

### 3 Stabilizer Trim Green Band Range

Corresponds to allowable range of trim settings for takeoff.

#### **4 Stabilizer Trim Switches (spring-loaded to neutral)**

Push (both) –

- electrically commands stabilizer trim in desired direction
- autopilot disengages if engaged.

#### **5 Stabilizer Trim Main Electric (MAIN ELECT) Cutout Switch**

NORMAL – normal operating position.

CUTOOUT – deactivates stabilizer trim switch operation.

#### **6 Stabilizer Trim AUTOPILOT Cutout Switch**

NORMAL – normal operating position.

CUTOOUT –

- deactivates autopilot stabilizer trim operation
- autopilot disengages if engaged.

#### **7 Stabilizer Trim Override Switch**

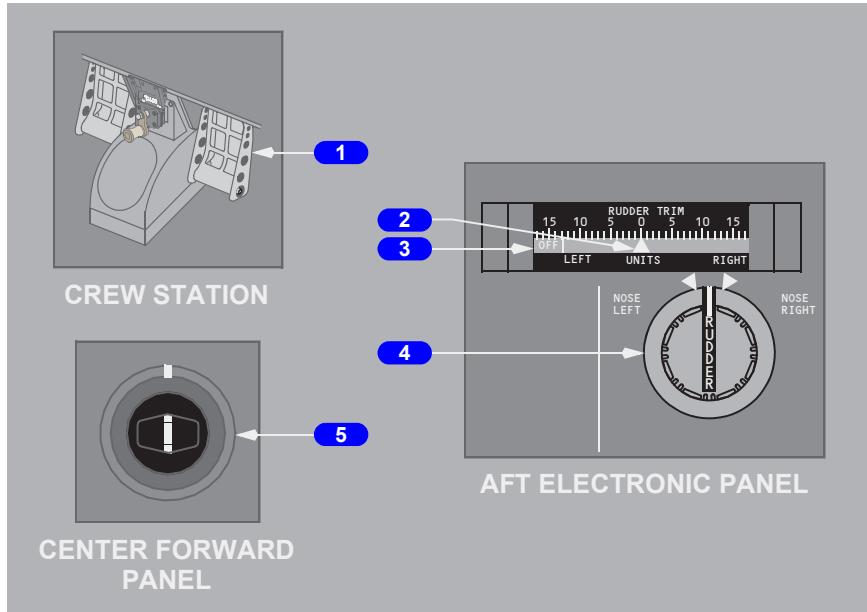
OVERRIDE – bypasses the control column actuated stabilizer trim cutout switches to restore power to the Stabilizer Trim Switches

NORM (guarded position) – normal operating position.

#### **8 Stabilizer Out of Trim (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.

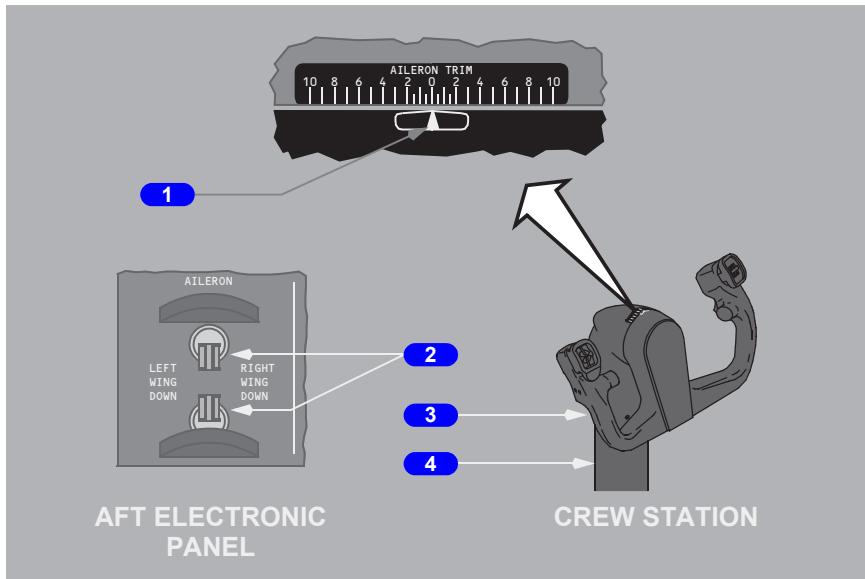
### 4 Rudder Trim Control (spring-loaded to neutral)

Rotate – electrically trims the rudder in the desired direction.

### 5 YAW DAMPER Indicator

- Indicates main yaw damper movement of rudder
- pilot rudder pedal inputs are not indicated.

## Aileron / Elevator / Flight Spoilers



### 1 AILERON TRIM Indicator

Indicates units of aileron trim.

### 2 AILERON Trim Switches (spring-loaded to the neutral position)

Movement of both switches repositions the aileron neutral control position.

### 3 Control Wheel

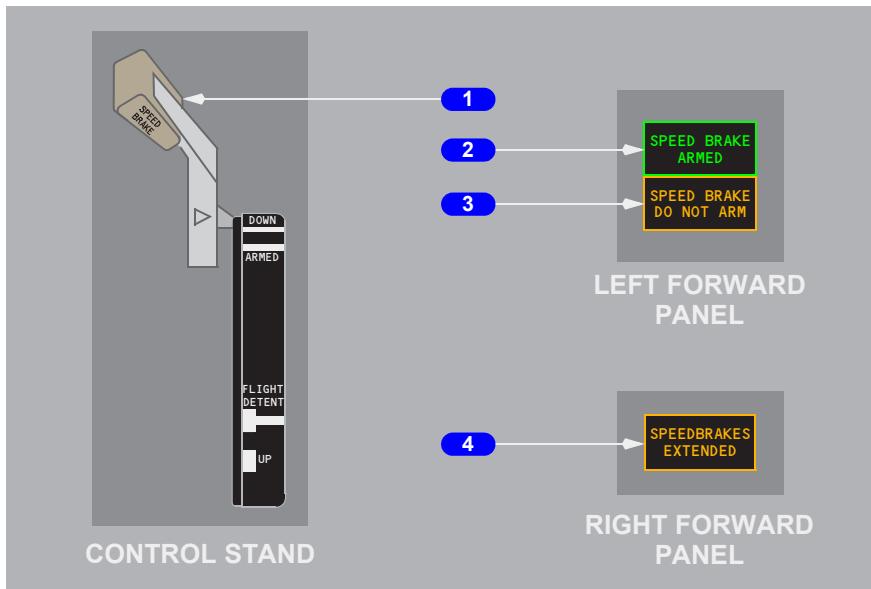
Rotate – operates ailerons and flight spoilers in desired direction.

### 4 Control Column

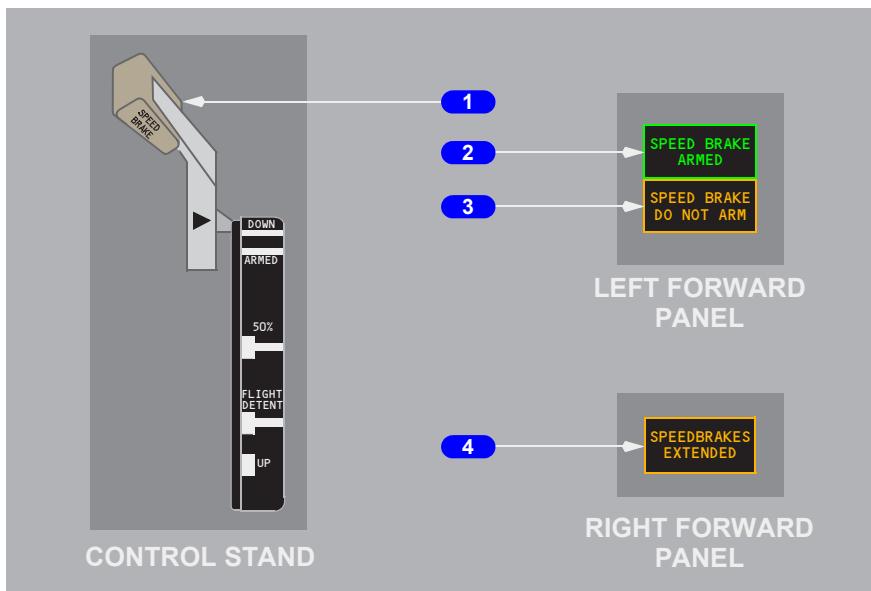
Push/Pull –

- operates elevators in the desired direction
- movement opposing stabilizer trim stops electric trimming.

## Speed Brakes



[Option - Speed Brake Load Alleviation System]



## 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.

### [Option - Speed Brake Load Alleviation System]

50% –

- if the speed brakes are deployed beyond the 50% position and the speed brake load alleviation feature is activated;
  - the speed brake lever moves to this position
  - all flight spoilers retract to one-half of their maximum position for inflight use.

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 ARMED Light

Light deactivated when SPEED BRAKE lever is in the DOWN position.

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

## 3 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
- indicates an abnormal condition or test input to the speed brake load alleviation system when the flaps are raised.

## 4 SPEEDBRAKES EXTENDED Light

Illuminated (amber) –

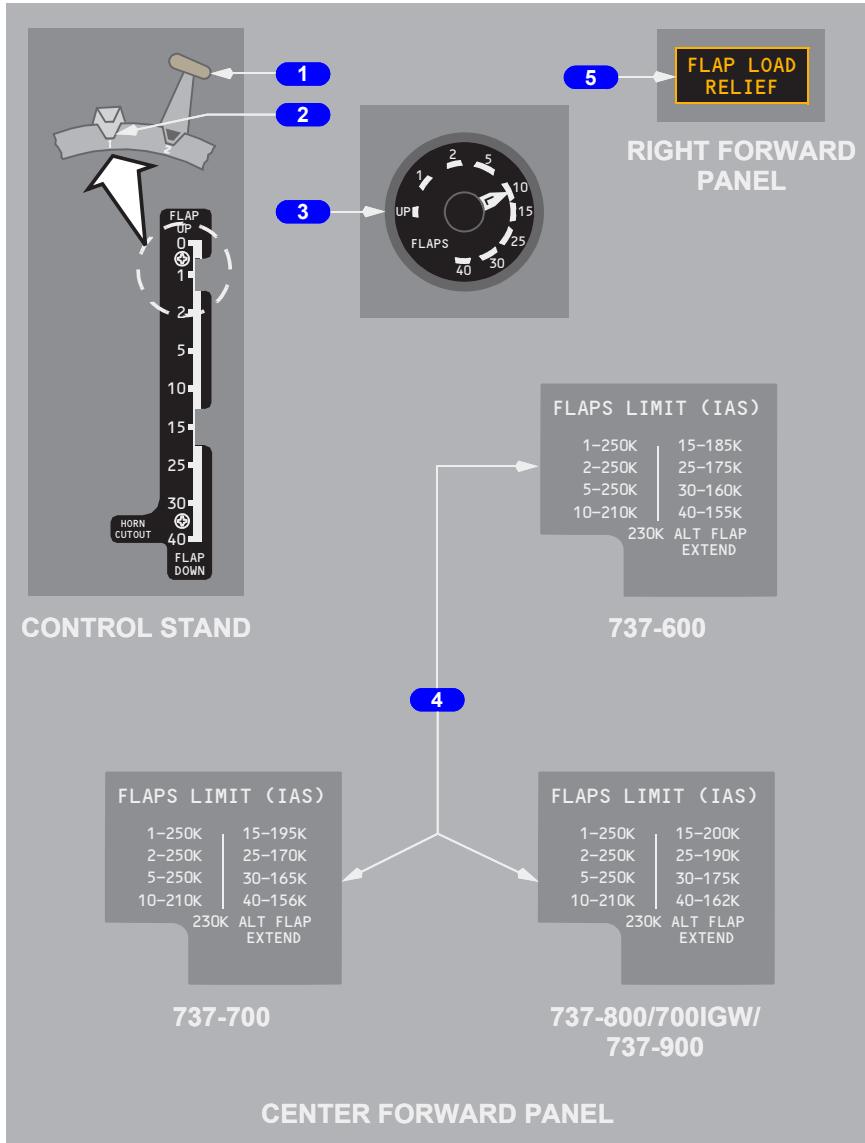
- in-flight -
  - SPEED BRAKE lever is beyond the ARMED position, and
  - TE flaps extended more than flaps 10, or
  - radio altitude less than 800 feet
- on the ground -
  - SPEED BRAKE lever is in the DOWN detent,

- ground spoilers are not stowed.

**Note:** On the ground, the SPEEDBRAKES EXTENDED light does not illuminate when hydraulic system A pressure is less than 750 psi.

## Trailing Edge Flaps

[Option - FLAP LOAD RELIEF light]



**1 FLAP Lever**

- selects position of flap control valve, directing hydraulic pressure for flap drive unit
- position of the LE devices is determined by selecting TE flap position
- flap lever positions 30 and 40 arms the flap load relief system as described in Section 9.20.
- flap lever positions 10, 15, 25, 30, and 40 arms the flap load relief system as described in Section 9.20.

**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 TE flaps
- provides TE flaps asymmetry and skew indication.

**4 FLAPS LIMIT Placard**

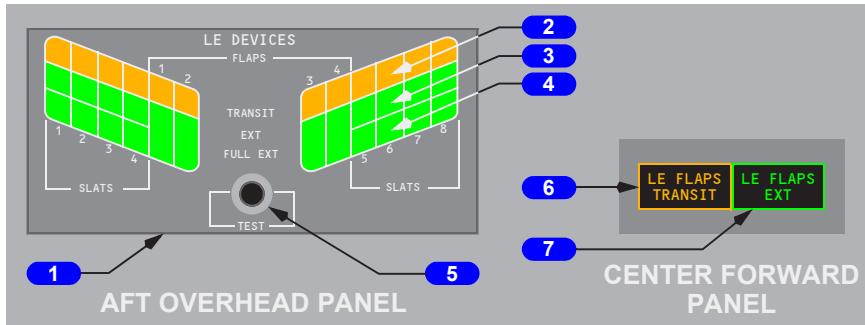
Indicates maximum speed for each flap setting.

**5 FLAP LOAD RELIEF Light****[Option]**

Illuminated (amber) –

- if flaps are set at 40:
  - flaps retract to 30 due to excess airspeed or
- if flaps are set at 30:
  - flaps retract to 25 due to excess airspeed.

## Leading Edge Devices



### 1 Leading Edge Devices (LE DEVICES) Annunciator Panel

Indicates position of individual LE flaps and slats.

Extinguished – related LE device retracted.

### 2 Leading Edge Devices TRANSIT Lights

Illuminated (amber) – related LE device in transit.

### 3 Leading Edge Devices Extended (EXT) Lights

Illuminated (green) – related LE slat in extended (intermediate) position.

### 4 Leading Edge Devices Full Extended (FULL EXT) Lights

Illuminated (green) – related LE device fully extended.

### 5 Leading Edge Annunciator Panel TEST Switch

Press – tests all annunciator panel lights.

### 6 Leading Edge Flaps Transit (LE FLAPS TRANSIT) Light

Illuminated (amber) –

- any LE device in transit
- any LE device not in programmed position with respect to TE flaps
- a LE slat skew condition exists (slats 2 through 7 only)
- during alternate flap extension until LE devices are fully extended and TE flaps reach flaps 10.

**Note:** Light is inhibited during autoslat operation in flight.

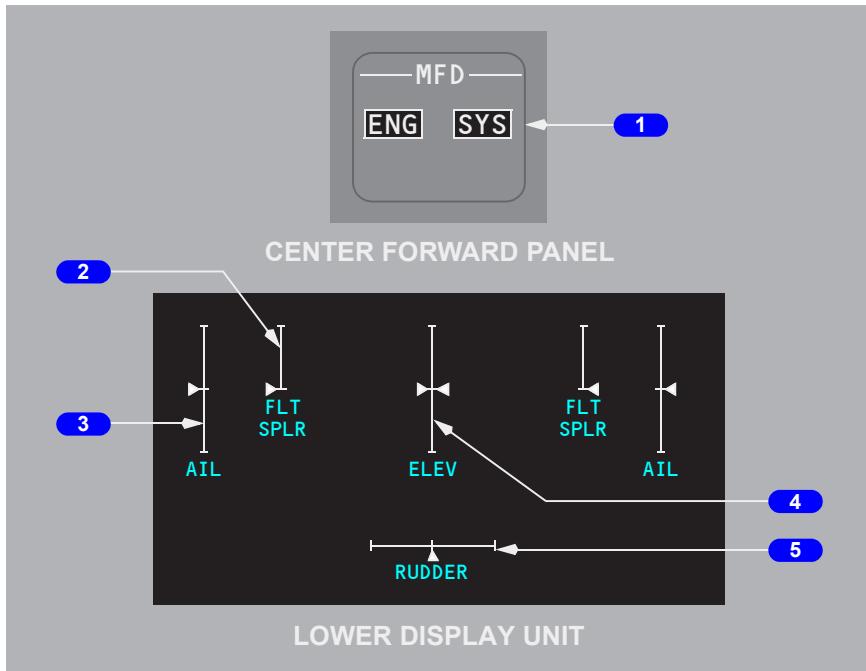
## 7 Leading Edge Flaps Extended (LE FLAPS EXT) Light

Illuminated (green) –

- all LE flaps extended and all LE slats in extended (intermediate) position (TE flap positions 1, 2 and 5)
- all LE devices fully extended (TE flap positions 10 through 40).

## Flight Control Surface Position Indicator

[Option]



### 1 MFD System (SYS) Switch

Push – SYS

- displays flight control surface position indications on lower DU; or the inboard DU if the MAIN PANEL DUs switch is placed to the INBD MFD position.
- second push removes indications from the respective DU.

## 2 Flight Spoilers (FLT SPLR) (white)

Indicates related (left/right) flight spoilers position:

- top mark depicts flight spoilers fully deployed
- bottom mark depicts the spoilers down.

## 3 Aileron (AIL) (white)

Indicates related (left/right) aileron position:

- top mark depicts maximum up position
- center mark depicts neutral position
- bottom mark depicts maximum down position.

## 4 Elevator (ELEV) (white)

Indicates elevator position:

- top mark depicts maximum up position
- center mark depicts neutral position when on the ground and trimmed in the green band
- bottom mark depicts maximum down position.

**Note:** Elevator neutral position varies with stabilizer position, flap position and Mach. The center index mark is set for nominal takeoff conditions. With certain airplane nose up trim settings, the pointer will be somewhat displaced.

## 5 RUDDER (white)

Indicates rudder position:

- left mark depicts maximum left position
- center mark depicts neutral position
- right mark depicts maximum right position.

## Flight Controls

### System Description

## Chapter 9

### Section 20

#### Introduction

The primary flight control system uses conventional control wheel, column and pedals linked mechanically to hydraulic power control units which command the primary flight control surfaces; ailerons, elevators and rudder. The flight controls are powered by redundant hydraulic sources; system A and system B. Either hydraulic system can operate all primary flight controls. The ailerons and elevators may be operated manually if required. The rudder may be operated by the standby hydraulic system if system A and system B pressure is not available.

The secondary flight controls, high lift devices consisting of trailing edge (TE) flaps and leading edge (LE) flaps and slats (LE devices), are powered by hydraulic system B. In the event hydraulic system B fails, the TE flaps can be operated electrically. Under certain conditions the power transfer unit (PTU) automatically powers the LE devices. (Refer to Chapter 13, Hydraulics, Power Transfer Unit). They can also be extended using standby hydraulic pressure.

#### Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- SPEED BRAKE lever
- FLAP lever
- STAB TRIM cutout switches
- STAB TRIM override switch
- stabilizer trim switches
- stabilizer trim wheel
- AILERON trim switches
- RUDDER trim control
- YAW DAMPER switch
- ALTERNATE FLAPS master switch
- alternate flaps position switch
- FLT CONTROL switches
- flight SPOILER switches

The columns and 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
- eight flight spoilers.

Yaw control is provided by a single rudder. During takeoff, the rudder becomes aerodynamically effective between 40 and 60 knots.

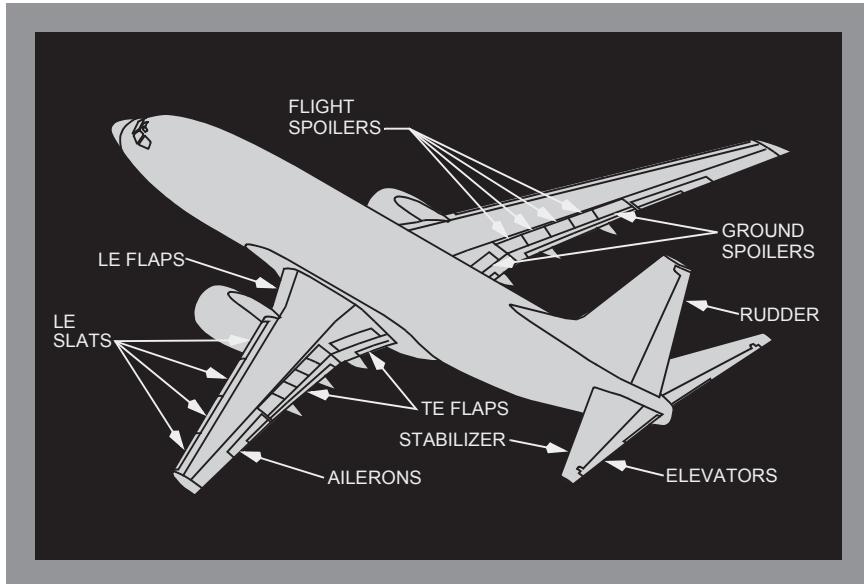
TE flaps and LE flaps and slats provide high lift for takeoff, approach and landing.

### [Option: Blended Winglets]

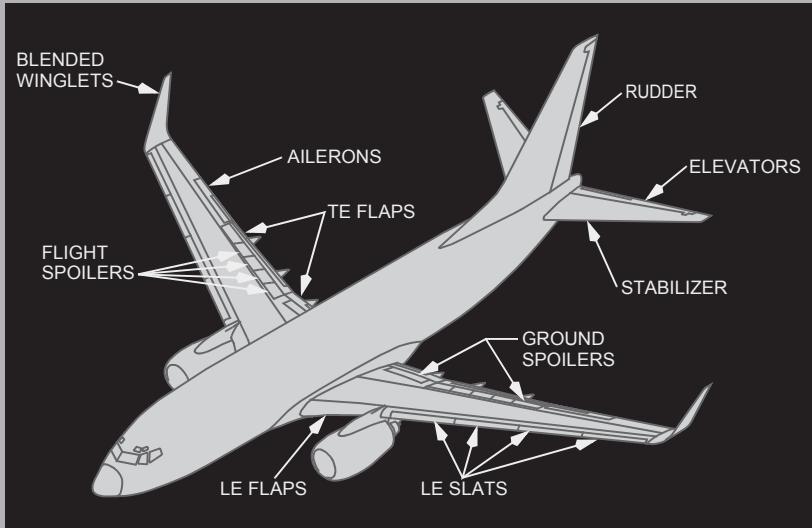
Blended winglets provide enhanced performance, extended range and increased fuel efficiency.

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



[Option: Blended Winglets]



## **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 each aileron, as well as the elevators and rudder, from 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.

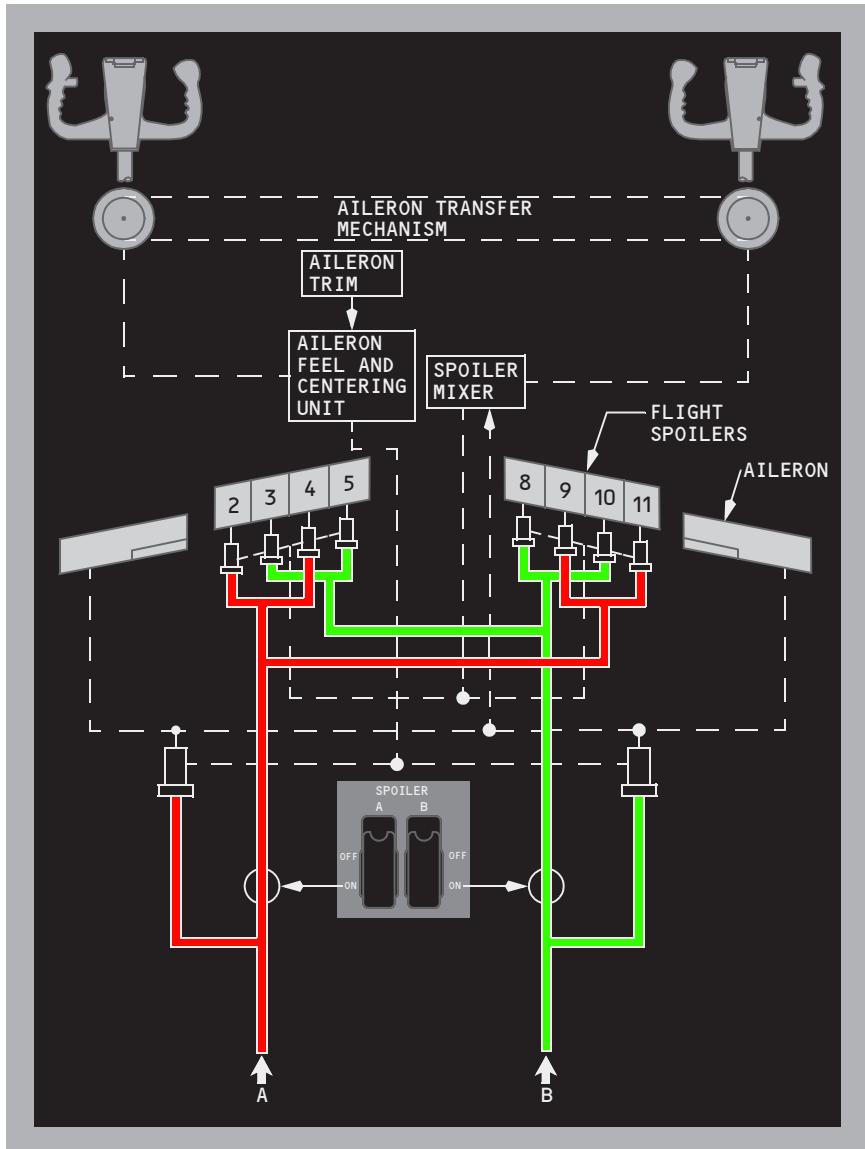
## Flight Spoilers

Four flight spoilers are located on the upper surface of each wing. Each hydraulic system, A and B, is dedicated to a different set of spoiler pairs 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 autopilot trim 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 Control Column Override Mechanism

In the event of a control column jam, an override mechanism allows the control columns to be physically separated. Applying force against the jam will breakout either the Captain's or First Officer's control column. Whichever column moves freely after the breakout can provide adequate elevator control.

Although total available elevator travel is significantly reduced, there is sufficient elevator travel available for landing flare. Column forces are higher and exceed those experienced during manual reversion. If the jam exists during the landing phase, higher forces are required to generate sufficient elevator control to flare for landing. Stabilizer trim is available to counteract the sustained control column force.

## 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 fails, 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 ADIRU 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.

## Stabilizer

The horizontal stabilizer is positioned by a single electric trim motor controlled through either the stab trim switches on the control wheel or autopilot trim. 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 ELECT 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 extended 0.05 to 14.5 units

### [737-600]

- flaps retracted 4.10 to 14.5 units

### [737-700]

- flaps retracted 4.30 to 14.5 units

### [737-800]

- flaps retracted 3.95 to 14.5 units

### [737-900]

- flaps retracted 3.90 to 14.5 units
- Autopilot Trim 0.05 to 14.5 units
- Manual Trim -0.20 to 16.9 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.

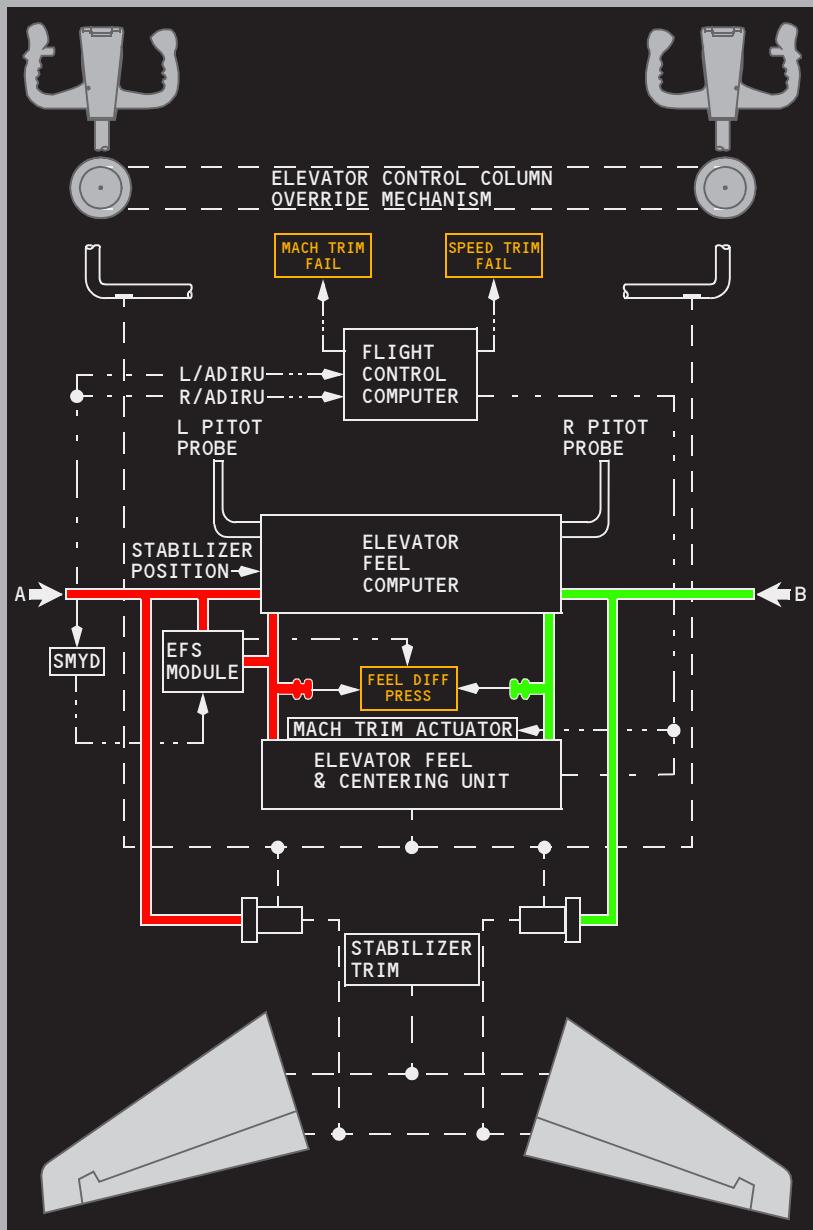
## Speed Trim System

The speed trim system (STS) is a speed stability augmentation system designed to improve flight characteristics during operations with a low gross weight, aft center of gravity and high thrust when the autopilot is not engaged. The purpose of the STS is to return the airplane to a trimmed speed by commanding the stabilizer in a direction opposite the speed change. The STS monitors inputs of stabilizer position, thrust lever position, airspeed and vertical speed and then trims the stabilizer using the autopilot stabilizer trim. As the airplane speed increases or decreases from the trimmed speed, the stabilizer is commanded in the direction to return the airplane to the trimmed speed. This increases control column forces to force the airplane to return to the trimmed speed. As the airplane returns to the trimmed speed, the STS commanded stabilizer movement is removed.

STS operates most frequently during takeoffs, climb and go-arounds. Conditions for speed trim operation are listed below:

- Airspeed between 100 KIAS and Mach 0.5
- 10 seconds after takeoff
- 5 seconds following release of trim switches
- Autopilot not engaged
- Sensing of trim requirement

## Pitch Control Schematic



## Stall Identification

Stall identification and control is enhanced by the yaw damper, the Elevator Feel Shift (EFS) module and the speed trim system. These three systems work together to help the pilot identify and prevent further movement into a stall condition.

During high AOA operations, the SMYD reduces yaw damper commanded rudder movement.

The EFS module increases hydraulic system A pressure to the elevator feel and centering unit during a stall. This increases forward control column force to approximately four times normal feel pressure. The EFS module is armed whenever an inhibit condition is not present. Inhibit conditions are: on the ground, radio altitude less than 100 feet and autopilot engaged. However, if EFS is active when descending through 100 feet RA, it remains active until AOA is reduced below approximately stickshaker threshold. There are no flight deck indications that the system is properly armed or activated.

As airspeed decreases towards stall speed, the speed trim system trims the stabilizer nose down and enables trim above stickshaker AOA. With this trim schedule the pilot must pull more aft column to stall the airplane. With the column aft, the amount of column force increase with the onset of EFS module is more pronounced.

## **Yaw Control**

Yaw control is accomplished by a hydraulically powered rudder and a digital yaw damper system. The rudder is controlled by displacing the rudder pedals. The yaw damping functions are controlled through the stall management/yaw damper (SMYD) computers.

## **Rudder**

### **[737 modified rudder - not installed]**

The rudder provides yaw control about the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

Each set of rudder pedals is mechanically connected by cables to the input levers of the main and standby rudder PCUs. The main rudder PCU is powered by hydraulic system A and B. The standby rudder PCU is powered by the standby hydraulic system. At speeds above approximately 135 kts, hydraulic system A pressure to the rudder PCU is limited by approximately 50%. This function limits full rudder authority in flight after takeoff and before landing.

The standby rudder PCU is powered by the standby hydraulic system. The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. With the standby PCU powered the pilot retains adequate rudder control capability. It can be operated manually through the FLT CONTROL switches or automatically. (Refer to Chapter 13, Hydraulics, Standby Hydraulic System)

## **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.

## **Rudder (with Rudder System Enhancement Program (RSEP) installed)**

### **[737 modified rudder- installed]**

The rudder provides yaw control about the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

Each set of rudder pedals is mechanically connected by cables to the input levers of the main and standby rudder PCUs. The main PCU consists of two independent input rods, two individual control valves, and two separate actuators; one for Hydraulic system A and one for Hydraulic system B. The standby rudder PCU is controlled by a separate input rod and control valve and powered by the standby hydraulic system. All three input rods have individual jam override mechanisms that allows input commands to continue to be transferred to the remaining free input rods if an input rod or downstream hardware is hindered or jammed.

At speeds above approximately 135 kts, both hydraulic system A and B pressure are each reduced within the main PCU by approximately 25% each. This function limits full rudder authority in flight after takeoff and before landing.

The main rudder PCU contains a Force Fight Monitor (FFM) that detects opposing pressure (force fight) between A and B actuators. This may occur if either system A or B input is jammed or disconnected. The FFM output is used to automatically turn on the Standby Hydraulic pump, open the standby rudder shutoff valve to pressurize the standby rudder PCU, and illuminate the STBY RUD ON, Master Caution, and Flight Control (FLT CONT) lights.

The standby rudder PCU is powered by the standby hydraulic system. The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. With the standby PCU powered the pilot retains adequate rudder control capability. It can be operated manually through the FLT CONTROL switches or automatically. (Refer to Chapter 13, Hydraulics, Standby Hydraulic System)

An amber STBY RUD ON light illuminates when the standby rudder hydraulic system is pressurized. The standby rudder system can be pressurized with either Flight Control switch, automatically during takeoff or landing (Refer to Chapter 13, Hydraulics, Standby Hydraulic System) or automatically by the Force Fight Monitor. The STBY RUD ON light illumination activates Master Caution and Flight Control warning lights on the Systems Annunciation Panel.

### Rudder Trim

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

### Yaw Damper

The yaw damper system consists of a main and standby yaw damper. Both yaw dampers are controlled through Stall Management/Yaw Damper (SMYD) computers. The SMYD computers receive inputs from both ADIRUs, both control wheels and the YAW DAMPER switch. SMYDs provide yaw damper inputs to the main rudder power control unit (PCU) or standby rudder PCU, as appropriate.

Either yaw damper is capable of providing dutch roll prevention, gust damping and turn coordination. Yaw damper operation does not result in rudder pedal movement. Only main yaw damper inputs are shown on the yaw damper indicator. The pilot can override either main or standby yaw damper inputs using either the rudder pedals or trim inputs.

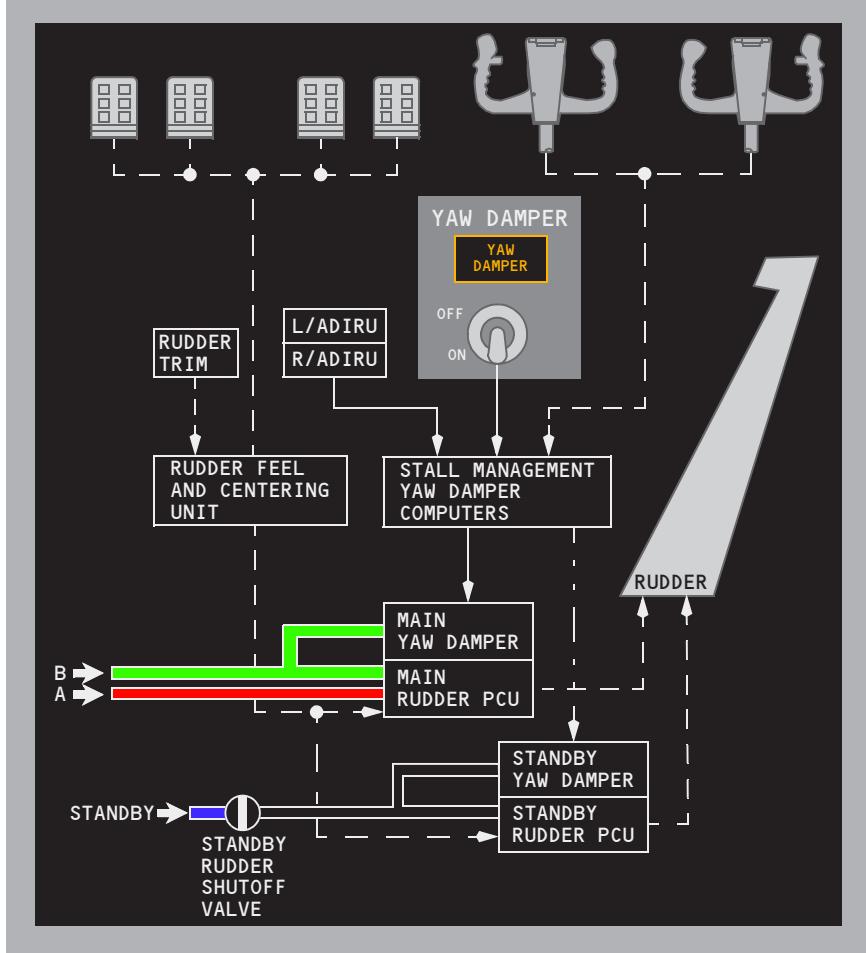
During normal operation the main yaw damper uses hydraulic system B and the SMYD computers provide continuous system monitoring. The YAW DAMPER Switch automatically moves to OFF, the amber YAW DAMPER light illuminates and the YAW DAMPER switch cannot be reset to ON when any of the following conditions occur:

- SMYD senses a yaw damper system fault,
- SMYD senses that the yaw damper does not respond to a command,
- B FLT CONTROL switch is positioned to OFF or STBY RUD.

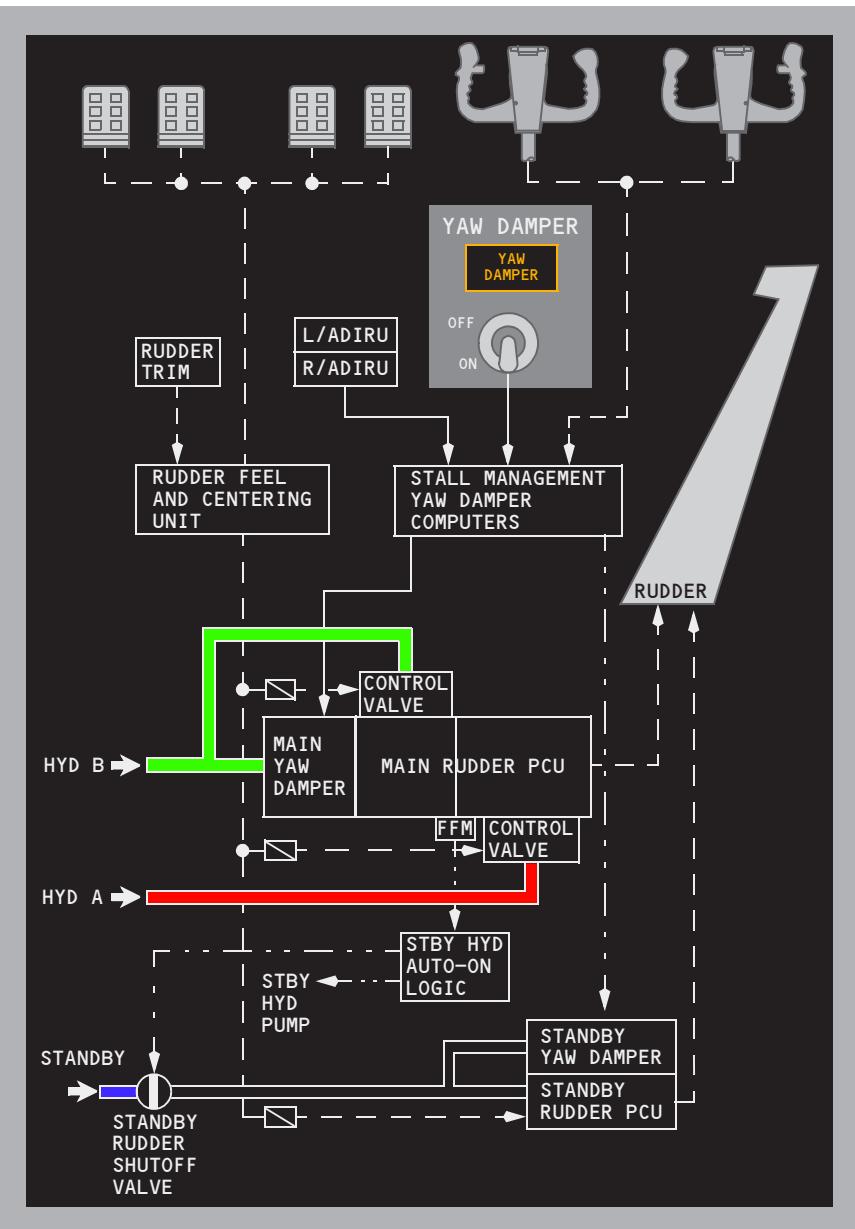
During manual reversion flight (loss of hydraulic system A and B pressure), both FLT CONTROL switches are positioned to STBY RUD. In this case, the YAW DAMPER switch can be reset to ON and the standby hydraulic system powers the standby yaw damper. During Standby Yaw Damper operation, movement of the control wheel sends a signal to the standby rudder PCU to move the rudder. This gives rudder assist to help turn the airplane when control of the ailerons is through manual reversion.

## Yaw Control Schematic

[RSEP not installed]



[RSEP installed]



## Speed Brakes

The speed brakes consist of flight spoilers and ground spoilers. Hydraulic system A powers all four ground spoilers, two 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.

The SPEEDBRAKES EXTENDED light provides an indication of spoiler operation in-flight and on the ground. In-flight, the light illuminates to warn the crew that the speed brakes are extended while in the landing configuration or below 800 feet AGL. On the ground, the light illuminates when hydraulic pressure is sensed in the ground spoiler shutoff valve with the speed brake lever in the DOWN position.

### 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 beyond the FLIGHT DETENT causes buffeting and is prohibited in flight.

#### [Option: Speed Brake Load Alleviation System]

The speed brake load alleviation feature limits the deployment of the speed brakes under certain high gross weight/airspeed combinations. Under these conditions, if the speed brakes are deployed to the FLIGHT DETENT, they automatically retract to 50 percent of the FLIGHT DETENT. The SPEED BRAKE lever moves to reflect the position of the speed brakes. Manual override is available. Increased force is needed to move the SPEED BRAKE lever beyond the 50 percent position with load alleviation active. The SPEED BRAKE lever must be held in place when manual override is used between 50 percent and the UP position. The SPEED BRAKE lever will remain stationary if moved to UP with load alleviation active. When load alleviation deactivates, the speed brakes can be manually returned to the FLIGHT DETENT position.

### 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
- radio altitude is less than 10 feet

- landing gear strut compresses on touchdown

**Note:** Compression of any landing gear strut enables the flight spoilers to deploy. Compression of the right main landing gear strut enables the ground spoilers to deploy.

- both thrust levers are retarded to IDLE
- main landing gear wheels spin up (more than 60 kts).

The SPEED BRAKE lever automatically moves to the UP position and the spoilers deploy.

If a wheel spin-up signal is not detected, when the air/ground system senses ground mode (any gear strut compresses) the SPEED BRAKE lever moves to the UP position and flight spoiler panels deploy automatically. When the right main landing gear strut compresses, a mechanical linkage opens the ground spoiler bypass valve and the ground spoilers deploy.

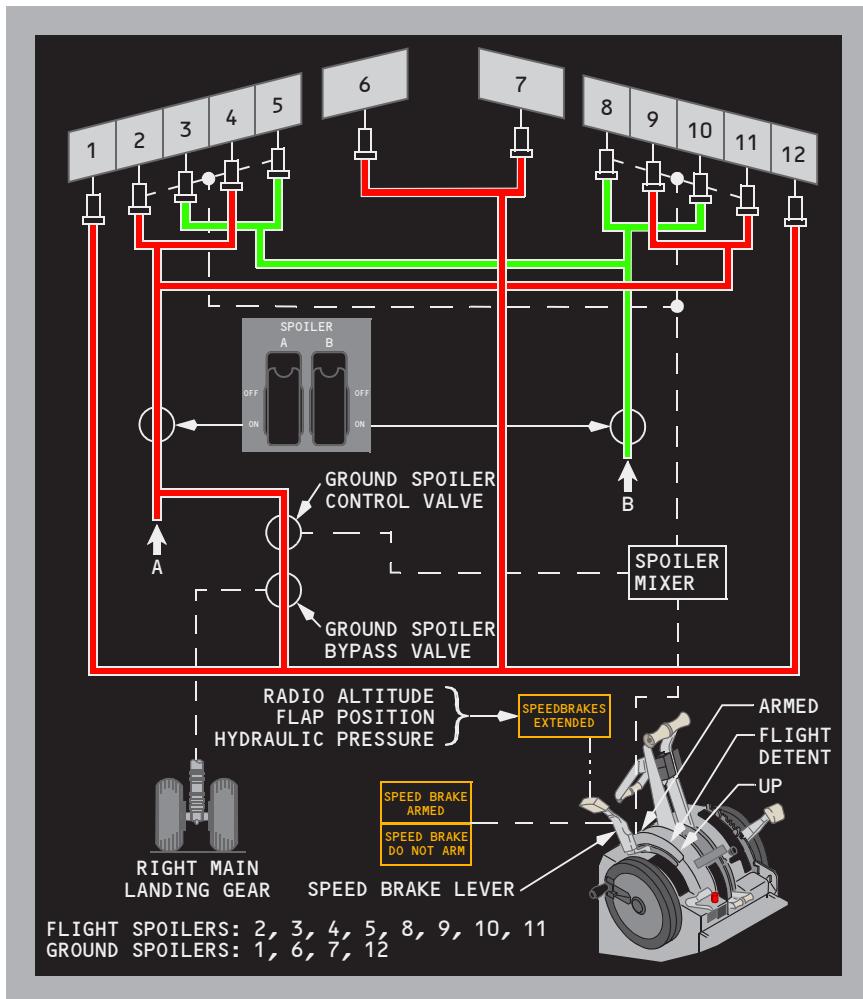
If the SPEED BRAKE lever is in the DOWN position during landing or rejected takeoff, the auto speed brake system operates when these conditions occur:

- main landing gear wheels spin up (more than 60 kts)
- both thrust levers are retarded to IDLE
- reverse thrust levers are positioned for reverse thrust.

The SPEED BRAKE lever automatically moves to the UP position and spoilers deploy.

After an RTO or landing, if either thrust lever is advanced, the SPEED BRAKE lever automatically moves to the DOWN detent and all spoiler panels retract. The spoiler panels may also be retracted by manually moving the SPEED BRAKE lever to the DOWN detent.

## Speed Brakes Schematic



## Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, low speed maneuvering and landing.

LE devices consist of four flaps and eight slats: two flaps inboard and four 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 double slotted flaps inboard and outboard of each engine.

TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flaps 15, 30 and 40 are normal landing flap positions. Flaps 15 is normally limited to airports where approach climb performance is a factor. Runway length and conditions must be taken into account when selecting a landing flap position.

### [Option: JAA]

TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flap positions 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 panel on the aft overhead panel indicates the positions of the individual flaps and slats.

## Flap Load Relief

The flaps/slat electronics unit (FSEU) provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the flaps 30 and flaps 40 positions only. The FLAP lever does not move, but the flap position indicator displays flap retraction and re-extension.

When the flaps are set at 40, the TE flaps:

- retract to 30 if airspeed exceeds 163 knots
- re-extend when airspeed is reduced below 158 knots.

When the flaps are set at 30, the TE flaps:

- retract to 25 if the airspeed exceeds 176 knots
- re-extend when airspeed is reduced below 171 knots.

### [Option: Short Field Performance]

The flaps/slat electronics unit (FSEU) provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the flaps 10, 15, 25, 30 and flaps 40 positions. The FLAP lever does not move, but the flap position indicator displays flap retraction and re-extension.

When the flaps are set at 40, the TE flaps:

- retract to 30 if airspeed exceeds 171 knots
- re-extend when airspeed is reduced below 166 knots.

When the flaps are set at 30, the TE flaps:

- retract to 25 if the airspeed exceeds 181 knots
- re-extend when airspeed is reduced below 176 knots.

When the flaps are set at 25, the TE flaps:

- retract to 15 if the airspeed exceeds 196 knots
- re-extend when airspeed is reduced below 191 knots.

When the flaps are set at 15, the TE flaps:

- retract to 10 if the airspeed exceeds 201 knots
- re-extend when airspeed is reduced below 196 knots.

When the flaps are set at 10, the TE flaps:

- retract to 5 if the airspeed exceeds 206 knots
- re-extend when airspeed is reduced below 201 knots.

### [Option]

The FLAP LOAD RELIEF light illuminates when the TE flap load relief function is activated.

## Autoslats

Autoslat operation is normally powered by hydraulic system B. An alternate source of power is provided by system A through a power transfer unit (PTU) if a loss of pressure is sensed from the higher volume system B engine driven pump. The PTU uses system A pressure to power a hydraulic motorized pump, pressurizing system B fluid to provide power for the autoslat operation. (Refer to Chapter 13, Hydraulics, Power Transfer Unit)

At flap positions 1, 2 and 5 an autoslat function is available that moves the LE slats to full extended 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 begin driving 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.

### [Option - Short Field Performance]

At flap positions 1, 2, 5, 10, 15, and 25 an autoslat function is available that moves the LE slats to full extended if the airplane approaches a stall condition.

### [Option: Short Field Performance]

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 25 are selected, the LE slats are in the extend position. As the airplane approaches the stall angle, the slats automatically begin driving 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.

## 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.

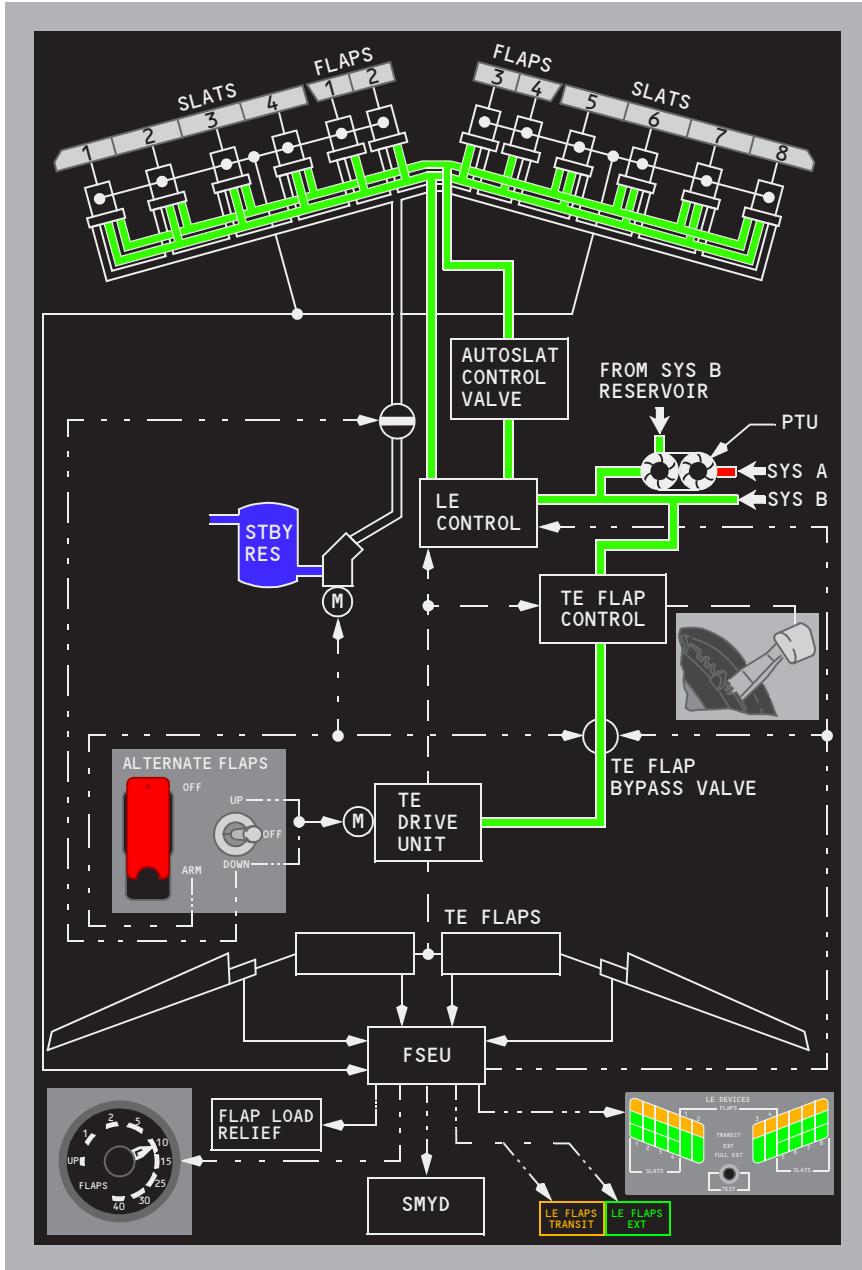
The TE flaps can be operated electrically through the use of two alternate flap switches. The guarded ALTERNATE FLAPS master switch closes a flap bypass valve to prevent hydraulic lock of the flap drive unit and arms the alternate flaps position switch. The ALTERNATE FLAPS position switch controls an 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 or skew protection is provided through the alternate (electrical) flap drive 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.

**Note:** The LE devices cannot be retracted by the standby hydraulic system.

## Leading Edge Devices and Trailing Edge Flaps Schematic

[Option: FLAP LOAD RELIEF light]



## Asymmetry and Skew Detection, Protection and Indication

The FSEU monitors the TE flaps for asymmetry and skew conditions. It also monitors the LE devices for improper position and skew conditions on slats 2 through 7. If a flap on one wing does not align with the symmetrical flap on the other wing, there is a flap asymmetry condition. A skew condition occurs when a TE flap or LE slat panel does not operate at the same rate causing the panel to twist during extension or retraction.

### Trailing Edge Flap Asymmetry and Skew

When the FSEU detects a trailing edge asymmetry or skew condition the FSEU:

- closes the TE flap bypass valve
- displays a needle split on the flap position indicator.

### Leading Edge Device Improper Position or Skew

When the FSEU detects a LE device in an improper position or a LE slat skew condition, 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.

There is no skew detection of the outboard slats, 1 and 8, or for the LE flaps. Slat skew detection is inhibited during autoslat operations.

## Uncommanded Motion Detection, Protection and Indication

The FSEU provides protection from uncommanded motion by the LE devices or TE flaps.

### Leading Edge Uncommanded Motion

Uncommanded motion is detected when no TE flap position or autoslat command is present and:

- two LE flaps move on one wing, or
- two or more slats move on one wing.

The FSEU shuts down the LE control and illuminates the amber LE FLAPS TRANSIT light.

In addition, to prevent uncommanded motion from occurring on the LE devices during cruise, the FSEU maintains pressure on the retract lines and depressurizes the extend and full extend lines.

## Trailing Edge Uncommanded Motion

Uncommanded motion is detected when no FLAP lever or flap load relief command is present and the TE flaps:

- move away from the commanded position
- continue to move after reaching a commanded position, or
- move in a direction opposite to that commanded.

The FSEU shuts down the TE drive unit by closing the TE flap bypass valve. The TE flap shutdown cannot be reset by the flight crew and they must use the alternate flap system to control TE flaps. The shutdown is indicated by the flap position indicator disagreeing with the FLAP lever position. There is no flap needle split.

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| Airport Heading Up (moving) Map .....     | 10.65.9  |
| Airport North Up (static) Map .....       | 10.65.13 |
| Airport Search .....                      | 10.65.16 |
| IDENT page .....                          | 10.65.18 |
| SYSTEM page .....                         | 10.65.20 |
| Documents (Typical) .....                 | 10.65.22 |
| Performance (Typical) .....               | 10.65.26 |
| Electronic Log Book (ELB Typical) .....   | 10.65.35 |
| LOGBOOK page .....                        | 10.65.35 |
| Electronic Log Book (Fault Locator) ..... | 10.65.38 |

Intentionally  
Blank

## Flight Instruments, Displays

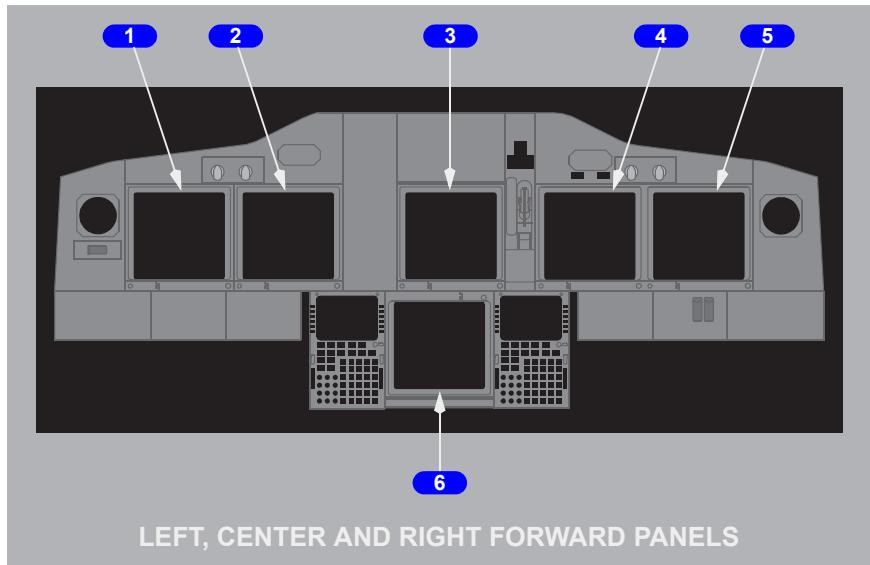
### EFIS/Map – Controls and Indicators

## Chapter 10

### Section 10

#### EFIS/Map Display System – Overview

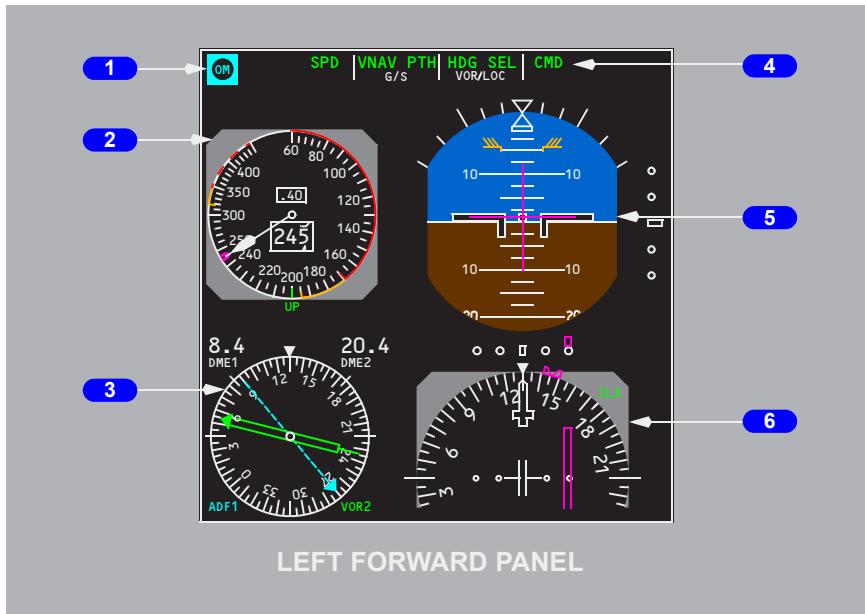
##### Display Units



- 1 Captain Outboard Display Unit**
- 2 Captain Inboard Display Unit**
- 3 Upper Display Unit**
- 4 First Officer Inboard Display Unit**
- 5 First Officer Outboard Display Unit**
- 6 Lower Display Unit**

## Captain Outboard Display

[Option - Split axis command bars]



**1** Marker Beacon

**2** Mach/Airspeed Indicator

**3** Radio Distance Magnetic Indicator

**4** Flight Mode Annunciations

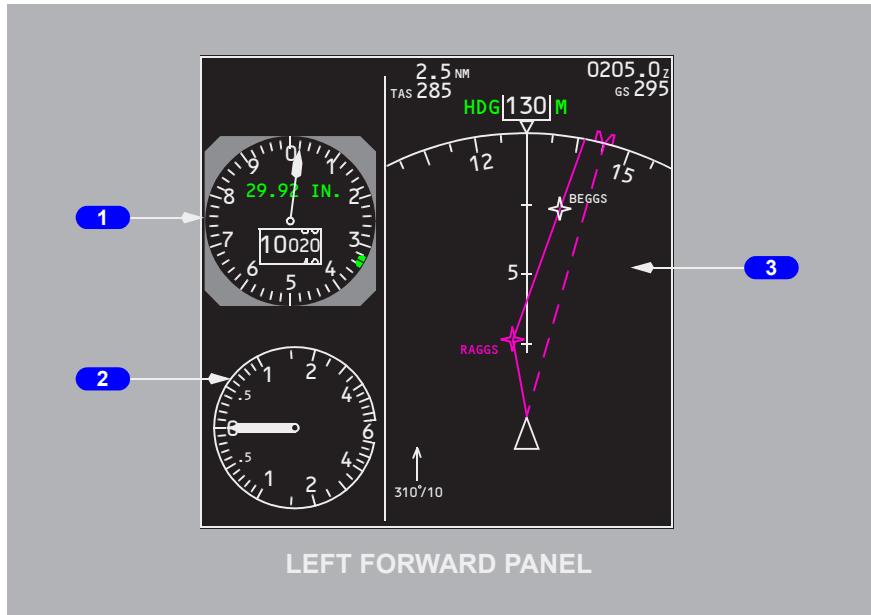
Refer to Chapter 4, Automatic Flight

**5** Attitude Indicator

**6** Horizontal Situation Indicator

## Captain Inboard Display

[Option - Heading-up display]



**1** Altimeter

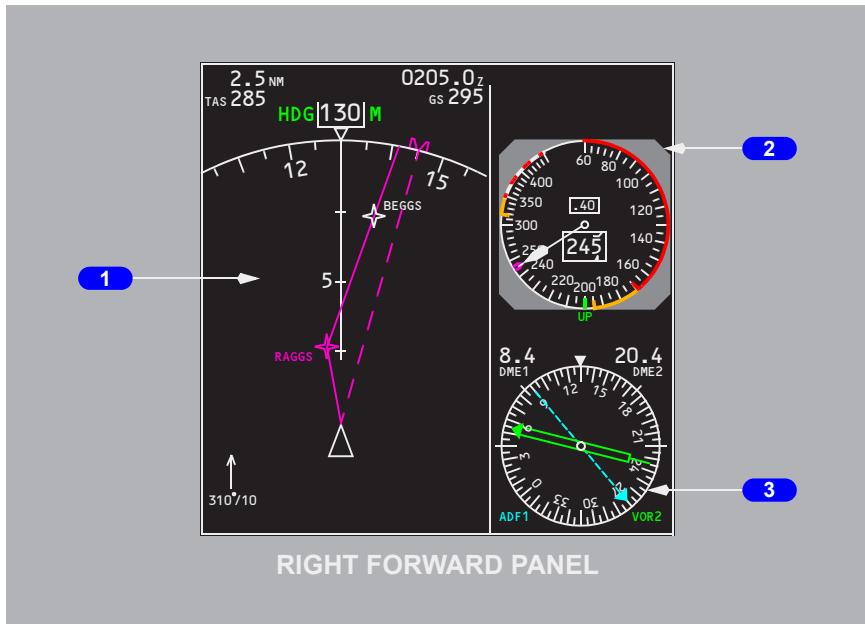
**2** Vertical Speed Indicator

**3** Navigation Display

Displays approach, VOR, moving map, or static map as selected on the EFIS control panel.

## First Officer Inboard Display

[Option - Heading-up display]



### 1 Navigation Display

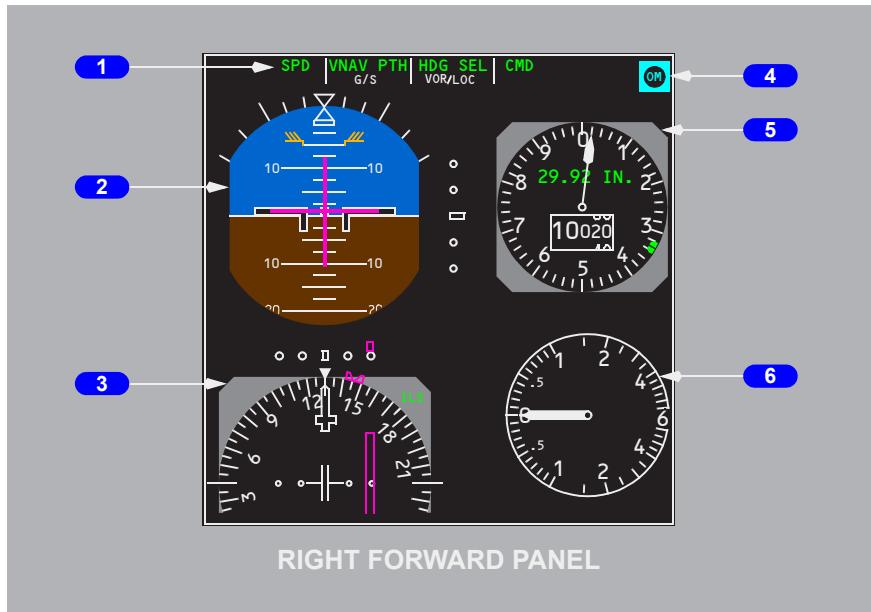
Displays approach, VOR, moving map, or static map as selected on the EFIS control panel.

### 2 Mach/Airspeed Indicator

### 3 Radio Distance Magnetic Indicator

## First Officer Outboard Display

[Option - Split axis command bars]



### 1 Flight Mode Annunciations

Refer to Chapter 4, Automatic Flight

### 2 Attitude Indicator

### 3 Horizontal Situation Indicator

### 4 Marker Beacon

### 5 Altimeter

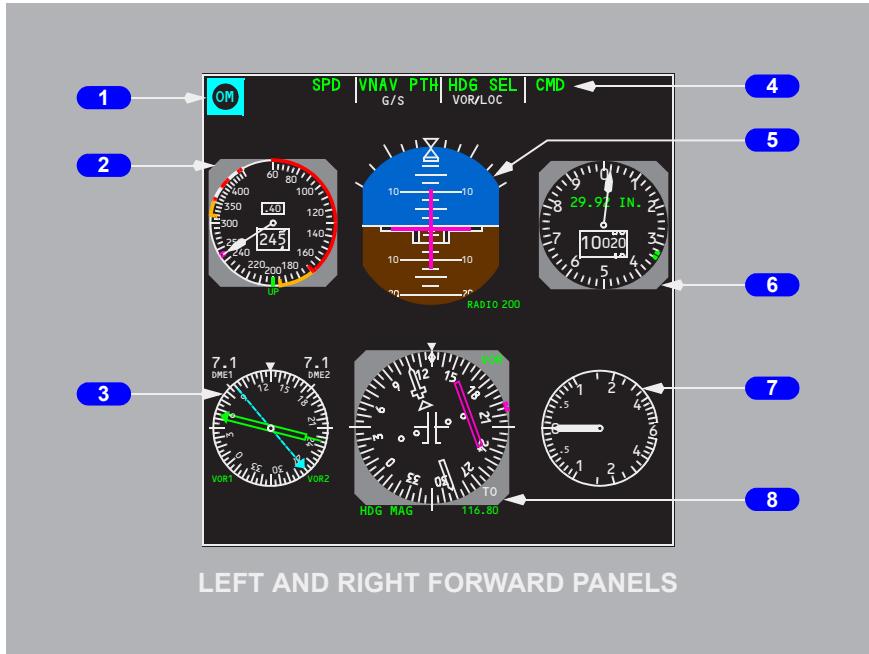
### 6 Vertical Speed Indicator

## Compact EFIS Format

The compact EFIS format is displayed automatically upon failure of either an inboard or an outboard display unit. The compact format can also be selected manually with the MAIN PANEL DUs selectors on the display select panel.

In the compact format, a full rose HSI is displayed. Other displays are about 25% smaller than normal.

[Option - Split axis command bars]



**LEFT AND RIGHT FORWARD PANELS**

- 1** Marker Beacon
- 2** Mach/Airspeed Indicator
- 3** Radio Distance Magnetic Indicator
- 4** Flight Mode Annunciations
- 5** Attitude Indicator
- 6** Altimeter

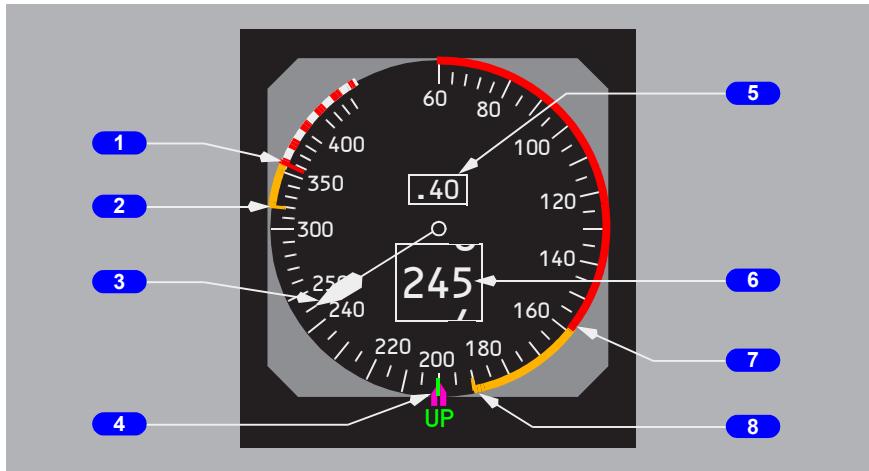
## 7 Vertical Speed Indicator

## 8 Horizontal Situation Indicator

# Electronic Flight Instrument System (EFIS) – Mach/Airspeed Indicator (MASI)

## Mach/Airspeed Indicator – General

The mach/airspeed indicator displays air data inertial reference system (ADIRS) airspeed and other airspeed related information.



### 1 Maximum Operating Speed (red and white)

Start of the arc indicates the maximum speed as limited by the lowest of the following:

- Vmo/Mmo
- landing gear placard speed
- flap placard speed.

### 2 High Speed Buffet/Flap Extension Speed (amber)

At high altitudes and flaps up, the start of the arc indicates the airspeed that provides a 0.3 g maneuver margin to high speed buffet.

#### [Option] - CDS Software Upgrade - Block point 02/04/06

When flaps are not up, the start of the arc indicates flap extension placard speed for the next normal flap setting. The arc is removed when the flap handle is moved to the landing flap selected on the APPROACH REF page or when the flap lever is moved to flaps 40.

**3 Airspeed Pointer (white)**

Indicates current calibrated airspeed in knots.

**4 Airspeed Cursor (magenta)**

Displays target airspeed:

- indicates the airspeed manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

**5 Mach Digital Counter (white)**

Indicates current Mach number:

- displays when airspeed increases above 0.40 Mach
- blanks when airspeed decreases below 0.38 Mach.

**6 Airspeed Digital Counter (white)**

Indicates current calibrated airspeed in knots.

When current airspeed decreases into the minimum maneuver speed amber bar:

- airspeed readout box turns amber and flashes for 10 seconds.
- box returns to white when airspeed is above minimum maneuver speed.

**7 Stick Shaker Speed (red)**

Red index mark indicates the speed at which stick shaker occurs.

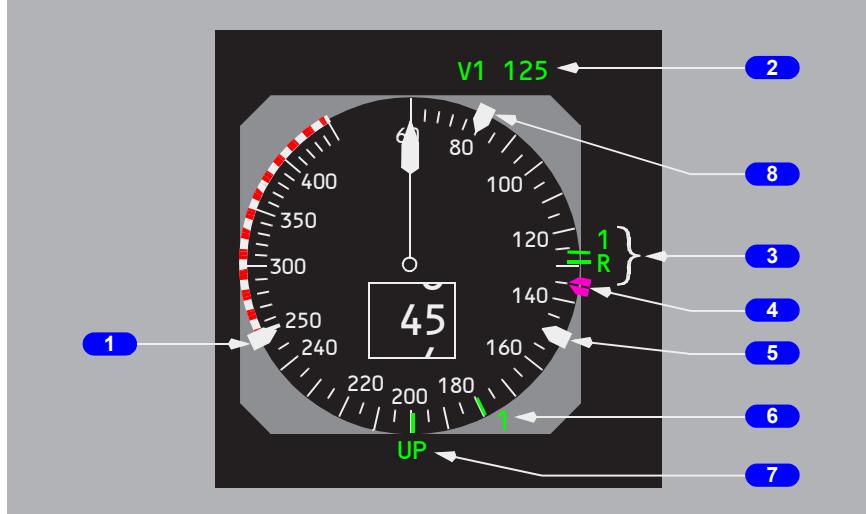
**8 Minimum Maneuver Speed (amber)**

Amber index mark indicates minimum maneuver speed.

Inhibited on takeoff until first flap retraction or valid VREF entered.

## Mach/Airspeed Indicator – Takeoff

[Option - 80 knot speed bug]



### 1 Bug 5 (white)

Displayed if the speed reference selector on the engine display control panel is in the bug 5 position and a value greater than 60 knots has been selected. Not available if the speed reference selector is in the AUTO position.

### 2 Speed Reference Display (green)

Displayed if the airspeed and/or weight is entered via the speed reference selector on the engine display control panel:

- on the ground, V1, VR, and takeoff gross weight may be selected; if VREF is selected, INVALID ENTRY is displayed
- in flight, VREF and landing gross weight may be selected; if V1 or VR is selected, INVALID ENTRY is displayed
- removed when the speed reference selector is moved to the SET position.

### 3 Takeoff Reference Speeds (green)

Indicates V1 (decision speed “V1”) and VR (rotation speed “VR”) as selected on the CDU TAKEOFF REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the SPD REF selector switch:

- amber NO VSPD flag is displayed on the ground if V1 and VR are not selected on the CDU or not set with the SPD REF selector
- displayed for takeoff when speed is greater than 80 knots

- removed at lift-off.

**[Option - V1 aural enabled]**

- V1 is automatically called out by voice aural.

**Note:** The Look Ahead Terrain Alerting system must be incorporated for the automatic V1 aural callout to be functional.

**4 Airspeed Cursor (magenta)**

Set with the speed selector on the mode control panel.

**5 V2+15 (white)**

Displayed for takeoff.

Removed when either of the following occurs:

- at first flap retraction
- when VREF is entered.

**6 Flap Maneuvering Speed (green)**

Indicates flap maneuvering speed for the displayed flap position:

- when the V2+15 bug is displayed for takeoff, the flap maneuvering speed bug for the current flap setting is not displayed except for a flaps 1 takeoff
- flap bugs inhibited if less than VREF +4.

**7 Flaps Up Airspeed (green)**

Displayed after zero fuel weight is entered in the CDU and takeoff gross weight is calculated, or after takeoff gross weight is set with the speed reference selector.

Not displayed above approximately 20,000 feet altitude.

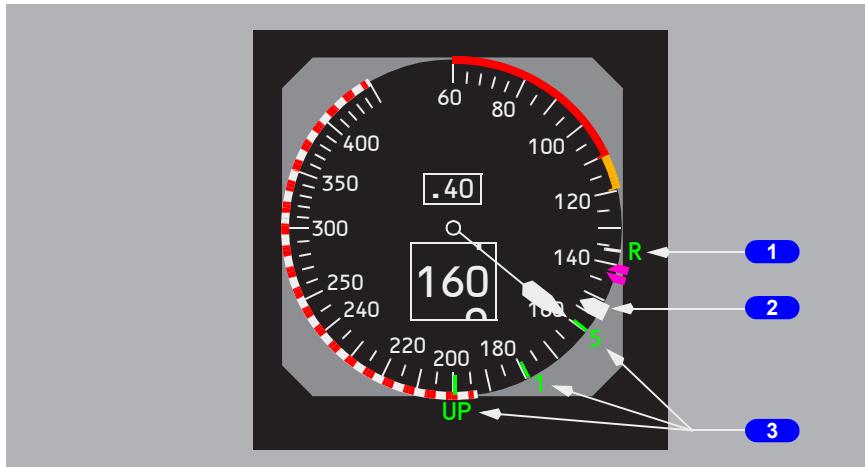
**8 80 Knots Airspeed Bug (white)**

**[Option - 80 knot speed bug]**

Indicates 80 knots:

- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

## Mach/Airspeed Indicator – Approach



### **1** Landing Reference Speed (green)

Indicates VREF (reference speed) as selected on the CDU APPROACH REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel.

### **2** VREF+15 (white)

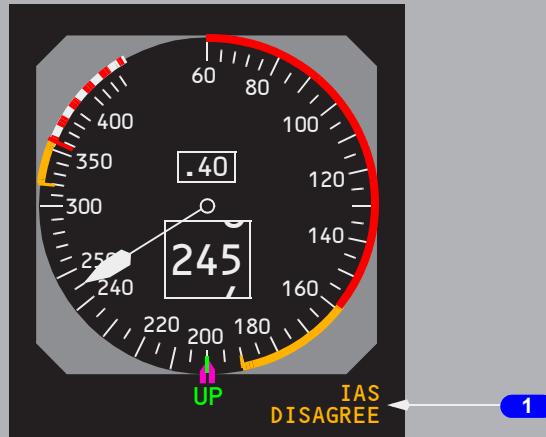
Displayed after selection of VREF.

### **3** Flap Maneuvering Speeds (green)

Indicate flap maneuvering speeds for the displayed flap position:

- not shown if less than or equal to VREF+4
- numbered flap maneuvering speed bugs are removed when the flap lever is moved to flaps 30 or 40.

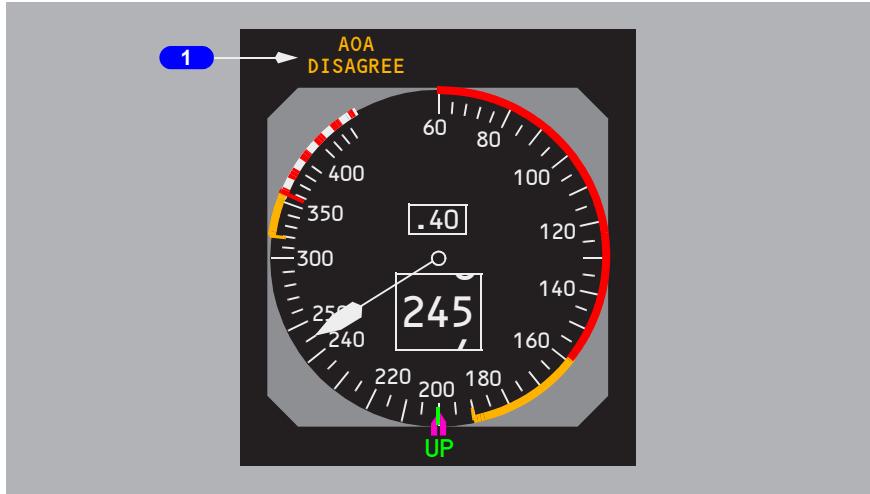
## Mach/Airspeed Indicator – IAS Disagree Alert



### **1** Airspeed Disagree Alert (amber)

Indicates the Captain's and F/O's airspeed indications disagree by more than 5 knots for 5 continuous seconds.

## Mach/Airspeed Indicator – Angle of Attack (AOA) Disagree Alert

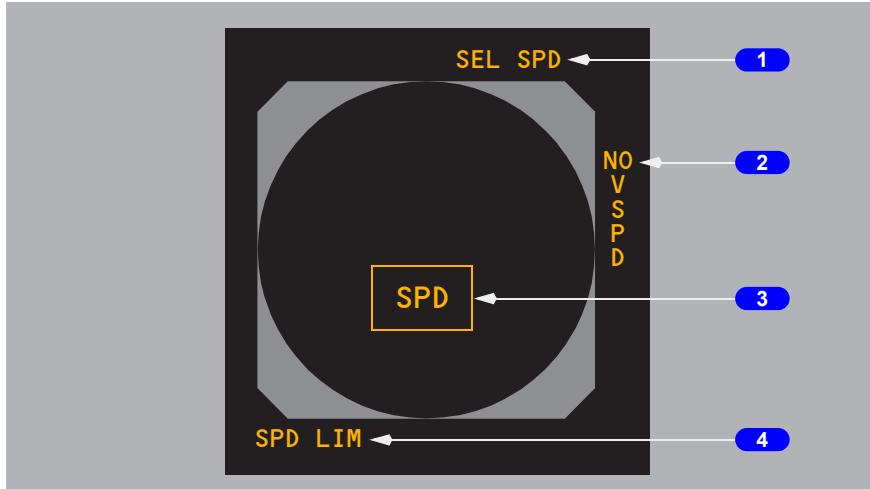


### 1 AOA Disagree Alert (amber)

Indicates the left and right AOA values disagree by more than 10 degrees for more than 10 continuous seconds.

## Mach/Airspeed Indicator Failure Flags

The flag replaces the appropriate display to indicate source system failure or lack of computed information.



## 1 Selected Speed Flag (amber)

The airspeed cursor is inoperative. The airspeed cursor is removed.

## 2 NO VSPD Flag (amber)

Displayed when the aircraft is on the ground and both V1 (decision speed) and VR (rotation speed) are not valid or are set to less than 80 knots.

## 3 Speed Flag (amber)

Speed data failed. Mach/airspeed indicator is inoperative.

## 4 Speed Limit Flag (amber)

Display related to stick shaker or maximum operating speed has failed:

- if the stick shaker warning has failed, the red stick shaker speed arc is removed
- if the maximum operating speed has failed, the red and white maximum operating speed arc is removed.

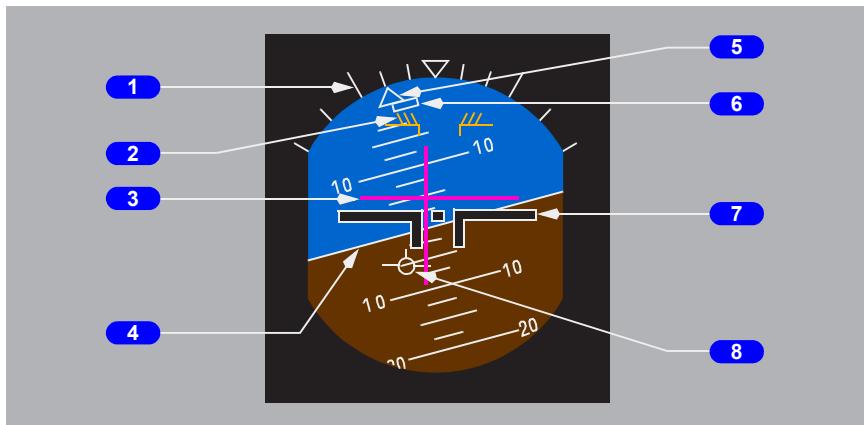
---

## EFIS – Attitude Indicator

### Attitude Indicator – General

The attitude indicator displays ADIRS attitude information.

[Option - Split axis command bars, flight path vector]



## 1 Bank Scale (white)

Provides fixed reference for the bank pointer; scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

**2 Pitch Limit Indicator (amber)**

Indicates pitch limit (stick shaker activation for existing flight conditions).

- displayed when flaps are not up

**[Option - PLI pop-up]**

- displayed at slow speed with flaps up

**3 Flight Director (magenta)**

Indicates flight director steering commands. (Refer to Chapter 4, Automatic Flight.)

**4 Horizon Line and Pitch Scale (white)**

Indicates the horizon relative to the airplane symbol; pitch scale is in 2.5 degree increments.

**5 Bank Pointer**

Indicates bank angle; fills and turns amber if bank angle is 35 degrees or more.

**6 Slip/Skid Indication**

Displaces beneath the bank pointer to indicate slip or skid:

- fills white at full scale deflection
- turns amber if bank angle is 35 degrees or more; fills amber if the slip/skid indicator is also at full scale deflection.

**7 Airplane Symbol**

Indicates airplane attitude relative to the horizon.

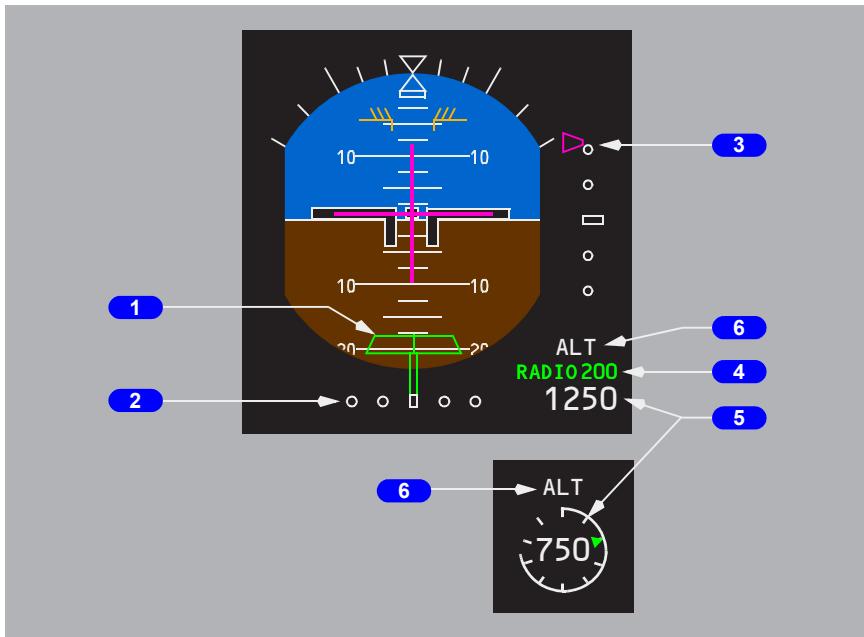
**8 Flight Path Vector (FPV) Indication (white)****[Option - Flight path vector]**

Displays flight path angle and drift when selected on the EFIS control panel:

- flight path angle is displayed relative to the horizon line
- drift angle is displayed relative to display center.

## Attitude Indicator – Instrument Landing System Indications

[Option - Split axis command bars, round dial, radio altitude below, rising runway, radio altitude height alert]



### 1 Rising Runway (green)

[Option - Rising runway]

- displayed when localizer pointer is in view and radio altitude is less than 2500 feet
- rises towards airplane symbol when radio altitude is below 200 feet
- is not displayed when the localizer signal is unusable.

### 2 Localizer Pointer and Deviation Scale

The pointer:

- indicates localizer position relative to the airplane.
- in view when the localizer signal is received.

The scale:

- indicates deviation.
- expands when the localizer is engaged and deviation is slightly more than  $\frac{1}{2}$  dot.

**[Option - Localizer/Glideslope fail flags displayed]**

- in view when the localizer signal is received.

At low radio altitudes with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive localizer course deviation.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC deviation alerting display on each attitude indicator.

**3 Glide Slope Pointer and Deviation Scale**

The pointer:

- indicates glide slope position.
- in view when the glide slope signal is received.
- the pointer is not displayed when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse).

The scale:

- indicates deviation

**[Option - Localizer/Glideslope fail flags displayed]**

- in view when the localizer signal is received.

At low radio altitudes with autopilot engaged, the scale turns amber and the pointer flashes to indicate excessive glide slope deviation.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second G/S deviation alerting display on each attitude indicator.

**4 Selected Radio Altitude Approach Minimums (green)**

- displays selected minimums as set on the EFIS control panel
- blank when an altitude less than 0 feet is selected
- “RADIO” legend and readout turn amber and flash for 3 seconds when descending through the selected minimum altitude; the legend and readout become steady amber after 3 seconds
- changes back to green:
  - when passing the selected minimum altitude plus 75 feet during go-around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

## 5 Radio Altitude (display –white, selected radio altitude pointer–green)

### [Option - Round dial]

- displayed below 2500 feet AGL
- blanked above 2500 feet AGL
- digital display from 2500 to 1000 feet AGL
- round dial display below 1000 feet AGL:
  - pointer replaces digital display of selected radio minimum altitude
  - the circumference of the dial is added to, or taken away from, to depict the airplane's radio altitude
- dial and readout turn amber and dial flashes for 3 seconds when descending through the selected minimum altitude; the dial becomes steady amber after 3 seconds
- changes back to white:
  - when passing through the selected minimum altitude plus 75 feet during go-around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

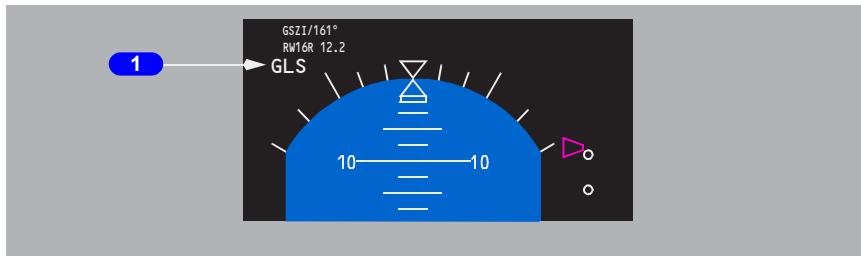
## 6 Radio Altitude Height Alert (white)

### [Option - 2500 ft height alert]

Displayed when radio altitude is less than or equal to 2500 feet. Blanked when descent continues below 500 feet AGL, or after pressing the RST switch on the EFIS control panel.

## Attitude Indicator – GLS Source Annunciation Indication

### [Option - GLS]

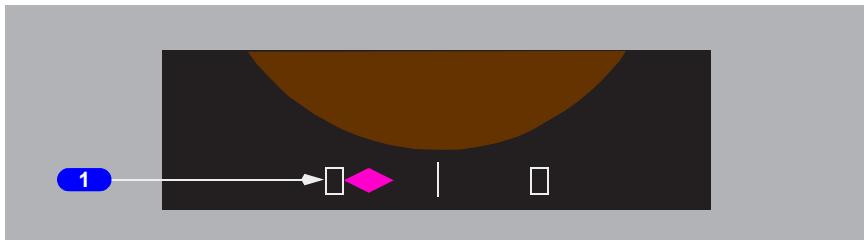


## 1 GLS Source Annunciation

Displays the selected GLS identifier, channel, selected course and source annunciation.

If the Captain's and First Officer's tuned GLS channels or approach courses disagree for more than one minute, the indication turns amber with an amber horizontal line until set identically.

## Expanded Localizer Indications



### **1    Expanded Localizer Scale**

[Option - Autopilot or flight director activated]

Displayed when the autopilot or flight director is in LOC mode, deviation is slightly more than  $\frac{1}{2}$  dot and track is within 5 degrees of the MCP selected course.

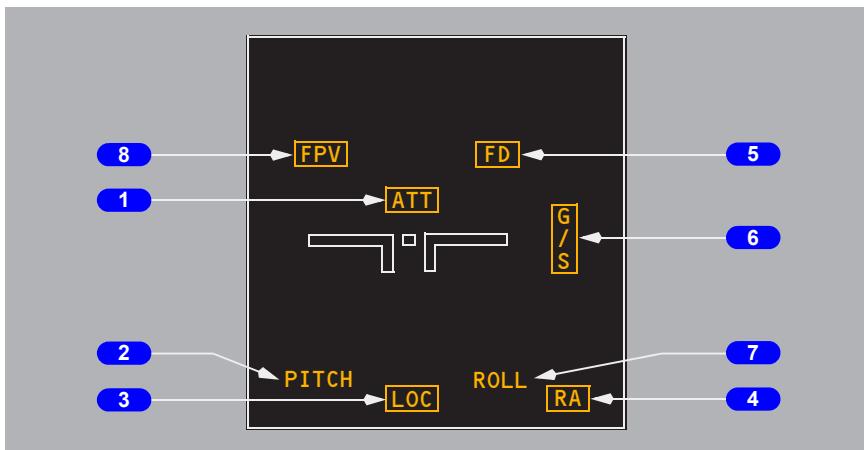
Reverts to standard scale when out of LOC mode, and groundspeed is less than 30 knots or radio altitude is greater than 200 feet.

A rectangle equals  $\frac{1}{2}$  dot deviation.

## Attitude Indicator Failure Flags

Flags replace the attitude displays to indicate source system failure or lack of computed information.

[Option - Split axis command bars, radio altitude below, flight path vector]



## **1 Attitude Flag (amber)**

The attitude display has failed.

## **2 Pitch Flag (amber)**

The Captain and First Officer pitch angle displays differ by more than 5 degrees.

[Option - Attitude comparator flashing]

The flag flashes for 10 seconds then remains steady.

## **3 Localizer Flag (amber)**

An ILS frequency is tuned and ILS localizer course guidance indication has failed.

## **4 Radio Altitude Flag (amber)**

Radio altitude indication has failed.

## **5 Flight Director Flag (amber)**

The flight director has failed.

## **6 Glide Slope Flag (amber)**

An ILS frequency is tuned and ILS glide slope indication has failed.

## **7 Roll Flag (amber)**

The Captain and First Officer roll displays differ by more than 5 degrees.

[Option - Attitude comparator flashing]

The flag flashes for 10 seconds then remains steady.

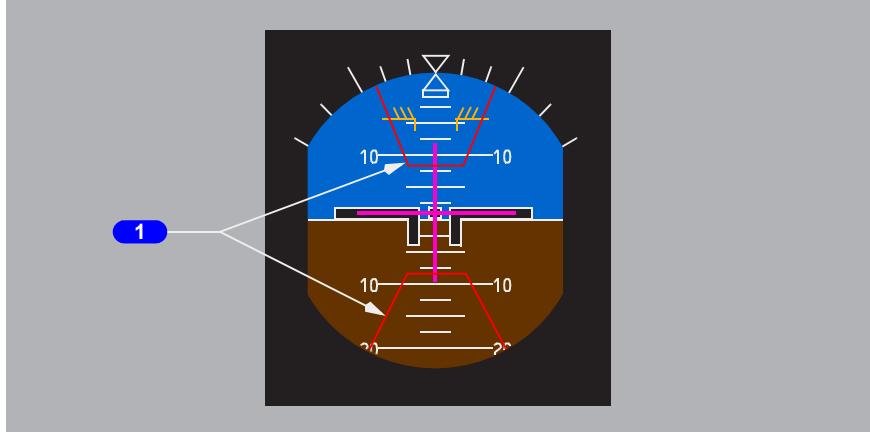
## **8 Flight Path Vector Flag (amber)**

[Option - Flight path vector]

FPV is selected on the EFIS control panel, but has failed. De-selection of FPV removes the flag.

## Traffic Alert and Collision Avoidance Indications

[Option - Split axis command bars]

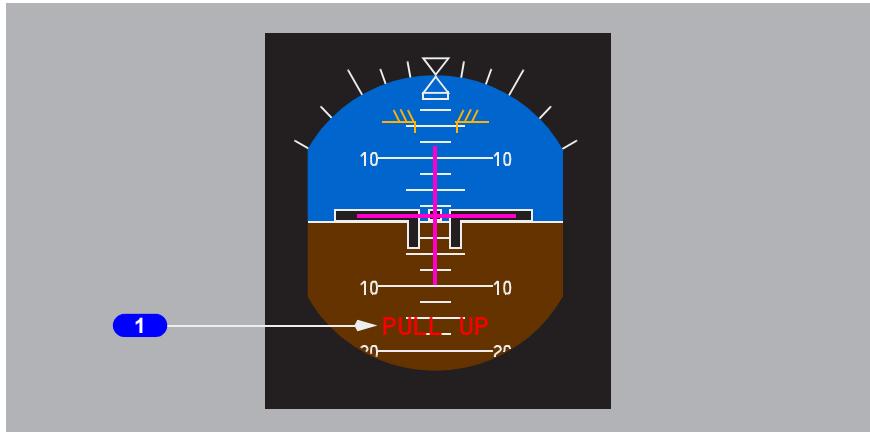


### 1 Traffic Alert and Collision Avoidance System Pitch Command (red)

The area(s) inside the red lines indicate(s) the pitch region(s) to avoid in order to resolve the traffic conflict. The airplane symbol must be outside the TCAS pitch command area(s) to ensure traffic avoidance. Refer to Chapter 15, Warning Systems.

## GPWS Annunciations

[Option - Split axis command bars]



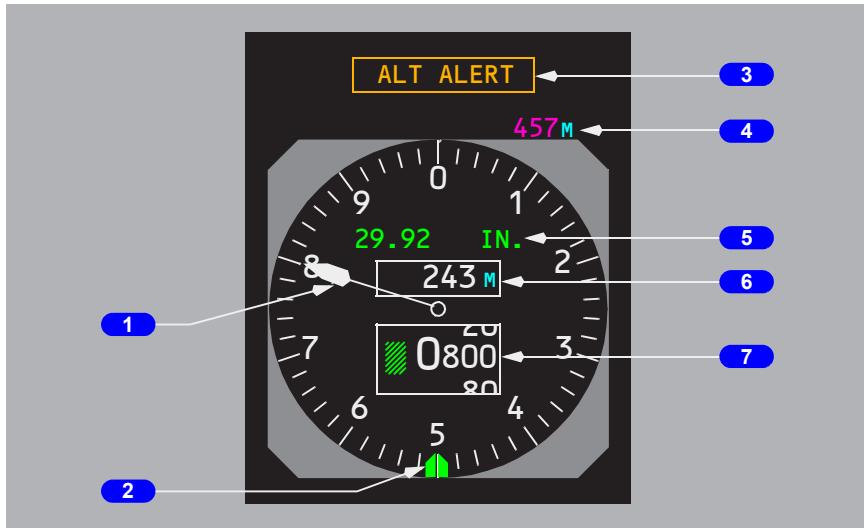
### 1 GPWS Annunciations (red)

Refer to Chapter 15, Warning Systems.

## EFIS – Altimeter

### Altimeter – General

The altimeter displays ADIRS altitude and other altitude related information.



#### 1 Altitude Pointer

Makes one revolution each one thousand feet.

#### 2 Reference Altitude Marker (green)

Indicates the barometric minimums as set by the minimums selector on the EFIS control panel.

The minimums reference selector must be in the BARO position to adjust the reference altitude marker.

#### 3 Altitude Alert Annunciation (amber)

- appears steady for altitude acquisition
- flashes during altitude deviation
- refer to Chapter 15, Warning Systems.

#### 4 Metric Selected Altitude Readout (readout=magenta, caption=cyan)

Displays MCP altitude in meters when MTRS is selected on the EFIS control panel. Not available in compact mode.

## 5 Barometric Setting (green)

Indicates the barometric setting in either inches of mercury (IN) or hectopascals (HPA) as selected on the EFIS control panel.

## 6 Metric Digital Readout (readout=white, caption=cyan)

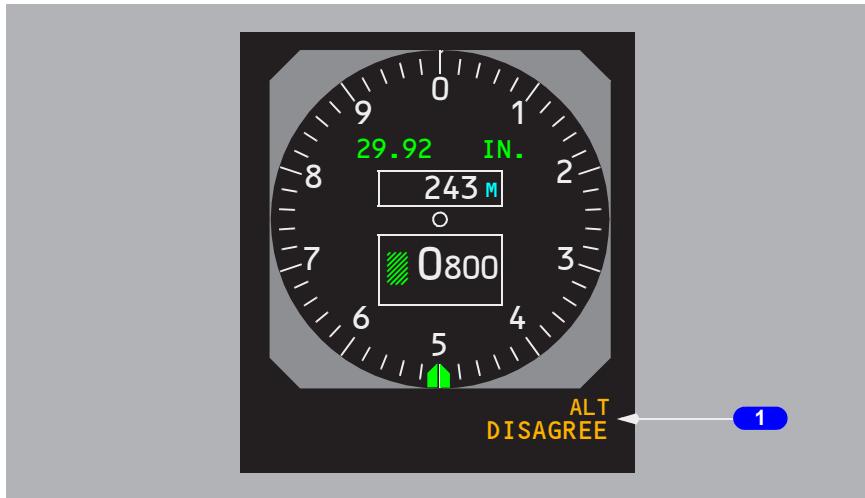
Displays current altitude in meters when MTRS is selected on the EFIS control panel. Not available in compact mode.

## 7 Digital Readout (white)

Displays current altitude in increments of thousands, hundreds and twenty feet:

- for positive values of altitude below 10,000 feet, a green crosshatch symbol is displayed
- a negative sign appears when altitude below zero feet is displayed.

## Altimeter – Altitude Disagree Alert



## 1 Altitude Disagree Alert (amber)

Indicates the Captain's and F/O's altitude indications disagree by more than 200 feet for more than 5 continuous seconds.

## Altimeter Failure Flag

The failure flag replaces the altitude displays to indicate system failure.



### 1 Altitude Failure Flag (amber)

The barometric altitude or barometric correction has failed:

- all altimeter symbols are removed except the ALT ALERT annunciation and the barometric setting.

## EFIS – Vertical Speed Indicator

### Vertical Speed Indicator – General

The vertical speed indicator displays ADIRS instantaneous vertical speed.

[Option - TCAS advisory]



**1 Vertical Speed Pointer (white)**

Depicts rate of climb or descent from 0 to 6000 feet per minute.

**2 TCAS Corrective Advisory (green)**

[Option - TCAS advisory]

Indicates range of recommended vertical speed.

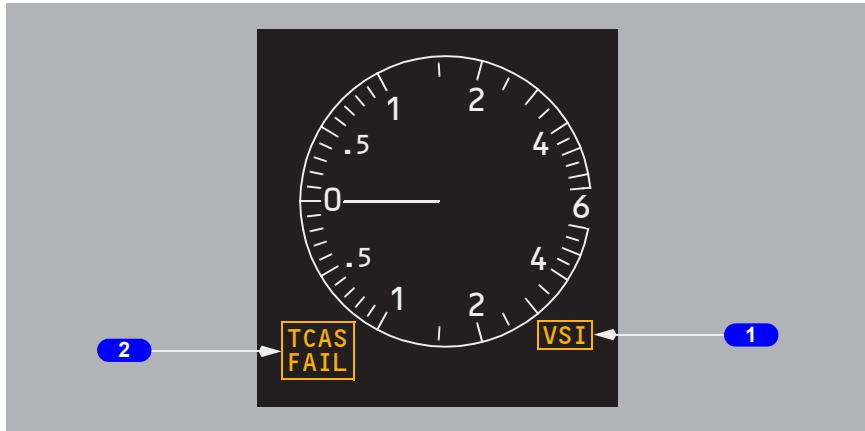
**3 TCAS Preventative Advisory (red)**

[Option - TCAS advisory]

Indicates range of vertical speed to be avoided.

**Vertical Speed Indicator Failure Flag**

[Option - VSI TCAS advisory]


**1 VSI Failure Flag (amber)**

Vertical speed has failed. The pointer is also removed.

**2 TCAS Failure Flag (amber)**

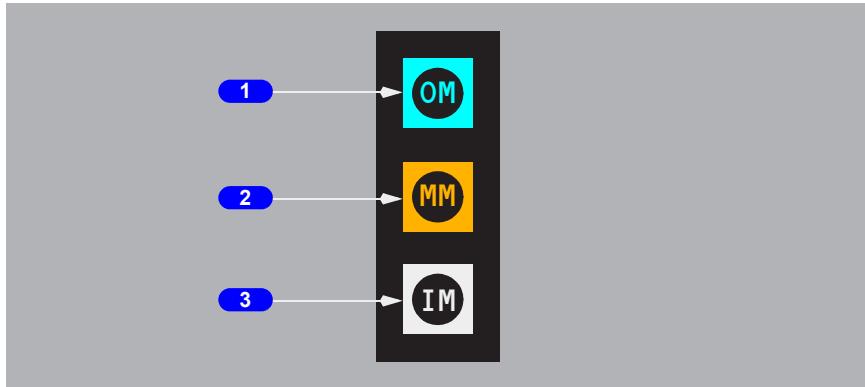
[Option - VSI TCAS advisory]

TCAS advisory function has failed. Compact format only.

## EFIS – Marker Beacon Indications

### Marker Beacon Indications

The marker beacon indication flashes when over one of the marker beacon transmitters.



#### **1 Outer Marker (cyan)**

Flashes when over an outer marker beacon.

#### **2 Middle Marker (amber)**

Flashes when over a middle marker beacon.

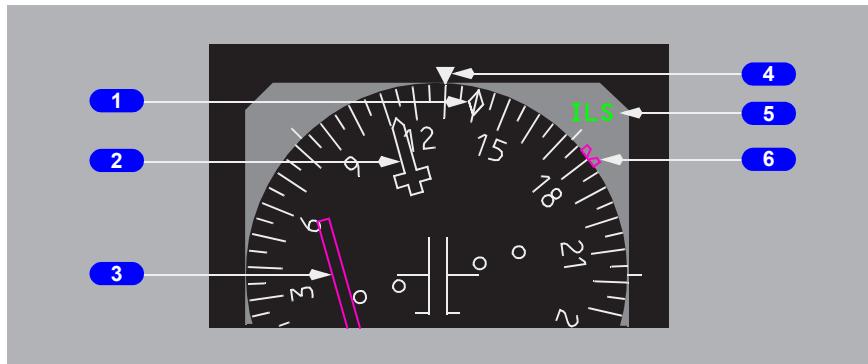
#### **3 Inner Marker (white)**

Flashes when over an inner marker beacon.

## Navigation Displays – Horizontal Situation Indicator (HSI)

### Horizontal Situation Indicator – General

The HSI displays current ADIRS heading, track and other information.



#### **1** Drift Angle Pointer (white)

Indicates current drift angle or track.

#### **2** Selected Course Pointer (white)

Indicates the course set on the mode control panel. Set by the related mode control panel course selector.

#### **3** Course Deviation Indicator (magenta)

Indicates deviation from the selected localizer or VOR course.

#### **4** Heading Pointer (white)

Indicates current heading.

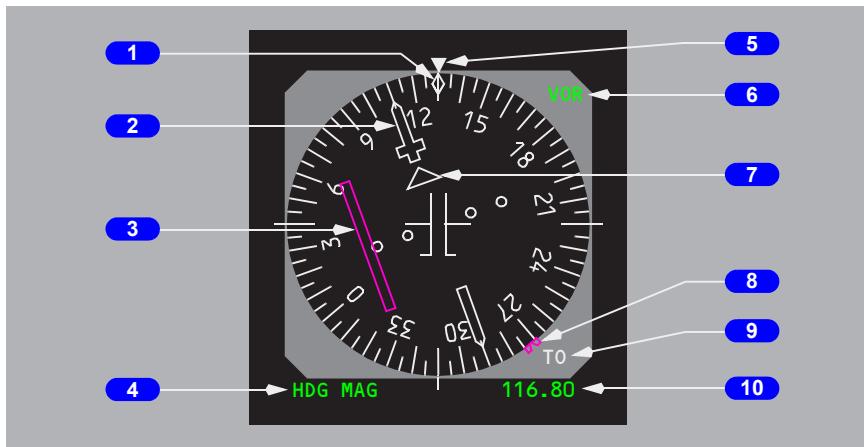
#### **5** Lateral Deviation Source Annunciation (green)

Identifies the selected navigation source as VOR or ILS.

#### **6** Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel. If the selected heading exceeds the display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

## Horizontal Situation Indicator – Compact Display



### 1 Drift Angle Pointer (white)

Indicates current drift angle or track.

### 2 Selected Course Pointer (white)

Indicates the course set on the mode control panel. Set by the related mode control panel course selector.

### 3 Course Deviation Indicator (magenta)

Indicates deviation from the selected localizer or VOR course.

### 4 Magnetic/True Heading Annunciation (green)

Indicates the HSI reference:

- HDG MAG (green) indicates display is oriented relative to magnetic north
- TRU HDG (green) indicates display is oriented relative to true north; a white box is displayed continuously around TRU HDG
- transition from TRU HDG to HDG MAG results in a green box around HDG MAG for 10 seconds
- when TRU HDG is displayed and the airplane descends more than 2000 feet at a descent rate greater than -800 feet per minute, an amber box is drawn around TRU HDG; the box flashes for 10 seconds, then turns steady amber.

### 5 Heading Pointer (white)

Indicates current heading.

## 6 Lateral Deviation Source Annunciation (green)

Identifies the selected navigation source as VOR or ILS.

## 7 TO/FROM Pointer (white)

## 8 Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel.

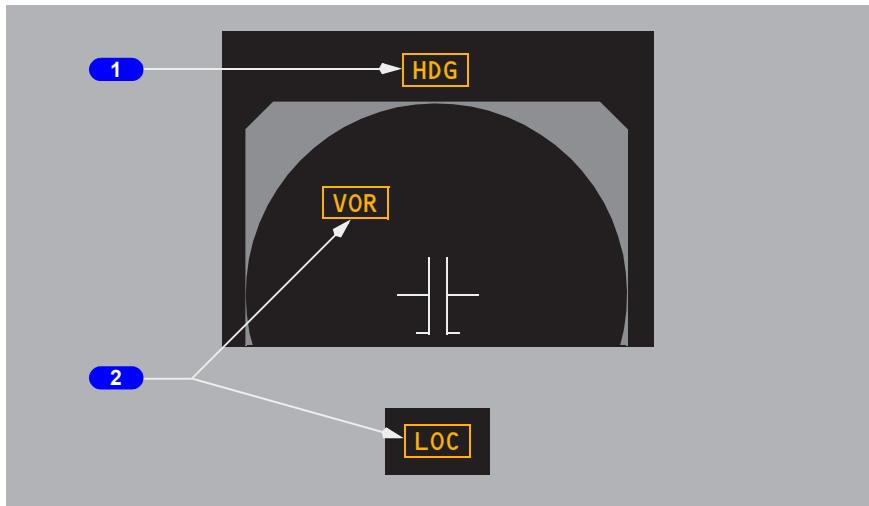
## 9 TO/FROM Annunciation (white)

## 10 Frequency Display (green)

Indicates selected navigation radio frequency.

## Horizontal Situation Indicator Failure Flags

The flags replace the horizontal situation indicator displays to indicate source system failure or lack of computed data.



### 1 Heading Failure Flag (amber)

The heading source has failed. The compass rose is removed.

### 2 VOR/LOC Failure Flag (amber)

The airplane navigation data source has failed.

## Navigation Displays –

### Radio Distance Magnetic Indicator (RDMI)

#### Radio Distance Magnetic Indicator – General

The RDMI provides the same information as a conventional RDMI.



#### 1 DME Indications (white)

Displayed if DME information is available from the navigation aid tuned in the VHF navigation control panel.

#### 2 Bearing Pointers (VOR source–green, ADF source–cyan)

- narrow pointer uses signals from the VHF NAV receiver No. 1 or ADF receiver No. 1

##### [Option - 2 ADF receivers]

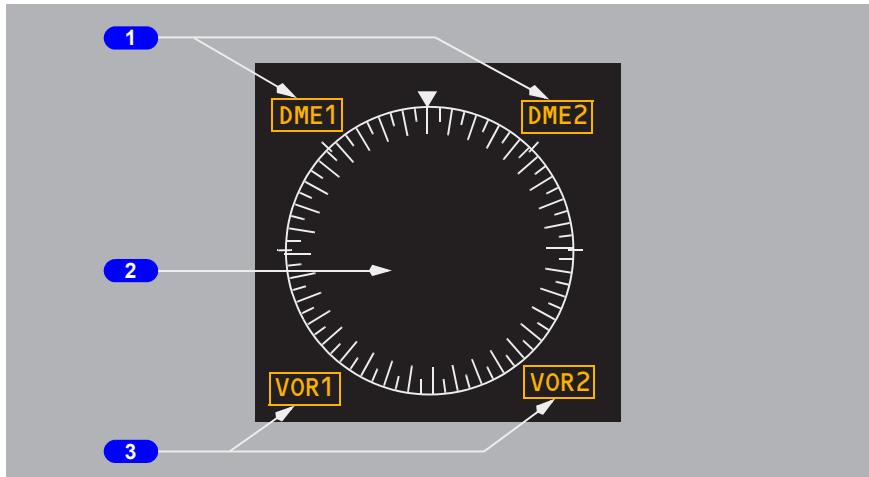
- wide pointer uses signals from the VHF NAV receiver No. 2 or ADF receiver No. 2.

#### 3 Bearing Source Indications (VOR source–green, ADF source–cyan)

- indicates “OFF” (white) if related VOR/ADF switch on the EFIS control panel is in the OFF position

## Radio Distance Magnetic Indicator Failure Flags

The flags replace the RDMI displays to indicate source system failure.



### **1 DME Failure Flags (amber)**

The DME system has failed.

### **2 Heading Failure**

The heading display is removed if heading information has failed.

### **3 VOR, ADF Failure Flags (amber)**

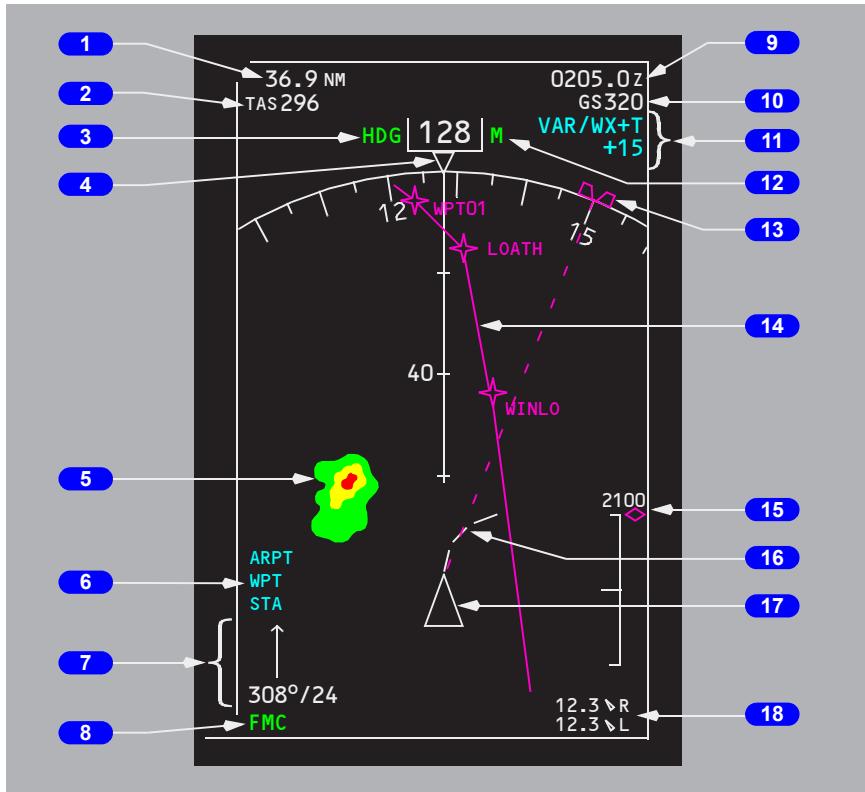
Selected VOR or ADF information is invalid.

## Navigation Displays – MAP Mode

**Note:** Refer to section 40 of this chapter for a detailed explanation of the navigation symbology shown on the following pages.

### Expanded MAP Mode

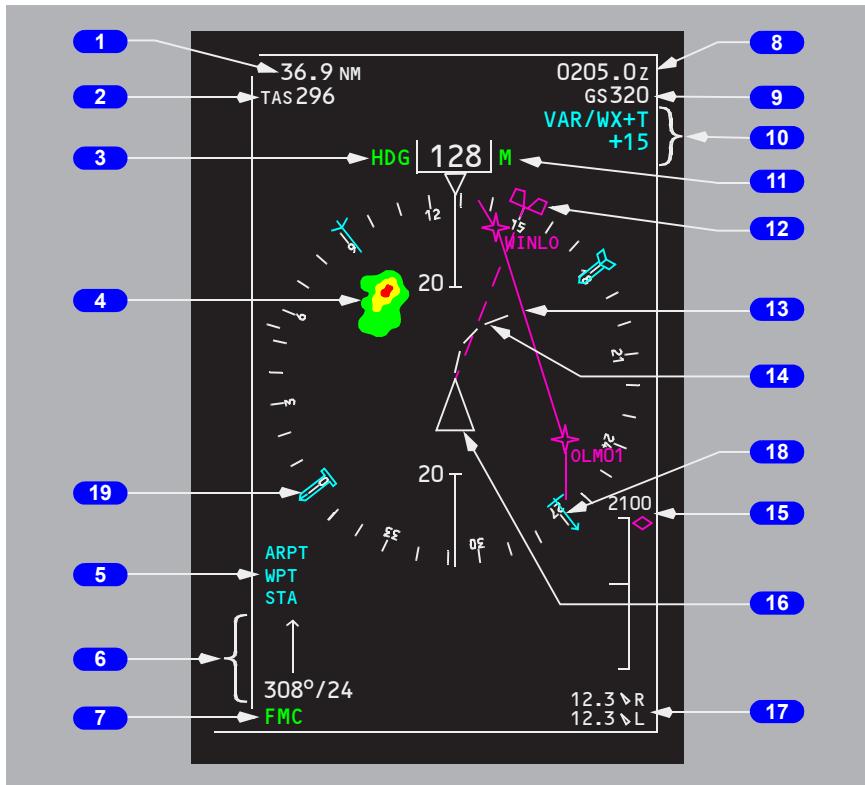
[Option - Heading-up display, weather radar range marks, single FMC]



**1 Distance to Next Active Waypoint****2 True Airspeed****3 Current Heading****[Option - Heading-up display]****4 Heading Pointer****5 Weather Radar Returns****6 MAP Options****7 Wind Direction and Speed****8 MAP Source Annunciation****9 Estimated Time of Arrival at Next Active Waypoint****10 Groundspeed****11 Weather Radar Annunciations****12 Magnetic/True Reference****13 Selected Heading Bug****14 Active LNAV Route****15 Vertical Deviation Scale and Pointer****16 Position Trend Vector****17 Airplane Symbol****18 Position Difference Display**

## Center MAP Mode

[Option - Heading-up display, full-time ADF, dual ADF, single FMC]



**1** Distance to Next Active Waypoint

**2** True Airspeed

**3** Current Heading

[Option - Heading-up display]

**4** Weather Radar Returns

**5** MAP Options

**6** Wind Direction and Speed

**7** MAP Source Annunciation

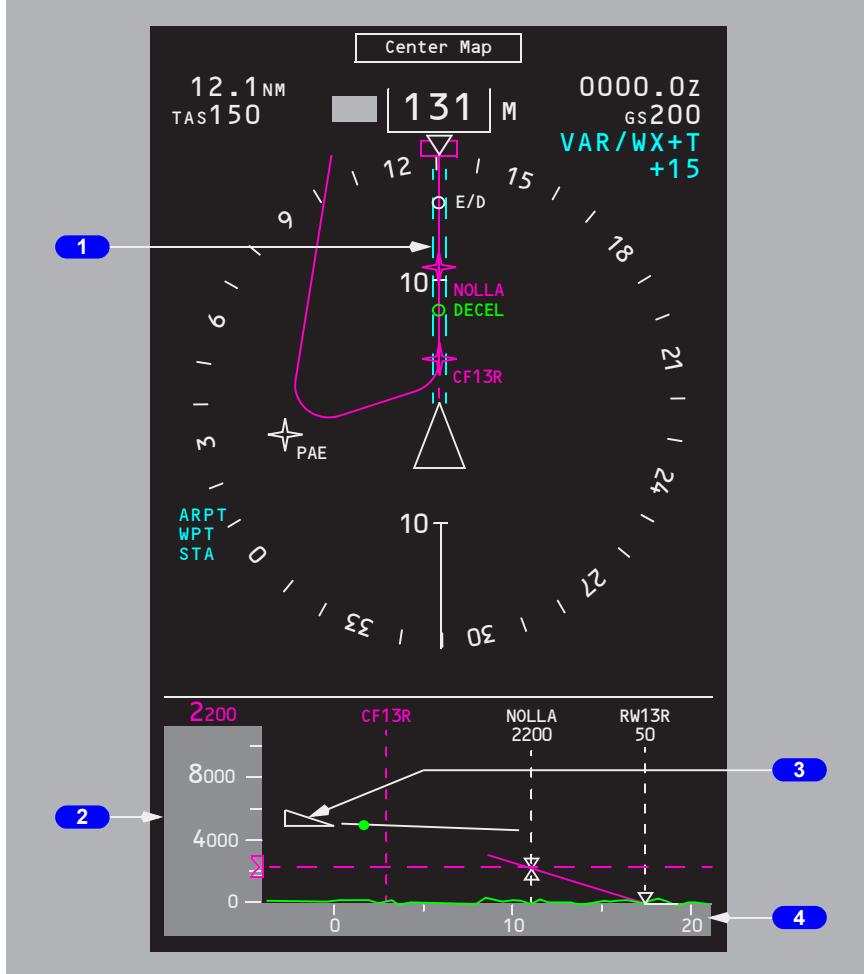
**8** Estimated Time of Arrival at Next Active Waypoint**9** Groundspeed**10** Weather Radar Annunciations**11** Magnetic/True Reference**12** Selected Heading Bug**13** Active Route**14** Position Trend Vector**15** Vertical Deviation Scale and Pointer**16** Airplane Symbol**17** Position Difference Display**18** ADF 1 Bearing Pointer**[Option - Full-time ADF]****19** ADF 2 Bearing Pointer**[Option - Full-time ADF, 2 ADF receivers]**

## Vertical Situation Display (VSD)

### [Option VSD]

The VSD represents a profile view of the airplane and its environment along the current track. Information shown within the cyan dashed lines (enroute corridor) on the ND is shown in profile on the VSD.

### Vertical Situation Display (VSD) - Reference Scales



### 1 Enroute Swath

Indicates area mapped by the VSD.

**2 Altitude Reference Scale**

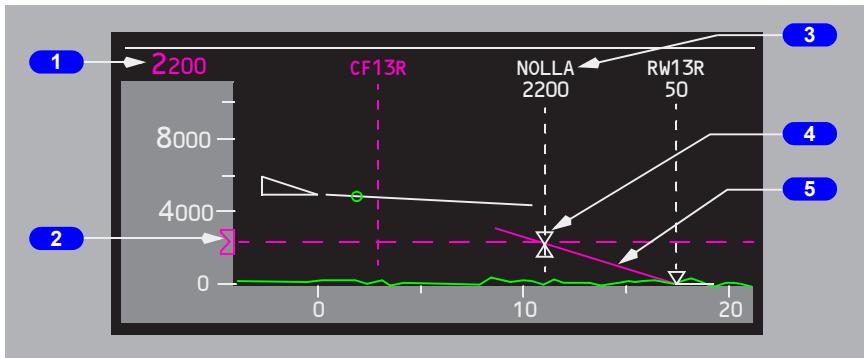
Displays altitude in reference to the vertical position of the airplane symbol, terrain, and other objects in the VSD background display.

**3 Airplane Symbol**

Indicates current airplane altitude (bottom of the triangle) and lateral position (point of the triangle) relative to terrain.

**4 Horizontal Reference Scale**

Displays range in nautical miles. Actual range shown on VSD is one half the range selected on the EFIS control panel.

**Vertical Situation Display (VSD) - General Background****1 MCP Selected Altitude Readout**

Displays the altitude set in the MCP altitude window.

**2 Selected Altitude Bug**

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom, with only one half the bug visible. The dashed line does not park.

**3 Waypoint ID and Anchor Line**

Displayed with any altitude constraint directly beneath. Dashed vertical line depicts lateral position. Conditional waypoints are depicted as a dashed vertical line only.

**4 Altitude Constraint Symbol**

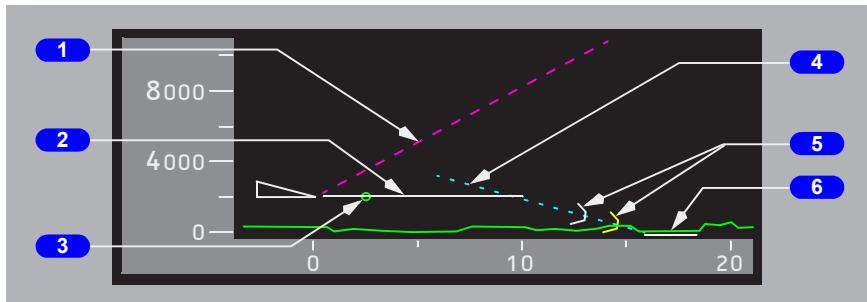
Displayed as triangle(s).

**5 FMC Approach Glidepath Angle Line**

Displayed for approaches that include a designated approach angle.

- extends 10 NM for situational awareness.
- anchored to the missed approach waypoint, not the runway.

## Vertical Situation Display (VSD) - Flight Path Background



### 1 MCP Selected Vertical Speed (V/S)

Displays the selected vertical speed as a dashed target angle line when the MCP V/S mode is selected.

### 2 Vertical Flight Path Vector

Indicates current flight path angle as a function of vertical speed and ground speed. The length of the vector is fixed at one half of the VSD range.

### 3 Range to Target Speed Dot (RTSD)

Indicates where the airplane will achieve the FMC or MCP target speed.

- dot is blanked within 5 knots of target speed.
- dot reappears if speed increases 10 knots or more faster than target speed.
- replaced with an unfilled dot at vector end if target speed will not be achieved within length of the vertical flight path vector line.

### 4 3-Degree Reference Line

Displayed for approaches that do not have a designated approach angle.

- dashed line extends 10 NM for situational awareness.
- anchored to the runway threshold.
- for reference only, line may intersect terrain.

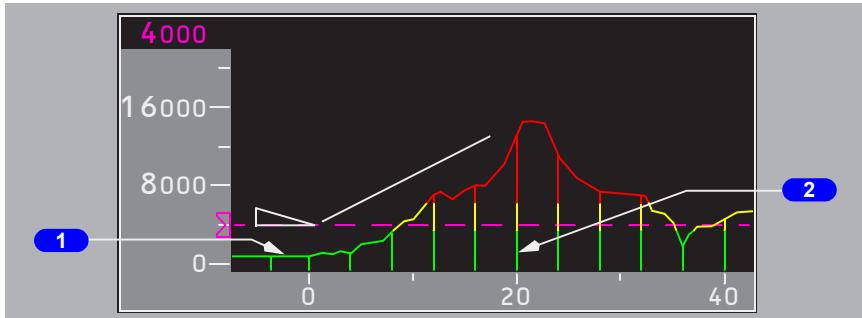
### 5 Decision Gates

Displayed on the FMC approach glidepath angle line or 3 degree reference line at 500 feet and 1000 feet above field elevation.

### 6 Runway

Represents the selected runway.

## Vertical Situation Display (VSD) - Terrain Background



### 1 Terrain Profile Line

Represents the highest terrain within the enroute swath.

- highest points of the terrain below and ahead of the airplane.
- terrain is depicted so the true altitude separation between the airplane and terrain is shown.
- terrain behind the airplane is drawn equal to the terrain at the current position.
- VSD terrain uses the same color coding that is used to depict EGPWS terrain on the lateral map:
  - green: terrain 250-500 feet or more below the airplane.
  - amber: terrain from 250-500 feet below to 2000 feet above the airplane.
  - red: terrain more than 2,000 feet above the airplane.

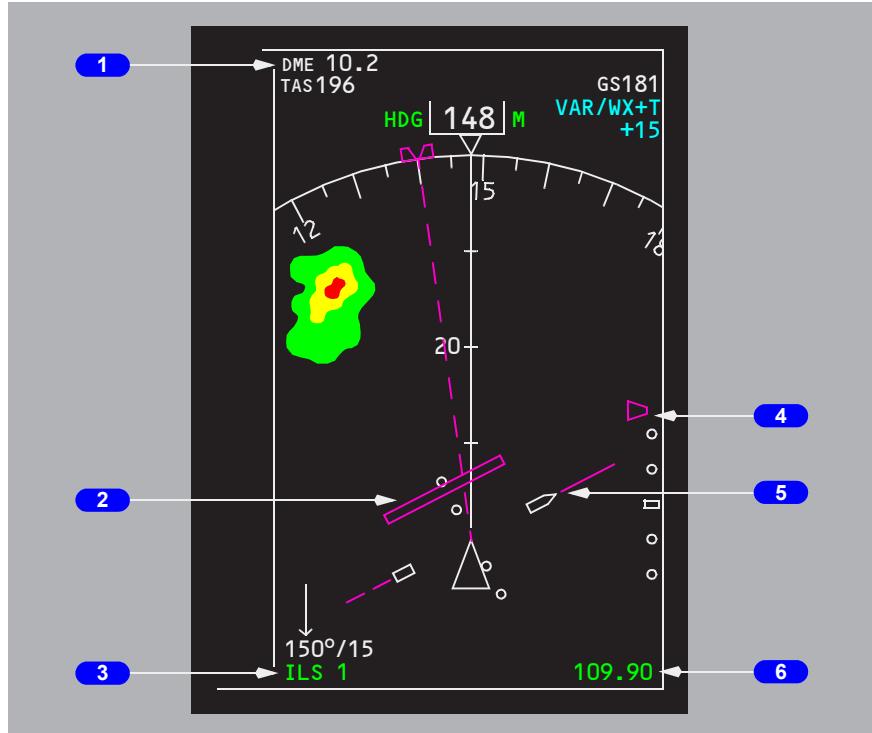
### 2 Vertical Support Lines

Vertical terrain vectors placed at constant intervals along the terrain profile line.

## Navigation Displays – Approach Mode

### Expanded Approach Mode

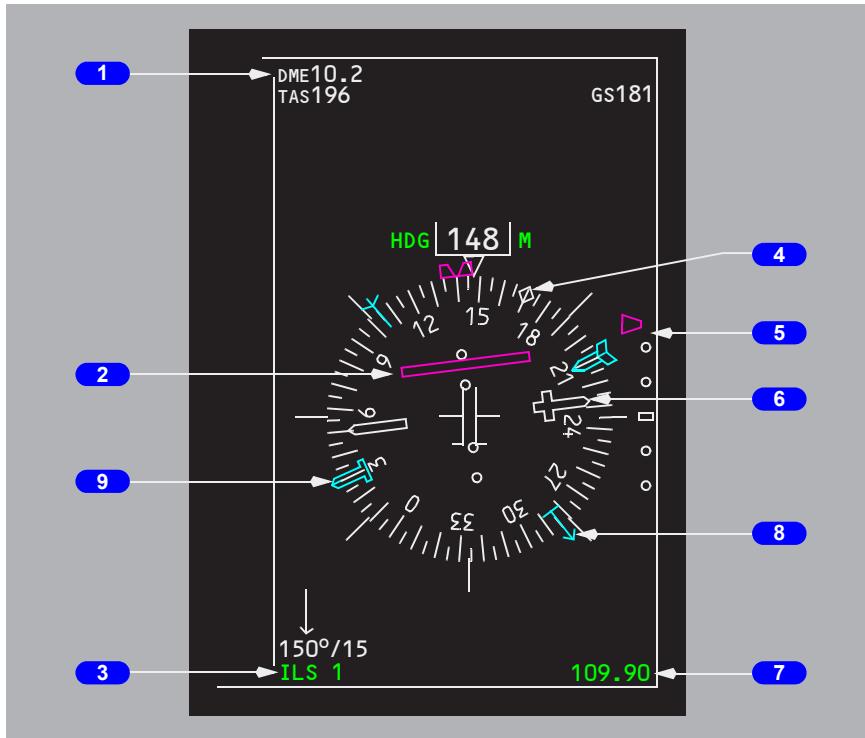
[Option - Weather radar range marks]



- 1** Reference ILS DME
- 2** Localizer Deviation Indication and Scale
- 3** Reference ILS Receiver
- 4** Glide Slope Pointer and Scale
- 5** Selected Course Pointer
- 6** Reference ILS Frequency

## Center Approach Mode

[Option - Dual ADF]



- 1** Reference ILS DME
- 2** Localizer Deviation Indication and Scale
- 3** Reference ILS Receiver
- 4** Drift Angle Pointer
- 5** Glide Slope Pointer and Scale
- 6** Selected Course Pointer

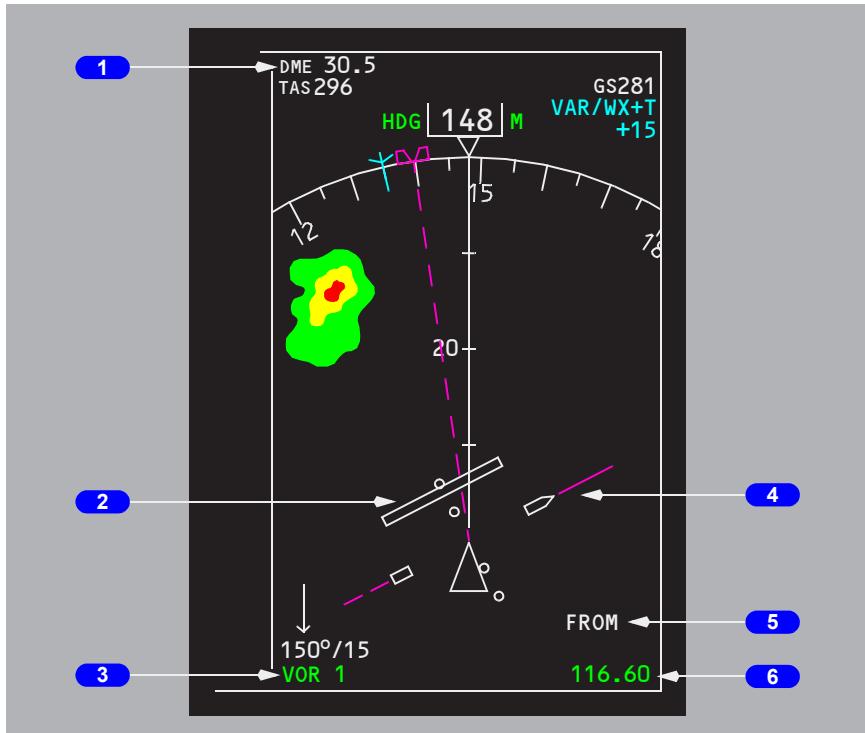
---

**7** Reference ILS Frequency**8** ADF 1 Bearing Pointer**9** ADF 2 Bearing Pointer**[Option - Dual ADF]**

## Navigation Displays – VOR Mode

### Expanded VOR Mode

[Option - Weather radar range marks]



**1** Reference VOR DME

**2** Lateral Deviation Indication and Scale

**3** Reference VOR Receiver

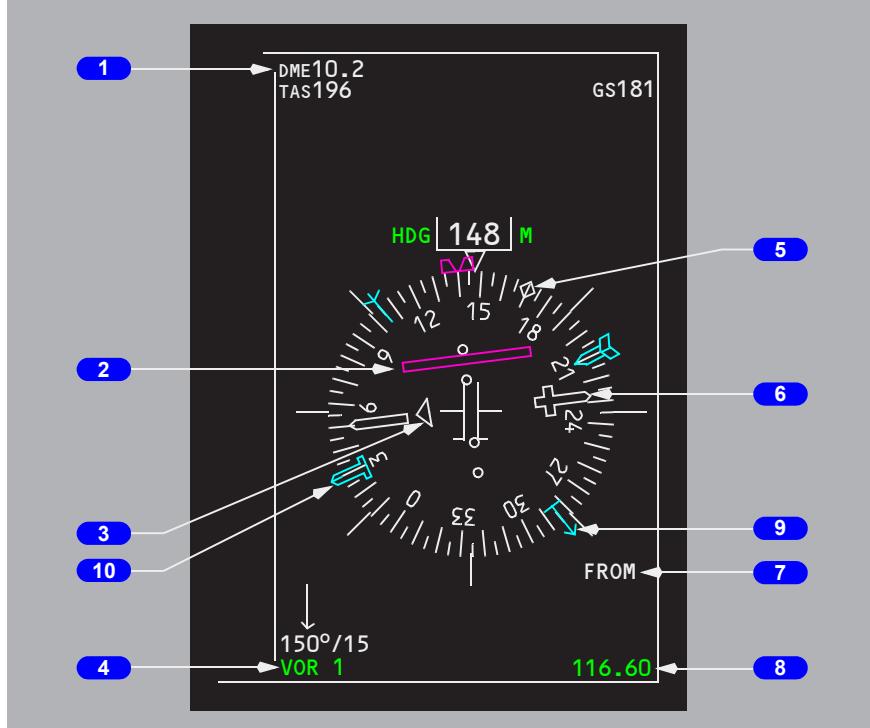
**4** Selected Course Pointer

**5** TO/FROM Indication

**6** Reference VOR Frequency

## Center VOR Mode

[Option - Dual ADF]



- 1** Reference VOR DME
- 2** Lateral Deviation Indication and Scale
- 3** TO/FROM Pointer
- 4** Reference VOR Receiver
- 5** Drift Angle Pointer
- 6** Selected Course Pointer
- 7** TO/FROM Indication

**8 Reference VOR Frequency**

**9 ADF 1 Bearing Pointer**

**10 ADF 2 Bearing Pointer**

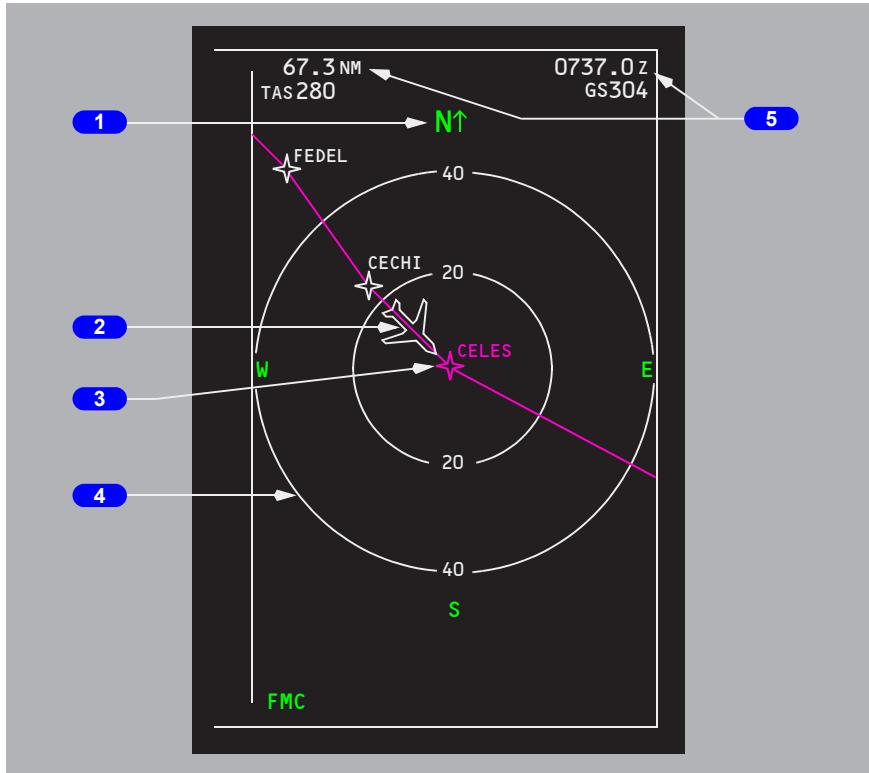
[Option - Dual ADF]

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## Navigation Displays – Plan Mode

### Plan Mode

[Option - Single FMC]



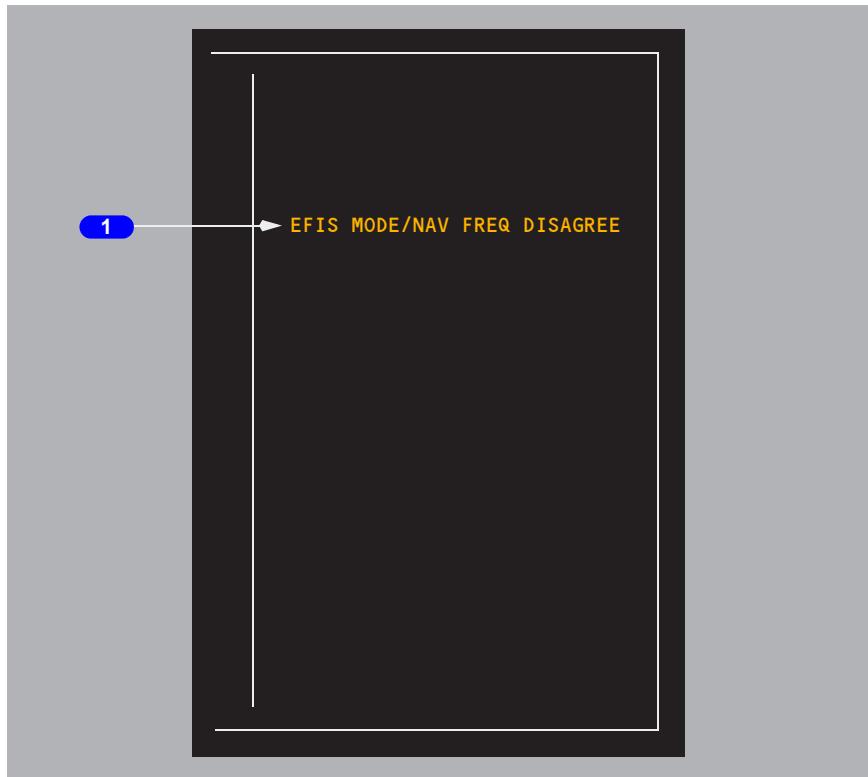
**1 True North Up Arrow**

**2 Airplane Symbol**

Denotes current position and true heading. Symbol does not display north of 82N latitude or south of 82S latitude.

**3 Center Waypoint**

The waypoint located at the display center is identified as CTR on the CDU RTE LEGS page.

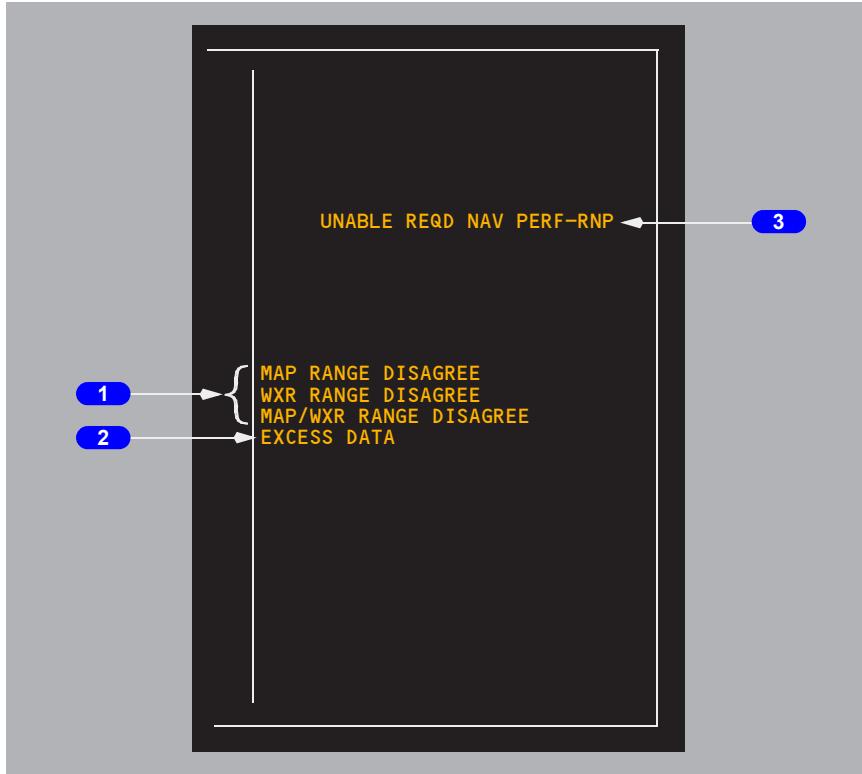
**4 Range Circle****5 Active Waypoint Information****Navigation Displays – Advisory Messages****Mode/Frequency Disagree Annunciation**

## **1 Mode/Frequency Disagree Annunciation (amber)**

Indicates APP is selected with a VOR frequency tuned, or VOR is selected with an ILS frequency tuned.

- the annunciation only applies to an on-side comparison of the EFIS control panel mode and tuned VOR/ILS frequency
- applicable to expanded and center APP and VOR modes
- dashes displayed on DME display and ILS/VOR frequency display
- localizer course deviation bar, VOR course deviation bar, and glide slope pointer (for APP mode) are not displayed.

## **Navigation Advisory Messages**



## **1 Range Disagreement Annunciations (amber)**

**MAP RANGE DISAGREE** – Indicates selected range on the EFIS control panel is different than the MAP display range.

**WXR RANGE DISAGREE** – Indicates selected range on the EFIS control panel is different than the WXR display range.

MAP/WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP and WXR display ranges.

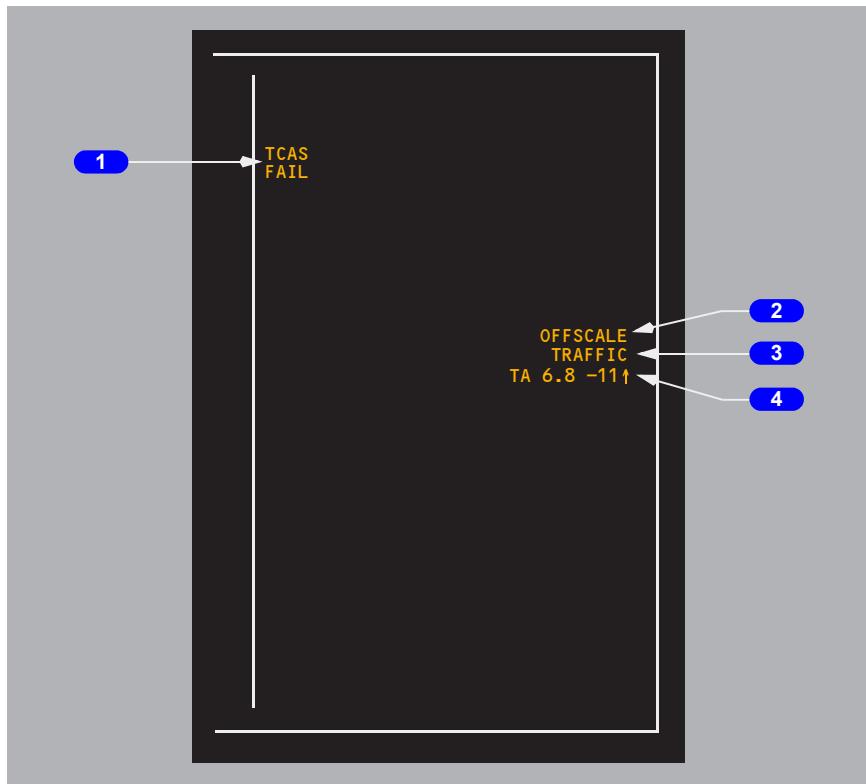
## 2 EXCESS DATA Annunciation (amber)

The amount of data sent to the navigation display exceeds the display capability.

## 3 Nav Advisory Message (amber)

UNABLE REQD NAV PERF–RNP – Displayed in MAP or Center MAP during approach. Refer to Chapter 11 section 60, FMC Messages.

## TCAS Messages



## 1 TCAS Annunciations

TFC (cyan) – TFC selected on the EFIS control panel in Expanded MAP, Center MAP, Expanded APP or Expanded VOR modes.

TCAS TEST (cyan) – TCAS in test mode.

TCAS FAIL (amber) – TCAS has failed.

TA ONLY (cyan) – TCAS TA only mode.

TCAS OFF (amber) – TCAS off.

## **2 OFFSCALE (red or amber)**

TA (amber) or RA (red) is beyond the display range.

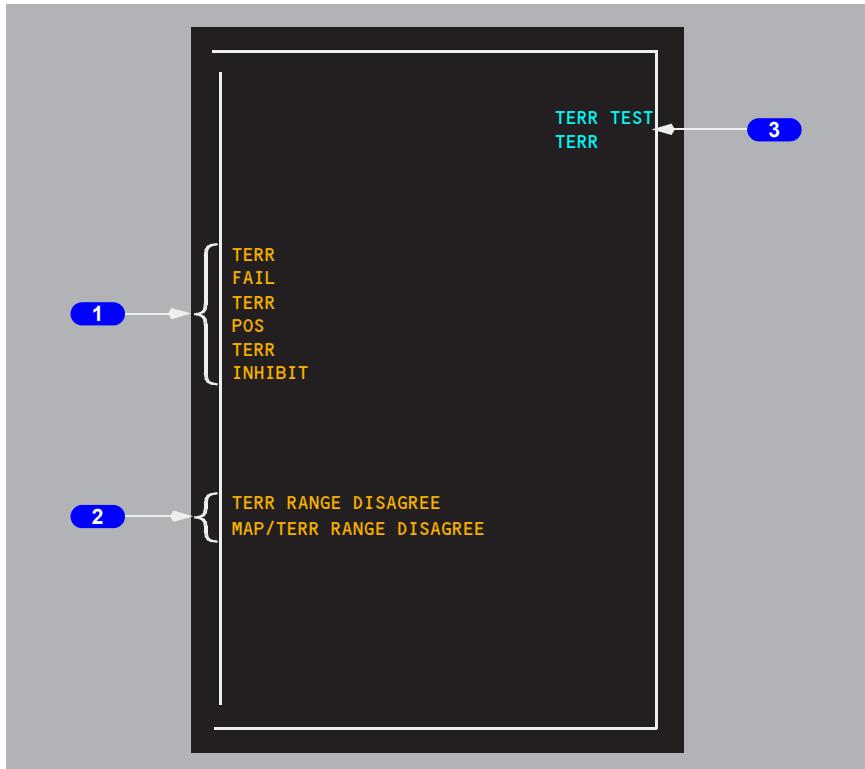
## **3 TRAFFIC (red or amber)**

Displayed during a TA (amber) or RA (red) condition.

## **4 No Bearing Message (red or amber)**

Displayed when no bearing information is available for traffic.

## **Look-Ahead Terrain Messages (GPWS)**



## **1 Terrain Status Annunciation (amber)**

TERR FAIL – Look-ahead terrain alerting and display have failed.

TERR POS – Look-ahead terrain alerting and display unavailable due to position uncertainty.

TERR INHIBIT – GPWS terrain inhibit switch in TERR INHIBIT position.

## **2 Terrain Range Status Annunciation (amber)**

TERR RANGE DISAGREE –

- terrain display enabled, and
- terrain output range disagrees with selected EFIS control panel range.

MAP/TERR RANGE DISAGREE –

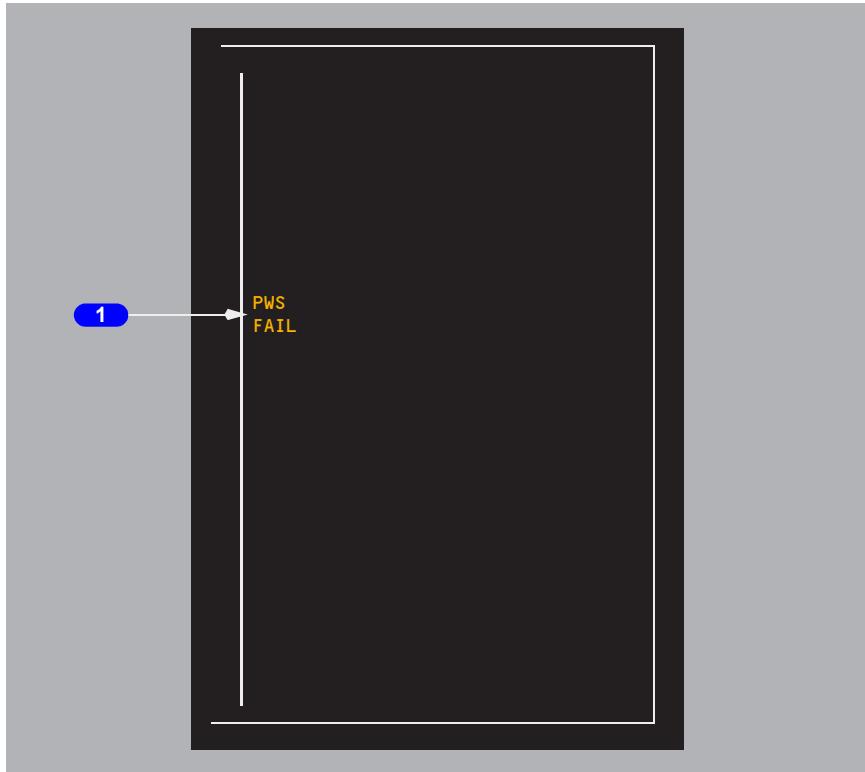
- terrain display enabled, and
- terrain output range disagrees with selected EFIS control panel range, and
- map display output range disagrees with selected EFIS control panel range.

## **3 Terrain Mode Annunciation (cyan)**

TERR TEST – GPWS is operating in self-test mode.

TERR – Terrain display enabled (manual or automatic display).

## Predictive Windshear System (PWS) Message



### **1 PWS FAIL Annunciation (amber)**

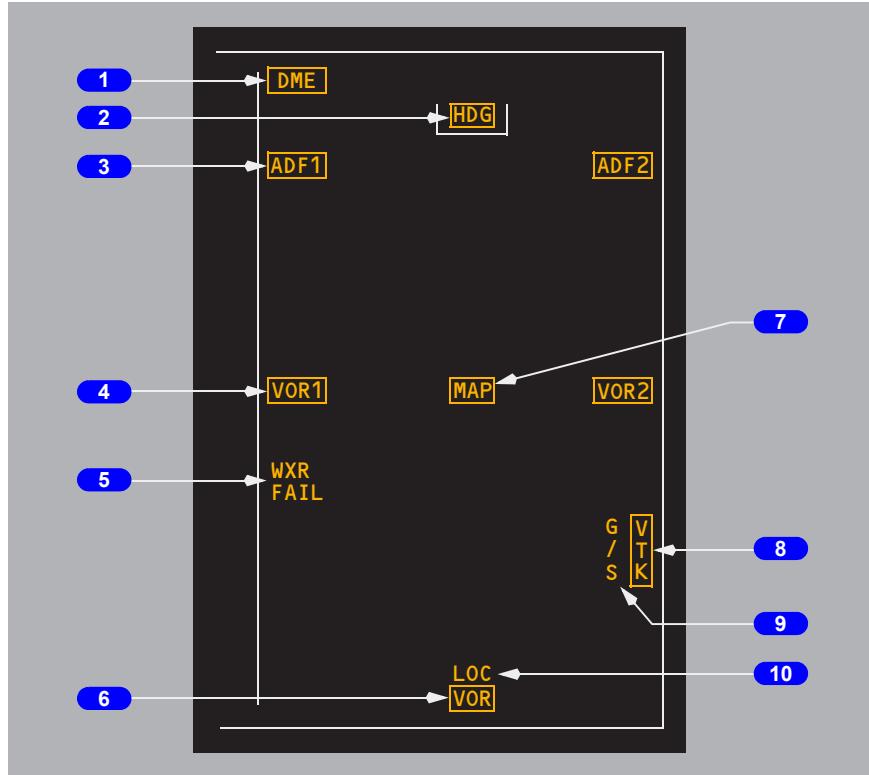
Predictive windshear alerting and display have failed.

## Navigation Displays – Failure Indications and Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate.

### Failure Flags – Expanded MAP, Center MAP, Expanded APP, Expanded VOR Modes

[Option - Heading-up display, dual ADF]



#### 1 DME Failure Flag (APP and VOR modes)

DME indication has failed.

#### 2 Heading Failure Flag (MAP, APP and VOR modes)

[Option - Heading-up display]

Heading information failed. Heading cannot be displayed.

### **3 ADF Failure Flag (MAP, APP and VOR modes)**

#### **[Option - Full time ADF in MAP mode]**

ADF indication has failed.

### **4 VOR Failure Flag (MAP modes)**

EFIS control panel POS switch selected and VOR has failed.

### **5 Weather Radar Annunciations (MAP, APP and VOR modes)**

WXR FAIL – Weather radar has failed. No weather data are displayed.

WXR WEAK – Weather radar calibration fault.

WXR ATT – Attitude stabilization for antenna has been lost.

WXR STAB – Antenna stabilization is off.

WXR DSP – Display unit cooling has been lost or an overheat condition has occurred. Weather radar display is blanked.

### **6 VOR Failure Flag (VOR modes)**

VOR indication has failed.

### **7 MAP Failure Flag (MAP modes)**

The related FMC generated map display has failed.

### **8 Vertical Track Failure Flag (MAP modes)**

FMC vertical track data is invalid.

### **9 ILS Glide Slope Failure Flag (APP modes)**

ILS glide slope has failed.

### **10 ILS Localizer Failure Flag (APP modes)**

ILS localizer course indication has failed.

## Vertical Situation Display (VSD)

### [Option VSD]



#### **1 Range Disagreement Annunciations (amber)**

MAP RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP display range.

TERR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the Terrain display range.

MAP/TERR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP and Terrain display ranges.

#### **2 Runway Data Annunciation (amber)**

FMC runway data is not available.

#### **3 Route Waypoints Modification Annunciation (white)**

FMC active route is being modified. Only active waypoint is displayed.

#### **4 VSD Failure Flag (amber)**

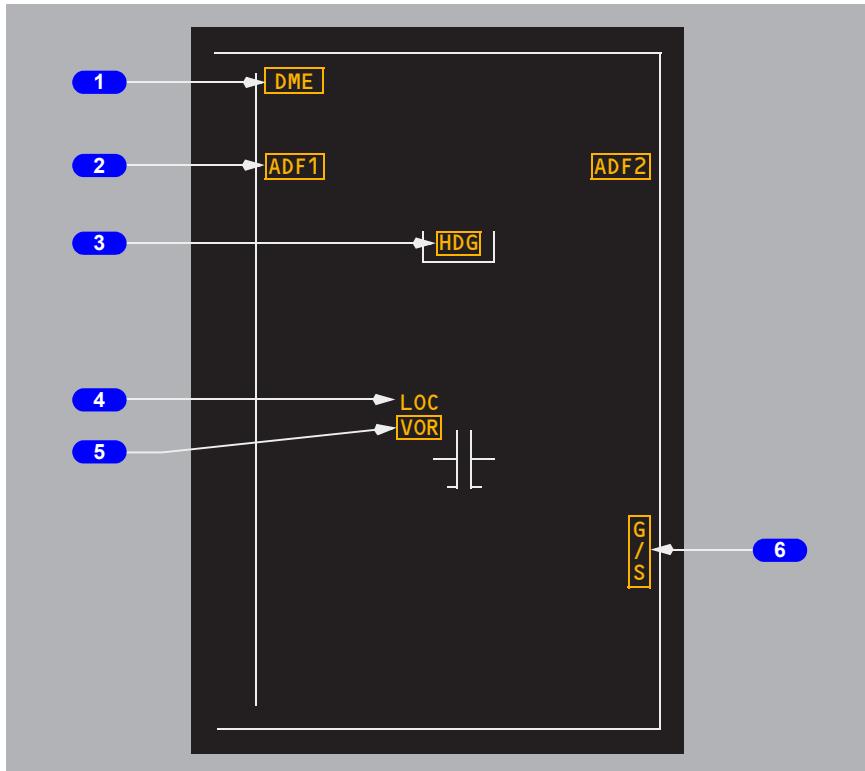
VSD cannot be displayed.

#### **5 Terrain Data Failure Annunciation (amber)**

EGPWS terrain data is not available. Annunciation is replaced with VSD TERR INHIBIT when GPWS control panel TERR INHIBIT switch is in the inhibit position.

## Failure Flags – Center APP and Center VOR Modes

[Option - Dual ADF]



### **1 DME Failure Flag (APP and VOR modes)**

DME indication has failed.

### **2 ADF Failure Flag (APP and VOR modes)**

ADF has failed.

### **3 Heading Failure Flag (APP and VOR modes)**

Heading information failed. Heading cannot be displayed.

### **4 ILS Localizer Failure Flag (APP modes)**

ILS localizer indication has failed.

**5 VOR Failure Flag (VOR modes)**

VOR indication has failed.

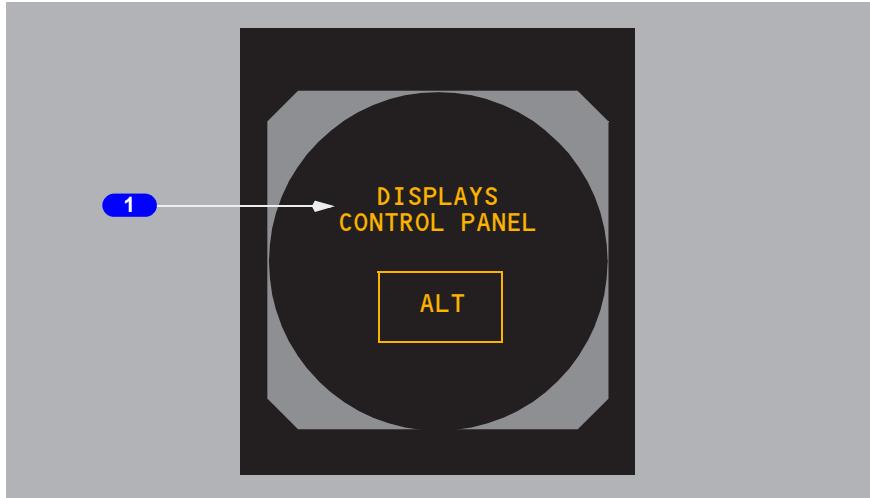
**6 ILS Glide Slope Failure Flag (APP modes)**

ILS glide slope indication has failed.

---

## Additional Flags and Annunciations

### Displays Control Panel Annunciation

**1 Displays Control Panel Annunciation (amber)**

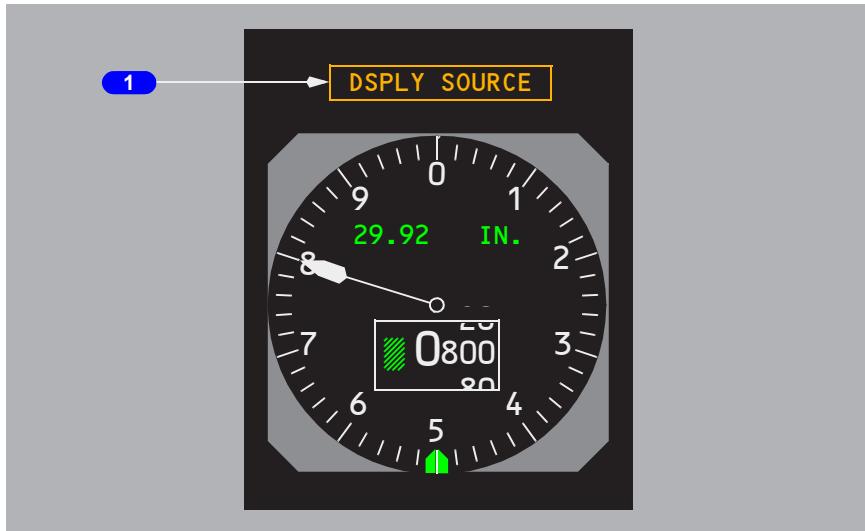
With the CONTROL PANEL select switch on the overhead panel in:

- BOTH ON 1 - left (Capt) EFIS control panel has failed
- NORMAL - corresponding EFIS control panel has failed
- BOTH ON 2 - right (F/O) EFIS control panel has failed.

Altitude information is removed.

## Display System Annunciations

**Note:** The following annunciations occupy the same display location above the altimeter.



### 1 Display System Annunciations

**DSPLY SOURCE** (amber) – A single DEU has been selected, either manually or automatically, to drive all six display units.

- If the DEU fails on the same side as the engaged autopilot during climb or descent –

#### [Option – Split axis command bars]

- the flight director pitch command bars are removed from both pilots' displays. The pitch command bars reappear at ALT ACQ
- the pitch mode reverts to CWS pitch
- the autopilot remains engaged.
- If the DEU fails on the same side as the engaged autopilot during level flight –
  - climb or descent to a new MCP altitude is not possible in LVL CHG, VNAV, or V/S modes with the autopilot engaged.
- If the DEU fails on the opposite side as the engaged autopilot or while in manual F/D mode during climb or descent –

#### [Option – Split axis command bars]

- the flight director pitch command bar is removed from the pilot's display on the failed side until ALT ACQ

- climb or descent is possible in LVL CHG, VNAV or V/S modes with the autopilot engaged.
- If the DEU fails on the same side as the engaged autopilot in the APPROACH mode –

**[Option – Split axis command bars]**

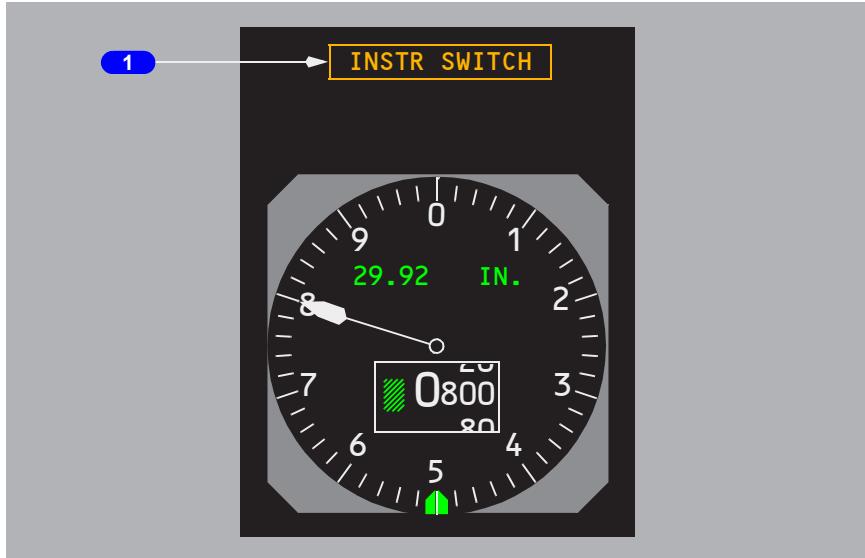
- the flight director pitch and roll command bars are removed from the pilot's display on the failed side.

**[Option - With CDS Block software upgrade]**

CDS MAINT (white) – A dispatchable CDS fault has occurred. Displayed on the ground only, prior to start of the second engine.

CDS FAULT (amber) – A non-dispatchable CDS fault has occurred. Displayed on the ground only, prior to start of the second engine.

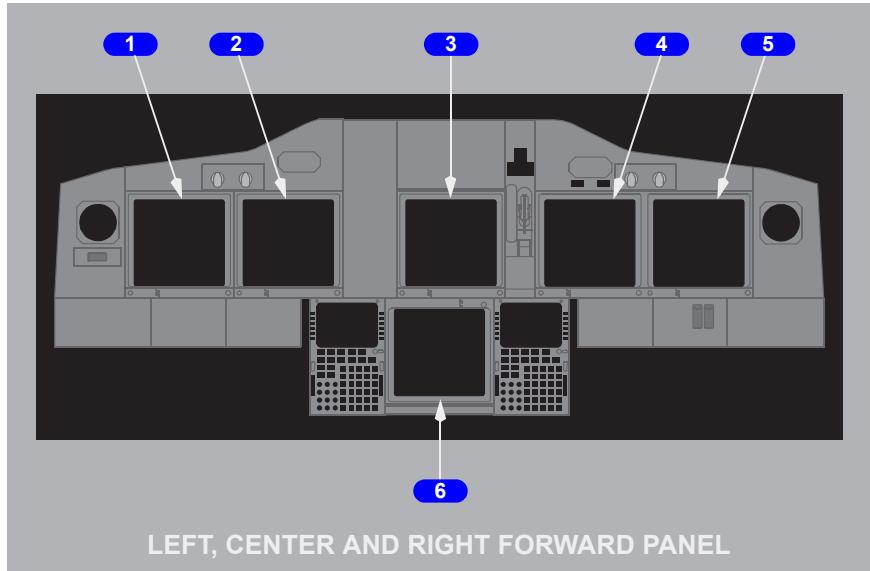
## Instrument Switch Annunciation



**1 INSTR SWITCH Annunciation (amber)**

Indicates both the Captain's and First Officer's displays are using the same source of IRU data. Displayed when the IRS switch on the overhead panel is not in the NORMAL position.

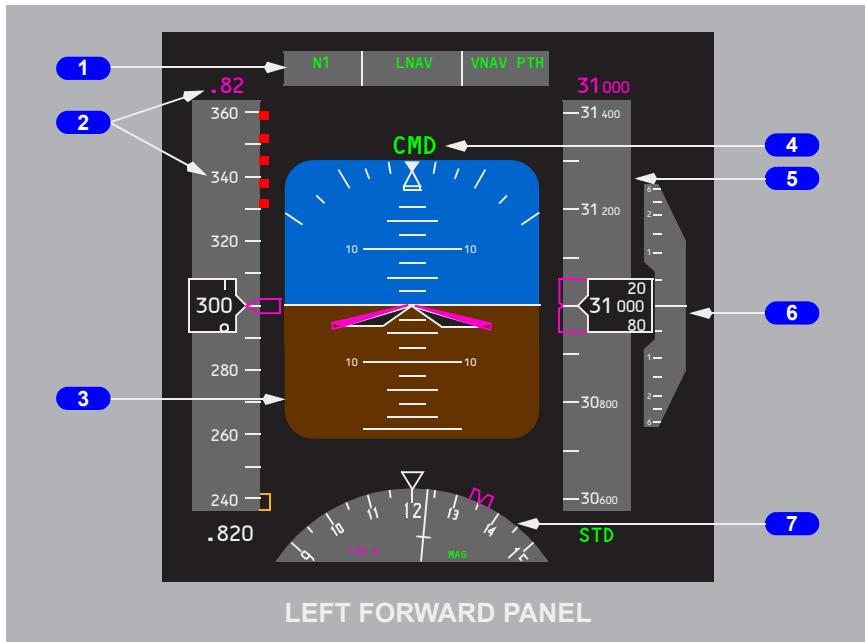
Intentionally  
Blank

**Flight Instruments, Displays****Chapter 10****PFD/ND – Displays****Section 11****PFD/ND Display System – Overview****Display Units**

- 1 Captain Outboard Display Unit**
- 2 Captain Inboard Display Unit**
- 3 Upper Display Unit**
- 4 First Officer Inboard Display Unit**
- 5 First Officer Outboard Display Unit**
- 6 Lower Display Unit**

## Captain Outboard Display

[Option - Integrated cue command bar]



### 1 Flight Mode Annunciator

Refer to Chapter 4, Automatic Flight

### 2 Airspeed/Mach Indications

### 3 Attitude Indications

### 4 Autopilot, Flight Director System Status

### 5 Altitude Indications

### 6 Vertical Speed Indications

### 7 Heading/Track Indications

## Captain Inboard Display

[Option - Track-up display, dual FMC]



### **1** Navigation Display

Displays map, approach, VOR, or plan modes as selected on the EFIS control panel.

## First Officer Inboard Display

[Option - Track-up display, dual FMC]

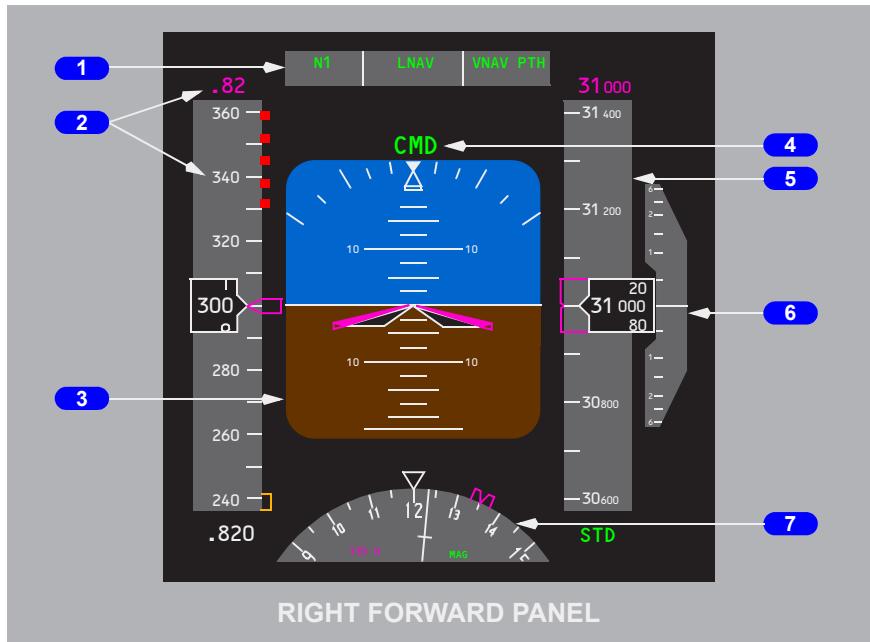


### 1 Navigation Display

Displays map, approach, VOR, or plan modes as selected on the EFIS control panel.

## First Officer Outboard Display

[Option - Integrated cue command bar]



### 1 Flight Mode Annunciator

Refer to Chapter 4, Automatic Flight

### 2 Airspeed/Mach Indications

### 3 Attitude Indications

### 4 Autopilot, Flight Director System Status

### 5 Altitude Indications

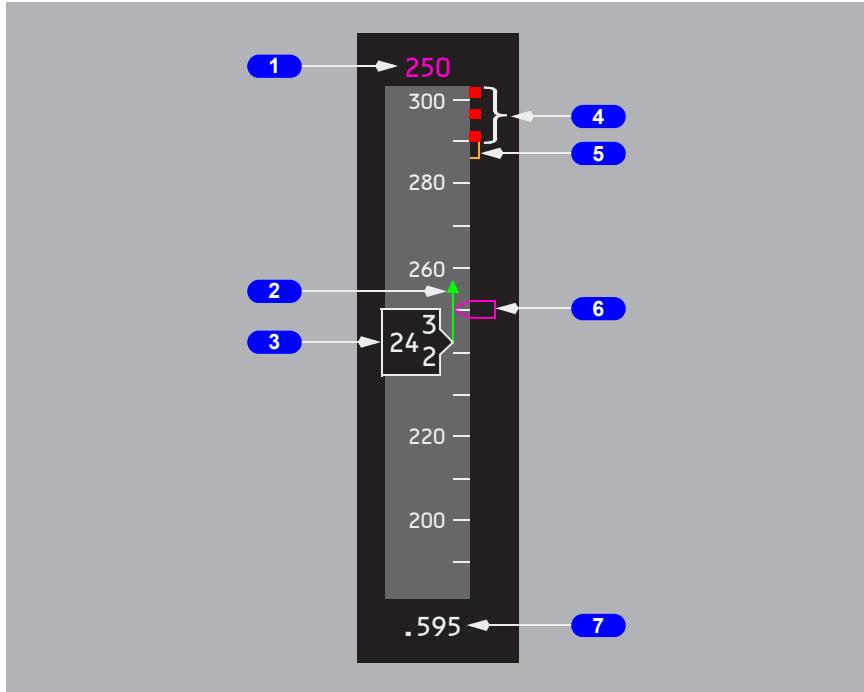
### 6 Vertical Speed Indications

### 7 Heading/Track Indications

## Primary Flight Display (PFD)– PFD Airspeed Indications

### PFD Airspeed Indications – General

The PFD airspeed indication displays air data inertial reference system (ADIRS) airspeed and other airspeed related information.



#### **1 Selected Speed (magenta)**

Displays target airspeed:

- indicates the airspeed manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

#### **2 Speed Trend Vector (green)**

Tip of arrow indicates predicted airspeed in the next 10 seconds based on the current airspeed and acceleration.

**3 Current Airspeed (white)**

Indicates current calibrated airspeed in knots.

**[Option - Low airspeed alert]**

When current airspeed decreases into the minimum maneuver speed amber bar:

- airspeed readout box turns amber and flashes for 10 seconds.
- box returns to white when airspeed is above minimum maneuver speed.

**4 Maximum Speed (red and black)**

Bottom of the bar indicates the maximum speed as limited by the lowest of the following:

- Vmo/Mmo
- landing gear placard speed
- flap placard speed.

**5 Maximum Maneuvering Speed (amber)**

Bottom of the bar indicates the airspeed that provides a 0.3 g maneuver margin to high speed buffet. May be displayed at high altitude with flaps up, at relatively high gross weights.

**6 Speed Bug (magenta)**

Points to the airspeed:

- manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

When the selected speed is off scale, the bug is parked at the top or bottom of the tape, with only one half bug visible.

**7 Current Mach (white)****[Option - Without groundspeed displayed]**

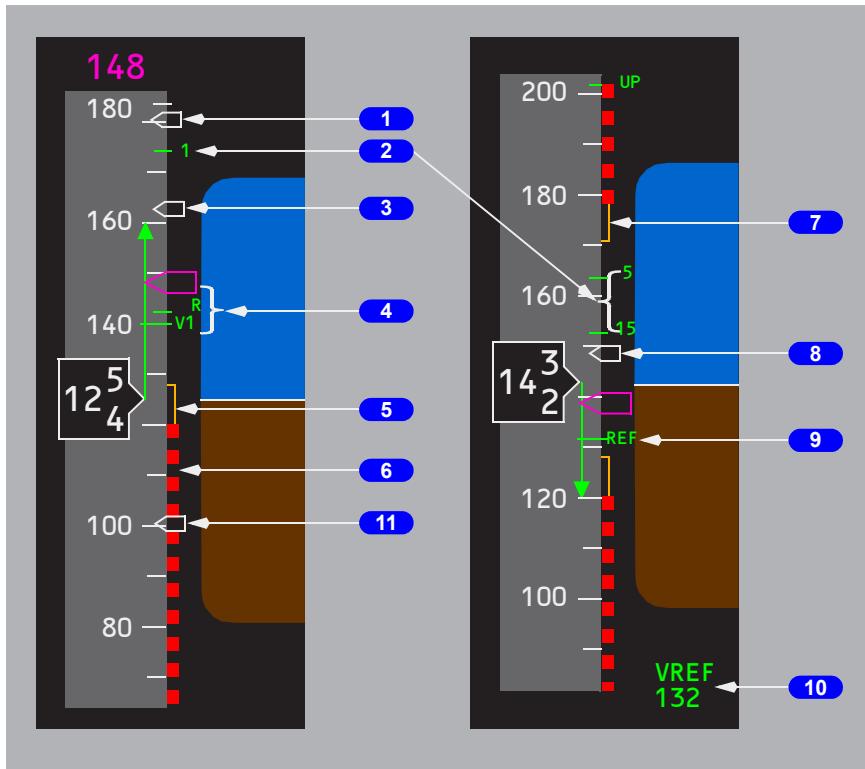
Indicates current Mach number:

- displays when airspeed is 0.40 Mach and above
- blanks when airspeed decreases below 0.40 Mach.

**7 Current Mach/Groundspeed (white)****[Option - With groundspeed displayed]**

Indicates current Mach or groundspeed:

- displays Mach when airspeed is 0.40 Mach and above
- displays groundspeed when airspeed decreases below 0.40 Mach
- when transitioning from Mach to groundspeed or from groundspeed to Mach, a white box shows around the numeric value for 10 seconds.

**PFD Airspeed Indications – Takeoff and Approach****[Option - 100 knot airspeed bug]****1 Bug 5 (white)**

Displayed if speed reference selector on the engine display control panel is in the bug 5 position or SET position and a value greater than 60 knots has been selected. Not available if the speed reference selector is in the AUTO position.

**2 Flaps Maneuvering Speeds (green)**

Indicates flap maneuvering speed for the displayed flap position:

- displayed after gross weight is entered in the CDU or after takeoff gross weight is set with the speed reference selector
- when the V2+15 bug is displayed for takeoff, the flap maneuvering speed bug for the current flap setting is not displayed, except for flaps 1 takeoff.
- numbered flap maneuvering speed bugs are removed when flap lever is moved to flaps 30 or 40
- flap bugs inhibited if less than VREF +4
- UP bug not displayed above approximately 20,000 feet altitude.

**3 V2+15 (white)**

Displayed for takeoff.

Removed when either of the following occurs:

- at first flap retraction
- when VREF is entered in the CDU.

**4 Takeoff Reference Speeds (green)**

Indicates V1 (decision speed “V1”) and VR (rotation speed “VR”) as selected on the CDU TAKEOFF REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the SPD REF selector switch:

- amber NO VSPD is displayed on the ground if V1 and VR are not selected on the CDU or are not set with the SPD REF selector
- displayed for takeoff when speed is greater than 80 knots
- removed at lift-off
- V1 speed is displayed at the top of airspeed indication when selected and value is off scale.

**[Option - V1 aural alert]**

- V1 is automatically called out by voice aural.

**Note:** The Look Ahead Terrain Alerting system must be incorporated for the automatic V1 aural callout to be functional.

**5 Minimum Maneuver Speed (amber)**

Top of bar indicates minimum maneuver speed for full maneuver capability and provides 40° bank capability in 1g flight to stick shaker or initial buffet.

Inhibited on takeoff until first flap retraction or valid VREF entered.

**6 Minimum Speed (red and black)**

Top of bar indicates the speed at which stick shaker occurs.

## 7 Maximum Maneuvering Speed (amber)

[Option] - CDS Software Upgrade - BP02/04/06

When flaps are not up, bottom of the bar indicates flap limit placard speed for the next normal flap setting. The display logic is based on a normal flap setting sequence of 1, 5, 15, 30. The bar is removed when the flap lever is moved to the landing flap selected on the APPROACH REF page or when the flap lever is moved to flaps 40.

## 8 VREF+20 (white)

Displayed after selection of VREF.

## 9 Landing Reference Speed (green)

Indicates REF (reference speed) as selected on the CDU APPROACH REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel.

REF speed is displayed at the bottom of airspeed indication when selected and value is off scale.

## 10 Speed Reference Display (green)

Displayed if the airspeed and/or weight is entered via the speed reference selector on the engine display control panel:

- on the ground, V1, VR, and takeoff gross weight may be selected; if VREF is selected, INVALID ENTRY is displayed
- in flight, VREF and landing gross weight may be selected; if V1 or VR is selected, INVALID ENTRY is displayed
- removed when the speed reference selector is moved to the SET position.

## 11 100 Knot Airspeed Bug (white)

[Option - 100 knot airspeed bug]

Indicates 100 knots:

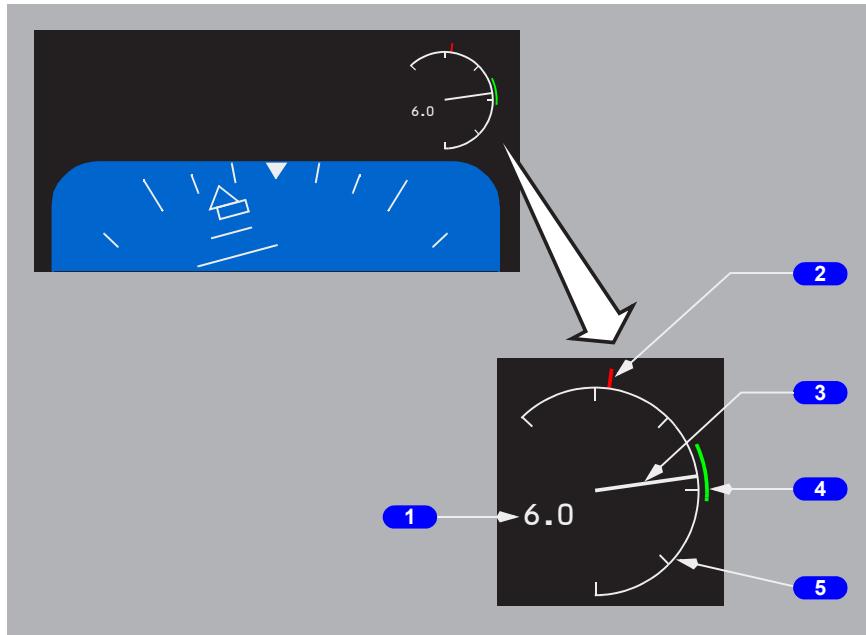
- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

## PFD Angle of Attack (AOA) Indications

### [Option]

#### Angle of Attack Indications - General

The angle of attack indications display ADIRU aircraft body angle of attack.



##### **1 Digital AOA Readout (white)**

Indicates digital AOA value to the nearest 0.2 degrees. When on the ground and ground speed less than 80 knots, the readout is fixed at 0.0 degrees.

##### **2 Stick Shaker Indicator (red)**

Indicates point at which stick shaker activation occurs for existing flight conditions.

Blank if AOA signal is invalid.

##### **3 Analog Needle (white)**

Indicates analog AOA value.

- needle travel is limited to a range of -6 degrees and +21 degrees
- fixed at 0.0 degrees when on the ground and ground speed is less than 80 knots.

**4 Approach Reference Band (green)**

Indicates appropriate range of approach AOA for a Vref(xx) + 5 approach.

- displayed when in normal or single engine landing flaps (15, 30, 40)
- moves with flap position
- inhibited on takeoff and initial climb.

**5 Zero Degree Reference Line (white)**

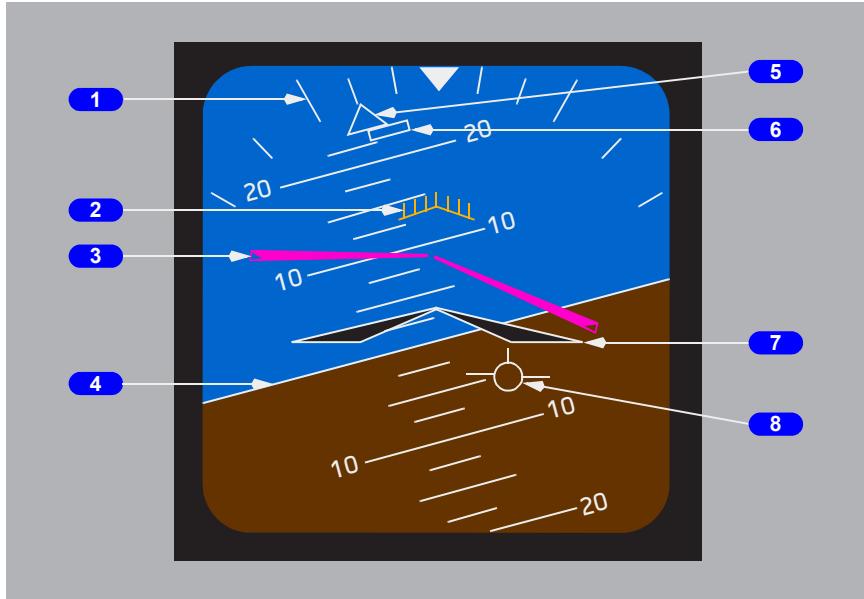
Indicates zero degrees angle of attack. Reference lines are displayed every 5 degrees from -5 degrees to +20 degrees.

---

**PFD – Attitude Indications****Attitude Indications – General**

The attitude indication displays ADIRS attitude information.

[Option - Integrated cue command bar]

**1 Bank Scale (white)**

Provides fixed reference for the bank pointer; scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

**2 Pitch Limit Indication (amber)**

Indicates pitch limit (stick shaker activation for existing flight conditions).

- displayed when the flaps are not up.

**[Option - PLI pop-up]**

- displayed at slow speeds with the flaps up.

**3 Flight Director Bar (magenta)**

Indicates flight director steering commands. (Refer to Chapter 4, Automatic Flight.)

**4 Horizon Line and Pitch Scale (white)**

Indicates the horizon relative to the airplane symbol; pitch scale is in 2.5 degree increments.

**5 Bank Pointer**

Indicates bank angle; fills and turns amber if bank angle is 35 degrees or more.

**6 Slip/Skid Indication**

Displaces beneath the bank pointer to indicate slip or skid:

- fills white at full scale deflection
- turns amber if bank angle is 35 degrees or more; fills amber if the slip/skid indication is also at full scale deflection.

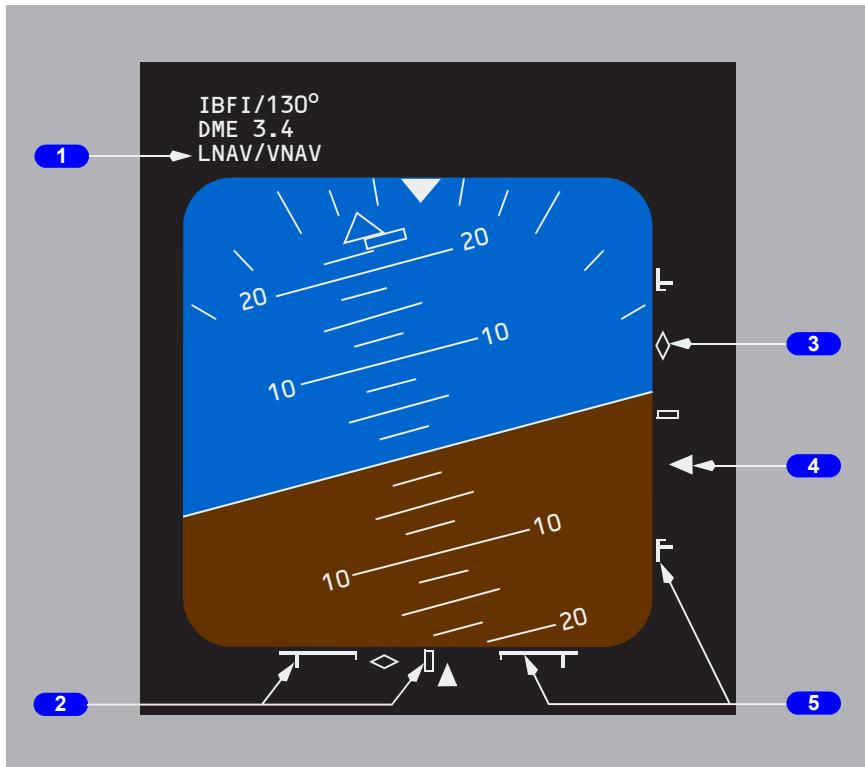
**7 Airplane Symbol**

Indicates airplane attitude relative to the horizon.

**8 Flight Path Vector (FPV) Indication (white)**

Displays flight path angle and drift when selected on the EFIS control panel:

- flight path angle is displayed relative to the horizon line
- drift angle is displayed relative to display center.

**PFD Navigation Performance Scales (NPS) Indications****[Option - NPS scale and pointer]****1 Scale ID Annunciation (white)**

- displayed above the left corner of ADI.
- indicates the source of displayed deviation for each scale.
- displayed when LNAV, VNAV, or TO/GA is engaged.
- Possible annunciations include:
  - INAV/VNAV - (LNAV and VNAV deviations)
  - LOC/VNAV - (ILS localizer course with VNAV deviation)
  - FAC/VNAV - (IAN final approach course with VNAV deviation)
  - LNAV/ G/S - (LNAV deviation with glideslope)
  - LNAV/ G/P - (LNAV deviation with IAN glidepath)
  - LOC/ G/P - (ILS localizer course with FMC glidepath)
  - ILS - (ILS approach)
  - FMC - (IAN approach)
  - GLS - (GLS approach)

**2 NPS Deviation Scale**

- lateral NPS deviation scale represents current FMC lateral RNP.
- vertical NPS deviation scale represents current FMC vertical RNP.
- displayed if an approach mode is not engaged and either TO/GA, LNAV or any VNAV mode is engaged.

**3 Anticipation Cues**

- displayed if valid approach course deviation information is being received while corresponding NPS deviation scale and pointer are displayed.
- an unfilled white diamond symbol.
- if engaged lateral mode subsequently transitions to LOC or IAN FAC, lateral NPS deviation indications will be removed, and normal ILS localizer or IAN FAC indications will be displayed.
- if engaged vertical mode subsequently transitions to G/S or IAN G/P, vertical NPS deviation indications will be removed, and normal ILS G/S or IAN G/P indications will be displayed.

**4 NPS Pointer**

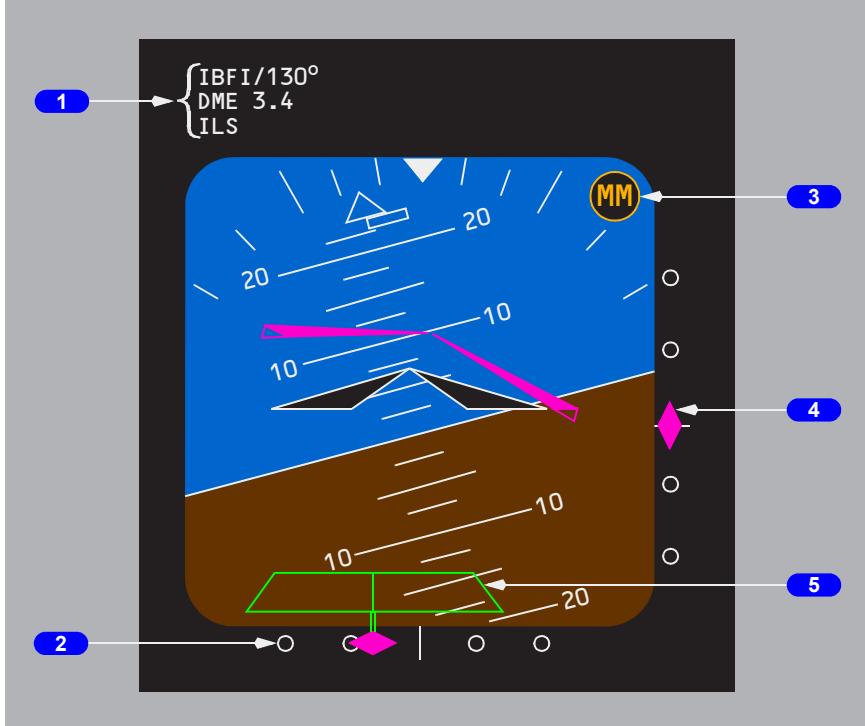
- a filled magenta symbol when it is not parked at deflection limit.
- an unfilled pointer outline when at deflection limit.
- indicates lateral/vertical paths relative to the airplane.
- will flash for 10 seconds if deviation is within ANP bar limits for 10 continuous seconds.

**5 Actual Navigation Performance (ANP) Bars**

- lateral/vertical indication of available flight technical error remaining based on total system error.
- lateral ANP bars can be displayed in all phases of flight.
- vertical ANP bars can be displayed only after reaching top-of-descent.
- originate from outer scale and expand inward as a function of increasing ANP relative to RNP.
- will just touch at center of scale when ANP equals RNP.
- turn from white to amber if current deviation is within the ANP bar limits for 10 continuous seconds.

## PFD Instrument Landing System Indications

[Option - Integrated cue command bar, rising runway, IAN]



### 1 Approach Reference

Set ILS frequency is displayed before the identifier is decoded. If the Captain's and First Officer's tuned frequencies or approach courses disagree for more than one minute, the identifier turns amber with an amber horizontal line until set identically.

[Option - IAN]

Displays the selected ILS/IAN frequency or identifier, approach course, ILS/DME/FMC distance and source annunciation.

[Option - GLS]

Displays the selected GLS identifier, channel, selected course, GLS approach distance and source annunciation.

If the Pilot's and First Officer's tuned GLS channels or approach courses disagree for more than one minute, the indication turns amber with an amber horizontal line until set identically.

**2 Localizer/FAC Pointer and Deviation Scale****[Option - IAN]**

The pointer:

- indicates localizer or FAC position relative to the airplane.
- in view when the localizer signal is received or IAN approach selected.
- fills in solid magenta when within 2 ½ dots from center.

The scale:

- indicates deviation.
- in view when the localizer frequency is tuned or IAN approach selected.
- expands when the localizer or FAC is engaged and deviation is slightly more than ½ dot.

At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive localizer or FAC deviation.

Below 1,000 feet AGL, with LNAV engaged and LOC or FAC armed, the localizer/FAC scale turns amber and the pointer flashes if the localizer or FAC is not captured.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC or FAC deviation alerting display on each attitude indicator.

**3 Marker Beacon symbol**

Flashes (and audible) when over one of the marker beacons:

OM (cyan) - outer marker beacon (two dashes per second)

MM (amber) - middle marker beacon (alternate dot and dash)

IM (white) - inner marker beacon (only dots).

**4 Glide Slope/Glide Path Pointer and Deviation Scale****[Option - IAN]**

The pointer:

- indicates glide slope/glide path position.
- in view when the glide slope signal is received or IAN approach is selected.
- fills in solid magenta when within 2 ½ dots from center.
- the pointer is not displayed when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse).

The scale:

- indicates deviation.
- in view when the localizer frequency is tuned or IAN approach is selected.

At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive glide slope/glide path deviation.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second G/S or G/P deviation alerting display on each attitude indicator.

## 5 Rising Runway (green with magenta stem)

### [Option - Rising runway]

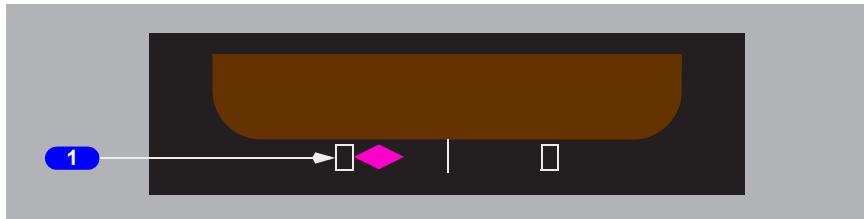
Displayed when:

#### [Option - IAN]

- localizer signal usable or IAN approach selected and pointer is in view.
- radio altitude is less than 2500 feet.

Rises towards airplane symbol when radio altitude is below 200 feet.

## Expanded Localizer Indications



## 1 Expanded Localizer Scale

### [Option - Autopilot or flight director activation]

Displayed when the autopilot or flight director is in LOC mode, deviation is slightly more than  $\frac{1}{2}$  dot and track is within 5 degrees of the MCP selected course.

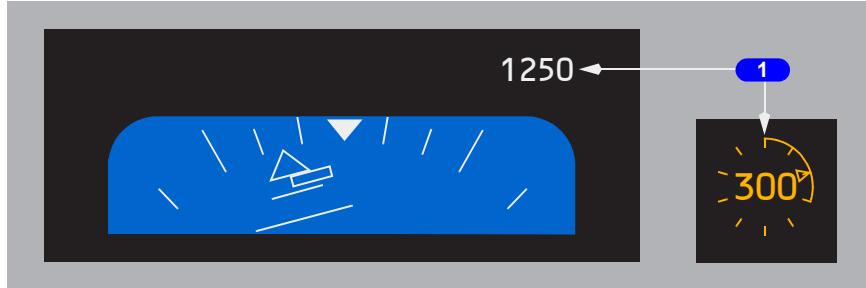
As deviation increases, the deviation pointer remains filled in solid magenta and parks at the limit of the expanded scale. Once the deviation reaches the equivalent of 2.4 dots from center on the standard scale, the pointer becomes unfilled.

Reverts to standard scale when out of LOC mode, and groundspeed is less than 30 knots or radio altitude is greater than 200 feet.

A rectangle equals  $\frac{1}{2}$  dot deviation.

## PFD Radio Altitude Indications

[Option - Radio altitude above, round dial]



### 1 Radio Altitude – Round Dial

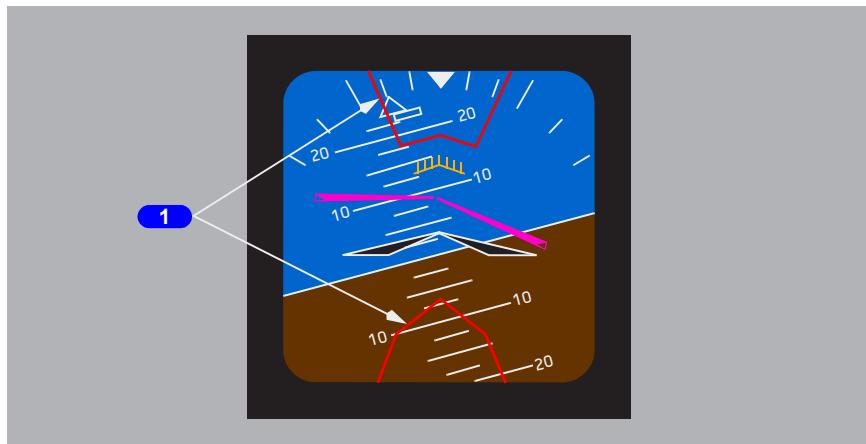
[Option - Radio altitude above, round dial]

Displayed below 2500 feet AGL:

- digital display from 2500 to 1000 feet AGL
- box highlighted white for 10 seconds upon descent below 2500 feet
- round dial displays below 1000 feet AGL
- pointer indicates selected radio altitude minimums
- the circumference of the dial is added to, or taken away from, to depict the airplane's radio altitude
- the remaining perimeter and pointer turn amber and flash for 3 seconds when below radio altitude minimums, the numeric readout does not flash.

## Traffic Alert and Collision Avoidance Indications

[Option - Integrated cue command bar]

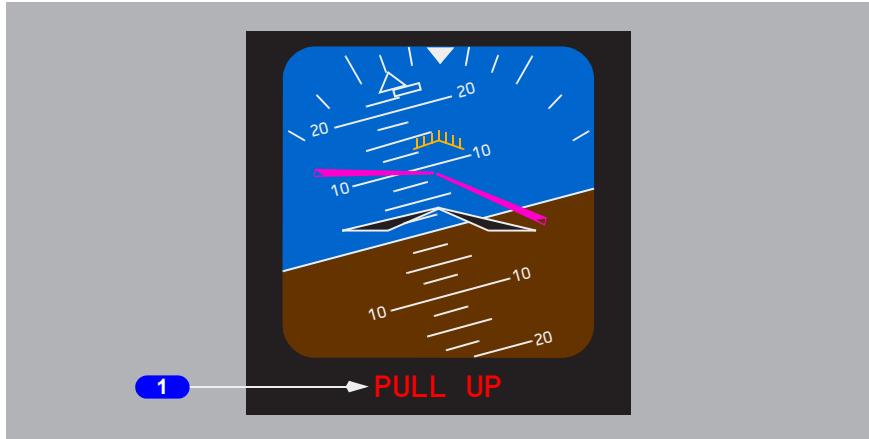


**1 Traffic Alert and Collision Avoidance System Pitch Command (red)**

The area(s) inside the red lines indicate(s) the pitch region(s) to avoid in order to resolve the traffic conflict. The airplane symbol must be outside the TCAS pitch command area(s) to ensure traffic avoidance. Refer to Chapter 15, Warning Systems.

**GPWS Annunciations**

[Option - Integrated cue command bar]

**1 GPWS Annunciations (red)**

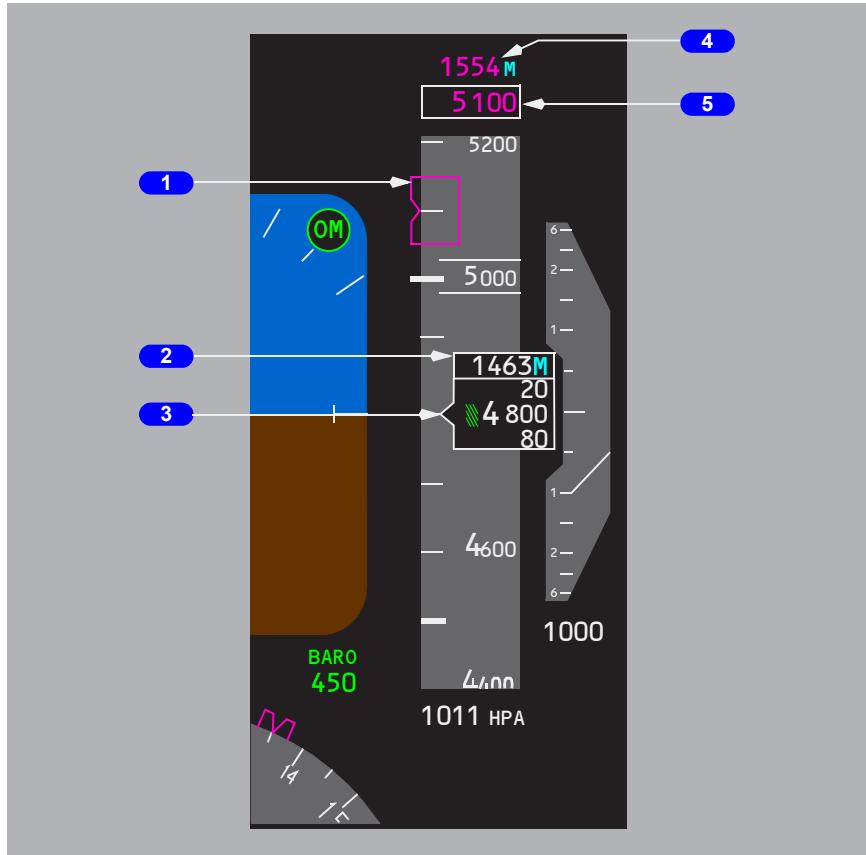
Displays WINDSHEAR or Pull UP alert.

Refer to Chapter 15, Warning Systems.

## PFD – Altitude Indications

### Altitude Indications– General

The altitude indication displays ADIRS altitude and other altitude related information.



#### 1 Selected Altitude Bug (magenta)

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

#### 2 Metric Digital Readout (readout and box–white, metric symbol–cyan)

Displays current altitude in meters when MTRS is selected on the EFIS control panel.

**3 Current Altitude**

Displays current altitude in increments of thousands, hundreds and twenty feet:

- for positive values of altitude below 10,000 feet, a green crosshatch symbol is displayed
- a negative sign appears when altitude below zero feet is displayed
- readout box becomes bold to denote altitude acquisition
- readout box is highlighted in amber and flashes to denote altitude deviation (refer to Chapter 4, Automatic Flight and Chapter 15, Warning Systems).

**4 Metric Selected Altitude Readout (readout—magenta, metric symbol—cyan)**

Displays MCP altitude in meters when MTRS is selected on the EFIS control panel.

**5 Selected Altitude (magenta)**

Displays the altitude set in the MCP altitude window.

The selected altitude box appears in white during an altitude alert. For more information, refer to Chapter 15, Warning Systems.

## PFD Barometric Indications

[Option - Altimeter with QFE]

**1 Barometric Settings (green)**

Indicates the barometric setting in either inches of mercury (IN) or hectopascals (HPA) as selected on the EFIS control panel.

Display is boxed amber if numeric is set and airplane is climbing above transition altitude, or if STD is set and descending below transition flight level.

**2 Preselected Barometric Setting (white)**

STD is displayed when the Barometric Standard (STD) switch is selected on the EFIS control panel.

When STD is displayed, a barometric setting can be preselected on the EFIS control panel barometric selector and is displayed in small white characters below STD.

**3 QFE Altitude Reference (green)****[Option - Altimeter with QFE]**

Indicates QFE altitude reference if selected on the CDU APPROACH REF Page or TAKEOFF REF Page 2/2.

When selected, QFE is boxed for 10 seconds.

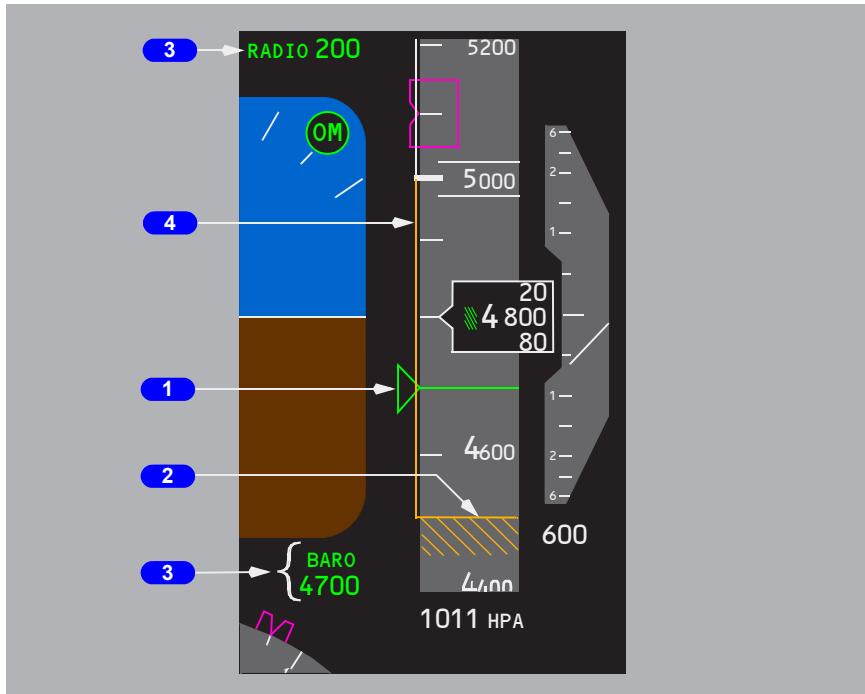
The altitude tape is shaded green during QFE operation.

When QNH is selected, the green shading is removed; QNH is displayed for 10 seconds, then blanks.

When STD is displayed, QFE in small white characters is displayed below STD, and a QFE altimeter setting can be preselected.

## Landing Altitude/Minimums Indications

[Option - Radio altitude above ADI, landing altitude reference bar]



### 1 BARO Minimums Pointer (green)

Indicates the barometric minimums selected on the EFIS control panel:

- pointer and line turn amber when airplane descends below selected minimum altitude
- reset with the RST switch on the EFIS control panel.

### 2 Landing Altitude Indication (amber)

The crosshatched area indicates:

- the FMC landing altitude for the destination runway or airport, or
- the landing altitude for departure runway or airport until 400 NM from departure or one-half the distance to destination, whichever occurs first.

### 3 Minimums Reference/Altitude (green)

[Option - Radio altitude above ADI]

Displays approach minimum reference and altitude set by the MINS selector on the EFIS control panel:

**BARO -**

- displayed below ADI when selector is set to BARO, minimums are in feet MSL
- turns amber and flashes for 3 seconds when airplane descends below selected minimum altitude.
- changes back to green:
  - when passing the selected minimum altitude plus 75 feet during go-around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

**RADIO -**

- displayed above ADI when selector is set to RADIO, minimums are in feet AGL
- blank when an altitude less than 0 feet is selected
- turns amber and flashes for 3 seconds when airplane descends below selected minimum altitude
- changes back to green:
  - when passing the selected minimum altitude plus 75 feet during go-around
  - at touchdown
  - after pressing the RST switch on the EFIS control panel.

**4 Landing Altitude Reference Bar****[Option]**

Indicates height above touchdown:

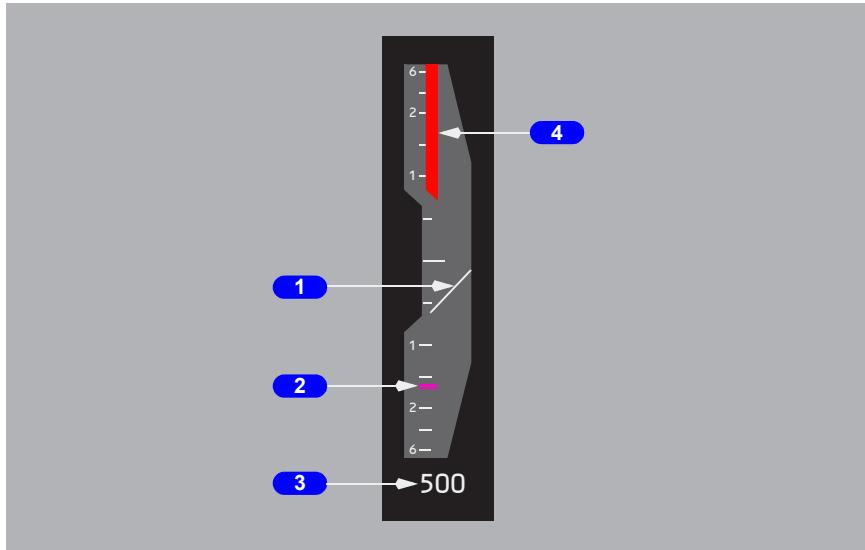
- White bar - 500 to 1000 feet above landing altitude
- Amber bar - 0 to 500 feet above landing altitude.

## PFD – Vertical Speed Indications

### Vertical Speed Indications – General

The vertical speed indication displays ADIRS instantaneous vertical speed.

[Option - VSI TCAS advisory]



#### 1 Vertical Speed Pointer (white)

Indicates current vertical speed.

#### 2 Selected Vertical speed Bug (magenta)

Indicates the speed selected in the MCP vertical speed window with V/S pitch mode engaged.

#### 3 Vertical speed (white)

Displays vertical speed when greater than 400 feet per minute.

The display is located above the vertical speed indication when climbing and below when descending.

#### 4 TCAS Vertical Speed Tape (red)

[Option - VSI TCAS advisory]

Tape turns red to indicate vertical speed values to avoid or exit during a TCAS resolution advisory.

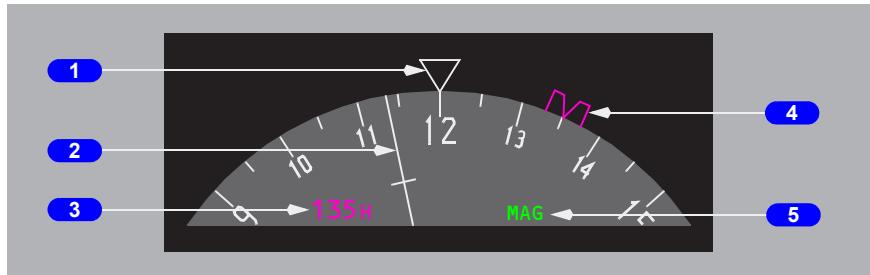
Vertical speed pointer is red if it is within the vertical speed tape range.

Supplements TCAS resolution advisory pitch commands on the attitude indication.

## PFD - Heading and Track Indications

### Heading and Track Indications– General

The heading and track indications display current FMC/ADIRS heading, track and other information.



#### 1 Current Heading Pointer (white)

Indicates current heading.

#### 2 Track Pointer (white)

Indicates current track.

#### 3 Selected Heading (magenta)

Digital display of the selected heading bug.

#### 4 Selected Heading Bug (magenta)

Indicates the heading selected on the mode control panel. If the selected heading exceeds the display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

#### 5 Magnetic/True Heading Annunciation (green)

Displays selected heading reference:

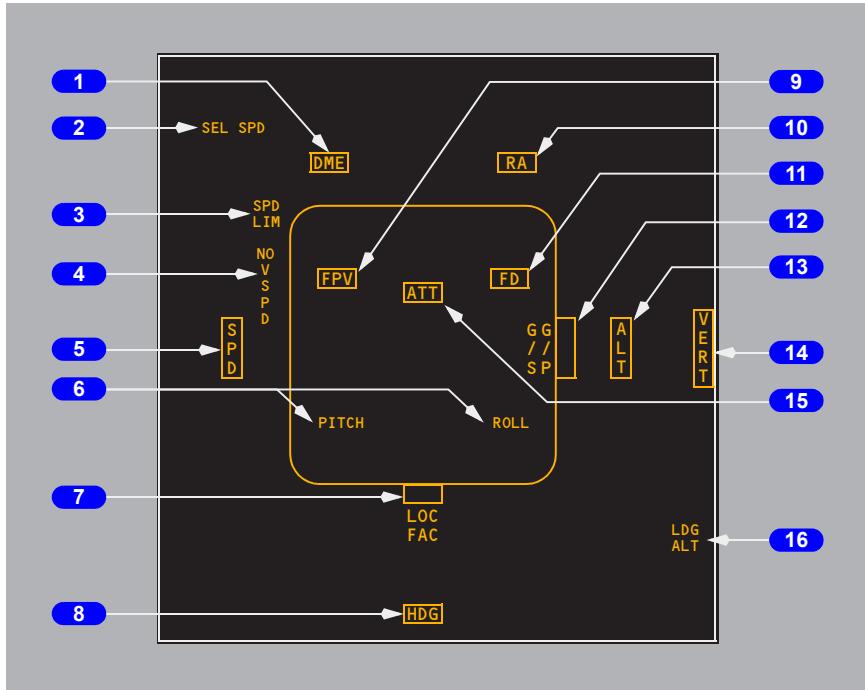
- MAG indicates display is oriented relative to magnetic north
- TRU indicates display is oriented relative to true north; a white box is displayed continuously around TRU

- transition from TRU to MAG results in a green box around MAG for 10 seconds
- when TRU is displayed and the airplane descends more than 2000 feet at a descent rate greater than -800 feet per minute, an amber box is drawn around TRU; the box flashes for 10 seconds, then turns steady amber.

## PFD Failure Flags

The flag replaces the appropriate display to indicate system failure.

[Option - Radio altitude above ADI, IAN]



### 1 Distance Measuring Equipment (amber)

The DME system has failed.

### 2 Selected Speed (amber)

Invalid data.

**3 Speed Limit Flag (amber)**

Displays related with stick shaker or maximum operating speed has failed:

- if the stick shaker warning has failed, the red and black stick shaker speed bar is removed
- if the maximum operating speed has failed, the red and black maximum operating speed bar is removed.

**4 No V Speeds Flag (amber)**

Displayed when the aircraft is on the ground and both V1 (decision speed) and VR (rotation speed) are not valid or are set to less than 80 knots.

**5 Speed Flag (amber)**

Speed indication is inoperative.

**6 Pitch/Roll Comparator Annunciation (amber)**

PITCH displayed when Captain's and F/O's pitch angle displays differ by more than 5 degrees.

ROLL displayed when Captain's and F/O's roll angle displays differ by more than 5 degrees.

**[Option - Attitude comparator flashing]**

The flags flash for 10 seconds then remain steady.

**7 Localizer/FAC Flag (amber)**

**[Option - IAN]**

An ILS frequency is tuned and localizer course indication has failed. An IAN approach is active and FAC indication has failed.

**8 Heading Flag (amber)**

Heading information failed. Aircraft heading cannot be displayed

**9 Flight Path Vector Flag (amber)**

FPV is selected on the EFIS control panel, but has failed. De-selection of FPV removes the flag.

**10 Radio Altitude Flag (amber)**

Radio altitude indication has failed.

**11 Flight Director Flag (amber)**

The flight director has failed.

**12 Glide Slope/Glide Path Flag (amber)****[Option - IAN]**

An ILS frequency is tuned and glide slope indication has failed. An IAN approach is active and glide path indication has failed.

**13 Altitude Flag (amber)**

The attitude display has failed.

**14 Vertical Speed Flag (amber)**

Vertical speed has failed.

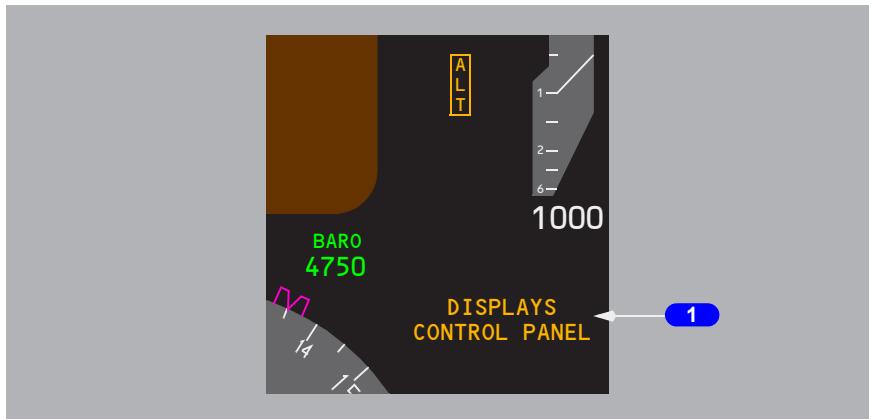
**15 Attitude Flag (amber)**

The attitude display has failed.

**16 Landing Altitude Flag (amber)**

The landing altitude input is not available or invalid.

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**Additional Annunciations and Alerts****Displays Control Panel Annunciation**

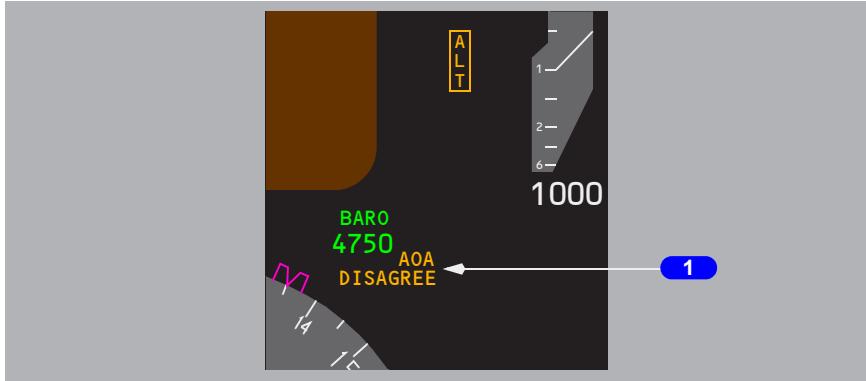
## 1 Displays Control Panel Annunciation (amber)

With the CONTROL PANEL select switch on the overhead panel in:

- BOTH ON 1 - left (Capt) EFIS control panel has failed
- NORMAL - corresponding EFIS control panel has failed
- BOTH ON 2 - right (F/O) EFIS control panel has failed.

Altitude information is removed.

## Angle of Attack (AOA) Disagree Alert

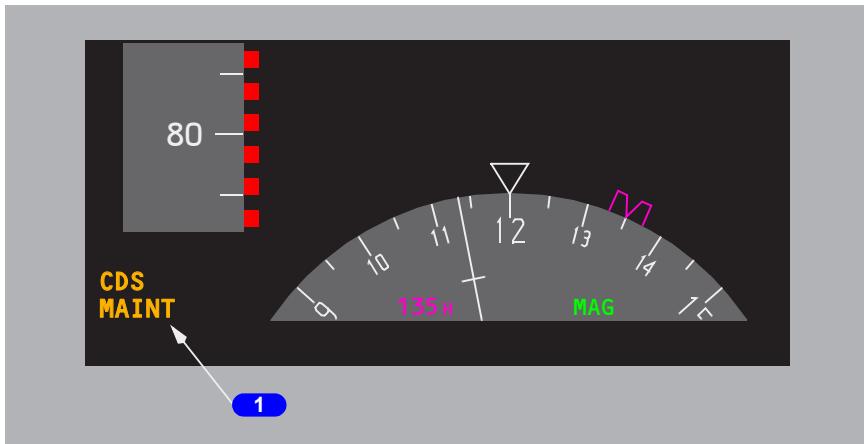


### 1 AOA Disagree Alert (amber)

Indicates the left and right AOA values disagree by more than 10 degrees for more than 10 continuous seconds.

## Display System Annunciations

**Note:** The following annunciations occupy the same display location in the lower left corner of the primary flight display.



### 1 Display System Annunciations

DSPLY SOURCE (amber) – A single DEU has been selected, either manually or automatically, to drive all six display units.

- If the DEU fails on the same side as the engaged autopilot during climb or descent –

#### [Option – Integrated cue command bar]

- the flight directors are removed from both pilots' displays. The flight directors reappear at ALT ACQ
  - the pitch mode reverts to CWS pitch
  - the autopilot remains engaged.
- If the DEU fails on the same side as the engaged autopilot during level flight –
    - climb or descent to a new MCP altitude is not possible in LVL CHG, VNAV, or V/S modes with the autopilot engaged.
  - If the DEU fails on the opposite side as the engaged autopilot or while in manual F/D mode during climb or descent –

#### [Option – Integrated cue command bar]

- the flight director is removed from the pilot's display on the failed side until ALT ACQ
- climb or descent is possible in LVL CHG, VNAV or V/S modes with the autopilot engaged.

- If the DEU fails on the same side as the engaged autopilot in the APPROACH mode –

**[Option – Integrated cue command bar]**

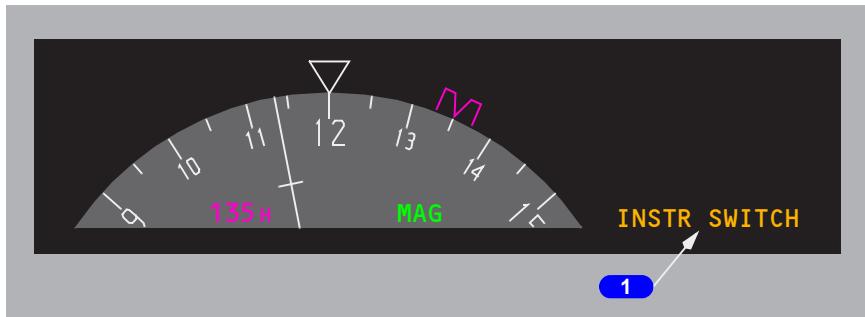
- the flight directors are removed from the pilot's display on the failed side.

**[Option - With CDS Block software upgrade]**

CDS MAINT (white) – A dispatchable CDS fault has occurred. Displayed on the ground only, prior to start of the second engine.

CDS FAULT (amber) – A non-dispatchable CDS fault has occurred. Displayed on the ground only, prior to start of the second engine.

## Instrument Switch Annunciation

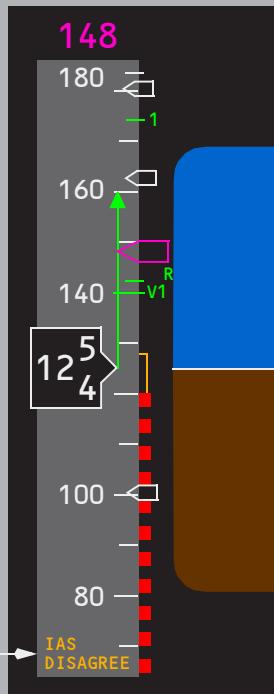


**1 INSTR SWITCH Annunciation (amber)**

Indicates both the Captain's and First Officer's displays are using the same source of IRU data.

Displayed when the IRS switch on the overhead panel is not in the NORMAL position.

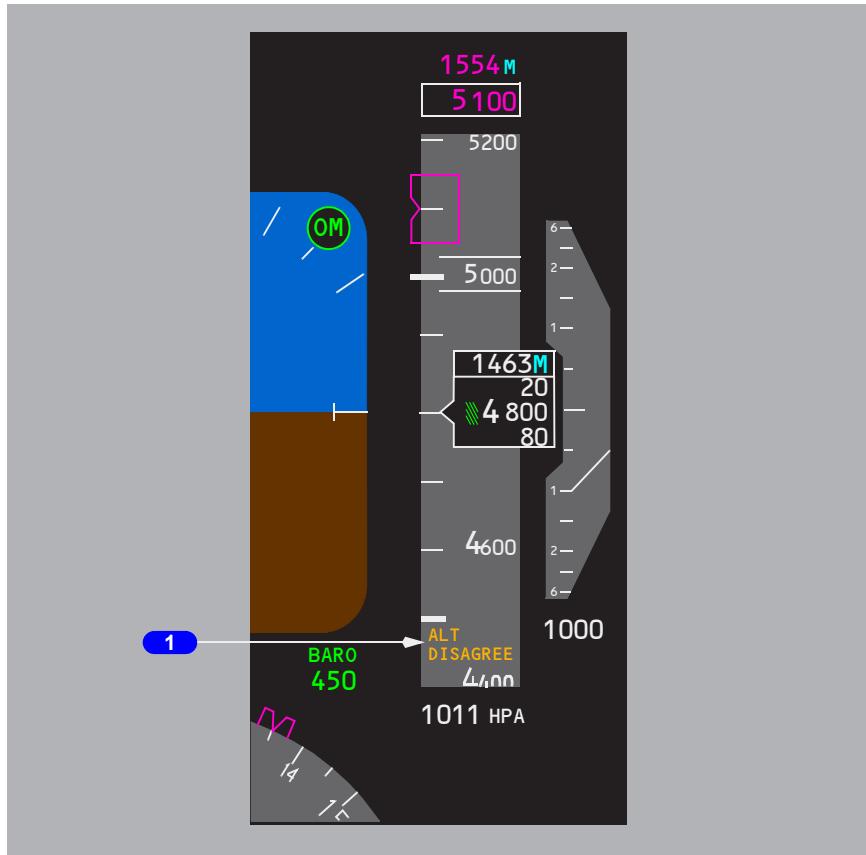
## Airspeed Disagree Alert



### **1** Airspeed Disagree Alert (amber)

Indicates the Captain's and F/O's airspeed indications disagree by more than 5 knots for 5 continuous seconds.

## Altitude Disagree Alert



### **1 Altitude Disagree Alert (amber)**

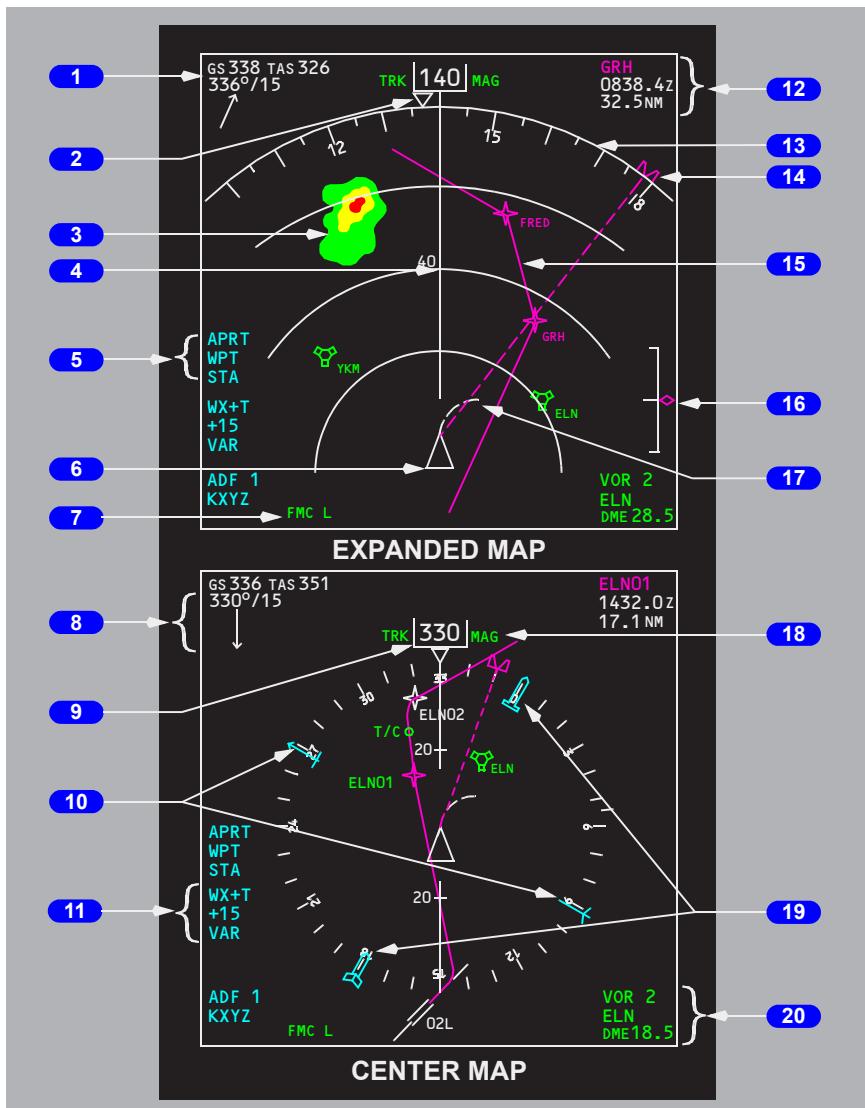
Indicates the Captain's and F/O's altitude indications disagree by more than 200 feet for more than 5 continuous seconds.

## Navigation Displays – MAP Mode

**Note:** Refer to section 41 of this chapter for a detailed explanation of the navigation symbology shown on the following pages.

## Expanded and Center MAP Modes

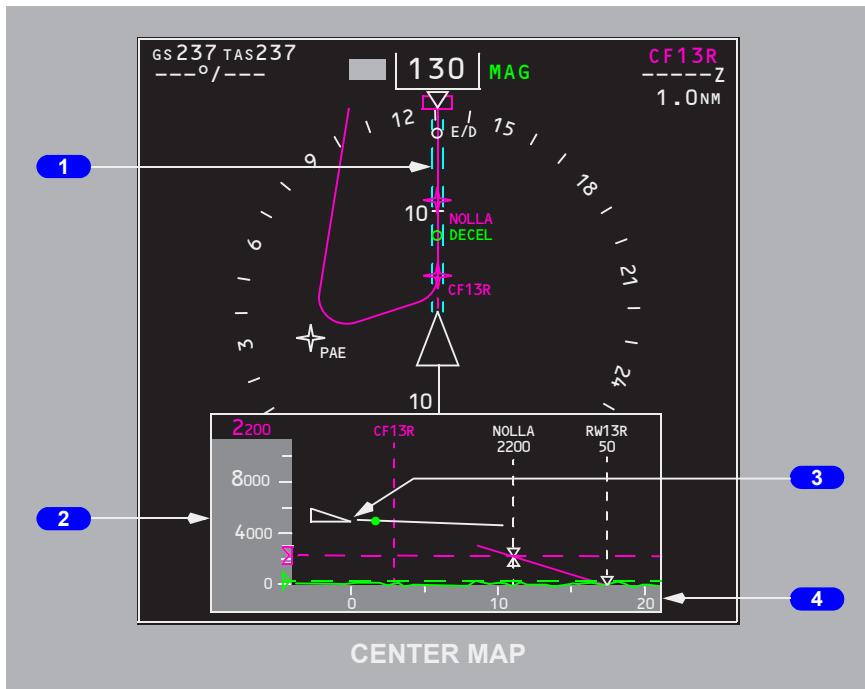
[Option - Track-up display, weather radar range arcs, dual FMC, ADF]



- 1 Groundspeed/True Airspeed**
- 2 Heading Pointer**
- 3 Weather Radar Returns**
- 4 Track Line and Range Scale**
- 5 Map Options**
- 6 Airplane Symbol**
- 7 Map Source Annunciation**
- 8 Wind Direction/Speed/Arrow**
- 9 Current Track**
- [Option - Track-up display]**
- 10 Number 1 VOR/ADF Pointer**
- [Option - ADF]**
- 11 Weather Radar Annunciations**
- 12 Active Waypoint/ETA/Distance-To-Go**
- 13 Compass Rose**
- 14 Selected Heading Bug**
- 15 Active LNAV Route**
- 16 Vertical Deviation Scale and Pointer**
- 17 Position Trend Vector**

**18 Magnetic/True Reference****19 Number 2 VOR/ADF Pointer****[Option - 2 ADF receivers]****20 VOR/ADF Selection, Ident/Frequency, VOR DME****[Option - 2 ADF receivers]****Vertical Situation Display (VSD)****[Option VSD]**

The VSD represents a profile view of the airplane and its environment along the current track. Information shown within the cyan dashed lines (enroute corridor) on the ND is shown in profile on the VSD.

**Vertical Situation Display (VSD) - Reference Scales****1 Enroute Swath**

Indicates area mapped by the VSD.

**2 Altitude Reference Scale**

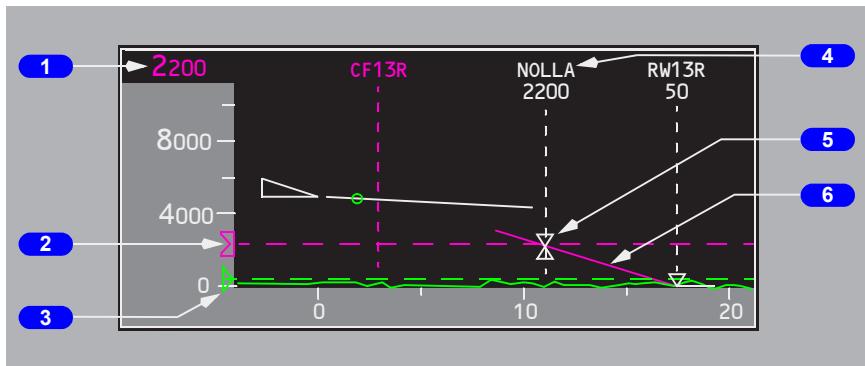
Displays altitude in reference to the vertical position of the airplane symbol, terrain, and other objects in the VSD background display.

**3 Airplane Symbol**

Indicates current airplane altitude (bottom of the triangle) and lateral position (point of the triangle) relative to terrain.

**4 Horizontal Reference Scale**

Displays range in nautical miles. Actual range shown on VSD is one half the range selected on the EFIS control panel.

**Vertical Situation Display (VSD) - General Background****1 MCP Selected Altitude Readout**

Displays the altitude set in the MCP altitude window.

**2 Selected Altitude Bug**

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom, with only one half the bug visible. The dashed line does not park.

**3 BARO Minimums Pointer**

Indicates the barometric minimums selected on the EFIS control panel:

- pointer and dashed line turn amber when airplane descends below selected minimum altitude
- reset with the RST switch on the EFIS control panel.

**4 Waypoint ID and Anchor Line**

Displayed with any altitude constraint directly beneath. Dashed vertical line depicts lateral position.

**5 Altitude Constraint Symbol**

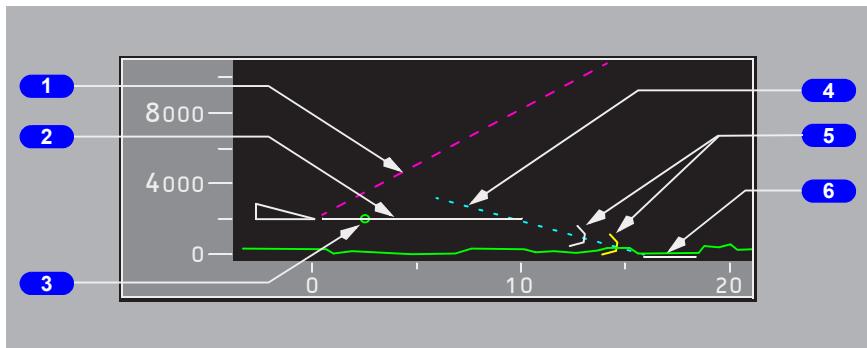
Displayed as triangle(s) on waypoint anchor line.

**6 FMC Approach Glidepath Angle Line**

Displayed for approaches that include a designated approach angle.

- extends 10 NM for situational awareness.
- anchored to the missed approach waypoint, not the runway.

## Vertical Situation Display (VSD) - Flight Path Background



### 1 MCP Selected Vertical Speed (V/S)

Displays the selected vertical speed as a dashed target angle line when the MCP V/S mode is selected.

### 2 Vertical Flight Path Vector

Indicates current flight path angle as a function of vertical speed and ground speed. The length of the vector is fixed at one half of the VSD range.

### 3 Range to Target Speed Dot (RTSD)

Indicates where the airplane will achieve the FMC or MCP target speed.

- dot is blanked within 5 knots of target speed.
- dot reappears if speed increases 10 knots or more faster than target speed.
- replaced with an unfilled dot at vector end if target speed will not be achieved within length of the vertical flight path vector line.

### 4 3-Degree Reference Line

Displayed for approaches that do not have a designated approach angle.

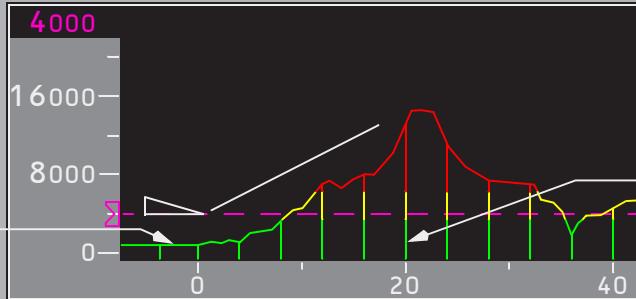
- dashed line extends 10 NM for situational awareness.
- anchored to the runway threshold.
- for reference only, line may intersect terrain.

### 5 Decision Gates

Displayed on the FMC approach glidepath angle line or 3 degree reference line at 500 feet and 1000 feet above field elevation.

### 6 Runway

Represents the selected runway.

**Vertical Situation Display (VSD) - Terrain Background****1 Terrain Profile Line**

Represents the highest terrain within the enroute swath.

- highest points of the terrain below and ahead of the airplane.
- terrain is depicted so the true altitude separation between the airplane and terrain is shown.
- terrain behind the airplane is drawn equal to the terrain at the current position.
- VSD terrain uses the same color coding that is used to depict EGPWS terrain on the lateral map:
  - green: terrain 250-500 feet or more below the airplane.
  - amber: terrain from 250-500 feet below to 2000 feet above the airplane.
  - red: terrain more than 2,000 feet above the airplane.

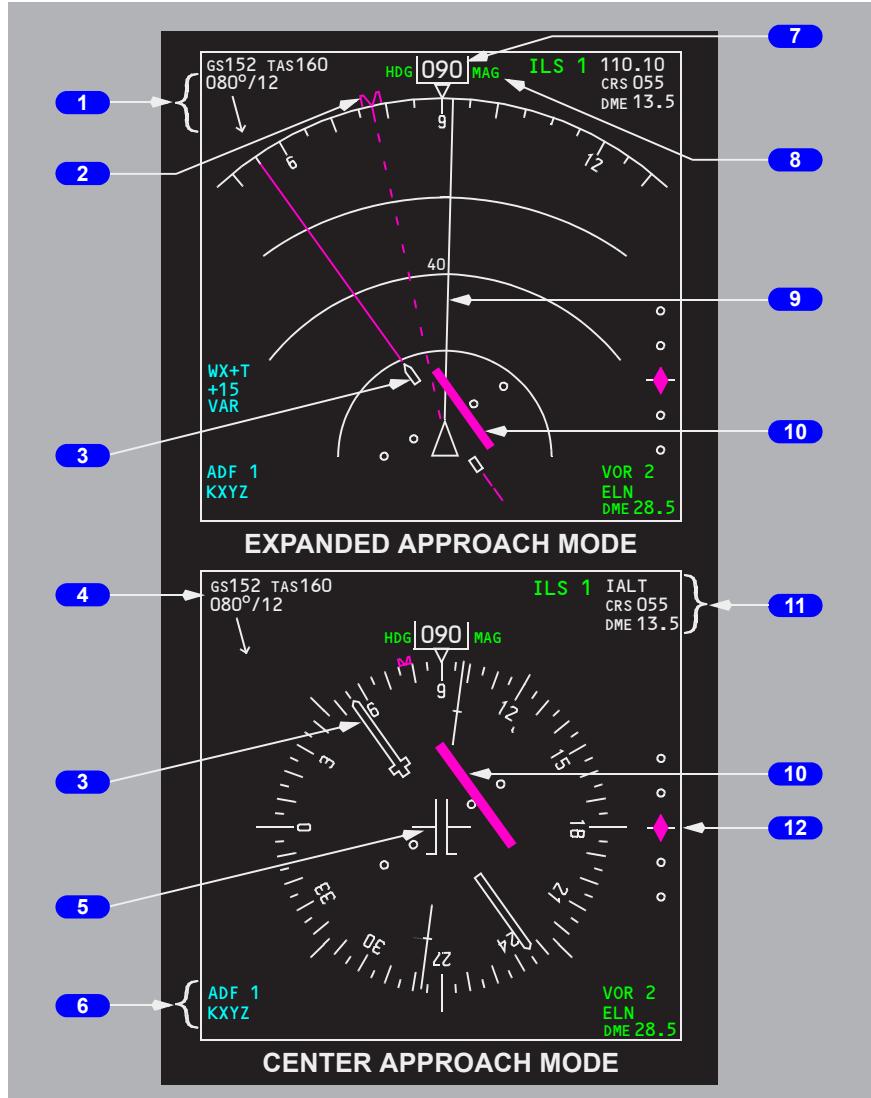
**2 Vertical Support Lines**

Vertical terrain vectors placed at constant intervals along the terrain profile line.

## Navigation Displays – Approach Mode

### Expanded and Center Approach Modes

[Option - Weather radar range arcs, ADF]

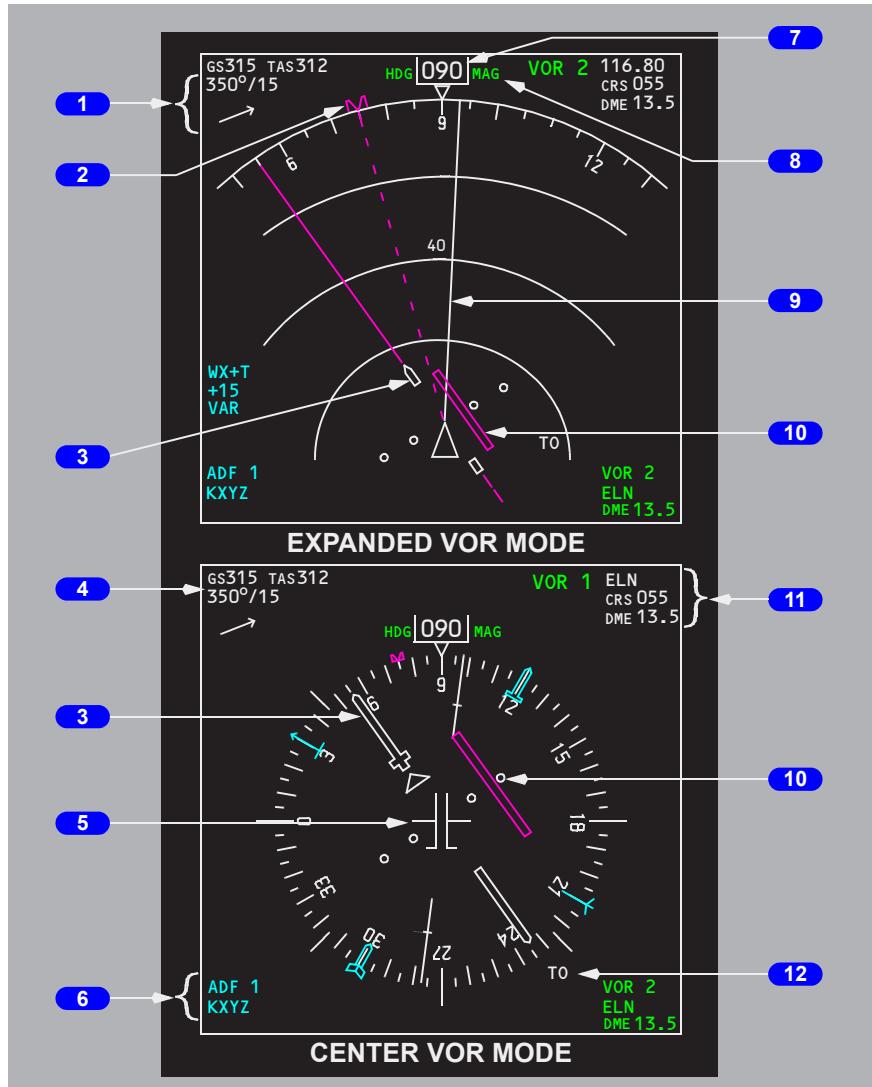


- 
- 1 Wind Direction/Speed/Arrow**
  - 2 Selected Heading Bug**
  - 3 Selected Course Pointer**
  - 4 Groundspeed/True Airspeed**
  - 5 Airplane symbol**
  - 6 VOR/ADF Selection/Ident or Frequency/VOR DME**  
[Option - ADF}
  - 7 Current Heading**
  - 8 Magnetic/True Reference**
  - 9 Track Line**
  - 10 ILS Localizer/IAN FAC Deviation Indication and Scale**  
[Option - IAN]
  - 11 Reference ILS Frequency or Ident/Course/DME/Distance and Source Annunciation**  
[Option - IAN]
  - 12 ILS Glideslope/IAN Glidepath Pointer and Scale**  
[Option - IAN]

## Navigation Displays – VOR Mode

### Expanded and Center VOR Modes

[Option - Weather radar range arcs, ADF]

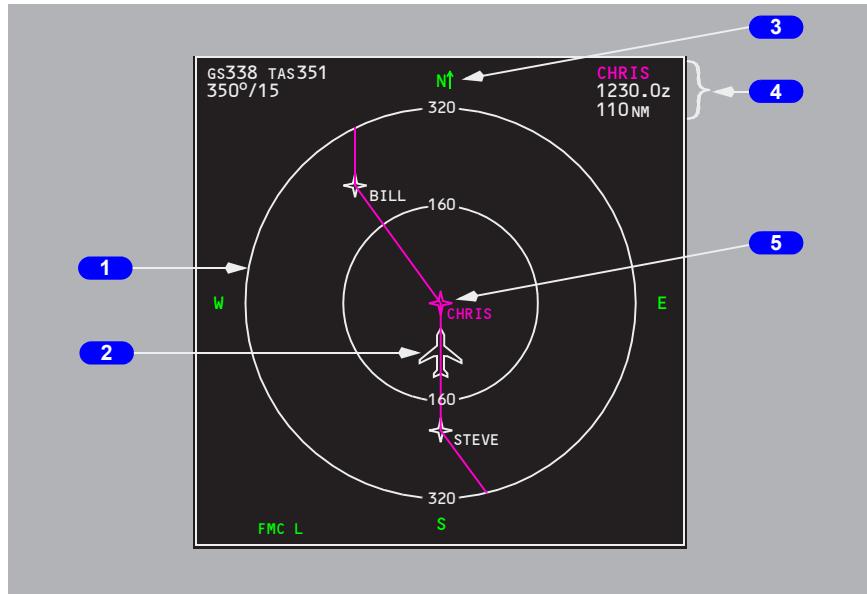


- 1 Wind Direction/Speed/Arrow**
- 2 Selected Heading Bug**
- 3 Selected Course Pointer**
- 4 Groundspeed/True Airspeed**
- 5 Airplane symbol**
- 6 VOR/ADF Selection/Ident or Frequency/VOR DME**  
**[Option - ADF]**
- 7 Current Heading**
- 8 Magnetic/True Reference**
- 9 Track Line**
- 10 Course Deviation Indication and Scale**
- 11 Reference VOR Receiver/Frequency or Ident/Course/DME**
- 12 TO/FROM Indication and TO pointer**

## Navigation Displays – Plan Mode

### Plan Mode

[Option - Dual FMC]

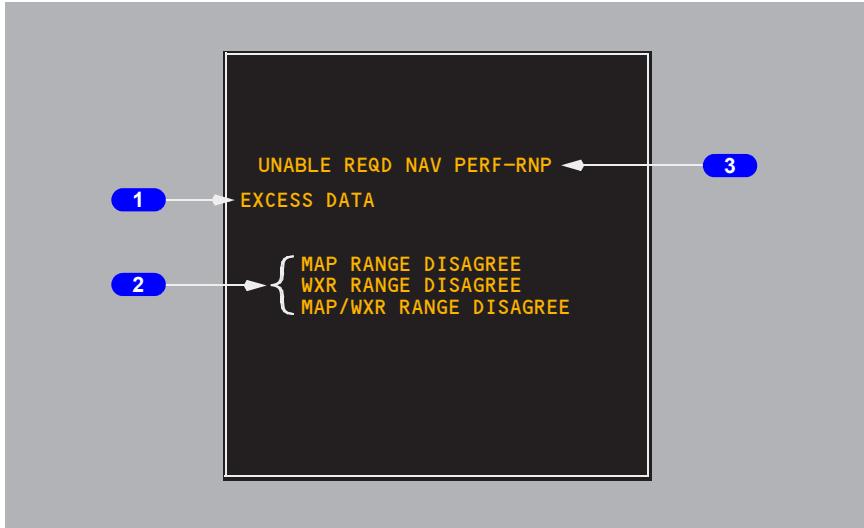


- 1** Range Circle
- 2** Airplane Symbol
- 3** True North Up Arrow
- 4** Active Waypoint Information
- 5** Center Waypoint

The waypoint located at the display center is identified as CTR on the CDU RTE LEGS page.

## Navigation Displays – Advisory Messages

### Navigation Advisory Messages



#### **1 Excess Data Annunciation (amber)**

The amount of map information sent to the primary display system is too great to display.

When this occurs, the primary display system removes information from the center of the display outward. Information near the outer selected range area is still displayed.

The message can be cleared by:

- decluttering - removing unnecessary navigation information
- reducing the display range
- deselecting one or more of the EFIS MAP switches (STA, WPT, ARPT, DATA, POS).

#### **2 Range Disagreement Annunciations (amber)**

MAP RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP display range.

WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the WXR display range.

MAP/WXR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP and WXR display ranges.

### 3 Nav Advisory Message (amber)

UNABLE REQD NAV PERF–RNP – Displayed in MAP or Center MAP during approach. Refer to Chapter 11 section 60, FMC Messages.

## Mode/Frequency Disagree Annunciation

[Option - Track-up display, ADF]



### 1 EFIS MODE/NAV FREQ DISAGREE (amber)

The ILS or VOR source annunciation corresponds to the position selected on the EFIS control panel and the tuned VOR/ILS frequency.

The annunciation is displayed:

- if APP is selected with a VOR frequency tuned
- if VOR is selected with an ILS frequency tuned.

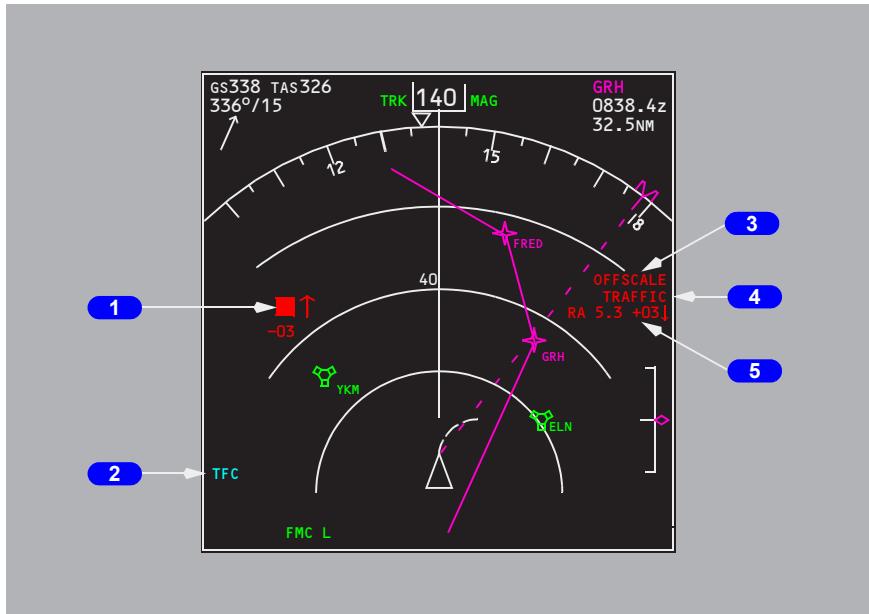
The DME display and ILS/VOR frequency at the upper right corner display dashes.

The localizer deviation bar, VOR course deviation bar and glide slope pointer are not displayed.

The annunciation is displayed in the expanded APP, center APP, expanded VOR and center VOR modes.

## TCAS Messages

[Option - Track-up display, weather radar range arcs, dual FMC]



### 1 TCAS Traffic Symbols

**Note:** Refer to section 41 of this chapter for a detailed explanation of the traffic symbology.

Indicates position of traffic targets.

Displayed in expanded MAP, center MAP, expanded APP and expanded VOR modes and TFC is selected on the EFIS control panel.

### 2 TCAS Annunciations

TFC (cyan) – Indicates TFC selected on EFIS control panel in expanded MAP, center MAP, expanded APP and expanded VOR.

TCAS TEST (cyan) – TCAS in test mode.

TA ONLY (cyan) – TCAS TA mode only.

TCAS OFF (amber) – TCAS off.

### 3 Offscale (red or amber)

TA (amber) or RA (red) is beyond the selected display range and TFC is selected on the EFIS control panel.

#### 4 Traffic (red or amber)

Displayed during a TA (amber) or RA (red) condition whether or not TFC is selected on the EFIS control panel.

#### 5 No-Bearing Messages (red or amber)

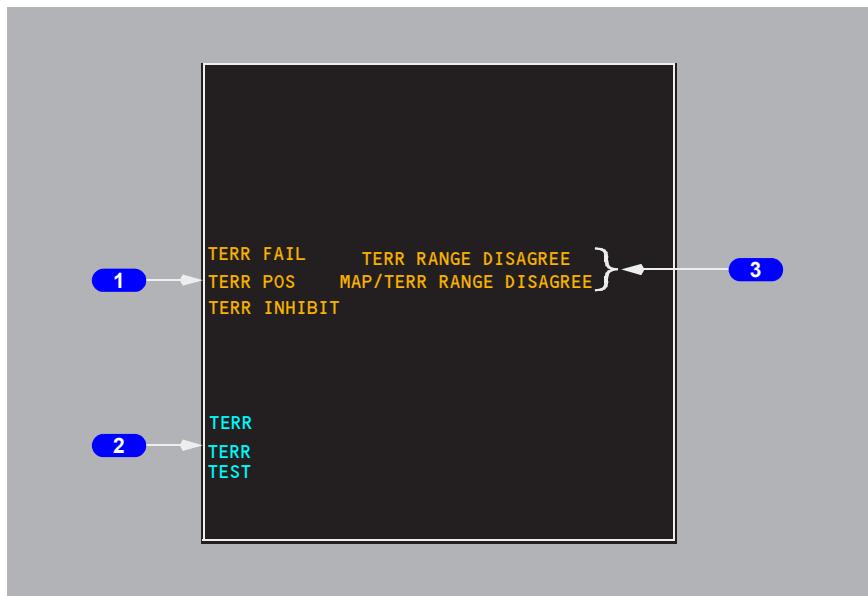
Textual description of TA (amber) or RA (red) traffic with no associated bearing.

Message provides traffic type, range in NM, altitude and a vertical motion arrow.

A maximum of two messages can be displayed simultaneously.

TFC selected on the EFIS control panel.

### Look-Ahead Terrain Messages (GPWS)



#### 1 Terrain Status Annunciation (amber)

TERR FAIL – Look-ahead terrain alerting and display have failed.

TERR POSS – Look-ahead terrain alerting and display unavailable due to position uncertainty.

TERR INHIBIT – GPWS terrain inhibit switch in TERR INHIBIT position.

#### 2 Terrain Mode Annunciation (cyan)

TERR – Terrain display enabled (manual or automatic display).

TERR TEST – GPWS is operating in self-test mode.

### 3 Terrain Range Status Annunciation (amber)

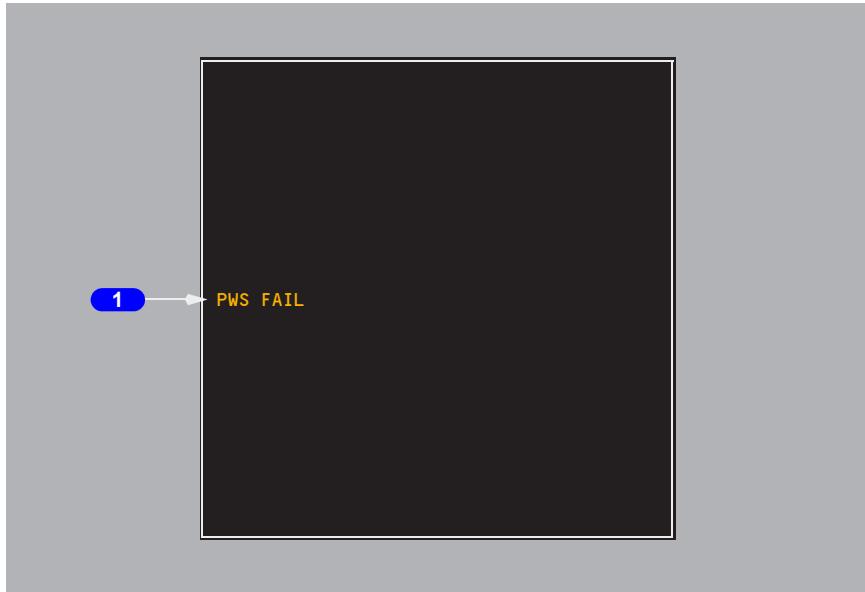
TERR RANGE DISAGREE –

- terrain display enabled, and
- terrain output range disagrees with selected EFIS control panel range.

MAP/TERR RANGE DISAGREE –

- terrain display enabled, and
- terrain output range disagrees with selected EFIS control panel range, and
- map display output range disagrees with selected EFIS control panel range.

### Predictive Windshear System (PWS) Message



### 1 PWS FAIL Annunciation (amber)

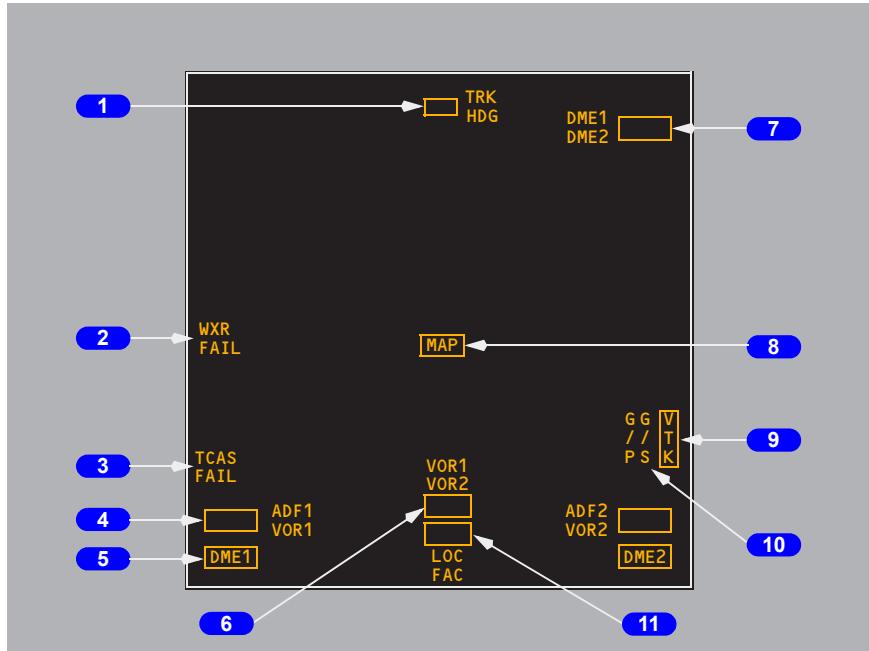
Predictive windshear alerting and display have failed.

## Navigation Displays – Failure Indications and Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate.

## Expanded MAP, Center MAP, Expanded APP, Expanded VOR Modes

[Option - Track-up display, dual ADF, IAN]



### 1 Track Failure Flag (expanded and center MAP modes)

[Option - Track-up display]

Track information failed. Track cannot be displayed.

### 2 Weather Radar Annunciations (expanded and center MAP, expanded APP, expanded VOR modes)

WXR FAIL – Weather radar has failed. No weather data are displayed.

WXR WEAK – Weather radar calibration fault.

WXR ATT – Attitude stabilization for antenna has been lost.

WXR STAB – Antenna stabilization is off.

---

WXR DSP – Range data input has failed. Only displayed in WXR TEST

**3 TCAS Failure Flag (expanded and center MAP, expanded VOR, expanded APP, PLAN modes)**

TCAS has failed.

**4 ADF 1 and ADF 2 or VOR 1 and VOR 2 Failure Flag (expanded and center MAP, expanded APP, expanded VOR modes)**

**[Option - Dual ADF]**

ADF or VOR has failed.

**5 DME 1 and DME 2 Failure Flag (expanded and center MAP, expanded APP, expanded VOR modes)**

Selected VOR DME has failed.

**6 VOR 1, 2 Failure Flag (expanded VOR mode)**

VOR has failed.

**7 Reference VOR DME (expanded VOR mode) and Reference ILS DME (expanded APP mode)**

Reference VOR or ILS DME has failed.

**8 MAP Failure Flag (expanded and center MAP, PLAN modes)**

The related FMC generated map display has failed.

**9 Vertical Track Failure Flag (expanded and center MAP modes)**

FMC vertical track data is invalid.

**10 ILS Glideslope/IAN Glidepath Failure Flag (expanded APP mode)**

**[Option - IAN]**

ILS glideslope or IAN glidepath has failed.

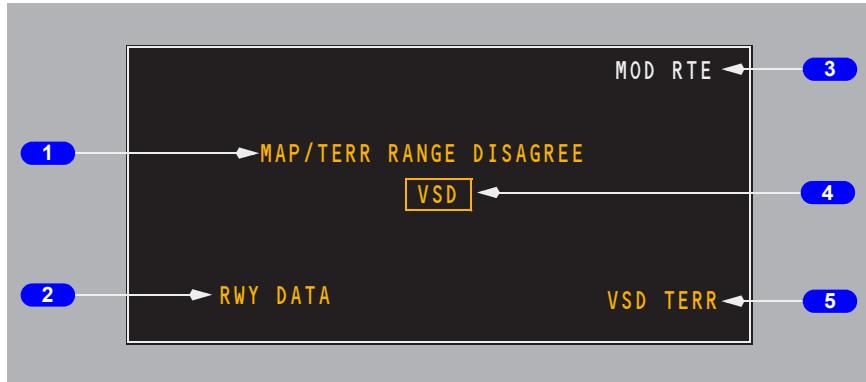
**11 ILS Localizer/IAN FAC Failure Flag (expanded APP mode)**

**[Option - IAN]**

ILS localizer course indication or IAN FAC has failed.

## Vertical Situation Display (VSD)

### [Option VSD]



#### **1 Range Disagreement Annunciations (amber)**

MAP RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP display range.

TERR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the Terrain display range.

MAP/TERR RANGE DISAGREE – Indicates selected range on the EFIS control panel is different than the MAP and Terrain display ranges.

#### **2 Runway Data Annunciation (amber)**

FMC runway data is not available.

#### **3 Route Waypoints Modification Annunciation (white)**

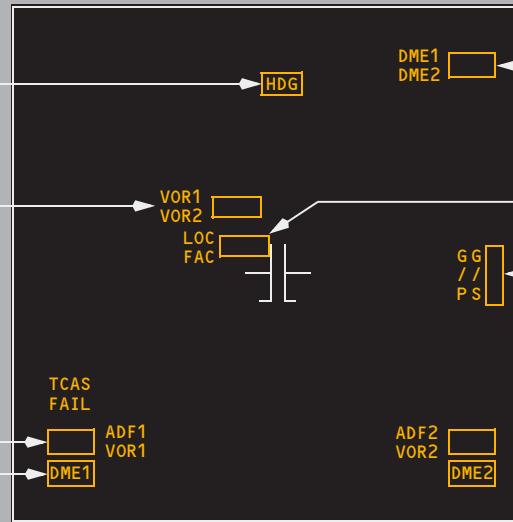
FMC active route is being modified. Only active waypoint is displayed.

#### **4 VSD Failure Flag (amber)**

VSD cannot be displayed.

#### **5 Terrain Data Failure Annunciation (amber)**

EGPWS terrain data is not available. Annunciation is replaced with VSD TERR INHIBIT when GPWS control panel TERR INHIBIT switch is in the inhibit position.

**ND Failure Flags – Center APP and Center VOR Modes****[Option - Dual ADF, IAN]****1 Heading Failure Flag (center APP, center VOR modes)**

Heading indication failed. Heading cannot be displayed.

**2 VOR Failure Flag (center VOR mode)**

VOR has failed.

**3 ADF 1 and ADF 2 or VOR 1 and VOR 2 Failure Flag (center APP, center VOR modes)****[Option - Dual ADF]**

VOR or ADF has failed.

**4 DME 1 and DME 2 Failure Flag (center APP, center VOR modes)**

Selected VOR DME has failed.

**5 Reference VOR DME (center VOR mode) and Reference ILS DME (center APP mode)**

Reference VOR or ILS DME has failed.

**6 ILS Localizer/IAN FAC Failure Flag (center APP mode)****[Option - IAN]**

ILS localizer course indication or IAN FAC has failed.

**7 ILS Glideslope/IAN Glidepath Failure Flag (center APP mode)****[Option - IAN]**

ILS glideslope or IAN glidepath has failed.

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# Flight Instruments, Displays

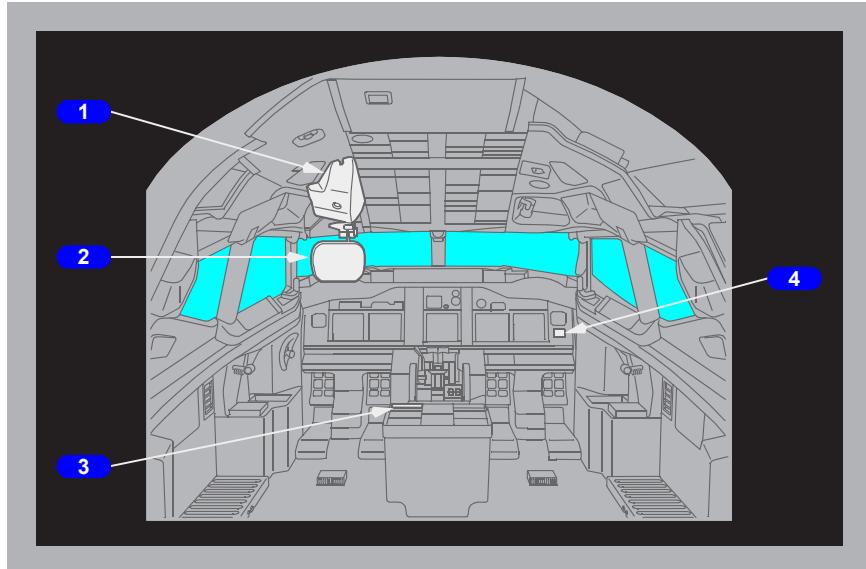
## Head-Up Display System - Displays

# Chapter 10

## Section 12

### System Components

[Option - Model 4000 without PATS aux tanks]



#### 1 Overhead Unit

Contains the CRT and projection optics to display the symbolic image on the combiner.

#### 2 Combiner

Combines displayed flight symbology with the pilot's view through window No. 1.

#### 3 Control Panel

Used for data entry and to select modes of operation.

#### 4 Annunciator

Provides system status and warning annunciations during a CAT III approach.

## Combiner Display

The combiner displays symbology and fault indications for the HUD system. Display modes of operation include:

- Primary (PRI)
- AIII approach
- Instrument Meteorological Conditions (IMC) approach
- Visual Meteorological Conditions (VMC) approach

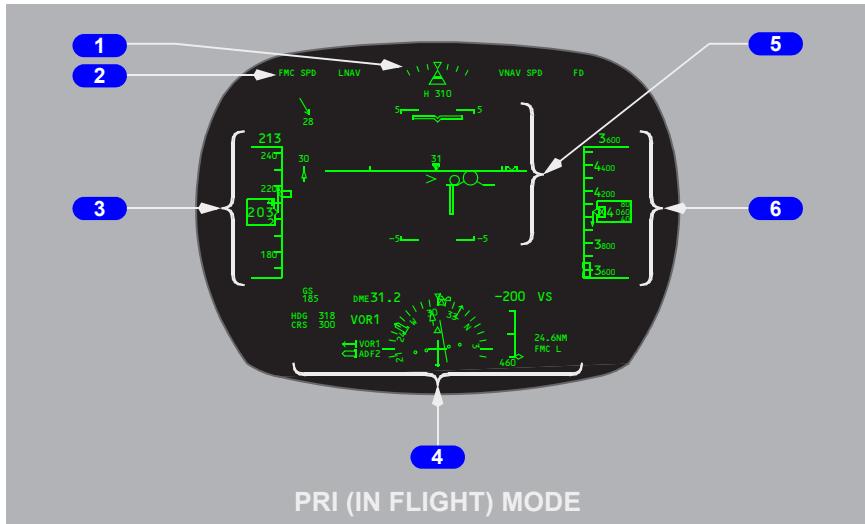
Typical display modes are shown below.

**Note:** Not all symbols are represented in this section. Refer to Section 10-42, Head-Up Display System, Symbology, for a complete listing of HUD system symbology.

### Primary (PRI) Mode Display

#### [Option - Model 4000]

The primary mode can be used for all phases of flight from takeoff to landing including low visibility takeoff and landing rollout operations.





**1 Bank Scale and Pointer**

**2 Flight Mode Annunciations (FMAs)**

Refer to Chapter 4, Automatic Flight.

**3 Airspeed Indications**

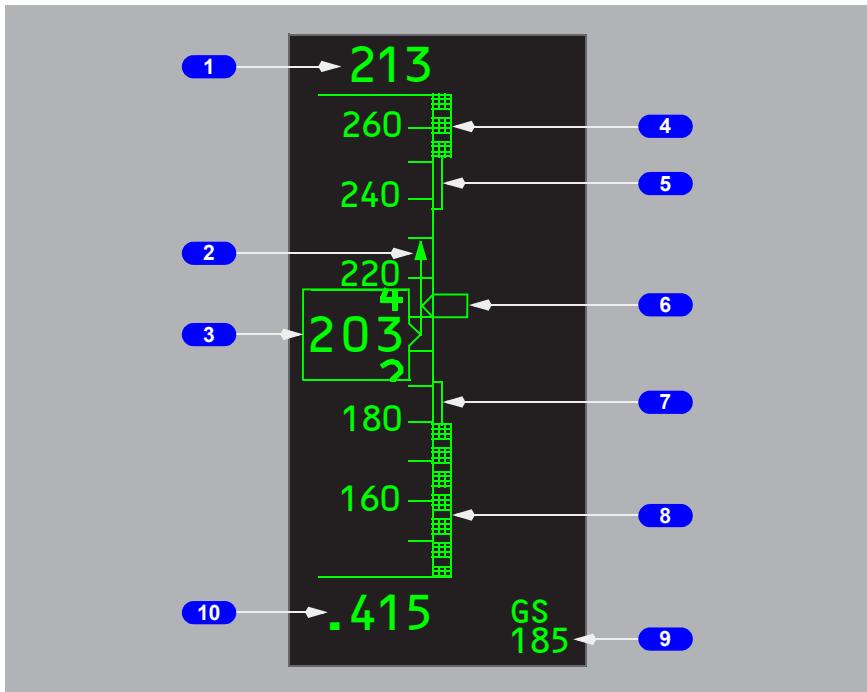
**4 Navigation Indications**

**5 Attitude Indications**

**6 Altitude Indications**

**7 Ground Localizer Line**

## Airspeed Indications - General



### 1 Selected Speed (all modes)

Displays target airspeed:

- manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

### 2 Speed Trend Vector (PRI in flight, PRI ground modes)

Tip of arrow indicates predicted airspeed in the next 10 seconds based on the current airspeed and acceleration.

### 3 Computed Airspeed (PRI in flight, PRI ground modes)

Indicates current computed airspeed in knots.

Displayed relative to a vertical scale along the edge of the tape and as a digital value.

**4 Maximum Speed (PRI in flight mode)**

Bottom of bar indicates the maximum speed as limited by the lowest of the following:

- Vmo/Mmo
- landing gear placard speed
- flap placard speed.

Inhibited on the ground.

**5 Maximum Maneuvering Speed (PRI in flight mode)**

At high altitudes and flaps up, the bottom of the bar indicates the airspeed that provides a 0.3 g maneuver margin to high speed buffet. May be displayed at high altitude with flaps up, at relatively high gross weights.

When flaps are not up, bottom of the bar indicates flap limit placard speed for the next normal flap setting. The display logic is based on a normal flap setting sequence of 1, 5, 15, 30. The bar is removed when the flap lever is moved to the landing flap selected on the APPROACH REF page or when the flap lever is moved to flaps 30 or 40.

**6 Speed Bug (PRI in flight, PRI ground modes)**

Points to the airspeed:

- manually selected in the IAS/MACH window
- indicates the FMC computed airspeed when the IAS/MACH window is blank.

When the selected speed is off scale, the bug is parked at the top or bottom of the tape, with only one half bug visible.

**7 Minimum Maneuver Speed (PRI in flight, PRI ground modes)**

Top of bar indicates minimum maneuver speed.

**8 Minimum Speed (PRI in flight mode)**

Top of bar indicates the speed at which stick shaker occurs.

Inhibited on the ground.

**9 Ground Speed (all modes)**

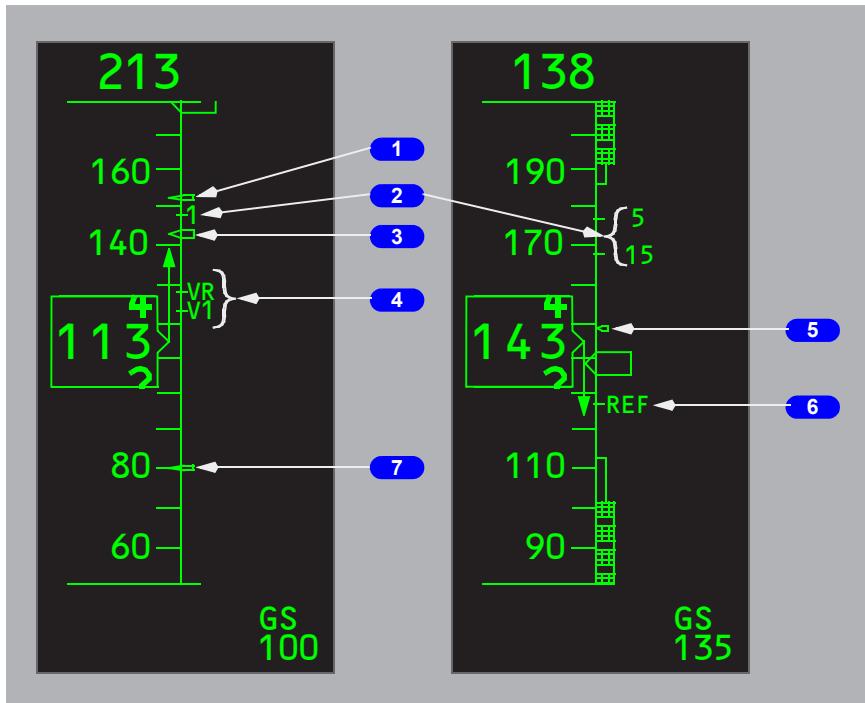
Indicates current ground speed in one knot increments.

## 10 Mach Speed (PRI in flight)

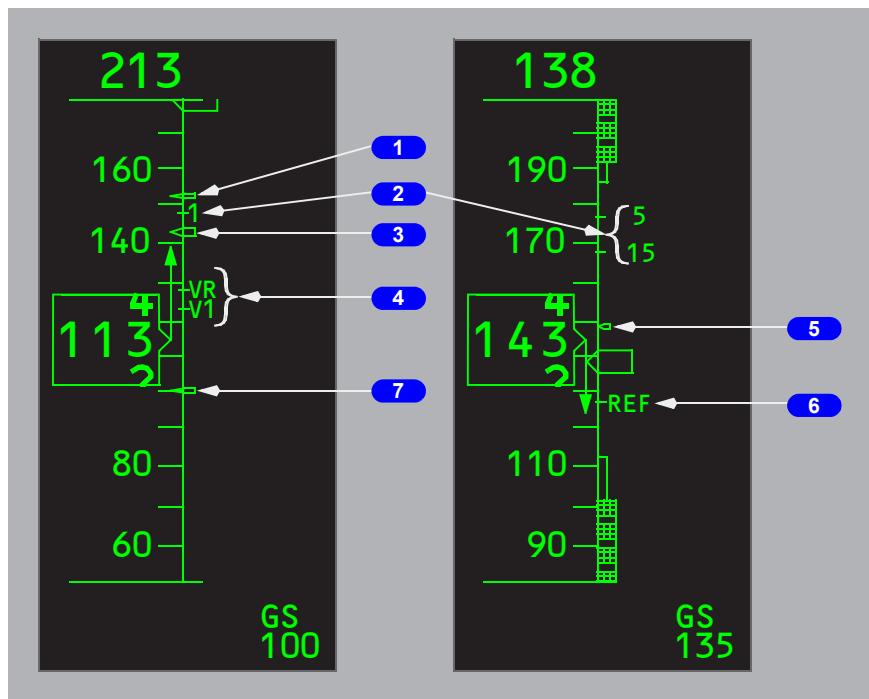
Indicates current mach speed when mach increases above .400 and removed when mach decreases below .380.

**Note:** In other than the PRI mode, the airspeed scale and associated symbols are replaced with a digital readout. The readout is positioned relative to the flight path vector. If the flight path vector is not displayed, the readout is positioned relative to the airplane reference symbol.

### Airspeed Indications - Takeoff and Approach



[Option - 100 knot airspeed bug]



### 1 Bug 5 (PRI in flight, PRI ground modes)

Displayed if speed reference selector on the engine display control panel is in the bug 5 position or SET position and a value greater than 60 knots has been selected. Not available if the speed reference selector is in the AUTO position.

### 2 Flaps Maneuvering Speeds (PRI in flight mode)

Indicates flap maneuvering speed for the displayed flap position.

### 3 V2+15 (PRI in flight mode)

Displayed for takeoff.

Removed when either of the following occurs:

- at first flap retraction
- when VREF is entered in the CDU.

---

**4 Takeoff Reference Speeds (PRI ground mode)**

Indicates V1 (decision speed) and VR (rotation speed) as selected on the CDU TAKEOFF REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel.

**5 VREF+15 (PRI in flight, PRI ground modes)**

Displayed after selection of VREF.

**6 Landing Reference Speed (PRI in flight, PRI ground modes)**

Indicates REF (reference speed) as selected on the CDU APPROACH REF page (refer to Chapter 11, Flight Management, Navigation) or as set with the speed reference selector on the engine display control panel. Replaced by a digital readout when off-scale at the bottom of the airspeed tape.

**7 80 Knot Airspeed Bug (PRI in flight, PRI ground modes)**

Indicates 80 knots:

- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

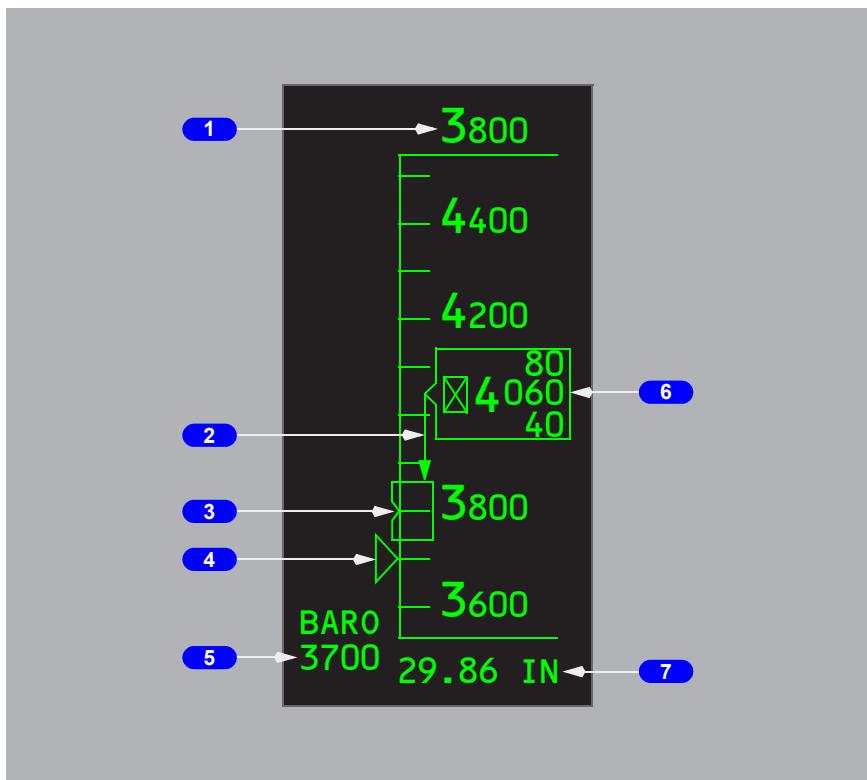
**7 100 Knot Airspeed Bug (PRI in flight, PRI ground modes)**

**[Option - 100 knot airspeed bug]**

Indicates 100 knots:

- displayed automatically during preflight
- removed at first flap retraction or when VREF is entered.

## Altitude Indications



**1 Selected Altitude (PRI in flight, PRI ground modes)**

Displays the altitude set in the MCP altitude window.

**2 Altitude Trend Vector (PRI in flight mode)**

Tip of arrow indicates predicted altitude in the next 6 seconds based on the current vertical speed.

**3 Selected Altitude Bug (PRI in flight, PRI ground modes)**

Points to the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom of the tape, with only one half bug visible.

**4 BARO Minimums Pointer (PRI in flight, PRI ground modes)**

Displays the barometric minimums selected on the EFIS control panel.

## 5 Minimums Reference/Altitude (PRI in flight, PRI ground modes)

Displays approach minimum reference and altitude set by the MINS selector on the EFIS control panel.

## 6 Current Altitude (PRI in flight, PRI ground modes)

Displays current altitude in increments of thousands, hundreds and twenty feet.  
For positive values of altitude below 10,000 feet, an “X” symbol is displayed.

## 7 Barometric Setting (PRI in flight, PRI ground modes)

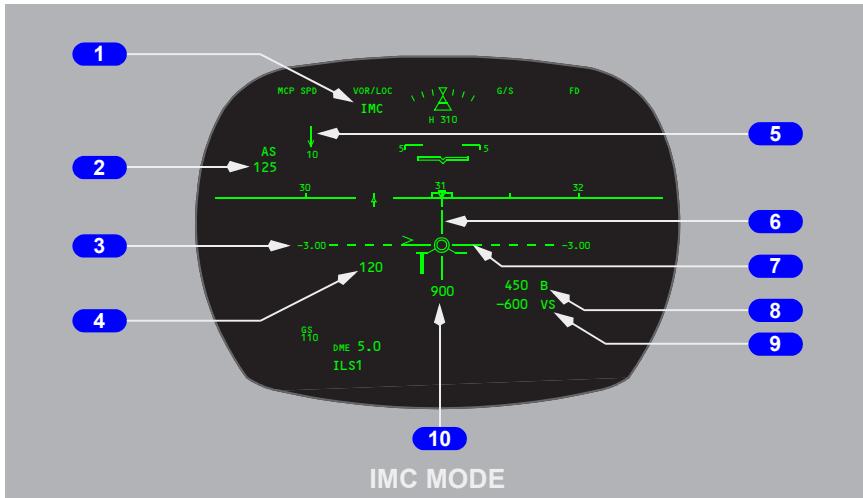
Displays the barometric setting in either inches of mercury (IN) or hectopascals (HPA) as selected on the EFIS control panel.

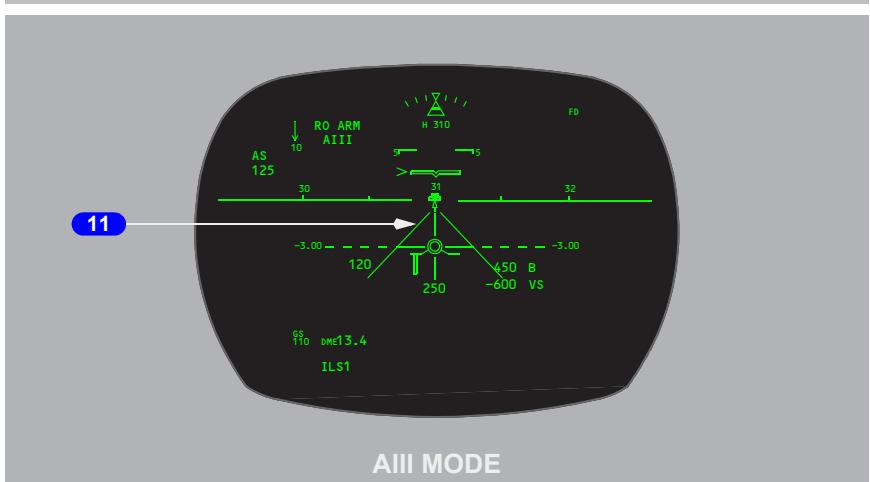
**Note:** In other than the PRI mode, the altitude scale and associated symbols are replaced with a digital readout. The readout is positioned relative to the flight path vector. If the flight path vector is not displayed, the readout is positioned relative to the airplane reference symbol.

## Approach Mode Displays

### [Option - Model 4000]

Refer to section 42 for symbology descriptions.





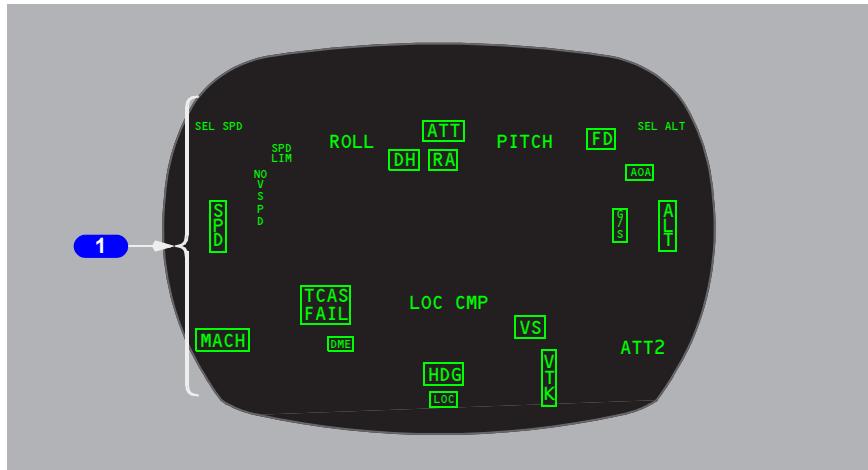
- 
- 1 Mode/Status**
  - 2 Digital Selected Airspeed**
  - 3 Glideslope Reference Line**
  - 4 Digital Airspeed**
  - 5 Wind Indications**
  - 6 Lateral Deviation Line**
  - 7 Glideslope Deviation Line**
  - 8 Digital Barometric Altitude**
  - 9 Digital Vertical Speed**
  - 10 Radio Altitude**
  - 11 Runway Edge Lines**
  - 12 TCAS Resolution Advisory**

## Failure Indications and Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate.

Data source flags are provided in a few cases to annunciate the source of displayed data when other than normal.

[Option - Model 4000]



### 1 HUD System Failure Indications and Flags

See section 42 for detailed information on the HUD system failure indications and flags.

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## Flight Instruments, Displays

### EFIS Instruments – Controls and Indicators

## Chapter 10

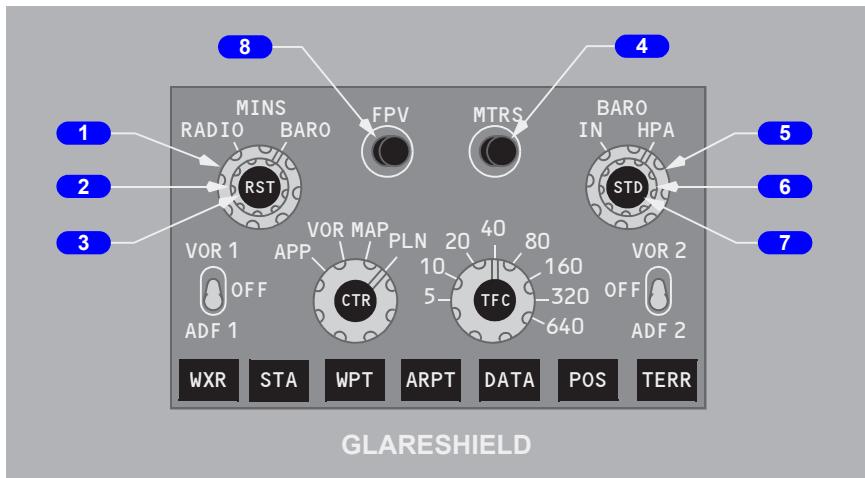
### Section 15

#### EFIS Control Panel (EFIS/Map Display)

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

#### EFIS Control Panel Controls – Flight Instrument Displays

[Option - Flight path vector, dual ADF



##### **1 Minimums (MINS) Reference Selector (outer) (two position)**

RADIO – selects radio altitude as the minimums reference.

BARO – selects barometric altitude as the minimums reference.

##### **2 Minimums (MINS) Selector (middle) (slew)**

ROTATE – adjusts the radio or baro minimums altitude.

##### **3 Minimums (MINS) Reset (RST) Switch (inner) (momentary action)**

PUSH –

- blanks radio height ALT alert
- resets the radio altitude minimums alert display on the attitude indicator
- blanks the reference altitude marker on the altimeter if displayed; sets the reference altitude marker to zero if not previously displayed.

#### 4 Meters (MTRS) Switch (momentary action)

PUSH – displays altitude indications in meters. Not available in compact display format.

#### 5 Barometric (BARO) Reference Selector (outer) (two position)

IN – selects inches of mercury as the barometric altitude reference.

HPA – selects hectopascals as the barometric altitude reference.

#### 6 Barometric (BARO) Selector (middle) (slew)

ROTATE – adjusts the barometric altitude setting on the altimeter.

#### 7 Barometric (BARO) Standard (STD) Switch (inner) (momentary action)

PUSH – selects the standard barometric setting (29.92 inches Hg/1013 HPA) for barometric altitude reference.

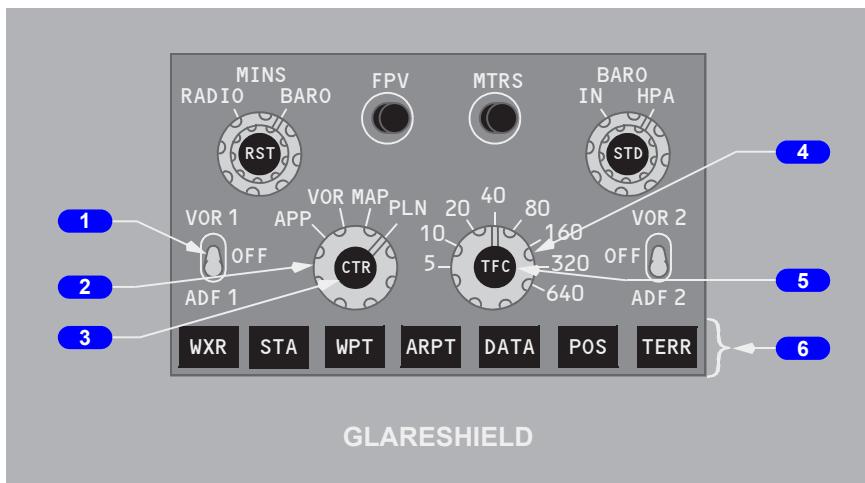
#### 8 Flight Path Vector (FPV) Switch (momentary action)

##### [Option - Flight path vector]

PUSH – displays flight path vector on the attitude indicator.

### EFIS Control Panel Controls – Navigation Displays

##### [Option - Dual ADF, flight path vector]



#### 1 VOR/ADF Switch (three position)

Displays VOR or ADF information on the respective RDMI.

VOR – displays the selected VOR bearing pointer and VOR bearing pointer source indicator.

OFF – removes the VOR or ADF displays and displays “OFF” in place of the bearing pointer source indicators.

ADF – displays the selected ADF pointer and ADF bearing pointer source indicator.

## **2 Mode Selector (outer)**

Selects the desired display.

APP –

- displays localizer and glideslope information in heading-up format
- displays reference ILS receiver, ILS frequency, course and DME
- displays reference GLS receiver, GLS channel/course and GLS distance.
- weather radar and TCAS are not displayed in center APP mode.

VOR –

- displays VOR navigation information in heading-up format
- displays reference VOR receiver, VOR frequency, course, DME and TO/FROM information
- weather radar and TCAS are not displayed in center VOR mode.

MAP –

### [Option - Heading-up display]

- displays FMC generated route and MAP information, airplane position, heading and track, in a heading-up format
- displays waypoints, including the active waypoint, within the selected range
- displays VNAV path deviation.

PLN –

- displays a non-moving, true north up, route depiction
- the airplane symbol represents actual airplane position
- allows route step-through using the CDU LEGS page
- weather radar and TCAS are not displayed.

## **3 Center (CTR) Switch (inner)**

PUSH –

- displays the full compass rose (center) for APP, VOR and MAP modes

### [Option - VSD]

- subsequent pushes alternate between center with VSD, expanded and center without VSD.

#### **4 Range Selector (outer)**

Selects desired display range in nautical miles for APP, VOR, MAP or PLN mode.

#### **5 Traffic (TFC) Switch (inner)**

PUSH – displays TCAS information (refer to Chapter 15, Warning Systems).

#### **6 MAP Switches (momentary action)**

The MAP switches:

- add background data/symbols to MAP and center MAP modes
- displays can be selected simultaneously
- second push removes the information.

WXR (weather radar) – energizes weather radar transmitter and displays weather radar returns in MAP, center MAP, expanded VOR and expanded APP modes. When the 640 nm range is selected, weather radar returns are limited to 320 nm (refer to Chapter 11, Flight Management, Navigation).

STA (station) –

- displays all FMC data base navigation aids if on map scales 5, 10, 20 or 40 nm.
- displays FMC data base high altitude navigation aids on map scales 80, 160, 320 or 640 nm.

WPT (waypoint) – displays the waypoints in the FMC data base which are not in the flight plan route if the selected range is 40 nm or less.

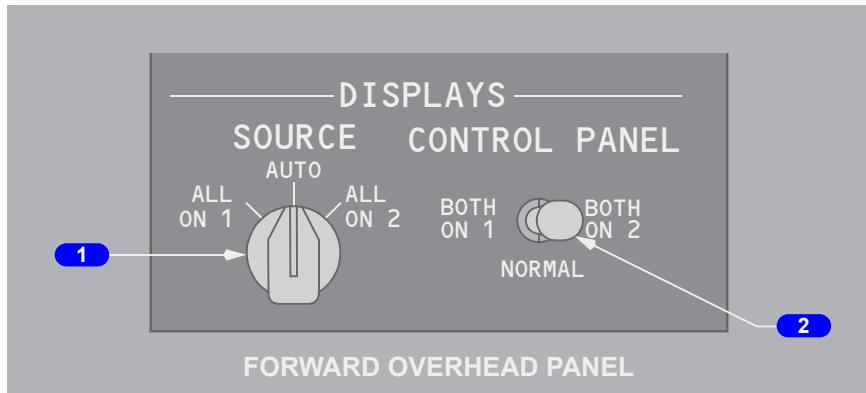
ARPT (airport) – displays all airports which are stored in the FMC data base and which are within the viewable map area.

DATA – displays altitude constraint, if applicable, and estimated time of arrival for each active route waypoint.

POS (position) – displays VOR and ADF bearing vectors extended from the nose of the airplane symbol to the stations.

TERR (terrain) – displays GPWS generated terrain data in MAP, center MAP, VOR, and APP modes (refer to Chapter 15, Warning Systems).

## Displays Source Panel



### **1 DISPLAYS SOURCE Selector**

AUTO – DEU 1 controls the Captain outboard, Captain inboard, and the upper display units; DEU 2 controls the First Officer outboard, First Officer inboard, and the lower display units. When a DEU fails, the other DEU controls all display units.

ALL ON 1/ALL ON 2 – provides a means of manually switching to a single DEU as the source of information for all six display units.

**Note:** Used on the ground for maintenance purposes.

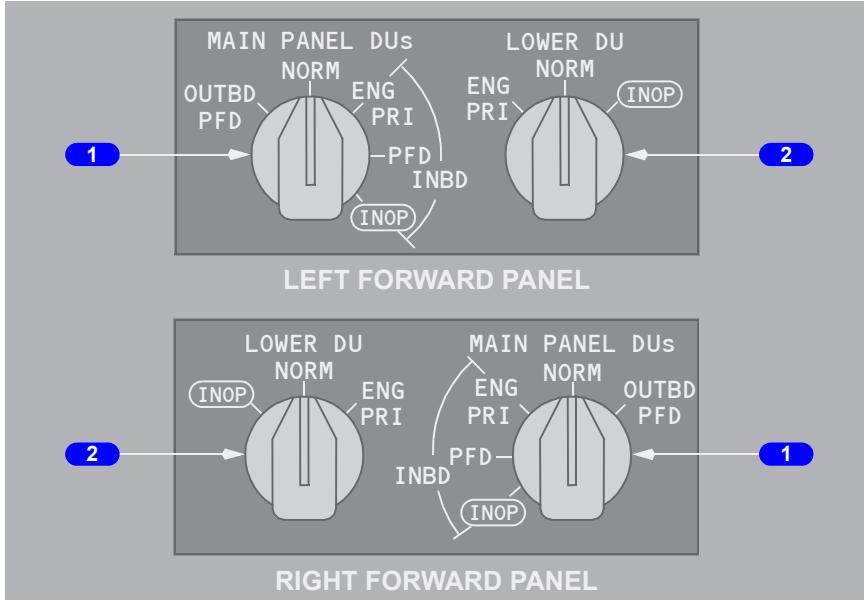
### **2 CONTROL PANEL Select Switch**

NORMAL – the left EFIS control panel controls the Captain's displays and the right EFIS control panel controls the First Officer's displays.

BOTH ON 1/BOTH ON 2 – provides a means of manually switching control of the Captain's and First Officer's displays to a single EFIS control panel.

## Display Select Panels

[Option - Side by side display]



### 1 Main Panel Display Units (MAIN PANEL DUs) Selector

Selects what is displayed on the respective outboard and inboard display units:

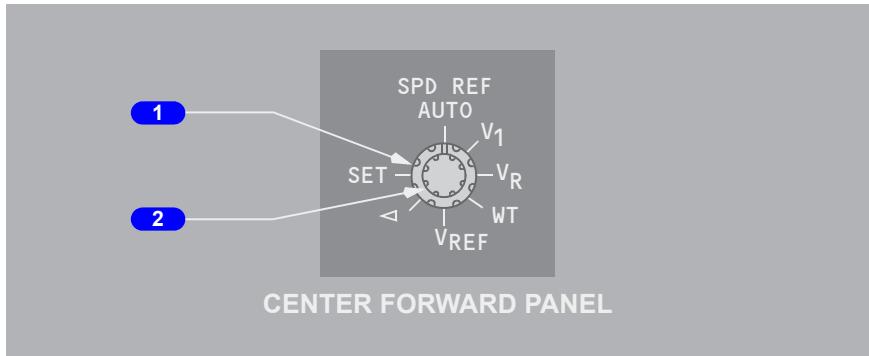
- Outboard Primary Flight Display (OUTBD PFD) – displays the compact EFIS format on the outboard display unit and blanks the inboard display unit.
- Normal (NORM) – displays normal EFIS and MAP displays on the outboard and inboard display units; provides automatic display switching if a display unit fails.
- Inboard Engine Primary (INBD ENG PRI) – displays the engine display on the inboard display unit and the compact EFIS format on the outboard display unit.
- Inboard Primary Flight Display (INBD PFD) – displays the compact EFIS format on the inboard display unit and blanks the outboard display unit.

## 2 Lower Display Unit (LOWER DU) Selector

Selects what is displayed on the lower display unit:

- Engine Primary (ENG PRI) – displays the engine display on the lower display unit and blanks the upper display unit.
- Normal (NORM) – displays the engine display on the upper display unit and no display on the lower display unit; provides automatic display switching to the lower display unit if the upper display unit fails.

## Speed Reference Selector



### 1 Speed Reference Selector (outer)

Sets the reference airspeed bugs on the Mach/airspeed indicator:

- AUTO – the reference airspeeds and gross weight are provided automatically through the FMC
- V1 – used to manually set decision speed on the ground; in flight, displays “INVALID ENTRY”
- VR – used to manually set rotation speed on the ground; in flight, displays “INVALID ENTRY”
- WT – allows manual entry of reference gross weight
- VREF – used to manually set the landing reference speed in flight; on the ground, displays “INVALID ENTRY”
- Bug 5 – used to manually set the white bug 5 to the desired value
- SET – removes the digital readout above the Mach/airspeed indicator.

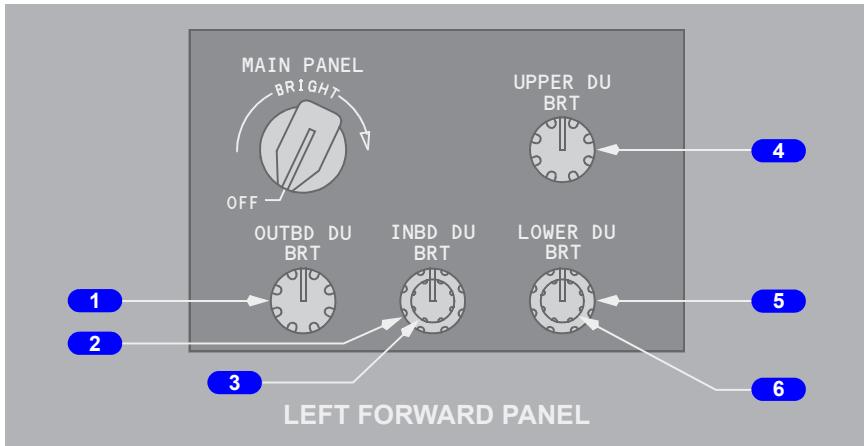
### 2 Speed Reference Selector (inner) (two speed slew)

ROTATE –

- manually sets the appropriate reference airspeed or gross weight
- the digital display appears above the Mach/airspeed indicator.

## Display Brightness Controls

### Captain Brightness Controls



#### **1 Outboard Display Unit Brightness (OUTBD DU BRT) Control (rotary)**

ROTATE – adjusts the brightness of the Captain outboard display unit.

#### **2 Inboard Display Unit Brightness (INBD DU BRT) Control (outer) (rotary)**

ROTATE – adjusts the brightness of the Captain inboard display unit.

#### **3 Inboard Display Unit Radar Brightness (INBD DU BRT) Control (inner) (rotary)**

ROTATE – adjusts weather radar and terrain display brightness on the Captain inboard display unit.

#### **4 Upper Display Unit Brightness (UPPER DU BRT) Control (rotary)**

ROTATE – adjusts the brightness of the upper display unit.

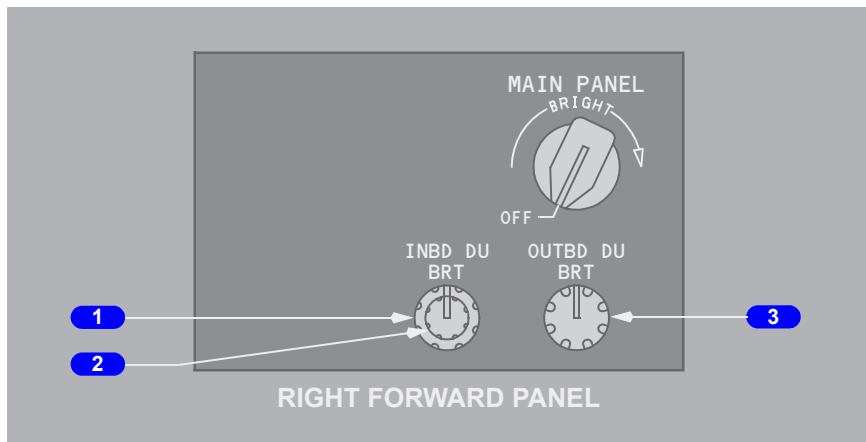
#### **5 Lower Display Unit Brightness (LOWER DU BRT) Control (outer) (rotary)**

ROTATE – adjusts the brightness of the lower display unit.

#### **6 Lower Display Unit Brightness (LOWER DU BRT) Control (inner) (rotary)**

Inoperative.

## First Officer Brightness Controls



**1 Inboard Display Unit Brightness (INBD DU BRT) Control (outer) (rotary)**

ROTATE – adjusts the brightness of the First Officer inboard display unit.

**2 Inboard Display Unit Radar Brightness (INBD DU BRT) Control (inner) (rotary)**

ROTATE – adjusts weather radar and terrain display brightness on the First Officer inboard display unit.

**3 Outboard Display Unit Brightness (OUTBD DU BRT) Control (rotary)**

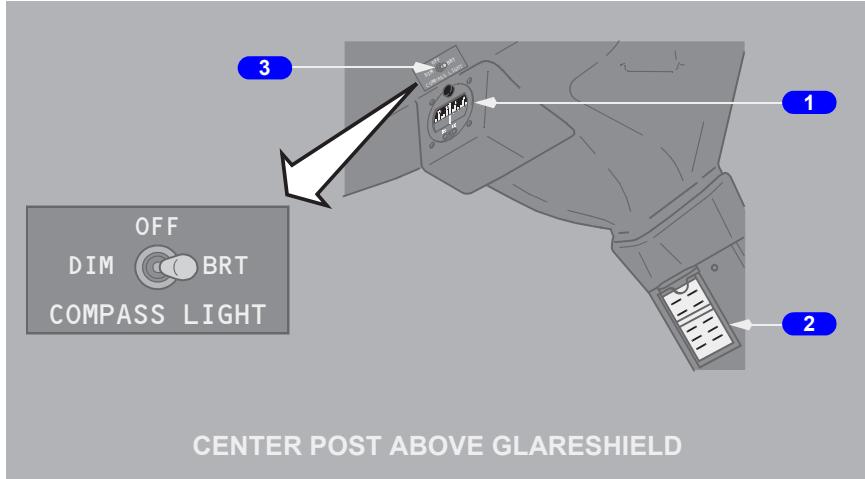
ROTATE – adjusts the brightness of the First Officer outboard display unit.

## Standby Flight Instruments

The standby flight instruments include the:

- standby magnetic compass
- standby attitude indicator
- standby altimeter/airspeed indicator
- integrated standby flight display
- standby radio magnetic indicator.

### Standby Magnetic Compass



#### **1 Standby Magnetic Compass**

Displays magnetic heading.

#### **2 Standby Magnetic Compass Correction Card**

Provides appropriate heading corrections.

#### **3 Compass Light Switch**

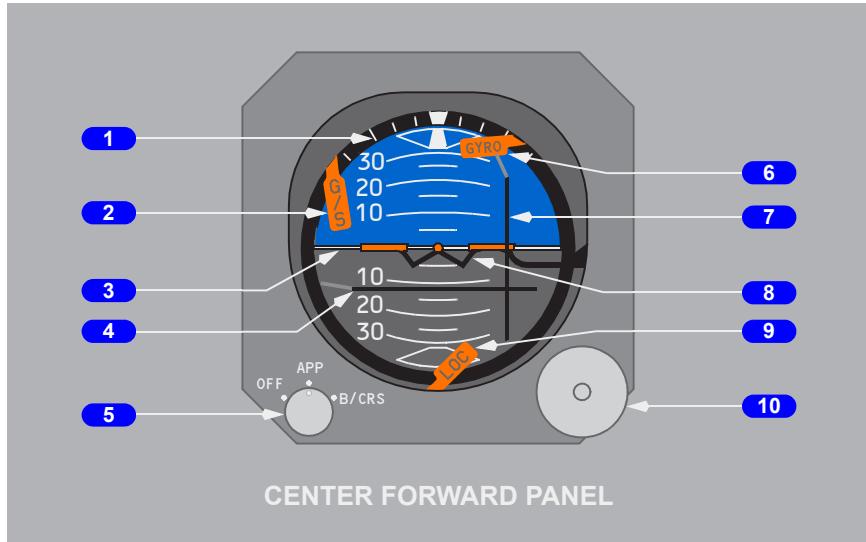
OFF – compass light is extinguished.

BRT – sets compass light to full brightness.

DIM – sets compass light to low brightness.

## Standby Attitude Indicator

[Option - Sextant 705-7V4]



### **1** Bank Indicator and Scale

Scale marks are at 0, 10, 20, 30, 45 and 60 degrees.

### **2** Glideslope Flag

- glideslope receiver has failed
- glideslope pointer is removed.

### **3** Horizon Line and Pitch Angle Scale

Pitch scale is in 5 degree increments.

### **4** Glideslope Pointer and Deviation Scale

- pointer indicates glideslope position
- pointer is not displayed when
  - approach selector is off or in B/CRS
  - no computed data exists
  - glideslope receiver has failed
- scale indicates deviation.

### **5** Approach Mode Selector

OFF – glideslope and localizer pointers retracted from view.

---

APP – 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**

Attitude is unreliable.

## **7 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.

## **8 Airplane Symbol**

## **9 Localizer Flag**

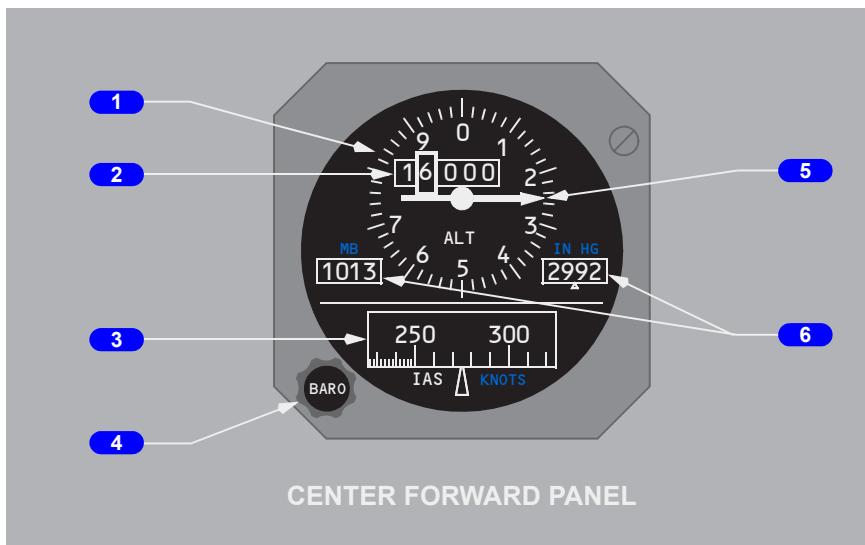
- localizer receiver has failed
- localizer pointer is removed.

## **10 Caging Control**

PULL – aligns horizon line with the airplane symbol.

RELEASE – the control contracts.

## Standby Altimeter/Airspeed Indicator



### **1** Standby Altimeter

Receives static pressure from the alternate static ports.

### **2** Digital Counter

- indicates thousand foot increments of current altitude
- 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** Standby Airspeed Indicator

Receives ram pressure from the auxiliary pitot probe and static pressure from the alternate static ports.

### **4** Barometric Setting Control

ROTATE – adjusts the barometric correction in both barometric windows.

### **5** Altitude Pointer

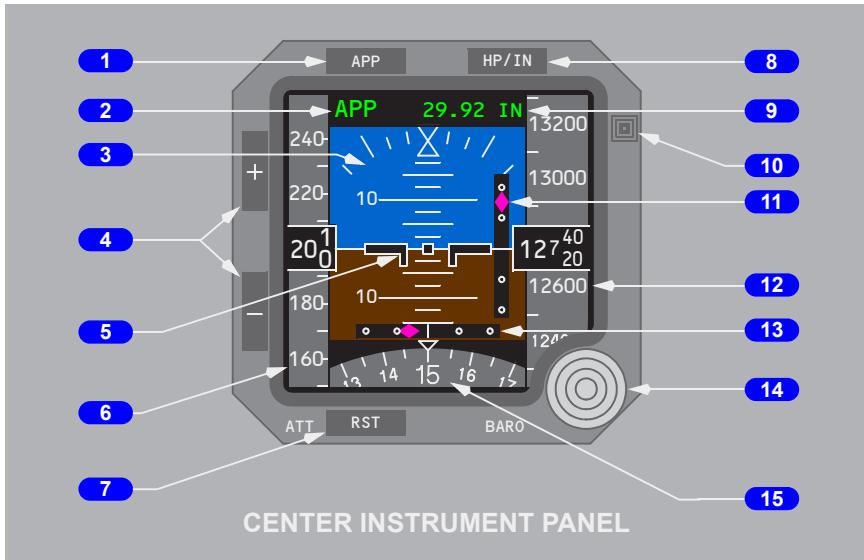
Indicates hundred foot increments of current altitude.

## 6 Barometric Setting Windows

Indicates barometric correction in millibars and inches of mercury as set by the barometric setting control.

### Integrated Standby Flight Display

[Option - Sextant S231A120]



#### 1 Approach (APP) Switch

Push –

- when blank, selects APP
- when APP displayed, selects BCRS
- when BCRS displayed, blanks

#### 2 Approach Mode Annunciation

Indicates approach mode selected.

- Blank – no approach deviation data displayed
- APP – ILS localizer and glideslope deviation data displayed
- BCRS (Back course) – reverses sensing for localizer pointer during back course approaches

**3 Attitude Display**

Displays airplane attitude.

- Indicates bank in reference to the bank scale
- Indicates the horizon relative to the airplane symbol
- Beyond 30 degrees pitch, large red arrowheads (V-shaped) indicate the attitude has become excessive, and the direction to the horizon line.

**4 Display Brightness Switches**

Push –

- + increases display brightness
- - decreases display brightness

**5 Airplane Symbol**

Indicates airplane attitude with reference to the horizon.

**6 Airspeed Indications**

Indicates current airspeed when above 30 knots.

**7 Attitude Reset (RST) Switch**

Push and hold at least two seconds

- aligns horizon with the airplane symbol
- reset takes approximately ten seconds

**8 Hectopascal/Inch (HP/IN) Switch**

Push – changes the units of the barometric reference.

**9 Barometric Setting**

Indicates the barometric setting selected with the barometric selector.

STD is displayed when selected with the barometric selector.

**10 Ambient Light Sensor**

Automatically adjusts display intensity for ambient lighting condition.

**11 Glideslope Pointer and Deviation Scale**

The glideslope pointer indicates glideslope position relative to the airplane.

- the pointer is in view when the glideslope signal is received
- the scale is in view when the APP mode is selected
- the pointer and scale are removed when the BCRS mode is selected

## 12 Current Altitude

## 13 Localizer Pointer and Deviation Scale

The localizer pointer indicates localizer position relative to the airplane.

- the pointer is in view when the localizer signal is received
- the scale is in view when either the APP or BCRS mode is selected

## 14 Barometric (BARO) Selector

Rotate – changes barometric setting

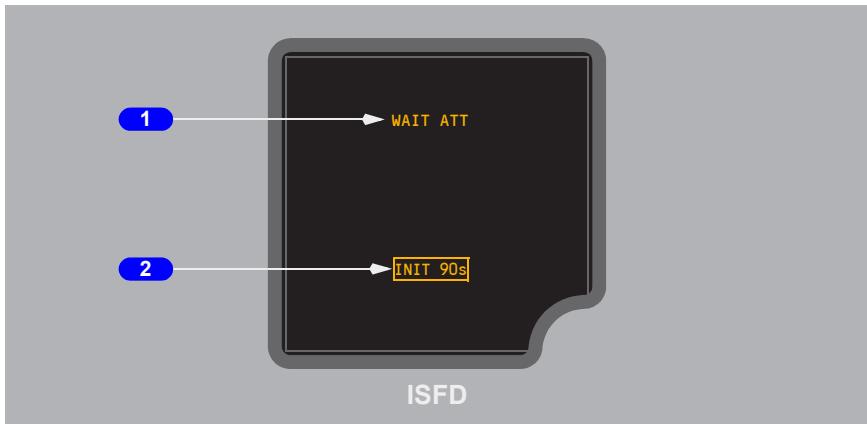
Push –

- selects standard barometric setting (29.92 inches Hg/1013 HPA)
- if STD is displayed, selects the preselected barometric setting

## 15 Heading Indication

Displays airplane heading.

### ISFD Messages



### 1 Attitude Messages

Indicates attitude display status.

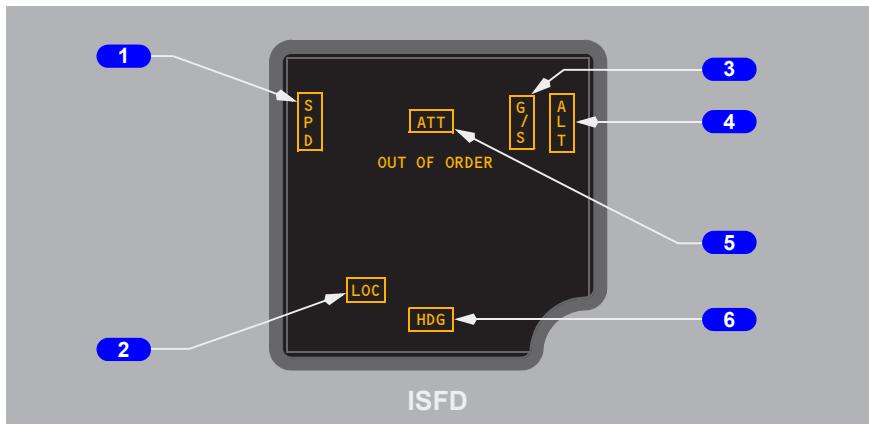
- ATT:RST (amber) – attitude must be reset using the attitude reset switch
- ATT 10s (amber) – 10 second attitude realignment in progress
- WAIT ATT (amber) – indicates temporary self correcting loss of attitude

### 2 Initialization Message

INIT 90s (amber) – 90 second initialization in progress.

## ISFD Failure Flags

The OUT OF ORDER annunciation replaces the display when a total ISFD system failure occurs.



### 1 Airspeed flag

Airspeed information has failed.

### 2 ILS localizer failure flag

ILS localizer has failed.

### 3 ILS glideslope failure flag

ILS glideslope has failed.

### 4 Altitude flag

Altitude information has failed.

### 5 Attitude flag

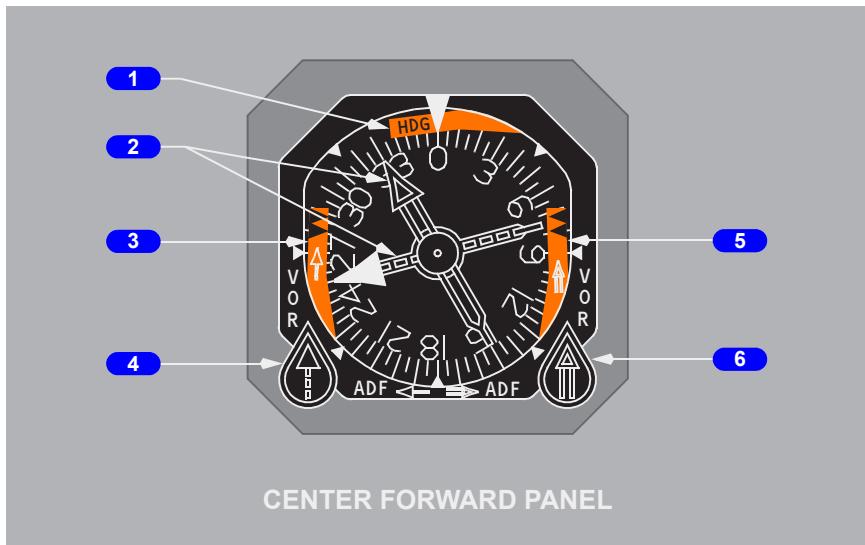
Attitude information has failed.

### 6 Heading flag

Heading data has failed.

## Standby Radio Magnetic Indicator

[Option - Dual ADF]



### 1 Heading Warning Flag

The compass signal from the air data inertial reference system is lost.

### 2 Bearing Pointers

- narrow pointer uses signals from the VHF NAV receiver No. 1 or ADF receiver No. 1.

[Option - Dual ADF]

- wide pointer uses signals from the VHF NAV receiver No. 2 or ADF receiver No. 2.

### 3 Bearing Pointer No. 1 Warning Flag

VOR mode:

- RMI power failure
- VHF NAV signal unreliable.

ADF mode:

- RMI power failure
- ADF failure or signal unreliable.

### 4 VOR/ADF Bearing Pointer No. 1 Switch

ROTATE – selects VOR or ADF for the bearing pointer.

## **5 Bearing Pointer No. 2 Warning Flag**

VOR mode

- RMI power failure
- VHF NAV signal unreliable.

[Option - Dual ADF]

ADF mode

- RMI power failure
- ADF failure or signal unreliable.

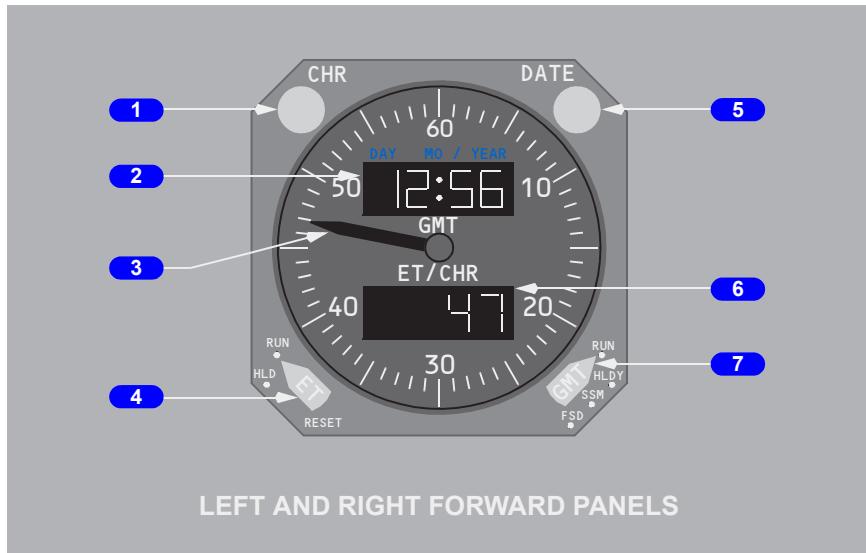
## **6 VOR/ADF Bearing Pointer No. 2 Switch**

[Option - Dual ADF]

ROTATE – selects VOR or ADF for the bearing pointer.

## **Clock**

[Option - Smiths 60B00303-105]



### **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 date control
- alternately displays day–month and year when date is selected with the date control.

## 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

Controls the date display.

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 or date is selected with the date control.

FS D (fast slew, day) –

- advances hours when time is selected with the date control
- advances days when date is selected with the date control.

SS M (slow slew, month) –

- advances minutes when time is selected with the date control
- advances months when date is selected with the date control.

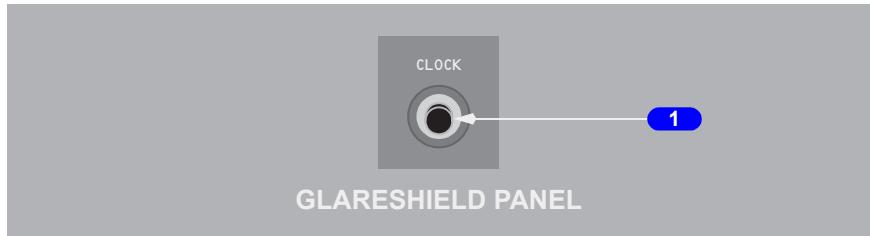
HLD Y (hold, year) –

- stops the time indicator and sets the seconds to zero when time is selected with the date control
- advances years when date is selected with the date control.

RUN – starts the time indicator.

## Clock Switch

**[Option]**



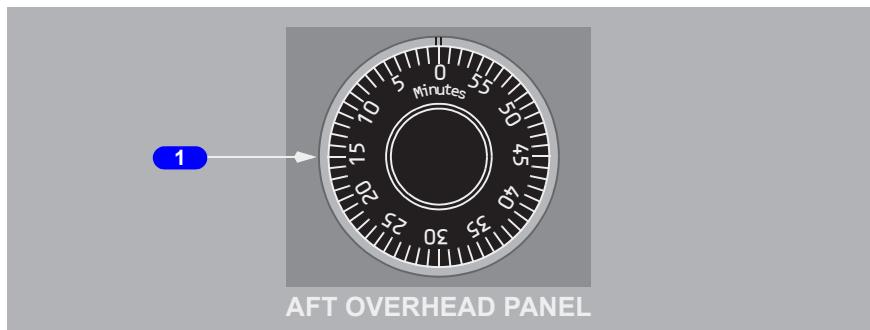
### 1 Clock Switch

Operates the same as the chronograph (CHR) control.

---

## Timer

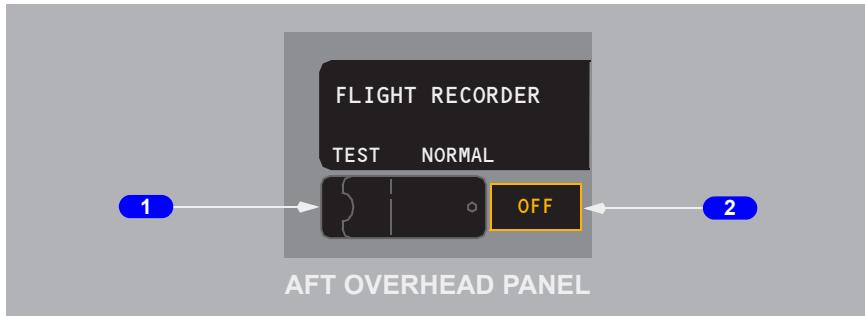
**[Option]**



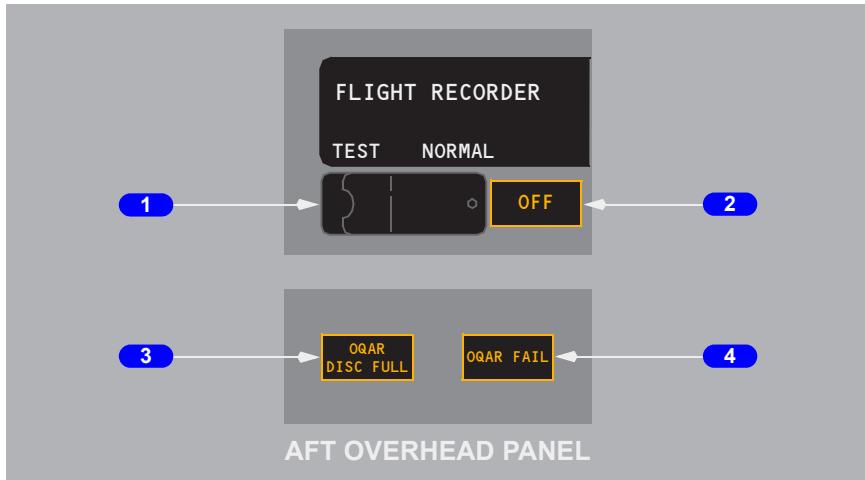
### 1 Mechanical Timer

## Flight Recorder

[Option - Without QAR lights]



[Option - With QAR lights]



### 1 Flight Recorder Test Switch

NORMAL (guarded position) –

- inflight – the recorder operates anytime electrical power is available
- on the ground – either engine must also be operating.

TEST – powers the flight recorder on the ground.

### 2 OFF Light (amber)

ILLUMINATED –

- indicates the recorder is not operating or the test is invalid
- may indicate power failure, loss of input data, or electronic malfunction.

**3 Optical Quick Access Recorder (OQAR) Disc Full (blue)****[Option - QAR lights]**

ILLUMINATED –

- indicates the quick access recorder is full

**4 Optical Quick Access Recorder (OQAR) FAIL (blue)****[Option - QAR lights]**

ILLUMINATED –

- indicates the quick access recorder has failed

Intentionally  
Blank

## Flight Instruments, Displays

### EFIS Instruments (PFD) – Controls

## Chapter 10

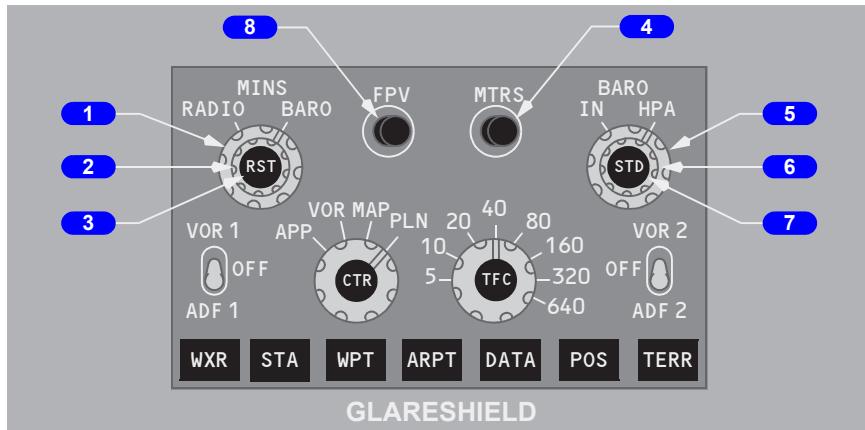
### Section 16

#### EFIS Control Panel (PFD/ND Display)

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

#### EFIS Control Panel Controls – Flight Instrument Displays

[Option - Dual ADF]



##### 1 Minimums (MINS) Reference Selector (outer) (two position)

RADIO – selects radio altitude as the minimums reference

BARO – selects barometric altitude as the minimums reference.

##### 2 Minimums (MINS) Selector (middle) (slew)

ROTATE – adjusts the radio or baro minimums altitude.

##### 3 Radio Minimums (MINS) Reset (RST) Switch (inner) (momentary action)

PUSH –

- resets the alert minimums annunciation
- blanks minimums display if alert is not active.

##### 4 Meters (MTRS) Switch (momentary action)

PUSH – displays altitude indications in meters.

## 5 Barometric (BARO) Reference Selector (outer) (two position)

IN – selects inches of mercury as the barometric altitude reference

HPA – selects hectopascals as the barometric altitude reference.

## 6 Barometric (BARO) Selector (middle) (slew)

ROTATE –

- adjusts the barometric altitude setting on the altitude tape
- if STD displayed, adjusts the preselected BARO reference.

## 7 Barometric (BARO) Standard (STD) Switch (inner) (momentary action)

PUSH –

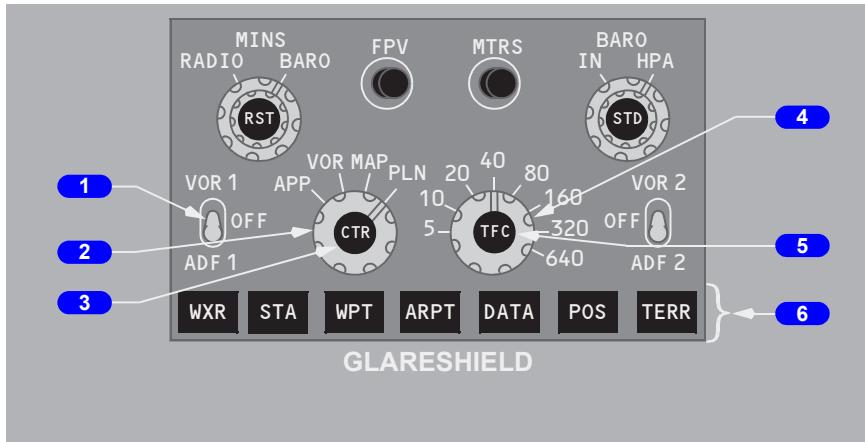
- selects the standard barometric setting (29.92 inches Hg/1013 HPA) for barometric altitude reference
- if STD is displayed, selects the preselected barometric reference
- if no preselected barometric is displayed, displays the last value before STD was selected.

## 8 Flight Path Vector (FPV) Switch (momentary action)

PUSH – displays flight path vector on the attitude indicator.

# EFIS Control Panel Controls – Navigation Displays

[Option - Dual ADF]



### 1 VOR/ADF Switch (three position)

Displays VOR or ADF information on all navigation modes except PLAN.

VOR – displays the selected VOR bearing pointer, frequency or identification and DME.

OFF – removes the VOR or ADF displays.

ADF – displays the selected ADF pointer and ADF frequency or identification.

## **2 Mode Selector (outer)**

Selects the desired display.

APP –

- displays localizer and glideslope information in heading-up format.

### [Option - IAN]

- displays FAC and glidepath information in heading-up format.
- displays reference IAN procedure, distance to missed approach point and source of IAN deviations.
- displays reference ILS receiver, ILS frequency or identification, course and DME.
- displays reference GLS receiver, GLS channel/course and GLS distance.
- weather radar and TCAS are not displayed in center APP mode.

VOR –

- displays VOR navigation information in heading-up format
- displays reference VOR receiver, VOR frequency or identification, course, DME and TO/FROM information
- weather radar and TCAS are not displayed in center VOR mode.

MAP –

### [Option - Track-up display]

- displays FMC generated route and MAP information, airplane position, heading and track, in a track-up format
- displays waypoints, including the active waypoint, within the selected range
- displays VNAV path deviation.

PLN –

- displays a non-moving, true north up, route depiction
- the airplane symbol represents actual airplane position and orientation
- allows route step-through using the CDU LEGS page
- weather radar and TCAS are not displayed.

### **3 Center (CTR) Switch (inner)**

PUSH –

- displays the full compass rose (center) for APP, VOR and MAP modes
- subsequent pushes alternate between expanded and center displays.

#### [Option - VSD]

- subsequent pushes alternate between center with VSD, expanded and center without VSD.

### **4 Range Selector (outer)**

Selects desired display range in nautical miles for APP, VOR, MAP or PLN mode.

### **5 Traffic (TFC) Switch (inner)**

PUSH – displays TCAS information on the navigation display (refer to Chapter 15, Warning Systems).

### **6 MAP Switches (momentary action)**

The MAP switches:

- add background data/symbols to MAP and center MAP modes
- displays can be selected simultaneously
- second push removes the information.

WXR (weather radar) – energizes weather radar transmitter and displays weather radar returns in MAP, center MAP, expanded VOR, and expanded APP modes. When the 640 nm range is selected, weather radar returns are limited to 320 nm (refer to Chapter 11, Flight Management, Navigation).

STA (station) –

- displays all FMC data base navigation aids if on map scales 5, 10, 20 or 40 nm
- displays FMC data base high altitude navigation aids on map scales 80, 160, 320 or 640 nm.

WPT (waypoint) – displays the waypoints in the FMC data base which are not in the flight plan route if the selected range is 40 nm or less.

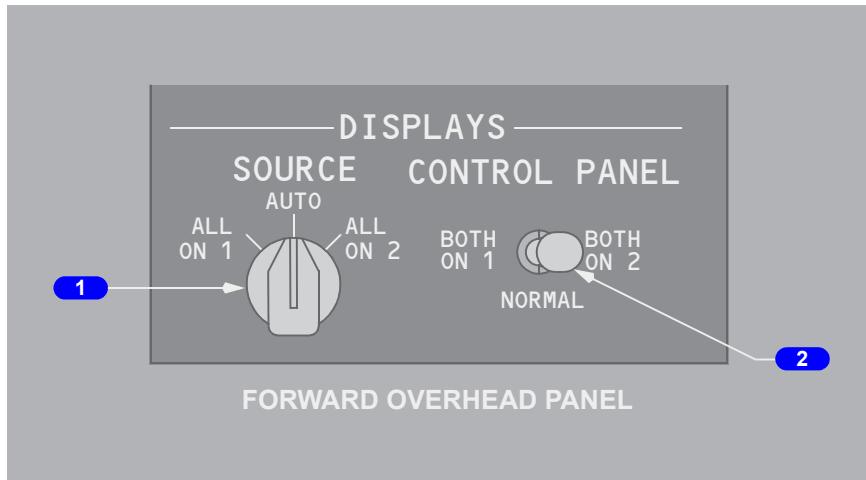
ARPT (airport) – displays all airports which are stored in the FMC data base and which are within the viewable map area.

DATA – displays altitude constraint, if applicable, and estimated time of arrival for each active route waypoint.

POS (position) – displays IRS positions, GPS positions and VOR bearing vectors extended from the nose of the airplane symbol to the stations.

TERR (terrain) – displays GPWS generated terrain data in MAP, center MAP, VOR, and APP modes (refer to Chapter 15, Warning Systems).

## Displays Source Panel



### 1 DISPLAYS SOURCE Selector

AUTO – DEU 1 controls the Captain outboard, Captain inboard, and the upper display units; DEU 2 controls the First Officer outboard, First Officer inboard, and the lower display units. When a DEU fails, the other DEU controls all display units.

ALL ON 1/ALL ON 2 – provides a means of manually switching to a single DEU as the source of information for all six display units.

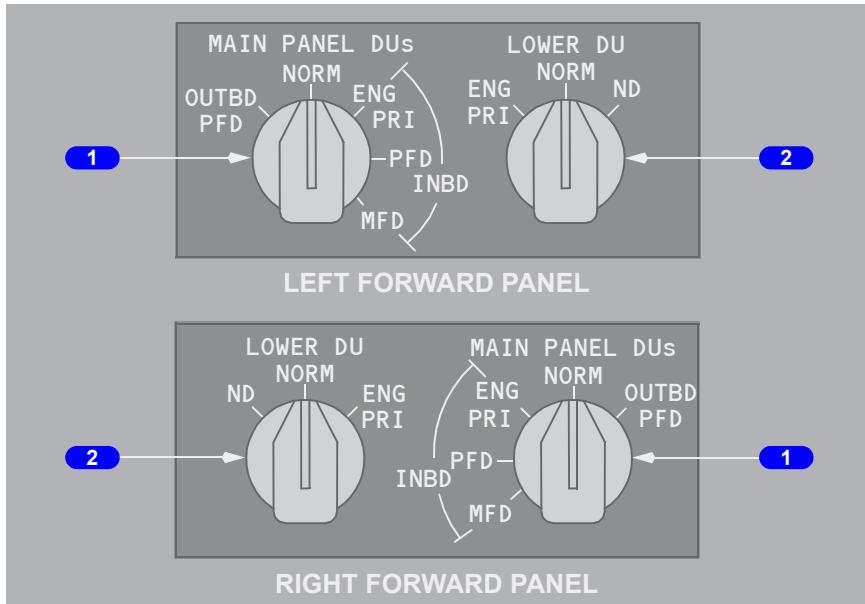
**Note:** Used on the ground for maintenance purposes.

### 2 CONTROL PANEL Select Switch

NORMAL – the left EFIS control panel controls the Captain's displays and the right EFIS control panel controls the First Officer's displays.

BOTH ON 1/BOTH ON 2 – provides a means of manually switching control of the Captain's and First Officer's displays to a single EFIS control panel.

## Display Select Panels



### **1 Main Panel Display Units (MAIN PANEL DUs) Selector**

Selects what is displayed on the respective outboard and inboard display units:

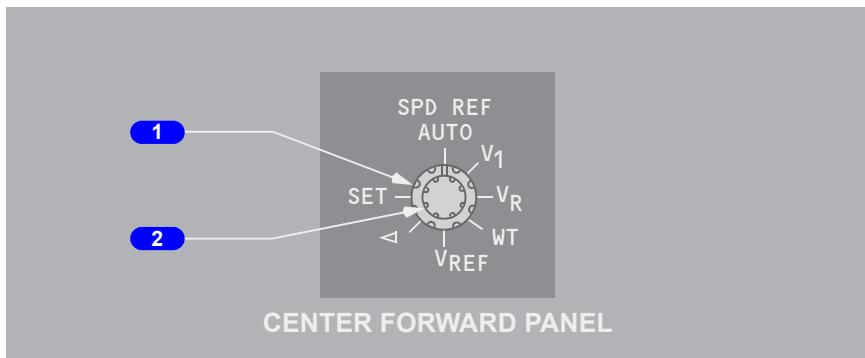
- Outboard Primary Flight Display (OUTBD PFD) – displays the PFD on the outboard display unit and blanks the inboard display unit
- Normal (NORM) – displays PFD on the outboard display unit and ND on the inboard display unit
- Inboard Engine Primary (INBD ENG PRI) – displays the primary engine instruments on the inboard display unit and the PFD on the outboard display unit
- Inboard Primary Flight Display (INBD PFD) – displays the PFD on the inboard display unit and blanks the outboard display unit
- Inboard Multifunction Display (INBD MFD) – displays PFD on the outboard display unit and blanks the inboard display unit. The inboard display unit stays blank until system format (SYS) or secondary engine format (ENG) is selected with MFD switches on the engine display control panel.

## 2 Lower Display Unit (LOWER DU) Selector

Selects what is displayed on the lower display unit:

- Engine Primary (ENG PRI) – displays the primary engine instruments on the lower display unit and blanks the upper display unit
- Normal (NORM) – display unit is normally blank or displays MFD format selected on the engine display control panel
- Navigation Display (ND) – displays the navigation display on the lower unit.

## Speed Reference Selector



### 1 Speed Reference Selector (outer)

Sets the reference airspeed bugs on the airspeed indication:

- AUTO – the reference airspeeds and gross weight are provided automatically through the FMC
- V1 – used to manually set decision speed on the ground; in flight, displays “INVALID ENTRY”
- VR – used to manually set rotation speed on the ground; in flight, displays “INVALID ENTRY”
- WT – allows manual entry of reference gross weight
- VREF – used to manually set the landing reference speed in flight; on the ground, displays “INVALID ENTRY”
- Bug 5 – used to manually set the white bug 5 to the desired value
- SET – removes the speed reference display.

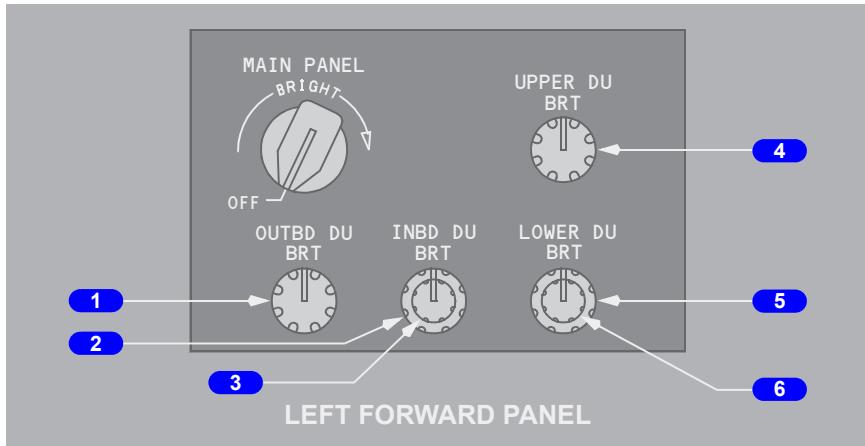
### 2 Speed Reference Selector (inner) (two speed slew)

ROTATE –

- manually sets the appropriate reference airspeed or gross weight
- the digital display appears below the airspeed indication.

## Display Brightness Controls

### Captain Brightness Controls



#### **1 Outboard Display Unit Brightness (OUTBD DU BRT) Control (rotary)**

ROTATE – adjusts the brightness of the Captain outboard display unit.

#### **2 Inboard Display Unit Brightness (INBD DU BRT) Control (outer) (rotary)**

ROTATE – adjusts the brightness of the Captain inboard display unit.

#### **3 Inboard Display Unit Radar Brightness (INBD DU BRT) Control (inner) (rotary)**

ROTATE – adjusts weather radar and terrain display brightness on the Captain inboard display unit.

#### **4 Upper Display Unit Brightness (UPPER DU BRT) Control (rotary)**

ROTATE – adjusts the brightness of the upper display unit.

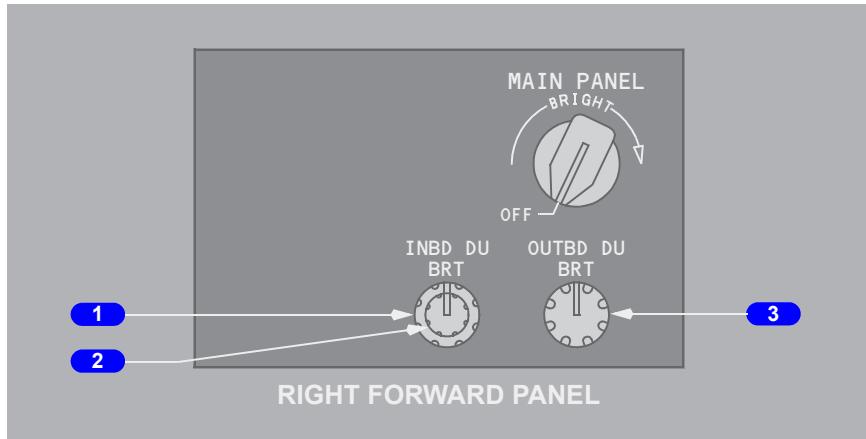
#### **5 Lower Display Unit Brightness (LOWER DU BRT) Control (outer) (rotary)**

ROTATE – adjusts the brightness of the lower display unit.

**6 Lower Display Unit Brightness (LOWER DU BRT) Control (inner)  
(rotary)**

ROTATE – adjusts weather radar and terrain display brightness on the lower display unit.

## First Officer Brightness Controls



**1 Inboard Display Unit Brightness (INBD DU BRT) Control (outer)  
(rotary)**

ROTATE – adjusts the brightness of the First Officer inboard display unit.

**2 Inboard Display Unit Radar Brightness (INBD DU BRT) Control  
(inner) (rotary)**

ROTATE – adjusts weather radar and terrain display brightness on the First Officer inboard display unit.

**3 Outboard Display Unit Brightness (OUTBD DU BRT) Control  
(rotary)**

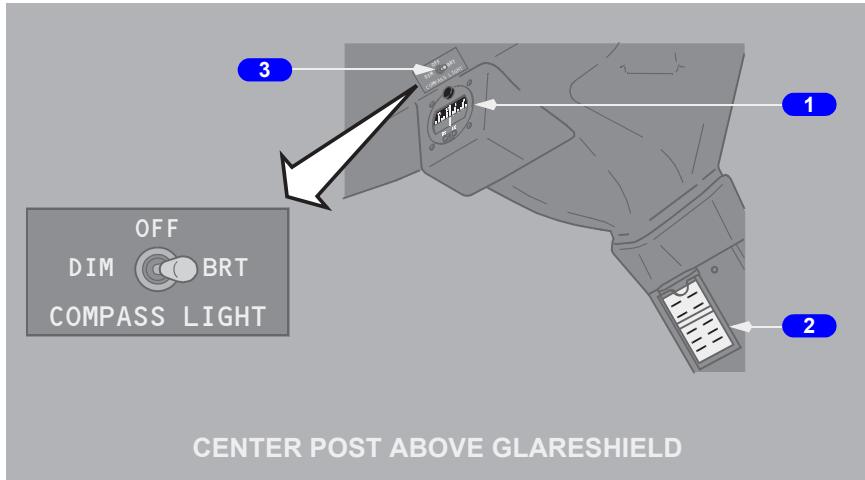
ROTATE – adjusts the brightness of the First Officer outboard display unit.

## Standby Flight Instruments

The standby flight instruments include the:

- standby magnetic compass
- standby attitude indicator
- standby altimeter/airspeed indicator
- integrated standby flight display
- standby radio magnetic indicator.

### Standby Magnetic Compass



#### **1 Standby Magnetic Compass**

Displays magnetic heading.

#### **2 Standby Magnetic Compass Correction Card**

Provides appropriate heading corrections.

#### **3 Compass Light Switch**

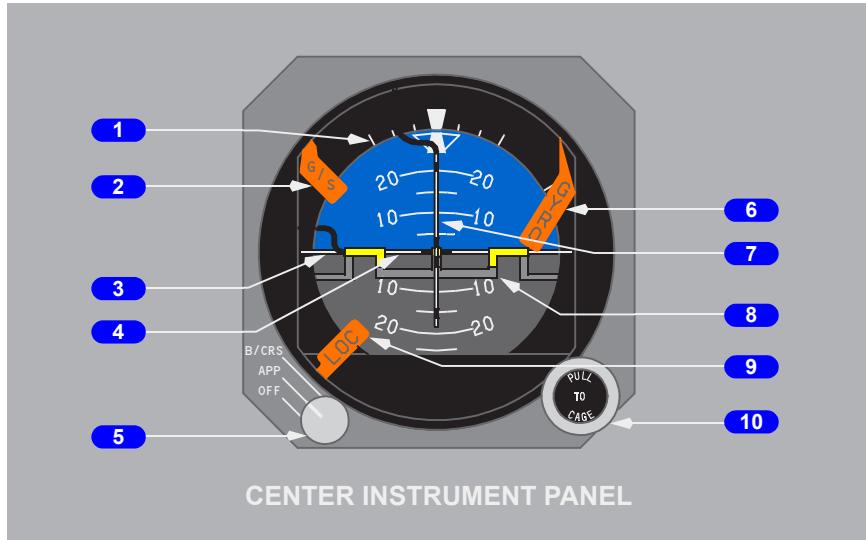
OFF – compass light is extinguished.

BRT – sets compass light to full brightness.

DIM – sets compass light to low brightness.

## Standby Attitude Indicator

[Option - Jet 501-1568-27 or BFG 501-1657-02]



### 1 Bank Indicator and Scale

Scale marks are at 0, 10, 20, 30, 45 and 60 degrees.

### 2 Glide Slope Flag

- glide slope receiver has failed
- glide slope pointer is removed.

### 3 Horizon Line and Pitch Angle Scale

Pitch scale is in 5 degree increments.

### 4 Glide Slope Pointer and Deviation Scale

- pointer indicates glide slope position
- pointer is not displayed when
  - approach selector is off or in B/CRS
  - no computed data exists
  - glide slope receiver has failed
- scale indicates deviation.

### 5 Approach Mode Selector

OFF – glide slope and localizer pointers retracted from view.

---

APP – glide slope 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; glide slope pointer not displayed.

## **6 GYRO Flag**

Attitude is unreliable.

## **7 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.

## **8 Airplane Symbol**

## **9 Localizer Flag**

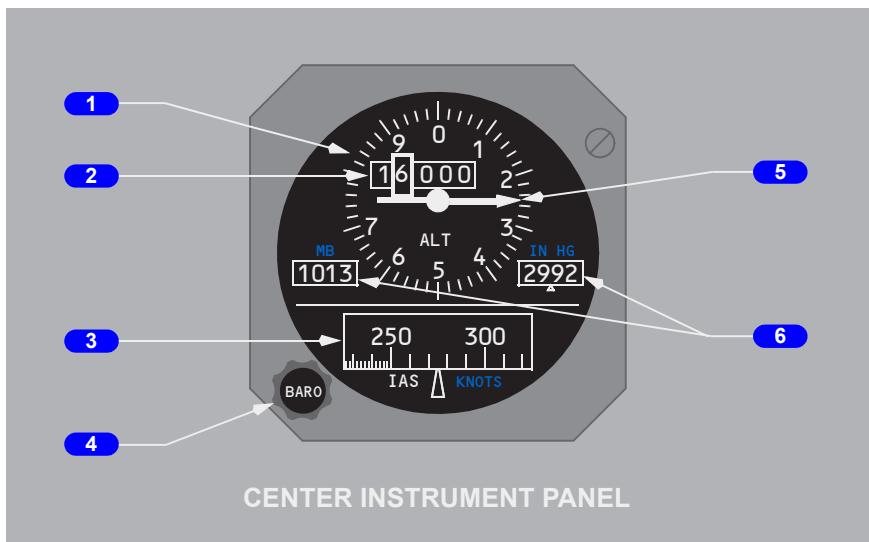
- localizer receiver has failed
- localizer pointer is removed.

## **10 Caging Control**

PULL – aligns horizon line with the airplane symbol

RELEASE – the control contracts.

## Standby Altimeter/Airspeed Indicator



### 1 Standby Altimeter

Receives static pressure from the alternate static ports.

### 2 Digital Counter

- indicates thousand foot increments of current altitude
- a green flag appears in the left side of the window when altitude is less than 10,000 feet
- a striped flag appears in the left side of the window when altitude is less than zero feet.

### 3 Standby Airspeed Indicator

Receives ram air pressure from the auxiliary pitot probe and static pressure from the alternate static ports.

### 4 Barometric Setting Control

ROTATE – adjusts the barometric correction in both barometric windows.

### 5 Altitude Pointer

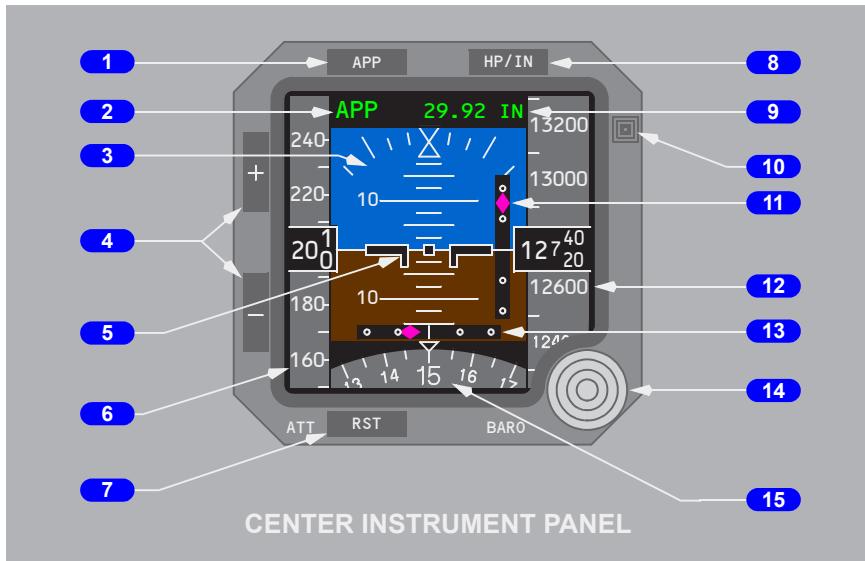
Indicates hundred foot increments of current altitude.

## 6 Barometric Setting Windows

Indicates barometric correction in millibars and inches of mercury as set by the barometric setting control.

### Integrated Standby Flight Display

[Option - Sextant S231A120-1, Sextant S231A120-5, Thales C16221MA01]



#### 1 Approach (APP) Switch

Push –

- when blank, selects APP
- when APP displayed, selects BCRS
- when BCRS displayed, blanks

#### 2 Approach Mode Annunciation

Indicates approach mode selected.

- Blank – no approach deviation data displayed
- APP – ILS localizer and glideslope deviation data displayed
- BCRS (Back course) – reverses sensing for localizer pointer during back course approaches

**3 Attitude Display**

Displays airplane attitude.

- Indicates bank in reference to the bank scale
- Indicates the horizon relative to the airplane symbol
- Beyond 30 degrees pitch, large red arrowheads (V-shaped) indicate the attitude has become excessive, and the direction to the horizon line.

**4 Display Brightness Switches**

Push –

- + increases display brightness
- - decreases display brightness

**5 Airplane Symbol**

Indicates airplane attitude with reference to the horizon.

**6 Airspeed Indications**

Indicates current airspeed when above 30 knots.

**7 Attitude Reset (RST) Switch**

Push and hold at least two seconds

- aligns horizon with the airplane symbol
- reset takes approximately ten seconds

**8 Hectopascal/Inch (HP/IN) Switch**

Push – changes the units of the barometric reference.

**9 Barometric Setting**

Indicates the barometric setting selected with the barometric selector.

STD is displayed when selected with the barometric selector.

**10 Ambient Light Sensor**

Automatically adjusts display intensity for ambient lighting condition.

**11 Glideslope Pointer and Deviation Scale**

The glideslope pointer indicates glideslope position relative to the airplane.

- the pointer is in view when the glideslope signal is received
- the scale is in view when the APP mode is selected
- the pointer and scale are removed when the BCRS mode is selected

## 12 Current Altitude

## 13 Localizer Pointer and Deviation Scale

The localizer pointer indicates localizer position relative to the airplane.

- the pointer is in view when the localizer signal is received
- the scale is in view when either the APP or BCRS mode is selected

## 14 Barometric (BARO) Selector

Rotate – changes barometric setting

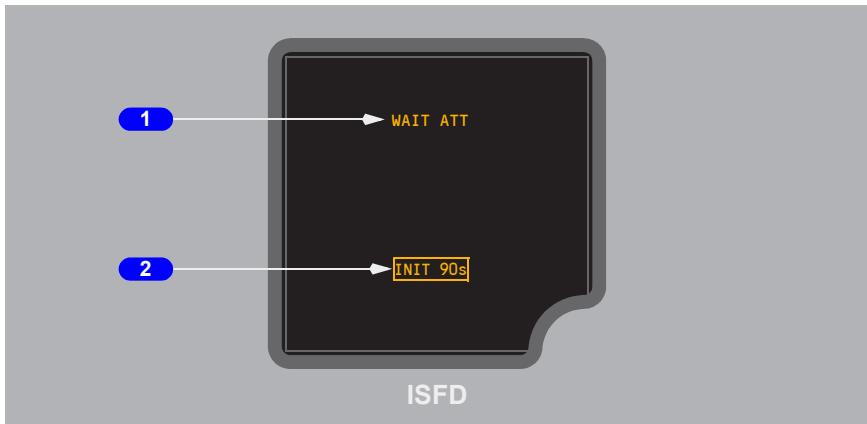
Push –

- selects standard barometric setting (29.92 inches Hg/1013 HPA)
- if STD is displayed, selects the preselected barometric setting

## 15 Heading Indication

Displays airplane heading.

### ISFD Messages



### 1 Attitude Messages

Indicates attitude display status.

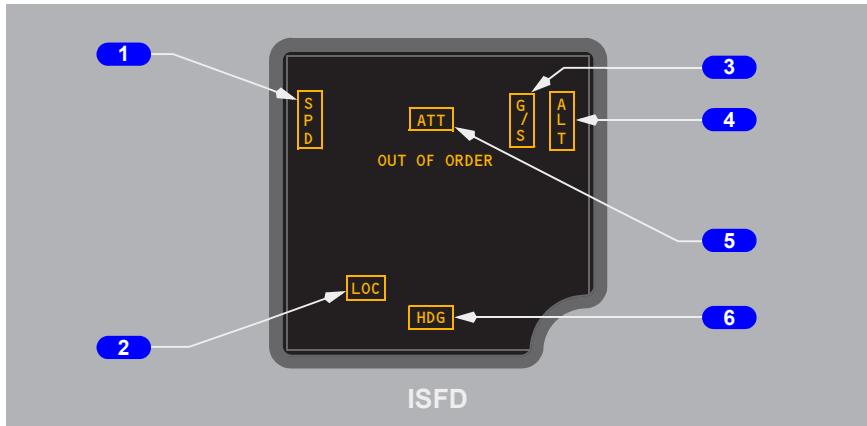
- ATT:RST (amber) – attitude must be reset using the attitude reset switch
- ATT 10s (amber) – 10 second attitude realignment in progress
- WAIT ATT (amber) – indicates temporary self correcting loss of attitude

### 2 Initialization Message

INIT 90s (amber) – 90 second initialization in progress.

## ISFD Failure Flags

The OUT OF ORDER annunciation replaces the display when a total ISFD system failure occurs.



### 1 Airspeed flag

Airspeed information has failed.

### 2 ILS localizer failure flag

ILS localizer has failed.

### 3 ILS glideslope failure flag

ILS glideslope has failed.

### 4 Altitude flag

Altitude information has failed.

### 5 Attitude flag

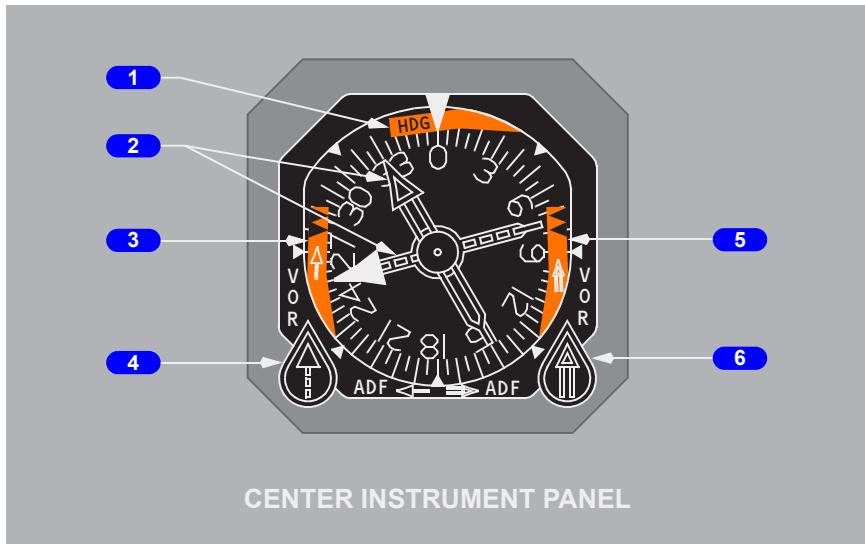
Attitude information has failed.

### 6 Heading flag

Heading data has failed.

## Standby Radio Magnetic Indicator

[Option - Dual ADF]



### 1 Heading Warning Flag

The compass signal from the air data inertial reference system is lost.

### 2 Bearing Pointers

- narrow pointer uses signals from the VHF NAV receiver No. 1 or ADF receiver No. 1

[Option - Dual ADF]

- wide pointer uses signals from the VHF NAV receiver No. 2 or ADF receiver No. 2.

### 3 Bearing Pointer No. 1 Warning Flag

VOR mode:

- RMI power failure
- VHF NAV signal unreliable.

ADF mode:

- RMI power failure
- ADF failure or signal unreliable.

### 4 VOR/ADF Bearing Pointer No. 1 Switch

ROTATE – selects VOR or ADF for the bearing pointer.

## 5 Bearing Pointer No. 2 Warning Flag

VOR mode:

- RMI power failure
- VHF NAV signal unreliable.

[Option - Dual ADF]

ADF mode:

- RMI power failure
- ADF failure or signal unreliable.

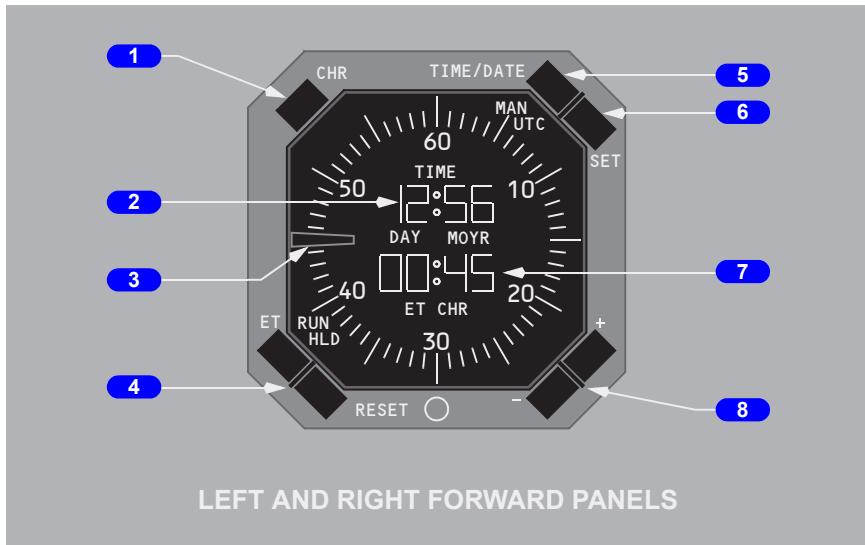
## 6 VOR/ADF Bearing Pointer No. 2 Switch

[Option - Dual ADF]

ROTATE – selects VOR or ADF for the bearing pointer.

## Clock

[Option - GPS capable]



### 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 Indicator

- displays UTC or manual time (hours, minutes) when time is selected with the time/date pushbutton
- alternately displays day–month and year when date is selected with the time/date pushbutton.

## 3 Chronograph Second Hand

- indicates chronograph seconds
- controlled by the CHR control.

## 4 Elapsed Time (ET) and RESET Pushbutton

Controls the elapsed time function:

- select the ET pushbutton once to run the elapsed time
- select the ET pushbutton again to hold the elapsed time
- select the RESET pushbutton to set the elapsed time to 0.

The RUN or HLD symbol is displayed on the lower left part of the LCD display.

## 5 TIME/DATE Pushbutton

Controls the time/date function:

- select the TIME/DATE pushbutton once to see UTC time
- select the TIME/DATE pushbutton again to see UTC date
- select the TIME/DATE pushbutton again to see manual time
- select the TIME/DATE pushbutton again to see manual date.

The UTC or MAN symbol is displayed on the upper right part of the LCD display.

In MAN mode, clock time and date come from the clock. In UTC mode, clock time and date come from the global positioning system.

## 6 SET Pushbutton

Controls the setting of manual time and date:

With manual time displayed:

- select the SET pushbutton once and the hours flash, use the plus or minus pushbutton to adjust the hours
- select the SET pushbutton again and the minutes flash, use the plus or minus pushbutton to adjust the minutes
- select the SET pushbutton again to run the time.

With manual date displayed:

- select the SET pushbutton once and the day flashes, use the plus or minus pushbutton to adjust the day
- select the SET pushbutton again and the month flashes, use the plus or minus pushbutton to adjust the month
- select the SET pushbutton again and the year flashes, use the plus or minus pushbutton to adjust the year
- select the SET pushbutton again to run the date.

**Note:** A delay greater than one minute while setting the time or date results in the clock reverting to the previous time/date setting.

## 7 Elapsed Time (ET)/Chronograph Indicator

- 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.

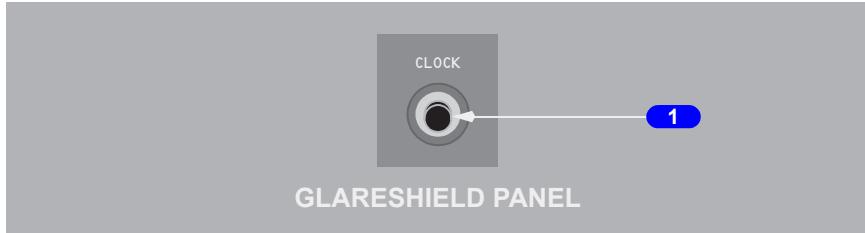
## 8 Plus (+) and Minus (-) Pushbuttons

Used to set the manual time and date:

- select the + pushbutton to increase the value
- select the - pushbutton to decrease the value.

## Clock Switch

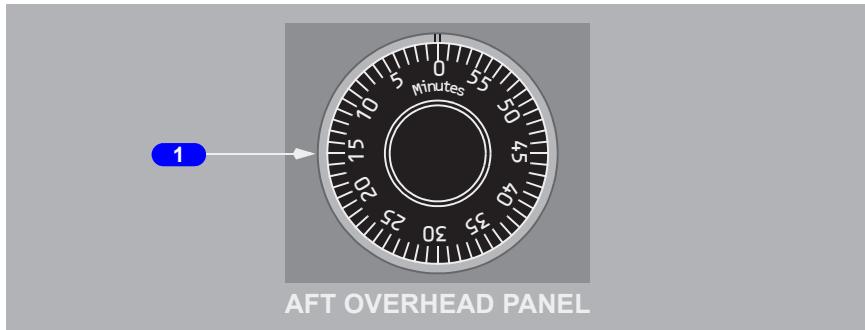
### [Option]



## 1 Clock Switch

Operates the same as the chronograph (CHR) control.

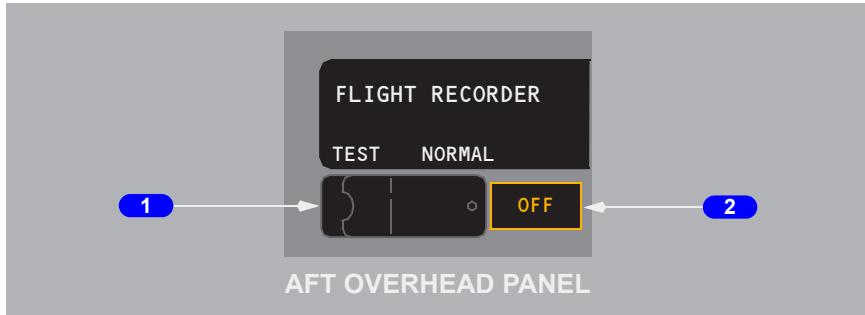
## Timer



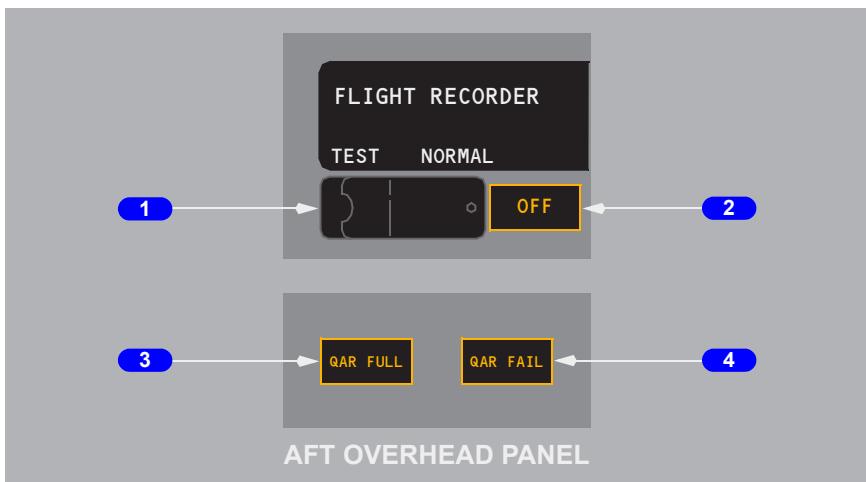
### 1 Mechanical Timer

## Flight Recorder

[Option - Without QAR lights]



[Option - With QAR FULL and FAIL lights]



### 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 – powers the flight recorder on the ground.

### 2 OFF Light (white)

ILLUMINATED –

- indicates the recorder is not operating or the test is invalid
- may indicate power failure, loss of input data, or electronic malfunction.

### 3 Optical Quick Access Recorder (QAR) FULL (white)

[Option - QAR FULL lights]

ILLUMINATED –

- indicates the quick access recorder is full

### 4 Optical Quick Access Recorder (QAR) FAIL (white)

[Option - QAR FAIL lights]

ILLUMINATED –

- indicates the quick access recorder has failed

Intentionally  
Blank

# Flight Instruments, Displays

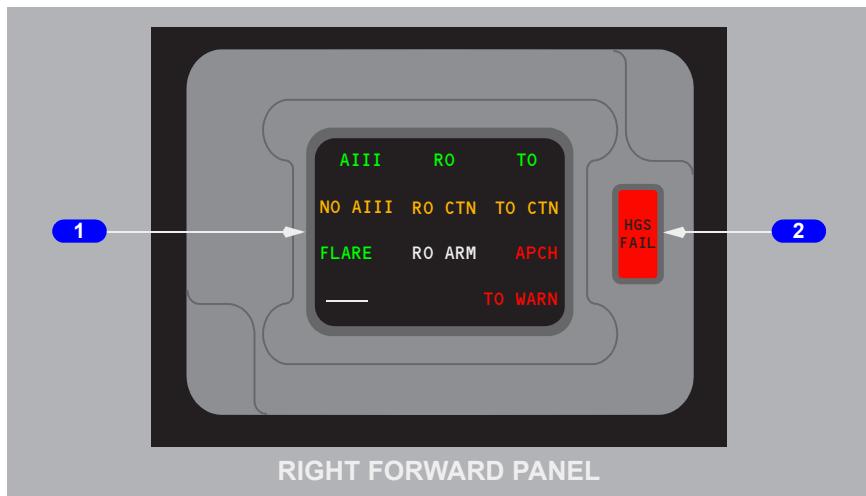
## Head-Up Display System – Controls

# Chapter 10

## Section 17

### HUD Annunciator Panel

[Option - Model 4000 Digital Twelve Light -Phases 1, 2, & 3]



#### 1 HGS Status Annunciations

- AIII (green) - AIII mode is active and all required systems and equipment are valid.
- NO AIII (amber) - loss of AIII capability above 500 feet AGL.
- APCH WARN (Approach Warning) (red) - system or approach conditions out of tolerance.
- FLARE (green) - system derived flare guidance is active.
- RO ARM (Rollout Guidance Armed) (white) - system capable of providing ground roll guidance during rollout. Displayed prior to touchdown during an AIII approach.
- RO CTN (Rollout Guidance Caution) (amber) - loss of rollout guidance below 500 feet AGL.
- RO (Rollout Guidance) (green) - rollout guidance is active.
- TO (green) - not used, displayed only during maintenance test.
- TO CTN (Takeoff Caution ) (amber) - not used, displayed only during maintenance test.
- TO WARN (Takeoff Warning) (red) - not used, displayed only during maintenance test.

## 2 HGS FAIL Light (red)

Illuminated (red) - indicates HGS failure below 500 ft AGL.

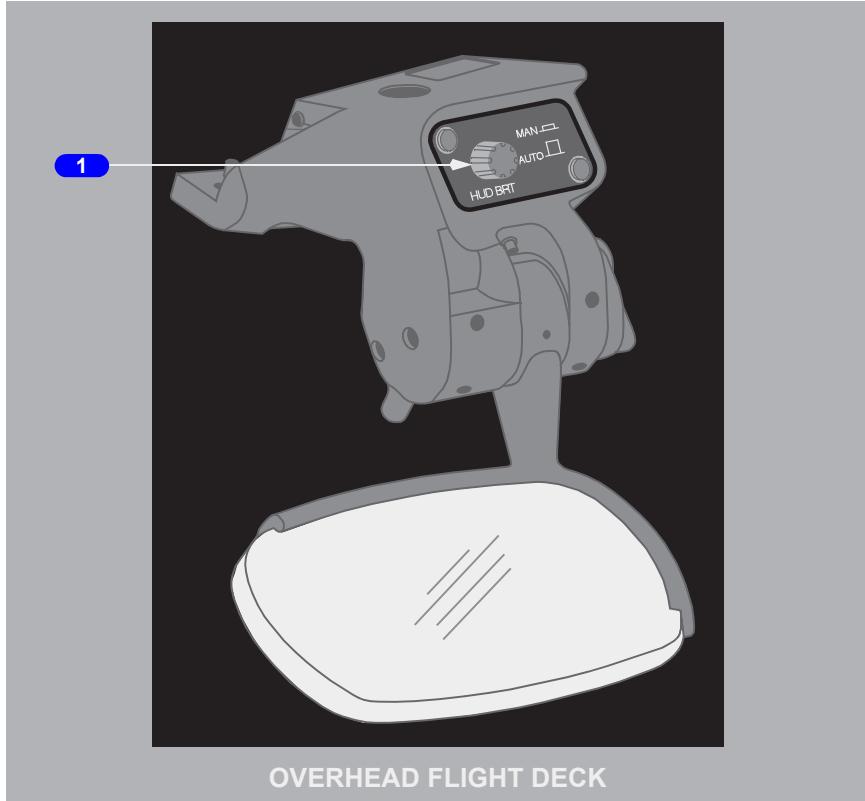
Push -

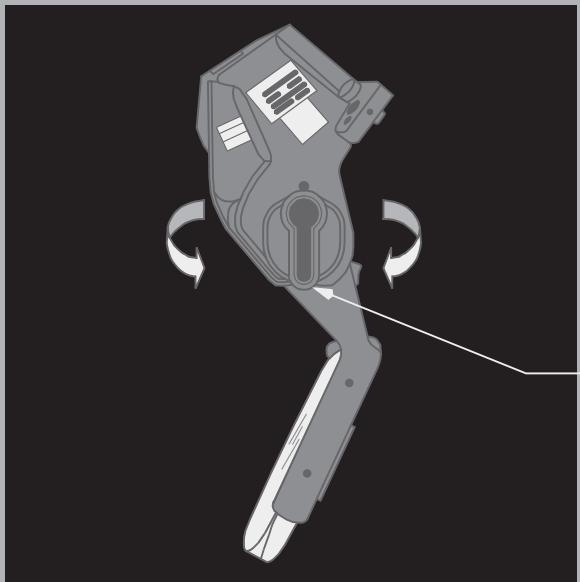
- extinguishes the HGS Fail Light.
- will not illuminate again until failure is cleared and another failure occurs.
- resets system for another failure.

## Combiner Controls

[Option - Model 4000]

### Brightness and Stow Controls



**OVERHEAD FLIGHT DECK****1 Brightness Control Knob**

MAN – push knob in for manual brightness adjustment.

AUTO – pull knob out for automatic brightness adjustment. Display intensity varies based on ambient light detected by a sensor on the combiner.

HUD BRT – rotate knob clockwise to increase display intensity. Rotate knob counter-clockwise to decrease display intensity.

**2 Stow Lever**

Pull lower portion of stow lever toward the pilot and rotate the glass down and forward to the normal operating detent. To stow the combiner glass, grasp and rotate aft and up until it locks in the stowed position.

The combiner also incorporates a breakaway position that allows the combiner glass to be displaced forward from its normal operating position. The combiner glass can be returned from the breakaway position by rotating the stow lever away from the pilot and rotating the glass aft to the normal operating detent.

**Note:** In the IMC or VMC modes, a combiner alignment out of tolerance condition results in an ALIGN HUD message on the combiner display. Gently push the combiner glass in the breakaway direction (forward) and release it to remove the message. If the message cannot be removed, the IMC or VMC mode should not be used.

## Flight Instruments, Displays

### EFIS/Map System Description

## Chapter 10

### Section 20

#### Introduction

The Common Display System (CDS) supplies information to the flight crew on six flat panel liquid crystal display units (DUs). The outboard and inboard display units present all primary flight and navigation information. Engine and system data are normally shown on the upper display unit. The lower display unit serves as a spare.

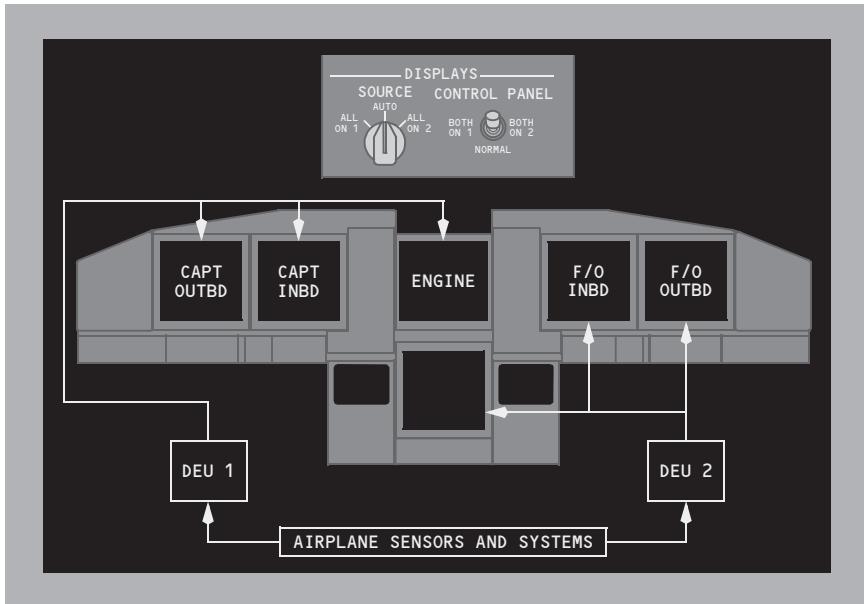
Detailed information on the following subjects is found in other sections of this chapter:

- Electronic Flight Instrument System (EFIS) – Section 30
- Navigation display – Section 40.

#### Display Brightness Control

Adjustment of the brightness of each DU is controlled by a combination of light sensors and brightness controls. Two remote light sensors, located left and right on the top of the glareshield, compensate for the amount of ambient light entering through the flight deck windows and adjust the brightness of the related DUs. Each DU also has an integral light sensor which provides automatic control of brightness as a function of ambient light striking the face of the DU. Brightness controls are used by the pilot to further adjust the intensity of each display unit.

## DISPLAYS SOURCE Panel



The DISPLAYS source panel, located on the forward overhead panel, contains source controls for the display electronic units (DEUs) and EFIS control panels.

Two DEUs receive data from sensors and airplane systems and supply data to the DUs. During normal operation, with the display SOURCE selector in the AUTO position, DEU1 supplies data to the Captain outboard, Captain inboard and upper DUs while DEU2 supplies data to the First Officer outboard, First Officer inboard and lower DUs. If a DEU fails, the remaining DEU automatically supplies data to all six displays. A single DEU failure will continue to supply each pilot with flight instrument information from independent sources. Each DEU receives data from both ADIRUs.

The display SOURCE selector, used on the ground for maintenance purposes, allows manual selection of either DEU1 or DEU2 for all six display units. If the displays are automatically or manually switched to a single DEU source, a “DSPLY SOURCE” annunciation illuminates above both pilot’s altimeters.

The CONTROL PANEL select switch determines which EFIS control panel controls the pilots’ display functions. With the switch positioned to either BOTH ON 1 or BOTH ON 2, the selected EFIS control panel provides inputs for both sets of pilot displays. When in the NORMAL position, a “DISPLAYS CONTROL PANEL” annunciation illuminates on the pilot’s altimeters and indicates a failure of the associated EFIS control panel.

---

## EFIS Control Panels

The EFIS control panels, located on the glareshield, control display options, mode, and range for the related pilot's displays. Refer to the EFIS and navigation display sections of this chapter for detailed information.

If an EFIS control panel fails, the displays can be controlled by the remaining control panel.

---

## Display Select Panel

The display select panel, located on the left and right forward panels, controls the displays on the inboard, outboard and lower DUs. Normal operation is all selectors in the NORMAL position. The pilots' outboard and inboard DUs display primary flight and navigation data and the upper DU displays engine data.

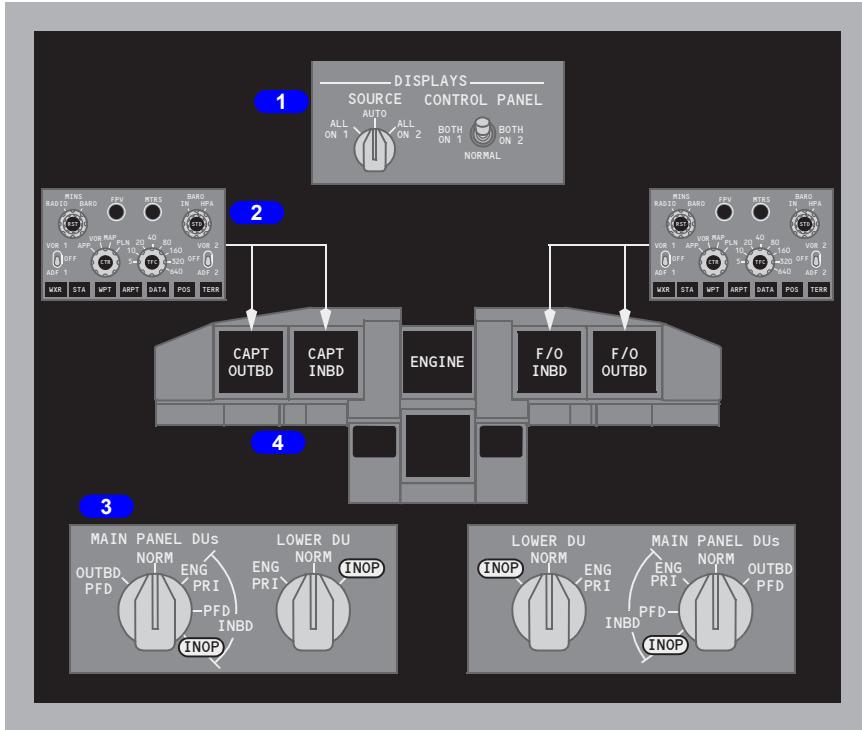
If a DU fails, automatic display switching ensures critical information remains available to the pilots at all times. If the system detects an operational failure on an outboard DU, the compact EFIS format automatically moves to the inboard DU and the failed outboard DU blanks. If the system detects a failure on an inboard DU, the compact EFIS format automatically moves to the outboard DU and the failed inboard DU blanks. If the upper DU fails, the engine display automatically moves to the lower DU.

Manual control of display formats is provided for undetected failures. The outboard rotary switch on the display select panel controls the formats displayed on either the outboard or inboard DUs. The inboard rotary switch controls the display format shown on the lower DU.

## Display Selection and Control Examples

The following examples show display selections.

### Normal Display Configuration



#### 1 DISPLAYS Source Panel

The display SOURCE select switch is in AUTO and the CONTROL PANEL select switch is in NORMAL.

#### 2 EFIS Control Panel

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

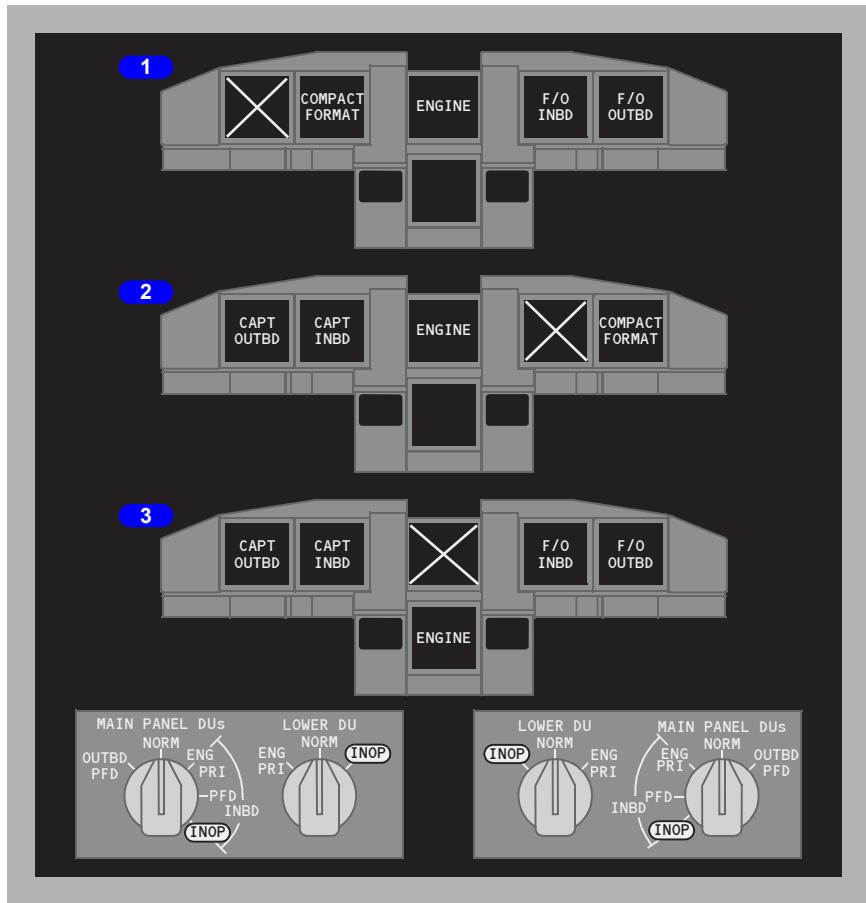
#### 3 Display Select Panel

All selectors are in NORMAL.

## 4 Display Units

The pilots' outboard and inboard DUs show the normal EFIS/MAP displays.

### Display Unit Failure Automatic Switching



#### 1 Outboard Display Unit Fails

If an outboard display unit fails, the compact EFIS format is automatically displayed on the inboard display unit and the outboard display unit blanks.

#### 2 Inboard Display Unit Fails

If an inboard display unit fails, the compact EFIS format is automatically displayed on the outboard display unit and the inboard display unit blanks.

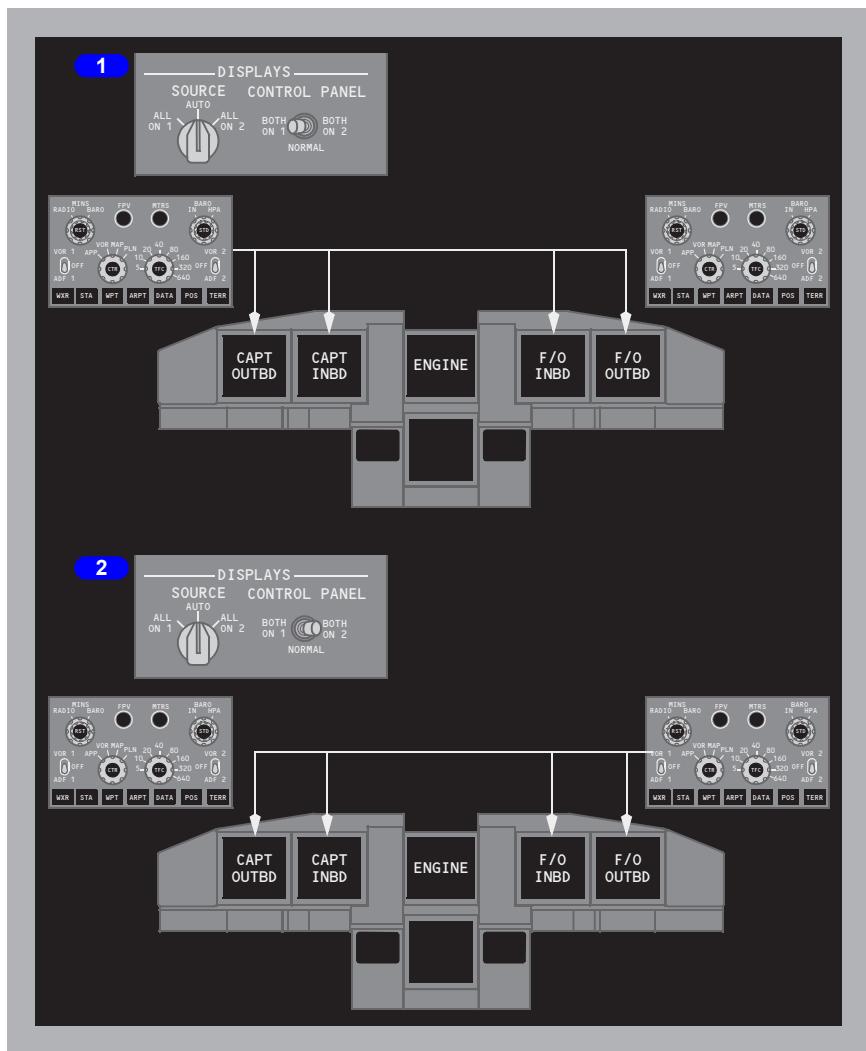
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**3 Upper Display Unit Fails**

If the upper display unit fails, the engine display automatically moves to the lower display unit and the upper display unit blanks.

**Note:** There is no automatic switching for a lower DU failure.

## EFIS Control Panel



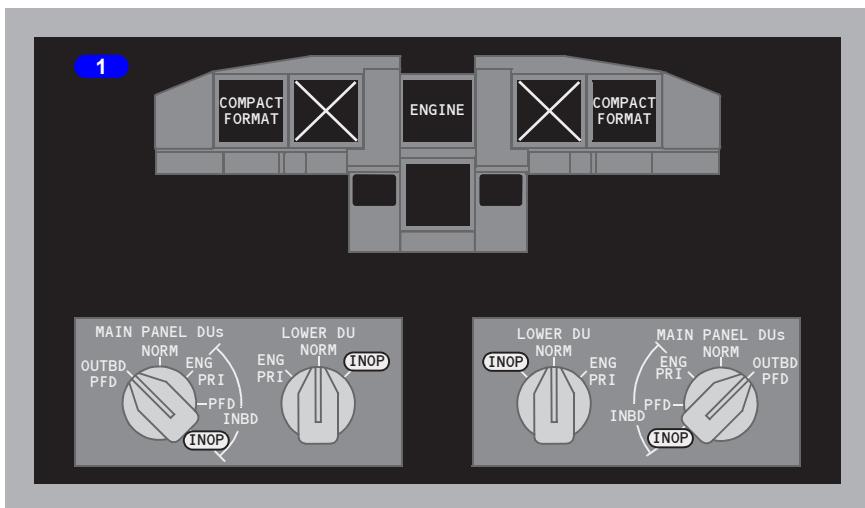
### 1 CONTROL PANEL Select Switch BOTH ON 1

The left EFIS control panel controls both pilots' outboard and inboard display units.

### 2 CONTROL PANEL Select Switch BOTH ON 2

The right EFIS control panel controls both pilots' outboard and inboard display units.

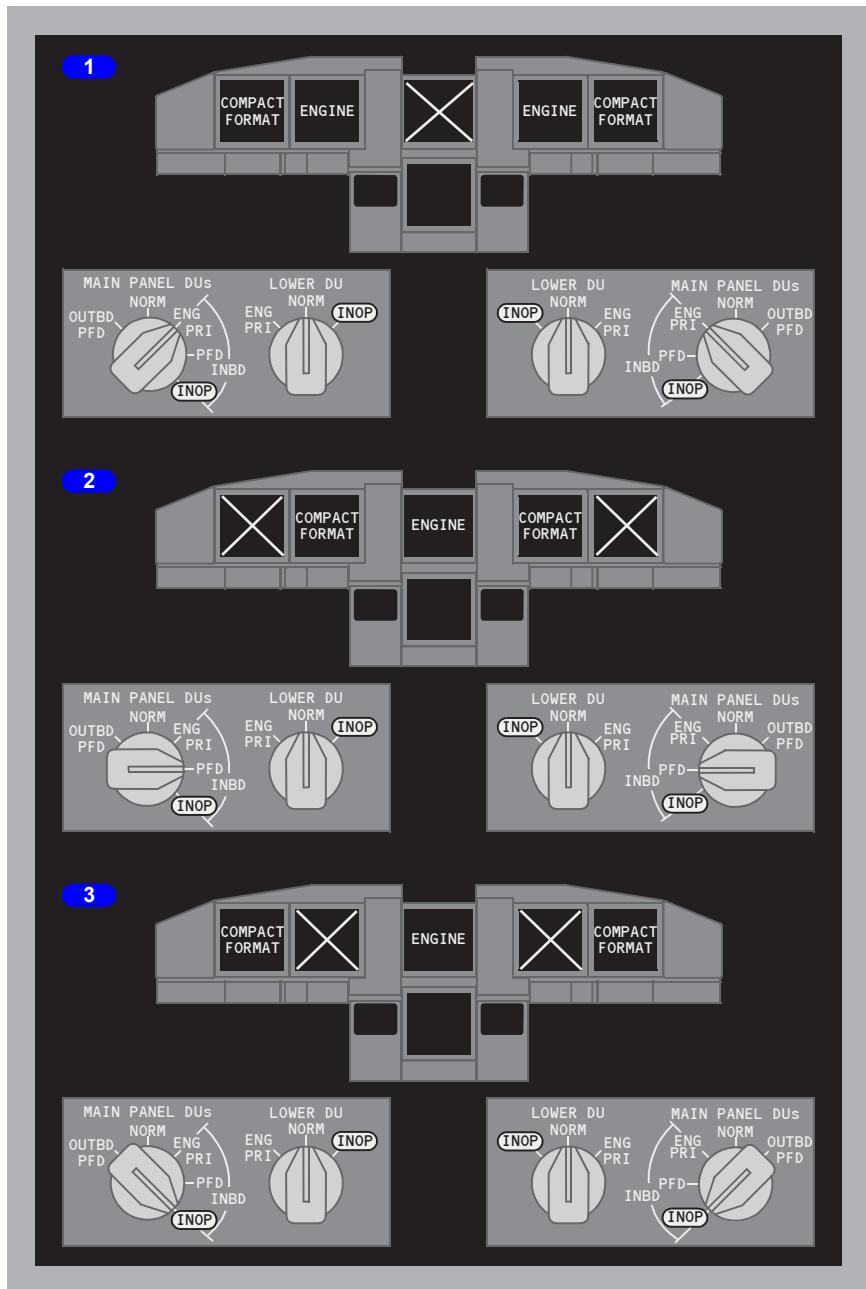
## Outboard Display Switching



### **1 MAIN PANEL DUs Switch to OUTBD PFD**

If the MAIN PANEL DUs switch is turned to Outboard Primary Flight Display (OUTBD PFD), the compact EFIS format is displayed on the outboard display unit and the inboard display unit blanks.

## Inboard Display Switching



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**1 MAIN PANEL DUs Switch to INBD ENG PRI**

If the MAIN PANEL DUs switch is turned to INBD ENG PRI, the engine display moves to the inboard DU, the compact EFIS format is displayed on the outboard DU and the upper DU blanks.

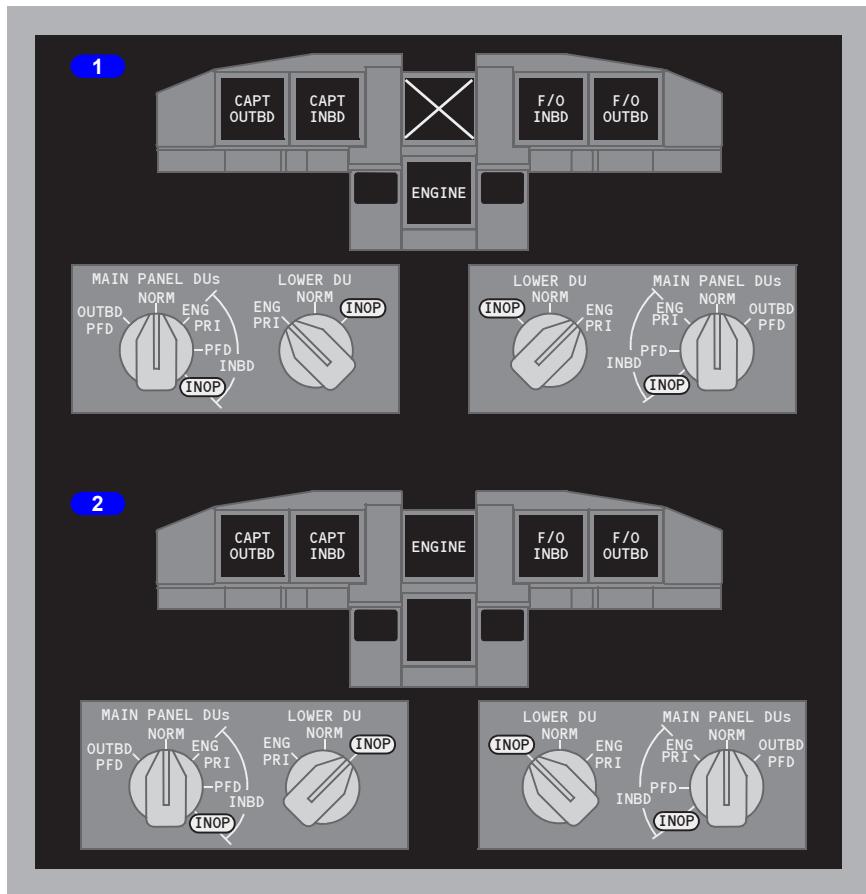
**2 MAIN PANEL DUs Switch to INBD PFD**

If the MAIN PANEL DUs switch is turned to INBD PFD the compact EFIS format is displayed on the inboard DU and the outboard DU blanks.

**3 MAIN PANEL DUs Switch to INOP**

If the MAIN PANEL DUs switch is turned to INBD INOP the compact EFIS format is displayed on the outboard DU and the inboard DU blanks.

## Lower Display Switching



### **1 LOWER DU Switch to ENG PRI**

If the LOWER DU switch is turned to ENG PRI, the engine display moves to the lower DU and the upper DU blanks.

### **2 LOWER DU Switch to INOP**

If the LOWER DU switch is turned to INOP the engine display is shown on the upper DU and the lower DU blanks.

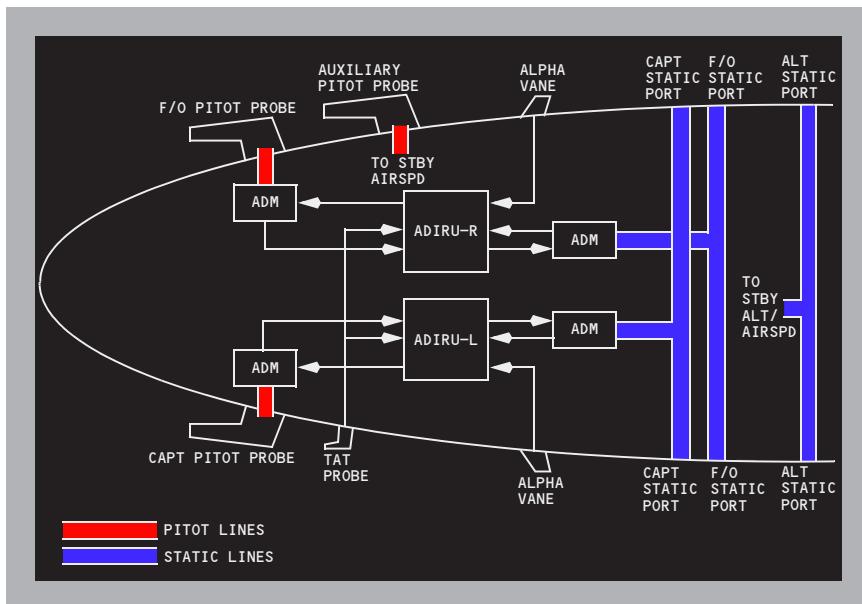
## Display System Information Sources

### Air Data Inertial Reference System (ADIRS)

The ADIRS produces flight data such as position, speed, altitude and attitude for the flight displays, flight management computers, flight controls, engine controls and all other systems requiring inertial and air data.

The major components of the ADIRS are:

- two air data inertial reference units (ADIRUs)
- four air data modules (ADMs)
- one inertial system display unit (ISDU)
- one dual mode select unit (MSU)
- six static ports
- three pitot probes
- two alpha vanes
- one total air temperature probe



### Air Data Inertial Reference Unit (ADIRU)

The ADIRUs provide inertial position and track data to the FMC as well as attitude, altitude and airspeed data to the displays. The ADIRUs process information measured by internal gyros and accelerometers, and from air data module inputs, the alpha vanes and other systems.

The ADIRUs are described in Chapter 11, Flight Management, Navigation.

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## Air Data

The pitot static system is comprised of three separate pitot probes and six flush static ports. Two pitot probes and four static ports interface with the air data modules. The remaining auxiliary pitot probe and alternate static ports provide pitot and static pressure to the standby instruments. The auxiliary pitot probe is located on the first officer's side of the airplane.

The air data modules convert pneumatic pressure to electrical signals and send these data to the ADIRUs. Each pitot air data module is connected to its on-side pitot probe; there is no cross connection. The air data module connected to the Captain's pitot probe sends information to the left ADIRU, while the air data module connected to the First Officer's pitot probe sends information to the right ADIRU. The remaining air data modules are located at the balance centers of the Captain's and First Officer's static ports. The air data module connected to the Captain's static ports sends information to the left ADIRU, while the air data module connected to the First Officer's static ports sends information to the right ADIRU.

## Angle-of-Attack

There are two alpha vanes, one located on each side of the forward fuselage. The vanes measure airplane angle-of-attack relative to the air mass.

## Total Air Temperature (TAT)

A total air temperature probe is mounted outside the airplane to sense air mass temperature. The temperature sensed by the probe is used by the ADIRUs to compute total air temperature.

**Note:** For manual CDU input of OAT on the ground, TAT indication is approximate and should not be used in lieu of ambient OAT for takeoff performance.

## Static Air Temperature (SAT)

Static air temperature, displayed on the CDU PROGRESS page, comes from the ADIRUs, using total air temperature probe information.

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## Standby Flight Instruments

The standby flight instruments include:

- standby magnetic compass
- standby attitude indicator
- standby altimeter/airspeed indicator
- integrated standby flight display
- standby radio magnetic indicator

## Standby Magnetic Compass

A standard liquid-damped magnetic standby compass is provided. A card located near the compass provides heading correction factors.

## Standby Attitude Indicator

The standby attitude 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.

## Integrated Standby Flight Display (ISFD)

The ISFD displays attitude, airspeed, altitude, ILS, and magnetic heading information. It is connected directly to the auxiliary pitot and alternate static sources. Attitude information is provided by internal inertial sensors. ILS information is provided by the No. 1 ILS receiver. The display receives its heading information from the same source as the captain's primary flight display. Heading information is not available in polar regions.

**Note:** The standby magnetic compass must be used to validate heading information.

The battery bus powers the ISFD. Selecting the battery switch ON activates the ISFD. After 10 seconds, an initialization sequence begins that requires 90 seconds to complete. ATT and INIT 90s messages are displayed during initialization. Upon completion of the initialization sequence, attitude information is displayed.

**Note:** Any change in airplane position during the initialization sequence may result in an inaccurate alignment. Inaccurate alignment is not annunciated and may result in the display of inaccurate attitude prior to, and during flight. Re-initialization can only be accomplished through maintenance action.

Detection of a momentary out-of-limit ISFD condition may cause the attitude display to blank and the WAIT ATT or ATT:RST message to display. Operation of the attitude reset switch is required in response to the ATT:RST message. This will reset the horizon line with the airplane symbol.

**Note:** Operation of the attitude reset switch will not correct an inaccurate alignment.

On the ground, operation of the attitude reset switch must be performed with the airplane stationary. In flight, operation of the attitude reset switch must be performed with the airplane in wings level, non-accelerated flight. During the process, the ATT 10s message displays. Failure to maintain straight and level flight for 10 seconds may result in an ATT:RST message. If the reset attempt is unsuccessful, the ATT:RST message remains displayed and the ISFD does not enter normal operation.

## **Standby Altimeter/Airspeed Indicator**

Standby altitude and airspeed are displayed on a single indicator.

The standby altimeter receives static pressure from the alternate static ports. Current altitude is displayed digitally. A pointer indicates altitude in hundreds of feet. Barometric setting windows display the barometric setting in both millibars and inches of mercury as set by the barometric setting control. The altimeter has a range of -1000 to 50,000 feet.

The standby airspeed indicator receives ram pressure from the auxiliary pitot probe and static pressure from the alternate static ports. It provides current airspeed in knots.

## **Standby Radio Magnetic Indicator**

The standby radio magnetic indicator (RMI) displays magnetic heading and VOR/ADF bearing to the station. The RMI is powered by the AC standby bus and remains powered after the loss of all normal AC power as long as battery power is available.

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## **Clocks**

### **[Option - Smiths 60B00303-105]**

Two electronic clocks are installed, with two digital displays on each clock. Either Greenwich Mean Time (GMT) or local time may be set on the upper time display. The lower ET/CHR display is used for either elapsed time or the chronograph. Separate controls are provided for each display.

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## **Clock Switch**

### **[Option - Remote clock switch]**

A remote clock switch, on the glareshield panel, operates the same as the chronograph (CHR) control.

## Flight Recorder (DFDR)

The Digital Flight Data Recorder (DFDR) provides a permanent record of operational and systems information including time, heading, altitude, airspeed, acceleration, attitude, engine thrust, and flight control surface position.

The recorder is a solid state device and complies with Federal Aviation Administration and European Aviation Safety Agency requirements for data sampling rates and number/type of parameters sampled.

Operational and systems information are automatically recorded whenever the flight recorder is powered.

The DFDR has the following features:

- Continuously records the most recent flight data, saving the most current data for the last 25 hours of operation
- The DFDR is housed in a sealed container located behind an access door in the far aft cabin ceiling
- Corrosion, fire and impact resistant, survives deep sea pressure to 13,451 feet (4,100 m)
- Locator beacon operable for 30 days
- Receptacle for downloading and copying data for analysis.

## Aircraft Condition Monitoring System (ACMS)

### [Option - ACMS]

The Aircraft Condition Monitoring System (ACMS) contains software that provides the operator useful reports on the condition of the airframe, engines, trends monitoring, and maintenance.

The ACMS consists of:

- ACMS software containing applicable maintenance and operations algorithms for each phase of flight.
- Digital Flight Data Acquisition Unit (DFDAU). The DFDAU receives signals representing certain flight condition and airplane systems operating performance and converts them to a digital form for recording on the DFDR.
- ACARS air/ground message functionality continuing to expand with additional message formats.

### [Option - Quick Access Recorder (QAR) lights]

- indicator on the aft overhead panel that illuminates when the QAR is full.

## Flight Instruments, Displays

### PFD/ND System Description

## Chapter 10

### Section 21

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#### Introduction

The Common Display System (CDS) supplies information to the flight crew on six flat panel liquid crystal display units (DUs). The outboard and inboard display units present all primary flight and navigation information. Primary engine indications are normally displayed on the upper DU. Secondary engine indications or system data are normally displayed on the lower DU.

Detailed information on the following subjects is found in other sections of this chapter:

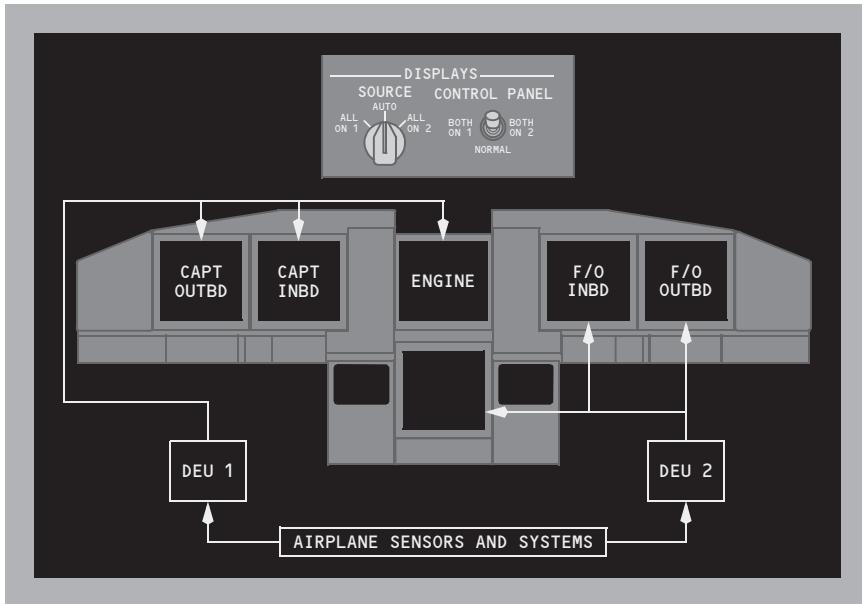
- Primary Flight Display (PFD)—Section 31
- Navigation display (ND)—Section 41.

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#### Display Brightness Control

Adjustment of the brightness of each DU is controlled by a combination of light sensors and brightness controls. Two remote light sensors, located left and right on the top of the glareshield, compensate for the amount of ambient light entering through the flight deck windows and adjust the brightness of the related DUs. Each DU also has an integral light sensor which provides automatic control of brightness as a function of ambient light striking the face of the DU. Brightness controls are used by the pilot to further adjust the intensity of each display unit.

## DISPLAYS SOURCE Panel



The DISPLAYS source panel, located on the forward overhead panel, contains source controls for the display electronic units (DEUs) and EFIS control panels.

Two DEUs receive data from sensors and airplane systems and supply data to the DUs. During normal operation, with the display SOURCE selector switch in the AUTO position, DEU1 supplies data to the Captain outboard, Captain inboard and upper DUs while DEU2 supplies data to the First Officer outboard, First Officer inboard and lower DUs. If a DEU fails, the remaining DEU automatically supplies data to all six displays. A single DEU failure will continue to supply each pilot with flight instrument information from independent sources. Each DEU receives data from both ADIRUs.

The display SOURCE selector, used on the ground for maintenance purposes, allows manual selection of either DEU1 or DEU2 for all six display units. If the displays are automatically or manually switched to a single DEU source, a “DSPLY SOURCE” annunciation illuminates on both pilot’s primary flight display.

The CONTROL PANEL select switch determines which EFIS control panel controls the pilots’ display functions. With the switch positioned to either BOTH ON 1 or BOTH ON 2, the selected EFIS control panel provides inputs for both sets of pilot displays. When in the NORMAL position, a “DISPLAYS CONTROL PANEL” annunciation illuminates below the altitude indication showing a failure of the associated EFIS control panel.

## EFIS Control Panels

The EFIS control panels, located on the glareshield, controls display options, mode, and range for the related pilot's displays. Refer to the PFD and ND sections of this chapter for detailed information.

If an EFIS control panel fails, the displays can be controlled by the remaining control panel.

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## Display Select Panel

The display select panel, located on the left and right forward panels, controls the displays on the inboard, outboard and lower DUs. Normal operation is all selectors in the NORMAL position. The pilots' outboard and inboard DUs display primary flight and navigation data and the upper DU displays primary engine data and fuel quantity.

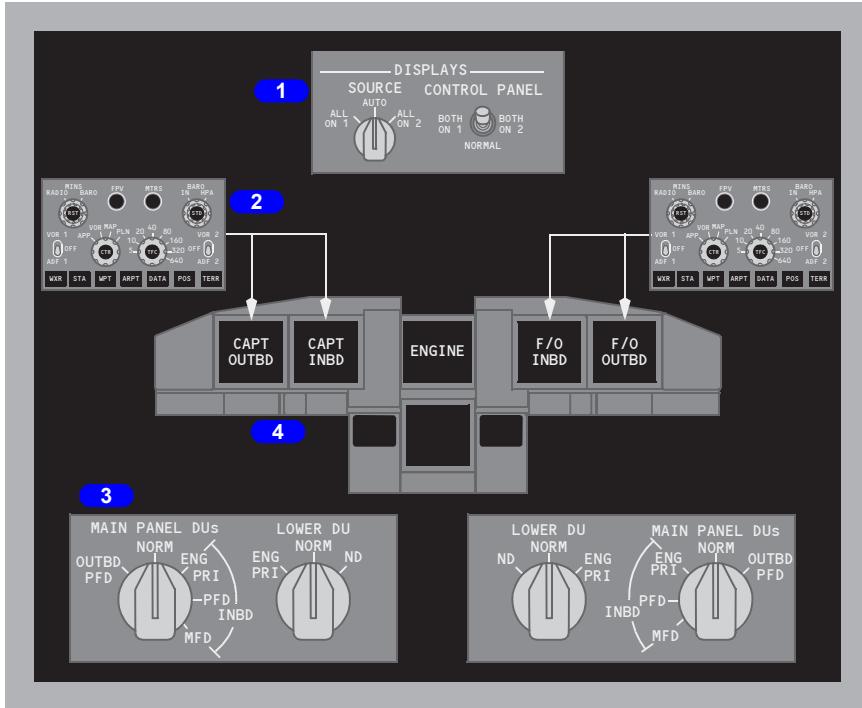
If a DU fails, automatic display switching ensures critical information remains available to the pilots at all times. If the system detects an operational failure on an outboard DU, the primary flight display automatically moves to the inboard DU and the failed outboard DU blanks. The OUTBD/INDB selector no longer has control over that display unit. If the upper DU fails, the engine display automatically moves to the lower DU.

Manual control of display formats is provided for undetected failures. The outboard rotary switch on the display select panel controls the formats displayed on either the outboard or inboard DUs. The inboard rotary switch controls the display format shown on the lower DU.

## Display Selection and Control Examples

The following examples show display selections.

### Normal Display Configuration



### 1 DISPLAYS Source Panel

The display SOURCE select switch is in AUTO and the CONTROL PANEL select switch is in NORMAL.

### 2 EFIS Control Panel

The left EFIS control panel controls the Captain outboard and inboard display units. The right EFIS control panel controls the First Officer outboard and inboard display units.

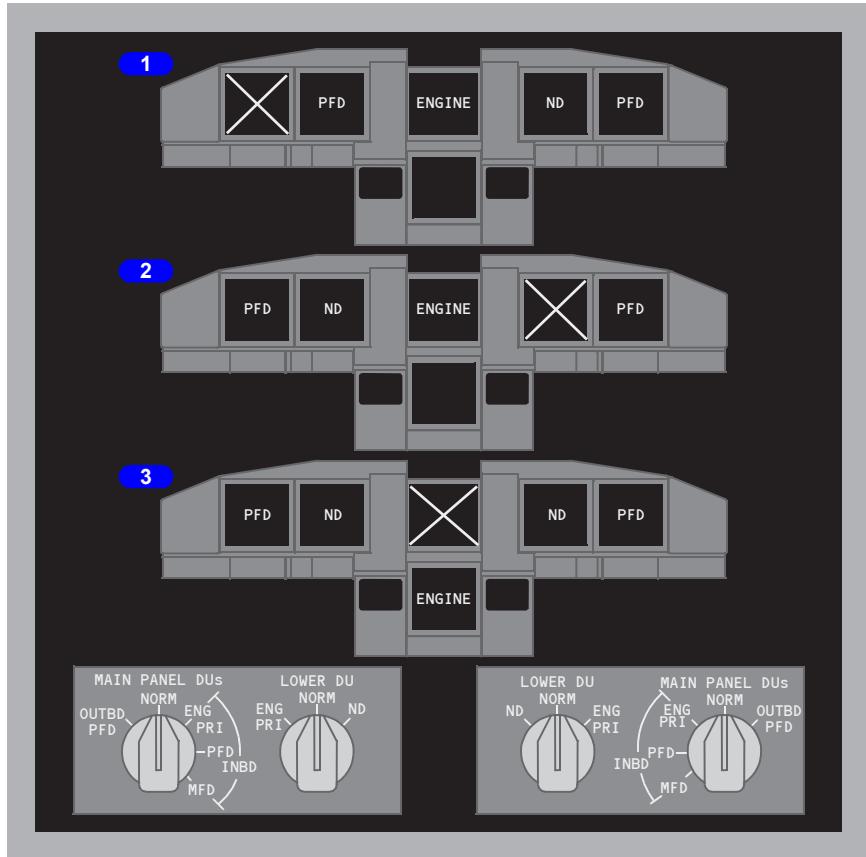
### 3 Display Select Panel

All selectors are in NORMAL.

### 4 Display Units

The pilots' outboard and inboard DUs show the normal PFD/ND displays.

## Display Unit Failure Automatic Switching



### 1 Outboard Display Unit Fails

If an outboard display unit fails, the PFD is automatically displayed on the inboard display unit and the outboard display unit blanks.

### 2 Inboard Display Unit Fails

If an inboard display unit fails, the PFD format remains displayed on the outboard display unit and the inboard display unit blanks.

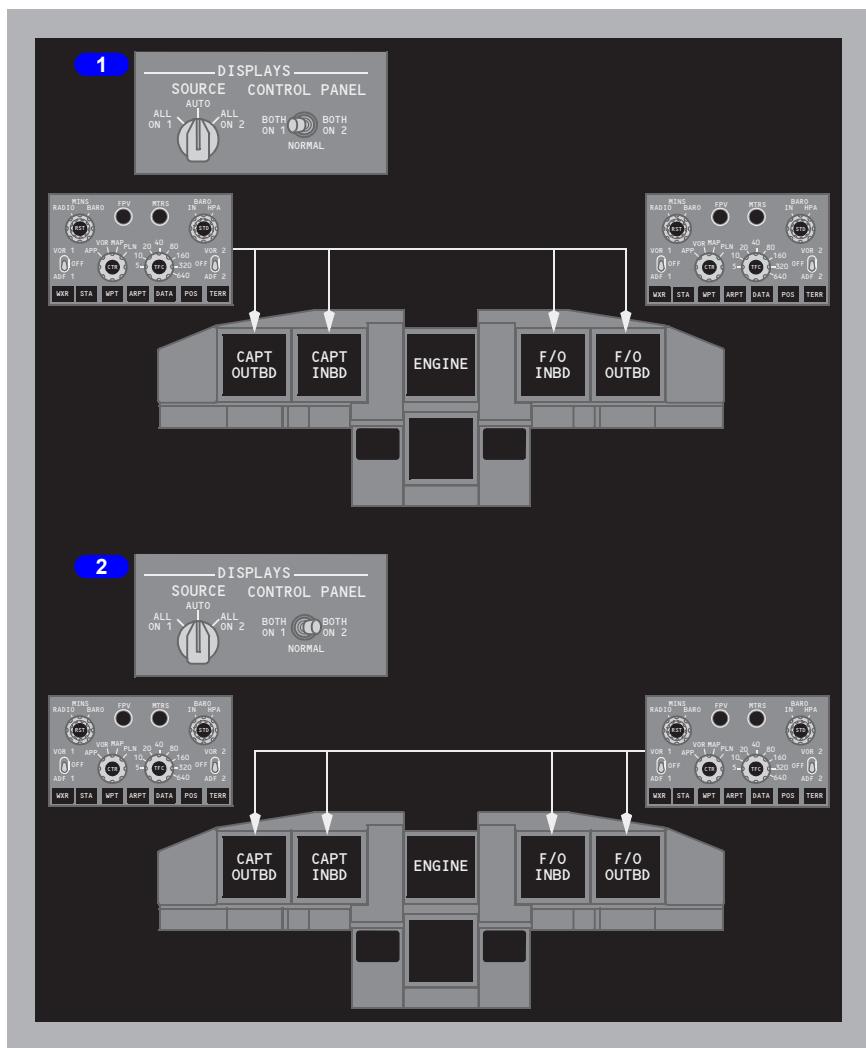
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**3 Upper Display Unit Fails**

If the upper display unit fails, the primary engine display automatically moves to the lower display unit and the upper display unit blanks. If the secondary engine display is already on the lower display unit, a compact engine display is then displayed.

**Note:** There is no automatic switching for a lower DU failure.

## EFIS Control Panel



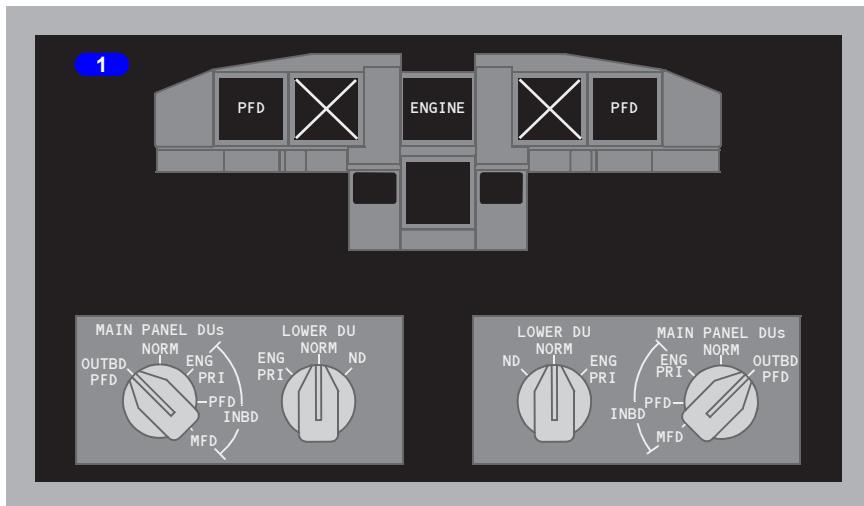
### 1 CONTROL PANEL Select Switch BOTH ON 1

The left EFIS control panel controls both pilots' outboard and inboard display units.

### 2 CONTROL PANEL Select Switch BOTH ON 2

The right EFIS control panel controls both pilots' outboard and inboard display units.

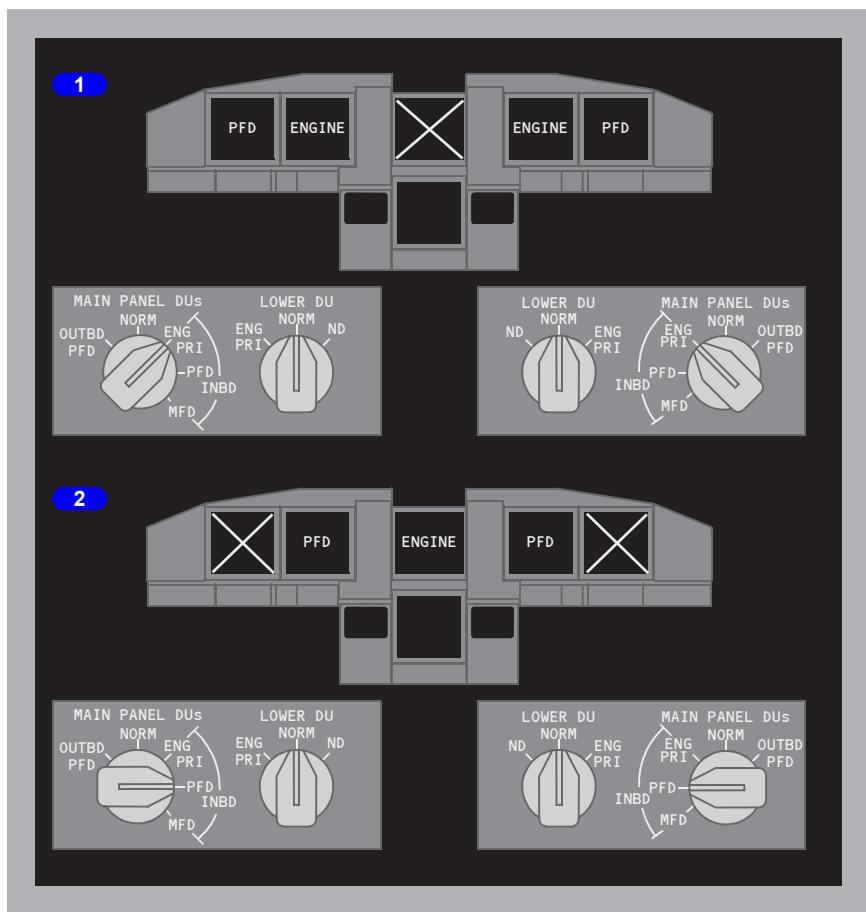
## Outboard Display Switching

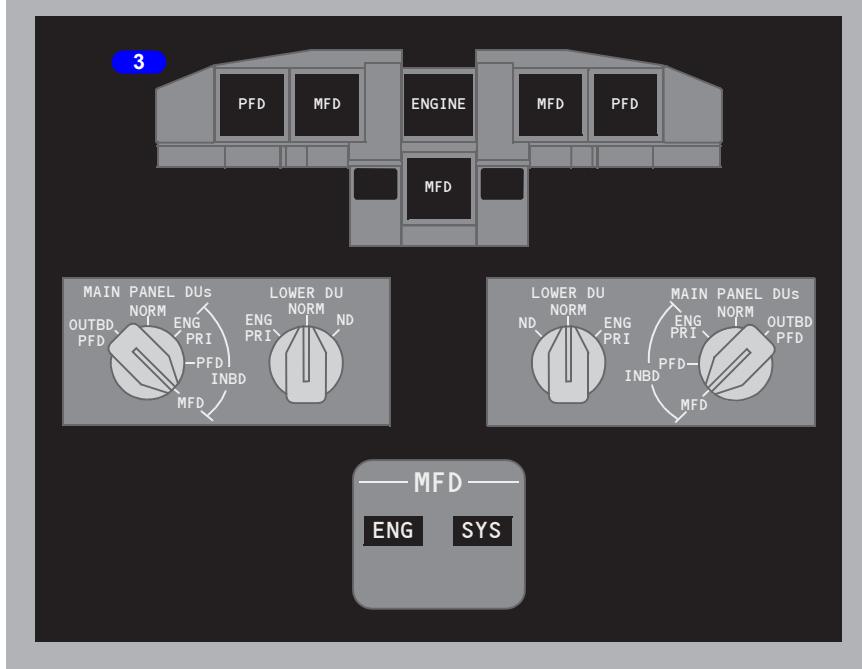


### **1** MAIN PANEL DUs Switch to OUTBD PFD

If the MAIN PANEL DUs switch is turned to Outboard Primary Flight Display (OUTBD PFD), the PFD format is displayed on the outboard display unit and the inboard display unit blanks.

## Inboard Display Switching





### 1 MAIN PANEL DUs Switch to INBD ENG PRI

If the MAIN PANEL DUs switch is turned to INBD ENG PRI, the primary engine display moves to the inboard DU, the PFD format is displayed on the outboard DU and the upper DU blanks.

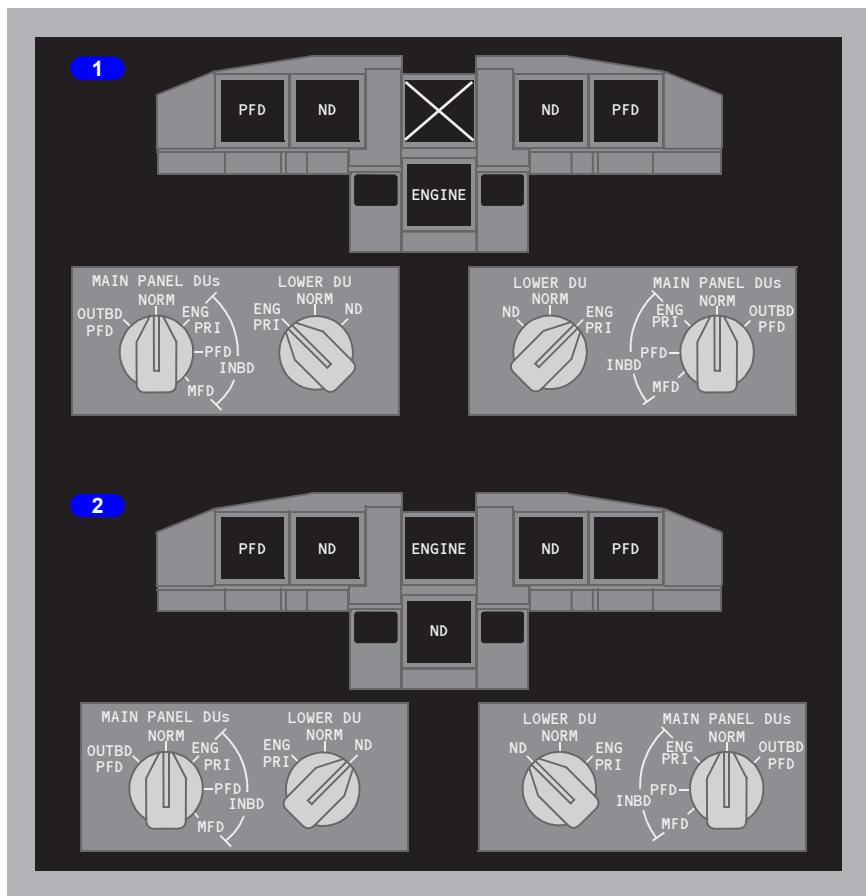
### 2 MAIN PANEL DUs Switch to INBD PFD

If the MAIN PANEL DUs switch is turned to INBD PFD, the PFD format is displayed on the inboard DU and the outboard DU blanks.

### 3 MAIN PANEL DUs Switch to MFD

If the MAIN PANEL DUs switch is turned to INBD MFD, the PFD continues to be displayed on the outboard display unit and the inboard display is blank. The system format (SYS) or secondary engine format (ENG) can then be selected to the inboard display unit and lower display unit with the MFD switches on the engine display control unit.

## Lower Display Switching



### 1 LOWER DU Switch to ENG PRI

If the LOWER DU switch is turned to ENG PRI, the engine display moves to the lower DU and the upper DU blanks.

### 2 LOWER DU Switch to ND

If the LOWER DU switch is turned to ND, the engine display is shown on the upper DU and the navigation display is shown on the lower DU. When the MFD ENG switch is selected, the compact engine display is shown on the upper DU.

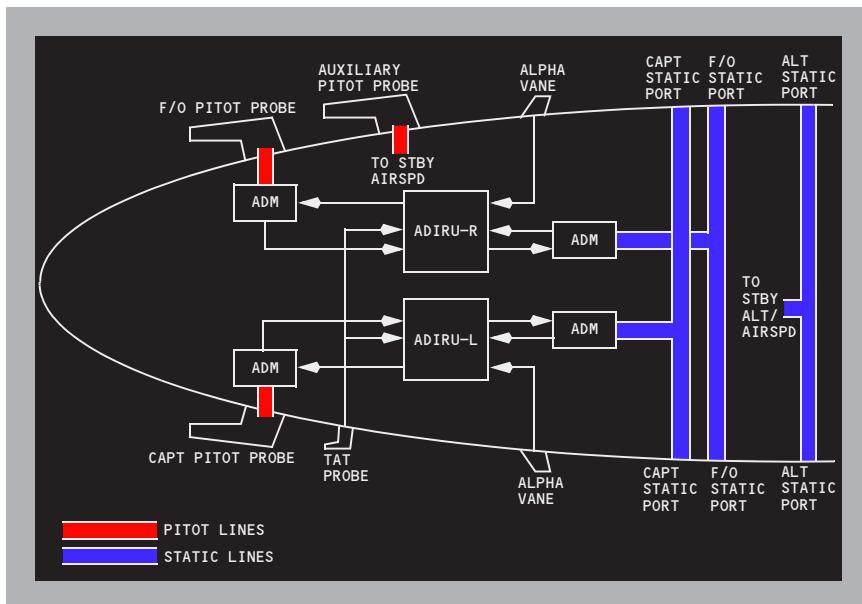
## Display System Information Sources

### Air Data Inertial Reference System (ADIRS)

The ADIRS produces flight data such as position, speed, altitude and attitude for the flight displays, flight management computers, flight controls, engine controls and all other systems requiring inertial and air data.

The major components of the ADIRS are:

- two air data inertial reference units (ADIRUs)
- four air data modules (ADMs)
- one inertial system display unit (ISDU)
- one dual mode select unit (MSU)
- six static ports
- three pitot probes
- two alpha vanes
- one total air temperature probe.



### Air Data Inertial Reference Unit (ADIRU)

The ADIRUs provide inertial position and track data to the FMC as well as attitude, altitude and airspeed data to the displays. The ADIRUs process information measured by internal gyros and accelerometers, and from air data module inputs, the alpha vanes and other systems.

The ADIRUs are described in Chapter 11, Flight Management, Navigation.

## Air Data

The pitot static system is comprised of three separate pitot probes and six flush static ports. Two pitot probes and four static ports interface with the air data modules. The remaining auxiliary pitot probe and alternate static ports provide pitot and static pressure to the standby instruments. The auxiliary pitot probe is located on the first officer's side of the airplane.

The air data modules convert pneumatic pressure to electrical signals and send these data to the ADIRUs. Each pitot air data module is connected to its on-side pitot probe; there is no cross connection. The air data module connected to the Captain's pitot probe sends information to the left ADIRU, while the air data module connected to the First Officer's pitot probe sends information to the right ADIRU. The remaining air data modules are located at the balance centers of the Captain's and First Officer's static ports. The air data module connected to the Captain's static ports sends information to the left ADIRU, while the air data module connected to the First Officer's static ports sends information to the right ADIRU.

## Angle-of-Attack

There are two alpha vanes, one located on each side of the forward fuselage. The vanes measure airplane angle-of-attack relative to the air mass.

### [Option - Angle of attack indicator]

The primary source of data for the AOA indicator on the PFD is supplied by the ADIRU, with the Stall Management Yaw Damper (SMYD) as the backup source. The source selection is automatic in the event of primary source failure. Slight differences between the Captain's and FO's indications may be noticed due to sideslip or vane installation errors. These differences could be as large as 2 degrees alpha.

## Total Air Temperature (TAT)

A total air temperature probe is mounted outside the airplane to sense air mass temperature. The temperature sensed by the probe is used by the ADIRUs to compute total air temperature.

**Note:** For manual CDU input of OAT on the ground, TAT indication is approximate and should not be used in lieu of ambient OAT for takeoff performance.

## Static Air Temperature (SAT)

Static air temperature, displayed on the CDU PROGRESS page, comes from the ADIRUs, using total air temperature probe information.

## Standby Flight Instruments

The standby flight instruments include:

- standby magnetic compass
- standby attitude indicator
- standby altimeter/airspeed indicator
- integrated standby flight display
- standby radio magnetic indicator.

### Standby Magnetic Compass

A standard liquid-damped magnetic standby compass is provided. A card located near the compass provides correction factors.

### Standby Attitude Indicator

The standby attitude 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.

### Integrated Standby Flight Display (ISFD)

The ISFD displays attitude, airspeed, altitude, ILS, and magnetic information. It is connected directly to the auxiliary pitot and alternate static sources. Attitude information is provided by internal inertial sensors. ILS information is provided by the No. 1 ILS receiver. The display receives its information from the same source as the captain's primary flight display. Information is not available in polar regions.

**Note:** The standby magnetic compass must be used to validate information.

The battery bus powers the ISFD. Selecting the battery switch ON activates the ISFD. After 10 seconds, an initialization sequence begins that requires 90 seconds to complete. ATT and INIT 90s messages are displayed during initialization. Upon completion of the initialization sequence, attitude information is displayed.

**Note:** Any change in airplane position during the initialization sequence may result in an inaccurate alignment. Inaccurate alignment is not annunciated and may result in the display of inaccurate attitude prior to, and during flight. Re-initialization can only be accomplished through maintenance action.

Detection of a momentary out-of-limit ISFD condition may cause the attitude display to blank and the WAIT ATT or ATT:RST message to display. Operation of the attitude reset switch is required in response to the ATT:RST message. This will reset the horizon line with the airplane symbol.

**Note:** Operation of the attitude reset switch will not correct an inaccurate alignment.

On the ground, operation of the attitude reset switch must be performed with the airplane stationary. In flight, operation of the attitude reset switch must be performed with the airplane in wings level, non-accelerated flight. During the process, the ATT 10s message displays. Failure to maintain straight and level flight for 10 seconds may result in an ATT:RST message. If the reset attempt is unsuccessful, the ATT:RST message remains displayed and the ISFD does not enter normal operation.

## Standby Altimeter/Airspeed Indicator

Standby altitude and airspeed are displayed on a single indicator.

The standby altimeter receives static pressure from the alternate static ports. Current altitude is displayed digitally. A pointer indicates altitude in hundreds of feet. Barometric setting windows display the barometric setting in both millibars and inches of mercury as set by the barometric setting control. The altimeter has a range of -1000 to 50,000 feet.

The standby airspeed indicator receives ram air pressure from the auxiliary pitot probe and static pressure from the alternate static ports. It provides current airspeed in knots.

## Standby Radio Magnetic Indicator

The standby Radio Magnetic Indicator (RMI) displays magnetic and VOR/ADF bearing to the station. The RMI is powered by the AC standby bus and remains powered after the loss of all normal AC power as long as battery power is available.

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## Clocks

### [Option - GPS capable]

Two electronic clocks are installed, with two digital displays on each clock. Universal time coordinated (UTC) time, UTC date, manual time or manual date 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.

Each clock is powered by the hot battery bus when the battery bus is not available. The clock reverts to hot battery bus power when the airplane is powered down. The hot battery bus power keeps the time base but does not provide power for the display or output of clock data and the clock reverts to manual mode. When the airplane is powered up and Global Position System (GPS) data is restored, the clock continues to operate in manual mode and will not automatically display UTC time. UTC time can be manually selected by using the TIME/DATE pushbutton.

**Note:** When on standby power, the F/O clock display is dim and UTC time is not available.

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## Clock Switch

### [Option - Remote clock switch]

A remote clock switch, on the glareshield panel, operates the same as the chronograph (CHR) control.

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## Flight Recorder (DFDR)

The Digital Flight Data Recorder (DFDR) provides a permanent record of operational and systems information including time, heading, altitude, airspeed, acceleration, attitude, engine thrust, and flight control surface position.

The recorder is a solid state device and complies with Federal Aviation Administration and European Aviation Safety Agency requirements for data sampling rates and number/type of parameters sampled.

Operational and systems information are automatically recorded whenever the flight recorder is powered.

The DFDR has the following features:

- Continuously records the most recent flight data, saving the most current data for the last 25 hours of operation
- The DFDR is housed in a sealed container located behind an access door in the far aft cabin ceiling
- Corrosion, fire and impact resistant, survives deep sea pressure to 13,451 feet (4,100 m)
- Locator beacon operable for 30 days
- Receptacle for downloading and copying data for analysis.

## Aircraft Condition Monitoring System (ACMS)

### [Option - ACMS]

The Aircraft Condition Monitoring System (ACMS) contains software that provides the operator useful reports on the condition of the airframe, engines, trends monitoring, and maintenance.

The ACMS consists of:

- ACMS software containing applicable maintenance and operations algorithms for each phase of flight
- Digital Flight Data Acquisition Unit (DFDAU). The DFDAU receives signals representing certain flight condition and airplane systems operating performance and converts them to a digital form for recording on the DFDR.
- Aircraft Communication Addressing and Reporting System (ACARS).
- ACARS air/ground message functionality continuing to expand with additional message formats.

### [Option - Quick Access Recorder (QAR) lights]

- indicator on the aft overhead panel that illuminates when the QAR is full.

Intentionally  
Blank

## Flight Instruments, Displays

### Head-Up Display System Description

## Chapter 10

### Section 22

#### Introduction

The Head-Up Display (HUD) system uses electronics and optics to calculate and display flight information. The flight information is displayed as flight symbols which project on to a transparent glass screen in front of the pilot. The flight symbols overlay and combine with the outside view through window No. 1.

The HUD system can be used during manual flight operations, or with the AFDS engaged during automatic flight operations. When used manually, internal HUD guidance is used to control flight symbology and is independent of any AFDS derived or displayed flight director guidance.

HUD system components, combined with other airplane systems, produce flight symbology displayed in four distinct modes of operation. Each mode of operation has unique characteristics, and is intended to be used during a particular phase of flight based on system capability and meteorological conditions. TCAS resolution advisories and system failure flags are also displayed when active. Detailed information on display symbology is found in Section 42 of this chapter.

The HUD system consists of the following components:

- HUD computer
- Overhead unit (OHU)
- Combiner
- Control panel
- Annunciator panel

#### HUD Computer

The HUD computer receives input signals from aircraft sensors and equipment and converts this data to symbology for display on the combiner. The computer also evaluates system and approach performance through extensive Built-In Test Equipment (BITE), input validation, and approach monitor processing. If an out of tolerance condition exists, the applicable annunciation appears on the combiner and/or annunciator panel. Internal components control the following functions:

- Guidance control
- Shape and position of flight symbols
- Airplane sensor status
- HUD system status
- HUD system mode.

## Overhead Unit (OHU)

The OHU contains the CRT and projection optics to display flight symbology on the combiner. Electronic circuitry within the OHU controls display intensity and system monitoring.

## Combiner

The combiner optically combines flight symbology from the OHU, with the pilot's view through window No.1. It acts as a wavelength selective mirror, reflecting only the flight symbology color (green) and lets other colors pass through.

The combiner alignment detector monitors the angular position of the combiner. The HUD computer uses the detector to verify correct combiner position for normal viewing. If the combiner is not in the correct position, and the HUD is in the IMC or VMC modes, the ALIGN HUD message appears on the combiner.

The combiner glass element has a break away safety feature which allows the element to rotate forward from the normal position, in case of abnormal deceleration.

## Control Panel

The HUD control panel is used to select and display modes of operation and enter data. Display intensity is controlled by panel switches or by an ambient light sensor located on the upper left corner of the panel.

## Annunciator Panel

The annunciator panel consists of lights to indicate HUD system status annunciations during AIII mode approach and landing operations.

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## Modes of Operation

The HUD system provides a mode-selectable display on the combiner. The modes are:

- PRI (Primary) - used for most HUD operations
- AIII - primarily used for manually flown CAT II or IIIa ILS approach and landing operations
- IMC - used for AFDS autopilot/flight director approaches
- VMC - used for visual approaches.

## Primary (PRI) Mode

The primary mode may be used during all phases of flight from takeoff to landing. This can include low visibility takeoff operations utilizing ground roll guidance, all enroute operations and either non-precision or precision approaches to CAT I or II minimums utilizing flight director guidance and/or raw data.

Attitude information is displayed in the form of a horizon line and pitch scales positioned relative to an airplane reference symbol. Airspeed and altitude are displayed in tapes along the left and right edges of the display. A sectored HSI is displayed in flight in the lower center of the display. On the ground, the HSI, flight path and guidance cue are not displayed. These symbols are automatically displayed once the aircraft is in flight.

During takeoff, a TOGA pitch target line and a guidance cue are displayed. The TOGA pitch target line is displayed as a horizontal dash line initially positioned at the top of the display. As the pitch attitude increases during rotation, its vertical position relative to the airplane reference symbol is adjusted to display the pitch command from the Captain's flight director. Initially, the flight director guidance cue is displayed when the airplane reference is within 2 degrees of the TOGA pitch target line or when climbing through 50 feet radar altitude, whichever occurs first. The TOGA pitch target line remains until the TO/GA mode is exited. The flight director guidance cue is displayed throughout flight when the Captain's flight director is selected on and both pitch and roll commands remain valid.

A full time slip-skid symbol is displayed as part of the roll scale. During any takeoff (after rotation) or go-around (below 1000 feet), additional slip-skid symbols are displayed to enhance lateral control in the event of an engine failure. These two additional symbols are displayed relative to the airplane reference and the flight path symbols and are removed above 1500 feet.

AFDS engaged modes, autothrottle modes and autopilot status is indicated across the top of the display similar to the flight mode annunciator display. Navigation information is displayed dependent on the selected navigation source and active AFDS mode. During LNAV operations, vertical and lateral deviations are similarly displayed based on FMC data. During ILS/VOR operations, course deviation is displayed within the HSI. Glideslope data is presented on a glideslope deviation scale adjacent to the altitude tape.

If the HUD is in a mode other than primary, depressing a TO/GA switch activates the primary mode independent of the standby mode indicated on the HUD control panel.

### **Primary Mode - Low Visibility Takeoff**

The primary mode includes special symbology used for a low visibility takeoff. The display supports visual runway centerline tracking and enhances situational awareness.

**Note:** Approval must be obtained from the appropriate regulatory authority prior to conducting HUD low visibility takeoff operations.

The low visibility takeoff display incorporates a ground roll reference symbol, ground roll guidance cue and a ground localizer line (if an ILS frequency is tuned on both nav receivers). The HUD derived ground roll guidance cue provides lateral guidance relative to the ground roll reference symbol to track the localizer. The ground localizer line provides raw localizer information any time the aircraft is on the ground and the Captain's navigation receiver is tuned to a localizer frequency. The localizer deviation is presented relative to the selected course mark on the horizon.

## **Primary Mode - Approach and Landing**

### **[Option - Model 4000]**

If the primary mode is used for an approach and landing, flight director guidance and navigation raw data is displayed. Once on the ground, the ground localizer line and ground localizer scale is displayed (if an ILS frequency is tuned on both nav receivers) to enhance centerline tracking.

## **AIII Approach Mode**

### **[Option - Model 4000]**

The HUD AIII mode is specifically designed for manual ILS approach and landing operations to CAT II or CAT IIIa minimums. Altitude and airspeed tape displays are replaced with digital values. The HSI is also replaced with ILS raw data displayed in proximity to the flight path group around the center of the display. In the AIII mode, flight path guidance is provided by the guidance cue which is derived from internal approach and landing guidance algorithms, and is independent of any AFDS derived or displayed flight director guidance.

**Note:** Approval must be obtained from the appropriate regulatory authority prior to conducting HUD Cat II or CAT IIIa operations.

AIII mode is dependent on the availability of all required systems and ILS approach criteria. Because of these requirements, the AIII mode is not identified as a selectable standby mode until these requirements are met. AIII capability is displayed on the control panel at any time, and on the combiner after LOC and G/S capture in the PRI mode.

ILS approach criteria requirements are satisfied when:

- Both VHF navigation receivers tuned to an ILS frequency, and
- VHF #1 or VHF #2 localizer deviation is less than approximately  $\frac{1}{4}$  dot and glideslope deviation is less than approximately 1 and  $\frac{1}{4}$  dots for at least five seconds, and

- The difference between the airplane's magnetic track and the captain's selected course is less than 15 degrees, and
- Radio altitude is greater than 500 feet.

**Note:** Once these criteria have been satisfied, subsequent deviations outside the criteria prior to AIII mode selection, will result in a loss of ability to select the AIII mode.

Automatic AIII mode arming requirements are satisfied when:

- PRI or IMC mode selected, and
- all required systems operating normally (AIII capable), and
- ILS frequency tuned on VHF NAV receiver No. 1 or No. 2, and
- radio altitude is greater than 500 feet, and
- TOGA mode not active.

To activate AIII ARM, push the STBY function key on the HUD control panel. When armed, "AIII ARM" is displayed on the standby mode display line and "AIII ARM" is displayed on the combiner. Approximately five seconds after the requirements for ILS approach criteria are satisfied, the AIII mode is automatically activated.

Once the AIII mode is active, the AIII mode symbology and related annunciations are displayed on the combiner, the control panel display, and the HUD annunciator panel.

Any sensor or equipment condition that results in a loss of AIII capability will cause a NO AIII annunciation displayed on the combiner and on the control panel display. The first officer's AIII annunciation is also extinguished. The annunciation will remain until another mode is selected or AIII capability is regained.

Below 500 feet radar altitude, with a loss of AIII capability or if the approach or flare performance does not ensure a safe touchdown within the required touchdown zone, an APCH WARN annunciation will be displayed on the combiner and on the HUD annunciator panel.

## IMC Mode

The IMC mode is an alternate approach mode primarily intended for autopilot approaches. Like the PRI mode, the IMC mode guidance cue utilizes AFDS derived guidance. The guidance cue is displayed when the Captain's flight director is active and both pitch and roll commands are valid.

Approach symbology format for the IMC mode is similar to the AIII approach mode. Altitude and airspeed data is displayed as digital values and navigation raw data is displayed in close proximity to the flight path vector.

## VMC Mode

The VMC mode is intended for visual approach operations. No flight director or HUD guidance is displayed. The flight path vector is used to control the approach to the runway.

Approach symbology format for the VMC mode is similar to the AIII and IMC modes. However, navigation data is not displayed.

The proper mechanical alignment of the combiner is critical during visual operations. Combiner position is monitored by the combiner alignment detector, to determine if the combiner is within allowable position tolerances while in the IMC or VMC mode. If its position is out of tolerance, an ALIGN HUD message is displayed on the combiner. Elimination of the message is accomplished by gently pushing the combiner in the breakaway direction and releasing. This allows the combiner to reposition itself. If the message cannot be removed, the IMC or VMC mode should not be used.

## TCAS Resolution Advisory

TCAS resolution advisories are displayed as preventive and corrective symbols, and are similar to the pitch commands displayed on the attitude indicator.

Preventive advisories do not require any crew action, but indicate an unsafe zone, displayed as a double lined bracket. On the unsafe side of the bracket, two angled lines are extended from the corners. The position of the bracket is determined by TCAS, and represents the vertical flight path position that is safe.

Corrective advisories require positive action by the crew and are indicated by a double lined box. The position of the box is determined by the vertical speed requirements from TCAS, and represents the vertical flight path position that is safe.

For additional information on TCAS, refer to Chapter 15, Warning Systems.

## Failure Flags and Data Source Annunciations

Failure flags are displayed for invalid sensor status and miscompares between similar parameters. These flags are generally indicated by boxed annunciations for the affected parameters, and in the case of failure, the removal of all symbols related to the fault. In some cases, symbols are removed as a result of other symbols being removed due to a fault.

Flags associated with a miscompare of similar data result in the display of a flag without the removal of the related symbols. The flag indicates the applicable data should be verified by cross-checks with other flight deck displays.

Data source annunciations are provided in a few cases to annunciate the source of displayed data when other than normal.



**DO NOT USE FOR FLIGHT**  
737 Flight Crew Operations Manual

Flight Instruments, Displays -  
Head-Up Display System  
Description

---

Dashes replace numbers if there is no computed data.

Intentionally  
Blank

## Flight Instruments, Displays

### Electronic Flight Instrument System (EFIS)

## Chapter 10

### Section 30

#### Introduction

The Electronic Flight Instrument system (EFIS) presents a dynamic color display of the parameters necessary for flight path control. The displays provide the following information:

- flight mode annunciation
- airspeed
- attitude
- steering information
- instrument landing system display
- approach minimums
- radio altitude
- altitude
- vertical speed
- GPWS annunciations
- TCAS indications.

Failure flags are displayed for airplane system failures. Displayed information is blanked or replaced by dashes if no valid information is available to the display system (because of out-of-range or malfunctioning navigation aids). Failure flags are displayed when aircraft systems cannot generate a reliable display.

Flight mode annunciations are described in Chapter 4, Automatic Flight.

#### Airspeed

Airspeed is displayed on a round dial Mach/airspeed indicator, or MASI. Current airspeed is displayed by an airspeed pointer and digital counter. Current Mach number is digitally displayed when the Mach number is greater than 0.40. Target airspeed is shown by the magenta airspeed cursor.

Takeoff and landing reference speeds and flap maneuvering speeds are shown along the circumference of the indicator. Maximum and minimum airspeeds are also displayed.

#### Attitude

The attitude indicator displays airplane pitch and roll attitude referenced to the horizon.

Pitch attitude is displayed by an airplane symbol against a pitch scale. The pitch scale is in 2.5 degree increments.

A pointer indicates bank angle in increments of 10, 20, and 30 degrees. Single marks indicate 45 and 60 degrees of bank. A small rectangle under the bank angle pointer indicates slip and skid conditions. Bank angle is also represented by the attitude of the airplane symbol against the horizon line and pitch scale.

---

### [Option - PLI pop-up]

A pitch limit indication is displayed at all times when the flaps are not up, or when flaps are up and airspeed approaches stick shaker activation for existing flight conditions.

---

## Steering Indications

### [Option - Split axis command bars]

Flight director pitch and roll bars are displayed when the related flight director switch is on. Pitch and roll commands are displayed independently.

### [Option - Flight path vector]

The Flight Path Vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the attitude indicator when the EFIS control panel FPV switch is selected on. The FPV shows the Flight Path Angle (FPA) above or below the horizon line and drift angle left or right of the pitch scale's center. The FPA uses inertial and barometric altitude inputs. The vertical FPA is unreliable with unreliable primary altitude displays.

The FPV symbol is displayed in two brightness levels. The FPV symbol is displayed dim when either the flight director or a TCAS resolution advisory is displayed. The FPV symbol is displayed bright when the flight director is off and there is no TCAS resolution advisory displayed.

---

## Instrument Landing System Indications

ILS glide slope and localizer deviation are provided.

The glide slope pointer and scale appear on the right side of the attitude indication when a valid signal is received. The scale turns amber and the pointer flashes to indicate an excessive glide slope deviation. The pointer is not displayed when the glide slope signal is unusable or when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse).

The localizer pointer and scale appear at the bottom of the attitude indicator when a valid signal is received. When the course deviation is slightly more than  $\frac{1}{2}$  dot and the localizer mode is engaged and track is within 5 degrees of the MCP selected course, the scale automatically expands. At low radio altitudes, with autopilot or flight director engaged, the scale turns amber and the pointer flashes to indicate excessive deviation. Below 1,000 feet AGL, with LNAV engaged and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC and G/S deviation alerting display on each attitude indicator.

#### [Option - Rising runway]

Below 2500 feet radio altitude, with the localizer pointer in view, a rising runway symbol comes into view. The symbol provides lateral guidance. At 200 feet radio altitude, the symbol rises toward the airplane symbol.

---

## Approach Minimums

#### [Option - Radio altitude below ADI]

The selected radio altitude set on the EFIS control panel is displayed near the bottom right of the attitude indicator. The barometric approach minimums is displayed as a marker on the altimeter.

---

## Radio Altitude

#### [Option - Radio altitude below ADI, round dial]

The current radio altitude is displayed near the bottom right of the attitude indicator when radio altitude is below 2,500 feet AGL. When between 1000 feet and 2500 feet AGL, the readout is digital. When below 1000 feet AGL, the readout is displayed in a round dial format. The display turns amber and the circumference flashes for 3 seconds as the radio altitude descends through the selected minimum altitude. The display changes back to white after one of the following occurs:

- when passing the selected minimum altitude plus 75 feet during go-around
- at touchdown
- after pressing the RST switch on the EFIS control panel.

---

## Radio Altitude Alert

#### [Option - 2500 ft height alert]

The altitude alert is triggered and "ALT" is shown above the radio altitude display when radio altitude is less than or equal to 2500 feet AGL.

---

## Altitude

Altitude is displayed on a round dial altimeter. Current altitude is displayed by an altitude pointer and a digital readout. A green reference altitude marker indicates the barometric minimums set on the EFIS control panel.

---

When meters is selected on the EFIS control panel, current altitude in meters is shown above the altitude window and the metric altitude equivalent of the selected MCP altitude is displayed above the altimeter. Metric readouts are not available in the compact EFIS mode.

The current barometric reference is displayed in either inches of mercury or hectopascals as selected on the EFIS control panel.

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## Vertical Speed

Vertical speed is indicated by a vertical speed pointer. The pointer depicts rate of climb or descent from 0 to 6000 feet.

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## Traffic Alert and Collision Avoidance (TCAS) Indications

### [Option - VSI TCAS advisory]

TCAS resolution advisories are displayed on the attitude indicator and vertical speed indicator.

Refer to Chapter 15, Warning Systems.

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## GPWS Warnings

GPWS warnings are displayed in large capital letters on the attitude indicator.

Refer to Chapter 15, Warning Systems.

## Flight Instruments, Displays

### Primary Flight Display (PFD)

## Chapter 10

### Section 31

#### Introduction

The Primary Flight Displays (PFDs) present a dynamic color display of all the parameters necessary for flight path control. The displays provide the following information:

- flight mode annunciation
- airspeed
- altitude
- vertical speed
- attitude
- steering information
- radio altitude
- instrument landing system display
- approach minimums
- heading/track indications
- TCAS indications
- GPWS annunciations.

Failure flags are displayed for airplane system failures. Displayed information is blanked or replaced by dashes if no valid information is available to the display system (because of out-of-range or malfunctioning navigation aids). Failure flags are displayed when aircraft systems cannot generate a reliable display.

Flight mode annunciations are described in Chapter 4, Automatic Flight.

#### Airspeed

##### [Option - Without groundspeed displayed]

Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the airspeed tape when the current Mach number is greater than 0.40. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the airspeed tape.

##### [Option - With groundspeed displayed]

Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the airspeed tape when the current Mach number is 0.40 Mach or above. Ground speed is displayed when airspeed decreases below 0.40 Mach. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the airspeed tape.

Takeoff and landing reference speeds and flap maneuvering speeds are shown along the right edge of the airspeed tape. Maximum and minimum airspeeds are also displayed along the right edge of the airspeed tape.

---

## Attitude

The attitude indication displays the airplane pitch and roll attitude referenced to the horizon.

Pitch attitude is displayed by an airplane symbol against a pitch scale. The pitch scale is in 2.5 degree increments.

A pointer indicates bank angle in increments of 10, 20, and 30 degrees. Single marks indicate 45 and 60 degrees of bank. A small rectangle under the bank angle pointer indicates slip and skid conditions. Bank angle is also represented by the attitude of the airplane symbol against the horizon line and pitch scale.

### [Option - PLI pop-up]

A pitch limit indication is displayed at all times when the flaps are not up, or when flaps are up and airspeed approaches stick shaker activation for existing flight conditions.

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## Angle of Attack

### [Option - Angle of Attack Indicator]

The Angle of Attack (AOA) indicator displays aircraft body angle of attack, stick shaker angle of attack, and the appropriate range of approach angle of attack. The indicator is located in the upper-right corner of the PFD, above the ADI.

If the AOA signal is determined to have failed or is invalid when ground speed is greater than 80 knots, the AOA indicator will be blanked and replaced with a fail flag.

During normal operation, the approach reference band moves with flap handle position. When the flap handle is in a landing flap detent, the band will depict the appropriate range of AOA for a Vref(xx)+5 approach, where Vref(xx) is for the corresponding flap detent position. If the flaps are driven in alternate mode, the band moves depending on actual flap position. If flap position is determined to be invalid, the band is blanked.

If an approach is flown faster than Vref(xx)+5, AOA is lower than normal and could potentially be below the band. If a slower approach is flown, AOA is higher than normal and could be above the band.

---

## Steering Indications

### [Option - Integrated cue command bar]

The flight director is displayed when the related flight director switch is on. Pitch and roll commands are combined on a single display.

The Flight Path Vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the PFD when the EFIS control panel FPV switch is selected on. The FPV shows the Flight Path Angle (FPA) above or below the horizon line and drift angle left or right of the pitch scale's center. The FPA uses inertial and barometric altitude inputs. The vertical FPA is unreliable with unreliable primary altitude displays.

The FPV symbol is displayed in two brightness levels. The FPV symbol is displayed dim when either the flight director or a TCAS resolution advisory is displayed. The FPV symbol is displayed bright when the flight director is off and there is no TCAS resolution advisory displayed.

---

## Instrument Landing System Indications

ILS glide slope and localizer deviation, frequency/identification, DME, course, and marker beacon indications are provided.

The approach reference information appears above and to the left of the attitude display. The ILS station identification or frequency, course, and (if available) DME are displayed.

The marker beacon indication (OM – outer marker, IM – inner marker, or MM – middle marker) is displayed in the upper right corner of the attitude display area.

The glide slope pointer and scale appear on the right side of the attitude indication when a valid signal is received. At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate an excessive glide slope deviation. The pointer is not displayed when the glide slope signal is unusable or when the track and the front course on the mode control panel differ by more than 90 degrees (backcourse).

The localizer pointer and scale appear at the bottom of the attitude indication when a valid signal is received. When the course deviation is slightly more than  $\frac{1}{2}$  dot, the localizer mode is engaged and track is within 5 degrees of the MCP selected course, the scale automatically expands. At low radio altitudes with autopilot engaged the scale turns amber and the pointer flashes to indicate excessive deviation. Below 1,000 feet AGL with LNAV engaged and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured.

Each pilot's deviation alerting system self-tests upon becoming armed at 1500 feet radio altitude. This self-test generates a two second LOC and G/S deviation alerting display on each attitude indicator.

### [Option - Rising runway]

Below 2500 feet radio altitude with the localizer pointer in view, a rising runway symbol comes into view. The symbol provides lateral guidance. At 200 feet radio altitude, the symbol rises toward the airplane symbol.

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## Integrated Approach Navigation (IAN) Indications

### [Option - IAN]

FMC glide path and FAC deviation, approach identifier, distance, and course are provided. The approach data appears above and to the left of the attitude display. Below the approach data is the IAN deviation source annunciation. Marker beacon indications are provided as in an ILS approach.

IAN glide path and FAC deviation indications and alerts are displayed like ILS. Deviation indications appear when a valid IAN approach is selected. IAN approach deviations are not available with QFE selected in the FMC.

---

## Approach Minimums

### [Option - Radio altitude above ADI]

The selected radio altitude or barometric approach minimums are set on the EFIS control panel. The radio altitude approach minimum is displayed near the top left of the altitude display and the barometric approach minimums is displayed near the bottom left of the altitude display.

---

## Radio Altitude

### [Option - Radio altitude above ADI, round dial]

The current radio altitude is displayed above the upper right corner of the attitude indication area when radio altitude is below 2,500 feet AGL. When between 1000 feet and 2500 feet AGL, the readout is digital. When below 1000 feet AGL, the readout is displayed in a round dial format. The display turns amber when the radio altimeter is below the radio altitude minimums.

---

## Altitude

Altitude is displayed on an altitude tape along the right side of the PFD. It is also shown digitally in a window in the middle of the tape. When meters is selected on the EFIS control panel:

- current altitude in meters is also shown above the altitude window
- selected altitude in meters is displayed above the altitude tape.

Selected altitude is displayed above the altitude tape and is boxed when approaching the selected altitude. Selected altitude is also depicted with a bug on the altitude tape.

The selected barometric approach minimum is indicated on the altitude tape with a triangular pointer and a line when BARO minimums are selected.

**[Option - Landing altitude reference bar]**

A landing altitude reference bar is displayed along the inner edge of the altitude indication. The reference bar indicates the height above touchdown. A white bar is displayed from 1000 to 500 feet above landing altitude. An amber bar is displayed from 500 feet to the landing altitude.

A landing altitude indication is displayed as a crosshatched area and indicates:

- the FMC landing altitude for destination runway or airport, or
- the landing altitude for departure runway or airport until 400 NM from departure or one-half the distance to destination, whichever occurs first.

The current barometric reference is displayed below the altitude tape in either inches of mercury or hectopascals as selected on the EFIS control panel. A preselected barometric reference can be displayed when STD is displayed.

**[Option - Altimeter with QFE]**

Altitude reference is selectable between QNH and QFE. QNH is the normal operating mode. A description of QFE operation is contained in the CDU Approach Reference Page description in Chapter 11, Flight Management, Navigation.

---

## Vertical Speed

Vertical speed is displayed to the right of the altitude tape with a tape and pointer. Vertical speed is digitally displayed above or below the vertical speed display when vertical speed is greater than 400 feet per minute. It is displayed above with positive vertical speed and below with negative vertical speed. The selected vertical speed bug shows the selected vertical speed when in the AFDS vertical speed (V/S) pitch mode.

---

## Heading/Track Indications

Heading/track information is displayed in the bottom section of the PFD on a section of the compass rose. Current heading is displayed under a pointer at the top of the compass rose. The MCP selected heading is displayed as a bug on the outside of the compass rose and digitally in the left half of the compass rose.

The current heading/track reference (MAG/TRU) is shown in the right half of the compass rose. A line drawn perpendicular to the edge of the compass rose from the invisible center depicts the current airplane track.

---

## Traffic Alert and Collision Avoidance (TCAS) Indications

### [Option - VSI TCAS advisory]

TCAS resolution advisories are displayed in the attitude indication and vertical speed indication areas.

Refer to Chapter 15, Warning Systems.

---

## GPWS Warnings

GPWS warnings are displayed in large capital letters between the attitude display and the heading/track compass rose. Refer to Chapter 15, Warning Systems.

## Flight Instruments, Displays

### Navigation Displays

## Chapter 10

### Section 40

#### Introduction

The navigation displays provide a color display of flight progress. The displays consist of the following:

- horizontal situation indicator
- radio distance magnetic indicator
- navigation display with MAP, APP (approach), VOR, and PLN (plan) modes.

The MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a center mode with a full compass rose.

#### Horizontal Situation Indicator (HSI)

The HSI provides heading and track data with VOR navigation or ILS approach information. The data are normally displayed on a compass rose with 200 degrees of heading. In the compact EFIS mode, the data are presented on a 360 degree display.

#### Radio Distance Magnetic Indicator (RDMI)

The RDMI provides the same information as a conventional RDMI.

#### Navigation Display – MAP Mode

The MAP mode is recommended for most phases of flight. This mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- current track
- selected and current heading
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points.

#### Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA) and position (POS) data are available for display in both the expanded and center MAP modes.

## VOR and Approach Modes

The VOR and APP modes are presented heading up. The VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or approach information.

### Plan Mode

The PLN mode is presented true north up. The active route may be viewed using the STEP prompt on the CDU LEGS pages.

## Navigation Display Information

### Heading

Heading is supplied by air data inertial reference system (ADIRS). The compass rose can be referenced to magnetic north or true north.

### Track

Track is supplied by the FMC during normal operation.

### Traffic

Traffic information from the TCAS can be displayed on the navigation display when in MAP, Center MAP, APP and VOR modes. TCAS is described in Chapter 15, Warning Systems.

### Weather Radar

Weather radar information can be displayed on the navigation display when in MAP, Center MAP, APP and VOR modes. The weather radar system is described in Chapter 11, Flight Management, Navigation.

### Failure Flags and Messages

Failure flags are displayed for system failures or invalid information. Indications are blanked or replaced by dashes when source system information is not available.

The message EXCESS DATA is displayed if the amount of information sent to the navigation display exceeds the display capability. The message can be removed by:

- reducing the amount of map information
- reducing range, or
- deselecting one or more of the EFIS control panel map switches (STA, WPT, ARPT, DATA, POS).

## Navigation Display 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) – dynamic conditions
- M (magenta) – command information, pointers, symbols, fly-to condition
- C (cyan) – nonactive or background information
- A (amber) – cautions, faults, flags
- R (red) – warnings
- B (black) – blank area, off condition.

## Heading, Track, and Speed

| SYMBOL  | NAME                           | MODE                   | REMARKS   |
|---|--------------------------------|------------------------|---|
|    | Selected heading bug (M)       | All except PLN         | Displays the MCP-selected heading. A dashed reference line (M) extends from the marker to the airplane symbol (VOR CTR and APP CTR do not display dashed line). |
|    | Current heading pointer (W)    | All except PLN         | Points to current heading on the compass rose.  |
|   | Track line and range scale (W) | MAP, MAP CTR, APP, VOR | Indicates current track.  |
|  | Expanded compass (W)           | MAP, APP, VOR          | Displays 60 degrees of compass rose.  |
|  | Groundspeed (W)                | All                    | Current ground speed.   |
|  | True airspeed (W)              | All                    | Current true airspeed displayed above 100 knots.  |

| SYMBOL   | NAME  | MODE              | REMARKS   |
|--|---|-------------------|---|
|  | Wind direction/<br>speed and wind<br>arrow (W)  | All               | Indicates wind speed and<br>direction, with respect to display<br>orientation and heading/track<br>reference. Displayed if wind<br>magnitude is greater than 6<br>knots and blanked if wind<br>magnitude becomes less than 4<br>knots. Blank until TAS is greater<br>than 101 knots. PLN mode<br>displays speed/direction only. |
|  | Heading/track<br>reference (G), box<br>(W) in TRU, box<br>(A) if TRU<br>displayed in<br>descent | All except<br>PLN | Indicates heading/track is<br>referenced to magnetic north or<br>true north. On transition from<br>TRU to M, a highlight box is<br>displayed around M for 10<br>seconds. When TRU is the<br>reference, the highlight box is<br>displayed full time (white).   |

### [Option - Heading-up display]

|  |   |                   |   |
|--|---|-------------------|---|
|  | Heading<br>orientation (G),<br>current heading<br>(W),<br>heading reference<br>(G),<br>heading pointer<br>(W) | All except<br>PLN | Displays HDG as the display<br>orientation, current heading,<br>MAG or TRU as the heading<br>reference, and points to the<br>heading on the compass rose. |
|--|---|-------------------|---|

## Radio Navigation

| SYMBOL   | NAME                                | MODE                                | REMARKS  |
|--|-------------------------------------|-------------------------------------|--|
|  | ILS/VOR<br>frequency display<br>(G) | APP,<br>APP CTR,<br>VOR,<br>VOR CTR | Displays frequency of manually<br>tuned navaid.    |
|  | DME distance (W)                    | APP,<br>APP CTR,<br>VOR,<br>VOR CTR | Indicates DME distance to the<br>reference navaid. |

| SYMBOL  | NAME   | MODE                    | REMARKS  |
|---|--|-------------------------|--|
|  | Selected course pointer (W) and line (M)           | VOR,<br>APP             | Displays selected course as set by the related MCP course selector.  |
|  | Selected course pointer (W)<br>TO/FROM pointer (W) | APP CTR,<br>VOR CTR     | Displays selected course as set by the related MCP course selector.<br>TO/FROM pointer is displayed when VOR navigation is being used.   |
|  | To/from indication (W)                             | VOR,<br>VOR CTR         | Displays VOR to/from indication.   |
|  | VOR (C, G),<br>DME/TACAN (C, G),<br>VORTAC (C, G)  | MAP,<br>MAP CTR,<br>PLN | When the EFIS control panel STA map 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 5, 10, 20 or 40 nm. Only high altitude navaids are displayed when the selected range is 80, 160, 320 or 640 nm. Nav aids not being used are displayed in cyan.<br><br>Manually tuned VHF navaids are displayed in green, regardless of STA map switch selection. |

**[Option - VOR course lines displayed]**

|   |                                |                         |  |
|---|--------------------------------|-------------------------|--|
|  | Manually tuned VOR radials (G) | MAP,<br>MAP CTR,<br>PLN | When a navaid is manually tuned, the selected course and reciprocal are displayed. |
|---|--------------------------------|-------------------------|--|

|   |                 |                 |   |
|---|-----------------|-----------------|---|
|  | VOR radials (G) | MAP,<br>MAP CTR | When the POS map switch is selected on and a valid VOR signal is received, the station radial is displayed. |
|---|-----------------|-----------------|---|

| SYMBOL | NAME | MODE | REMARKS |
|--------|------|------|---------|
|--------|------|------|---------|

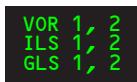
**[Option - Dual ADF]**

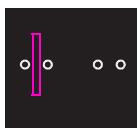
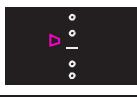
|  |                  |                 |  |
|--|------------------|-----------------|--|
|  | ADF bearings (C) | MAP,<br>MAP CTR | When the POS map switch is selected on and a valid ADF signal is received, the relative bearing to the tuned ADF station is displayed. |
|--|------------------|-----------------|--|

**[Option - ADF Full time MAP]**

|  |                                 |                |  |
|--|---------------------------------|----------------|--|
|  | ADF 1 (C) pointer head and tail | All except PLN | Indicates bearing to (head) or from (tail) the tuned station. Not displayed if POS selected on the EFIS control panel. |
|  | ADF 2 (C) pointer head and tail |                |  |

**[Option - GLS]**

|  |                                |                                     |   |
|--|--------------------------------|-------------------------------------|---|
|  | System source annunciation (G) | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Indicates the selected receiver as the display reference. |
|--|--------------------------------|-------------------------------------|---|

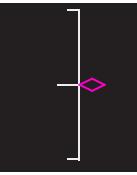
|  |  |                                     |  |
|--|--|-------------------------------------|--|
|  | ILS localizer or VOR course deviation indication (M) and scale (W) | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Displays LOC or VOR course deviation.        |
|  | Glide slope pointer (M) and scale (W)                              | APP,<br>APP CTR                     | Displays glide slope position and deviation. |

**MAP**

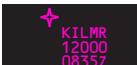
| SYMBOL   | NAME                | MODE                | REMARKS   |
|--|---------------------|---------------------|---|
|  | Airplane symbol (W) | VOR CTR,<br>APP CTR | Current airplane position is at the center of the symbol. |

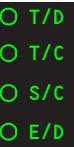
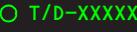
| SYMBOL  | NAME                | MODE                            | REMARKS   |
|---|---------------------|---------------------------------|---|
|  | Airplane symbol (W) | PLN                             | Indicates actual position and track along the flight plan route. Inhibited north of 82N latitude and south of 82S latitude. |
|  | Airplane symbol (W) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Current airplane position is at the apex of the triangle.   |

**[Option - BP04/BP06]**

|   |   |                 |   |
|---|---|-----------------|---|
|  | VNAV path pointer (M) and deviation scale (W) | MAP,<br>MAP CTR | Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates $\pm$ 400 feet deviation. Digital display is provided when the pointer deviates more than $\pm$ 30 feet from center. |
|---|---|-----------------|---|

|   |   |                         |   |
|---|---|-------------------------|---|
|    | Position trend vector (W) (dashed line) | MAP,<br>MAP CTR         | Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range: <ul style="list-style-type: none"> <li>• &gt; 20 NM, 3 segments</li> <li>• = 20 NM, 2 segments</li> <li>• &lt; = 10 NM, 1 segment.</li> </ul> |
|  | Active waypoint identifier (M)          | MAP,<br>MAP CTR,<br>PLN | Indicates the active flight plan waypoint, the next waypoint on the route of flight.  |
|  | Active waypoint distance (W)            | MAP,<br>MAP CTR,<br>PLN | Distance to the active waypoint.  |
|  | Active waypoint ETA (W)                 | MAP,<br>MAP CTR,<br>PLN | Indicates FMS-calculated ETA at the active waypoint.  |

| SYMBOL   | NAME  | MODE                    | REMARKS   |
|--|---|-------------------------|---|
|    | Waypoint:<br>active (M),<br>modified (W),<br>inactive (C)                         | MAP,<br>MAP CTR,<br>PLN | Active – represents the waypoint the airplane is currently navigating to.<br><br>Modified – represents the waypoints on the active route that are being modified.<br><br>Inactive – represents the waypoints on the active route.   |
|    | Off route waypoint<br>(C)   | MAP,<br>MAP CTR,<br>PLN | When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed, for ranges of 5, 10, 20, or 40 NM.  |
|    | Flight plan route:<br>active (M),<br>modified (W),<br>inactive (C),<br>offset (M) | MAP,<br>MAP CTR,<br>PLN | The active route is displayed with a continuous line (M) between waypoints.<br><br>Active route modifications are displayed with short dashes (W) between waypoints.<br><br>Inactive routes are displayed with long dashes between waypoints.<br><br>An offset route, selected through the FMC, is displayed with a dot-dash line (M) parallel to the active route. |
|  | Route data:<br>active (M),<br>inactive (W)  | MAP,<br>MAP CTR,<br>PLN | When the EFIS control panel DATA switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed.  |
|  | Holding pattern:<br>active (M),<br>modified (W),<br>inactive (C)                  | MAP,<br>MAP CTR,<br>PLN | A holding pattern appears when in the flight plan.<br><br>The holding pattern appears as a fixed size if the selected range is greater than 80 NM.<br><br>A scaled representation of the holding pattern is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the holding fix.   |

| SYMBOL  | NAME  | MODE                    | REMARKS  |
|---|---|-------------------------|--|
|    | Altitude range arc (G)                                  | MAP,<br>MAP CTR         | Based on vertical speed and<br>groundspeed, indicates the<br>approximate map position where<br>the MCP altitude will be reached.   |
|    | Conditional<br>waypoint:<br>active (M),<br>inactive (W) | MAP,<br>MAP CTR,<br>PLN | Active - represents the<br>conditional waypoint event the<br>airplane is currently navigating<br>to.<br><br>Inactive - represents the<br>conditional waypoints on the<br>route.<br><br>Data within parentheses for<br>conditional waypoints indicates<br>type of conditional waypoint<br>(ALTITUDE, COURSE<br>INTERCEPT, etc.)   |
| <br><br> | Altitude profile<br>point and identifier<br>(G)         | MAP,<br>MAP CTR,<br>PLN | Indicates the approximate map<br>position of the FMC-calculated<br>T/C (top-of-climb), T/D (top-of-descent), S/C (step climb),<br>and E/D (end of descent) points.<br><br>Indicates intermediate T/D points<br>for level flight path segments<br>during descent. Level flight path<br>segment altitude is displayed.<br><br>Indicates the beginning of a<br>deceleration segment resulting<br>from deceleration to a holding<br>pattern, a waypoint speed<br>restriction or flaps up<br>maneuvering speed.<br><br>Indicates airport speed restriction<br>deceleration point (no identifier). |

| SYMBOL   | NAME  | MODE                            | REMARKS   |
|--|---|---------------------------------|---|
|    | Procedure turn:<br>active (M),<br>modified (W),<br>inactive (C) | MAP,<br>MAP CTR,<br>PLN         | A procedure turn appears when in the flight plan.<br><br>The procedure turn appears as a fixed size if the selected range is greater than 80 NM.<br><br>A scaled representation of the procedure turn is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the procedure turn. |
|    | Airport and runway<br>(W)                                       | MAP,<br>MAP CTR,<br>PLN         | Displayed when selected as the origin or destination and selected range is 80, 160, 320, or 640 NM.   |
|    | Airport (C)   | MAP,<br>MAP CTR,<br>PLN         | Displayed if the EFIS control panel ARPT map switch is selected on.<br><br>Origin and destination airports are always displayed, regardless of map switch selection.  |
|    | Airport and runway<br>(W)                                       | MAP,<br>MAP CTR,<br>PLN         | Displayed when selected as the origin or destination and selected range is 5, 10, 20, or 40 NM.<br>Dashed runway centerlines extend 14.2 NM.  |
|  | Selected reference point and bearing distance information (G)   | MAP,<br>MAP CTR,<br>PLN         | Displays the reference point selected on the CDU FIX page.<br>Bearing and/or distance from the fix are displayed with dashes (G).   |
|  | Weather radar returns (R, A, G, M)                              | MAP,<br>MAP CTR,<br>VOR,<br>APP | The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.   |
|  | Selected map options (C)  | MAP,<br>MAP CTR,<br>PLN         | Displays EFIS control panel selected map options.   |
|  | Drift angle pointer<br>(W)                                      | VOR CTR,<br>APP CTR             | Indicates airplane's present track.<br>Replaces track line in the center APP and VOR modes.   |

| SYMBOL | NAME | MODE | REMARKS |
|--------|------|------|---------|
|--------|------|------|---------|

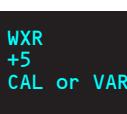
**[Option - AUTO Position Difference]**

|   |                                 |                 |  |
|---|---------------------------------|-----------------|--|
|  | Position difference display (W) | MAP,<br>MAP CTR | <p>Values indicate NM difference between present FMC position and IRS-L/R present positions. The selected IRS source is displayed on the first line.</p> <p>Arrows indicate the relative bearing to IRS present positions.</p> <p>Displayed when the position difference of the IRS-L and/or IRS-R exceeds limits.</p> |
|---|---------------------------------|-----------------|--|

**[Option - GPS]**

|   |   |     |   |
|---|---|-----|---|
|  | Position shift:<br>Active (M),<br>Update (W),<br>Other position (G) | PLN | Displays the position of each navigation sensor. Symbols only appear if the POS SHIFT page is displayed on the CDU. |
|---|---|-----|---|

**[Option - FMC Qty 1]**

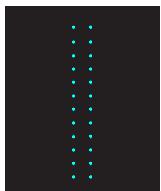
|   |  |                                 |  |
|---|--|---------------------------------|--|
|    | MAP source<br>annunciation (G)                                     | MAP,<br>MAP CTR,<br>PLN         | Displays source of FMC data used by CDS for data presentation. |
|  | Weather radar<br>annunciations:<br>Mode (C), Tilt (C),<br>Gain (C) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Annunciations vary with option selected                        |

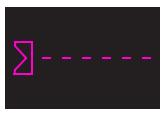
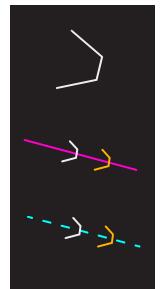
## Vertical Situation Display (VSD)

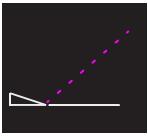
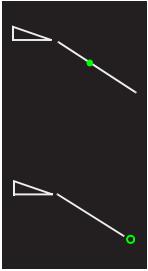
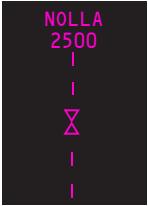
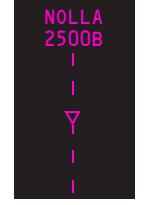
### [Option VSD]

| SYMBOL   | NAME                | REMARKS  |
|--|---------------------|--|
|  | Airplane symbol (W) | Current airplane altitude is the bottom of the triangle. Current airplane lateral position relative to terrain is the point of the triangle. |

### [Option - BP04/BP06]

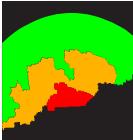
|  |                                    |   |
|--|------------------------------------|---|
|  | Enroute swath (C)<br>(dashed line) | Indicates area of the map that is shown on the VSD. Display is inhibited both on takeoff and approach when the airplane is within 6 NM of the runway and less than 3000 feet above field elevation. During turns, the swath edge leading the turn opens in the direction of the turn. |
|--|------------------------------------|---|

|  |                                    |   |
|--|------------------------------------|---|
|    | Selected altitude bug and line (M) | Bug indicates the altitude set in the MCP altitude window. When the selected altitude is off scale, the bug is parked at the top or bottom, with only one half the bug visible.<br><br>Dashed line extends from bug to background display boundary. Line does not park.   |
|   | Decision gates (W, A)              | Indicates suggested points where airplane should be path and speed stable on approach. Gates are placed on the 3 Degree Reference Line or FMC Approach Glidepath Angle Line: <ul style="list-style-type: none"> <li>• at 1000 feet above field elevation (W).</li> <li>• at 500 feet above field elevation (A).</li> </ul> Decision gates that are below the missed approach waypoint altitude will not be displayed. |
|  | Flight path vector (W)             | Fixed length line indicates current flight path angle and rotates about the point of the triangle. Angle of the line is dependent on the vertical speed and ground speed of the airplane.   |

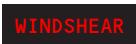
| SYMBOL  | NAME   | REMARKS  |
|---|--|--|
|    | MCP selected vertical speed vector (M)                       | Dashed line indicates the selected vertical speed as a target angle when the MCP V/S mode is selected.<br><br>Extends to the edge of the background display and rotates about the point of the triangle.   |
|    | Range to target speed dot (G)                                | Indicates where the airplane will achieve the FMC or MCP target speed. If the airplane is within 5 knots of the target speed the dot will be blanked. If the airplane increases 10 knots or more faster than the target speed the dot will reappear.<br><br>Displayed at the end of the Flight Path Vector as an unfilled dot if the target speed will not be achieved within the vector length. |
|    | Waypoint altitude constraint:<br>active (M),<br>inactive (W) | At Altitude example.   |
|   | Waypoint altitude constraint:<br>active (M),<br>inactive (W) | At or Above Altitude example.  |
|  | Waypoint altitude constraint:<br>active (M),<br>inactive (W) | At or Below Altitude example.  |

| SYMBOL   | NAME   | REMARKS                 |
|--|--|-------------------------|
| <p>NOLLA<br/>FL200B<br/>FL180A<br/> <br/>▽<br/> <br/>△<br/> </p> | Waypoint altitude constraint:<br>active (M),<br>inactive (W) | Block Altitude example. |

## Look-Ahead Terrain

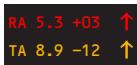
| SYMBOL  | NAME                                   | MODE                            | REMARKS  |
|---|--|---------------------------------|--|
|  | Terrain display (R, A, G, M)           | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displays terrain data from the GPWS terrain data base. Color and density vary based on terrain height vs. airplane altitude. Refer to Chapter 15, Warning Systems. |
| <b>TERR</b>   | Terrain mode annunciation (C)          | MAP,<br>MAP CTR,<br>VOR,<br>APP | Terrain display enabled (manual or automatic display).   |
| <b>TERR TEST</b>  | Terrain test mode annunciation (C)     | All                             | GPWS operating in self-test mode.  |
| <b>TERRAIN</b>  | Terrain annunciation (R, A)            | All                             | Look-ahead terrain caution alert active (A), look-ahead terrain warning alert active (R).  |
| <b>TERR FAIL</b>  | Terrain status annunciations (A)       | All                             | Look-ahead terrain alerting and display have failed.   |
| <b>TERR POS</b>   | Terrain status annunciations (A)       | All                             | Look-ahead terrain alerting and display unavailable due to position uncertainty.   |
| <b>TERR INHIBIT</b>   | Terrain status annunciations (A)       | All                             | GPWS terrain inhibit switch in TERR INHIBIT position.  |
| <b>TERR RANGE DISAGREE</b>  | Terrain range status annunciations (A) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Terrain output range disagrees with selected EFIS control panel range.   |
| <b>MAP/TERR RANGE DISAGREE</b>  | Terrain range status annunciations (A) | MAP,<br>MAP CTR                 | Terrain output range and map display output range disagree with selected EFIS control panel range.   |

## Predictive Windshear

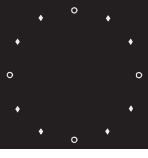
| SYMBOL   | NAME   | ND MODE                         | REMARKS  |
|--|--|---------------------------------|--|
|  | Predictive windshear symbol (R, B, A)        | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displays windshear location and approximate geometric size (width and depth).<br><br>Amber radials extend from predictive windshear symbol to help identify location of windshear event. |
|  | Windshear annunciation (R, A)                | All                             | Predictive windshear caution active (A).<br><br>Predictive windshear warning active (R).   |
|  | Predictive windshear status annunciation (A) | All                             | Predictive windshear alerting and display have failed.   |

## TCAS

| SYMBOL   | NAME   | MODE                            | REMARKS  |
|--|--|---------------------------------|--|
|    | TCAS resolution advisory (RA), relative altitude (R) | MAP,<br>MAP CTR,<br>VOR,<br>APP | These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 15, Warning Systems.  |
|  | TCAS traffic advisory (TA), relative altitude (A)    |                                 | The arrow indicates traffic climbing or descending at a rate $\geq 500 \text{ fpm}$ . At rates $< 500 \text{ fpm}$ , the arrow is not displayed.                                       |
|  | TCAS proximate traffic, relative altitude (W)        |                                 | The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane.   |
|  | TCAS other traffic, relative altitude (W)            |                                 | 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. |

| SYMBOL  | NAME                                    | MODE                            | REMARKS  |
|---|---|---------------------------------|--|
|    | TCAS no bearing message (RA-R, TA-A)    | MAP,<br>MAP CTR,<br>VOR,<br>APP | Message provides traffic type, range in NM, altitude and vertical direction. TFC must be selected on.  |
|    | 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.   |
|    | TCAS off scale message (RA-R, TA-A)     | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range. Displayed only if the EFIS control panel TFC switch is selected on. |
|    | TCAS mode (C)                           | MAP,<br>MAP CTR,<br>VOR,<br>APP | Indicates the ND TCAS display is active; the EFIS control panel TFC switch is selected on.   |
|    | TCAS mode (C)                           | All                             | Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.                                     |
|   | TCAS mode (C)                           | All                             | Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.   |
|  | TCAS mode (A)                           | All                             | Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA. Not displayed if TCAS is failed.   |
|  | TCAS mode (A)                           | All                             | Indicates TCAS failure, if traffic is selected.  |

[Option - 3NM TCAS range ring]

|   |                |                                 |  |
|---|----------------|---------------------------------|--|
|  | Range Ring (W) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displayed when TFC selected on EFIS Control Panel. Shows 3 NM range ring oriented to aircraft heading. Displayed at ranges of 80 NM or less. |
|---|----------------|---------------------------------|--|

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## Flight Instruments, Displays

### PFD/ND Navigation Displays

## Chapter 10

### Section 41

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### Introduction

The NDs provide a mode-selectable color flight progress display. The modes are:

- MAP
- VOR
- APP (approach)
- PLN (plan).

The MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose.

---

### Map Mode

The MAP mode is recommended for most phases of flight. This mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- current track
- selected and current heading
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points.

### Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (ARPT), route progress (DATA) and position (POS) data are available for display on the ND in both the expanded and center map modes.

---

### VOR and Approach Modes

The VOR and APP modes are presented heading up. The VOR and APP modes display track, heading, and wind speed and direction with VOR navigation or approach information.

---

### Plan Mode

The PLN mode is presented true north up. The active route may be viewed using the STEP prompt on the CDU LEGS pages.

## ND Information

### Heading

Heading is supplied by the FMC or air data inertial reference system (ADIRS). The ND compass rose can be referenced to magnetic north or true north.

### Track

Track is supplied by the FMC during normal operation.

### Traffic

Traffic information from the TCAS can be displayed on the ND. TCAS is described in Chapter 15, Warning Systems.

### Weather Radar

Weather radar information can be displayed on the ND. The weather radar system is described in Chapter 11, Flight Management, Navigation.

### Failure Flags and Messages

Failure flags are displayed for system failures or invalid information. Indications are blanked or replaced by dashes when source system information is not available.

The message EXCESS DATA is displayed if the amount of information sent to the ND exceeds the display capability. When this occurs, the primary display system removes information from the outer edge of the display. The message can be removed by:

- reducing the amount of map information
- reducing range, or
- deselecting one or more of the EFIS control panel map switches (STA, WPT, ARPT, DATA, POS).

## ND Symbolology

The following symbols can be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

- W (white) – present status, range scales
- G (green) – dynamic conditions
- M (magenta) – command information, pointers, symbols, fly-to condition
- C (cyan) – nonactive or background information
- A (amber) – cautions, faults, flags
- R (red) – warnings
- B (black) – blank area, off condition.

## Heading, Track, and Speed

| SYMBOL  | NAME                           | MODE           | REMARKS  |
|---|--------------------------------|----------------|--|
|    | Selected heading bug (M)       | All except PLN | Displays the MCP-selected heading. A dashed reference line (M) extends from the marker to the airplane symbol (VOR CTR and APP CTR do not display dashed line).<br><br>In the MAP mode with LNAV or VORLOC engaged, the dashed line is removed 10 seconds after the selected heading bug is moved. |
|  | Current heading pointer (W)    | All except PLN | Points to current heading on the compass rose.   |
|  | Track line and range scale (W) | All except PLN | Indicates current track.<br><br>Number indicates range (VOR CTR and APP CTR do not display range).   |
|  | Expanded compass (W)           | MAP, VOR, APP  | Displays 90 degrees of compass rose.   |
|  | Groundspeed (W)                | All            | Displays current groundspeed.  |
|  | True airspeed (W)              | All            | Displays current true airspeed above 100 knots.  |

| SYMBOL   | NAME   | MODE | REMARKS   |
|--|--|------|---|
|  | Wind direction/<br>speed and wind<br>arrow (W) | All  | Indicates wind speed and<br>direction, with respect to display<br>orientation and heading/track<br>reference. Displayed if wind<br>magnitude is greater than 6 knots<br>and blanked if wind magnitude<br>becomes less than 4 knots. Blank<br>until TAS is greater than 101<br>knots. PLN mode displays<br>speed/direction only. |

[Option - Track-up display]

|  |   |                                     |   |
|--|---|-------------------------------------|---|
|  | Track orientation<br>(G),<br>current track (W),<br>track reference (G)  | MAP,<br>MAP CTR                     | Displays TRK as the orientation,<br>the current track, and MAG or<br>TRU as the reference, and points<br>to the heading on the compass<br>rose.           |
|  | Heading<br>orientation (G),<br>current heading<br>(W),<br>heading reference<br>(G),<br>heading pointer<br>(W) | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Displays HDG as the display<br>orientation, current heading,<br>MAG or TRU as the heading<br>reference, and points to the<br>heading on the compass rose. |

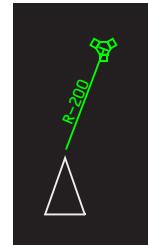
## Radio Navigation

| SYMBOL  | NAME   | MODE                                | REMARKS   |
|---|--|-------------------------------------|---|
|    | ILS /VOR<br>Reference receiver frequency or identifier display (W) | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Located upper right corner.<br>Frequency displayed before the identifier is decoded. The decoded identifier replaces the frequency. Medium size characters for VOR, small size characters for DME only. |
|    | Reference ILS or VOR course (W)                                    | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Located upper right corner.<br>Indicates the VOR course or ILS localizer course.  |
|    | Reference VOR or ILS DME (W)                                       | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Located upper right corner.<br>Indicates DME distance to the reference navaid.  |
|    | DME distance (G)   | All except PLN                      | Located lower left or right corner.<br>Indicates DME distance to navaid.  |
|    | Selected course pointer (W) and line (M)                           | VOR,<br>APP                         | Displays selected course as set by the related MCP course selector.   |
|   | Selected course pointer (W)<br>TO/FROM pointer (W)                 | APP CTR,<br>VOR CTR                 | Displays selected course as set by the related MCP course selector.<br>TO/FROM pointer is displayed when VOR navigation is being used.  |
|  | To/from indication (W)   | VOR,<br>VOR CTR                     | Displays VOR to/from indication.  |

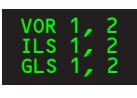
| SYMBOL   | NAME  | MODE                    | REMARKS  |
|--|---|-------------------------|--|
|  | VOR (C, G),<br>DME/TACAN (C, G),<br>VORTAC (C, G) | MAP,<br>MAP CTR,<br>PLN | When the EFIS control panel STA map switch is selected on, appropriate navaids are displayed. All navaids contained in the FMC data base and within the MAP area are displayed when the selected range is 5, 10, 20 or 40 nm. Only high altitude navaids are displayed when the selected range is 80, 160, 320 or 640 nm. Nav aids not being used are displayed in cyan.<br><br>Manually tuned VHF navaids are displayed in green, regardless of STA map switch selection. |

[Option - VOR course lines displayed]

|  |                                   |                         |  |
|--|-----------------------------------|-------------------------|--|
|  | Manually tuned<br>VOR radials (G) | MAP,<br>MAP CTR,<br>PLN | When a navaid is manually tuned, the selected course and reciprocal are displayed. |
|--|-----------------------------------|-------------------------|--|

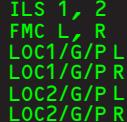
|   |  |                 |   |
|---|--|-----------------|---|
|  | VOR/DME raw data radial and distance (G) | MAP,<br>MAP CTR | When the POS map switch is selected on, the station radial extends to the airplane. |
|---|--|-----------------|---|

[Option - GLS]

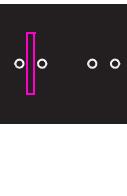
|  |                                   |                                     |   |
|--|-----------------------------------|-------------------------------------|---|
|  | System source<br>annunciation (G) | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Indicates the selected receiver as the display reference. |
|--|-----------------------------------|-------------------------------------|---|

| SYMBOL | NAME | MODE | REMARKS |
|--------|------|------|---------|
|--------|------|------|---------|

**[Option - IAN]**

|   |                             |                 |  |
|---|-----------------------------|-----------------|--|
|  | IAN source annunciation (G) | APP,<br>APP CTR | Indicates the selected source of the deviation displays. |
|---|-----------------------------|-----------------|--|

**[Option - IAN]**

|   |   |                                     |   |
|---|---|-------------------------------------|---|
|  | ILS localizer, FMC IAN or VOR course deviation indication (M) and scale (W) | VOR,<br>VOR CTR,<br>APP,<br>APP CTR | Displays LOC, FMC IAN or VOR course deviation. Deviation indicator points in direction selected course. For ILS and FMC IAN deviation, indicator fills (M) when less than 2 1/2 dots from center. |
|  | ILS Glide slope or FMC IAN Glide path pointer (M) and scale (W)             | APP,<br>APP CTR                     | Displays glide slope or glide path position and deviation.  |

**[Option - ADF]**

|  |  |                |  |
|--|--|----------------|--|
|  | VOR frequency or identifier (G), ADF frequency or identifier (C) | All except PLN | Located lower left or right corner. Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency. For VORs, small size characters indicate only DME information is being received. |
|--|--|----------------|--|

| SYMBOL | NAME | MODE | REMARKS |
|--------|------|------|---------|
|--------|------|------|---------|

**[Option - Dual ADF]**

|  |  |                |   |
|--|--|----------------|---|
|  | VOR (G) or ADF (C) selection                 | All except PLN | Located lower left or right corner.<br>Represents positions of the EFIS control panel VOR/ADF switches.         |
|  | VOR 1 (G) or ADF 1 (C) pointer head and tail | All except PLN | Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel. |
|  | VOR 2 (G) or ADF 2 (C) pointer head and tail | All except PLN | Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective EFIS control panel. |

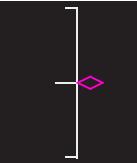
## Map

| SYMBOL  | NAME                | MODE                            | REMARKS   |
|---|---------------------|---------------------------------|---|
|  | Airplane symbol (W) | VOR CTR,<br>APP CTR             | Current airplane position is at the center of the symbol.   |
|  | Airplane symbol (W) | PLN                             | Indicates actual position and track along the flight plan route. Inhibited north of 82N latitude and south of 82S latitude. |
|  | Airplane symbol (W) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Current airplane position is at the apex of the triangle.   |

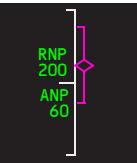
[Option - NPS]

|   |   |                                 |  |
|---|---|---------------------------------|--|
|  | Airplane symbol (W),<br>Lateral ANP/RNP<br>values (G) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Current airplane position is at the apex of the triangle. Displays lateral path deviation distance in MAP and MAP CTR mode only. Whenever ANP exceeds RNP, the ANP/RNP labels and values are displayed in amber. |
|---|---|---------------------------------|--|

[Option - BP04/BP06]

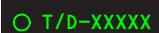
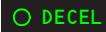
|  |   |                 |   |
|--|---|-----------------|---|
|  | VNAV path pointer (M) and deviation scale (W) | MAP,<br>MAP CTR | Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates ± 400 feet deviation. Digital display is provided when the pointer deviates more than ± 30 feet from center. |
|--|---|-----------------|---|

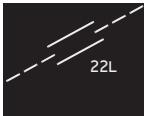
[Option - NPS]

|   |  |                 |   |
|---|--|-----------------|---|
|  | Path deviation band (M),<br>Vertical ANP/RNP<br>values (G) | MAP,<br>MAP CTR | Path deviation band is symmetric about the pointer and represents vertical RNP. Whenever ANP exceeds RNP, the ANP/RNP labels and values are displayed in amber. |
|---|--|-----------------|---|

| SYMBOL   | NAME  | MODE                    | REMARKS  |
|--|---|-------------------------|--|
|    | Position trend vector (W) (dashed line)                   | MAP,<br>MAP CTR         | Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and ground speed. Selected range determines the number of segments displayed. For range: <ul style="list-style-type: none"> <li>• &gt; 20 NM, 3 segments</li> <li>• = 20 NM, 2 segments</li> <li>• &lt;= 10 NM, 1 segment.</li> </ul> |
| <b>ABCDE</b>   | Active waypoint identifier (M)                            | MAP,<br>MAP CTR,<br>PLN | Indicates the active flight plan waypoint, the next waypoint on the route of flight.   |
| <b>124NM</b>   | Active waypoint distance (W)                              | MAP,<br>MAP CTR,<br>PLN | Distance to the active waypoint.   |
| <b>0835.4z</b>   | Active waypoint ETA (W)                                   | MAP,<br>MAP CTR,<br>PLN | Indicates FMS-calculated ETA at the active waypoint.   |
|    | Waypoint:<br>active (M),<br>modified (W),<br>inactive (C) | MAP,<br>MAP CTR,<br>PLN | Active – represents the waypoint the airplane is currently navigating to.<br><br>Modified – represents the waypoints on the active route that are being modified.<br><br>Inactive – represents the waypoints on the active route.  |
|  | Off route waypoint (C)                                    | MAP,<br>MAP CTR,<br>PLN | When the EFIS control panel WPT map switch is selected on, waypoints not on the selected route are displayed, for ranges of 5, 10, 20, or 40 NM.   |

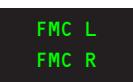
| SYMBOL  | NAME  | MODE                    | REMARKS   |
|---|---|-------------------------|---|
|  | Flight plan route:<br>active (M),<br>modified (W),<br>inactive (C),<br>offset (M) | MAP,<br>MAP CTR,<br>PLN | The active route is displayed with a continuous line (M) between waypoints.<br><br>Active route modifications are displayed with short dashes (W) between waypoints.<br><br>Inactive routes are displayed with long dashes between waypoints.<br><br>An offset route, selected through the FMC, is displayed with a dot-dash line (M) parallel to the active route. |
|  | Route data:<br>active (M),<br>inactive (W)  | MAP,<br>MAP CTR,<br>PLN | When the EFIS control panel DATA switch is selected on, entered or procedural altitude and ETAs for route waypoints are displayed.  |
|  | Holding pattern:<br>active (M),<br>modified (W),<br>inactive (C)                  | MAP,<br>MAP CTR,<br>PLN | A holding pattern appears when in the flight plan.<br><br>The holding pattern appears as a fixed size if the selected range is greater than 80 NM.<br><br>A scaled representation of the holding pattern is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the holding fix.   |

| SYMBOL   | NAME   | MODE                    | REMARKS  |
|--|--|-------------------------|--|
|    | Altitude range arc (G)                               | MAP,<br>MAP CTR         | Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.  |
|    | Conditional waypoint:<br>active (M),<br>inactive (W) | MAP,<br>MAP CTR,<br>PLN | Active - represents the conditional waypoint event the airplane is currently navigating to.<br><br>Inactive - represents the conditional waypoints on the route.<br><br>Data within parentheses for conditional waypoints indicates type of conditional waypoint (ALTITUDE, COURSE INTERCEPT, etc.)  |
| <br><br><br><br><br><br> | Altitude profile point and identifier (G)            | MAP,<br>MAP CTR,<br>PLN | 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.<br><br>Indicates intermediate T/D points for level flight path segments during descent. Level flight path segment altitude is displayed.<br><br>Indicates the beginning of a deceleration segment resulting from deceleration to a holding pattern, a waypoint speed restriction or flaps up maneuvering speed.<br><br>Indicates airport speed restriction deceleration point (no identifier). |

| SYMBOL  | NAME  | MODE                    | REMARKS   |
|---|---|-------------------------|---|
|    | Procedure turn:<br>active (M),<br>modified (W),<br>inactive (C) | MAP,<br>MAP CTR,<br>PLN | A procedure turn appears when in the flight plan.<br><br>The procedure turn appears as a fixed size if the selected range is greater than 80 NM.<br><br>A scaled representation of the procedure turn is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the procedure turn. |
|    | Airport and runway<br>(W)                                       | MAP,<br>MAP CTR,<br>PLN | Displayed when selected as the origin or destination and selected range is 80, 160, 320, or 640 NM.   |
|    | Airport (C)   | MAP,<br>MAP CTR,<br>PLN | Displayed if the EFIS control panel ARPT map switch is selected on.<br><br>Origin and destination airports are always displayed, regardless of map switch selection.  |
|    | Airport and runway<br>(W)                                       | MAP,<br>MAP CTR,<br>PLN | Displayed when selected as the origin or destination and selected range is 5, 10, 20, or 40 NM.<br>Dashed runway centerlines extend 14.2 NM.  |
|  | Selected reference point and bearing distance information (G)   | MAP,<br>MAP CTR,<br>PLN | Displays the reference point selected on the CDU FIX page.<br>Bearing and/or distance from the fix are displayed with dashes (G).   |
|  | GPS position (W)  | MAP,<br>MAP CTR         | When the EFIS POS map switch is selected on, indicates GPS position relative to FMC position.   |
|  | ADIRU position<br>(W)   | MAP,<br>MAP CTR         | When the EFIS control panel POS map switch is selected on, the star indicates ADIRU position relative to FMC position.  |

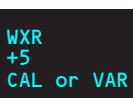
| SYMBOL   | NAME                               | MODE                            | REMARKS   |
|--|------------------------------------|---------------------------------|---|
|  | Weather radar returns (R, A, G, M) | MAP,<br>MAP CTR,<br>VOR,<br>APP | The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta. |
|  | Selected map options (C)           | MAP,<br>MAP CTR,<br>PLN         | Displays EFIS control panel selected map options.   |

## [Option - FMC Qty 2]

|  |                             |                         |  |
|--|-----------------------------|-------------------------|--|
|  | MAP source annunciation (G) | MAP,<br>MAP CTR,<br>PLN | Displays source of FMC data used by CDS for data presentation. |
|--|-----------------------------|-------------------------|--|

## [Option - Range Arcs]

|  |                |                     |  |
|--|----------------|---------------------|--|
|  | Range arcs (W) | MAP,<br>VOR,<br>APP | Displayed in APP and VOR modes when the WXR map, TERR map or TCAS TFC switches are selected. |
|--|----------------|---------------------|--|

|  |   |                                 |   |
|--|---|---------------------------------|---|
|  | Weather radar annunciations:<br>Mode (C), Tilt (C),<br>Gain (C) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Annunciations vary with option selected |
|--|---|---------------------------------|---|

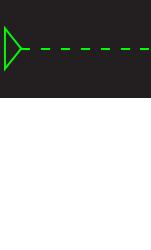
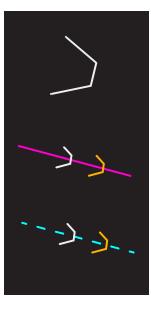
## Vertical Situation Display (VSD)

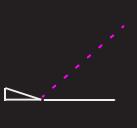
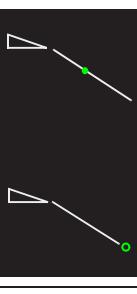
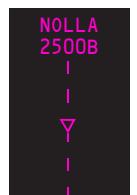
### [Option VSD]

| SYMBOL  | NAME                | REMARKS  |
|---|---------------------|--|
|  | Airplane symbol (W) | Current airplane altitude is the bottom of the triangle. Current airplane lateral position relative to terrain is the point of the triangle. |

### [Option - BP04/BP06]

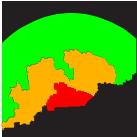
|   |                                    |   |
|---|------------------------------------|---|
|  | Enroute swath (C)<br>(dashed line) | Indicates area of the map that is shown on the VSD. Display is inhibited both on takeoff and approach when the airplane is within 6 NM of the runway and less than 3000 feet above field elevation. During turns, the swath edge leading the turn opens in the direction of the turn. |
|---|------------------------------------|---|

|   |                                       |  |
|---|---------------------------------------|--|
|    | Selected altitude<br>bug and line (M) | Bug indicates the altitude set in the MCP altitude window. When the selected altitude is off scale, the bug is parked at the top or bottom, with only one half the bug visible.<br><br>Dashed line extends from bug to background display boundary. Line does not park.  |
|   | BARO minimums<br>pointer and line (G) | Pointer indicates the barometric minimums selected on the EFIS control panel.<br><br>Dashed line extends from pointer to background display boundary.<br><br>Pointer and line turn amber when airplane descends below selected minimum altitude. Reset with the RST switch on the EFIS control panel.  |
|  | Decision gates<br>(W, A)              | Indicates suggested points where airplane should be path and speed stable on approach. Gates are placed on the 3 Degree Reference Line or FMC Approach Glidepath Angle Line: <ul style="list-style-type: none"><li>• at 1000 feet above field elevation (W).</li><li>• at 500 feet above field elevation (A).</li></ul> Decision gates that are below the missed approach waypoint altitude will not be displayed. |

| SYMBOL   | NAME   | REMARKS  |
|--|--|--|
|    | Flight path vector (W)                                       | Fixed length line indicates current flight path angle and rotates about the point of the triangle.<br>Angle of the line is dependent on the vertical speed and ground speed of the airplane.   |
|    | MCP selected vertical speed vector (M)                       | Dashed line indicates the selected vertical speed as a target angle when the MCP V/S mode is selected.<br>Extends to the edge of the background display and rotates about the point of the triangle.   |
|    | Range to target speed dot (G)                                | Indicates where the airplane will achieve the FMC or MCP target speed. If the airplane is within 5 knots of the target speed the dot will be blanked. If the airplane increases 10 knots or more faster than the target speed the dot will reappear.<br>Displayed at the end of the Flight Path Vector as an unfilled dot if the target speed will not be achieved within the vector length. |
|   | Waypoint altitude constraint:<br>active (M),<br>inactive (W) | At Altitude example.   |
|  | Waypoint altitude constraint:<br>active (M),<br>inactive (W) | At or Above Altitude example.  |
|  | Waypoint altitude constraint:<br>active (M),<br>inactive (W) | At or Below Altitude example.  |

| SYMBOL  | NAME  | REMARKS                 |
|---|---|-------------------------|
|  | Waypoint altitude<br>constraint:<br>active (M),<br>inactive (W) | Block Altitude example. |

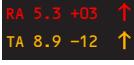
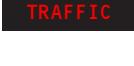
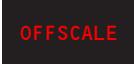
## Look-Ahead Terrain

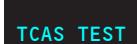
| SYMBOL   | NAME                                   | MODE                            | REMARKS  |
|--|--|---------------------------------|--|
|    | Terrain display (R, A, G, M)           | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displays terrain data from the GPWS terrain data base. Color and density vary based on terrain height vs. airplane altitude. Refer to Chapter 15, Warning Systems. |
|    | Terrain mode annunciation (C)          | MAP,<br>MAP CTR,<br>VOR,<br>APP | Terrain display enabled (manual or automatic display).   |
|    | Terrain test mode annunciation (C)     | All                             | GPWS operating in self-test mode.  |
|    | Terrain annunciation (R, A)            | All                             | Look-ahead terrain caution alert active (A), look-ahead terrain warning alert active (R).  |
|    | Terrain status annunciations (A)       | All                             | Look-ahead terrain alerting and display have failed.   |
|    | Terrain status annunciations (A)       | All                             | Look-ahead terrain alerting and display unavailable due to position uncertainty.   |
|    | Terrain status annunciations (A)       | All                             | GPWS terrain inhibit switch in TERR INHIBIT position.  |
|  | Terrain range status annunciations (A) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Terrain output range disagrees with selected EFIS control panel range.   |
|  | Terrain range status annunciations (A) | MAP,<br>MAP CTR                 | Terrain output range and map display output range disagree with selected EFIS control panel range.   |

## Predictive Windshear

| SYMBOL  | NAME   | MODE                            | REMARKS  |
|---|--|---------------------------------|--|
|  | Predictive windshear symbol (R, B, A)        | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displays windshear location and approximate geometric size (width and depth).<br><br>Amber radials extend from predictive windshear symbol to help identify location of windshear event. |
|  | Windshear annunciation (R, A)                | All                             | Predictive windshear caution active (A).<br><br>Predictive windshear warning active (R).   |
|  | Predictive windshear status annunciation (A) | All                             | Predictive windshear alerting and display have failed.   |

## TCAS

| SYMBOL   | NAME   | MODE                            | REMARKS  |
|--|--|---------------------------------|--|
|    | TCAS resolution advisory (RA), relative altitude (R) | MAP,<br>MAP CTR,<br>VOR,<br>APP | These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 15, Warning Systems.  |
|    | TCAS traffic advisory (TA), relative altitude (A)    |                                 | The arrow indicates traffic climbing or descending at a rate $\geq 500$ fpm. At rates $< 500$ fpm, the arrow is not displayed.   |
|    | TCAS proximate traffic, relative altitude (W)        |                                 | The number and associated signs indicate altitude of traffic in hundreds of feet relative to the airplane.   |
|    | TCAS other traffic, relative altitude (W)            |                                 | The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown. |
|    | TCAS no bearing message (RA-R, TA-A)                 | MAP,<br>MAP CTR,<br>VOR,<br>APP | Message provides traffic type, range in NM, altitude and vertical direction. TFC must be selected on.  |
|  | 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.   |
|  | TCAS off scale message (RA-R, TA-A)                  | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range.<br>Displayed only if the EFIS control panel TFC switch is selected on.                        |
|  | TCAS mode (C)  | MAP,<br>MAP CTR,<br>VOR,<br>APP | Indicates the ND TCAS display is active; the EFIS control panel TFC switch is selected on.   |

| SYMBOL  | NAME          | MODE | REMARKS  |
|---|---------------|------|--|
|  | TCAS mode (C) | All  | Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off. |
|  | TCAS mode (C) | All  | Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.     |
|  | TCAS mode (A) | All  | Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA. Not displayed if TCAS is failed.                     |
|  | TCAS mode (A) | All  | Indicates TCAS failure, if traffic is selected.  |

**[Option - 3NM TCAS range ring]**

|   |                |                                 |  |
|---|----------------|---------------------------------|--|
|  | Range Ring (W) | MAP,<br>MAP CTR,<br>VOR,<br>APP | Displayed when TFC selected on EFIS Control Panel. Shows 3 NM range ring oriented to aircraft heading. Displayed at ranges of 80 NM or less. |
|---|----------------|---------------------------------|--|

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## Flight Instruments, Displays

## Chapter 10

### Head-Up Display System, Symbology

### Section 42

#### Introduction

HUD symbology consists of green symbols projected on the combiner from the OHU. The PRI mode display symbols are similar to those on the CDS, and can be used for all phases of flight. The approach mode displays (AIII, IMC, VMC) are optimized to enhance aircraft control and situational awareness during final approach, flare, and touchdown.

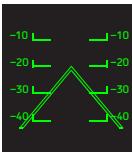
In addition to flight symbology, TCAS resolution advisories and HUD system failure flags and data source annunciations are displayed when active.

#### Head-Up Guidance Display Symbology

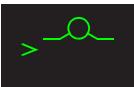
##### [Option - Model 4000]

The following symbols can be displayed on the combiner, depending on HUD and EFIS control panel switch selections.

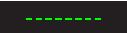
| SYMBOL  | NAME               | MODE   | REMARKS  |
|---|--------------------|--|--|
|    | Airplane reference | All  | Top center point of the symbol represents airplane projected centerline. The symbol is positioned at a fixed position 7 ° above the display's vertical center.<br>Symbol is fixed at display center when the unusual attitude display is active. |
|  | Horizon Line       | All  | Indicates the horizon relative to the airplane reference symbol.<br>Position based on current airplane pitch and roll attitude.  |
|  | Pitch Scale        | PRI in flight,<br>AIII approach,<br>IMC, VMC | Displays airplane pitch in five degree increments between -20 ° and +25 °.   |

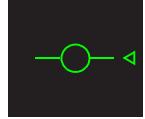
| SYMBOL   | NAME                   | MODE                                   | REMARKS   |
|--|------------------------|--|---|
|    | Compressed pitch scale | PRI in flight, AIII approach, IMC, VMC | Displays airplane pitch in ten degree increments between +/-30 ° and +/-90 °.<br>A chevron appears on the pitch scale at -20 ° and +30 °.   |
|    | Bank Scale and Pointer | All                                    | Displays the corresponding roll attitude in ten degree increments between 0 ° and +/-30 °. Tic marks at +/-45 ° and +/-60 ° are added when the airplane exceeds +/-35 ° and +/-50 ° respectively. |
|    | Horizon heading scale  | All                                    | Magnetic heading is displayed in five degree increments (and labeled every 10 °) on the horizon line.<br>A downward pointing triangle indicates current airplane magnetic heading.                |
|  | HSI heading scale      | PRI in flight                          | Displays airplane magnetic heading in a 210 ° compass rose format.  |
|  | Heading pointer        | PRI in flight                          | Indicates current heading.  |
|  | Drift angle pointer    | PRI in flight                          | Indicates current drift angle or track.   |

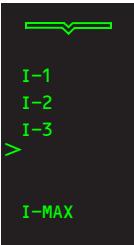
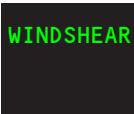
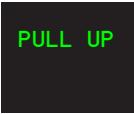
| SYMBOL   | NAME                     | MODE                                   | REMARKS  |
|--|--------------------------|--|--|
|   | Selected heading bug     | All                                    | Displays selected heading on the horizon line and on the HSI (when in view).<br>Not displayed if the selected heading is outside of the currently displayed heading scale. |
|   | Digital selected heading | All                                    | Displayed full time in PRI mode and for five seconds after selection in the IMC, VMC or AIII modes.  |
|   | Digital heading          | All                                    | Displays current magnetic heading directly below the roll scale pointer.   |
|   | Ground roll reference    | PRI ground                             | Provides a reference for ground roll guidance during low visibility takeoff operations.<br>Displayed on the horizon line until 3° of attitude is achieved.                 |
|  | Flight path symbol       | PRI in flight, AIII approach, IMC, VMC | Displays the actual flight path vector of the aircraft.<br>Has display priority over all other symbols except the guidance cue and the FLARE command.                      |

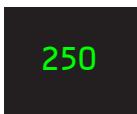
| SYMBOL   | NAME   | MODE                                   | REMARKS  |
|--|--|--|--|
|    | Flight path acceleration                                   | All                                    | Positioned left of the flight path vector; indicates sum of all forces affecting the airplane including thrust, drag, and wind.<br><br>Positioned above flight path vector; airplane is accelerating. Positioned below flight path vector; airplane is decelerating.<br><br>Removed from display when a decreasing performance low-level windshear is detected below 400 feet AGL. |
|    | Pitch limit indication (also called angle of attack limit) | PRI in flight, AIII approach, IMC, VMC | Displayed whenever the airplane's angle of attack is within 5° of stick shaker, any time stick shaker is active, or whenever WINDSHEAR guidance cue is displayed.  |
|   | Slip/skid indicator  | All                                    | The bottom portion of the bank scale pointer moves laterally with respect to the top triangle portion of the pointer.  |
|  | Additional slip/skid indicators                            | PRI in flight, AIII approach, IMC, VMC | Positioned below the airplane reference and flight path symbols.<br><br>Displayed during takeoff or low altitude go-around.  |

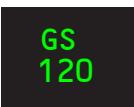
| SYMBOL  | NAME                    | MODE   | REMARKS   |
|---|-------------------------|--|---|
|    | Speed error tape        | PRI in flight,<br>AIII approach,<br>IMC, VMC | Displays the difference between indicated airspeed and the reference speed selected on the mode control panel.<br><br>Tape length equal to the diameter of the flight path circle represents approximately 5 knots of error. Maximum tape length is limited to 15 knots of error. |
|    | Bank warning            | PRI in flight,<br>AIII approach,<br>IMC, VMC | Displayed if radio altitude is less than 100 feet and airplane roll angle exceeds 5°.<br><br>Symbol remains until roll angle is less than 3° or radio altitude greater than 100 feet.   |
|    | Tail strike pitch limit | PRI ground                                   | Tail strike occurs if this symbol meets the aircraft reference symbol.<br><br>Displayed if the airplane pitch angle approaches the tail strike angle or the pitch rate is too excessive during takeoff rotation, below 10 feet AGL.   |
|  | Unusual attitude        | PRI in flight,<br>AIII approach,<br>IMC, VMC | Automatically displayed when pitch exceeds -20°/+35° or roll exceeds 55°.   |

| SYMBOL   | NAME                         | MODE                         | REMARKS  |
|--|------------------------------|------------------------------|--|
|    | Flight director guidance cue | PRI in flight,<br>IMC        | <p>Functions similar to the flight director, but is designed for control of flight path.</p> <p>Automatically displayed when within 2° of pitch command or radio altimeter indicates 50 feet.</p> <p>The objective is to capture the guidance cue inside the flight path vector circle.</p>  |
|    | HUD guidance cue             | PRI ground,<br>AIII approach | <p>Similar to flight director guidance cue, but driven by HUD computer.</p> <p>During low visibility takeoff, the cue provides localizer tracking.</p> <p>During AIII approach, the cue provides approach and flare commands.</p> <p>The objective is to capture the guidance cue inside the flight path vector or ground roll reference circle.</p> |
|  | TO/GA pitch target line      | PRI in flight                | <p>Displayed when greater than 65 knots, AFDS TO/GA mode active and a valid pitch command input of greater than 10 ° is received. Symbol remains until TO/GA mode is exited.</p> <p>The objective is to place the airplane reference symbol on the target line.</p>  |

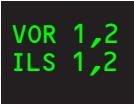
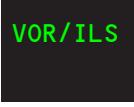
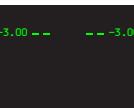
| SYMBOL  | NAME                                 | MODE                    | REMARKS   |
|---|--------------------------------------|-------------------------|---|
|    | AIII flare command                   | AIII approach           | <p>Initially displayed 2-3 ° directly below the guidance cue at 105 feet above runway elevation.</p> <p>The symbol flashes for one second and rises toward the guidance cue at a rate proportional to the expected flare pitch rate.</p> <p>At an altitude between 45 and 55 feet, the flare command and guidance cue meet and continue rising to command the flare maneuver until touchdown.</p> |
|    | Flare cues                           | PRI in flight, IMC, VMC | <p>Displayed on each side of the flight path symbol, indicating the flare maneuver must be accomplished. The cues flash continuously as the airplane descends through 55 feet radio altitude, until 10 feet radio altitude is reached.</p>  |
|  | Rollout excessive deviation triangle | AIII rollout            | <p>Points in the direction of runway centerline during excessive deviation from the localizer on rollout.</p>   |

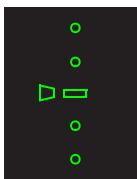
| SYMBOL   | NAME                      | MODE                                   | REMARKS  |
|--|---------------------------|--|--|
|    | Ground deceleration scale | PRI ground, AIII rollout, IMC, VMC     | Scale marks are labeled with autobrake settings.<br>Displayed during all landings.<br>Displayed during takeoff if deceleration is sensed when groundspeed above 50 knots. Removed when groundspeed below 25 knots, airplane is accelerating or after lift off. |
|    | Wind speed and direction  | PRI in flight, AIII approach, IMC, VMC | Indicates wind speed and direction, with respect to airplane magnetic heading. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots.  |
|    | Windshear warning         | PRI in flight, AIII approach, IMC, VMC | Displayed above the airplane reference symbol during a GPWS or PWS windshear warning.  |
|  | Ground proximity warning  | PRI in flight, AIII approach, IMC, VMC | Displayed whenever the GPWS is activated.  |
|  | Windshear guidance cue    | PRI in flight                          | During a windshear warning, and in TO/GA mode, the PRI mode is automatically selected and the guidance cue becomes a solid circle to provide guidance to exit windshear conditions.  |

| SYMBOL  | NAME                      | MODE                                   | REMARKS  |
|---|---------------------------|--|--|
|    | Radio altitude            | PRI in flight, AIII approach, IMC, VMC | Displayed below the flight path symbol, or relative to the airplane reference symbol if the flight path symbol is not displayed.<br><br>The value is removed from the display at 1500 feet when ascending and again displayed at 1400 feet when descending.<br><br>This value is displayed in ten foot increments between 50 and 1500 feet, five foot increments between 10 and 50 feet and one foot increments below 10 feet. |
|    | Decision height           | PRI in flight, AIII approach, IMC      | Displayed left of radio altitude when selected decision height is reached.<br><br>When decision height is reached, the message flashes for 3 seconds and then remains steady.  |
|  | Marker beacon             | PRI in flight, AIII approach, IMC      | Displayed below the airplane reference symbol for marker beacon passage.   |
|  | Digital airspeed          | AIII approach, AIII rollout, IMC, VMC  | Displays airspeed next to the flight path symbol if it is displayed, and next to the airplane reference symbol if flight path is not displayed.  |
|  | Digital selected airspeed | All                                    | Displays speed selected on the MCP.  |

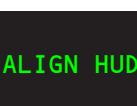
| SYMBOL   | NAME                        | MODE                                   | REMARKS   |
|--|-----------------------------|--|---|
|    | Digital ground speed        | All                                    | Displays digital ground speed.  |
|    | Digital mach                | PRI in flight                          | Displays mach speed below airspeed scale when mach speed is above .400. Removed when below .380.  |
|    | Selected mach               | All                                    | Displays selected mach speed above airspeed scale (PFD/ND format only).   |
|    | Digital barometric altitude | AIII approach, AIII rollout, IMC, VMC  | Displays barometric altitude relative to the flight path symbol if it is displayed, and relative to the airplane reference symbol if flight path is not displayed.                      |
|    | Digital vertical speed      | PRI in flight, AIII approach, IMC, VMC | In PRI mode, displayed in the lower right corner of the display. In all other modes, displayed to the right of the flight path symbol.<br>Value displayed in 50 feet/minute increments. |
|  | DME distance                | PRI in flight, AIII approach, IMC, VMC | Indicates DME distance to the reference navaid.   |

| SYMBOL  | NAME   | MODE                        | REMARKS   |
|---|--|-----------------------------|---|
|    | Digital runway elevation   | AIII approach               | Displays runway elevation entered on the HUD control panel for 5 seconds: <ul style="list-style-type: none"> <li>• after AIII mode selected, or</li> <li>• runway elevation value changed during an AIII mode approach.</li> </ul>  |
|    | Digital runway length in feet.<br>Digital runway length in meters.     | AIII approach, AIII rollout | Displays runway length entered on the HUD control panel for 5 seconds: <ul style="list-style-type: none"> <li>• after AIII mode selected, or</li> <li>• runway length value changed during an AIII mode approach.</li> </ul> <p>When AIII mode active and above 500 feet AGL, display flashes when runway length entered is outside of rollout guidance capability.</p> |
|  | Digital runway remaining in feet<br>Digital runway remaining in meters | PRI ground, AIII rollout    | Displays the length of runway remaining between airplane and end of runway based on runway length entered on the HUD control panel.   |
|  | Distance to go   | PRI in flight, IMC          | Distance to next waypoint.  |

| SYMBOL   | NAME  | MODE   | REMARKS   |
|--|---|--|---|
|    | Selected course (digital)                           | All  | Displayed full time in PRI mode and for five seconds after selection in the IMC, VMC or AIII modes.   |
|    | Selected course pointer                             | All  | Displays MCP selected course below the horizon line and on the HSI (PRI mode only).<br>The horizon line pointer is surrounded by a 3° gap in the horizon line.                                  |
|    | System source annunciation                          | PRI in flight,<br>PRI ground,<br>AIII approach,<br>AIII rollout<br>IMC | Indicates the selected receiver as the display source.  |
|    |   |  | Indicates source cannot be determined.  |
|    | FMC source annunciation                             | All  | Indicates the selected FMC as the system source.  |
|   | Glideslope reference line                           | AIII approach,<br>IMC, VMC   | Displays the glideslope value entered on the HUD control panel.<br>Positioning the flight path symbol over the glideslope reference line results in a descent angle equal to the value entered. |
|  | ILS localizer or VOR deviation indication and scale | PRI in flight  | Displays LOC or VOR course deviation on the HSI.<br>With excessive localizer deviation during an ILS approach, the symbol will flash until the excessive deviation is no longer present.        |

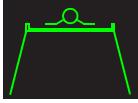
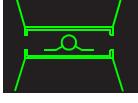
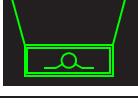
| SYMBOL  | NAME   | MODE                     | REMARKS   |
|---|--|--------------------------|---|
|    | Glideslope pointer and deviation scale       | PRI in flight            | Displays glideslope position and deviation during ILS approach.<br><br>With excessive glideslope deviation, the pointer will flash until the excessive deviation is no longer present.  |
|    | Ground localizer pointer and deviation scale | PRI ground, AIII rollout | Displays airplane lateral deviation relative to the runway centerline.  |
|    | Vertical deviation pointer and scale         | PRI in flight, IMC       | Full scale represents 400 feet of vertical deviation.<br><br>When the deviation is off scale, the pointer is parked at the top or bottom of the tape, and the digital value is displayed at the appropriate end of the scale. |
|  | Lateral deviation line                       | AIII approach, IMC       | Displayed as vertical lines referenced to the selected course.<br><br>In IMC mode, the line will flash during excessive localizer deviation.  |

| SYMBOL | NAME   | MODE                          | REMARKS  |
|--------|--|-------------------------------|--|
|        | Glideslope deviation line  | AIII approach, IMC            | Displayed as horizontal lines referenced to the glideslope reference line.<br>In IMC mode, the line will flash during excessive glideslope deviation.<br>The line is removed below 70 feet radio altitude. |
|        | Ground localizer line  | PRI ground, AIII rollout, IMC | Displays localizer deviation as a vertical line below the airplane reference symbol and is referenced to the selected course.  |
| <br>   | VOR1/ADF 1 pointer head and tail<br>VOR2/ADF 2 pointer head and tail | PRI in flight                 | Indicates bearing to (head) or from (tail) the tuned station.  |
|        | Bearing source annunciations   | PRI in flight                 | Indicates pointer source.  |
|        | To/from pointer  | PRI in flight, PRI ground     | A triangle pointing in the same direction as the selected course indicates a "to" condition. Pointing away from the selected course indicates a "from" condition.  |
|        | TO/FROM annunciation   | AIII approach, IMC            | Displayed below the VOR system source annunciation. Indicates movement to or from a VOR station.   |

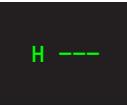
| SYMBOL  | NAME              | MODE                                  | REMARKS   |
|---|-------------------|---------------------------------------|---|
|    | Runway elevation  | AIII approach                         | Indicates entered runway elevation for 5 seconds after AIII mode is selected or if elevation value is changed during AIII mode operation.   |
|    | Runway edge lines | AIII approach                         | Displayed between 300 and 60 feet radio altitude. The lines are scaled to a width of 200 feet and a length of 8000 feet.<br><br>Tic marks are displayed at the touchdown aimpoint representing 1050 feet from the runway threshold. |
|    | IDLE message      | AIII approach                         | Displayed below the radio altitude when flare guidance commands a thrust reduction to idle for touchdown.<br><br>Message is displayed between 25 to 5 feet radio altitude, depending on airspeed.                                   |
|  | ALIGN HUD message | IMC, VMC                              | Indicates the combiner is not properly aligned with the OHU.  |
|  | HUD system mode   | AIII approach, AIII rollout, IMC, VMC | Indicates current HUD system mode.<br><br>The PRI mode is not indicated as it is uniquely identifiable by the airspeed and altitude tapes.  |

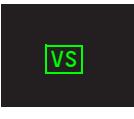
| SYMBOL  | NAME                                | MODE                                   | REMARKS   |
|---|-------------------------------------|--|---|
|   | AIII approach status                | PRI in flight                          | A flashing “AIII” indicates availability of AIII approach mode.   |
|   |                                     | AIII approach                          | Indicates AIII mode selection once all AIII approach requirements have been satisfied.<br>If AIII capability is lost, the “NO AIII” status message is displayed.                |
|   | Approach warning                    | AIII approach                          | Displayed below 500 feet if approach monitoring tolerances are exceeded or AIII capability is lost.   |
|   | Tail strike warning                 | PRI in flight, AIII approach, IMC, VMC | Displayed when a tail strike is likely during landing. Tail strike monitoring is active below 100 feet AGL.   |
|  | Angle of attack scale and indicator | PRI in flight, AIII approach, IMC, VMC | Displays current angle of attack, stick shaker trip point and approach reference band. Tic marks every 5°.<br>Approach reference band is added after the first flap retraction. |

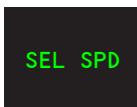
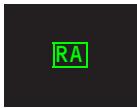
## TCAS Resolution Advisory

| SYMBOL   | NAME                   | MODE   | REMARKS   |
|--|------------------------|--|---|
|   | Down preventive        | PRI in flight,<br>AIII approach,<br>IMC, VMC | Area(s) inside the lines indicate the pitch region(s) to avoid in order to resolve the traffic conflict. The flight path symbol should be positioned outside the pitch command area(s) to ensure traffic avoidance. |
|   | Up preventive          |  | A double-lined box indicates a corrective action is required, and represents TCAS maneuver guidance to maintain or increase separation from the traffic.  |
|   | Up and down preventive |  |   |
|   | Descend corrective     |  |   |
|   | Climb corrective       |  |   |
|  | Combined corrective    |  |   |

## Failure Flags and Data Source Annunciations

| SYMBOL  | NAME                  | MODE | REMARKS   |
|---|-----------------------|------|---|
|   | IRS attitude flag     | All  | IRS pitch or roll attitude has failed.  |
|   | Pitch miscompare flag | All  | Indicates a pitch miscompare of greater than 5 ° for more than 1.5 seconds.   |
|   | Roll miscompare flag  | All  | Indicates a roll miscompare of greater than 5 ° for more than 1.5 seconds.  |
|   | Heading flag          | All  | Heading data has failed.  |
|   | No heading            | All  | IRU heading has no computed data.   |
|  | Airspeed flag         | All  | Airspeed information has failed. In PRI mode, if airspeed has no computed data, airspeed data is removed and no failure flag is displayed.<br><br>The boxed characters are positioned vertically in the PRI mode or horizontally in the AIII, IMC or VMC modes. |

| SYMBOL  | NAME                   | MODE                         | REMARKS   |
|---|------------------------|------------------------------|---|
|    | Altitude flag          | All                          | Altitude information has failed. In PRI mode, if altitude has no computed data, altitude data is removed and no failure flag is displayed.<br>The boxed characters are positioned vertically in the PRI mode or horizontally in the AIII, IMC or VMC modes. |
|    | Decision speed flag    | PRI ground                   | V1 decision speed or VR rotation speed has not been entered or is invalid.  |
|    | Speed limit flag       | PRI in flight,<br>PRI ground | Maximum operating speed data has failed.  |
|   | Mach flag              | PRI in flight,<br>PRI ground | MACH airspeed has failed.   |
|  | Vertical speed flag    | All                          | Vertical speed has failed.<br>In AIII, IMC or VMC modes, may also show for no computed data.  |
|  | Vertical speed         | PRI in flight                | Vertical speed has no computed data.  |
|  | Selected altitude flag | PRI in flight,<br>PRI ground | Selected altitude has failed.   |

| SYMBOL   | NAME                      | MODE   | REMARKS  |
|--|---------------------------|--|--|
|    | Selected airspeed flag    | All  | Selected speed has failed.   |
|    | Radio altitude flag       | All  | Radio altitude has failed.   |
|    | Localizer miscompare flag | PRI in flight<br>PRI ground;<br>AIII rollout | Localizer miscompare has occurred during low visibility takeoff or rollout.                                |
|    | Vertical deviation flag   | PRI in flight,<br>IMC                        | FMC vertical track data is invalid.<br>Vertical deviation pointer is removed if there is no computed data. |
|    | DME flag                  | All  | DME has failed.  |
|   | DME                       | All  | DME has no computed data.  |
|  | Flight director flag      | PRI in flight,<br>PRI ground,<br>IMC         | Flight director has failed.  |
|  | TCAS fault                | PRI in flight,<br>AIII approach,<br>IMC, VMC | TCAS has a fault.  |
|  | Right (#2) IRS source     | All  | All IRS information used or displayed by the HUD is taken from the right (#2) IRS.                         |

| SYMBOL   | NAME                         | MODE   | REMARKS   |
|--|------------------------------|--|---|
|   | Glideslope flag              | PRI in flight,<br>AIII approach,<br>IMC      | ILS has failed.   |
|   | Ground speed                 | All  | Ground speed has no<br>computed data.   |
|   | Lateral deviation fault      | PRI in flight,<br>PRI ground                 | ILS has failed.   |
|   | Distance to next<br>waypoint | PRI in flight,<br>AIII approach,<br>IMC, VMC | Distance to next<br>waypoint has no<br>computed data.                                   |
|   | Decision height flag         | PRI in flight,<br>AIII approach,<br>IMC      | Decision height data has<br>failed.<br><br>Displayed below 1500<br>feet radio altitude. |
|   | VOR failure flag             | PRI in flight,<br>AIII approach,<br>IMC      | VOR has failed.   |
|  | Angle of attack fault        | PRI in flight,<br>AIII approach,<br>IMC, VMC | Loss of valid angle of<br>attack data.  |

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## Flight Instruments, Displays

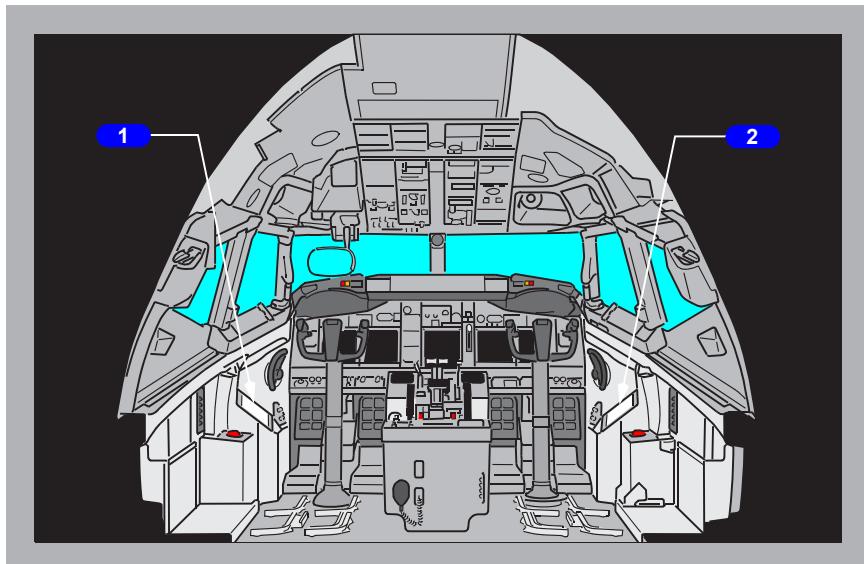
### Electronic Flight Bag (EFB)

## Chapter 10

### Section 65

[Option]

#### System Components



#### 1 Captain Display Unit

Used for input and display of captain's pertinent flight information.

#### 2 First Officer Display Unit

Used for input and display of first officer's pertinent flight information.

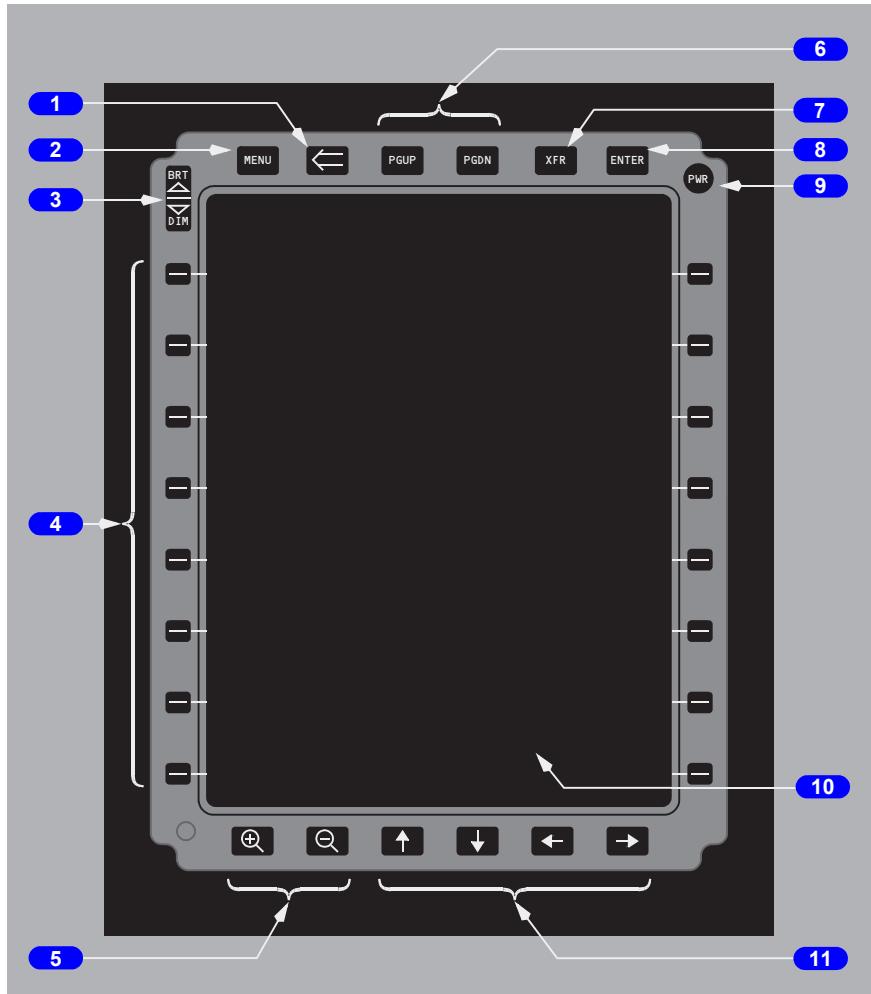
#### System Description

The Electronic Flight Bag (EFB) is a suite of applications designed to assist the flight crew with routine tasks and reduce the reliance on paper documents. The EFB allows flight crews to view pertinent flight data available through interactive display units located on the side panels.

Under typical flight conditions, the pilots manipulate Line Select Keys or the touch screen on a display unit to display data.

The suite of applications available to the flight crew may be customized by airlines. User modifiable portions of each application may be further customized. These customizing options include assigning applications to input keys, revising application names, defining the order in which applications appear, and choosing different colors, fonts, icons and cursors. Descriptions and illustrations provided in this section are examples of a typical Boeing Class 3 Electronic Flight Bag with the standard suite of applications installed, plus Electronic Log Book (ELB), and may not reflect the exact installed configuration.

## Display Unit



### 1 Back Key

Returns to the previous level.

### 2 Main Menu (MENU) key

Displays MAIN MENU.

### **3 Bright (BRT) Dim (DIM) Control**

Rocker switch, upper portion brighter, lower portion dimmer.

### **4 Line Select Keys**

Selects item next to key.

### **5 Zoom Keys**

Left key is zoom in, right is zoom out. Repeated selection increases or decreases the zoom level.

### **6 Page Up (PGUP)/Page Down (PGDN) Keys**

Moves up or down within an application where the display exceeds one display screen in length.

### **7 Transfer (XFR) Key**

- View other pilot's EFB display on this display
- XFR displays in green text on upper right
- Selections made off-side are seen on the on-side display in real time
- XFR key (second push) exits transfer and returns display to last view prior to selecting XFR
- MENU key exits transfer and displays the MAIN MENU

### **8 Enter (ENTER) Key**

Activates a high-lighted item when applicable.

### **9 Power (PWR) Switch**

Turns the display backlight on or off.

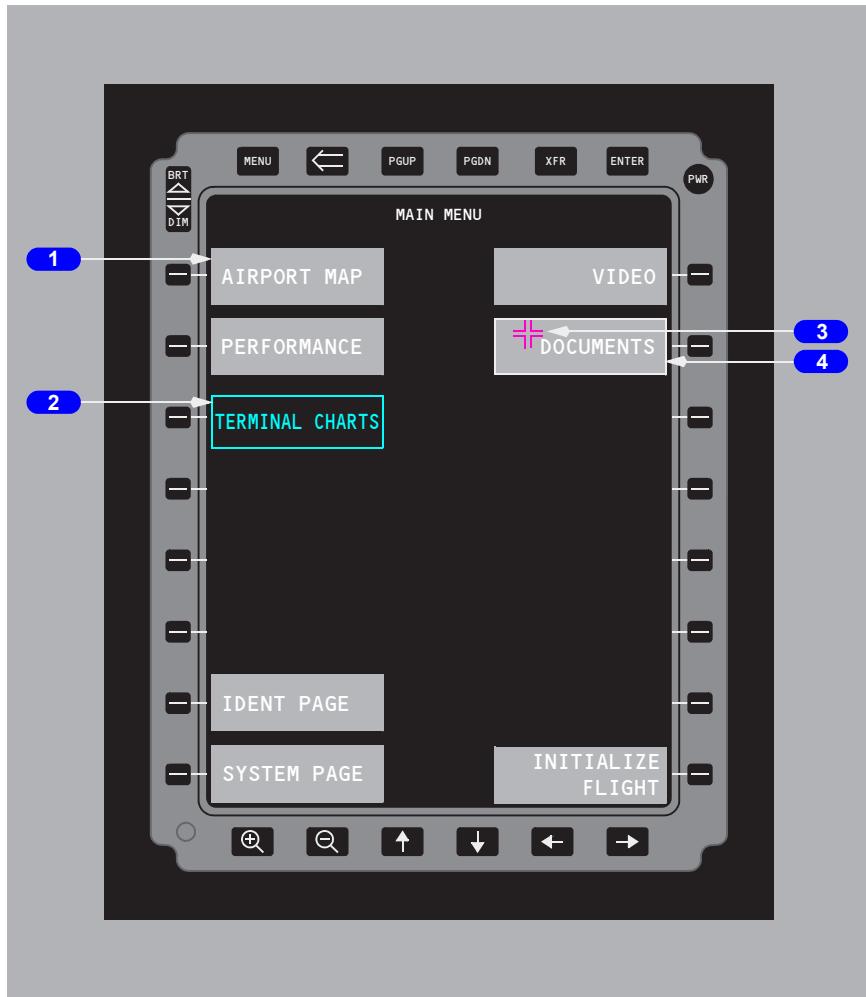
### **10 Touch sensitive screen**

Enables direct selection on the display screen, and in some applications panning and scrolling.

### **11 Arrow Keys**

Moves the viewing window over the display in the direction of the selected arrow.

## Display Description



### 1 Selectable Applications

Menu items for selectable applications display in white text with gray background.

### 2 Applications not selectable

Menu items for applications that are installed but are not selectable display in cyan text in a cyan box. An application may be initializing and may become selectable later.

### 3 Cursor

A magenta cursor appears on the display when the SIDE switch is selected on a cursor control device.

### 4 High-light Box

A white high-light box displays around a selectable application when:

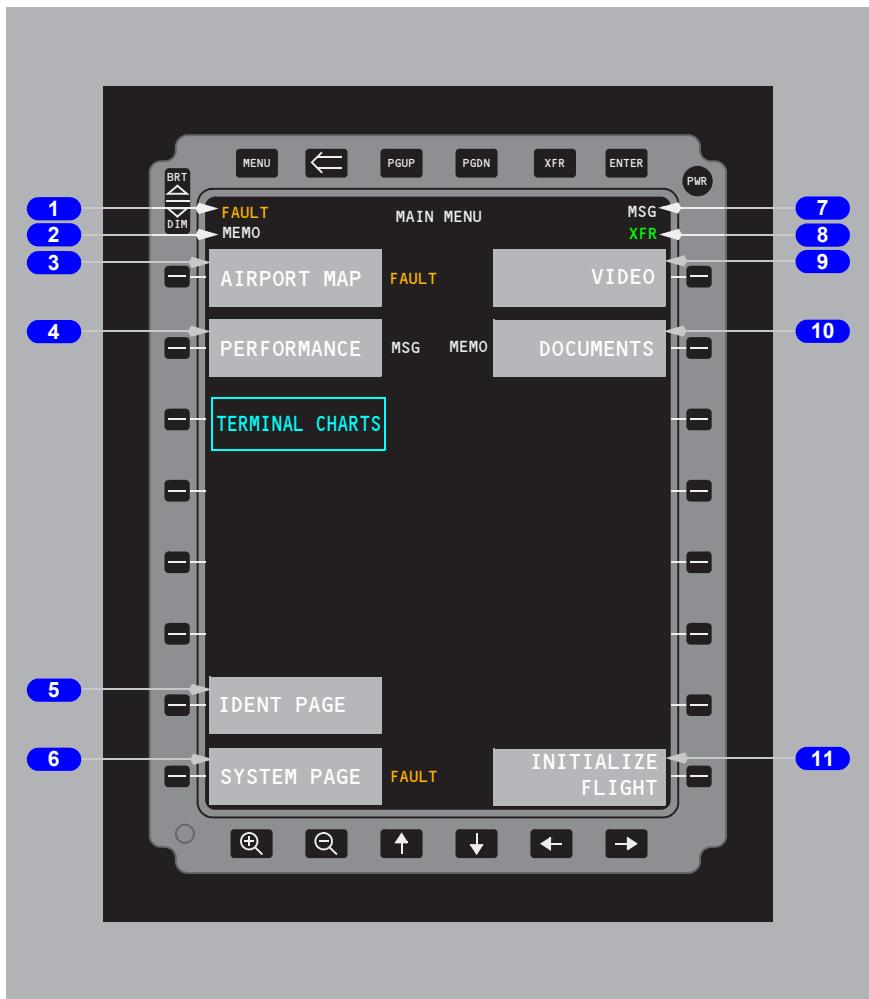
- The cursor is moved over the menu item
- The selectable menu item is touched
- A line select key is selected

A selectable application is selected when:

- It is high-lighted with the cursor and the cursor select switch is pushed
- A menu item is touched and released
- A line select key is selected

The menu item for a selected application displays a green background momentarily and then the selection displays.

## Main Menu



### 1 FAULT

Displayed (amber) -

- A fault has occurred within an application
- Displays in the header regardless of the application displayed
- Displays next to the affected application on the MAIN MENU
- Removed from header upon selection of the SYSTEM page

Only one message at a time may display next to an application. FAULT takes priority over MEMO and MSG. MEMO or MSG display as applicable after the fault is cleared.

## **2 MEMO**

Displayed (white) -

- One or more applications need attention
- Displays in the header regardless of the application displayed
- Displays next to the affected application on the MAIN MENU

## **3 AIRPORT MAP Application**

Selects the AIRPORT MAP application.

- After flight initialization, displays the departure airport in HDG-UP (heading up) mode when on the ground at the departure airport
- Displays the departure airport NORTH UP when in the air

## **3 AIRPORT MAP Application**

Selects the AIRPORT MAP application.

- After flight initialization, displays the departure airport in TRK-UP (track up) mode when on the ground at the departure airport
- Displays the departure airport NORTH UP when not on the ground

## **4 PERFORMANCE Application**

Selects the PERFORMANCE application.

- After flight initialization, displays the takeoff performance page
- Computes takeoff and landing performance based on user inputs
- Subsequent selections of the application display the selection that was in view when the application was last exited

## **5 IDENT PAGE**

Displays the IDENT page.

## **6 SYSTEM PAGE**

Displays the SYSTEM page.

**7 MSG**

Displayed (white) -

- One or more applications has an uplink available
- Displays in the header regardless of the application displayed
- Displays next to the affected application on the main menu. Takes priority over MEMO

**8 XFR**

Displayed (green) -

- The display is in transfer mode
- No selections except MENU and XFR are enabled

**9 VIDEO Application**

Displays views from surveillance cameras of area outside the flight deck door.

**10 DOCUMENTS Application**

Selects the DOCUMENTS application

- After flight initialization, displays the documents library
- Subsequent selections of the application display the selection that was in view when the application was last exited

**11 INITIALIZE FLIGHT**

Initializes all the installed applications for flight

- Clears search results of all previous searches in all applications
- All applications and functions restored to default settings
- Cross loads from FMC applicable data if it has been entered in the FMC
- Menu changes to CLOSE FLIGHT
- CLOSE FLIGHT is not selectable (cyan) during flight

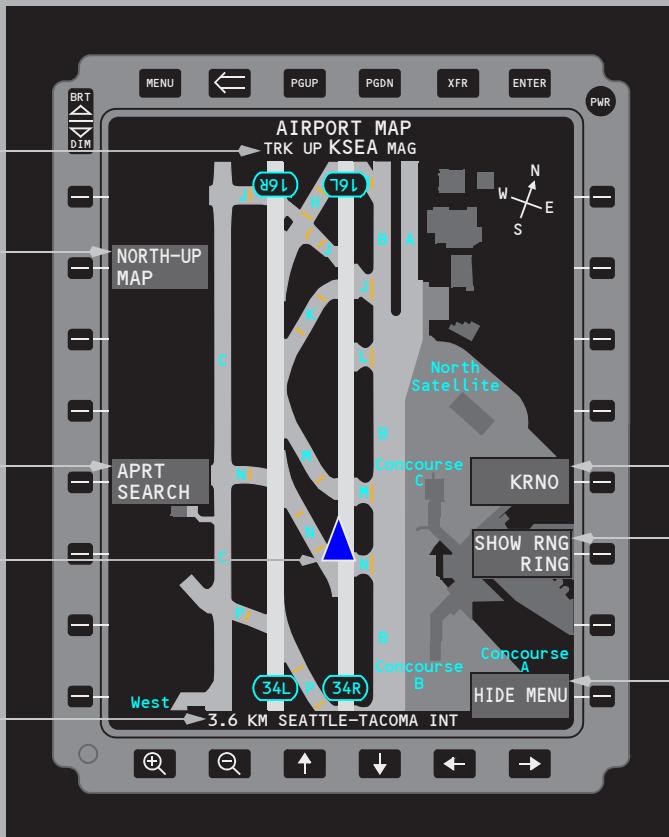
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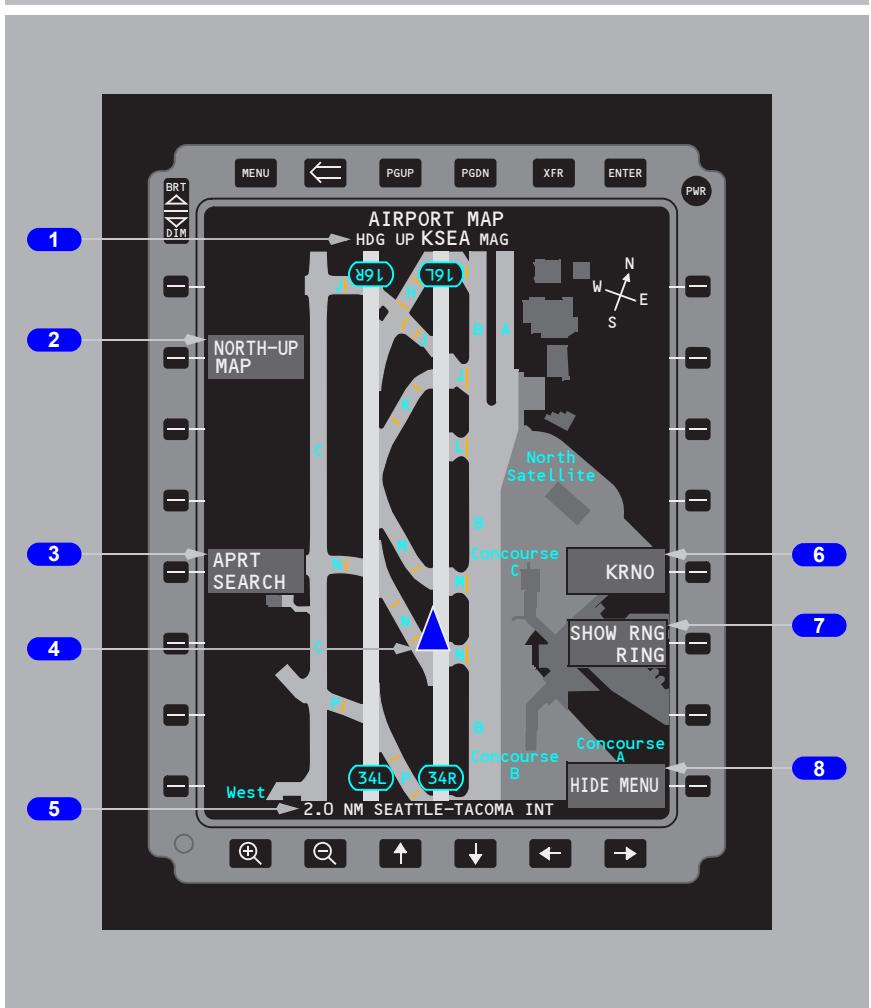
**Airport Maps (Typical)**

The maps are based on precise survey of airport geometry by satellite and other means. There may be differences between the electronic airport map and the airport diagrams that are part of the terminal charts, since these charts are derived from different survey methods.

**Airport Track Up (moving) Map****Airport Heading Up (moving) Map**

The airplane symbol remains stationary and the map moves to provide the location and orientation of the airplane relative to the map.





## 1 Map Reference

Displays the map reference.

- HDG-UP (heading up) and MAG (magnetic)
- TRK-UP (track up) and MAG (magnetic)

## 2 NORTH-UP MAP

Selects north up (static) map display.

### **3 Airport (APRT) SEARCH**

Allows searching the database for other airport maps.

### **4 Airplane symbol**

Displays when airplane is on the ground at the displayed airport and groundspeed is less than 40 knots.

### **5 Display range**

Indicates the map range from top to bottom of the display.

### **6 Airport Identifier**

When departure airport is displayed, identifier is destination airport if entered in FMC.

- Selection displays the destination airport in HDG-UP (moving map) mode when on the ground at the destination airport
- Selection displays the destination airport in TRK-UP (moving map) mode when on the ground at the destination airport
- Displays the destination airport in NORTH UP (static) mode when in the air

When destination airport is displayed, identifier is departure airport.

### **7 SHOW/HIDE Range (RNG) RING**

Displays or removes a 300 meter radius range ring around the airplane symbol.

### **7 SHOW/HIDE Range (RNG) RING**

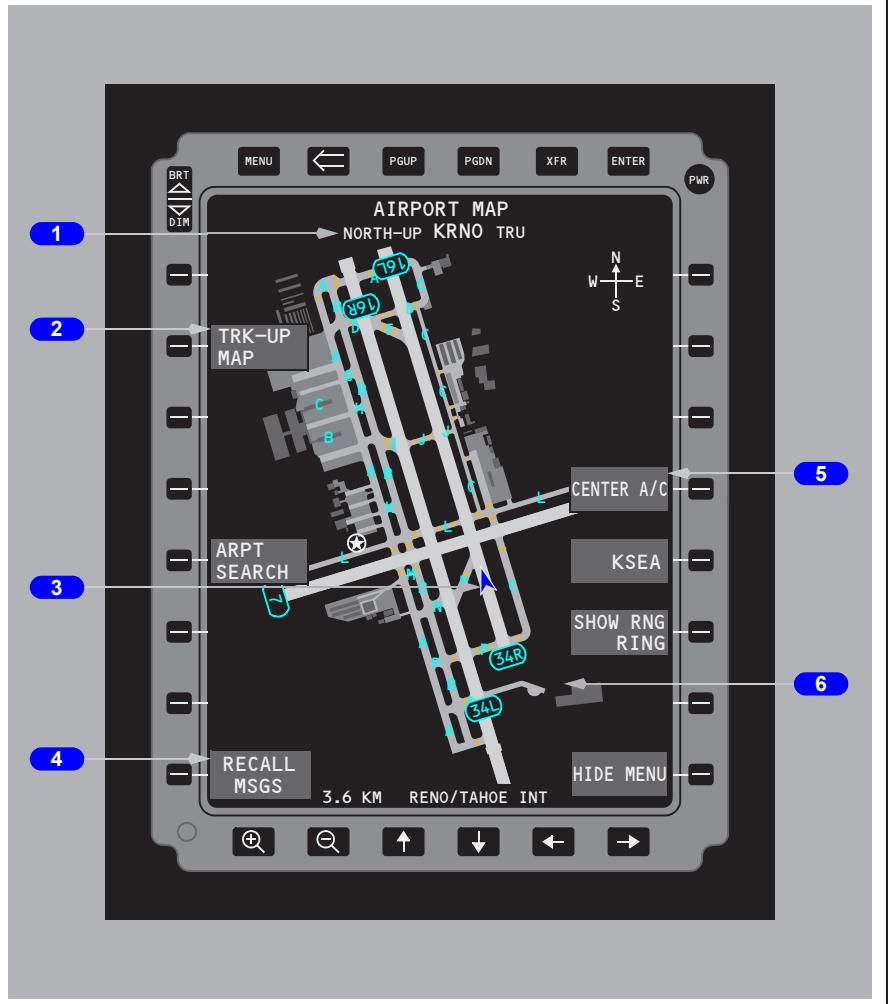
Displays or removes a 1000 foot radius range ring around the airplane symbol.

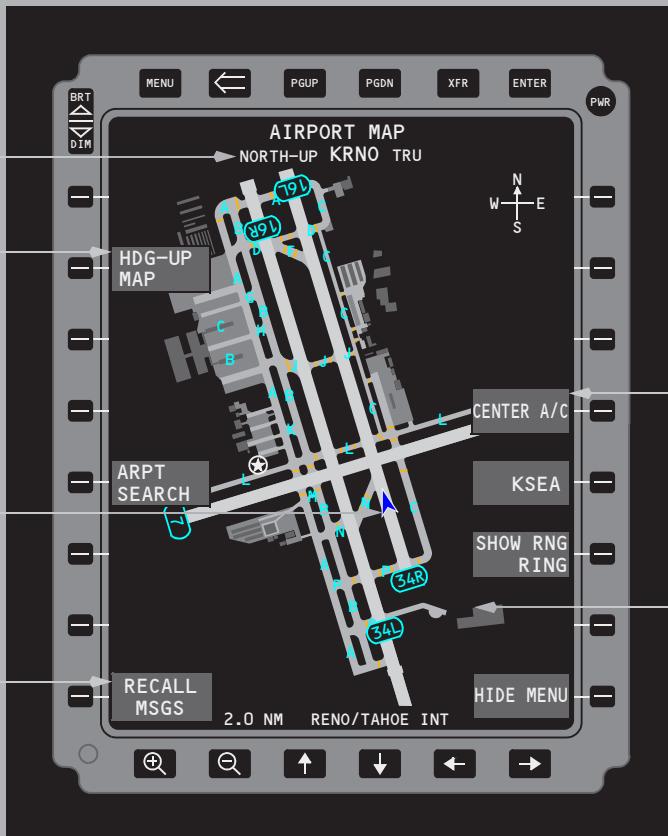
### **8 SHOW/HIDE MENU**

Displays or hides all other menu selections.

## Airport North Up (static) Map

The airplane symbol moves on a stationary map showing the airplanes general location and orientation on the ground at the selected airport. Using the touch screen to “touch and drag”, or using the arrow keys, the map may be repositioned on the display.





## 1 Map reference

Displays the map reference

- NORTH UP
- TRU (true) heading

## 2 HDG-UP MAP

Selects heading up moving map display.

**2 TRK-UP MAP**

Selects track up moving map display.

**3 Airplane Symbol**

Displays when airplane is on the ground at the displayed airport and groundspeed is less than 40 knots.

**4 CANCEL/RECALL MSGS (Messages)**

Toggles between Cancel and Recall when map faults exist

- CANCEL removes fault messages from the display
- RECALL re-displays fault messages

The menu item is inhibited when there are no faults to display.

**5 CENTER A/C**

Centers airplane symbol horizontally and vertically on the display.

**6 Map fault message display area**

Amber fault messages display in this area. More than one message may display at a time.

Faults may appear on both NORTH-UP and HDG-UP displays.

Faults may appear on both NORTH-UP and TRK-UP displays.

| Fault  | NORTH-UP                    | HDG-UP<br>TRK-UP  |
|--|-----------------------------|---|
| ADIRU DATA<br>(ADIRU data is lost or invalid.)   | Airplane symbol is removed. | Airplane symbol is removed. Map freezes on position and last known heading. |
| GPS DATA<br>(GPS position data is lost or invalid.)  | Airplane symbol is removed. | Airplane symbol is removed. Map freezes on heading and last known position. |
| UNABLE POS ACCURACY<br>(GPS position accuracy limits are exceeded.<br>Inhibited by GPS DATA and when in flight.) | Airplane symbol is removed. | Airplane symbol is removed. Map freezes on heading and position             |



## Airport Search

Airport search allows the search and display of other airport maps. Keypad operation for entering, clearing, and deleting characters is the same as with the FMS CDU. All EFB applications that have a search function use an identical keypad and scratchpad in the lower half of the respective search display.



## 1 SEARCH IDENT

Initiates a search of the ident data base using the scratchpad entry.

**2 SEARCH ALL**

Initiates a search of the data base using the scratchpad entry.

**3 Scratchpad****4 SYMB/NUM key**

Alternates between SYMB and NUM.

- SYMB displays symbols on the keypad
- NUM displays numbers on the keypad

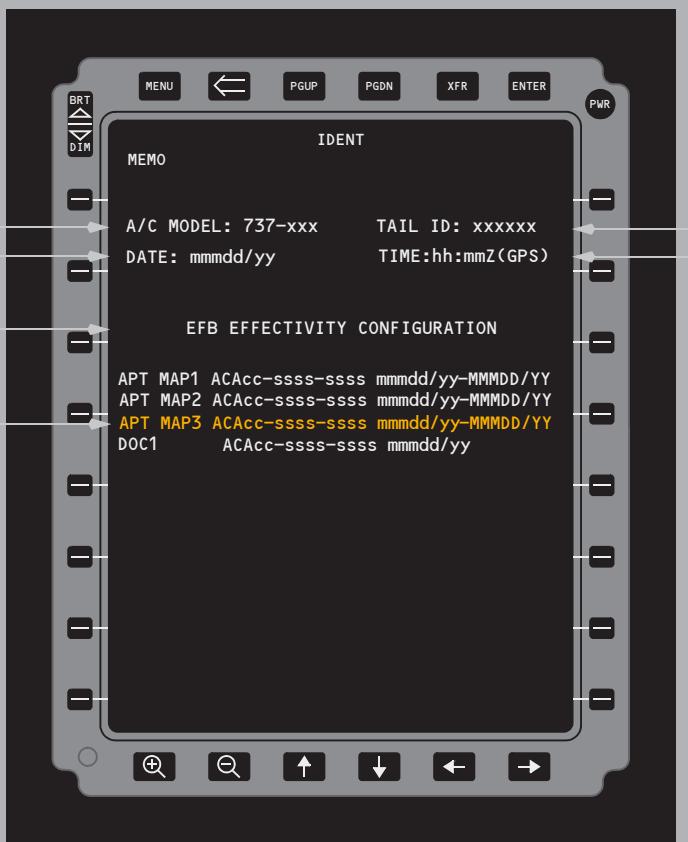
**5 SHIFT key**

Changes letter keys between upper case and lower case.

**6 Airport Identifier**

The results of the airport search are displayed here. Selecting the airport displays the airport map in North Up mode.

## IDENT page



### 1 A/C MODEL

Display of aircraft model.

### 2 DATE

Display of current date.

### 3 EFB EFFECTIVITY CONFIGURATION

Display of effectivity dates for loaded databases.

**4 Out of date data base (amber)**

An out of date database displays in amber. MEMO displays in the header on all pages and next to affected applications on the Main Menu page.

**5 TAIL ID**

Display of tail identification number.

**6 TIME**

Display of time and source of time.

## SYSTEM page



### 1 Acknowledged fault

Fault information is displayed in cyan.

### 2 Un-acknowledged fault

Fault information is displayed in white.

**3 ACKNOWLEDGE NEW FAULTS**

- Becomes selectable when there are un-acknowledged faults
- Selection acknowledges all new faults
- Selection removes FAULT on MAIN MENU next to SYSTEM

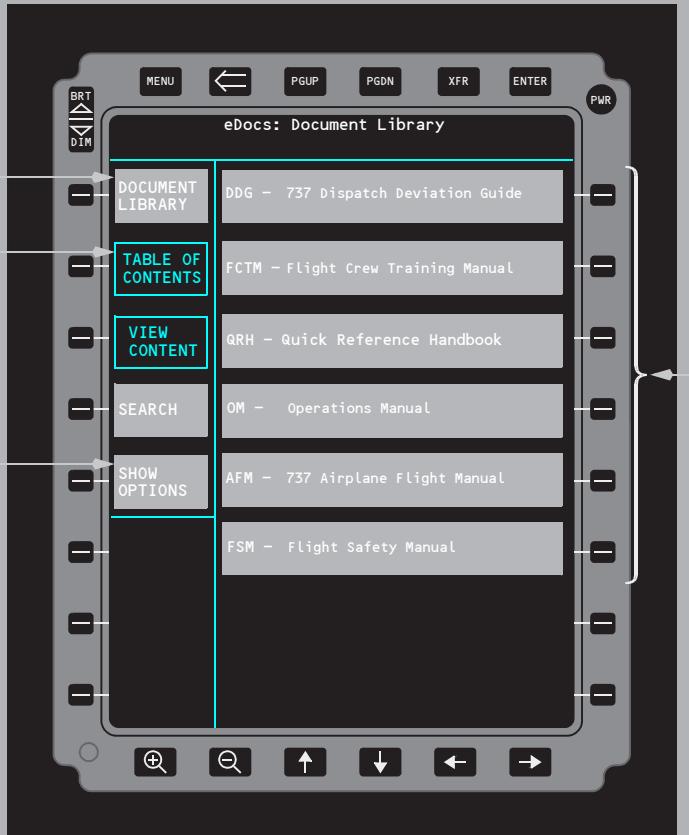
**4 EFB MAINTENANCE**

Provides access to the maintenance menu page.

**5 RESTART**

Re-initializes Windows applications.

## Documents (Typical)



### 1 Application functions

- Functions for this application display along the left side
- Selectable functions display with gray background

**2 Functions not selectable**

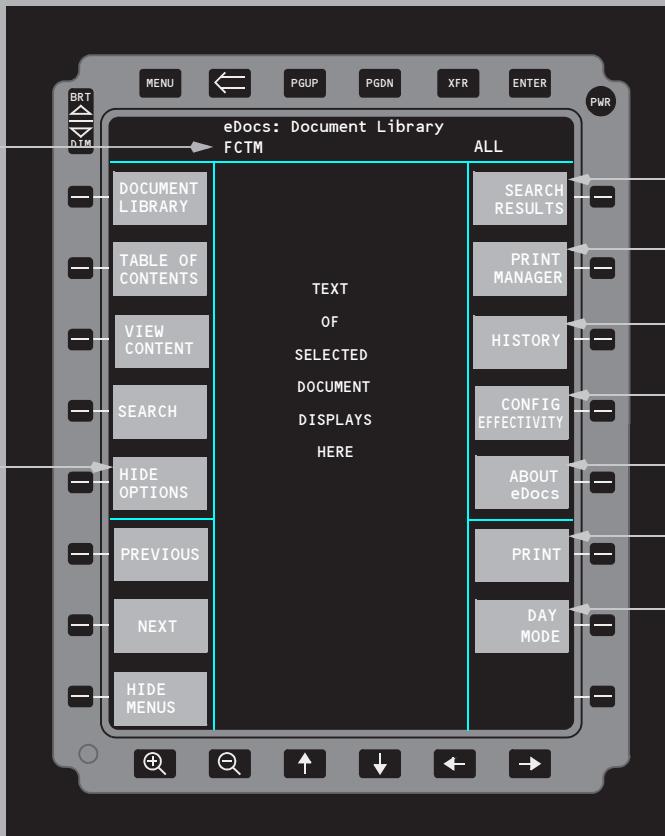
Functions that are not selectable display in cyan. In this example the TABLE OF CONTENTS function is not selectable because no document is selected. Once a document is selected, the function turns white with gray background and is selectable.

**3 SHOW OPTIONS**

- Displays a list of options along the right side of the display
- Menu changes to HIDE OPTIONS

**4 Selectable documents**

Displays a list of the installed and selectable documents.



## 1 Selected document

Selected documents display their acronym in the header below the application title. The area is blank when no document is selected.

## 2 HIDE OPTIONS

- Removes the list of options from the right side of the display
- Menu is replaced with SHOW OPTIONS

## 3 SEARCH RESULTS

Displays a list of results as links, based on a search of a particular manual.

**4 PRINT MANAGER**

Displays all pending print jobs.

**5 HISTORY**

Displays a list of entries as links for information previously displayed in the VIEW CONTENTS screen.

**6 CONFIG EFFECTIVITY**

A selectable list of all the configurations supported by the manual (if applicable).

**7 ABOUT eDocs**

Contains the latest application version information.

**8 PRINT**

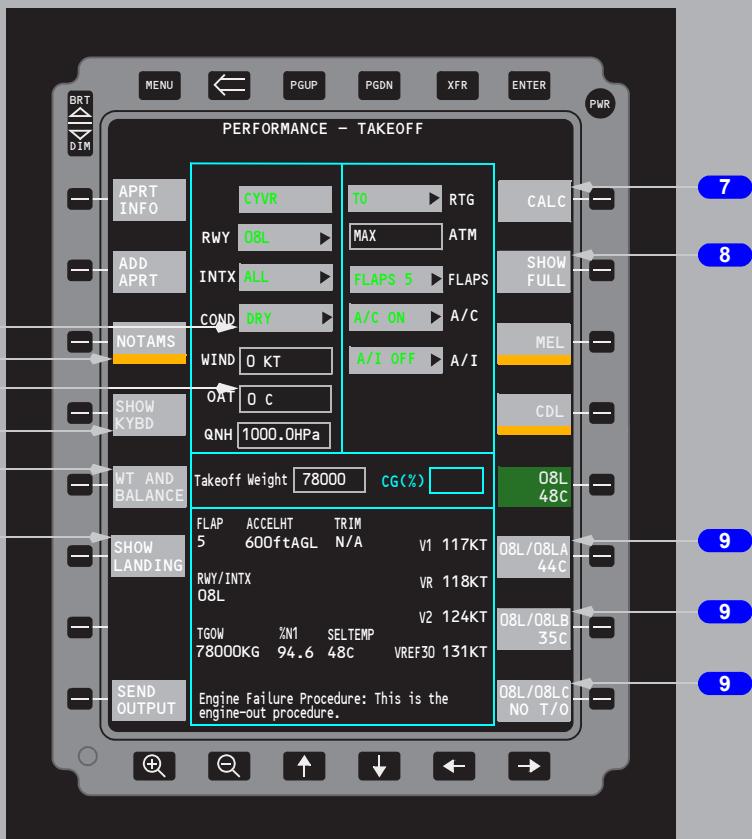
Information displayed in the VIEW CONTENTS screen is printed on the flight deck printer (if applicable).

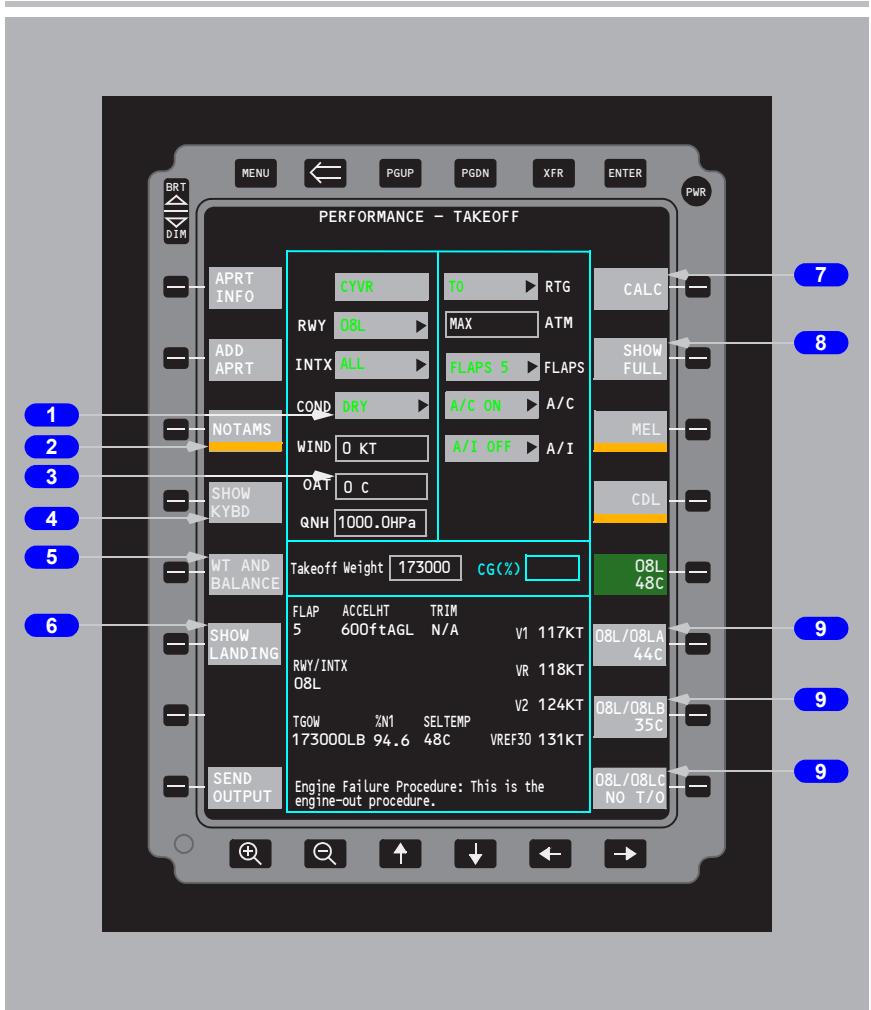
**9 DAY/NIGHT MODE**

Selects either day and night mode.

- DAY - dark text on a light background
- NIGHT - light text on a dark background

## Performance (Typical)





## 1 DRY (green)

- DRY has been selected for the runway condition
- Triangle in right side of menu indicates a list of options exists
- Selection display the options

## 2 NOTAMS

- May be used to enter temporary data
- Amber bar displays across menu when data has been entered

---

**3 Data field**

Boxes display for fields that require data entry.

**4 SHOW KYBD (Keyboard)**

Displays a touch sensitive keyboard at the bottom of the page that is used for data entry.

**5 WT (Weight) AND BALANCE**

Displays the weight and balance page.

**6 SHOW LANDING**

Displays the landing page.

**7 CALC (Calculate)**

- Cyan - data has not been entered in all required fields
- White - all required fields have data

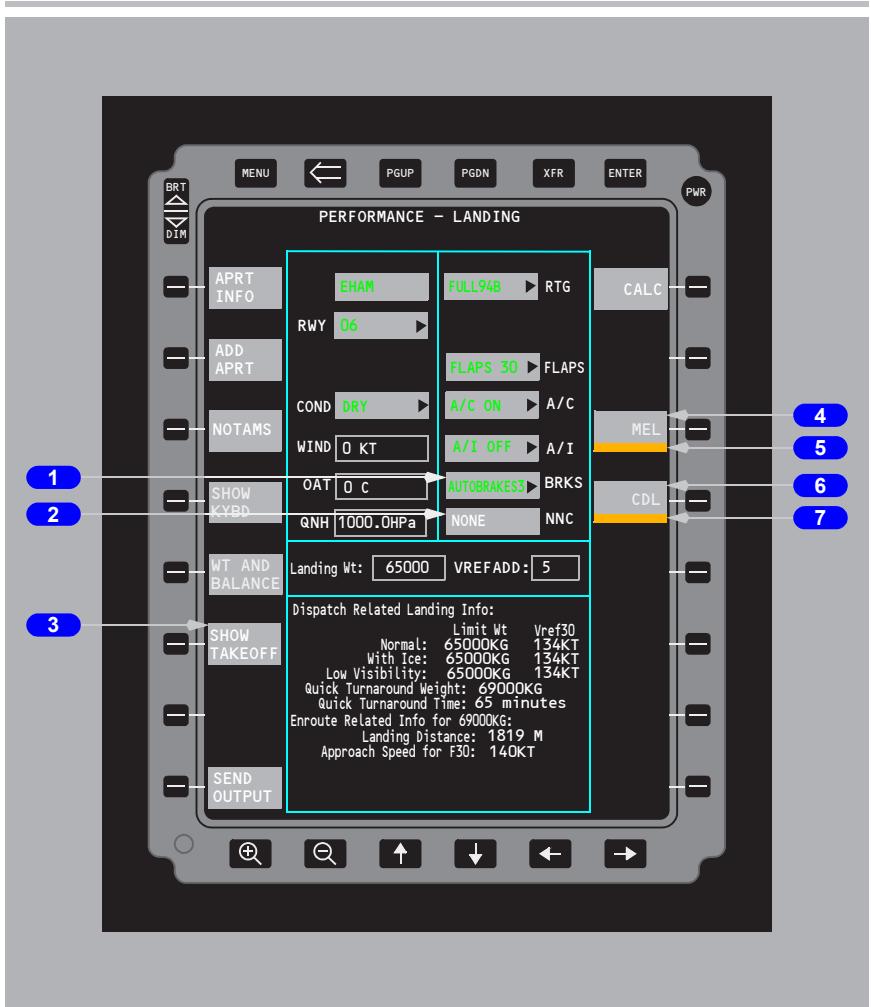
Selection initiates the calculation of takeoff data.

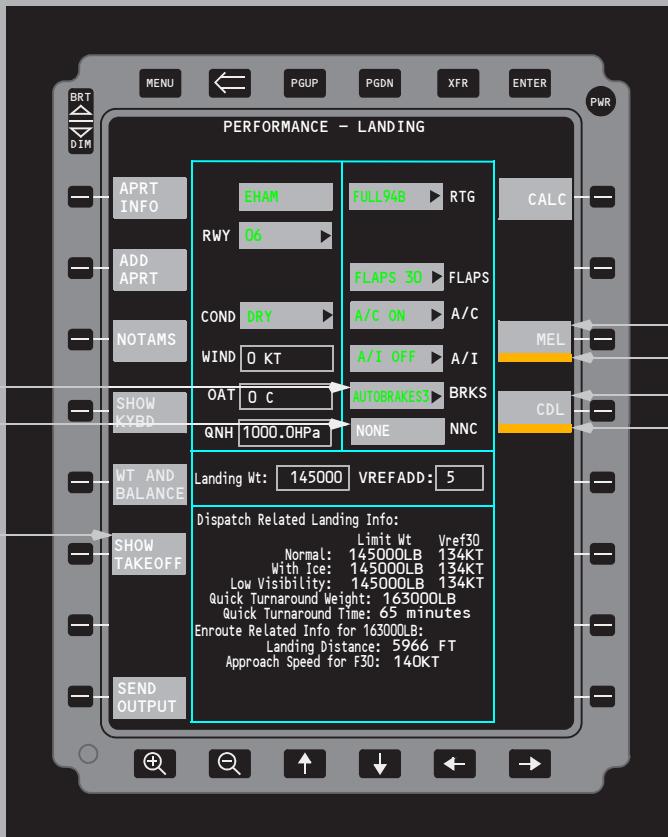
**8 SHOW FULL**

Selection displays full thrust data for the airport/runway entered.

**9 Intersection Takeoff Options**

- Intersection takeoff options display on the right side when ALL is selected for INTX (intersection)
- Selection displays takeoff data for the selected intersection





### 1 BRKS (Brakes)

Selection of a brake setting is required for in-flight landing calculations, not dispatch calculations.

### 2 NNC

Selection is required for in-flight calculations, not dispatch calculations.

### 3 SHOW TAKEOFF

Displays the takeoff page.

**4 MEL**

Displays MEL page.

**5 Amber bar**

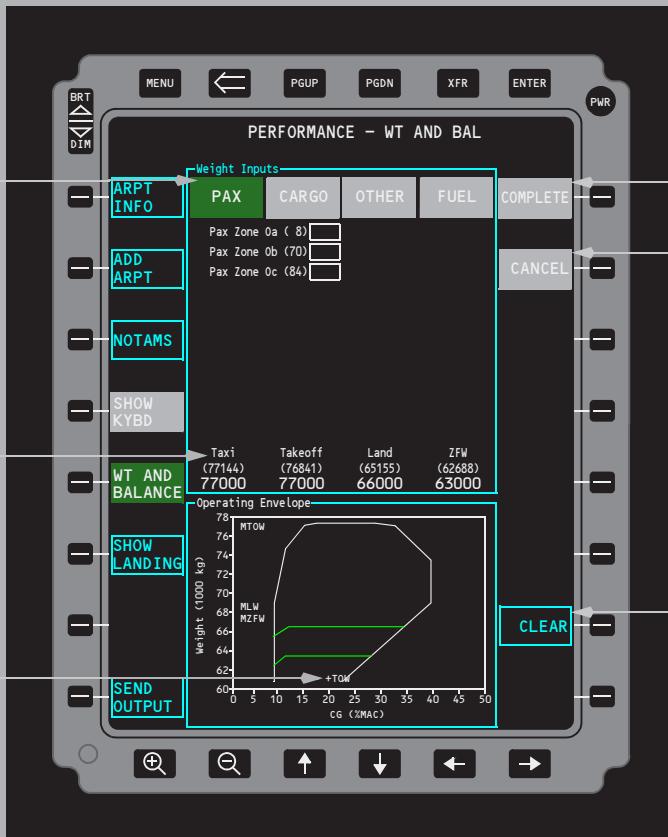
Indicates an active MEL item exists that will be considered in the calculations.

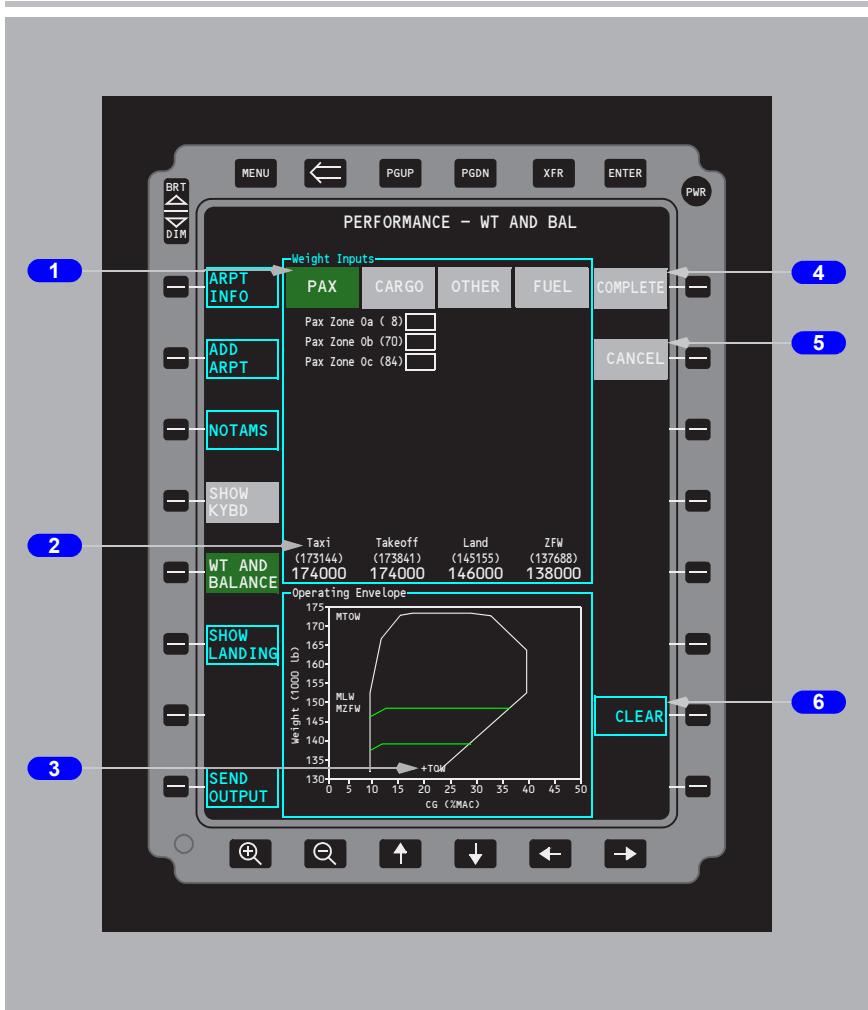
**6 CDL**

Displays the CDL page.

**7 Amber bar**

Indicates an active CDL item exists that will be considered in the calculations.





### **1 PAX/CARGO/OTHER/FUEL**

Displays applicable input screen.

### **2 Aircraft weights**

- Initially displays airplane operating empty weight
- Updates as data fields are filled

### **3 +TOW**

Symbol displays airplane CG relative to the CG limits.

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**4 COMPLETE**

Selection loads the takeoff page with the calculated takeoff gross weight and CG.

**5 CANCEL**

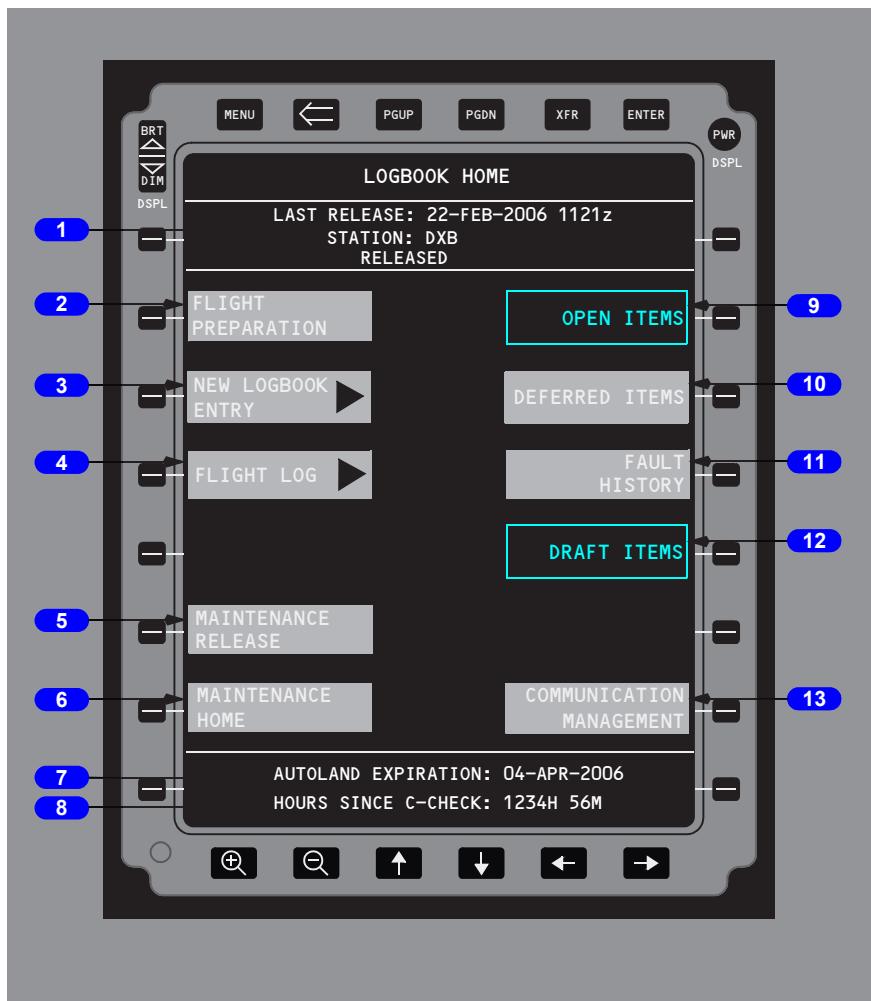
Clears all entries and returns to the takeoff page.

**6 CLEAR**

Clears all entries.

## Electronic Log Book (ELB Typical)

### LOGBOOK page



#### 1 Release Information

- Date and time of last release for flight
- Station where the last release occurred
- Current state of the airplane.

## 2 FLIGHT PREPARATION

Starts a guided process that prepares a flight log to document the upcoming flight. This function is intended to be used prior to flight.

## 3 NEW LOGBOOK ENTRY

Documents observed faults into the logbook. Uses a graphical fault finder tool that navigates through a series of images to identify selection of a fault. The purpose is to find the appropriate fault description and have it associated with the respective Fault Reporting Manual (FRM) fault code.

## 4 FLIGHT LOG

Displays the flight log for the current flight.

## 5 MAINTENANCE RELEASE

The maintenance release form has 2 pages plus a summary page. The first page includes information such as comments and release date. The second page allows the maintenance crew to document any restrictions associated with this release. Before a release can be signed, the user is required to review the summary page 3 contents of the maintenance release

## 6 MAINTENANCE HOME

The purpose of the maintenance home page is to provide maintenance crews a summary of the maintenance status of the airplane (release status, open & deferred item counts) and quick access to the maintenance functions. This page is accessible only when the airplane is in ground mode

## 7 AUTOLAND EXPIRATION

Displays the date and time the autoland currency expires.

## 8 HOURS SINCE C-CHECK

Displays the hours and minutes since the last C-check was accomplished.

## 9 OPEN ITEMS

Displays all open faults that have been documented for this airplane. It also includes any expired deferrals.

## 10 DEFERRED ITEMS

Displays all deferred faults reported for the airplane. On this page the user can view a brief description, the expiration of the deferral and an indication if any Maintenance (M) or Operational (O) procedures related to this deferral exist.

**11 FAULT HISTORY**

Lists all fault reports for the aircraft. It provides a description of the fault report plus the time it was reported and the current status. This list is organized by the DATE/TIME field.

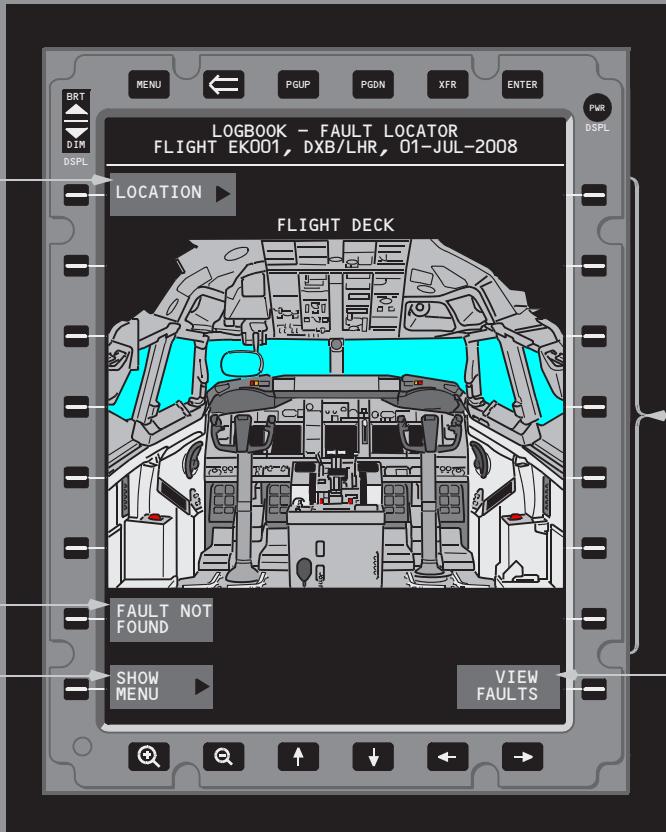
**12 DRAFT ITEMS**

Provides the user with a view of all fault reports that have been created but not signed for official entry into the logbook. If a record has not been signed the user will have a choice of either signing the report to make it an official record, modify, or delete.

**13 COMMUNICATION MANAGEMENT**

Select to receive and send messages to the ground databases. All messages are sent over a secure link to ensure the integrity of the information.

## Electronic Log Book (Fault Locator)



### 1 LOCATION

Displays a list of airplane areas (Flight Deck, Engine, Exterior, etc.) for use in locating an area where a fault has occurred.

### 2 FAULT NOT FOUND

Displays a blank fault report form for the user to complete. This is required when a fault can not be found in the selected area.

**3 SHOW/HIDE MENU**

Toggle button to either show or hide the extended menu selections.

**4 Panel Selection Area**

Selection of line select keys within the brackets navigates through a series of images to help identify a fault. The purpose is to narrow the search area to find the appropriate fault code.

**5 VIEW FAULTS**

Displays a list of all faults associated with the region displayed. The more the region is narrowed by selecting specific areas within a graphic, the fewer faults are returned.

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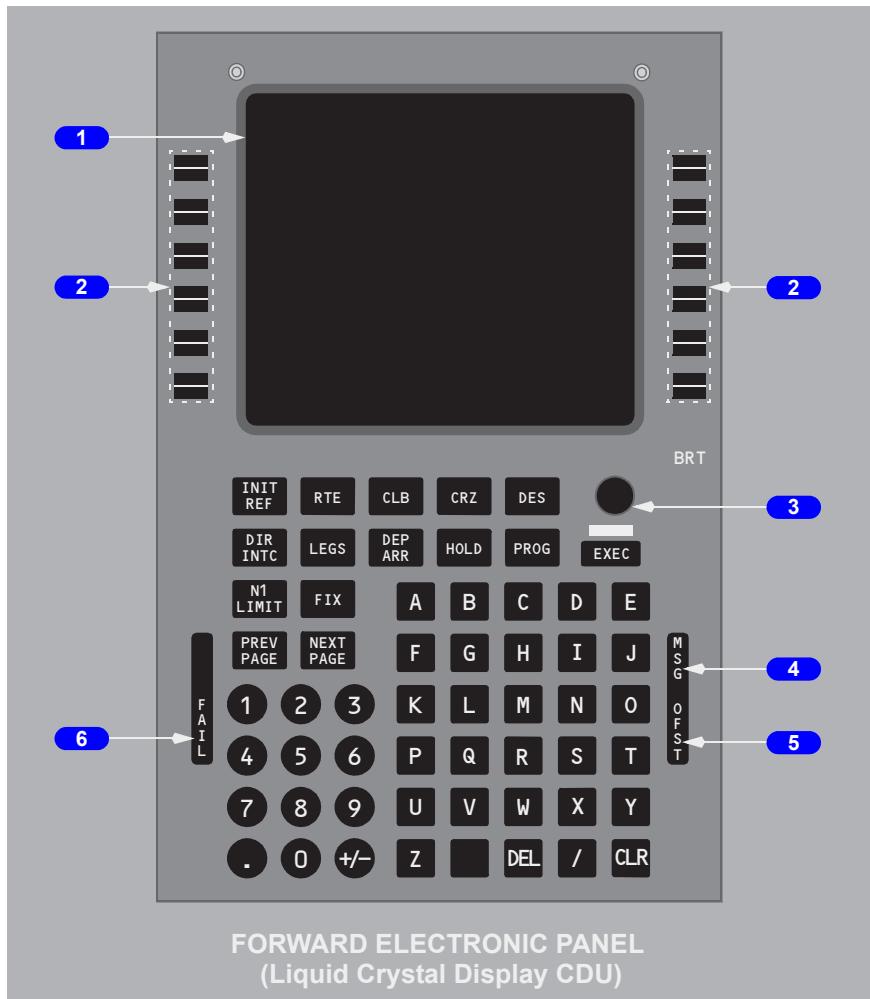
# Flight Management, Navigation Controls and Indicators

## Chapter 11 Section 10

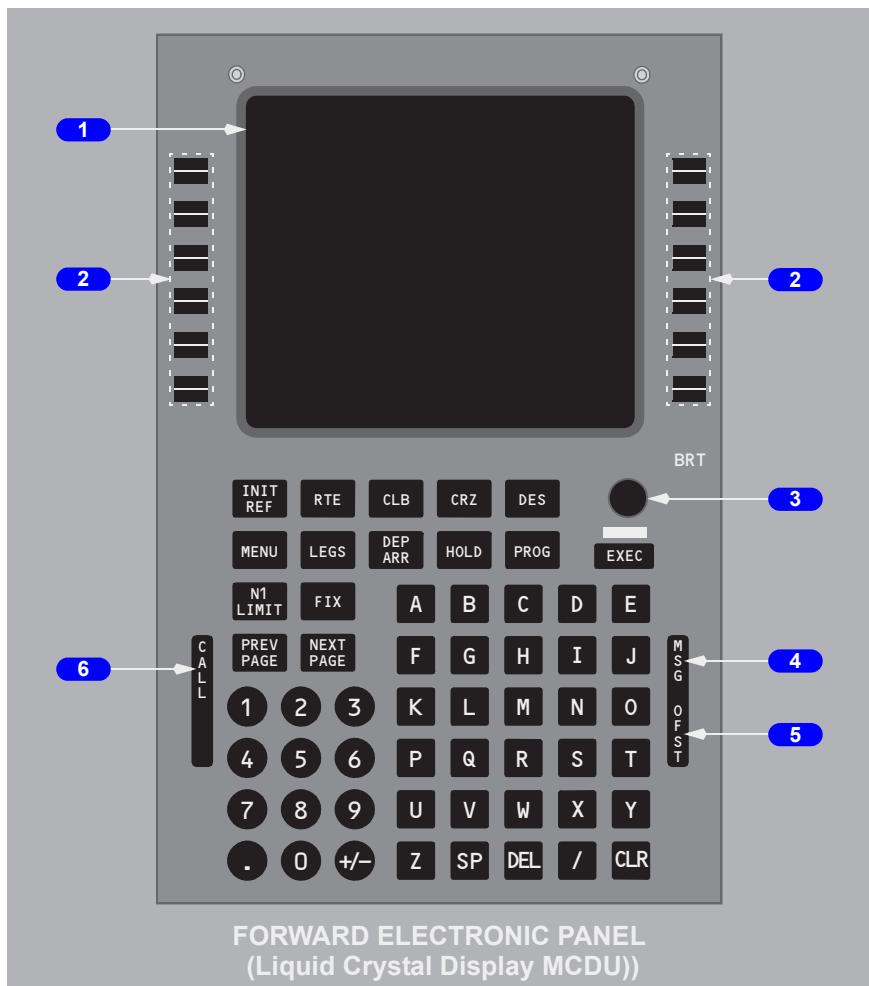
### Flight Management System

#### Control Display Unit (CDU)

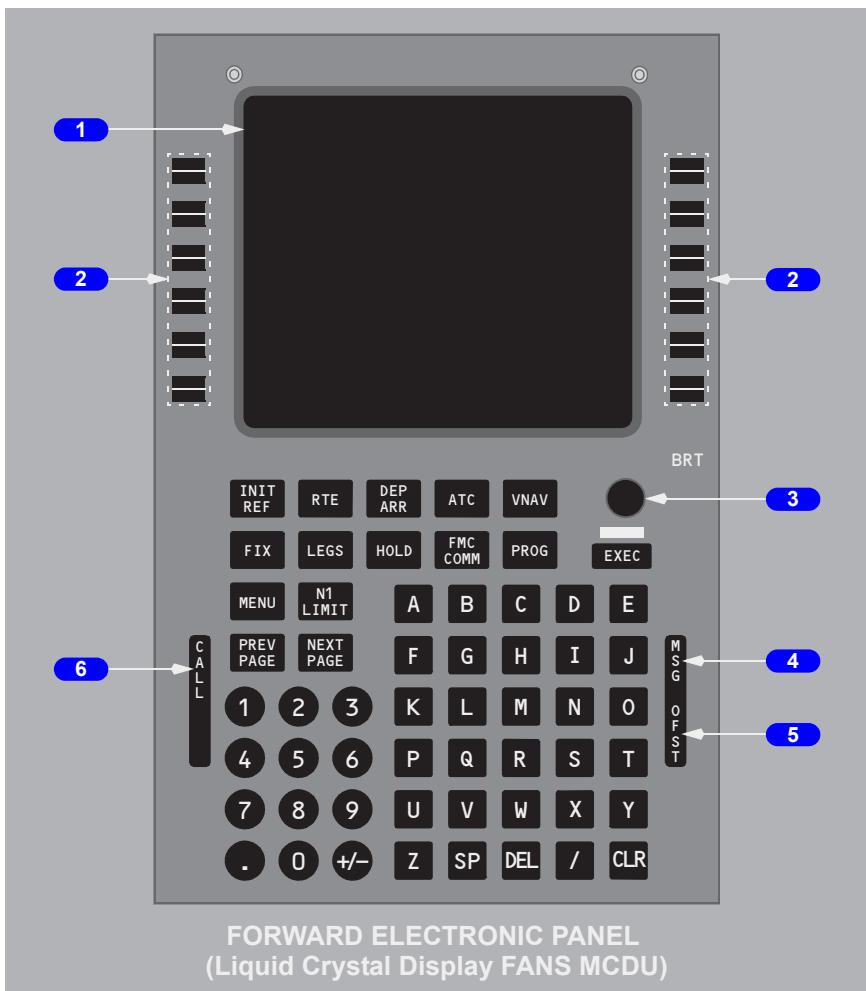
[Option – Liquid crystal display CDU]



[Option – Liquid crystal display MCDU]



## [Option – Liquid crystal display FANS MCDU]


**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 Brightness Control

Rotate – controls display brightness.

### 4 Message (MSG) Light

Illuminated (white) – scratchpad message is shown.

### 5 Offset (OFST) Light

Illuminated (white) – LNAV gives guidance for lateral route offset.

### 6 CALL Light

#### [Option – MCDU]

Illuminated (white) – a subsystem other than the FMC is requesting control of the CDU.

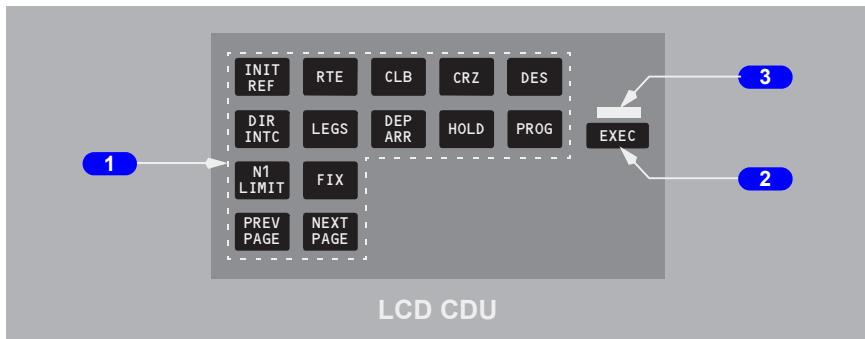
### 6 FAIL Light

#### [Option – CDU with single FMC]

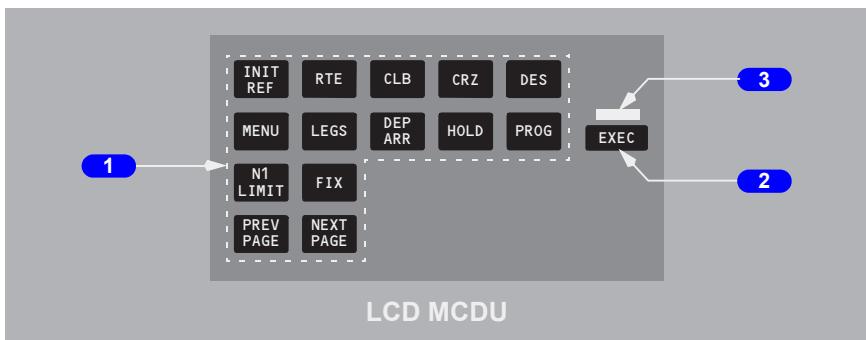
Illuminated (amber) – the FMC has failed.

## Function and Execute Keys

#### [Option – Liquid crystal display CDU]



## [Option – Liquid crystal display MCDU]


**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

**[Option – CDU]**

- DIR INTC – shows page to modify route to fly directly from present position to any waypoint or to intercept any course to any waypoint

**[Option – MCDU]**

- MENU – shows page to choose subsystems controlled by CDU
- 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**

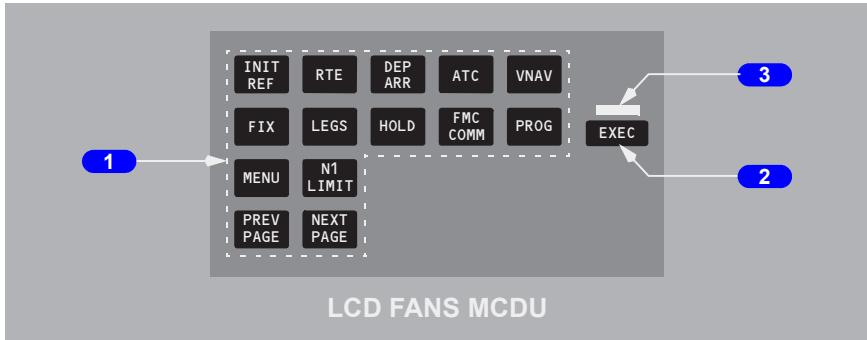
Push –

- makes data modification(s) active
- extinguishes execute light.

**3 Execute Light**

Illuminated (white) – active data is modified but not executed.

[Option – Liquid crystal display FANS MCDU]

**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
- DEP ARR – shows page to input or change departure and arrival procedures
- ATC – inoperative (scratchpad message KEY/FUNCTION INOP displayed)
- VNAV –
  - shows currently active performance page (CLB, CRZ, DES)
  - CLB page is displayed if no active phase exists
- FIX – shows page to create reference points on map display
- LEGS –
  - shows page to evaluate or modify lateral and vertical route data
  - shows page to control PLAN mode display
- HOLD – shows page to create holding patterns and show holding pattern data

[Option – With AOC data link]

- FMC COMM – displays FMC COMM status page.

- PROG – shows page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- MENU – shows page to choose subsystems controlled by CDU
- N1 LIMIT – shows page to view or change N1 thrust limits
- 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 –

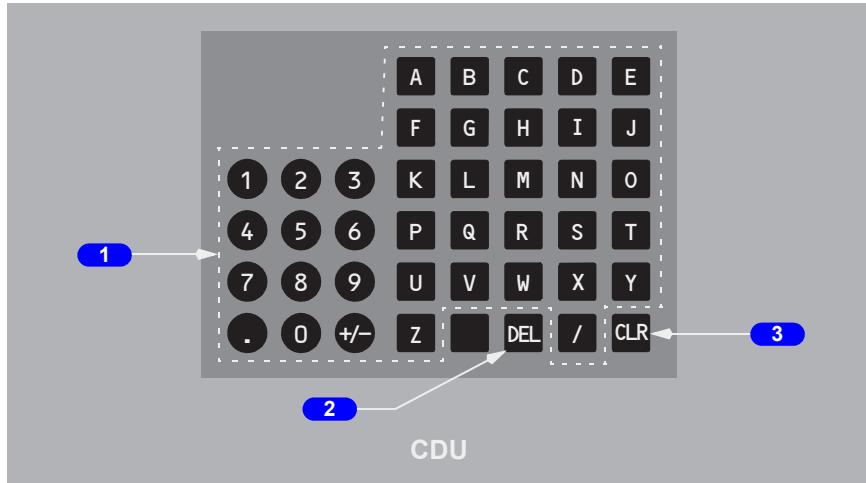
- makes data modification(s) active
- extinguishes execute light.

## **3 Execute Light**

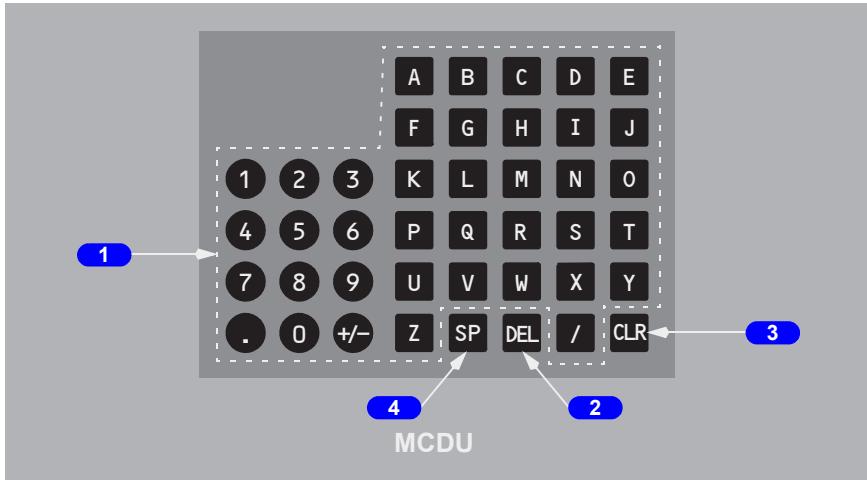
Illuminated (white) – active data is modified but not executed.

## **Alpha/Numeric and Miscellaneous Keys**

[Option – CDU]



[Option – MCDU]



**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.

**4 Space (SP) Key**

[Option – MCDU]

Push – puts space in scratchpad.

## CDU Page Components

[Option – FMC U10.3 and later with flight number entry]



### 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

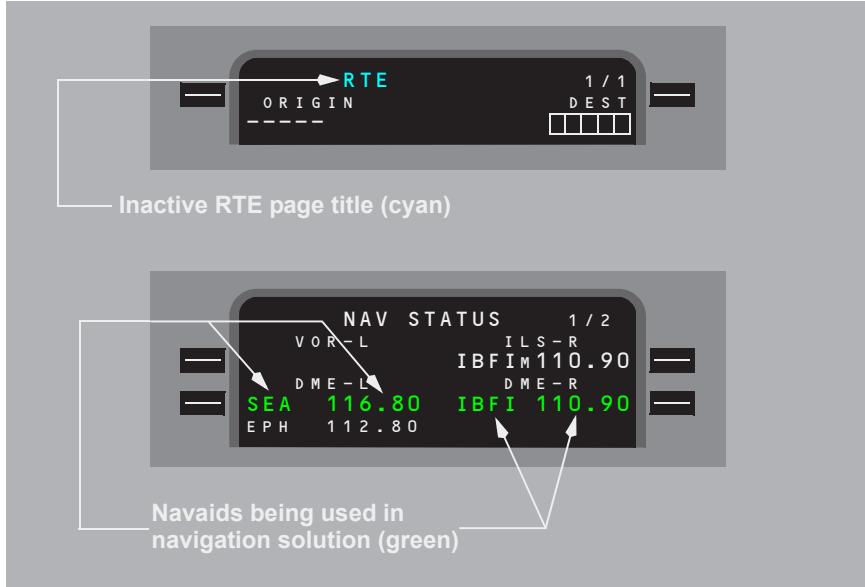
Data input is optional. The data is not mandatory.

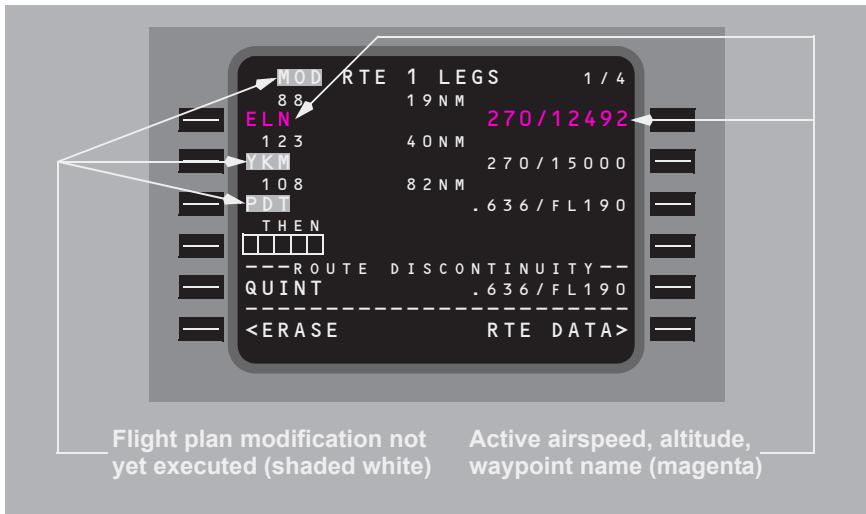
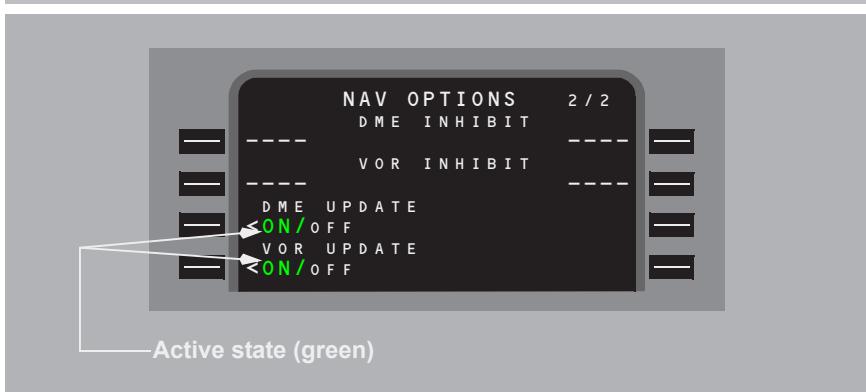
## 8 Prompts

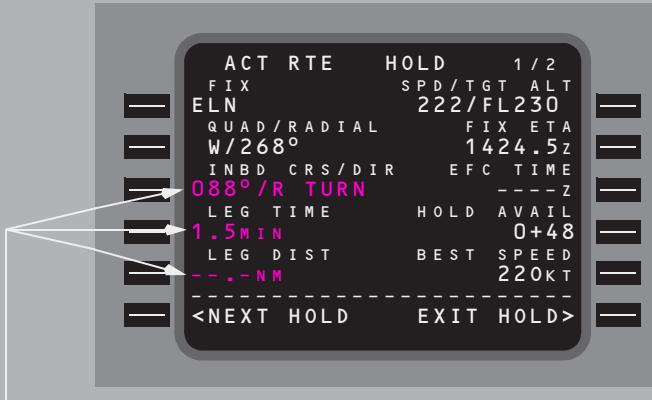
Show pages, select modes, and control displays. Caret “<” or “>” is before or after prompt.

### CDU Page Color

#### [Option]







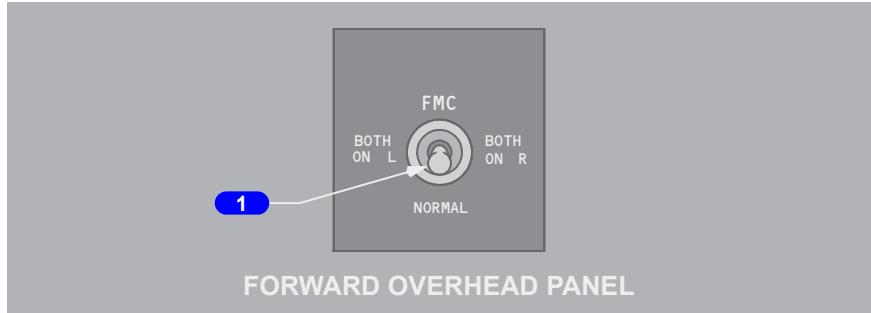
Holding pattern inbound course, direction of turn,  
leg distance or leg time (magenta)

Color is used as follows:

- black – background color of page
- cyan –
  - inactive RTE, RTE LEGS and RTE HOLD page titles
- green –
  - actively tuned VOR, ILS, or DME data (frequency, station ID, course)
  - active state of two-position and three-position selectors.
- magenta – data used by FMC for lateral and vertical flight commands
  - active waypoint
  - active airspeed
  - active altitude
  - holding pattern inbound course, direction of turn, and leg time or leg distance
- shaded white –
  - modifications
  - MOD precedes page titles of modified pages
- white – most data

## FMC Source Select Switch

[Option – Dual FMC]



### 1 FMC Source Select Switch

BOTH ON L –

- selects left FMC for all FMC operations
- right map will annunciate “FMC L.”

NORMAL –

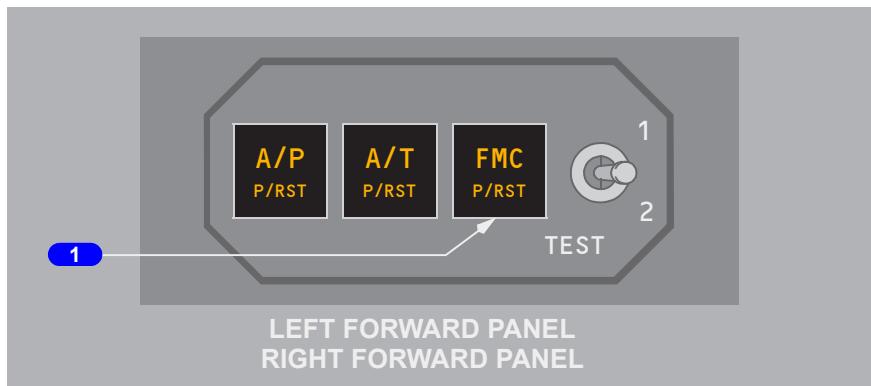
- left FMC controls CDUs and provides input to the autothrottle system
- right FMC operates in synchronization with left FMC
- maps display composite information from both FMCs

BOTH ON R –

- selects right FMC for all FMC operations
- left map will annunciate “FMC R.”

**Note:** Moving the source select switch will cause LNAV and VNAV to disengage.

## FMC Alert Light



## 1 FMC Alert Light

Illuminated (amber) –

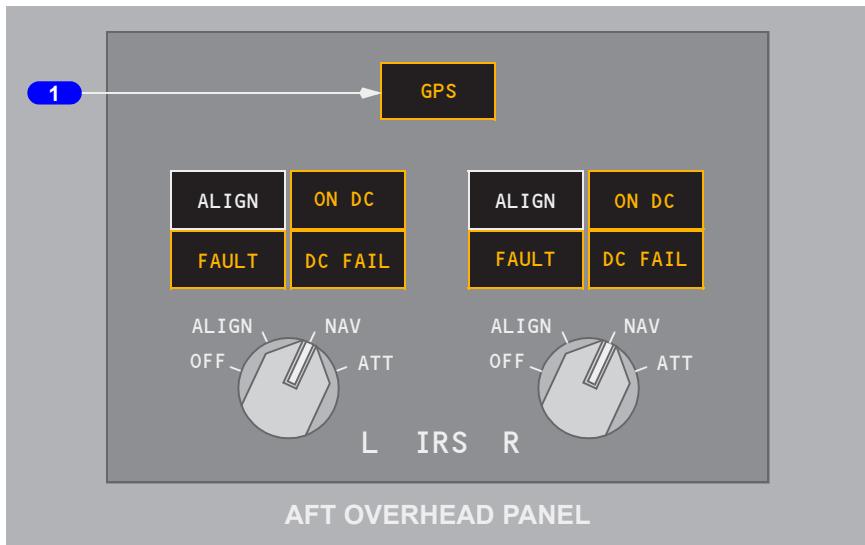
[Option – CDU]

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

Push – both pilots' FMC alert lights extinguish.

## Global Positioning System (GPS) Light

[Option – With GPS]




**AFT OVERHEAD PANEL**

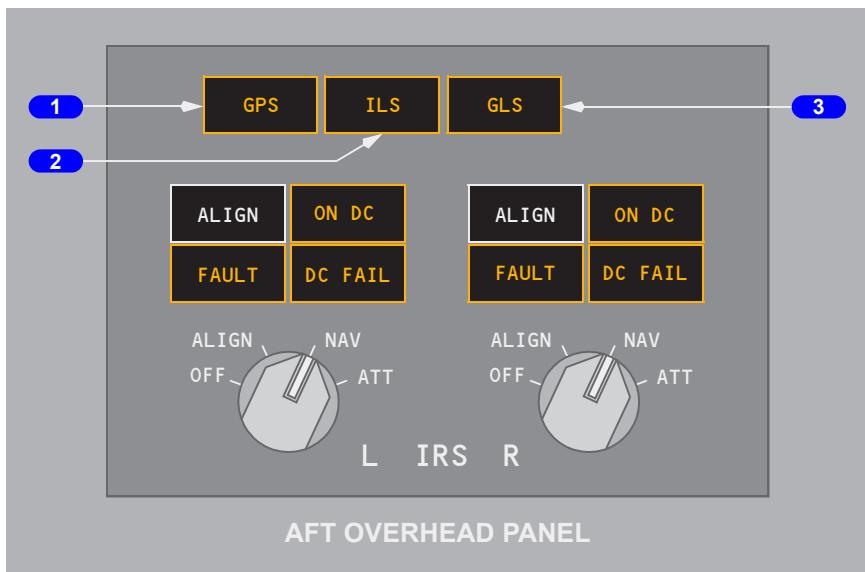
### **1 Global Positioning System (GPS) Light**

Illuminated (amber) –

- indicates failure of both GPS sensor units
- indicates failure of a single GPS sensor unit when either system annunciator panel is pushed to initiate a recall

## GPS Landing System (GLS) Lights

### [Option – With GLS]



#### 1 Global Positioning System (GPS) Light

Illuminated (amber) –

- indicates failure of both GPS sensor units
- indicates failure of a single GPS sensor unit when either system annunciator panel is pushed to initiate a recall

#### 2 Instrument Landing System (ILS) Light

Illuminated (amber) –

- indicates failure of both ILS sensor units
- indicates failure of a single ILS sensor unit when either system annunciator panel is pushed to initiate a recall
- with single ILS sensor failure, light extinguishes when the system recall is reset.

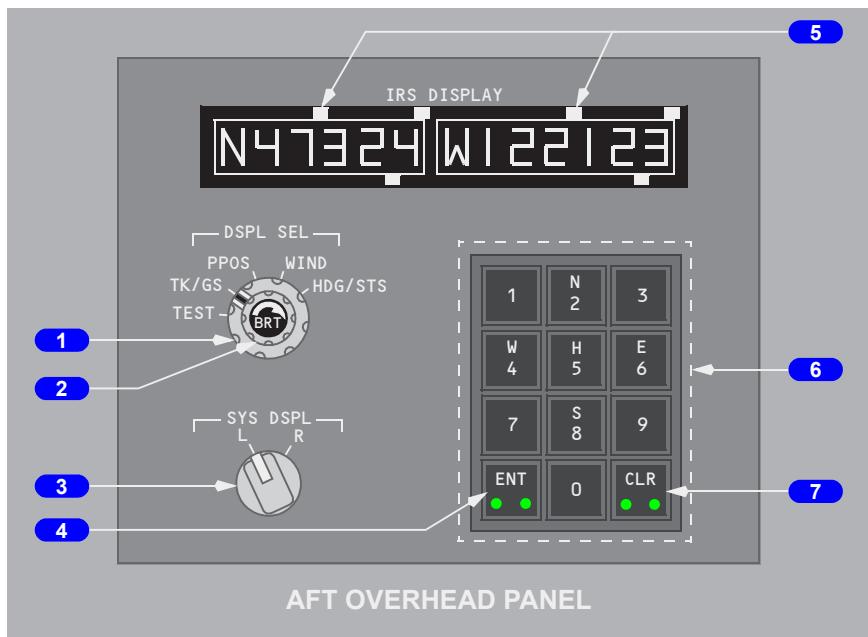
### **3 GPS Landing System (GLS) Light**

Illuminated (amber) –

- indicates failure of both GLS sensor units
- indicates failure of a single GLS sensor unit when either system annunciator panel is pushed to initiate a recall
- with single GLS sensor failure, light extinguishes when the system recall is reset.

## Inertial System

### IRS Display Unit (ISDU)



### **1 Display Selector (DSPL SEL)**

TEST (spring-loaded to TK/GS) –

- all lights in data displays and on the mode selector unit momentarily illuminate, followed by a 10 second self-test
- use only during alignment.

TK/GS –

- left window displays true track (course)
- right window displays present ground speed (knots).

**PPOS –**

- left window displays present latitude
- right window displays present longitude.

**WIND –**

- left window displays present inflight true wind direction
- right window displays present inflight wind speed (knots).

**HDG/STS –**

- left window displays present true heading
- right window displays any applicable maintenance status codes
- during alignment, right window displays minutes remaining until alignment is complete. For alignments greater than 15 minutes, the window displays 15 until the time remaining reaches 14 minutes. The display then counts down in one minute intervals.

**2 Brightness (BRT) Control**

Rotate – adjusts brightness of the data displays.

**3 System Display (SYS DSPL) Selector**

L – selects left IRS for the data displays.

R – selects right IRS for the data displays.

**4 Enter (ENT) Key**

Illuminated (white) – N, S, E, W, or H entries are being keyed.

Push – keyed data is entered into IRS following completion of valid self-test for reasonableness.

**5 Data Displays**

Two windows display data for the IRS selected with the system display selector

- type of data displayed is normally determined by the display selector
- keyboard entry of present position or magnetic heading overrides the selected display
- last digit of each window is for a decimal place (tenths).

**6 Keyboard**

Push –

- alpha keys:
  - data displays are controlled by the keyboard when the N, S, E, W (latitude/longitude) or H (heading) keys are pushed

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

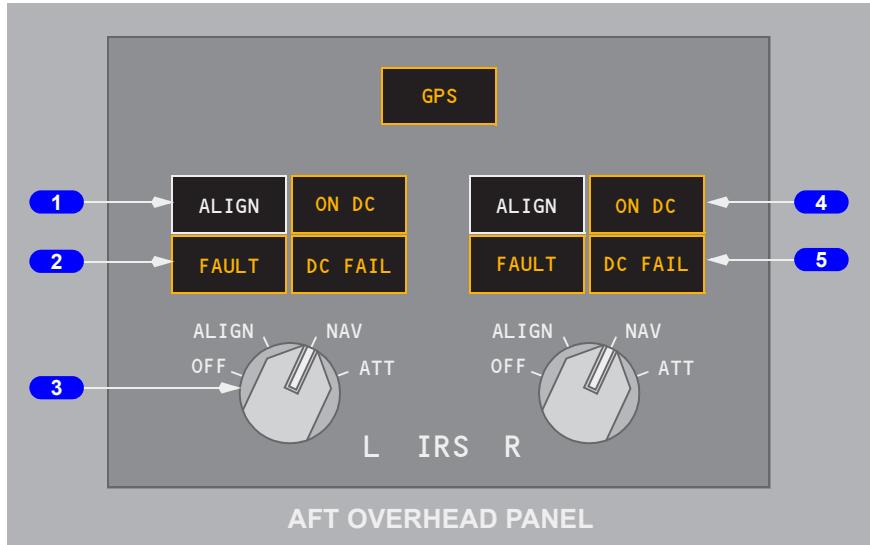
## **7 Clear (CLR) Key**

Illuminated (white) – an ENT attempt has failed (entry not accepted by IRS).

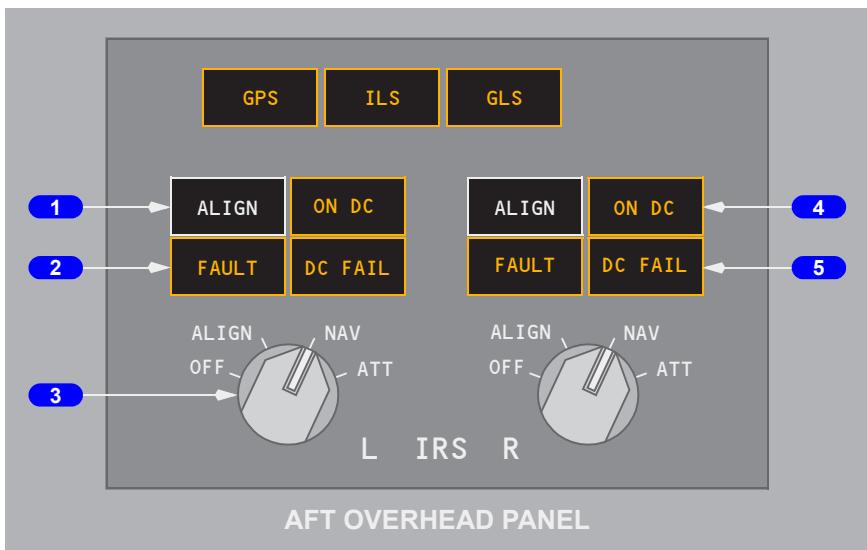
Push – clears data display of any data not yet entered or accepted. If illuminated, cue lights extinguish.

## **IRS Mode Selector Unit**

[Option – With GPS]



[Option – With GLS]



## 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 or an unreasonable present position entry
  - no present position entry.

Extinguished –

- IRS not in ALIGN mode
- with mode selector in NAV, alignment is complete, and all IRS information is available
- with mode selector in ATT, attitude information is available. Heading information is available following entry of initial magnetic heading.

## 2 FAULT Light

Illuminated (amber) – a system fault affecting the related IRS ATT and/or NAV modes has been detected.

**3 Inertial Reference System (IRS) Mode Selector**

OFF –

- alignment is lost
- all electrical power is removed from the system after a 30 second shutdown cycle.

ALIGN –

- rotating the selector from OFF to ALIGN initiates the alignment cycle
- rotating the selector from NAV to ALIGN automatically updates alignment and zeroes ground speed error.

NAV (detented position) –

- system enters the NAV mode after completion of the alignment cycle and entry of present position
- in NAV mode, all IRS information is available to airplane systems for normal operations.

ATT – provides only attitude and heading information:

- attitude information is invalid (attitude flag in view) until ALIGN light is extinguished
- heading information is invalid (heading flags in view) until the actual magnetic heading is manually entered after 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) –

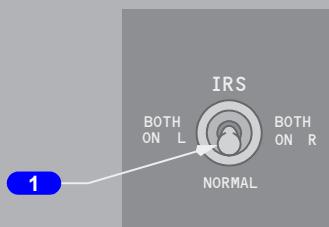
- the related IRS is operating on DC power from the switched hot battery bus (AC power not normal)
- if on the ground, the ground-call horn in the nose wheel well sounds, providing an alert that a battery drain condition exists
- momentary illumination is normal during alignment self-test.

**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.

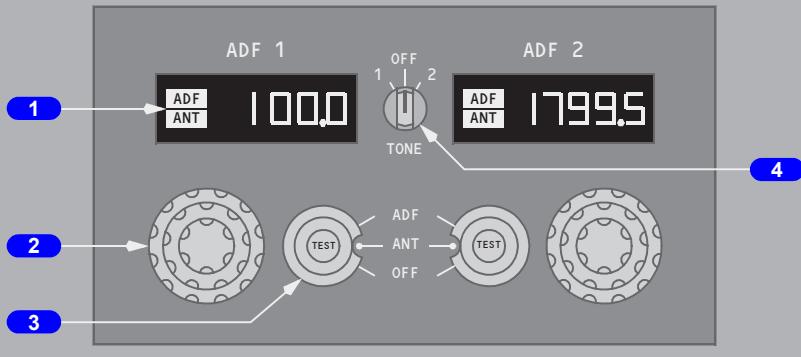
NORMAL – flight instruments attitude and heading source is from default IRS.

BOTH ON R – switches the flight instruments attitude and heading source to right IRS.

## Radio Navigation Systems

### Automatic Direction Finding (ADF) Control

[Option – Gables G7403-03]



### 1 Frequency Indicator

Shows the frequency selected with the related frequency selector.

Shows if the system is in the ADF or antenna (ANT) mode.

**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 Switch**

ADF –

- audio reception possible
- ADF bearing sent to the DUs and the standby radio magnetic indicator.

ANT –

- audio reception optimized
- no ADF bearing data available.

OFF – removes power from selected receiver.

TEST – tests related ADF bearing pointers and warning flags on the DUs and the standby radio magnetic indicator.

- DU ADF indications:
  - show ADF fail flag and ADF bearing pointer goes out of view
  - ADF fail flag goes out of view and ADF bearing pointer remains out of view
  - ADF bearing pointer slews to 135 degrees relative bearing.
- Standby radio magnetic indicator:
  - shows ADF fail flag
  - ADF fail flag goes out of view and ADF bearing pointer stays at its last position before test
  - ADF bearing pointer slews to 135 degrees relative bearing.

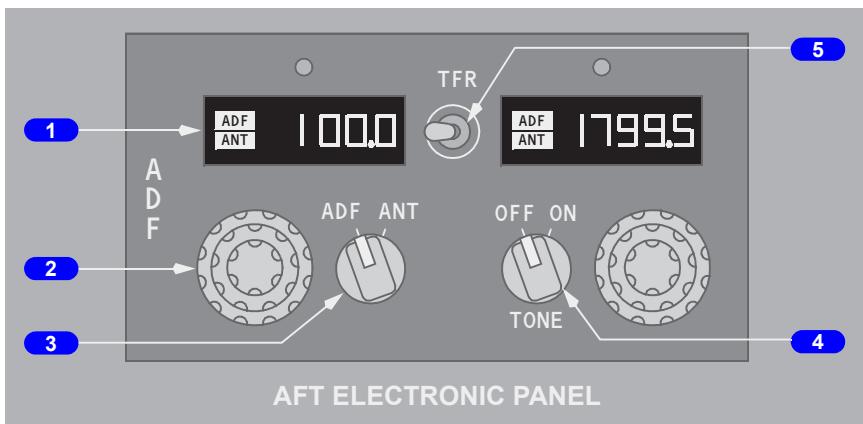
**4 TONE Switch**

1 – adds tone to ADF receiver No. 1 audio.

2 – adds tone to ADF receiver No. 2 audio.

OFF – disables tones.

[Option – Gables G7402-02, -05]



### 1 Frequency Indicator

Shows the frequency selected with the related frequency selector.

Shows if the system is in the ADF or antenna (ANT) mode.

### 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

ADF –

- audio reception possible
- ADF bearing sent to the DUs and the standby radio magnetic indicator.

ANT –

- audio reception optimized
- no ADF bearing data available.

### 4 TONE Switch

OFF – disables tones.

ON – adds tone to selected ADF receiver audio.

### 5 Transfer (TFR) Switch

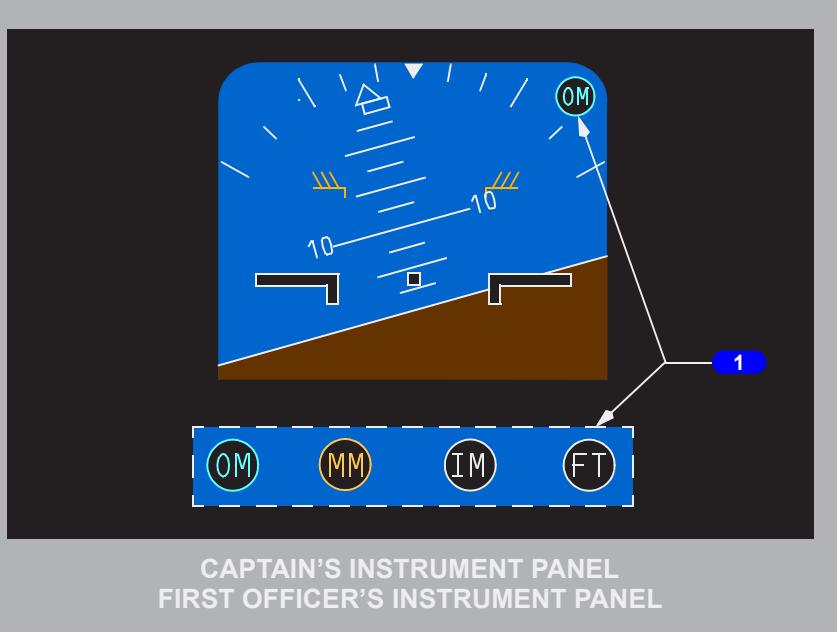
Selects ADF for display.

## Marker Beacon Annunciations

[Option – EFIS/MAP]



[Option – PFD/ND]



### **1 Marker Beacon Lights**

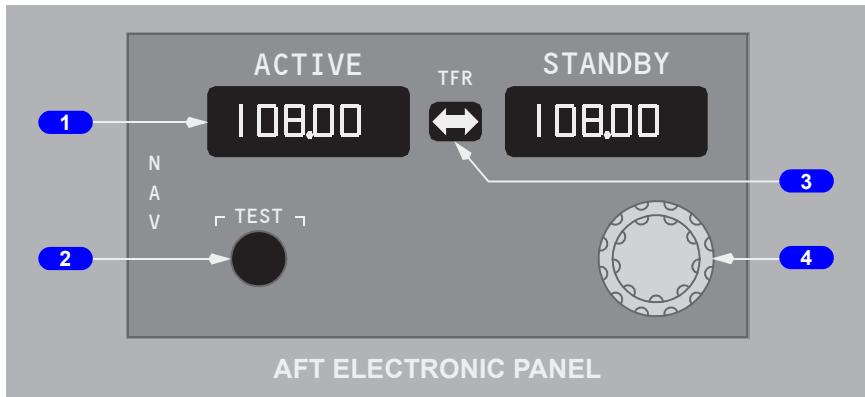
OM (cyan) – illuminates over an outer marker beacon.

MM (amber) – illuminates over a middle marker beacon.

IM (white) – illuminates over an inner marker beacon.

FT (white) – illuminates during self test.

## VHF Navigation Control



### 1 Frequency Indicator

Indicates the frequency selected by the frequency selector

- tuned frequency displayed in STANDBY display
- TFR switch moves STANDBY frequency to ACTIVE frequency.

### 2 TEST Switch

With a VOR frequency tuned and a course of 000 selected:

- shows VOR fail flag
- deviation bar biases out of view and then returns to centered position
- bearing pointer slews to 180 degrees
- DME displays:
  - DME fail flag
  - dashes
  - normal DME distance.

With ILS frequency tuned and a course within 90 degrees of airplane heading:

- pointers disappear and LOC and G/S flags appear momentarily
- pointers appear and display one dot up and one dot left
- pointers then display one dot low and one dot right
- pointers then return to normal display

- DME displays:
  - DME fail flag
  - dashes
  - normal DME distance.

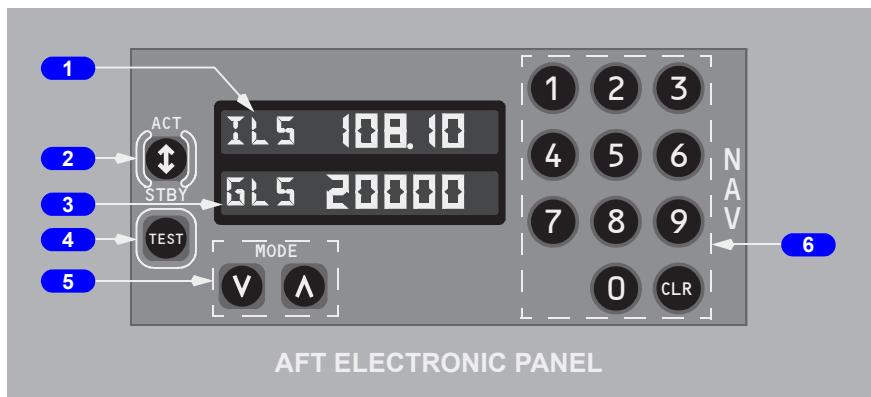
### 3 Transfer (TFR) Switch

TFR – STANDBY frequency moved to ACTIVE frequency; ACTIVE frequency moved to STANDBY frequency.

### 4 Frequency Selector

Rotate – manually selects the standby frequency.

## Multi-Mode Navigation Control



### 1 Active (ACT) Mode and Frequency Indicator

Indicates the active mode and frequency.

### 2 Transfer Switch

Push – standby mode and frequency moved to active indicator window; active mode and frequency moved to standby indicator window.

### 3 Standby (STBY) Mode and Frequency Indicator

Indicates the standby mode and frequency.

### 4 TEST Switch

With a VOR frequency tuned and a course of 000 selected:

- shows VOR fail flag
- deviation bar biases out of view and then returns to centered position

- bearing pointer slews to 180 degrees
- DME displays:
  - DME fail flag
  - dashes
  - normal DME distance.

With a ILS frequency tuned and a course within 90 degrees of airplane heading:

- pointers disappear and LOC and G/S flags appear momentarily
- pointers appear and display one dot up and one dot left
- pointers then display one dot low and one dot right
- pointers then return to normal display
- DME displays:
  - DME fail flag
  - dashes
  - normal DME distance.

With a GLS frequency tuned and a course within 90 degrees of airplane heading:

- pointers disappear and LOC and G/S flags appear momentarily
- pointers appear and display one dot up and one dot left
- pointers then display one dot low and one dot right
- pointers then return to normal display.

**Note:** DME is not tested with GLS and no indications will be displayed.

## 5 Mode Switches

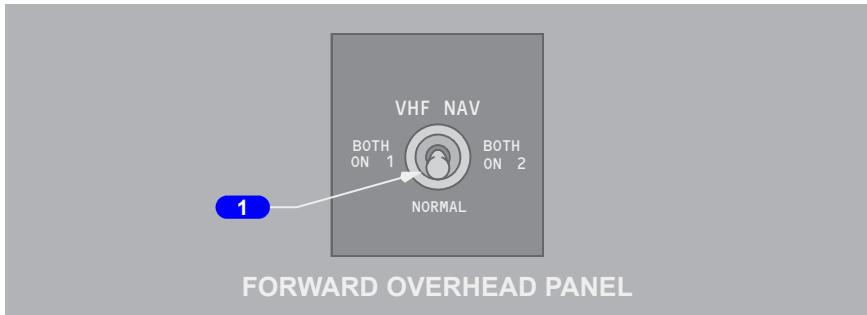
Push – manually inserts ILS, VOR or GLS into the standby indicator window.

## 6 Frequency Selection Keypad

Push – manually selects the standby frequency.

CLR – clears the standby frequency.

## VHF NAV Transfer Switch



## 1 VHF NAV Transfer Switch

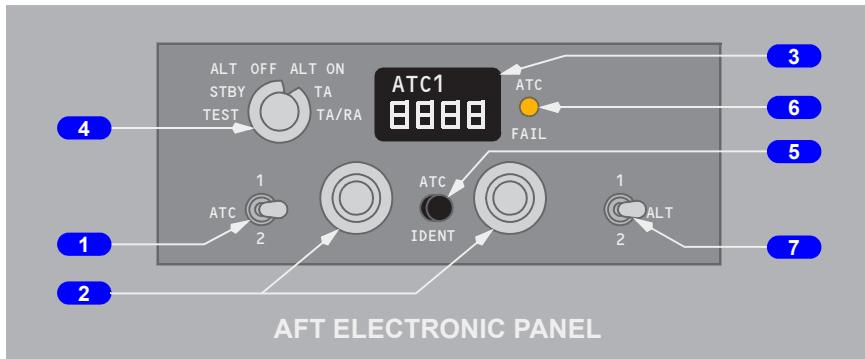
BOTH ON 1 – switches the VHF navigation source to VHF NAV receiver No. 1.

NORMAL – VHF navigation source is from default VHF NAV receiver.

BOTH ON 2 – switches the VHF navigation source to VHF NAV receiver No. 2.

## Transponder Panel

[Option – AlliedSignal 071-01503-2601]



### 1 Transponder (ATC) Selector

1 – selects transponder No. 1.

2 – selects transponder No. 2.

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

Rotate – sets transponder code in transponder.

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

Shows transponder code.

Shows operating transponder (1 or 2).

### 4 Transponder Mode Selector

TEST – starts ATC transponder functional test.

STBY (standby) – does not transmit.

ALT (altitude reporting) OFF – transponder operates without altitude reporting.

ALT (altitude reporting) ON – transponder operates with altitude reporting.

TA(traffic advisory) and TA/RA (resolution advisory) – Refer to Chapter 15, Warning Systems.

**5 Identification (IDENT) Switch**

Push – transmits an identification signal.

**6 Transponder (ATC) FAIL Light**

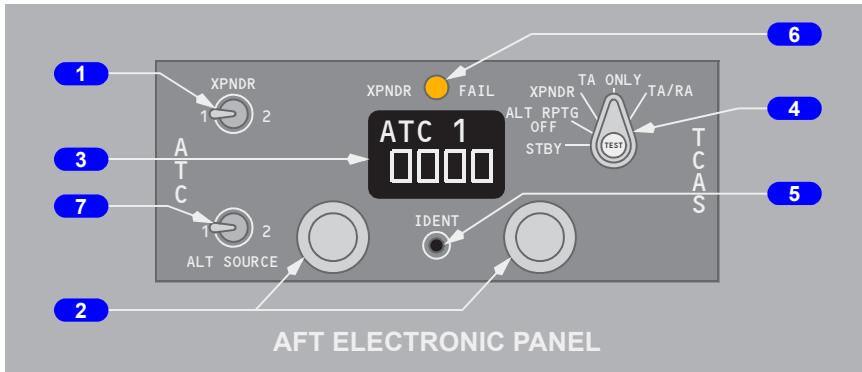
Illuminated (amber) – indicates transponder malfunction.

**7 Altitude (ALT) Selector**

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

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

[Option – Gables G6992-02]

**1 Transponder (XPNDR) Selector**

1 – selects transponder No. 1.

2 – selects transponder No. 2.

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

Rotate – sets transponder code in transponder.

**3 Air Traffic Control (ATC) Code Indicator**

Shows transponder code.

Shows operating transponder (1 or 2).

**4 Transponder Mode Selector**

TEST – starts ATC transponder functional test.

STBY (standby) – does not transmit.

ALT RPTG (altitude reporting) OFF – transponder operates without altitude reporting.

XPNDR (transponder) – transponder operates with altitude reporting.

TA (traffic advisory) ONLY, and TA/RA (resolution advisory) – Refer to Chapter 15, Warning Systems.

## **5 Identification (IDENT) Switch**

Push – transmits an identification signal.

## **6 Transponder (XPNDR) FAIL Light**

Illuminated (amber) – indicates transponder malfunction.

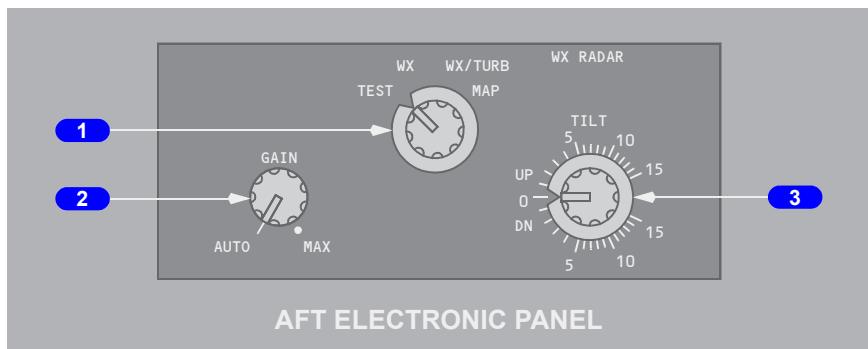
## **7 Altitude (ALT) SOURCE Selector**

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

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

## **Weather Radar Panel**

[Option – AlliedSignal 2041223-0414]



## **1 Mode Selector Switch**

Rotate – selects mode.

TEST –

- tests weather radar system operation
- shows test pattern and any fault messages on navigation display MAP, center MAP, VOR, and APP modes, with WXR selected.

**[Option – With predictive windshear]**

**Note:** If the airplane is on the ground and the thrust levers are not advanced for takeoff, WXR tests the predictive windshear system (PWS) indications. These include PWS FAIL, PWS caution, and PWS warning. Deactivating WXR on the EFIS control panel will not discontinue the test and can result in automatic WXR activation on both pilot displays. The PWS test lasts approximately 15 seconds.

WX (weather) – shows weather radar returns at selected gain level.

WX/TURB (turbulence) –

- shows weather radar returns
- shows turbulence within 40 miles.

**Note:** Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

MAP – shows ground returns.

**2 GAIN Control**

Rotate –

- sets receiver sensitivity to enhance ground mapping in MAP mode only
- system automatically sets gain in other modes.

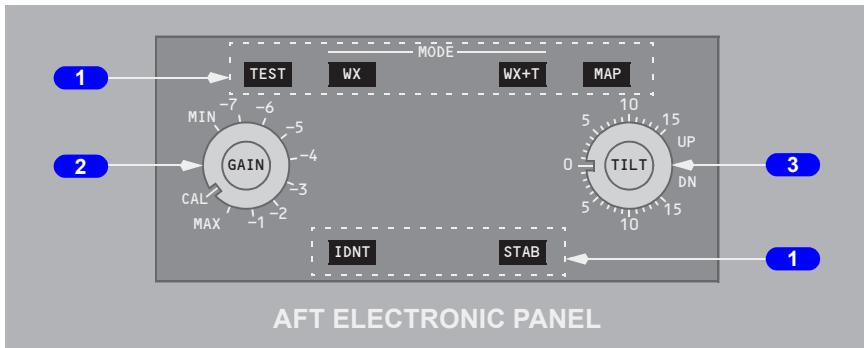
AUTO (automatic) – gain control is automatic.

MAX (maximum) – reduces amount of ground return.

**3 TILT Control**

Rotate clockwise – radar antenna tilts up to selected degrees above horizon.

Rotate counterclockwise – radar antenna tilts down to selected degrees below horizon.

**[Option – Collins 622-5129-105]**

## 1 Mode Switches

Push – selects mode.

TEST –

- tests weather radar system operation without transmitting
- shows test pattern and any fault messages on navigation display MAP, center MAP, VOR, and APP modes, with WXR selected.

### [Option – With predictive windshear]

**Note:** If the airplane is on the ground and the thrust levers are not advanced for takeoff, WXR tests the predictive windshear system (PWS) indications. These include PWS caution, PWS FAIL, and PWS warning. Deactivating WXR on the EFIS control panel will not discontinue the test and can result in automatic WXR activation on both pilot displays. The PWS test lasts approximately 15 seconds.

WX (weather) – shows weather radar returns at selected gain level.

WX+T (turbulence) –

- shows weather radar returns
- shows turbulence within 50 miles.

**Note:** Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

MAP – shows ground returns.

IDNT – suppresses ground return in WX and WX+T modes.

STAB – antenna tilt automatically adjusts to correct for airplane attitude changes.

## 2 GAIN Control

Rotate – sets receiver sensitivity in WX, WX+T, and MAP modes.

CAL (calibrated) – presets an optimum receiver sensitivity for best weather radar display.

## 3 TILT Control

Rotate clockwise – radar antenna tilts up to selected degrees above horizon.

Rotate counterclockwise – radar antenna tilts down to selected degrees below horizon.

Intentionally  
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## Flight Management, Navigation Navigation Systems Description

## Chapter 11 Section 20

### Introduction

#### [Option – With GPS]

Navigation systems include the flight management system (FMS); global positioning system (GPS); air data inertial reference system (ADIRS); radio navigation systems (ADF, DME, ILS, marker beacons, and VOR); transponder; and weather radar.

#### [Option – HUD]

Many of the flight instrument display symbols listed in this chapter also appear on the Heads Up Display (HUD) System. Refer to Chapter 10, Flight Instruments, for HUD system display symbol descriptions.

### 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)
- global positioning system (GPS).

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.

#### [Option – Dual FMC]

The primary flight deck controls are the AFDS MCP, two control display units (CDU's), two electronic flight instrument system (EFIS) control panels, and an FMC source selector switch. The primary displays are the CDUs, outboard display units, inboard display units, and upper display unit.

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### [Option – Single FMC]

The primary flight deck controls are the AFDS MCP, two control display units (CDU's), two electronic flight instrument system (EFIS) control panels. The primary displays are the CDUs, outboard display units, inboard display units, and upper display unit.

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 navigation displays. 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.

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## Global Positioning System (GPS)

### [Option]

Two GPS receivers receive GPS satellite positioning signals. The left and right GPS receivers are independent and each provides an accurate airplane geographical position to the FMC and other aircraft systems. GPS operation is automatic.

### GPS Displays

POS REF page 2/3 shows the left and right GPS latitude and longitude position. POS SHIFT page 3/3 shows the left and right GPS position relative to the FMC position. NAV STATUS page 1/2 shows the GPS currently in use by the FMC for position calculation.

### [Option – EFIS/MAP]

When the navigation display plan mode is selected and POS SHIFT page 3/3 is displayed, the navigation display shows the left and right GPS symbols. The GPS symbols are identical and show as a single symbol when the GPS receivers calculate the same position.

### [Option – PFD/ND]

When the POS (position) switch on the EFIS control panel is selected, the navigation display shows the left and right GPS symbols. The GPS symbols are identical and show as a single symbol when the GPS receivers calculate the same position.

An amber GPS light illuminates to indicate a failure of both GPS sensor units. Failure of a single GPS sensor causes the light to illuminate when either system annunciator panel is pushed.

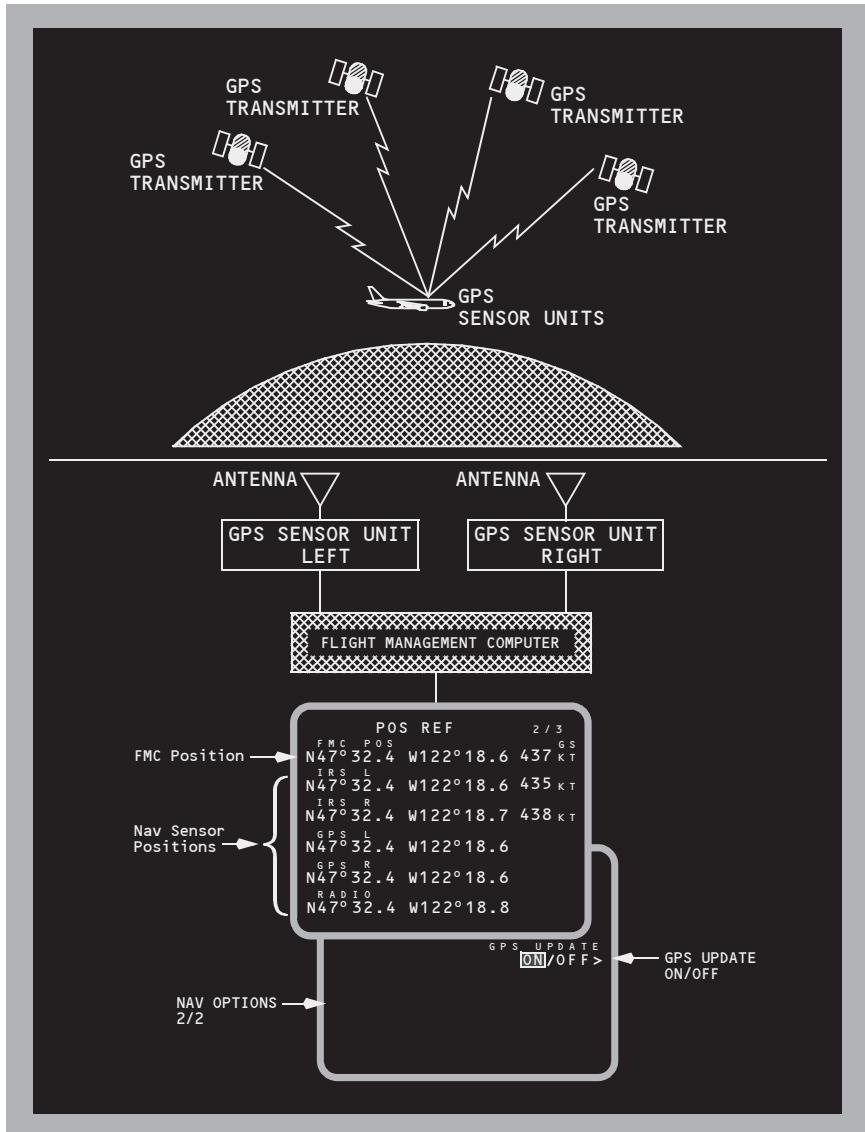
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## GPS Data

FMC logic selects the position from one of the GPS sensor units as the primary update to the FMC position. When GPS position data is available, radio updating can also occur. If all GPS data becomes unavailable, the FMC position will be determined by radio or inertial (IRS) updating.

GPS navigational information can be manually deselected on the NAV OPTIONS page 2/2. No other controls are provided because the operation of the GPS is completely automatic.

## GPS System Schematic



## Inertial System

The inertial system computes airplane position, ground speed, and attitude data for the DUs, flight management system, autoflight system, and other systems. The major components of the inertial system are the air data inertial reference units (ADIRU), an inertial system display unit (ISDU), IRS mode select unit (MSU), and an IRS transfer switch. For information about the air data part of the system, see chapter 10. The ADIRUs provide inertial position and track data to the FMC, and attitude, altitude, and airspeed data to the CDS. Each ADIRU has an IRS section and an air data section.

## Inertial Reference System

Two independent IRSs are installed. Each IRS has three sets of laser gyros and accelerometers. The IRSs are the airplane's sole source of attitude and heading information, except for the standby attitude indicator and standby magnetic compass.

In their normal navigation mode, the IRSs provide attitude, true and magnetic heading, acceleration, vertical speed, ground speed, track, present position, and wind data to appropriate airplane systems. IRS outputs are independent of external navigation aids.

## IRS Alignment

An IRS must be aligned and initialized with airplane present position before it can enter the navigation 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 78 degrees 15 minutes North or South 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. Alignment time varies from five minutes to seventeen minutes depending on airplane latitude.

Magnetic variation between 82 degrees north and 82 degrees 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 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 IRS automatically begins the full alignment process.

### **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 attitude 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 ground-call horn in the nose 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.

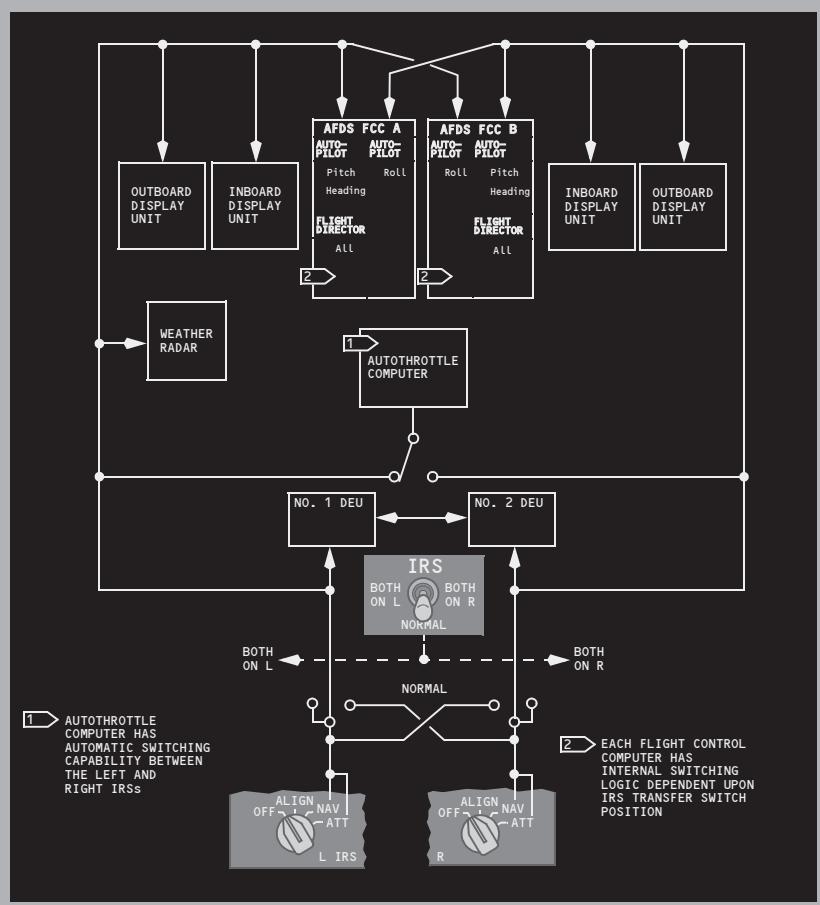
## Mode Select Unit (MSU)

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.

#### [Option – With 2 ADF receivers]

Two ADF receivers are installed. The ADF bearing signals are sent to the pointers on the DUs and the standby radio magnetic indicator. 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 DUs will be removed, and ADF bearing pointers on the standby radio magnetic indicator will not display correct magnetic bearing. Relative bearings indicated by pointers may be correct if the receiver is operating.

## Distance Measuring Equipment (DME)

Two frequency scanning DME systems are installed.

The FMC autotunes DME receivers as necessary for position updating. During normal operations, two different DME signals or a signal from a collocated VOR/DME pair provide an accurate radio geographical position to the FMC. The identifiers of DMEs currently providing update data to the FMC are displayed on the NAV STATUS page 1/2. The radio position is displayed on the POS REF page 2/3. Specific DME station tuning for FMC position updating can be inhibited on the NAV OPTIONS page 2/2.

The flight crew must manually tune the DME on the VHF navigation control panel and the respective EFIS control panel VOR/ADF switch must be in the VOR position for DME to be displayed on the CDS. DME distance is also displayed on the CDS when the ILS receivers are tuned to a collocated DME and localizer facility.

## Instrument Landing System (ILS)

Two ILS receivers are installed.

The ILS receivers are tuned manually on the VHF navigation control panel. The flight crew must manually tune the ILS for display on CDS. The ILS localizer and glideslope can also be displayed on the standby attitude indicator.

LOC updating of the FMC occurs only after the ILS is manually tuned. The tuned ILS frequency is displayed on the navigation display in the APP modes.

## Navaid Identifier Decoding

### [Option – PFD/ND]

The Morse code identifier of a tuned VOR, ILS, or ADF can be converted to alpha characters. The decoded identifier is then shown on the PFD and ND. The crew should monitor this identifier for correct navigation radio reception. The identifier name is not compared with the FMC database.

Due to the large variation in ground station identifier quality, the decode feature may incorrectly convert the intended identifier name. Examples: the Hong Kong localizer “KL” may show as “KAI,” or the Boeing Field ILS may show as “QBFI” or “TTTT” instead of “IBFI.”

Pilots should verify the identity of the tuned navigation station from the audio Morse code when the tuned frequency remains shown or an incorrect identifier is shown.

## Marker Beacon

### [Option – EFIS/MAP]

Marker beacon indications for outer, middle, and inner marker are displayed on the upper outboard corner of the Captain's and First Officer's outboard display units.

### [Option – PFD/ND]

Marker beacon indications for outer, middle and inner marker are displayed on the upper right hand corner of the attitude display located on the Captain's and First Officer's Primary Flight Display (PFD) units.

## Very High Frequency Omni Range (VOR)

Two VOR receivers are installed.

The flight crew must manually tune the VOR on the navigation control panel for display on the DUs and the standby radio magnetic indicator. VOR–DME radio updating is available if the crew manually tunes a valid in-range VOR station.

### [Option – EFIS/MAP]

Left and right VOR bearings are displayed on the DUs when a valid in-range VOR station is tuned, the respective EFIS control panel VOR/ADF switch is in the VOR position and the respective EFIS control panel POS switch is pushed. The DUs also show course deviation.

### [Option – PFD/ND]

Left and right VOR bearings are displayed on the DUs when a valid in-range VOR station is tuned and the respective EFIS control panel VOR/ADF switch is in the VOR position. The DUs also show course deviation.

## VHF NAV Transfer Switch

Should either VOR receiver fail, the VHF NAV transfer switch enables selection of the opposite VHF NAV receiver for display.

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## 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.

Transmissions are automatically enabled when the air/ground system indicates air mode.

TCAS is also controlled from the transponder panel. The TCAS system is described in Chapter 15.

Transponders may also transmit information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc., depending on the level of enhancement. Airport equipment monitors airplane position on the ground when the transponder is active (mode selector not in STANDBY or OFF). TCAS modes should not be used on the ground for ground tracking.

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## Weather Radar

The 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. The radar antenna sweeps a forward arc of 180 degrees.

The radar indicates 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 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 anticolision protection.

The turbulence mode 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 40 nautical mile range, regardless of the selected range.

### [Option – Weather radar with IDNT]

The IDNT position 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 position is provided for analysis by the pilot and is not for continuous use.

### [Option – With predictive windshear]

The weather radar also provides predictive windshear alerting below 1,200 feet RA. On the ground or in flight below 2,300 feet RA, radar antenna scan sweep is limited to 120 degrees with PWS enabled. Above 2,300 feet RA the radar sweep reverts to 180 degrees. (Refer to Chapter 15, Warnings.)

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## Flight Management, Navigation

### Flight Management System Description

## Chapter 11

### Section 30

#### Introduction

The flight management system (FMS) aids the flight crew in managing automatic navigation, in-flight performance optimization, 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 procedure turns. 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 enroute 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.

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 DUs. The EFIS control panels are used to select the desired information for the navigation displays. 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 enroute and terminal area navigation, RNAV approaches and to supplement primary navigation means when conducting all types of instrument approaches.

#### [Option – Dual FMC]

The dual FMC installation is certified as a “sole source” navigation system. Airplanes equipped with two FMCs are certified to operate outside radio navaid coverage. The second FMC serves as a backup, providing complete navigational functions if the other FMC fails.

#### [Option – Dual FMC]

With a dual FMC installation, one FMC is always designated as primary. This is controlled by the position of the FMC Source Select switch. Refer to Chapter 11, FMC Source Select Switch.

#### [Option – Dual FMC]

The primary FMC:

- allocates navaid tuning and updating functions between FMCs
- insures synchronization between FMCs
- controls CDU displays
- provides input to the autopilot
- provides input to the autothrottle system
- processes ACARS (data link) messages.

#### [Option – Dual FMC]

Positioning the FMC Source Select Switch to BOTH ON L or BOTH ON R isolates FMC operation to use only the left or right FMC respectively. In the NORMAL position, the left FMC is primary by default. Although the aircrew can enter information into either CDU, the primary FMC is responsible for synchronizing this information with the secondary FMC and updating both CDU displays.

When external position updating is not available, the FMC uses the IRS position as reference. When the IRS is the only position reference, the FMC applies an automatic correction to the IRS position to determine the most probable FMC position. This correction factor is developed by the FMC's monitoring IRS performance during periods of normal position updating to determine the typical IRS error value. It is important to note that, when external position updating is not available, navigation accuracy may be less than required. Flight crews should closely monitor FMC navigation, especially when approaching the destination. The accuracy of the FMC navigation should be determined during descent phase by using radio navaids and radar information if available.

**Note:** Inaccurate position updating may cause the airplane to deviate from the desired track.

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## Control Display Units (CDUs)

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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.

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## Flight Management, Navigation

### Flight Management System Operation

## Chapter 11

### Section 31

#### Introduction

When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS automatically transitions to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete.

#### Preflight

During preflight, flight plan and load sheet information are entered into the CDU. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet information provide performance information to initialize VNAV.

Required preflight information consists of:

- initial position
- route of flight
- performance data
- takeoff data.

Optional preflight data includes:

- navigation database
- SID
- STAR
- RTA data
- cruise wind
- reduced takeoff and climb thrust limits.

Each required or optional data item is entered on specific preRNPflight pages.

Preflight begins with the IDENT page. If the IDENT page is not displayed, it can be selected from the IDENT prompt on the INIT/REF INDEX page. Visual prompts provide assistance in selecting the appropriate CDU pages. Preflight pages can be manually selected in any order.

After entering and checking the necessary data on each preflight page, the lower right line select key is pushed to select the next page. When ACTIVATE is selected on the RTE page, the execute light illuminates. The EXEC key is then pushed to complete the task of making the route active before continuing with the preflight.

If a standard instrument departure (SID) is to be entered into the route, the departure/arrival (DEP/ARR) page is selected. After selecting the desired SID, the resulting modification must be appropriately linked to the existing route and executed. This can be accomplished on the RTE or RTE LEGS page.

When all required preflight entries are complete, the preflight status prompts on the TAKEOFF REF page are no longer displayed.

## Takeoff

The takeoff phase begins with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected.

## Climb

The climb phase begins at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C point is where the airplane reaches the cruise altitude entered on the PERF INIT page.

## Cruise

The cruise phase begins at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

## Descent

The descent phase begins at the T/D point or when either a level change or vertical speed descent is initiated. The descent phase extends to the beginning of the approach phase.

## Approach

The approach phase begins two miles from the first waypoint of a published approach or approach transition selected from the ARRIVALS page.

## Flight Complete

After landing, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

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## FMC and CDU Terminology

The following paragraphs describe FMC and CDU terminology.

Active – flight plan information currently being used to calculate LNAV or VNAV guidance commands.

Activate – designating an entered route as the active route for navigation. It is a two step process:

- push the ACTIVATE prompt
- push the execute (EXEC) key.

Altitude restriction – a crossing restriction at a waypoint.

Delete – remove FMC data and revert to default values, dash or box prompts, or a blank entry using the DELETE key.

Econ – a speed schedule calculated to minimize operating cost. The economy speed is based on the flight crew CDU–entered cost index. A low cost index reflects high fuel costs and results in a lower cruise speed.

Enter – placing an entry into the CDU scratchpad and then line selecting the information to the desired location. New characters can be typed, or existing data can be line selected into the scratchpad.

Erase – removing flight crew–entered information, which has resulted in a modification, by pushing the ERASE prompt.

Execute – making modified information part of the active flight plan by pushing the EXEC key.

Inactive – route, climb, cruise, or descent information not currently being used to calculate LNAV or VNAV commands.

Initialize – entering information required to make the system operational.

Message – information the FMC automatically writes in the scratchpad to inform the flight crew of a system condition.

Modify – active data that is changed but not yet executed. When a modification is made to the active route or performance mode, MOD is displayed in the page title, ERASE appears next to line select key 6 left, and the execute key illuminates.

Prompt – CDU displays that aid the flight crew in accomplishing a task. Prompts can be boxes, dashes, or a caredt (< or >) line to remind the flight crew to enter or validate information.

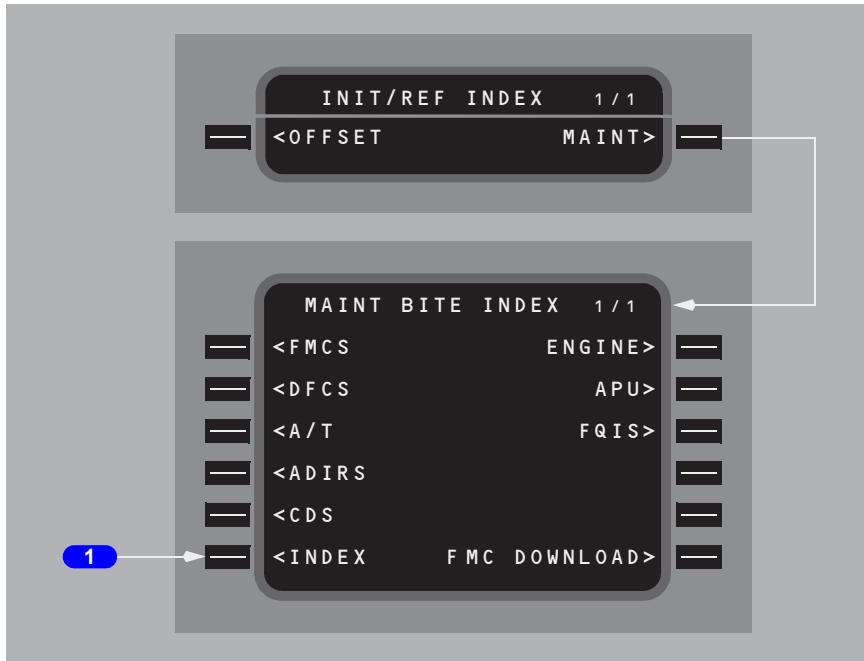
Select – pushing a key to obtain the desired information or action, or to copy selected data to the scratchpad.

Speed restriction – an airspeed limit associated with a specified altitude or waypoint.

Waypoint – a point on the route. It can be a fixed point such as a latitude and longitude, VOR or ADF station, airway intersection, or a non–fixed point such as a conditional waypoint. A conditional waypoint is not necessarily associated with a land reference; it reflects a time position, or altitude requirement. An example of a conditional waypoint is “when reaching 1000 feet.”

## Maintenance Index Page

The MAINT BITE INDEX page is available only on the ground and provides access to data for use by maintenance personnel.



### 1 INDEX

Push – displays the INIT/REF INDEX page.

## Navigation Position

### [Option – With GPS]

The FMC determines present position from the IRS, GPS, and navigation radios. The FMC uses its calculated present position to generate lateral steering commands along the active leg to the active waypoint.

### [Option – Dual FMC with GPS]

When the FMC Source Select Switch is positioned to NORMAL, the left FMC becomes primary, however, data from both FMCs is combined to determine a composite position and velocity for guidance and map displays.

## FMC Position Update

### [Option – With GPS]

On the ground, the FMC calculates present position based on GPS data. If GPS data is not available, the FMC calculates present position based on IRS data.

### [Option – FMC U10.2 and later]

If GPS UPDATE is OFF, the FMC updates position to the takeoff runway threshold when a TO/GA switch is pushed. When making an intersection takeoff, the intersection data must be entered on the TAKEOFF REF page. If GPS UPDATE is ON, the TO/GA update is inhibited. GPS UPDATE is on the NAV OPTIONS page.

### [Option – Runway position update via the CDU only]

On the ground prior to takeoff, FMC position update to the takeoff runway threshold position can be done on the TAKEOFF REF page.

### [Option – With GPS]

In flight, the FMC position is continually updated from the GPS, navigation radios, and IRS. Updating priority is based on the availability of valid data from the supporting systems.

FMC position updates from navigation sensor positions are used in the following priority order:

- GPS
- 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 NAV STATUS page 1/2.

FMC logic selects the GPS position as the primary update to the FMC position. If all GPS data becomes unavailable, the FMC reverts to radio or IRS updating.

The dual frequency-scanning 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, unless a specific station is required by the flight plan. Radio position is determined by the intersection of two DME arcs.

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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.

#### [Option – FMC U10.3 and later]

**Note:** If the flight crew observes either of these indications, the FMC should be carefully monitored.

When adequate radio updating is not available, navigation display map mode may display a shift error. This error results in the displayed position of the airplane, route, waypoints, and navigation aids shifted from their actual positions.

An across track, undetected map shift may result in the airplane flying a ground track that is offset from the desired track. An along track, undetected map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the airplane on the navigation display map mode with data from the ILS, VOR, DME, and ADF systems.

## Navigation Performance

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.

#### [Option – With GPS]

The FMC position is derived from a mathematical combination of the positions determined by the IRS, radio, and GPS 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.

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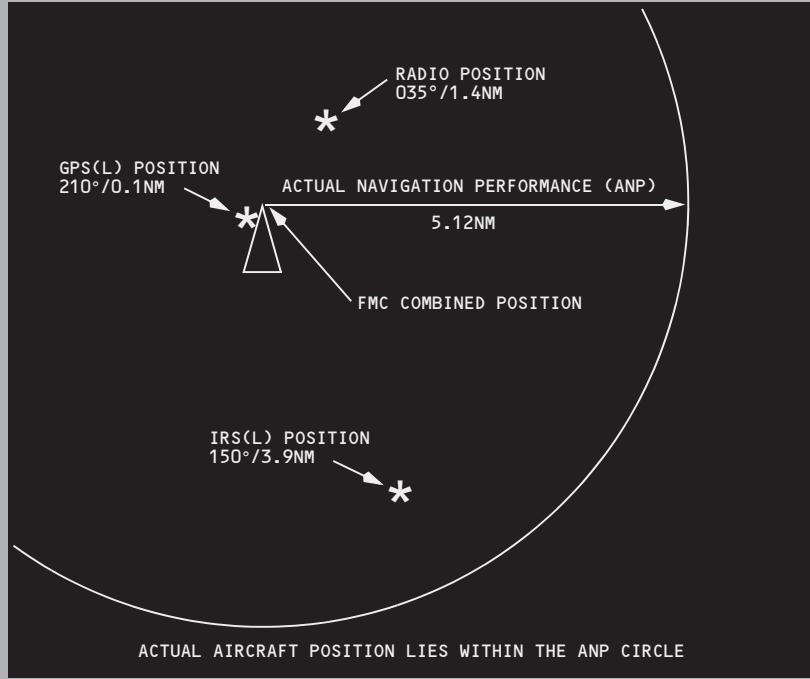
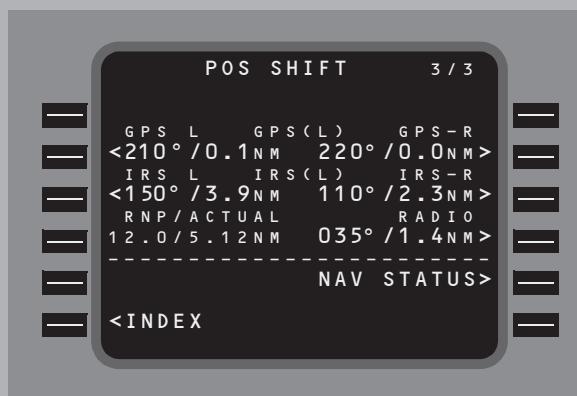
**[Option – FMC U10.4 and later]**

**Note:** If the GPS position update is excessive, GPS updating is suspended until the GPS position can be determined to be reasonable.

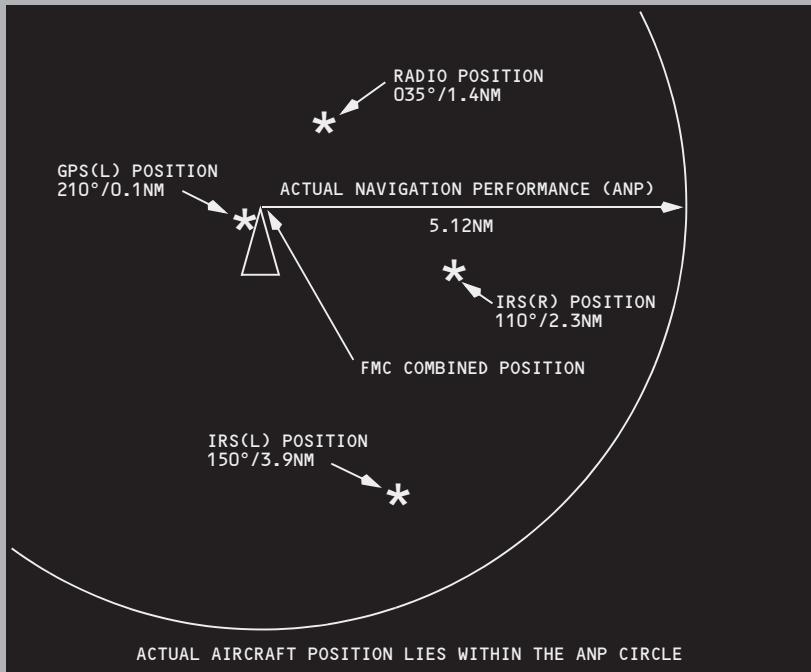
### Actual Navigation Performance (ANP)

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.

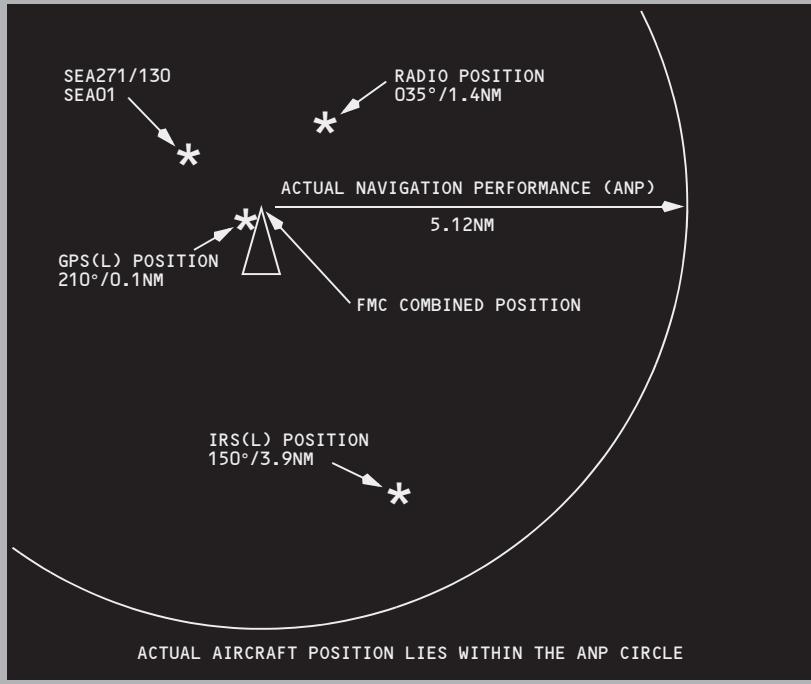
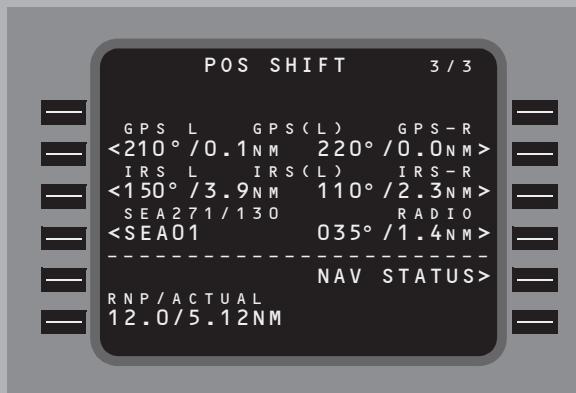
[Option – Single FMC with GPS]



## [Option – Dual FMC with GPS]



[Option – Single FMC with GPS, U10.6 or later with manual position update]



## Vertical Actual Navigation Performance (VANP)

### [Option – FMC U10.5 and later with vertical RNP enabled]

Vertical Actual Navigation Performance (VANP) is the FMC's estimate of the quality of its altitude determination. It is shown on RNP PROGRESS page 4/4. VANP represents the estimated maximum altitude error with 99.7% probability. That is, the FMC is 99.7% certain that the airplane's actual altitude lies within a vertical band equal to plus or minus the ANP value. The lower the VANP value, the more confident the FMC is of its altitude estimate.

**Note:** VANP is calculated from the baro-corrected altitude provided by the Air Data System. The pilot must set the baro setting reported by ATIS or provided in the approach clearance for the 99.7% confidence level to be valid.

## Required Navigation Performance (RNP)

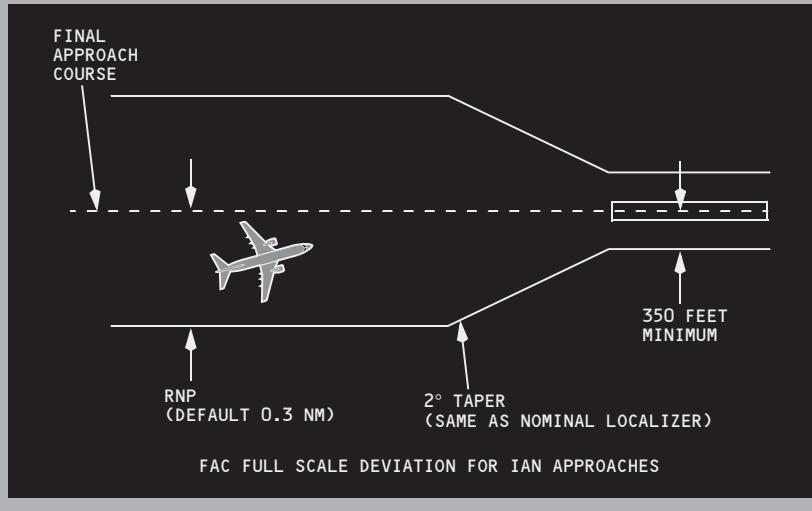
The FMC supplies a default required navigation performance (RNP) value for oceanic, en route, terminal, and approach environments. RNP can also be supplied by the Navigation Database or may be entered by the crew. Actual navigation performance (ANP) should not exceed RNP.

| Environment | Default RNP                      | Time to Alert                   |
|-------------|----------------------------------|---------------------------------|
| Oceanic     | 12.0 NM                          | [Option – FMC U10.7]<br>60 sec. |
| En route    | 2.0 NM                           | [Option – FMC U10.7]<br>30 sec. |
| Terminal    | 1.0 NM                           | [Option – FMC U10.7]<br>10 sec. |
| Approach    | 0.5 NM<br><br>[Option]<br>0.3 NM | 10 sec.                         |

### [Option – FMC U10.7 and later]

If ANP exceeds the displayed RNP value, the UNABLE REQD NAV PERF–RNP message will be displayed on the CDU scratchpad after the designated time to alert has elapsed. An additional amber UNABLE REQD NAV PERF–RNP will be displayed on the MAP. The amber FMC lights located on the forward instrument panel will also illuminate with the annunciation of this message. RNP is shown on the POS SHIFT, RNP PROGRESS 4/4 and the RTE LEGS pages.

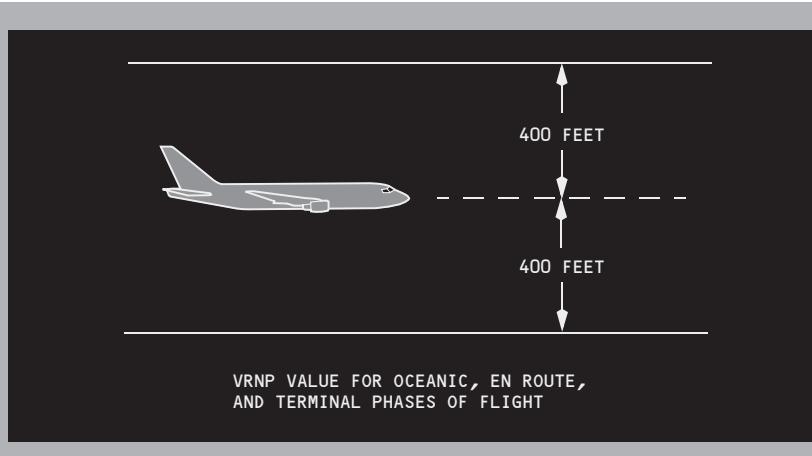
[Option – FMC U10.5 and later with Integrated Approach Navigation]

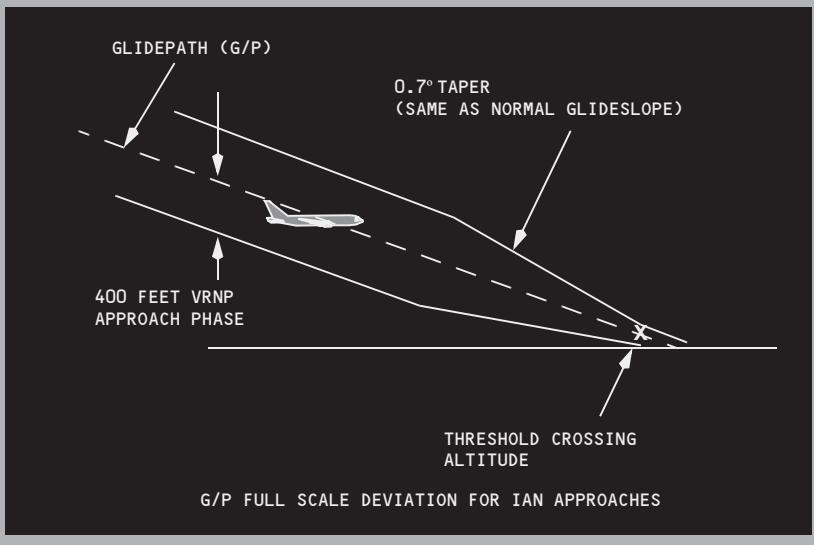


### Vertical Required Navigation Performance (VRNP)

[Option – FMC U10.5 and later with vertical RNP enabled]

The FMC uses 400 feet as a default Vertical Required Navigation Performance (VRNP) value for oceanic, en route, and terminal phases of flight.





When required, VRNP values may be manually entered or displayed on RNP PROGRESS page 4/4. The FMC will accept manual entry of a VRNP value greater than the default value, but the VERIFY VERT RNP VALUE advisory message will be displayed in the scratchpad. Manual entries are cleared at flight completion.

## Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint. If selected, LNAV engages when laterally within 3 nautical miles of the active route leg. If outside of 3 nautical miles of the active route leg, LNAV engages if on an intercept heading of 90 degrees or less and the intercept will occur before the active waypoint. FMC LNAV guidance normally provides great circle courses between waypoints. However, when an arrival or approach from the FMC database is entered into the active route, the FMC can supply commands to fly a constant heading, track, or follow an arc, as required by the procedure.

## Waypoints

Waypoint (navigation fix) identifiers are displayed on the CDU and navigation display.

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.

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

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

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

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

Examples: CI32R, PV15, FN24L.

Unnamed turn points – unnamed turn points that are part of a procedure are identified as a latitude and longitude waypoint. These include waypoints (except conditional waypoints) defined by flying a course or track from a waypoint (except conditional waypoints) to a radial or DME distance. These waypoints are automatically entered in a route by selection of a procedure using these waypoints, from the departures or arrivals page.

Airport reference points – airport reference points are identified by the ICAO identifier.

### Duplicate Waypoint Names

Duplicate identifiers – should application of these rules result in more than one waypoint having the same identifier, then a CDU page change occurs when an attempt is made to enter the duplicated identifier.

#### [FMC U10.6 and later]

The page title is SELECT DESIRED XXX, where XXX is the three letter identifier of the waypoint in question.

The page lists the latitude and longitude of waypoints with the same identifier and the type of facility or waypoint. Selecting the latitude/longitude of the desired waypoint enters the correct waypoint on the original page. See chapter 11, section 42, “Select Desired Waypoint Page” for additional information.

When a waypoint identifier is listed in the route more than once, certain route modifications (such as DIRECT TO or HOLD) use the first occurrence of the waypoint even if the second occurrence is selected. If a new waypoint entry is attempted that has the same identifier as a waypoint already in the route, the select desired waypoint page will not be displayed and the first waypoint will be used. To use the second occurrence waypoint, the first occurrence waypoint must be deleted from the route.

### **Conditional Waypoint Names**

Conditional waypoints are automatically entered into a route as a result of selecting a procedure on a DEPARTURES or ARRIVALS page. Normally, conditional waypoints cannot be manually entered on a route or legs page. These waypoints are events when a condition occurs and are not at a geographically-fixed position. The types of conditions are:

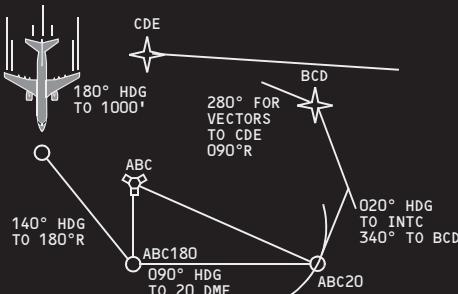
- passing through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vector to a course or fix.

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

**EXAMPLE:**

RTE LEGS

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

**MEANING:**


NOTE: ALL WAYPOINTS EXCEPT BCD AND CDE ARE EXAMPLES OF CONDITIONAL WAYPOINTS.

**Note:** When (VECTOR) is the active leg and LNAV is not engaged, the FMC automatically sequence to the next waypoint when within 3 nm of the next leg. If (VECTOR) is the active waypoint and LNAV is engaged, the FMC does not automatically sequence to the next waypoint. The next waypoint becomes active only upon EXECution of the procedures for Proceeding Direct To a Waypoint or Intercepting a Leg to a Waypoint.

### 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.

## Greater Than 99 Numbered Waypoints

### [FMC U10.6 and later]

When the quantity of numbered waypoints exceeds 99 the identifier shall use the first two characters of the entry followed by the smallest three-digit sequence number beginning with 100. Examples:

- SEA104/74 becomes SE100
- SEA104/OLM064 becomes SE101.

## Navigation Displays

The route is displayed on the navigation display in the map, map center, 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
- executed route offsets are displayed as a dot and dash magenta line.

---

## Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

### Speed/Altitude Restrictions

#### [Option – With color]

A waypoint restriction is magenta when it is active. The restriction does not have to be in line 1 to be active.

#### [Option – With color]

Modified waypoint restrictions are shaded white until they are executed.

#### [Option – U10.7 and later]

All speed restrictions are considered by the FMC as “at” restrictions, unless modified by the pilot.

#### [Option – U10.7 and later]

When modified by the pilot:

- “At or above” airspeed restrictions are entered with a suffix letter A (example: 250A/).
- “At or below” airspeed restrictions are entered with a suffix letter B (example: 200B/).
- Mandatory airspeed restrictions are entered without any suffix letter (example: 220/).

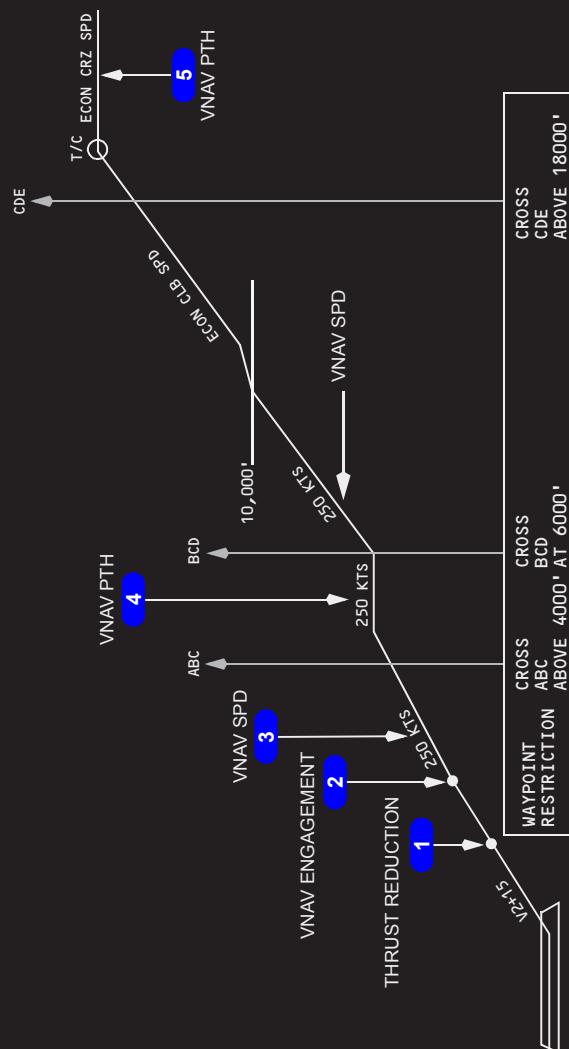
At or above altitude restrictions are entered with a suffix letter A (example: 220A).

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.

**[Option – With automatic thrust reduction after takeoff]**

Climb thrust is selected by pushing the N1 switch or automatically upon reaching the thrust reduction altitude.

**[Option – With quiet climb]**

When cutback mode is selected ON, the FMC calculates and commands a thrust cutback at the required cutback altitude. A new N1 is calculated during climb and normal climb thrust is restored at the RESTORE altitude.

**2 VNAV Engagement**

VNAV commands an airspeed increase to the planned climb speed profile, limited by configuration.

**3 VNAV Climb**

The VNAV climb profile uses VNAV SPD at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude restrictions that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

**Note:** Selection of ENG OUT on the CLB page provides the crew with advisory engine out performance information.

If the climb speed profile cannot achieve an altitude restriction, the UNABLE NEXT ALTITUDE scratchpad message is shown.

**4 Climb Restrictions**

VNAV enters the VNAV PTH mode to remain within departure or waypoint restrictions. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed.

**5 Top Of Climb (T/C)**

The point where the climb phase meets the cruise altitude is called the top of climb. Approaching this point, the FMC changes from the climb phase to the cruise phase. The T/C is shown any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point is shown on the map as a green open circle with the label T/C.

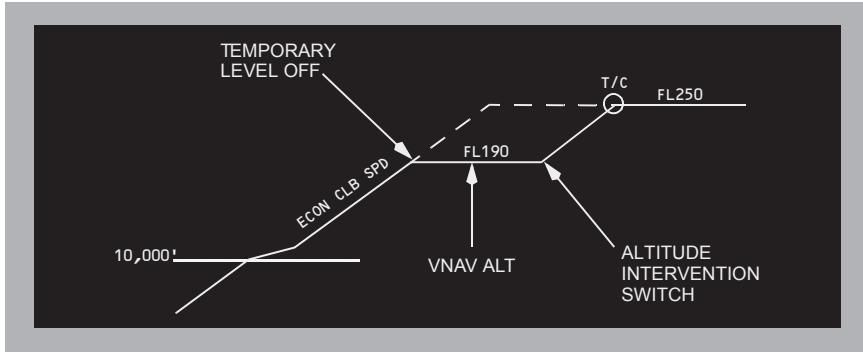
## MCP Altitude Intervention

### [Option]

#### [Option – With VNAV ALT]

The altitude intervention switch may be used to resume climb after a temporary level off.

#### [Option – With VNAV ALT]



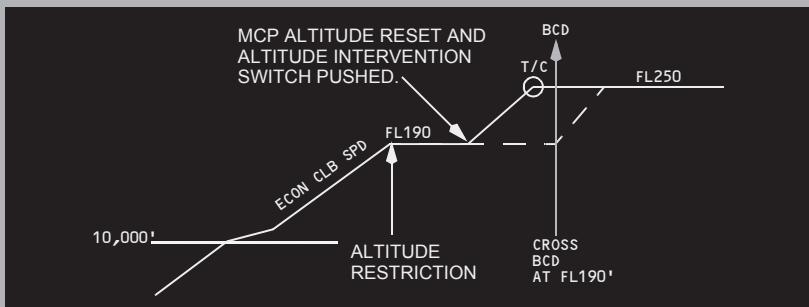
#### [Option – With VNAV ALT]

Whenever the airplane levels off at an MCP altitude that is not in the FMC, VNAV ALT engages. In the illustration above, FMC cruise altitude is FL250 and the clearance altitude, FL190, is set in the MCP. Pitch maintains altitude and thrust maintains FMC target speed. In the illustration above, the speed after the temporary level off would be ECON CLB SPEED.

#### [Option – With VNAV ALT]

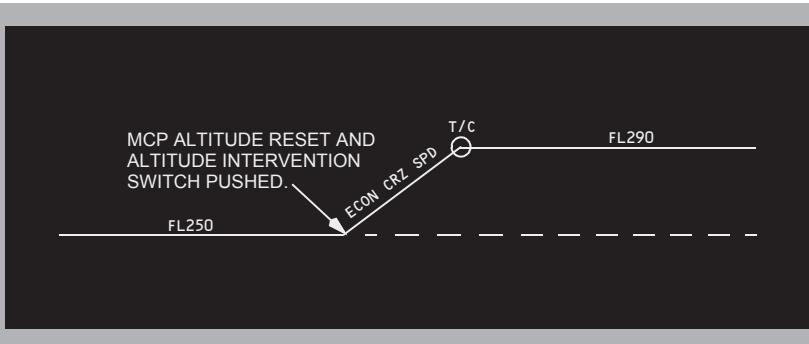
To resume the climb, put the clearance altitude into the MCP altitude window and push the altitude intervention switch. VNAV SPD engages. Pitch maintains FMC speed and thrust increases to the climb limit. In the example, the airplane climbs to FMC CRZ ALT and then levels off in cruise.

The altitude intervention switch may be used during climb or descent to delete altitude restrictions between the current altitude and the MCP altitude. When level at a restriction altitude, and cleared to a higher altitude prior to crossing the restriction waypoint, reset the MCP altitude to the new clearance altitude and push the altitude intervention switch.



In the illustration above, the current altitude restriction is deleted and the airplane continues VNAV climb to the cruise altitude. T/C moves to match the new climb profile.

The altitude intervention switch may be used to increase cruise altitude. When level at a cruise altitude, and then cleared to a higher cruise altitude, reset the MCP altitude to the new cruise altitude and push the altitude intervention switch.



In the illustration above, the cruise altitude is increased and the airplane enters a VNAV cruise climb at the economy cruise speed.

Altitude intervention cannot be used to decrease cruise altitude. Setting a lower altitude then pushing the altitude intervention switch causes the FMC to enter an early descent in the selected descent mode.

## 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.

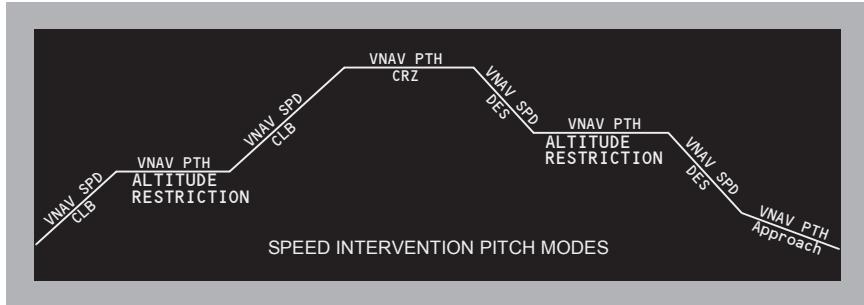
### Step Climb

If a step climb altitude is entered in the CRZ page STEP altitude, the FMC calculates the point where the step climb should begin.

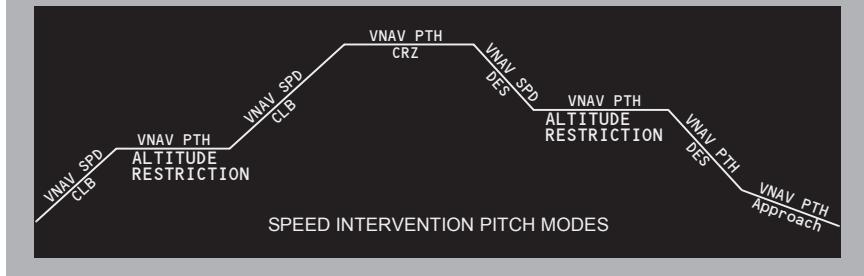
The distance and ETA to the next step point are shown on the CRZ and PROGRESS pages. The next step point is shown on the map as a green open circle with the label S/C.

### MCP Speed Intervention

#### [Option – Speed intervention]



#### [Option – Speed intervention with geometric descent path]



The above illustration shows VNAV mode for each phase of flight during speed intervention.

With VNAV engaged, pushing the speed intervention switch enables speed intervention. Speed intervention allows the flight crew to change airplane speed with the IAS/MACH selector.

In a path descent using speed intervention, VNAV PTH changes to VNAV SPD when the active descent segment is an idle thrust segment.

**Note:** Aircraft equipped with geometric descent path will transition to VNAV PTH after the first altitude restriction.

#### [Option – FMC U10.6 and later]

On non-idle descent segments, the pitch mode will switch to VNAV PTH if not already in VNAV PTH. In VNAV PTH, thrust controls speed.

When a navigation data base vertical angle leg is flown (GP x.xx on RTE LEGS page), VNAV switches to VNAV PTH if not already in VNAV PTH.

In approach phase during speed intervention, the pitch mode remains in VNAV PTH after speed intervention is exited. The FMC shall remain in the current vertical mode regardless of IAS MACH selector changes.

#### [Option – FMC U10.4 and later]

When speed intervention is exited the descent mode will switch back to path mode.

## 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.

#### [Option – With common VNAV]

VNAV performs descents using pitch control to maintain a vertical path. Thrust is used to control speed, similar to a glideslope in three dimensions.

## Top Of Descent (T/D)

The point where the cruise phase changes to the descent phase is the top of descent. The T/D point is shown on the map as a green open circle with the label T/D. T/D is calculated from an end of descent (E/D) point.

Intermediate T/D points show on the map as green open circles with the label T/D-XXXXX (altitude). Intermediate T/D points exist when path segments between altitude restricted waypoints produce a level path segment. The intermediate T/D point shows where the descent will resume.

## End of Descent (E/D)

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:

- the runway threshold for approaches with a runway waypoint on the RTE LEGS page, or
- the missed approach point for approaches not showing a runway waypoint on the RTE LEGS page, or

### [Option – FMC U10.6 or later]

- the last descent waypoint, 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

### [Option – With geometric descent path]

After the first “at” or “at or below” restriction, the path angle is constant between waypoints.

### [Option – FMC U10.2 and later]

**Note:** When passing top of descent following high speed cruise operation (within approximately 6 knots of Vmo/Mmo, cost index of 100 or higher), VNAV may revert to LVL CHG to prevent overspeed. Reduce airspeed to the VNAV target descent speed prior to reengaging VNAV.

### [Option – With common VNAV]

**Note:** When passing top of descent following high speed cruise operation (within approximately 6 knots of Vmo/Mmo, cost index of 100 or higher), VNAV may revert to VNAV SPD to prevent overspeed.

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.

The descent path assumes deceleration to reach the final approach fix (FAF), or the glideslope intercept point at VREF 40+20 knots.

Target speeds are changed by entries on the DESCENT page. Entries made on the LEGS page are “at or below” and may limit the target speed. Wind and thrust assumptions are changed on the DES FORECASTS page.

Deceleration points show on the map as green open circles with the label DECEL. Deceleration points show prior to:

- airspeed constrained waypoints
- holding patterns
- approach flap extension.

If more than one deceleration segment exists in the flight plan, only the next deceleration point shows. Deceleration points can also show prior to cruise holding patterns or other speed reductions.

#### [Option – With VNAV ALT]

During descent, VNAV ALT engages if the airplane levels at an MCP altitude not in the FMC.

#### 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.

#### [FMC U10.5A and earlier]

The FMC defaults to the path descent mode for planning purposes. If the necessary information for a path descent is not available by the time the airplane reaches the T/D point, the FMC will revert to the speed descent mode.

The path descent normally begins automatically at the calculated T/D point, provided the MCP altitude is reset for the descent. If descent is not initiated by the T/D, a path descent may not be achievable. At the T/D, the FMC commands idle thrust and pitch to follow the descent path.

The descent complies with waypoint altitude restrictions by following the calculated vertical path.

**Note:** A path descent uses the target speed for planning purposes only. There is no attempt to maintain the target speed during the idle portion of the descent.

**Note:** When descending in VNAV PTH, the FCC will disengage VNAV and switch to LVL CHG if actual speed becomes equal to or slightly less than the minimum speed, denoted by the underspeed limiting symbol in the MCP IAS/Mach window. This can also happen in turbulence or gusty conditions when the minimum speed may momentarily increase due to G loading. See section 4.20, Minimum Speed Reversion.

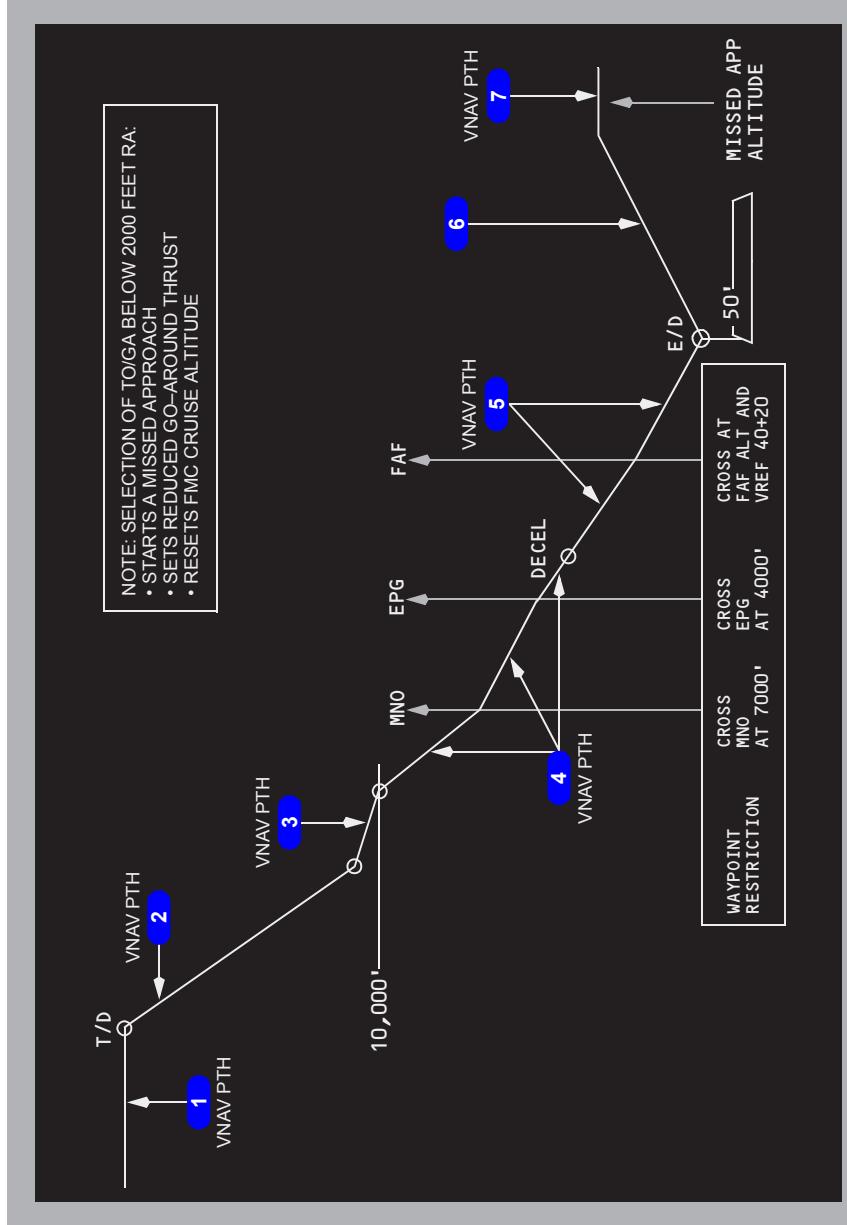
The FMC uses a special program called “Energy Compensation” at certain times during an ACT PATH DES. This program goes into effect when the MCP has been temporarily set to an altitude above the planned descent path. The airspeed cursor will slowly move toward a slower airspeed while the “TARGET” speed on the FMC remains constant. The airspeed reduction improves the capability of recapturing the planned descent path. When the airplane is cleared to resume the descent, the airspeed will slowly build up to the FMC target speed as the airplane recaptures the planned descent path.

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

The CDU message DRAG REQUIRED is displayed if an unexpected tailwind results in a significant increase in airspeed to maintain path. The CDU message DES PATH UNACHIEVABLE is displayed if the FMC determines that the planned descent profile cannot be accomplished. VNAV reverts to VNAV SPD if a limit speed will be exceeded, with COMMON VNAV and U10.6 or later.

#### **[Option – FMC U10.4 and later]**

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. VNAV will remain in path regardless of cross-track.

**VNAV Cruise and Path Descent Profile (Instrument Approach using VNAV)**
**[Option – With geometric descent path]**


## 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

[Option – With geometric descent path]

The VNAV path conforms to altitude restrictions at MNO, EPG, and the FAF. The thrust mode changes to FMC SPD as required to maintain the target speed.

## 5 Approach

VNAV descends and starts approach in VNAV PTH at the commanded speed.

## 6 Missed Approach

When TOGA is pushed during approach, or when crossing the missed approach point, VNAV disengages.

When selected during missed approach, VNAV engages in VNAV SPD.

## 7 Missed Approach Level Off

At missed approach altitude VNAV changes to VNAV PTH.

### VNAV Speed Descent

A speed descent may be selected manually by selecting the SPEED prompt on the PATH DES page. With no E/D specified, the speed descent is the only descent mode available.

The speed descent maintains the target speed. Normally, the target speed is economy above the airspeed restriction altitude and 240 knots below that altitude, until deceleration is necessary for the approach. VNAV will not permit descent below the altitude restriction until the airspeed is at or below the restricted value.

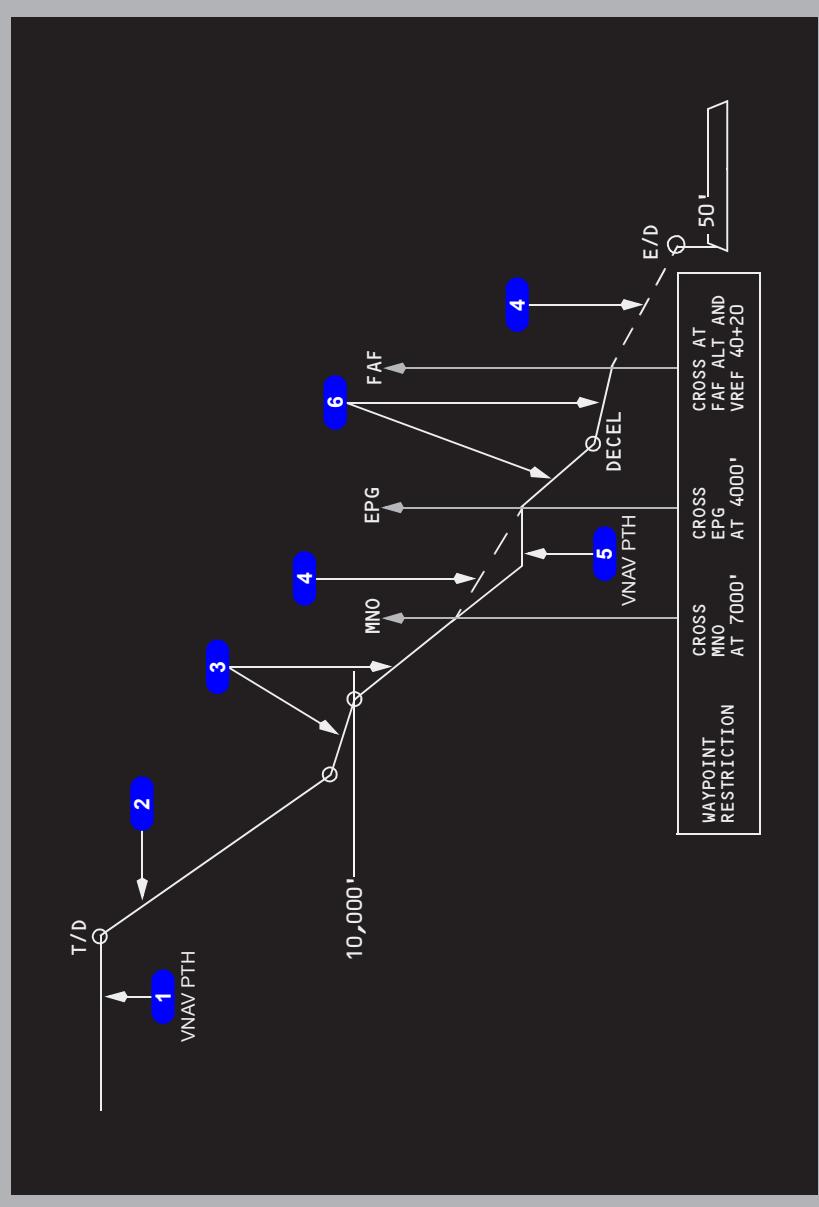
The speed descent normally begins automatically at the calculated T/D, provided the MCP altitude is reset for the descent. At the T/D, the FMC commands pitch to maintain target descent speed. LNAV does not have to be engaged in order to fly a VNAV speed descent.

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 during STAR, approach transition, or approach leg with a vertical angle. However, if all required parameters for a path descent are available, a path descent may be manually selected at any time by selecting the PATH prompt on the speed descent page.

## VNAV Cruise and Speed Descent Profile (Instrument Approach using VNAV)

[Option – With geometric descent path]



**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 SPD.

**3 Speed Restriction Deceleration**

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV SPD.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV SPD.

**4 VNAV Path**

During a speed descent, VNAV may not maintain the FMC computed VNAV path. However, if E/D shows, a VNAV path is available.

**5 Altitude Restrictions**

VNAV conforms to altitude restrictions at MNO and EPG. After MNO VNAV continues an idle thrust descent using VNAV SPD.

Upon reaching the next altitude restriction, VNAV commands level flight using VNAV PTH. The thrust mode changes to FMC SPD.

**6 Descent and Approach**

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

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

## Vertical Angle

A vertical angle can be assigned to a waypoint from the navigation database. This vertical angle defines a VNAV path between the waypoint and the waypoint preceding it. This feature can be available in approaches, approach transitions, and STARs. For example, the vertical angle for the glidepath of an ILS approach would typically be 3 degrees. This angle is displayed on the ACT RTE LEGS page above the speed/altitude line for the associated waypoint. Vertical angles may be expected in any approach ending at RWXXX or MAXXX. The E/D will be RWXXX or MAXXX, and the E/D altitude will be either threshold crossing height (TCH – typically 50 feet above the touchdown zone elevation) or the altitude specified at MAXXX.

If a path (VNAV PTH) descent is active when a vertical angle leg becomes active, the path mode will remain active, but VNAV will follow the vertical angle rather than the idle thrust descent path.

If the vertical angle leg becomes active during a speed (VNAV SPD) descent, the VNAV mode will change to VNAV PTH automatically, and there will be no SPEED prompt on the descent page.

## Early Descent

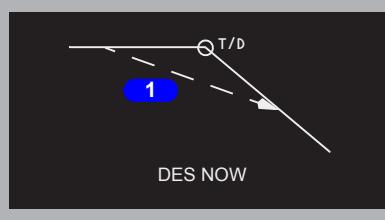
A descent in VNAV started before the top of descent point is an early descent. If a path descent is planned, VNAV commands a 1000 fpm descent until the idle descent path is intercepted. If a speed descent is planned, VNAV commands an idle thrust descent.

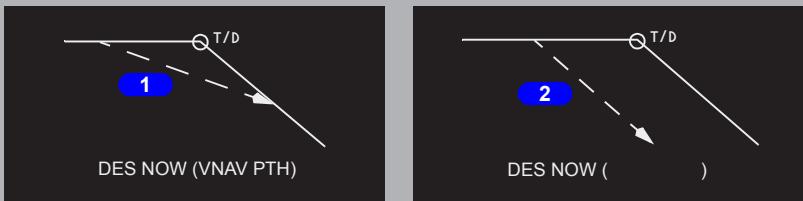
A descent in VNAV started before the top of descent point is an early descent. VNAV commands a 1000 fpm descent until the idle descent path is intercepted.

To start an early descent, use DES NOW prompt on the DES page.

### [Option – With speed and altitude intervention]

An early descent can also be started by pushing the altitude intervention switch.





## 1 DES NOW

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.

### 1 DES NOW (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 DES NOW (VNAV SPD)

With a VNAV speed descent planned, VNAV starts an idle thrust early descent. VNAV does not attempt to capture the VNAV descent path. VNAV uses VNAV SPD for the pitch mode and the autothrottle commands IDLE, followed by ARM.

## Approach

The FMC transitions to “on approach” when the airplane is within:

- 2 NM of the first approach waypoint (including approach transitions such as arcs and procedure turns), or
- 2000 feet of airport elevation, whichever occurs first.

When the FMC is “on approach”, the following features are available:

- UNABLE RNP alerting levels are higher
- when preparing for a missed approach and the MCP altitude is set at least 300 feet above the current airplane altitude, VNAV will continue to command a descent
- if the airplane is more than 200 feet below the vertical path, VNAV commands zero vertical speed until intercepting the path.

**Note:** Display of a specified path angle is not limited to approaches. A path angle may be defined for a leg in a STAR and displays on the RTE LEGS page for the procedure.

The FMC transitions out of “on approach” under the following conditions:

- selecting TO/GA
- the airplane lands
- the waypoint cycles to the first waypoint of the missed approach
- executing a direct-to waypoint in the missed approach.

The following situations are generally encountered during approach operations, but are not determined by “on approach” logic:

- If speed intervention is engaged:
  - during a path descent with flaps up on an idle leg, VNAV switches to VNAV SPD
  - with flaps down, VNAV remains in VNAV PTH
- when a point to point (geometric path) leg is active, VNAV remains in VNAV PTH
- while a vertical angle leg (GP x.xx on RTE LEGS page) is active, VNAV remains in VNAV PTH
- if a vertical angle leg (GP x.xx on RTE LEGS page) becomes active, VNAV switches to VNAV PTH without pilot action
- if on a vertical angle leg, and cross track exceeds two times the RNP value, while LNAV is not engaged, VNAV will disengage.

VNAV will remain engaged at all flap settings, allowing approaches to be flown using the vertical angle guidance. Speed for final approach can be set on the APPROACH REF page.

#### **[Option – FMC U10.3 and later]**

If an ILS approach is flown in VNAV using vertical angle guidance, VNAV will disconnect when passing the GS-XXX point if G/S is armed, but it can be reengaged. If the GS-XXX point is deleted, VNAV will remain engaged throughout the approach.

For an approach without a runway waypoint on the RTE LEGS page, the VNAV path is calculated to the MDA or a calculated altitude at the missed approach point. The calculated altitude may be below the MDA to ensure a flight path angle and normal threshold crossing height.

**Note:** It is the flight crew’s responsibility not to descend below the MDA until adequate visual contact is achieved.

#### **Integrated Approach Navigation (IAN)**

#### **[Option – FMC U10.5 and later with integrated approach navigation]**

Integrated Approach Navigation (IAN) provides the capability to fly most FMC instrument approaches utilizing a procedure similar to that for ILS approaches. No special aircrew action is required other than to line select a IAN compatible approach into the FMC flight plan.

During an IAN approach, the FMC provides:

- glidepath (G/P) deviations from the defined VNAV vertical path to the missed approach waypoint
- final approach course (FAC) deviations from the defined LNAV lateral path to the missed approach waypoint
- a source for the deviation scales
- distance to the missed approach waypoint.

Additionally, normal flight director steering bars are displayed that reflect G/P and FAC guidance.

IAN provides both lateral and vertical deviation for the following approaches:

- |              |           |
|--------------|-----------|
| • NDB        | • VOR/DME |
| • NDB/DME    | • GPS     |
| • RNV (RNAV) |           |
| • VOR        |           |

IAN provides vertical deviations for the following approaches:

- |                 |       |
|-----------------|-------|
| • BCS (BAC)     | • LOC |
| • ILS (G/S OFF) |       |

IAN approaches are designed to be flown to published CAT I minimums, and may be flown with or without the autopilot. At or above minimums, the pilot flying is expected to disengage the autopilot and manually complete the flare and touchdown. Both visual and aural alerts are provided if the autopilot remains engaged below 100 feet RA with either FAC or G/P engaged. “AUTOPILOT, AUTOPILOT” is annunciated over the flight deck speaker and an amber AUTOPILOT flashes over the attitude display.

RNP is used to scale the displayed FAC deviations.

Both RNP and VRNP are used to scale the displayed FAC and G/P deviations.

If the UNABLE REQD NAV PERF - RNP message is displayed on the MAP, IAN FAC and/or G/P deviation point will be sent invalid.

Lateral RNP may be revised from the RNP PROGRESS, RTE LEGS and POS SHIFT pages.

VRNP values may be revised on RNP PROGRESS page 4/4. The FMC will accept manual entry of a VRNP value greater than the default value, but the scratchpad message VERIFY VERT RNP VALUE will be displayed.

Manual entries are cleared at flight completion.

For additional IAN information, see chapters 4, 10, 15, and Normal Procedures in Volume 1.

## Go-Around

Below 2000 feet radio altitude, the FMC transitions to go-around logic from approach logic when any of the following events occur:

- pushing either TO/GA switch while in a descent
- executing a direct-to waypoint in the missed approach (other than the missed approach point)
- automatically while in a descent and the last waypoint of the approach cycles to the first waypoint of the missed approach.
- the airplane climbs at a vertical speed greater than 600 fpm and the flaps are retracted from a landing setting toward a flap setting of 15 or 1

Once the FMC go-around logic is established:

- the FMC transitions from active descent to active climb
- the thrust limit changes to go-around thrust
- all descent altitude constraints below the current airplane altitude are deleted and replaced with predicted altitudes
- the original destination airport (airport from which the go-around was just initiated) becomes the new origin airport allowing SID selection if a diversion to another airport is required.

**Note:** LNAV may be engaged when the airplane climbs above 400 feet radio altitude, but VNAV should not be engaged until after flap retraction.

If the go-around was initiated by pushing a TO/GA switch or selection of go-around thrust, the CRZ ALT will change to the highest of:

- the highest constraint in the missed approach
- 1500 feet above airport elevation
- the MCP altitude.

**Note:** If the MCP altitude is the lowest of the three, the autopilot, if engaged, will level off at the MCP altitude.

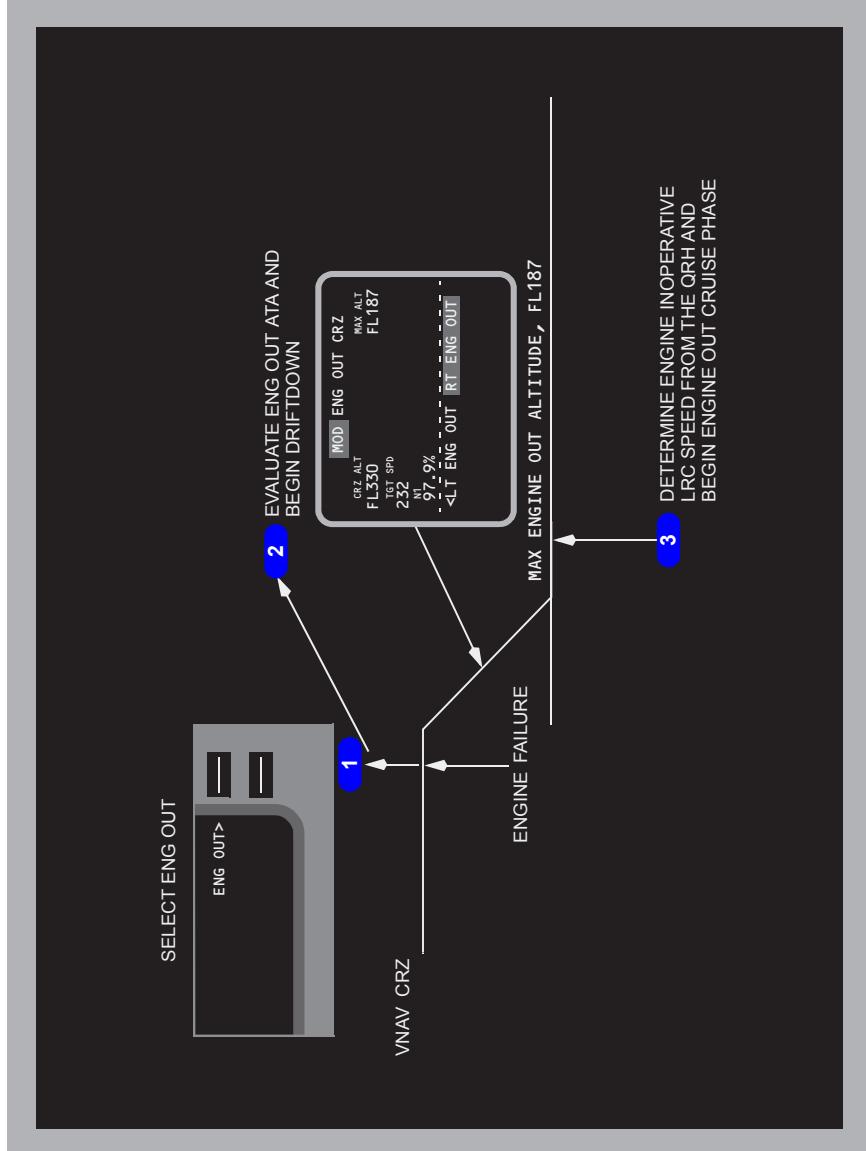
If the go-around was initiated by direct-to or waypoint sequencing, the CRZ ALT will change to the highest of:

- the highest constraint in the missed approach
- 1500 feet above airport elevation.

Refer to section NP20.xx, Go-Around Procedure and section 4.20, Go-Around for additional information.

## VNAV Cruise (Engine Out Above Eng Out Max Alt)

[Option – FMC U10.3 and later]



## 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)

### [Option – FMC U10.3 and later]

- set MCP speed to ENG OUT 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, determine Engine Inoperative LRC speed from the QRH. 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.

## Flight Management, Navigation

### Flight Management Computer

## Chapter 11

### Section 32

#### FMC Databases

The FMC contains two databases:

- performance database
- navigation database.

The performance database eliminates the need for the flight crew to refer to a performance manual during flight, and provides the FMC with the information required to calculate pitch and thrust commands. All information normally required can be displayed on the CDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

Maintenance personnel can refine the database by entering correction factors for drag and fuel flow.

The navigation database includes most information normally determined by referring to navigation charts. This information can be displayed on the CDU or navigation display. The database contains:

- the location of VHF navigation aids
- waypoints
- airports
- runways
- other airline selected information, such as SIDs, STARs, approaches, and company routes.

If the permanent database does not contain all of the required flight plan data, additional airports, navaids, and waypoints can be defined by the crew and stored in either a supplemental or a temporary 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 supplemental and temporary 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.

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## 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 electronic engine controls.

Thrust limits are expressed as N1 limits. Thrust equalization references N1.

The FMC calculates a reference thrust for the following modes:

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

### [Option – With takeoff bump thrust]

The FMC calculates a reference thrust for the following modes:

- |  |  |
|--|--|
| <ul style="list-style-type: none"><li>• takeoff</li><li>• derated takeoff</li><li>• assumed temperature takeoff</li><li>• takeoff bump</li><li>• climb</li></ul> | <ul style="list-style-type: none"><li>• reduced climb</li><li>• cruise</li><li>• continuous</li><li>• go-around.</li></ul> |
|--|--|

### [Option –With takeoff bump thrust and quiet climb]

The FMC calculates a reference thrust for the following modes:

- |  |  |
|--|--|
| <ul style="list-style-type: none"><li>• takeoff</li><li>• derated takeoff</li><li>• assumed temperature takeoff</li><li>• takeoff bump</li><li>• climb</li></ul> | <ul style="list-style-type: none"><li>• reduced climb</li><li>• cruise</li><li>• continuous</li><li>• go-around</li><li>• noise abatement (cutback).</li></ul> |
|--|--|

The thrust reference mode automatically transitions for the respective phase of flight. These modes can be selected on the N1 LIMIT page. The selected thrust reference mode is displayed on the thrust mode display.

**[Option – FMC U10.1 and later, with automatic thrust reduction after takeoff]**

The flight crew can specify the thrust reduction height where the transition from takeoff to climb thrust takes place by making an entry on TAKEOFF REF page 2. Allowable entries are 800 feet to 9,999 feet.

**[Option – FMC U10.3 and later]**

The default value is determined by the airline and is stored in the model/engine database.

**[Option – With quiet climb]**

With cutback mode selected ON, the flight crew can specify the thrust reduction and restore altitudes on TAKEOFF REF page 2. The FMC calculates and commands a cutback thrust rating based on data provided through the model/engine database. In addition the FMC uses the reduction altitude to calculate the required cutback altitude. A new N1 is calculated during climb and normal climb thrust is restored at the RESTORE altitude.

## Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

### Takeoff Derate

**[Option – FMC U10.1 and later]**

Fixed derates can be selected on the N1 LIMIT page. Performance data for these derates is provided in the Airplane Flight Manual (AFM).

With 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.

Derated takeoff rating can be further reduced by assumed temperature.

**[Option – With FMC computed QRH takeoff speeds]**

Use the takeoff speeds provided by the FMC or specified in Chapter PI, Performance-Inflight, for the selected derate or variable takeoff rating condition.

Use the takeoff speeds specified in Chapter PI, Performance-Inflight, for the selected derate or variable takeoff rating condition.

## Assumed Temperature Thrust Reduction Takeoff

### [Option – FMC U10.1 and later]

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 the N1 LIMIT page or TAKEOFF REF page 2. Use approved sources for selecting the assumed temperature.

The maximum thrust reduction authorized is 25 percent below any certified rating. Do not use assumed temperature reduced thrust if conditions exist that affect braking, such as slush, snow, or ice on the runway, or if potential windshear conditions exist.

If the assumed temperature method is applied to a fixed derate, application of additional power should not exceed the fixed derate N1 limit as loss of directional control could occur while on the ground.

When the assumed temperature method is used with full rate, the reduced thrust setting is not considered a limitation. If conditions are encountered where additional thrust is desired, the crew can manually apply full thrust.

## Takeoff Bump Thrust

### [Option]

Takeoff bump thrust may be used to meet extra thrust requirements for takeoff at certain airports. Takeoff bump thrust provides thrust above normal maximum takeoff thrust. The takeoff thrust bump setting may be selected on the N1 LIMIT page. Takeoff thrust bump is only available for takeoff, and cannot be applied to go around, max continuous, or climb thrust ratings. If takeoff thrust bump is selected, assumed temperature reduced thrust is not available.

## Derated Thrust Climb

Two fixed climb thrust derates can be selected on the N1 LIMIT page. CLB-1 provides a climb limit reduced by 3% N1 (approximately 10% thrust). CLB-2 provides a climb limit reduced by 6% N1 (approximately 20% thrust). The reduced climb setting gradually increases to full rated climb thrust by 15,000 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 the FMC's climb derate computation. If a reduced thrust takeoff has been specified on the TAKEOFF REF page, the FMC will re-compute CLB-1 and CLB-2 values as required to avoid a climb N1 value greater than the reduced thrust takeoff N1 value.

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Use of derated climb thrust reduces engine maintenance costs, but increases total trip fuel.

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## Fuel Monitoring

The FMC receives fuel data from the fuel quantity indicating system. Fuel quantity values show on the PERF INIT page and on PROGRESS page 1/3.

The scratchpad message VERIFY GW AND FUEL shows if total fuel quantity data is invalid. The PERF INIT page FUEL line changes to dashes. The FMC uses the last valid fuel quantity for performance predictions and VNAV operation. The flight crew should manually enter estimated fuel weight. Periodic fuel weight update is required for the remainder of the flight to keep gross weight current. The FMC does not update the manual fuel weight entry. The scratchpad message VERIFY GW AND FUEL shows again each 30 minutes if subsequent entries are not performed. The scratchpad message does not show during descent with Vref selected.

The scratchpad message CHECK FMC FUEL QUANTITY shows if the FMC has detected an unexpected drop in fuel quantity.

The FMC continually estimates the amount of fuel that will remain when the destination airport is reached if the active route is flown. The CDU message USING RSV FUEL is displayed if the estimate is less than the fuel reserve value entered on the PERF INIT page. The CDU message INSUFFICIENT FUEL is displayed if predicted fuel at destination will be 2000 lb. (900 kg) or less.

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## 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 RTE LEGS page is displayed with the scratchpad 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

### [Option – Dual FMC]

#### Single FMC Failure

The FMC/CDU is designed to automatically preserve the most capable modes of navigation and guidance that can be maintained with the equipment and navigation aids available. If an error or system failure results in reduced capability, then the FMC may generate a crew message for display in the CDU scratchpad. If other system inputs to the FMC should fail, affected CDU displays are blanked to prevent the display of misleading or erroneous data. For example, loss of the total fuel input causes some performance related data to be blank. The messages and FMC internal responses provide an orderly transition from full FMC guided flight to less automated capability.

If the right FMC fails, the FMC alert light and the FMC message light will illuminate. The message SINGLE FMC OPERATION will be displayed in both scratchpads. VTK will display on the right navigation display. LNAV and VNAV will disengage if autopilot B is in use (can be reengaged if autopilot A is selected). After 25 to 30 seconds, the right navigation display will display failure information. The right navigation display may be restored by placing the FMC source select switch to BOTH ON L.

**Note:** If the above indications are observed with no VTK on the right navigation display, there is a disagreement between left and right FMC data. Moving the FMC Source Select Switch to BOTH ON L should allow the two FMCs to resynchronize. The switch may then be returned to NORMAL when the message DUAL FMC OP RESTORED is displayed on both scratch pads.

### [Option – MCDU]

If the left FMC fails, the FMC alert light will illuminate. The MENU page will appear on both CDUs. VTK will appear on the left navigation display. LNAV and VNAV will disengage, but can be reengaged if autopilot B is in use or is selected. After 25 to 30 seconds, the left navigation display will display failure information. To restore full operation, the FMC source select switch must be moved to BOTH ON R.

### [Option – FMC U10.2 and later]

**Note:** During an FMC software restart, the navigation display map track may rapidly slew to 0 degrees then to the correct value.

## Dual FMC Failure

### [Option – MCDU]

If both FMCs fail, the FMC alert light will illuminate. The MENU page will appear on both CDUs. VTK will appear on both navigation displays. LNAV and VNAV will disengage. After 25 to 30 seconds, both navigation displays will display failure information.

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## FMC Failure

### [Option – Single FMC]

#### [Option – CDU]

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 navigation displays. LNAV and VNAV will disengage. After 25 to 30 seconds, both navigation displays will display failure information.

#### [Option – MCDU]

If the FMC fails, the FMC alert light will illuminate. The MENU page will appear on both CDUs. VTK will appear on both navigation displays. LNAV and VNAV will disengage. After 25 to 30 seconds, both navigation displays will display failure information.

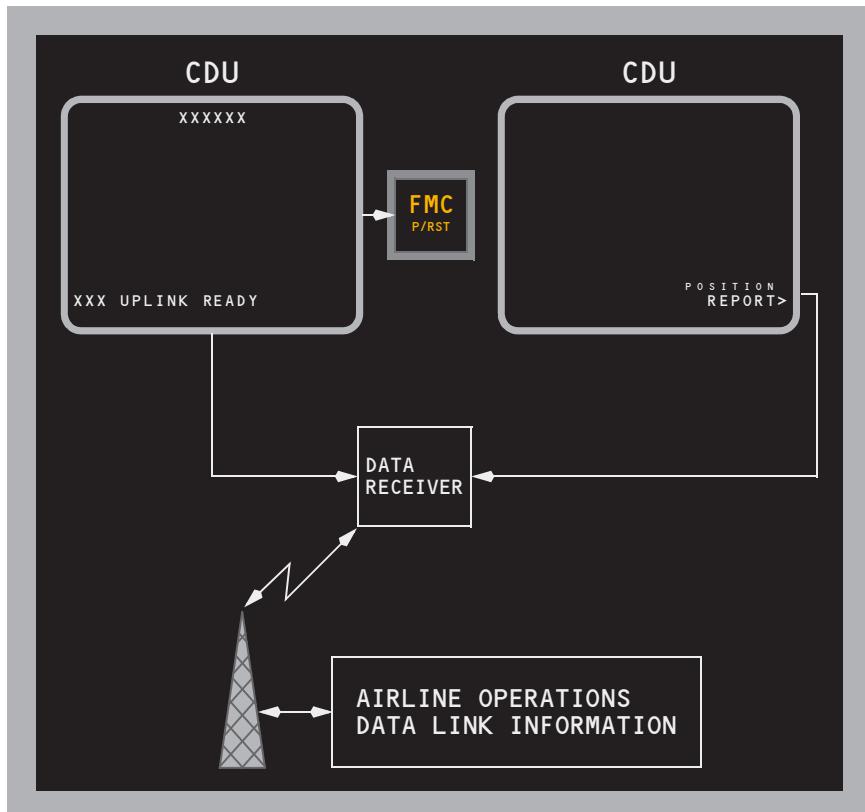
#### [Option – FMC U10.2 and later]

**Note:** During an FMC software restart, the navigation display map track may rapidly slew to 0 degrees then to the correct value.

Intentionally  
Blank

Flight Management, Navigation  
Company Data LinkChapter 11  
Section 33**[Option]****Company Data Link**

The airplane communications system enables two-way data link communications between the FMC and airline operations. A downlink occurs when data is transferred from the FMC and transmitted through the airplane communications system to a receiver on the ground. Data may be downlinked from the FMC either manually or automatically. An uplink is the opposite of a downlink; data is transmitted from a ground station for input to the FMC. Data may be uplinked at the discretion of the airline operations dispatcher or in response to a downlink request.



## Data Link

Downlinks are data link messages transmitted to a ground station. Requests for data and reports of FMC information are two types of downlinks. Requests are made manually by the flight crew. Reports can be made manually or may occur automatically.

Uplinks are messages transmitted to the airplane. Most uplinks require manual selections by the flight crew. Some uplinks are input automatically.

### Manual Downlinks

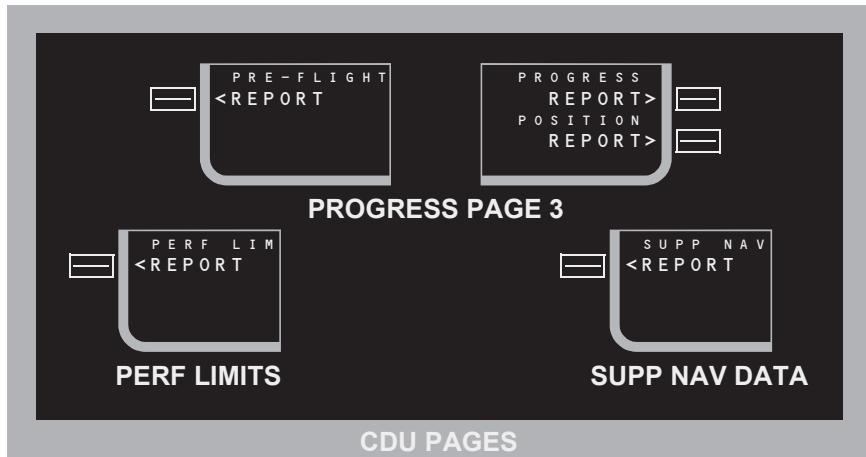
Select a REQUEST prompt to start the downlink request for data. REQUEST prompts are on PERF INIT, PERF LIMITS, TAKEOFF REF, PROGRESS, DES FORECASTS, RTE, ALTERNATE DEST, RTE DATA, and SUPP NAV DATA pages. Downlink reports of the active route may be accomplished by selection of the REPORT prompt on the PERF LIMITS or PROGRESS page and a position report may be downlinked by selection of the REPORT prompt on the PROGRESS page. The contents of the supplemental navigation database can be downlinked by selection of the REPORT prompt on the SUPP NAV DATA page.

When the communications function is unable to process FMC downlinks, the words FAIL, VOICE, NO COMM, or FULL are displayed on the CDU pages in place of the REQUEST and REPORT prompts and the header line displays the word DATALINK. The status messages are:

- FAIL
  - the ACARS management unit is inoperative
- VOICE
  - radio is operating in the VOICE mode
- NO COMM
  - radio is operational but not available
- FULL
  - all available downlink space is full.

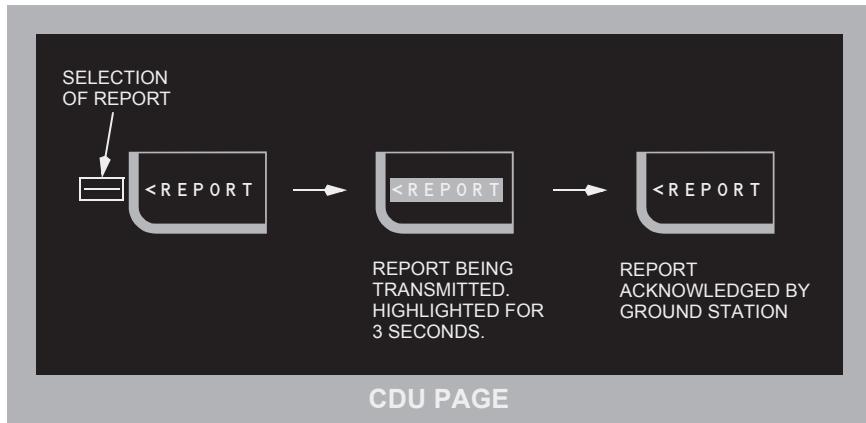
## Reports

A REPORT prompt on each page downlinks a unique report applicable to that page. The pages below contain report prompts.



## Report Status

Below is a typical sequence of status in response to sending a report.



## Automatic Downlinks

The FMC can be configured by the airline to automatically transmit downlinks of FMC data at predetermined points during the flight or in response to specific information requests from the airline dispatcher. The FMC response in these cases is completely automatic and no crew action is necessary.

## Uplinks

Uplinked data may be loaded automatically or may require flight crew action. Three uplinks automatically load data into the FMC when the REQUEST prompt is selected and do not require execution.

Uplinked data that waits in system memory for flight crew action are considered to be pending. A pending uplink is included or discarded when the flight crew selects the applicable prompt. Flight crew response to an uplink depends on the type of uplink. Flight crew action is made with ACCEPT/REJECT or LOAD prompts, FMC modification ERASE prompt or EXEC key, or when the page with the uplink is selected.

Data can be uplinked from the airline dispatcher directly to the FMC. The uplinks are annunciated to the crew by the FMC alert lights. The uplink is identified by a CDU scratchpad message.

PERF INIT uplinks are available only on the ground and after an origin airport has been entered on the RTE page.

RTE DATA cruise winds are available when not in descent and a cruise altitude and a flight plan route exist.

DES FORECASTS winds are available if a cruise altitude exists.

## Long Delete Function

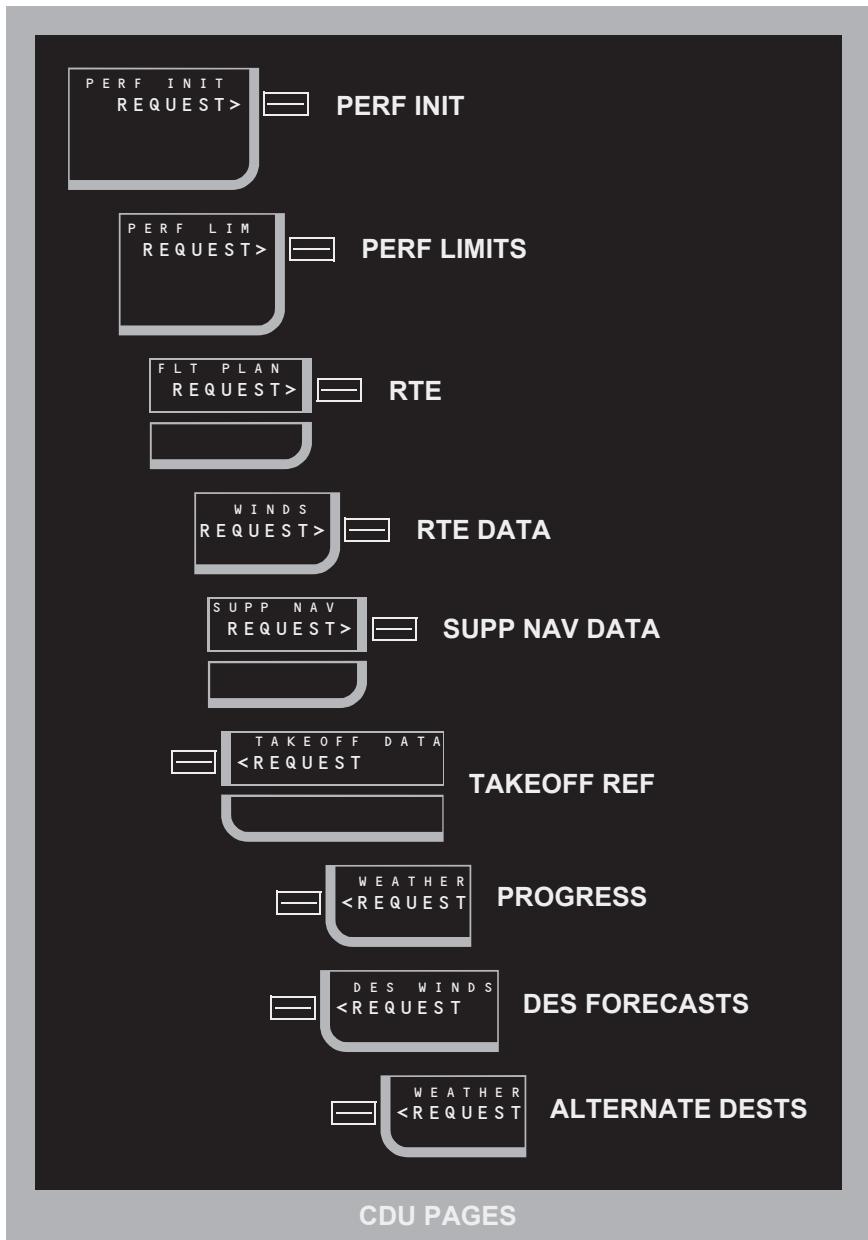
### [Option – MCDU]

During uplink, CDU keys are ignored until data is loaded into the FMC. The uplink may be suspended by pressing and holding down the DEL key for at least one second. For all uplinks, except SUPP NAV DATA uplinks, the loaded data is then removed from the flight plan and placed back into the ready to be loaded state. Uplinks that do not generate a modified plan are reloaded when there has been no CDU pushbutton activity for 30 seconds. Uplinks that do generate a modified plan can be reloaded using the LOAD prompt on the appropriate page.

When the long delete is used during a SUPP NAV DATA uplink, the uplink is suspended, but the data loaded up to that point remains in the database. After 30 seconds of keyboard inactivity, the remaining data is loaded.

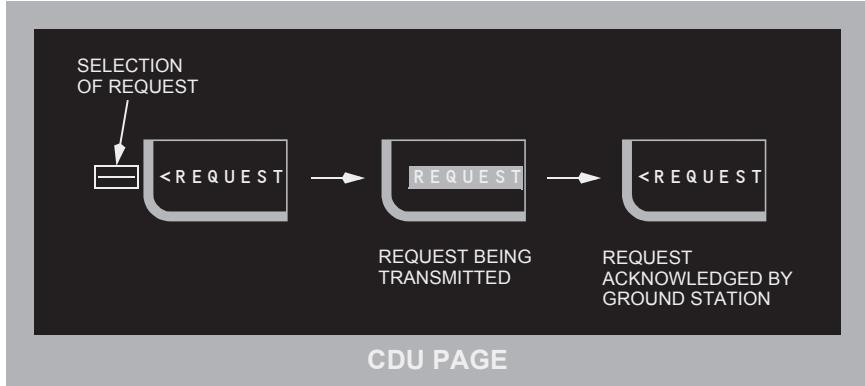
## Requests

A REQUEST prompt on each page downlinks a unique request applicable to that page. The pages below contain request prompts.



## Request Status

Below is a typical sequence of status in response to sending a request.



## FMC Data Link Uplinks (Accept/Reject)

ACCEPT and REJECT are shown on the TAKEOFF REF 1/2 page following receipt of uplink data.

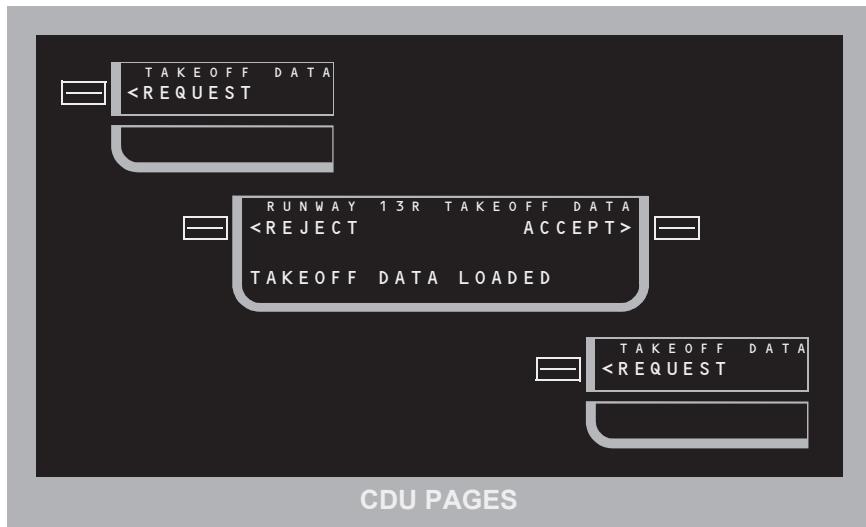
Uplink data for the current runway is shown initially in small font for preview.

Selecting ACCEPT:

- displays uplinked data in large font
- replaces previous data with uplinked data
- returns page display to normal (pre-uplink) format
- clears scratchpad message
- transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting REJECT:

- replaces uplinked data with previous data
- returns page display to normal (pre-uplink) format
- clears scratchpad message
- transmits a downlink reject message (if enabled) to inform of rejection.



## FMC Data Link Uplinks (Load/Activate/Exec)

LOAD is shown on the RTE page after receipt of uplink data. After the uplinked data is loaded, the ACTIVATE prompt is shown. After selecting ACTIVATE, the EXEC light illuminates.

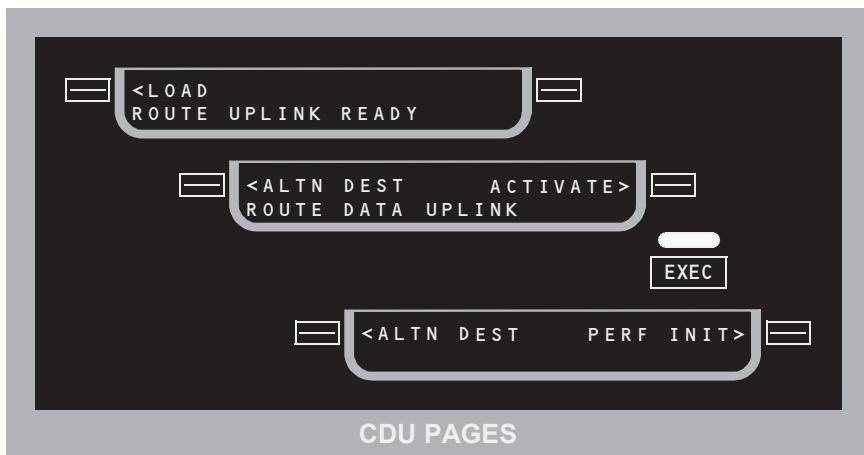
Selecting LOAD:

- loads uplinked data into FMC for viewing
- updates scratchpad message
- transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting ACTIVATE and EXEC:

- puts uplinked data in active flight plan
- returns page display to normal (pre-uplink) format
- clears scratchpad message
- transmits a downlink accept message (if enabled) to acknowledge acceptance.

[Option – Liquid crystal display CDU or Liquid crystal display MCDU or Liquid crystal FANS MCDU]



## FMC Data Link Uplinks (Load/Exec-Erase)

LOAD shows on the PERF INIT, PERF LIMITS, RTE DATA, and DES FORECASTS pages after receipt of uplink data.

After the uplinked data is loaded, the EXEC light illuminates and the ERASE prompt is displayed.

Selecting LOAD:

- loads uplinked data into FMC for viewing
- updates scratchpad message

- uplinked data modifies previous data
- ERASE prompt displays
- EXEC light illuminates.

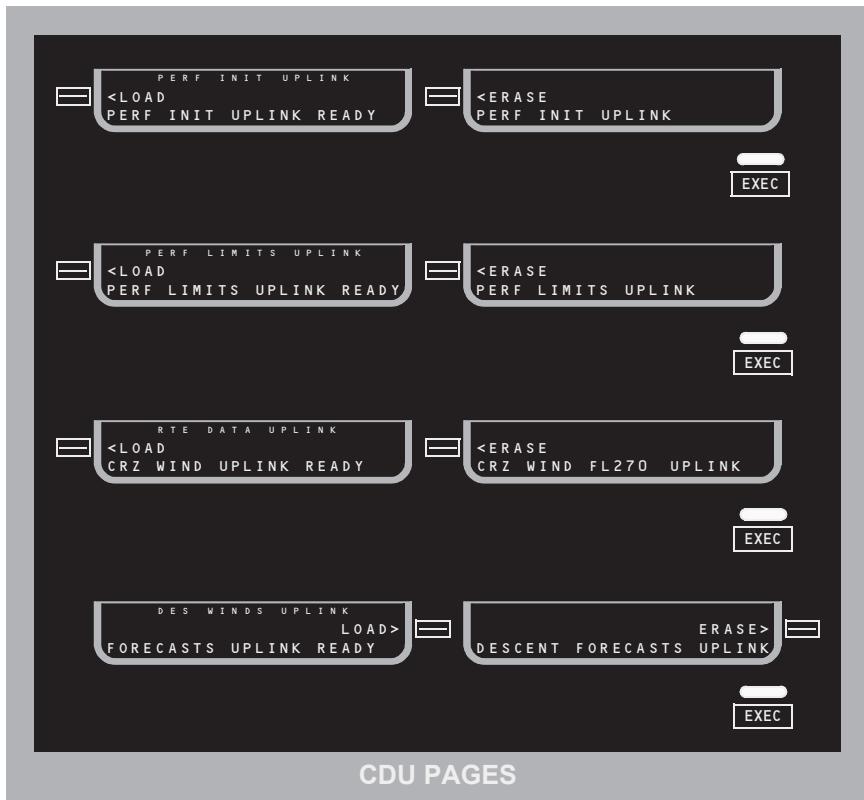
Pushing the EXEC key:

- incorporates modified data into active flight plan
- clears scratchpad message
- returns page display to normal (pre-uplink) format
- transmits a downlink accept message (if enabled) to acknowledge acceptance.

Selecting ERASE:

- removes modified data
- clears scratchpad message
- returns page display to normal (pre-uplink) format.
- transmits a downlink reject message (if enabled) to inform of rejection.

[Option – Liquid crystal display CDU or Liquid crystal display MCDU or Liquid crystal FANS MCDU]



## CDU PAGES

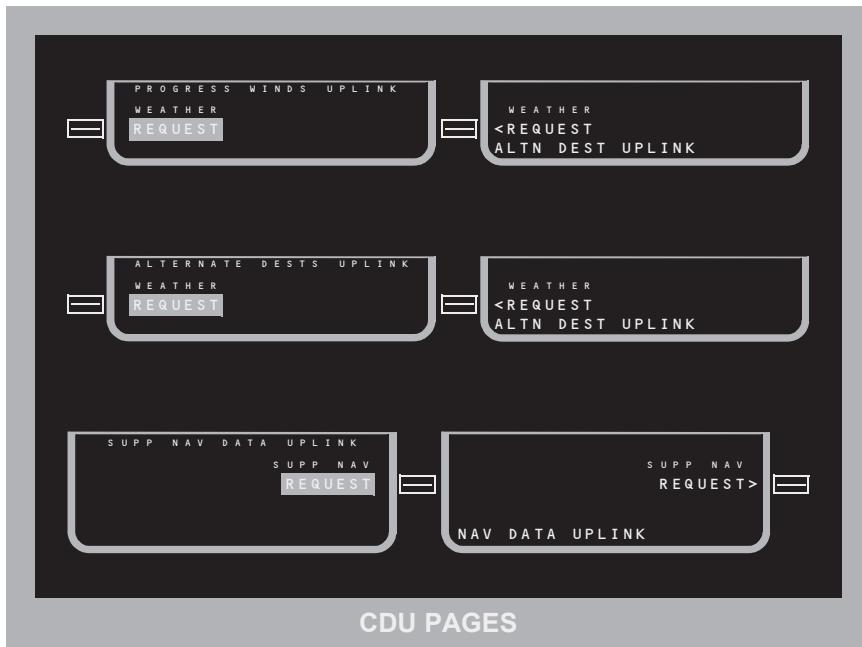
## FMC Data Link Uplinks (Request)

Selecting the REQUEST prompt is the only action required to uplink data on the PROGRESS, ALTERNATE DEST, and SUPP NAV DATA pages.

After the uplinked data is loaded, an uplink message appears in the scratchpad.

Selecting REQUEST:

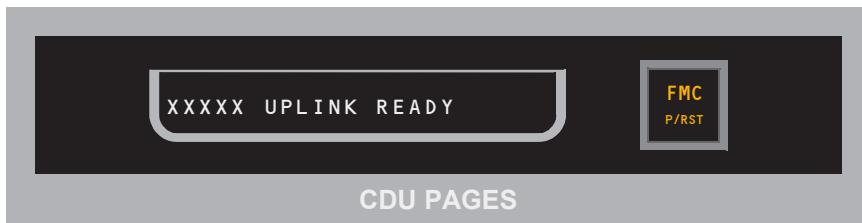
- loads uplinked data into FMC
- displays scratchpad message when uplink complete
- uplinked data modifies previous data.



## FMC Data Link Uplinks (Automatic)

Data can be automatically uplinked.

The scratchpad message XXXXX UPLINK READY is displayed and the FMC alert light illuminates.

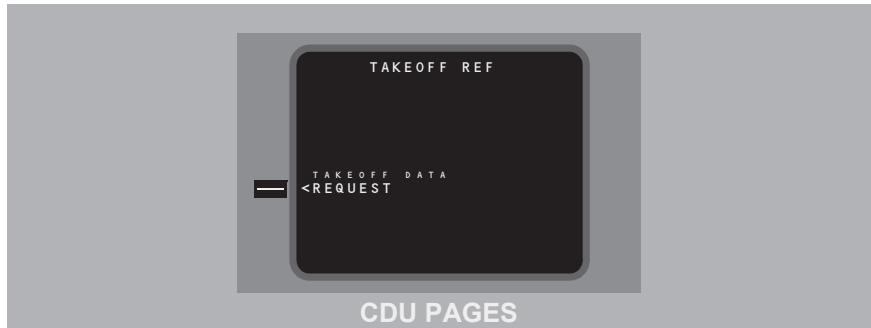


## Data Link Management

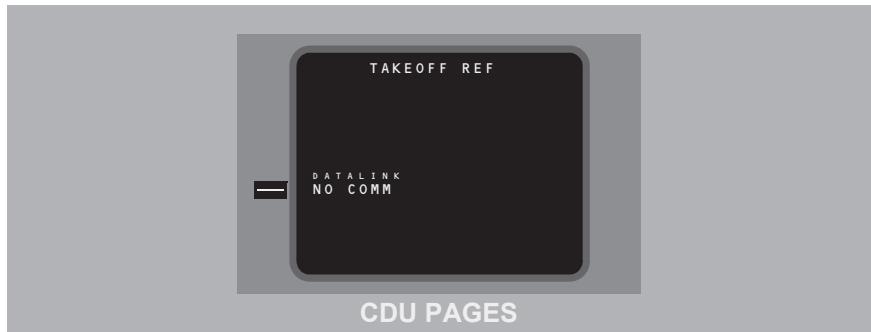
The flight crew should monitor system status of FMC data link by observing status displays on CDU pages.

### CDU Data Link Status Displays

Data link operation is verified when the correct line title is above the related prompt. In the example below, the line title TAKEOFF DATA is above the REQUEST prompt on the TAKEOFF REF page.



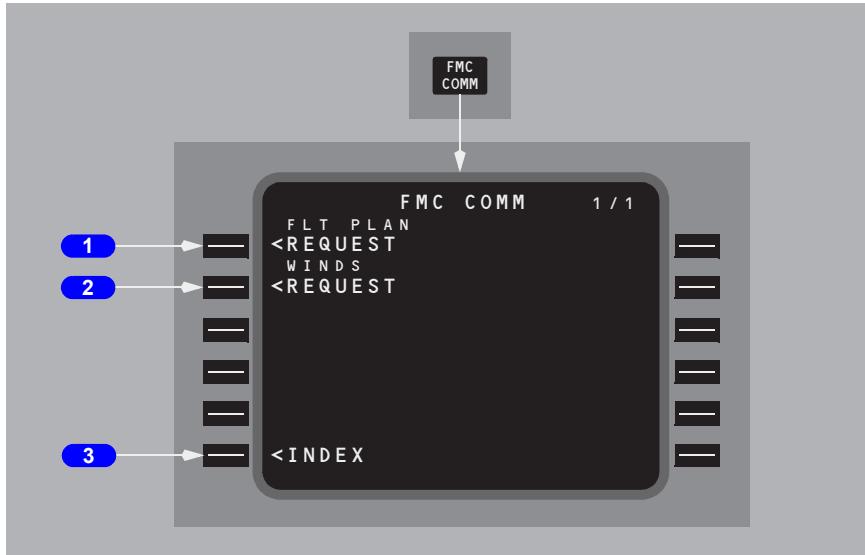
When the data link system is not operating, CDU page prompts change to FAIL, VOICE, NO COMM or FULL and the headings change to DATALINK. A typical example is shown below.



## FMC Communications Page

### [Option – FANS MCDU with company data link]

FMC communication page provides ability to initiate AOC datalink downlink requests. The actual prompts available and types of information requests generated is customer definable. The page examples below are representative only.



#### **1 Flight Plan Request (FLT PLAN)**

Push – transmits a data link request for a flight plan uplink.

#### **2 Winds Request (WINDS)**

Push – transmits a data link request for a winds uplink.

#### **3 INDEX**

Push – displays the INIT/REF INDEX page.

## Flight Management, Navigation

### FMC Preflight

## Chapter 11

### Section 40

---

#### 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.

#### [Option – With company data link]

Data link can be used to load preflight data from airline ground stations. Using data link reduces the required crew actions. Manual crew entries replace existing data. Data link can also be used to load takeoff data onto the TAKEOFF REF pages.

---

#### Preflight Page Sequence

The normal preflight sequence follows paging prompts on each CDU page.

The normal FMC power-up page is the identification page. Preflight flow continues in this sequence:

- identification (IDENT) page
- position initialization (POS INIT) page
- route (RTE) page
- DEPARTURES page (no automatic prompt)
- performance initialization (PERF INIT) page

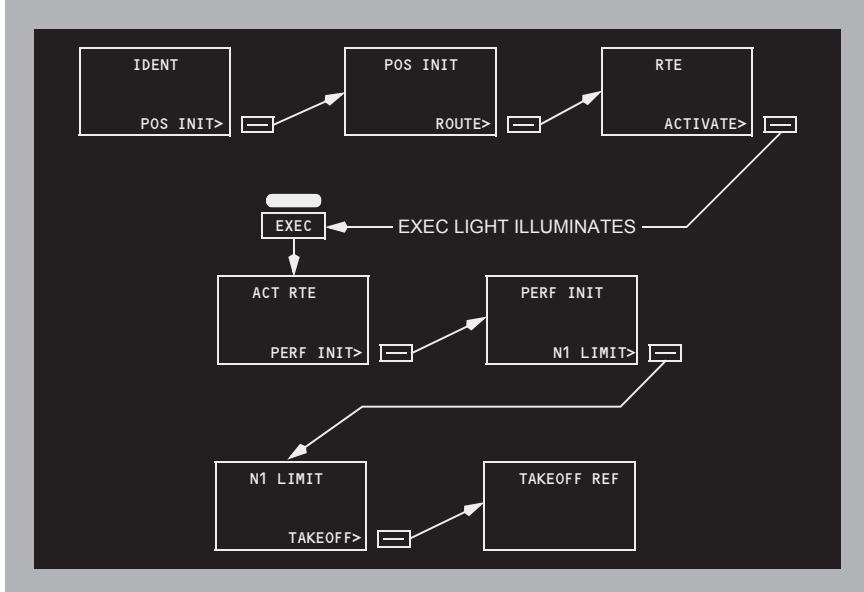
#### [Option – FMC U10.1 and later]

- with U10.1 or later installed:
  - N1 LIMIT page
  - takeoff reference (TAKEOFF REF) page.

Some of these pages are also used in flight.

## Minimum Preflight Sequence

[Option – FMC U10.1 and later]



During preflight, a prompt in the lower right of the CDU page automatically directs 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.

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.

## 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.

**[Option – With alternate destination prediction]**

Alternate airports are added on the ALTERNATE DESTS page. The ALTERNATE DESTS page is described in the FMC Descent/Approach section 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.

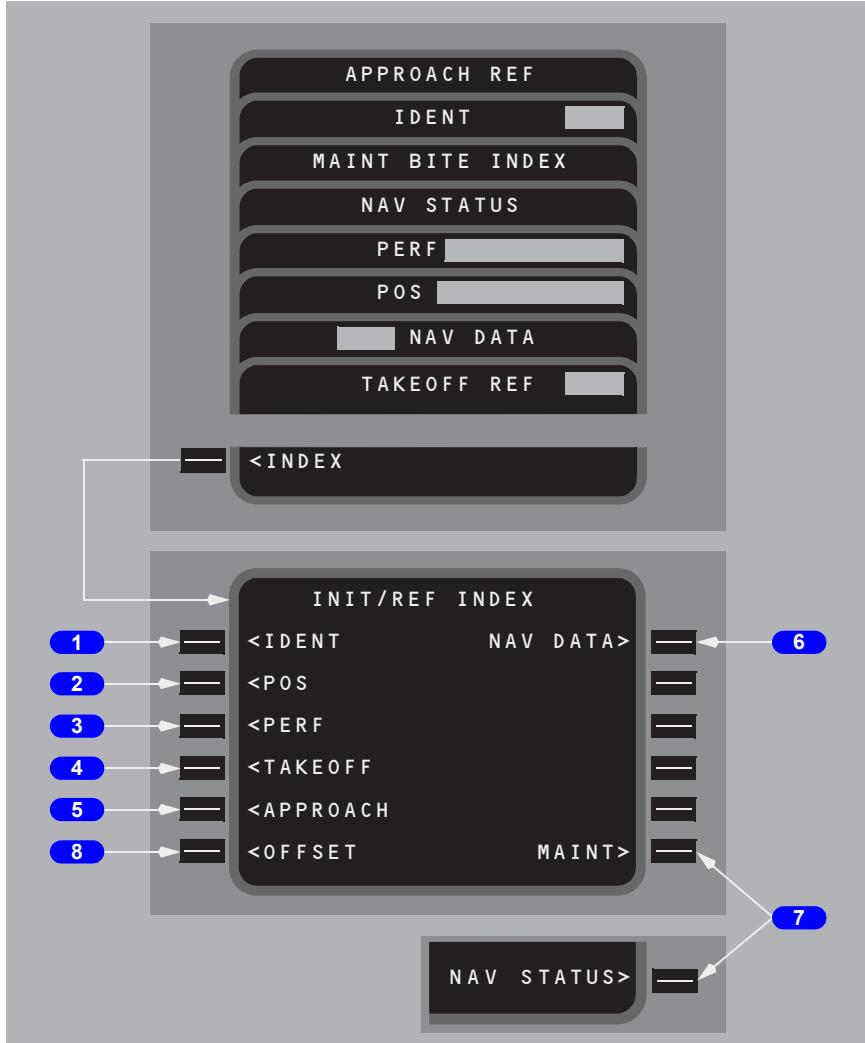
## Preflight Pages

The preflight pages are presented in the sequence used during a typical preflight.

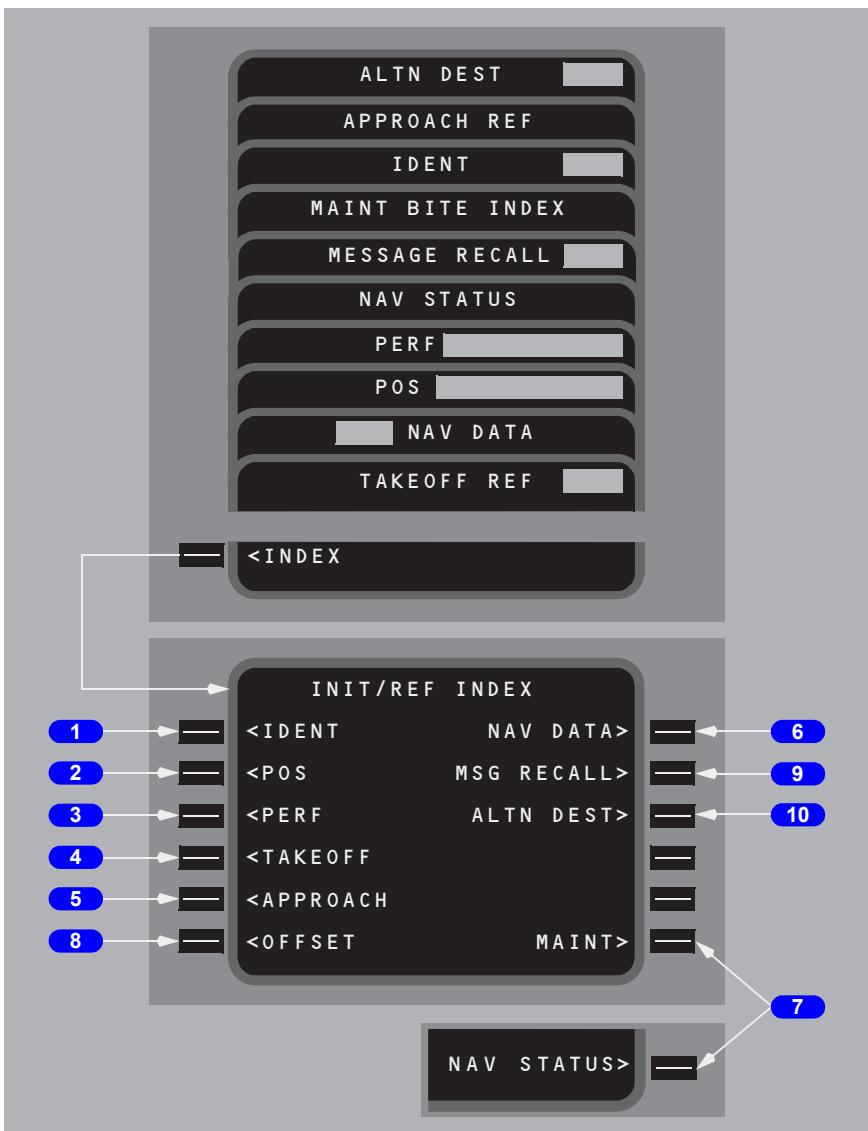
### Initialization/Reference Index Page

The initialization/reference index page provides manual selection of FMC pages. It provides access to pages used during preflight and not normally used in flight.

[Option – Without alternate destination prediction or message recall]



[Option – With alternate destination prediction and message recall]



### 1 IDENT

Push – displays the IDENT page, the first page in the automatic preflight sequence.

## 2 Position Initialization (POS)

- Push – 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 Initialization (PERF)

Push – displays the PERF INIT page for initialization of data required for VNAV operations and performance predictions.

## 4 Takeoff Reference (TAKEOFF)

Push – displays the TAKEOFF REF page to enter takeoff reference information and V speeds.

## 5 APPROACH

Push – displays the APPROACH REF page for entry of the approach VREF speed.

## 6 Navigation Data (NAV DATA)

Push – displays the REF NAV DATA page to display information about waypoints, navaids, airports, and runways. On the ground, displays the SUPP NAV DATA page if SUPP is entered in the scratchpad prior to selection.

## 7 Maintenance (MAINT) or Navigation Status (NAV STATUS)

- MAINT – On ground only.  
Push – displays maintenance pages for maintenance use.
- NAV STATUS – Replaces MAINT prompt when in air.  
Push – displays NAV STATUS page which shows status of navigation aids being tuned by the FMC. Replaces MAINT prompt when in air.

## 8 OFFSET

Push – displays the LATERAL OFFSET page for initiating a lateral offset.

## 9 Message Recall (MSG RECALL)

### [Option – With message recall]

Push – displays the MESSAGE RECALL page to view active messages.

## 10 Alternate Destinations (ALTN DEST)

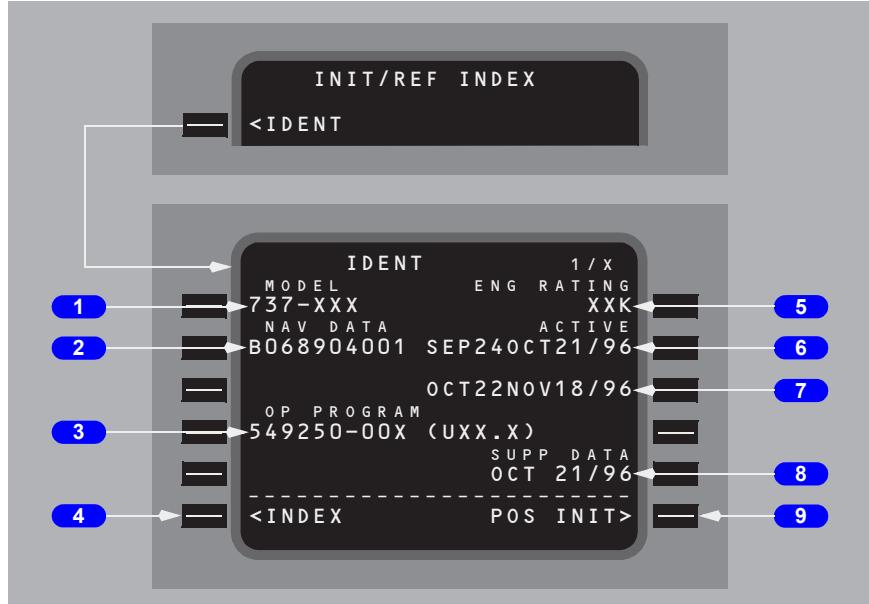
### [Option – With alternate destination prediction]

Push – displays the ALTERNATE DESTS page used for alternate airport planning and diversions.

## Identification Page

Most of the data on this page is for crew verification. Active date accepts manual entries.

The crew verifies FMC data and selects a navigation database on the identification page.



### 1 MODEL

Displays the airplane model from the FMC performance database (e.g., 737-600, 737-700, 737-800 or 737-900).

### 2 Navigation Data (NAV DATA)

Displays the navigation database identifier.

### 3 Operational Program (OP PROGRAM)

Displays the Boeing software part number and update version. Update version installed at delivery:

#### [Option – FMC U10.7]

- Update 10.7 (U10.7)

#### [Option - FMC U10.8]

- Update 10.8 (U10.8)

## 4 INDEX

Push – displays the INIT/REF INDEX page.

## 5 Engine Rating (ENG RATING)

Displays the engine thrust stored in the FMC performance database (e.g., 20K, 22K, 24K, 26K or 27K ).

## 6 ACTIVE Date Range

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)

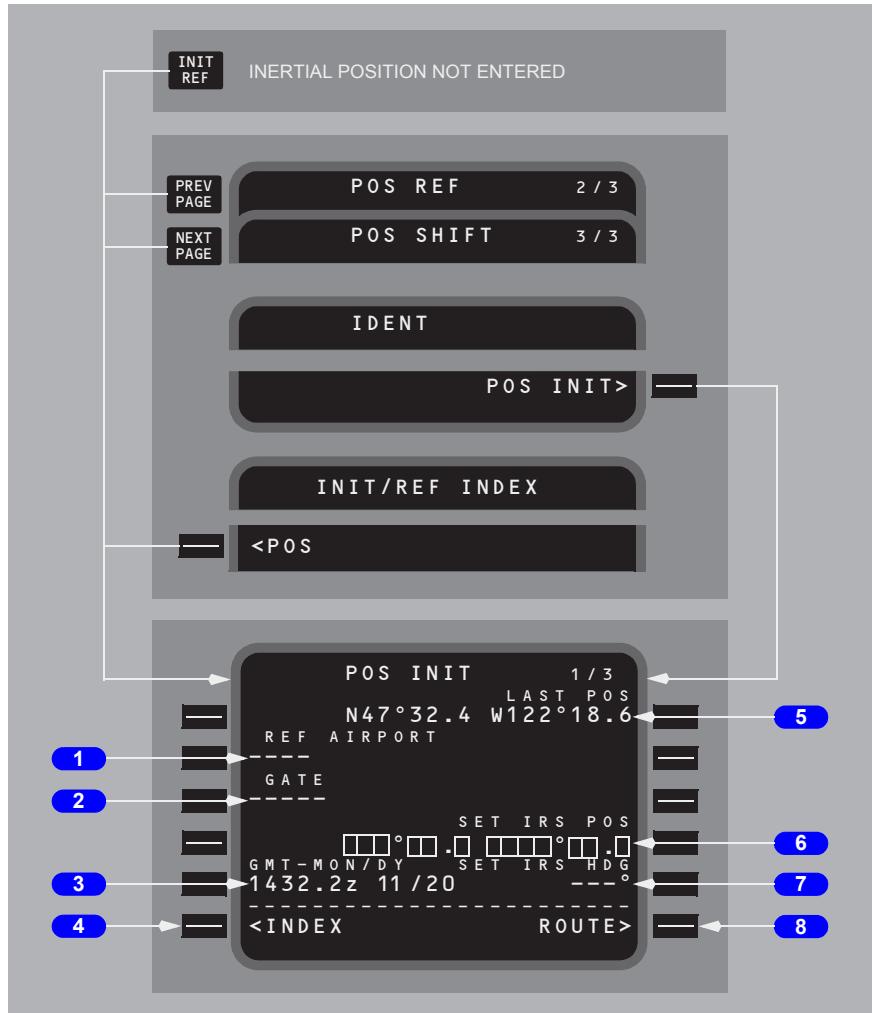
Displays the effective date of supplemental data. Blank if supplemental database is empty.

## 9 Position Initialization (POS INIT)

Push – displays the POS INIT page.

## Position Initialization Page 1/3

The position initialization page 1/3 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 GMT – Month/Day (GMT – MON/DY)**

### **[Option – With GPS]**

Displays GPS time and date. If the GPS time 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.

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.

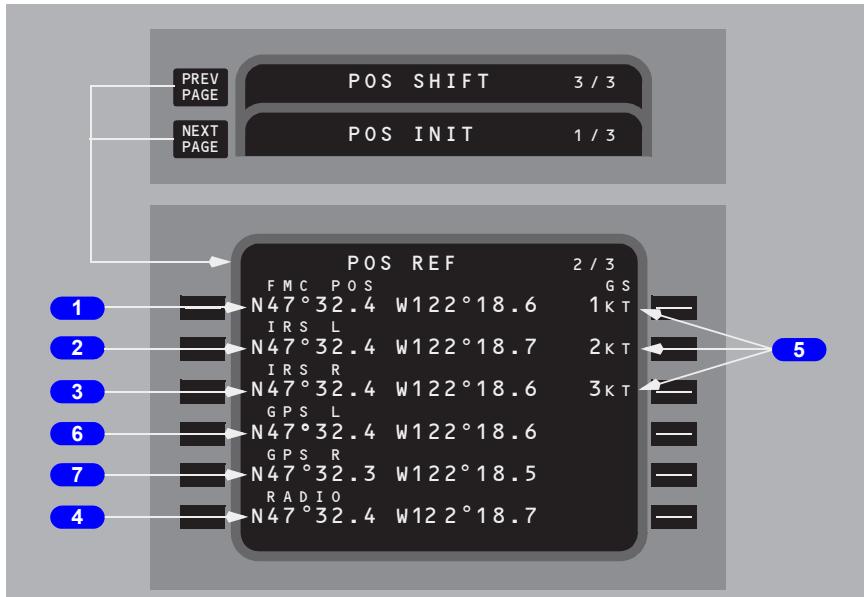
## Position Reference Page 2/3

### [Option – With GPS]

Position reference page 2 displays the airplane positions as calculated by the FMC, IRS, GPS, 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.

### [Option – With GPS]



#### 1 FMC Position (FMC POS)

Displays the FMC calculated latitude/longitude.

Blank if FMC position is invalid.

#### 2 IRS L

Displays the latitude/longitude position as determined by the left IRS.

Blank if IRS position is invalid.

#### 3 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 Groundspeed (GS)**

Displays the ground speed for FMC and IRS.  
Blank if ground speed of related system is invalid.

**6 GPS L****[Option – With GPS]**

Displays the latitude/longitude position as determined by the left GPS.  
Blank if GPS position is invalid.

**7 GPS R****[Option – With GPS]**

Displays the latitude/longitude position as determined by the right GPS.  
Blank if GPS position is invalid.

## Route Page 1/X

The route is entered and displayed in air traffic control format.

### [Option – FMC U10.3 and later]

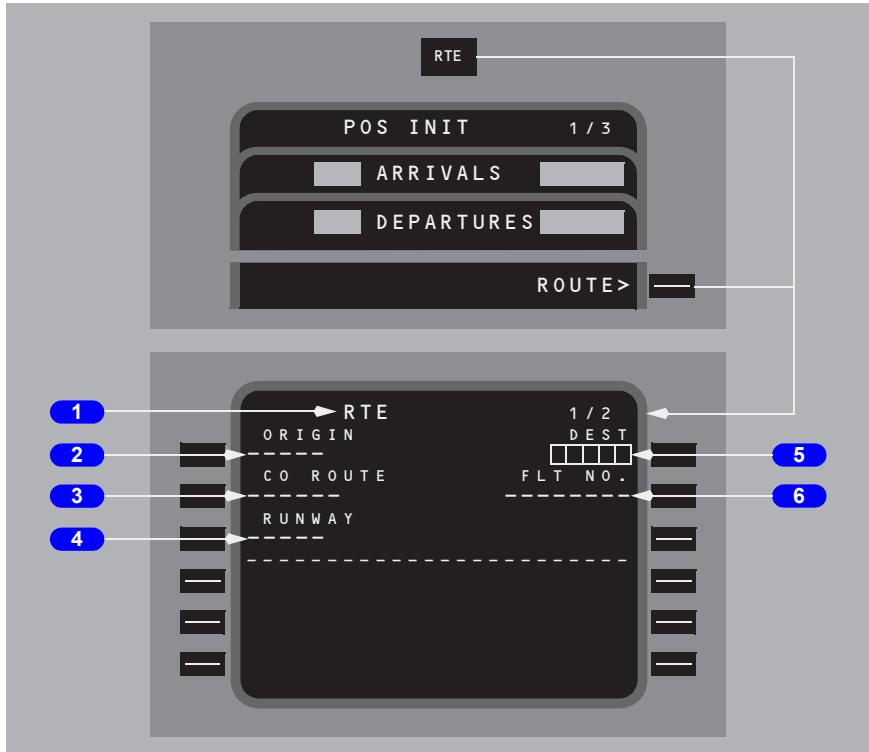
The first route page displays origin and destination data. Route segments are displayed on subsequent route pages.

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.

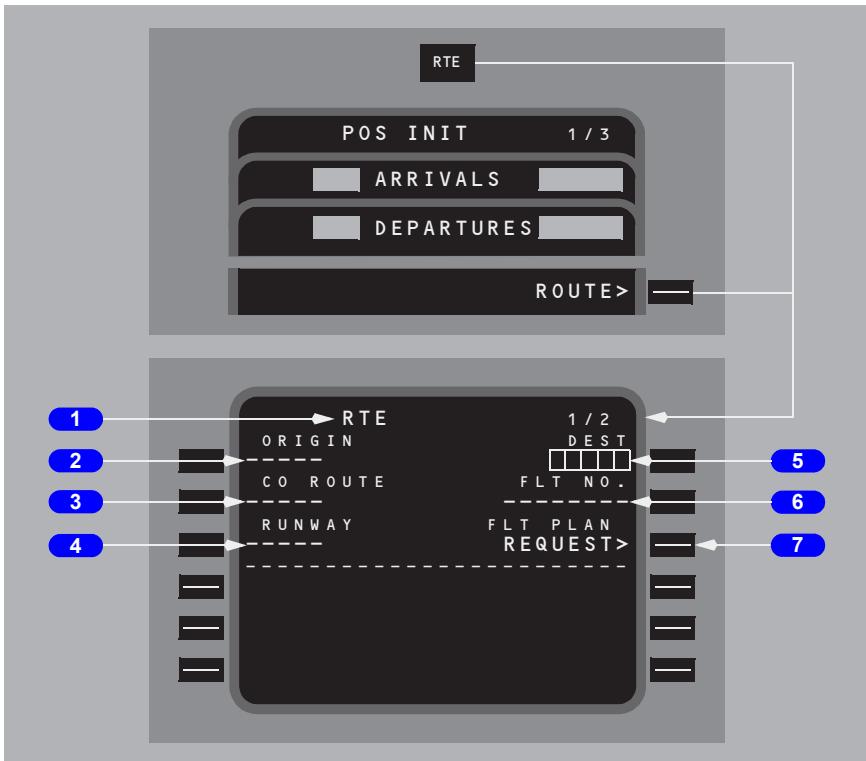
### [Option – With company data link]

The route may also be uplinked.

### [Option – FMC U10.3 and later with flight number entry]



[Option – FMC U10.3 and later, with flight number entry and company data link]



## 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.

[Option – FMC U10.3 and later]

Entry is allowed for all phases of flight. Entry of a new origin erases the previous route.

---

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 DATA BASE is displayed.

Entry of a new company route replaces the previous route.

Inflight entry is inhibited for the active route.

### **4 RUNWAY**

Line title does not display until after entry of origin airport.

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.

Can be entered from the DEPARTURES page.

Entry is deleted upon takeoff.

### **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.)****[Option – With flight number entry]**

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.

**[Option – With Elementary Surveillance]**

As installed:

Transponder transmits flight number to ATC.

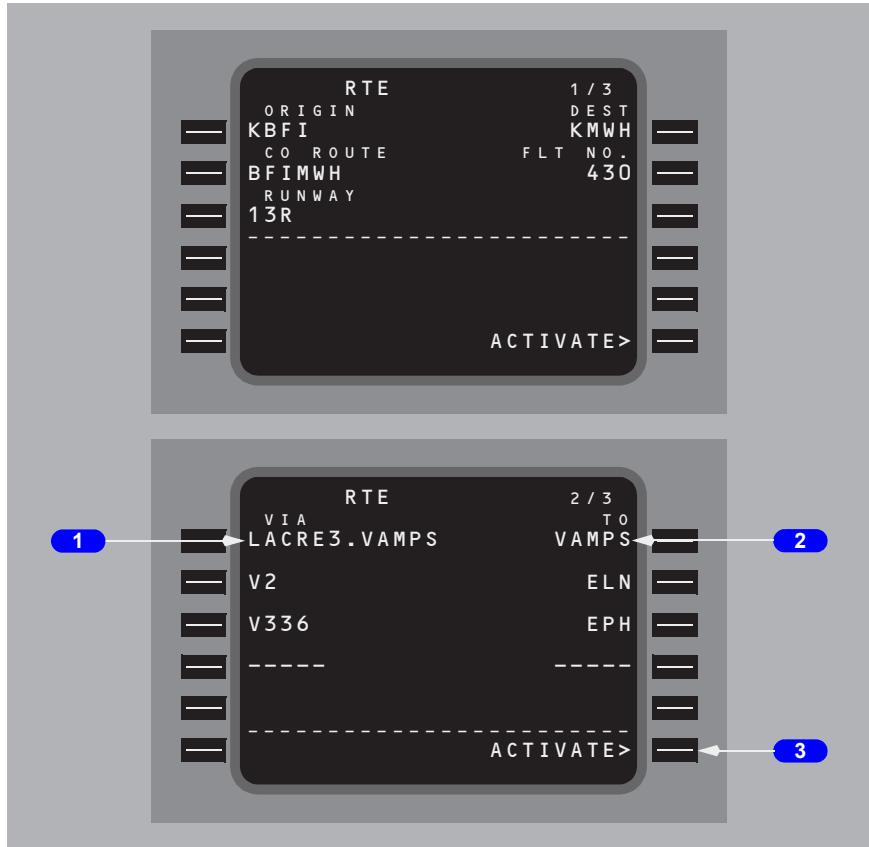
**7 FLT PLAN REQUEST****[Option – With company data link]**

Push – transmits a data link request for a flight plan route uplink

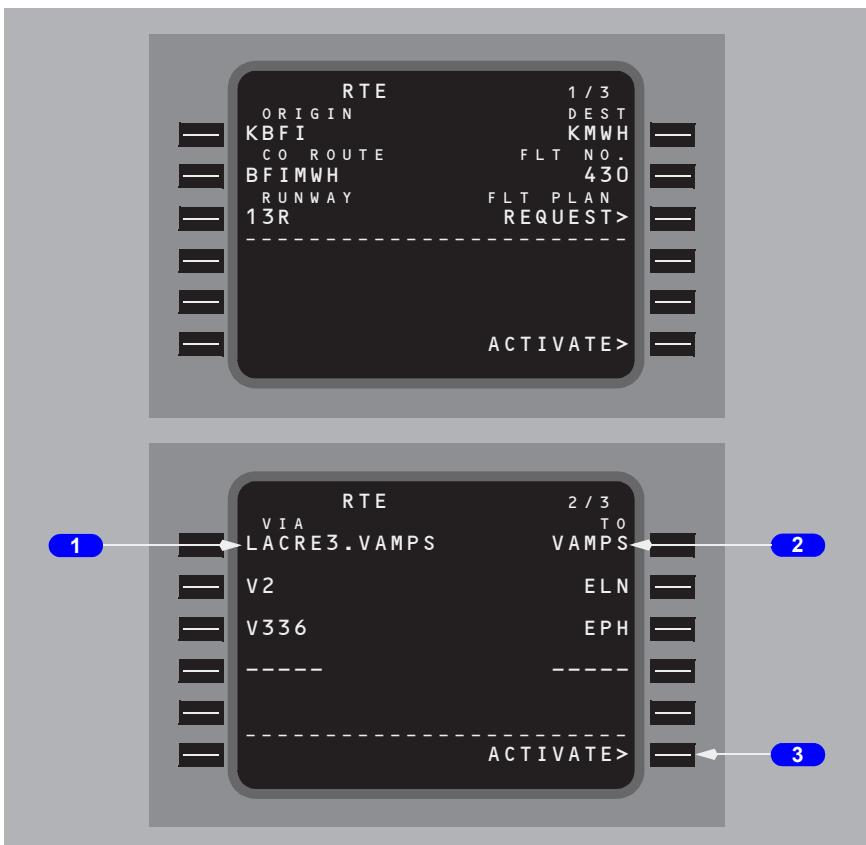
## Route Pages 1/X and 2/X with Data Entries

[Option – FMC U10.3 and later]

[Option – With flight number entry]



[Option – With flight number entry and company data link]



## 1 VIA

The VIA column displays the route segment to the waypoint or 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, or

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.

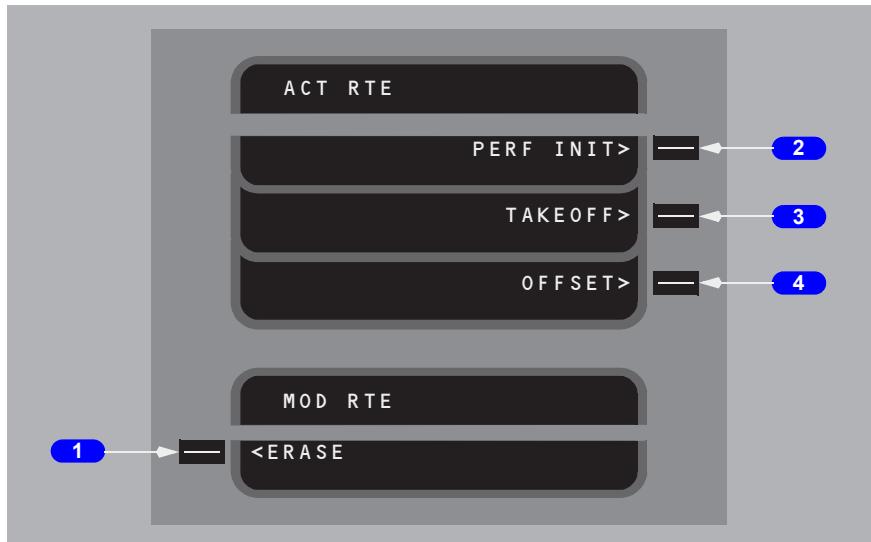
Activation of a route is required for completion of the preflight.

Displayed on inactive route pages.

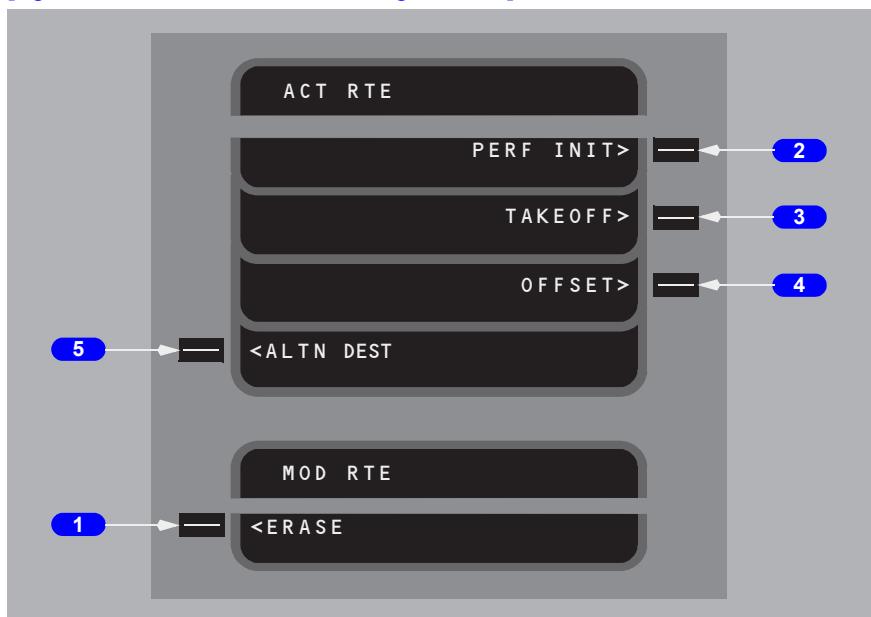
After route activation, the ACTIVATE prompt is replaced by:

- 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



[Option – With alternate destination prediction]



## 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 1/2.

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.

## 5 Alternate Destination (ALTN DEST)

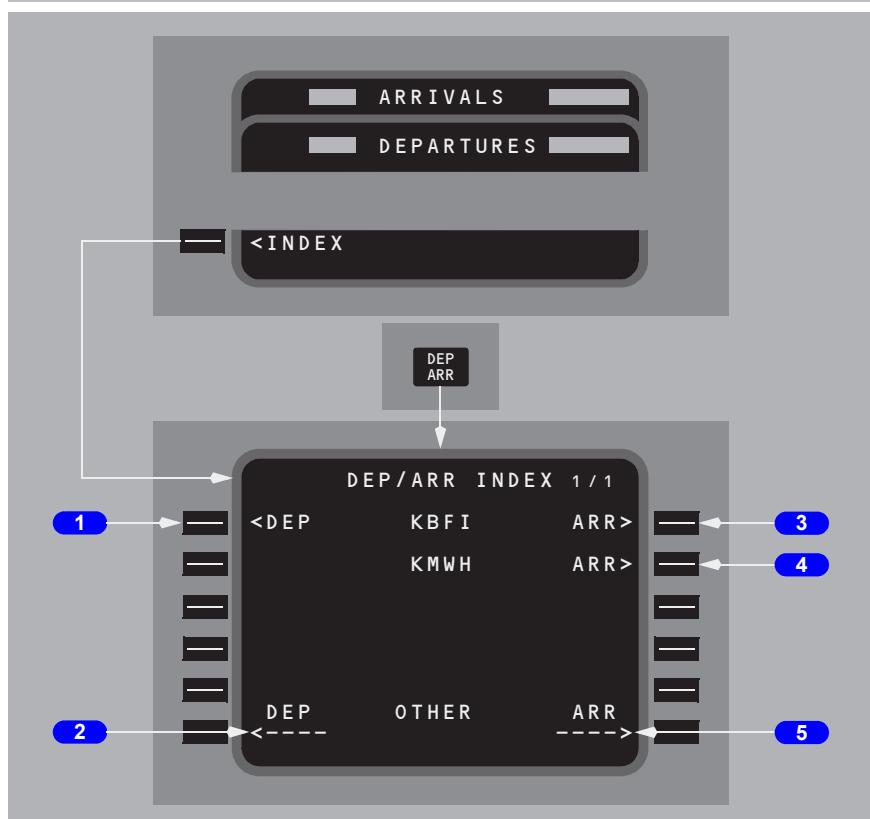
### [Option – With alternate destination prediction]

Push – displays ALTERNATE DESTS page 1/6.

## Departure/Arrival Index Page

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival 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 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 origin airport. Origin airport arrivals selection is used during a turn-back situation.

---

**4 Arrival (ARR) – Destination**

Push – displays the arrival page for destination airport.

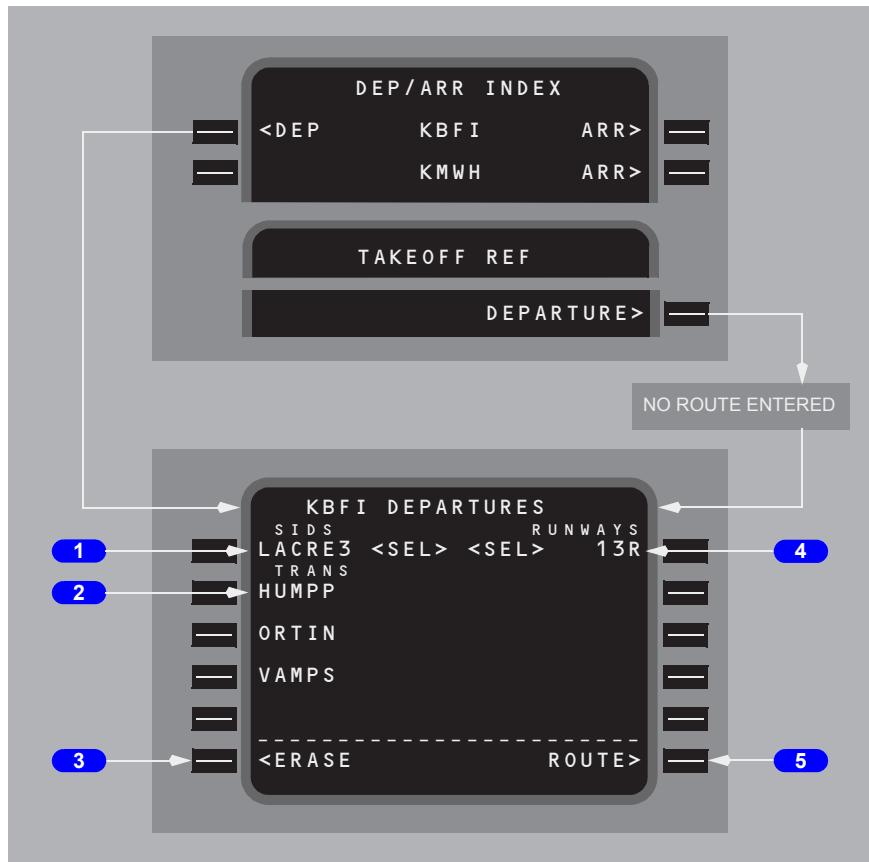
**5 Arrival (ARR) – OTHER**

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.

#### [Option – With engine out SIDS]

Displays the engine-out SIDS for the airport and runway selections following the last SID display line or on the first line if there are no SIDS for the departure airport and runway.

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.

Push – removes route modifications that are not executed and restores the original route.

INDEX is displayed when no route modification is pending.

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.

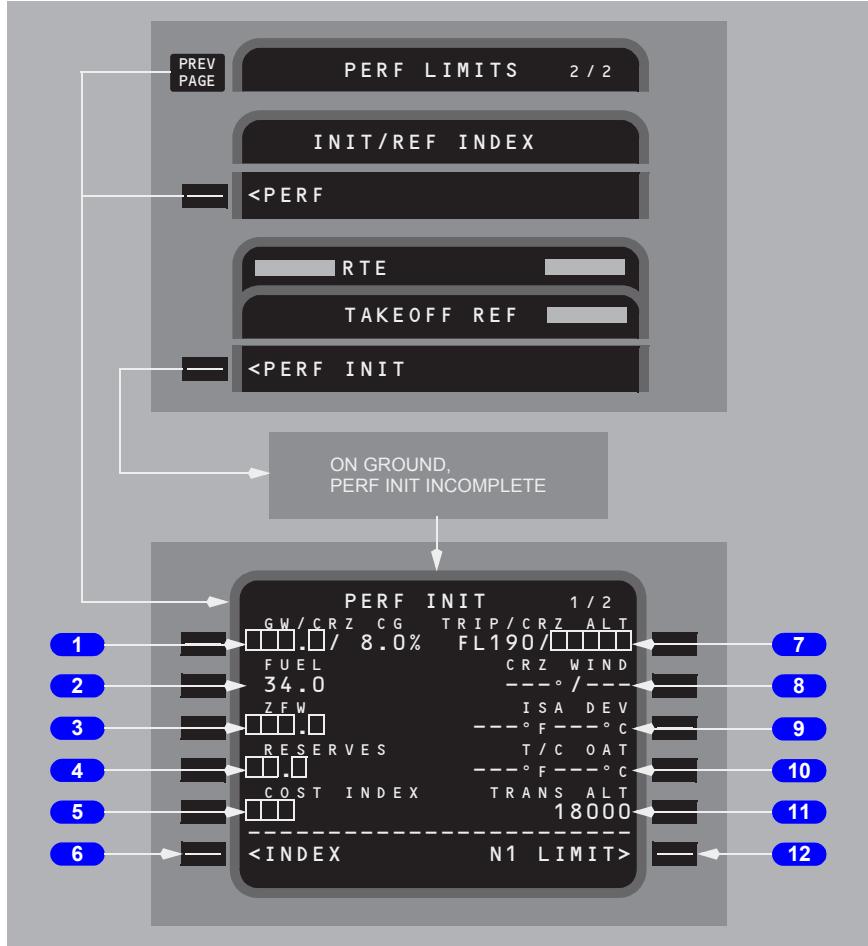
### Selecting Options

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.

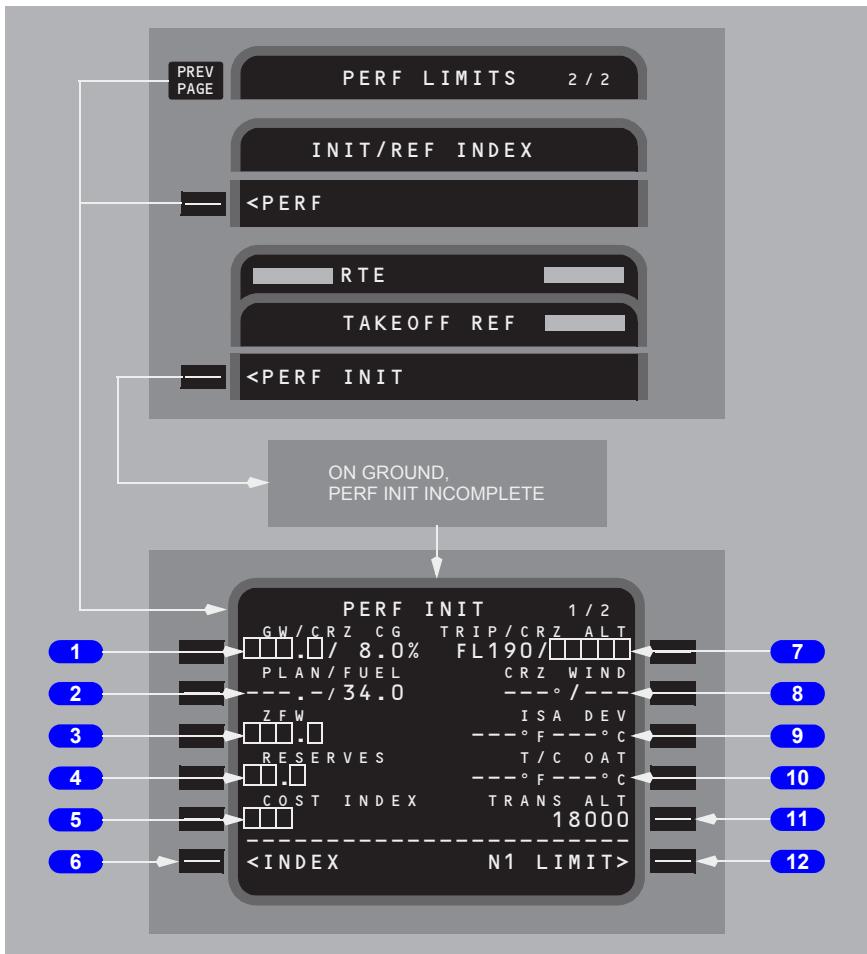
## Performance Initialization Page

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This information is required for VNAV calculations.

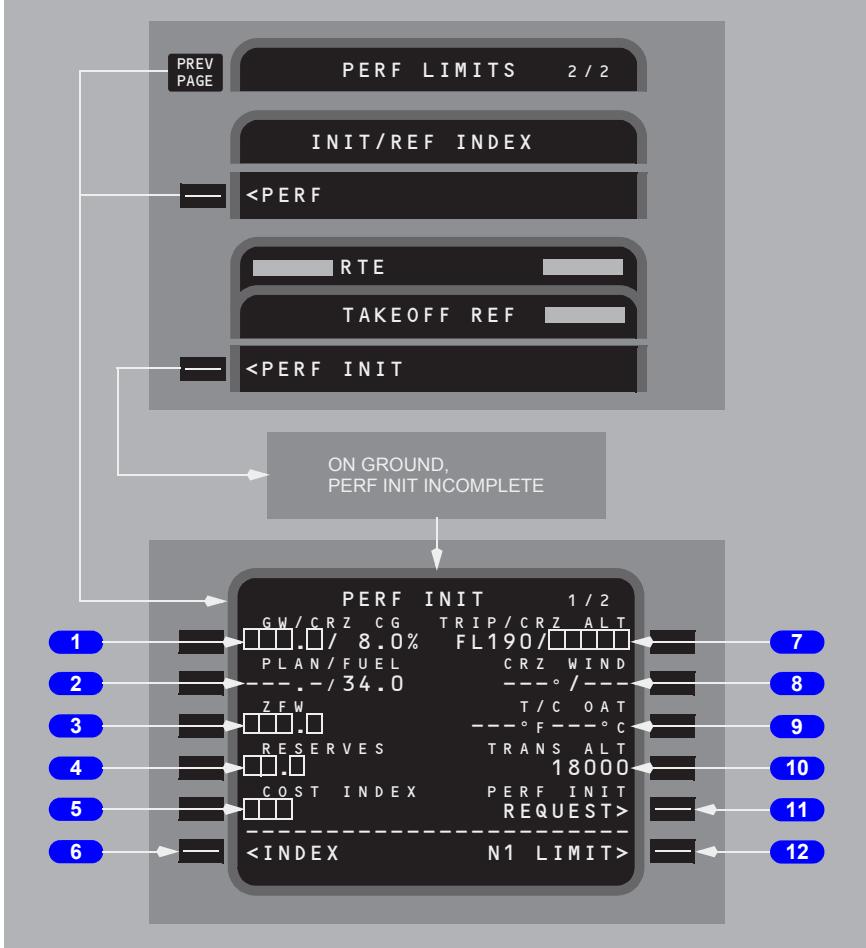
[Option – FMC U10.1 and later]



[Option – FMC U10.1 and later, with PLAN FUEL line]



[Option – FMC U10.1 and later, with company data link and PLAN FUEL line]



### 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 quantity indication system.

In flight, when the FMC is not receiving the required fuel data, the CDU displays dashes and allows manual entry of fuel weight. After manual entry, MAN (manual) appears next to the fuel weight. Manual entry of fuel weight should continue approximately every 30 minutes for the remainder of the flight to keep gross weight current.

## 2 PLAN/FUEL

### [Option – With PLAN FUEL line]

Fuel on board is automatically displayed as received from the airplane fuel quantity indication system.

### [Option – FMC U10.3 and later]

PLAN entry allows fuel predictions before actual fuel is known. Entry is blanked with flaps extended or in flight.

In flight, when the FMC is not receiving the required fuel data, the CDU displays dashes and allows manual entry of fuel weight. After manual entry, MAN (manual) appears next to the fuel weight. Manual entry of fuel weight should continue approximately every 30 minutes for the remainder of the flight to keep gross weight current.

## 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 500. 0 causes the ECON speed to be MAX RANGE; 500 results in a minimum time flight.

Entry of a company 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 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 made, FMC assumes zero deviation.

## 9 Top of Climb Outside Air Temperature (T/C OAT)

### [Option – With company data link]

T/C OAT entry provides input to optimize FMC calculations.

Entry causes ISA DEV to be computed and displayed.

Enter top of climb OAT.

If no entry made, FMC assumes ISA value.

## 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 top of climb OAT.

If no entry made, FMC assumes ISA value.

## 10 Transition Altitude (TRANS ALT)

### [Option – With company data link]

Displays 18,000 feet at FMC power up.

Changes automatically after selecting a departure procedure with a different transition altitude.

Manual entry has priority.

## 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.

## 11 PERF INIT REQUEST

### [Option – With company data link]

Push – transmits a data link request for a PERF INIT uplink

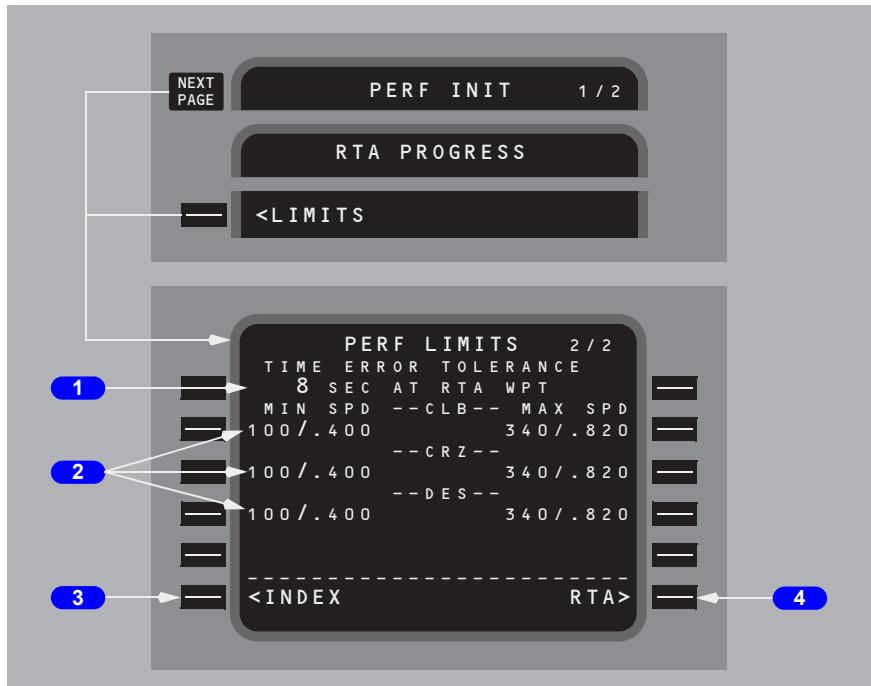
## 12 N1 LIMIT

### [Option – FMC U10.1 and later]

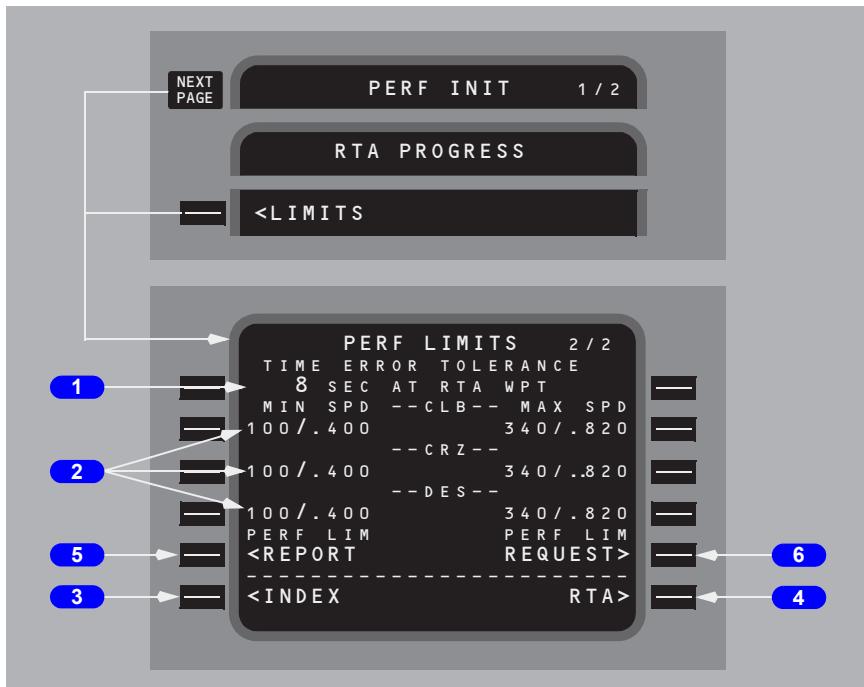
Push – displays the N1 LIMIT page.

## Performance Limits Page

The performance limits page allows the entry of performance limits affecting RTA and ECON calculations.



[Option – With company data link]



## 1 TIME ERROR TOLERANCE

Used during RTA calculations to establish a boundary on computed speeds.

Valid entry range is from 5 to 30 seconds.

Default value is 30 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 100/.400 for lower limit and 340/.820 for upper limit. Default values are displayed in small font and entered values are displayed in large 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.

**5 PERF LIM REPORT****[Option – With company data link]**

Push – transmits displayed performance limits to ground station.

**6 PERF LIM REQUEST****[Option – With company data link]**

Push – transmits a data link request for a performance limits uplink.

## N1 LIMIT Page - Preflight

### [Option – FMC U10.1 and later]

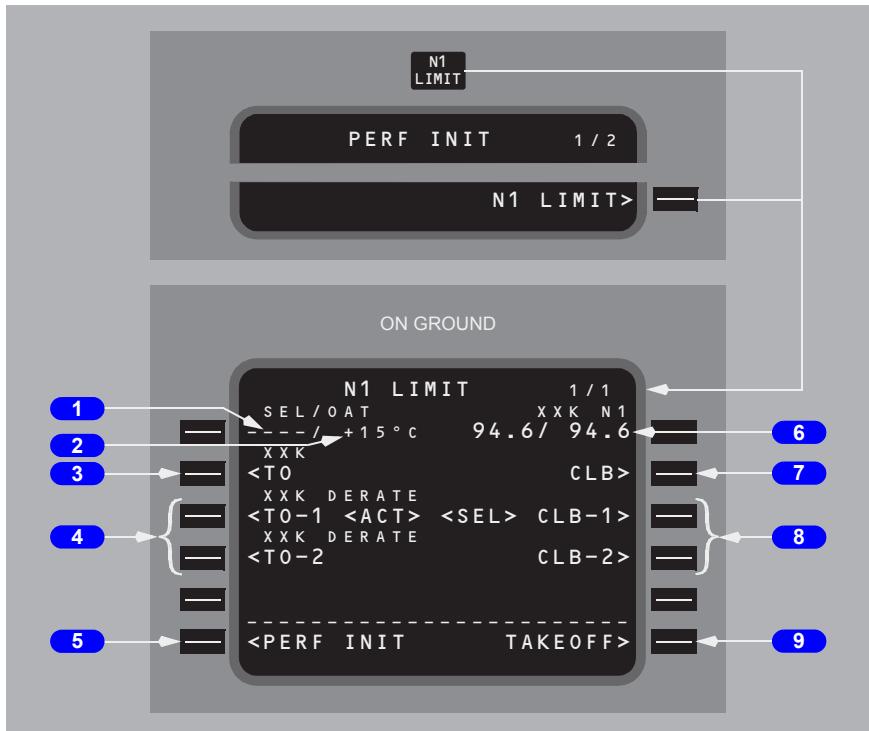
This section describes the preflight version of the N1 LIMIT page. See the FMC Takeoff and Climb section for a description of the in-flight version of the N1 LIMIT page.

The N1 LIMIT page is used during preflight to manage takeoff and climb thrust. Temperature data is entered, allowing the FMC to make N1 computations for normal or reduced thrust takeoff. Fixed takeoff and climb thrust derates may be selected.

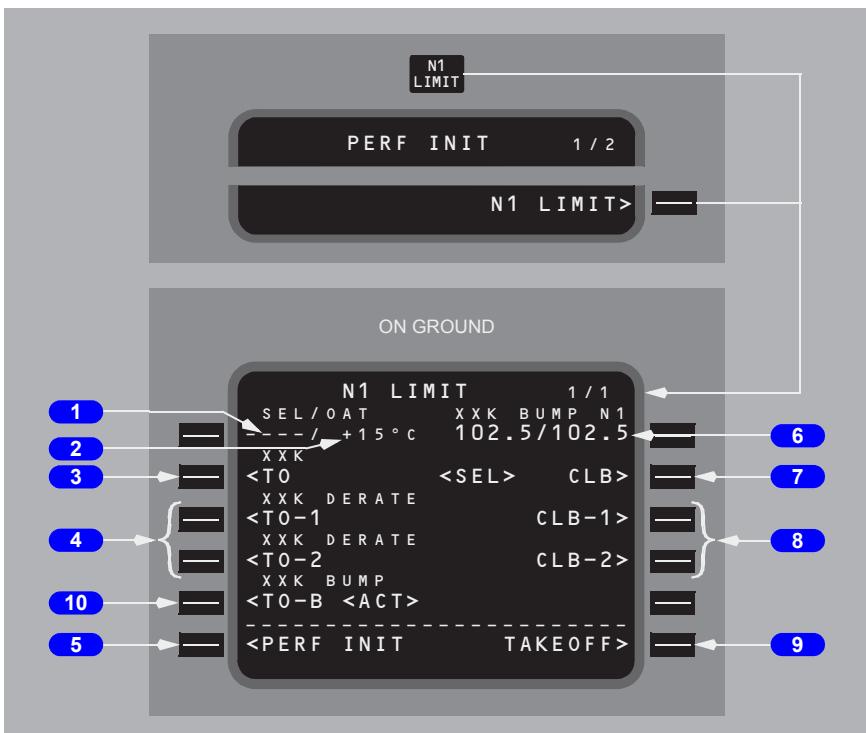
### [Option – Takeoff bump thrust]

The N1 LIMIT page is also used to select a takeoff bump thrust setting to meet extra thrust requirements for takeoff at certain airports.

### [Option – Aspirated TAT]



## [Option – Aspirated TAT, with takeoff bump thrust]


**1 Selected Temperature (SEL)**

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

Maximum allowable entry is 70 degrees C (158 degrees F). The FMC, however, will limit the N1 to 25% takeoff reduction.

**2 Outside Air Temperature (OAT)**
**[Option – Aspirated TAT]**

Aspirated TAT displays the sensed OAT in small-size characters. Manual entry of actual takeoff OAT is displayed in large-size characters.

Sensed or manually entered OAT is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

## 2 Outside Air Temperature (OAT)

### [Option – Non-aspirated TAT]

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.

## 3 Takeoff Thrust Limit (TO XXX)

Push – selects full rated takeoff thrust limit.

Selection of TO automatically selects CLB thrust.

Data line title displays full rated thrust. Typical line titles display as “24K” or “22K.”

Selection of a new rating after V speeds are selected on the TAKEOFF REF page causes the V speeds to display in small font, and the NO VSPD flag to show on the airspeed indication.

## 4 Takeoff Derates (TO-1 and TO-2)

Push – selects the associated takeoff thrust limit.

### [Option – With company data link]

Takeoff data uplink may automatically select a thrust derate.

Data line title displays the associated reduced thrust rating. Typical line titles display as “22K DERATE” or “20K DERATE”

Normally, selecting TO-1 automatically arms CLB-1 and selecting TO-2 automatically arms CLB-2.

**Note:** If a reduced thrust takeoff has been specified, then either CLB-1 or CLB-2 may be automatically specified if required to avoid a climb N1 value greater than the specified reduced thrust takeoff N1.

Selection of a new rating after V speeds are selected on the TAKEOFF REF page causes the V speeds to display in small font, and the NO VSPD flag to show on the airspeed indication.

## 5 PERF INIT

Push – displays the PERF INIT page.

## 6 Takeoff N1 (XXX N1)

Displays the FMC computed N1 for takeoff

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as “24K N1” or “22K N1”

Data line title changes to RED XXK N1 when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected the data line title will change to "RED XXK 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.

**[Option – Takeoff bump thrust]**

Data line title changes to XXK BUMP N1 when takeoff bump thrust is selected.

**7 Climb (CLB)**

Push – selects full rated climb thrust limit.

**[Option – Automatic takeoff thrust reduction]**

Climb thrust is automatically selected at the thrust reduction point on the TAKEOFF REF page 2.

**8 Reduced Climb (CLB-1 and CLB-2)**

Push – selects the associated reduced thrust climb mode.

CLB-1 provides a climb limit reduced by 3% N1 (approximately 10% thrust).

CLB-2 provides a climb limit reduced by 6% N1 (approximately 20% thrust).

Deletion results in the selection of CLB thrust.

Manual selection of a climb thrust rating overrides the automatic selection.

**[Option – With company data link]**

Takeoff data uplink may automatically select a thrust derate.

**9 TAKEOFF**

Push – displays the TAKEOFF REF page.

**10 Takeoff Bump Thrust (TO-B)****[Option]**

Push – selects takeoff bump thrust limit

Selection of TO-B automatically selects CLB thrust.

Data line title displays takeoff bump thrust. Typical line titles display as "26K BUMP" or "24K BUMP."

When takeoff bump thrust is selected, assumed temperature (SEL temperature) thrust reduction is not available.

**[Option – With company data link]**

Takeoff data uplink may automatically select takeoff bump thrust.

## Selecting Takeoff Thrust

Selecting the maximum takeoff thrust or a derate (TO, TO-1, TO-2) displays <ACT> inboard of the option. The FMC automatically selects the highest climb thrust available (CLB, CLB-1, CLB-2) which would not result in a thrust lever push, when the aircraft transitions from takeoff to climb. <SEL> is displayed inboard of the selected climb N1 limit.

## Takeoff Reference Page 1/2

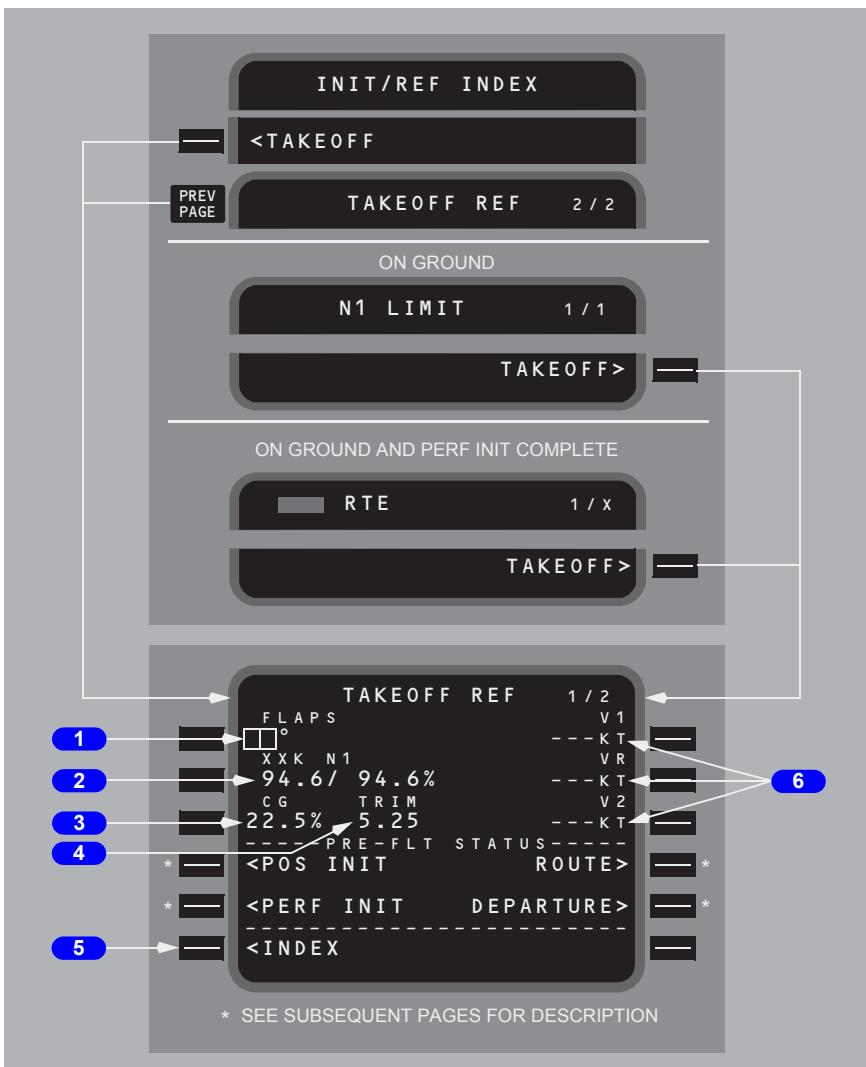
The takeoff reference page allows the crew to manage takeoff performance.

### [Option – FMC U10.1 and later]

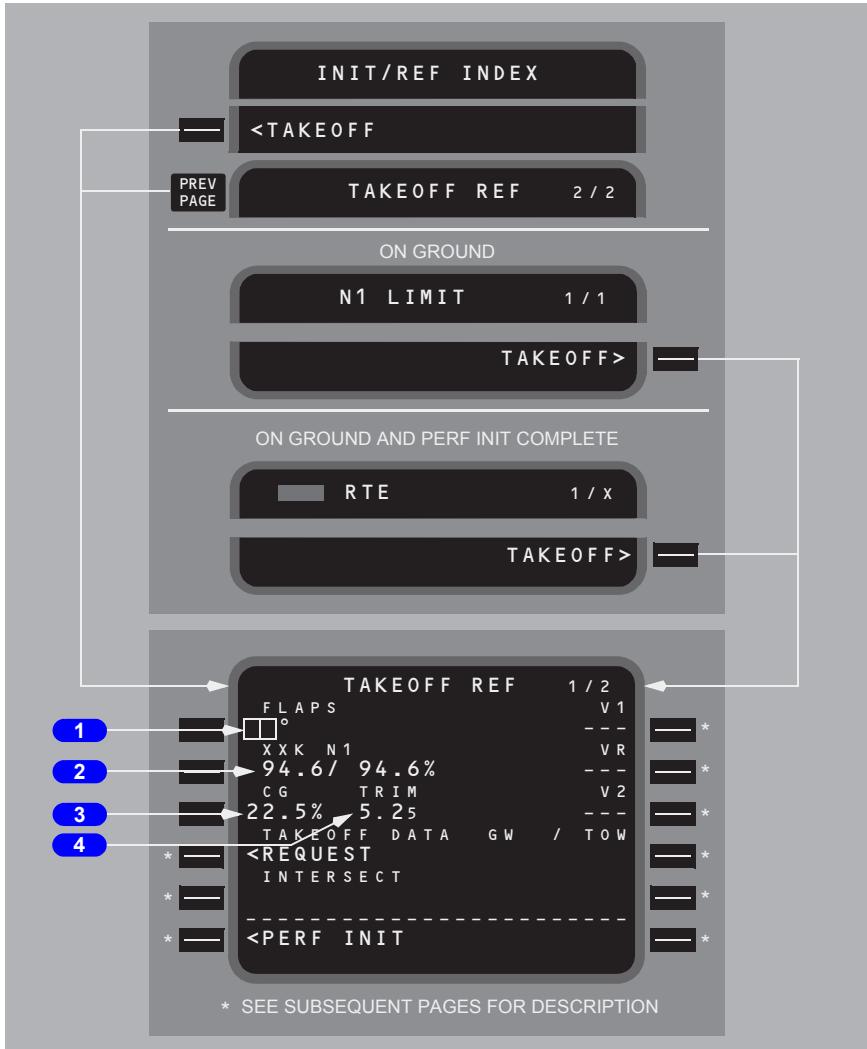
Takeoff flap setting and V speeds are entered and verified. Thrust limits, takeoff position, CG, and trim can be verified or changed.

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.

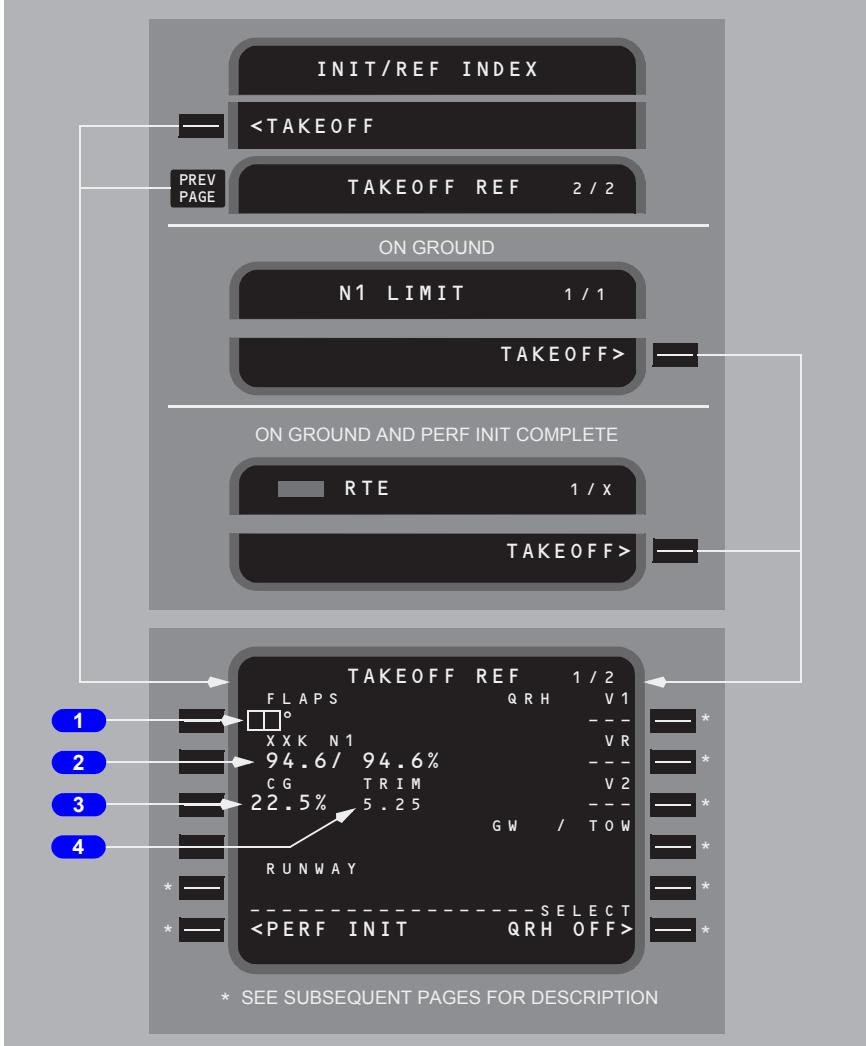
[Option – FMC U10.1 and later, without data link or takeoff speeds]



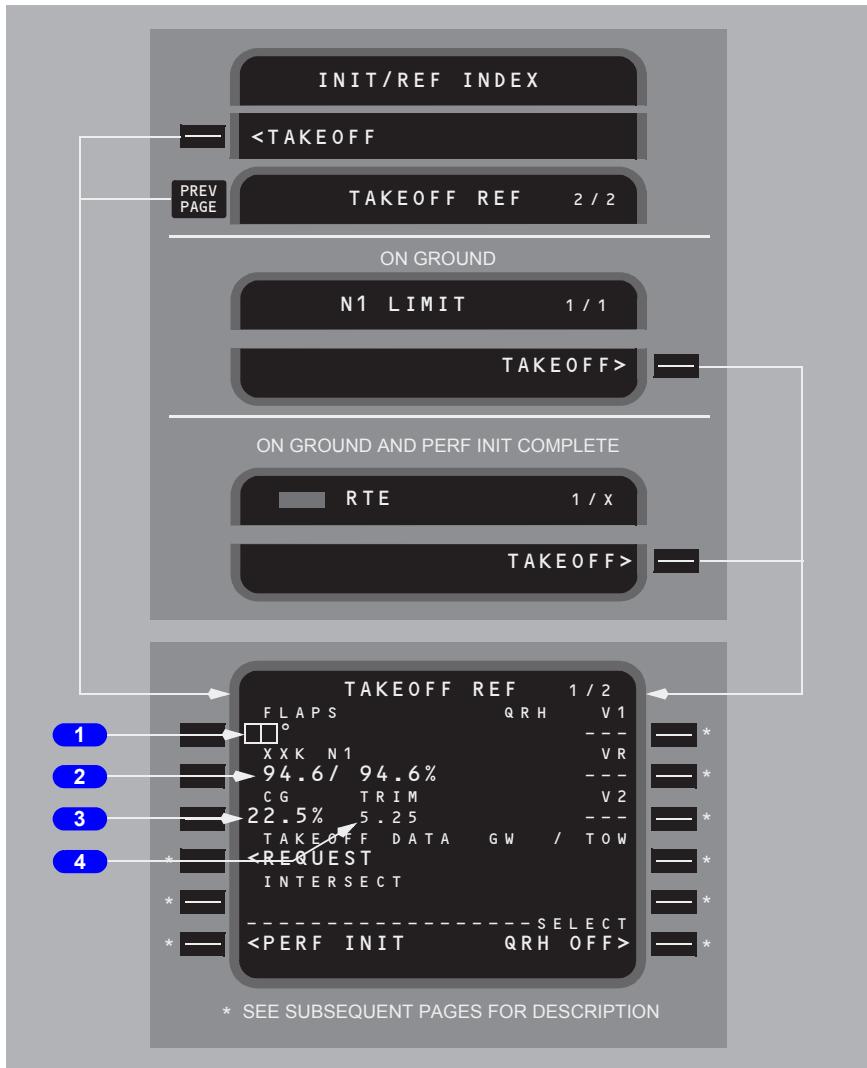
[Option – FMC U10.1 and later, with company data link]



[Option – FMC U10.1 and later, with FMC computed QRH takeoff speeds]



[Option – FMC U10.1 and later, with company data link and FMC computed QRH takeoff speeds]



## 1 FLAPS

Enter takeoff flaps setting. Manual entry of 1, 5, 10, 15, or 25 allowed.

## 2 Takeoff N1 (XXK N1)

Displays the FMC computed N1 for takeoff.

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as "24K N1" or "22K N1."

Data line title changes to RED XXK N1 when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected the data line title will change to "RED XXK 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.

#### [Option – Takeoff bump thrust]

Data line title changes to XXK BUMP N1 when takeoff bump thrust is selected.

### 3 Center of Gravity (CG)

Initial display is dashes.

After CG is entered, the FMC calculates and displays stabilizer takeoff trim settings.

### 4 TRIM

Displays stabilizer takeoff trim setting.

Display is blank unless FLAPS and CG are entered.

### 5 INDEX

#### [Option – FMC U10.1 and later without data link or takeoff speeds]

Push – displays the INIT/REF INDEX page.

### 6 V Speeds

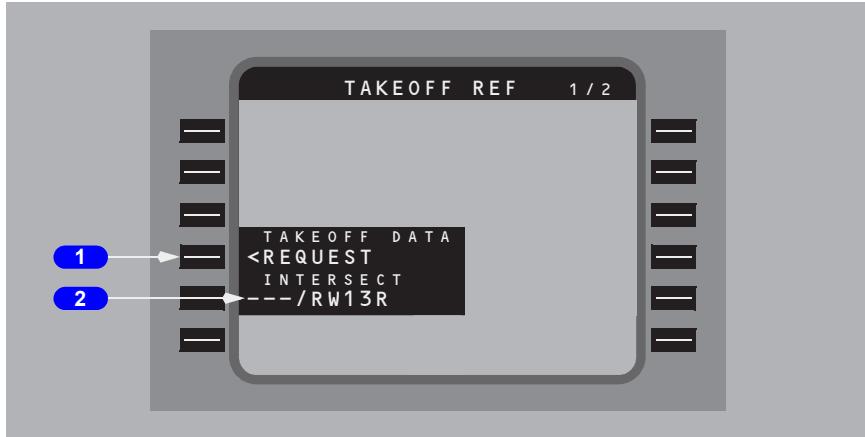
#### [Option – FMC U10.1 and later without data link or takeoff speeds]

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

Entered V1 and VR will automatically display on the airspeed indication.

## Company Data Link

### [Option – With company data link]



#### **1 TAKEOFF DATA REQUEST**

Push – transmits a data link request for a takeoff data uplink. Resulting TAKEOFF REF uplink may contain takeoff data for up to 6 runways, which are stored in FMC uplink memory.

#### **2 Intersection (INTERSECT)**

Displays active runway.

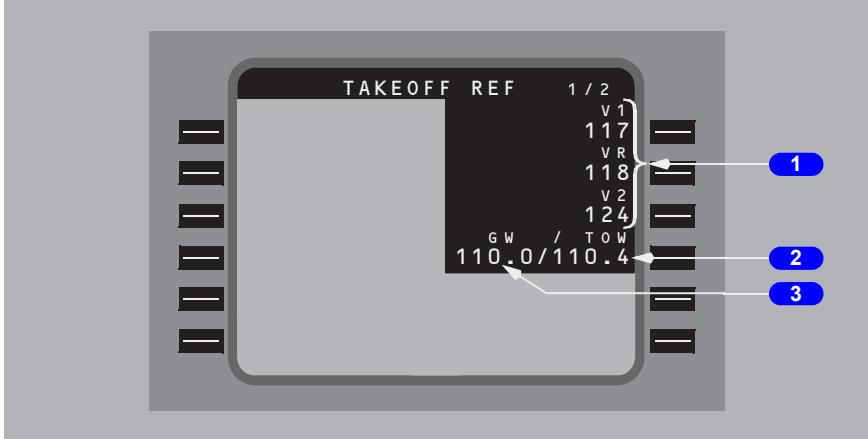
An intersection may be entered. Valid entries are 1 to 3 alphanumerics.

If an intersection is entered and TAKEOFF DATA REQUEST is made, the runway/intersection pair is included in the request downlink.

If the displayed runway or runway/intersection pair matches a runway or runway/intersection pair in FMC uplink memory, the associated TAKEOFF REF UPLINK is annunciated for flight crew ACCEPT/REJECT.

## V Speed Data

[Option – With company data link, without FMC computed takeoff speeds]



### 1 V Speeds (V1, VR, and V2)

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

V speeds may be uplinked.

Large font V speeds are displayed on the airspeed indication.

### 2 Takeoff Weight (TOW)

Displays gross weight the uplink V speeds are based on.

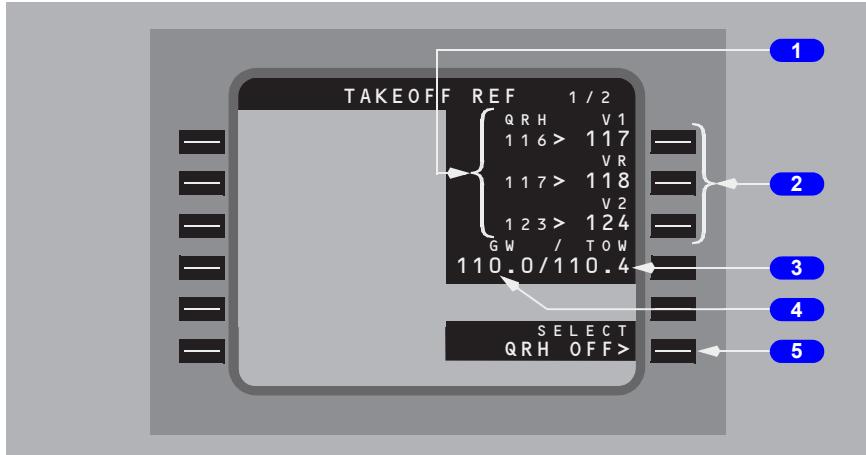
Blank if there are no uplinked V speeds in the column above.

### 3 Gross Weight (GW)

Displays current gross weight.

## FMC Computed V Speed Data

[Option – With FMC computed QRH takeoff speeds]



### 1 QRH

[Option – With FMC computed QRH takeoff speeds]

Displays FMC computed V speeds, based on assumed temperature, current gross weight and flap setting.

### 2 V Speeds (V1, VR, and V2)

Push – selects associated FMC computed V speed from center column.

Manual entry may be made.

Large font V speeds are displayed on the airspeed indication.

### 3 Takeoff Weight (TOW)

Displays gross weight that the large font V speeds in the column above are based on.

Blank if there are no large font V speeds in the column above.

### 4 Gross Weight (GW)

Displays current gross weight.

FMC computed V speeds in the column above are based on this weight.

## 5 Select FMC Computed V Speeds On/Off (SELECT QRH ON/OFF)

### [Option – With FMC computed QRH takeoff speeds]

When SELECT QRH OFF displayed

- Push – Removes FMC computed V speeds from display.

When SELECT QRH ON displayed

- Push – Displays FMC computed V speeds.

Default is FMC Computed V speeds displayed.

### Change of Performance Data After V Speed Entry

V speeds should be entered on the TAKEOFF REF page as a final step of FMC preflight. If V speeds are entered and then performance data (for example, OAT or takeoff thrust) is subsequently changed, the FMC automatically removes the previously entered V speeds and the NO VSPD flag shows on the airspeed indication.

In addition, the scratchpad message VERIFY TAKEOFF SPEEDS displays if any of the following items are changed after V speeds have been entered:

- gross weight
- zero fuel weight
- plan fuel.

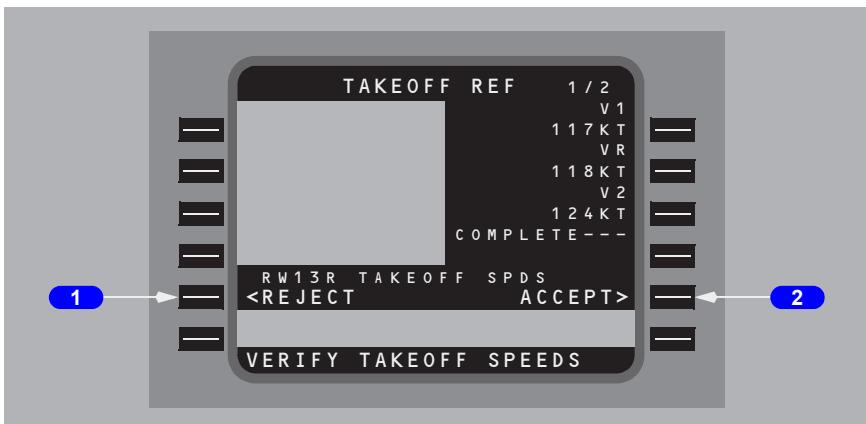
### [Option – Without company data link or FMC computed takeoff speeds]

The FMC allows the flight crew to re-display the previously entered V speeds.

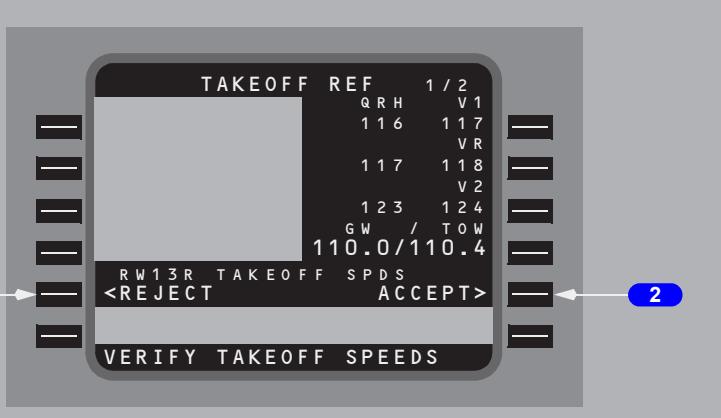
### [Option – With company data link or FMC computed takeoff speeds]

The previously entered V speeds are displayed in small font on the TAKEOFF REF page.

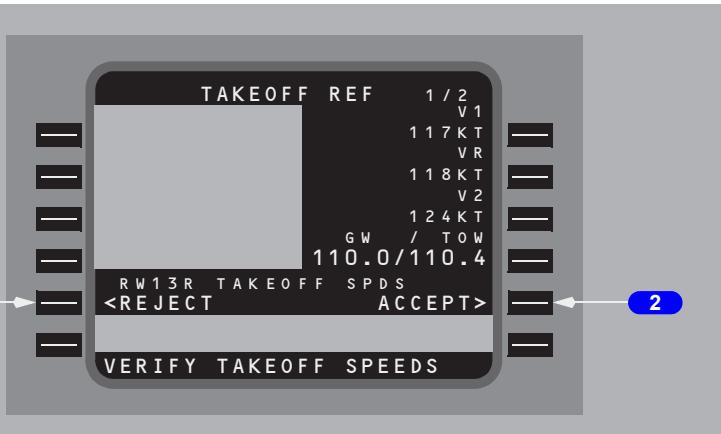
### [Option – Without FMC computed takeoff speeds]



[Option – With FMC computed QRH takeoff speeds]



[Option – Data link without FMC computed takeoff speeds]



**1 REJECT**

[Option – With plan fuel]

Displayed if V speeds have been entered and airplane gross weight, ZFW, or plan fuel has been changed.

[Option – Without plan fuel]

Displayed if V speeds have been entered and airplane gross weight or ZFW has been changed.

Push – causes the now small font takeoff speeds to disappear.

## 2 ACCEPT

### [Option – With plan fuel]

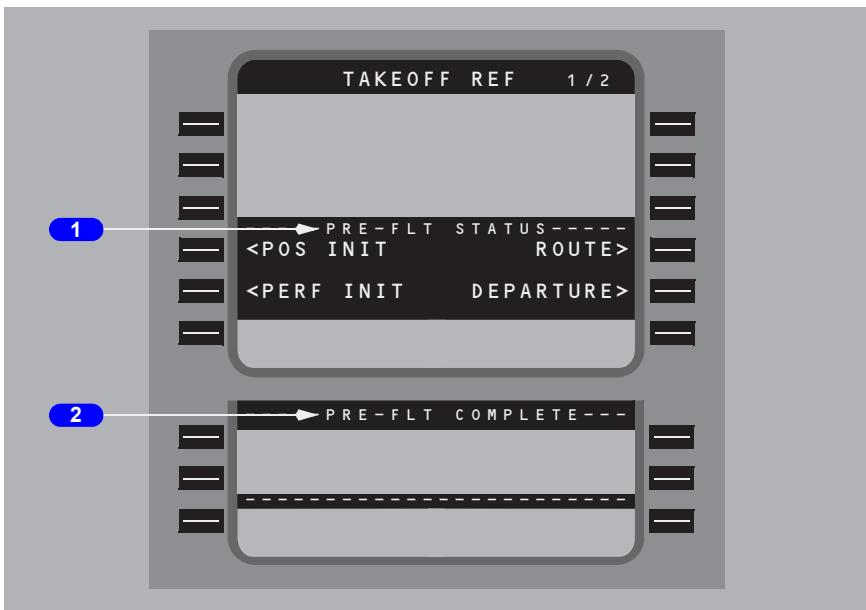
Displayed if V speeds have been entered and airplane gross weight, ZFW, or plan fuel has been changed.

### [Option – Without plan fuel]

Displayed if V speeds have been entered and airplane gross weight or ZFW has been changed.

Push – changes the small font takeoff speeds to large font.

## Preflight Status



### 1 Preflight Status (PRE-FLT STATUS)

Displays when required preflight data is not complete. Lines below are selectively displayed to allow line selection of incomplete pages;

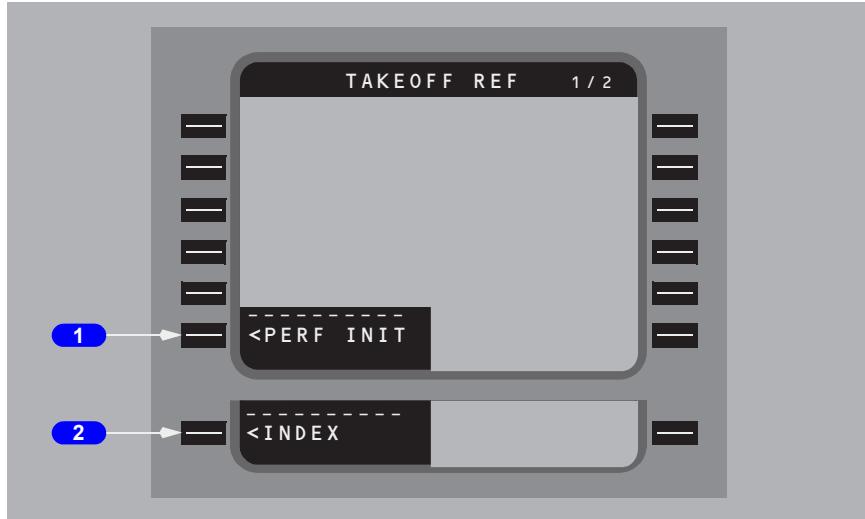
- POS INIT shows if a valid IRS position entry disagrees with the position determined by any IRS in the ALIGN mode; otherwise blank
- PERF INIT shows if any required PERF INIT entries not completed; otherwise blank
- ROUTE shows if a route is not active; otherwise blank
- DEPARTURE shows if RTE page 1 displays prompts for RUNWAY and VIA lines; otherwise blank.

[Option – FMC U10.1 and later]

- N1 LIMIT shows if valid OAT has not been entered.

**2 Preflight Complete (PRE-FLT COMPLETE)**

Displayed following completion of required entries on the POS INIT, RTE, and PERF INIT pages.



**1 Preflight Incomplete**

When required preflight entries are not complete, the related page title displays

- POS INIT – IRS position not entered or invalid
- PERF INIT – required performance data not entered or executed
- ROUTE – required RTE page data not entered
- DEPARTURE – runway or route data not entered on the RTE page.

[Option – Non-aspirated TAT]

- N1 LIMIT – OAT not entered.

Push – Displays associated page.

**2 Preflight Complete (INDEX)**

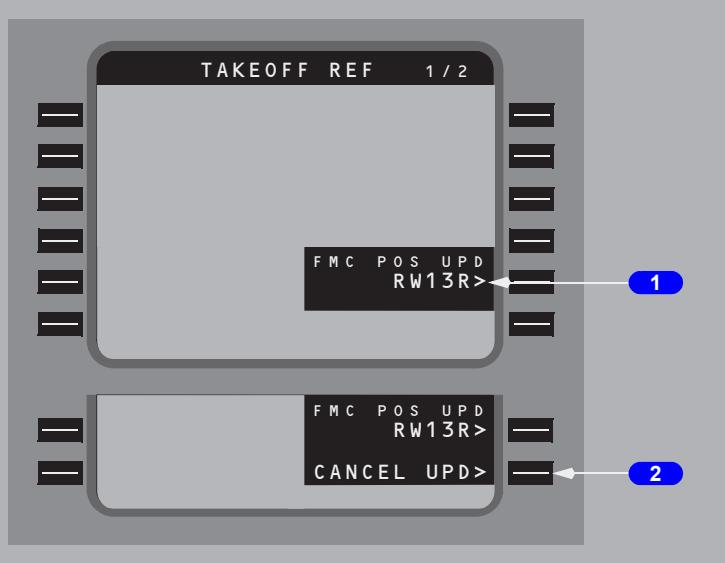
When the required preflight entries are complete, the index prompt is displayed below the takeoff reference page data. When required preflight entries are not complete, the related page title replaces the INDEX prompt.

Displayed following completion of required preflight entries on the POS INIT, RTE, and PERF INIT pages.

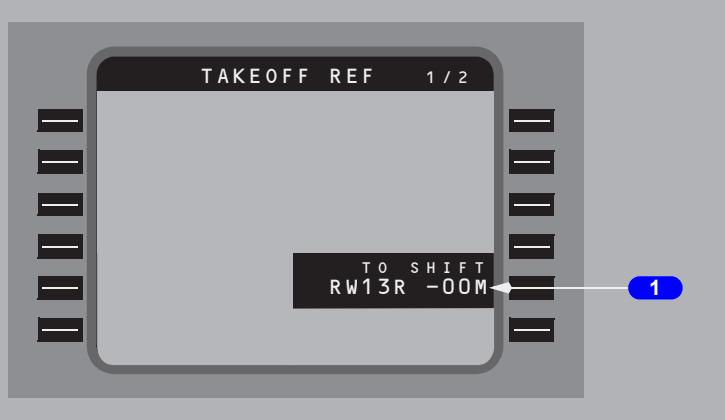
Push – Displays INIT REF INDEX page.

## FMC Takeoff Position Update

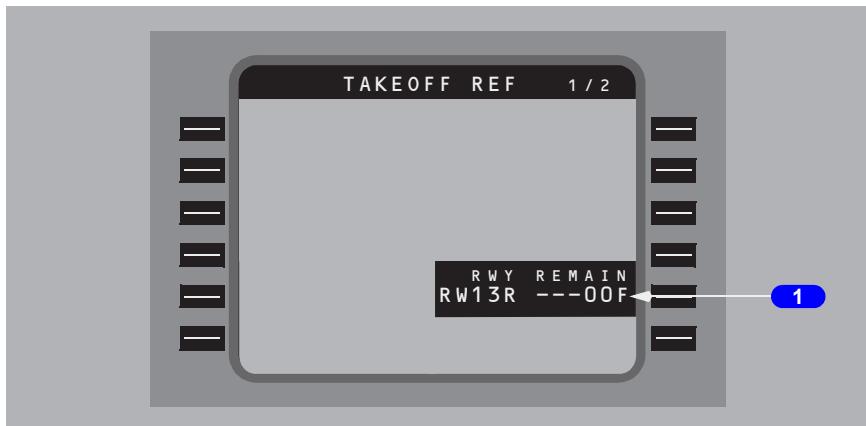
[Option – Runway position update via the CDU only]



[Option – Runway position update with TO/GA activation, meters]



[Option – Runway remaining update with TO/GA activation, feet]



### 1 FMC Position Update (FMC POS UPD)

[Option – Runway position update via the CDU only]

Displayed automatically on the ground when preflight complete and a departure runway is entered into the active route.

Selection illuminates the execute key and displays the CANCEL UPDATE prompt on line 6R.

Execution updates the computed FMC position to the threshold of the departure runway.

### 1 Takeoff Shift (TO SHIFT)

[Option – Runway position update with TO/GA activation, FMC U10.2 and later]

Automatically displays the departure runway from the route page.

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

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

TO/GA position update inhibited if GPS UPDATE is ON.

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

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

**1 Runway Remaining (RWY REMAIN)****[Option – Runway remaining update with TO/GA activation, FMC U10.2 and later]**

Automatically displays the departure runway from the RTE page.

If a runway remaining distance is not entered and GPS UPDATE is OFF, the FMC updates to the runway threshold when TO/GA is pushed.

If a runway remaining distance is entered and GPS UPDATE is OFF, the FMC updates to the runway length remaining when the TO/GA switch is pushed.

TO/GA position update inhibited if GPS UPDATE is ON.

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

To remove a RWY REMAIN entry, reselect RWY on RTE page.

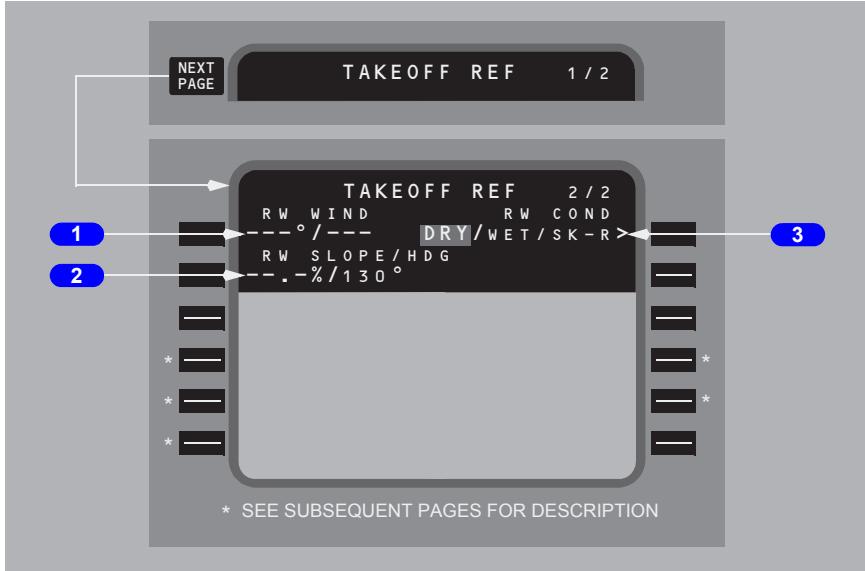
**2 Cancel Update (CANCEL UPD)****[Option – Runway position update via the CDU only]**

Displayed after line selection of the FMC POS UPD prompt.

Push – clears the prompt, cancels the position update armed condition, and extinguishes the execute key light.

## Takeoff Reference Page 2/2

[Option – FMC U10.1 and later, with company data link or FMC computed takeoff speeds]



### 1 Runway Wind (RW WIND)

Enter surface wind direction and speed.

Entry is optional for preflight completion.

### 2 Runway Slope/Heading (RW SLOPE/HDG)

Enter runway slope.

Entry is optional for preflight completion.

Valid runway slope is U or + for up or D or – for down followed by slope in percent gradient.

HDG displays runway heading for origin airport.

### 3 Runway Condition (RWY COND)

Active runway condition is highlighted:

- DRY – Dry runway computations
- WET – Wet runway computations
- SK-R – Skid resistant runway computations

Default condition is DRY.

**[Option – With company data link and FMC computed takeoff speeds]**

Runway condition can be selected by the flight crew or uplinked.

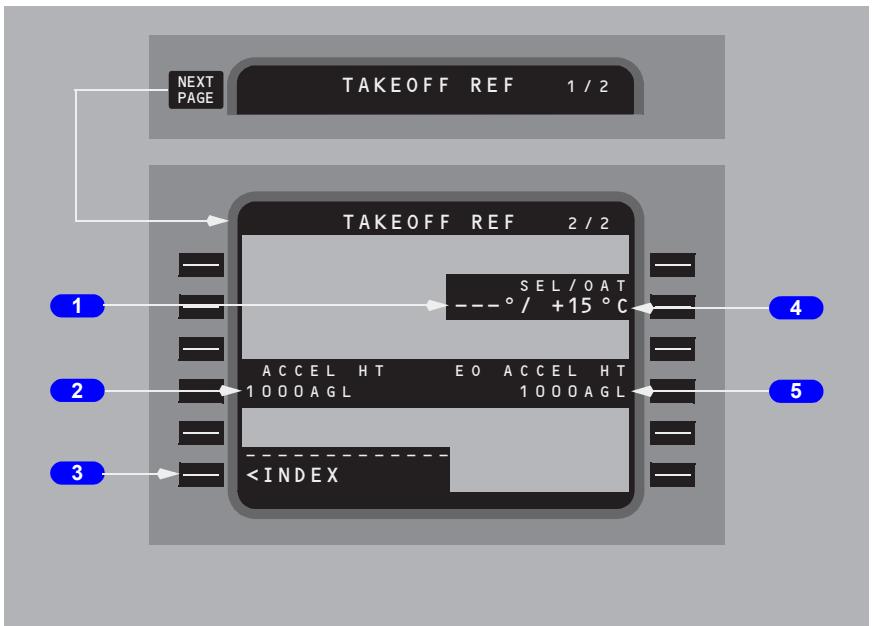
**[Option – With company data link]**

The runway condition can be viewed by flight crew and shows under what conditions the uplinked V Speeds have been computed for. The runway condition is displayed for reference only and cannot be changed by the flight crew.

**[Option – With FMC computed takeoff speeds]**

Runway condition can be selected by the flight crew.

### Takeoff Thrust



**1 Selected Temperature (SEL)**

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

Maximum allowable entry is 70 degrees C (158 degrees F). The FMC, however, will limit the N1 to 25% takeoff reduction.

Repeats data shown on the preflight version of the N1 LIMIT page.

**2 Acceleration Height (ACCEL HT)**

Displays acceleration height for flap retraction.

Default value is from the airline.

Entry is optional. Value is a height from 400 to 9999 feet.

### 3 INDEX

Push – displays the INIT/REF INDEX page.

### 4 Outside Air Temperature (OAT)

Aspirated TAT displays the sensed OAT in small-size characters. Manual entry of actual takeoff OAT is displayed in large-sized characters.

Sensed or manually entered OAT is used by the FMC to calculate the takeoff N1 limits.

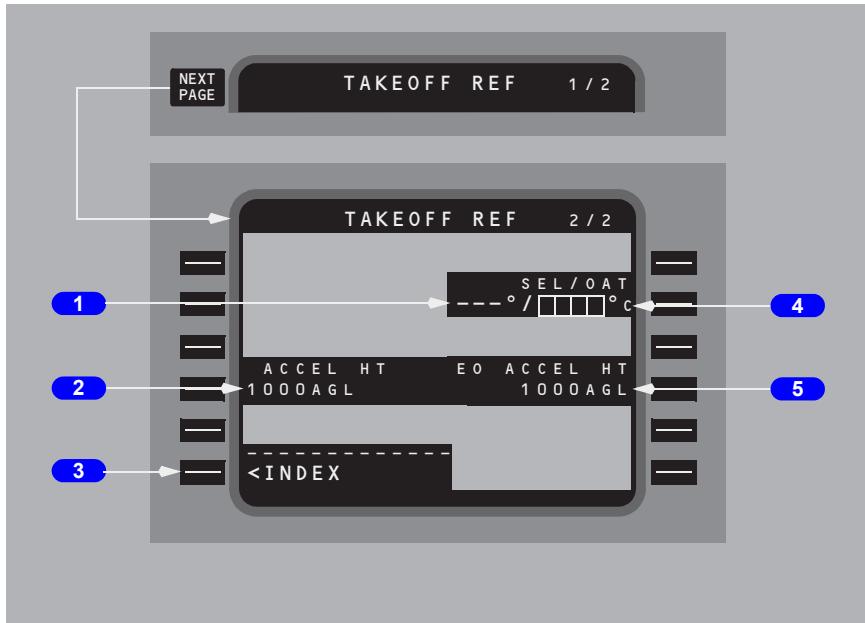
Entry can be made in degrees C or degrees F.

### 5 Engine Out Acceleration Height (EO ACCEL HT)

Displays acceleration height for flap retraction with an engine out.

Default value is from the airline.

Entry is optional. Value is a height from 400 to 9999 feet.



### 1 Selected Temperature (SEL)

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

Maximum allowable entry is 70 degrees C (158 degrees F). The FMC, however, will limit the N1 to 25% takeoff reduction.

Repeats data shown on the preflight version of the N1 LIMIT page.

**2 Acceleration Height (ACCEL HT)**

Displays acceleration height for flap retraction.

Default value is from the airline.

Entry is optional. Value is a height from 400 to 9999 feet.

**3 INDEX**

Push – displays the INIT/REF INDEX page.

**4 Outside Air Temperature (OAT)**

Manual entry of actual takeoff OAT is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

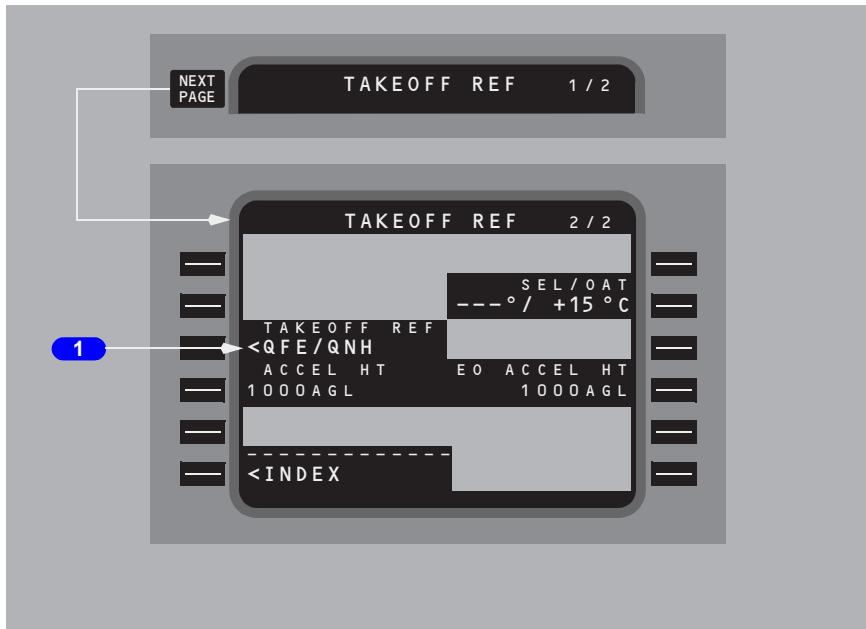
**5 Engine Out Acceleration Height (EO ACCEL HT)**

Displays acceleration height for flap retraction with an engine out.

Default value is from the airline.

Entry is optional. Value is a height from 400 to 9999 feet.

## Takeoff Reference



### 1 Takeoff Reference (TAKEOFF REF)

Push – Toggles altimeter reference between QFE and QNH.

Default is QNH.

Resets to QNH at flight complete.

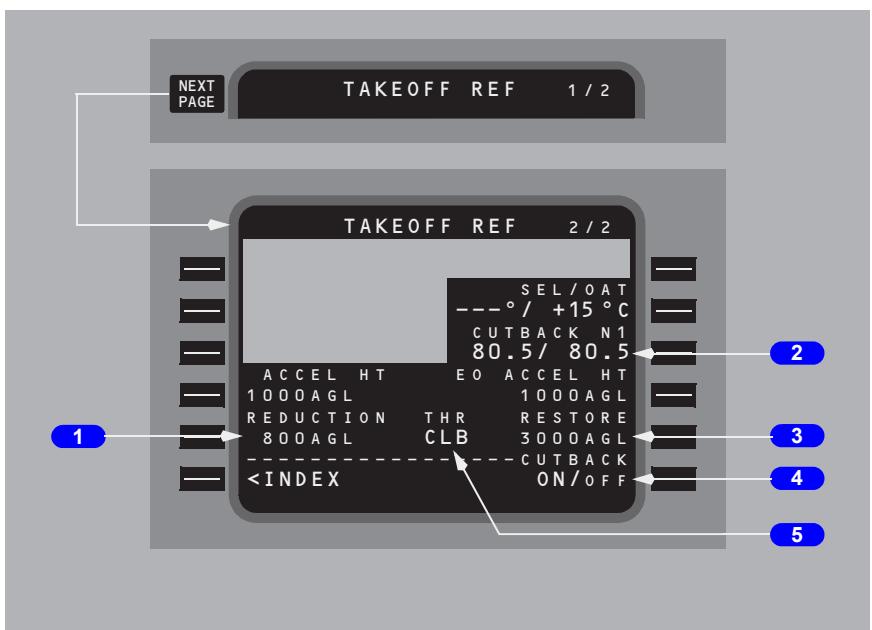
Reflects LANDING REF selection on APPROACH REF page.

Active altimeter reference is highlighted.

During preflight with QFE selected, the PFD altitude indications show zero feet at the departure runway threshold. The PFD altitude indication background colors change to green.

If QFE is the current altimeter reference, and the EFIS control panel STD switch is pushed, the takeoff reference automatically changes to QNH.

## Cutback Mode



### 1 REDUCTION

With cutback mode OFF, altitude above origin airport elevation at which the autothrottle reduces from takeoff N1 to climb N1.

With cutback mode ON, altitude above origin airport elevation at which the transition from takeoff thrust to cutback thrust occurs.

Manual entries allowed on the ground.

The default value is determined by the airline and is stored in the model/engine database. The default is displayed in small font.

### 2 CUTBACK N1

FMC calculated cutback N1.

Prior to takeoff, if the FMC is unable to calculate the cutback N1 using the entered data, CUTBACK UNAVAILABLE displays.

### 3 RESTORE

The altitude at which the selected climb thrust is restored.

### 4 CUTBACK ON/OFF

Push – selects cutback mode ON/OFF.

Currently selected cutback mode is displayed in large font.

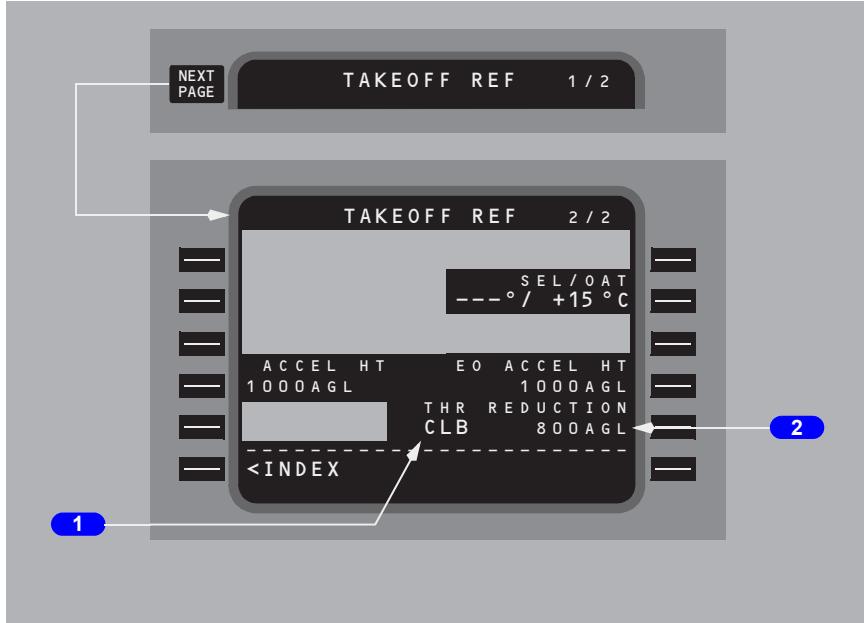
Default is cutback mode OFF.

## 5 Selected Climb Rating

Displays the climb rating that will be set at the THR REDUCTION altitude, as selected on the preflight version of the N1 LIMIT page.

### Automatic Thrust Reduction

[Option – U10.7 and with automatic takeoff thrust reduction ]



## 1 Selected Climb Rating

Displays the climb rating that will be set at the THR REDUCTION altitude, as selected on the preflight version of the N1 LIMIT page.

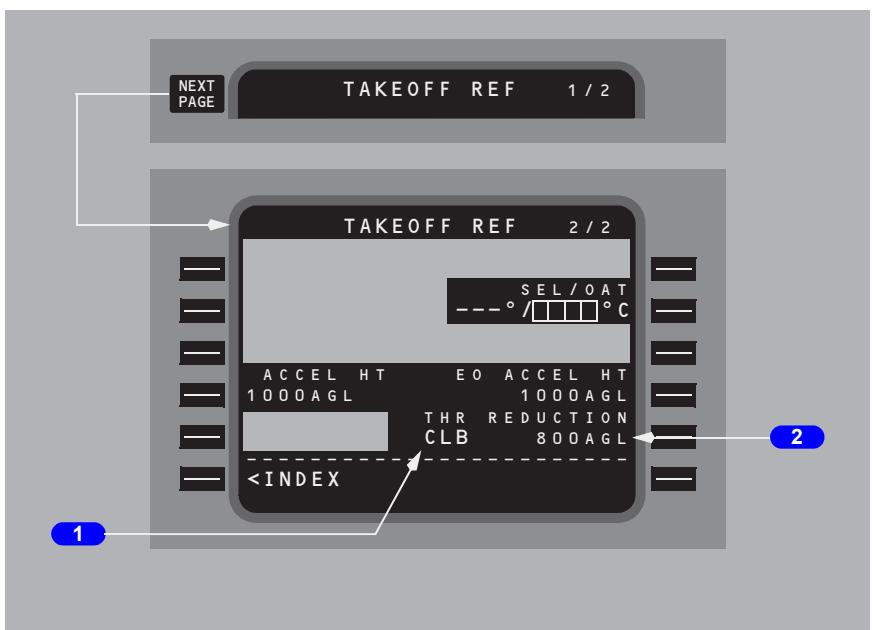
## 2 Thrust Reduction (THR REDUCTION)

Altitude above origin airport elevation at which the autothrottle reduces from takeoff N1 to climb N1.

The default value is determined by the airline and is stored in the model/engine database. The default is displayed in small font.

Manual entries allowed on the ground. Entries must be between 800 to 9,999 feet and are displayed in large font.

Deletion of a manual entry returns the display to the default value.



### 1 Selected Climb Rating

Displays the climb rating that will be set at the THR REDUCTION altitude, as selected on the preflight version of the N1 LIMIT page.

### 2 Thrust Reduction (THR REDUCTION)

Altitude above origin airport elevation at which the autothrottle reduces from takeoff N1 to climb N1.

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Manual entries allowed on the ground. Entries must be between 800 to 9,999 feet and are displayed in large font.

Deletion of a manual entry returns the display to the default value.

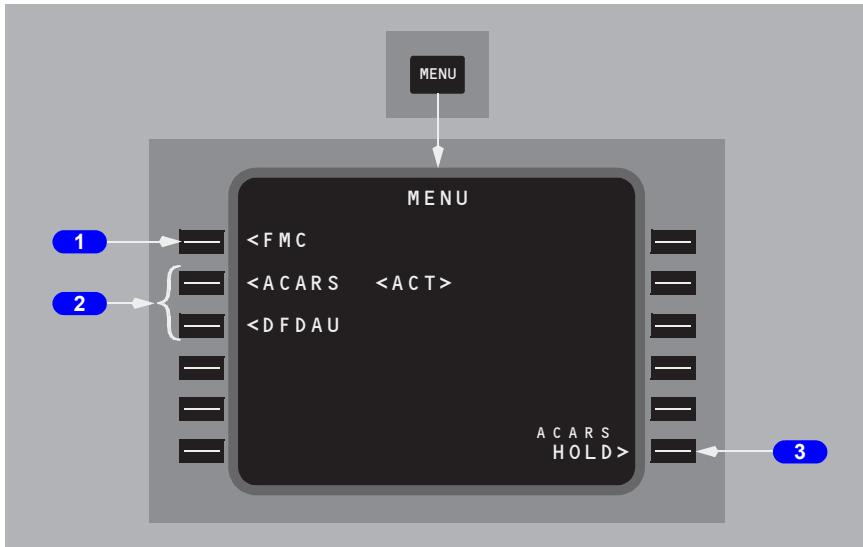
## Menu Page

### [Option – MCDU]

The menu page is selected with the MENU key or is automatically displayed when the currently active subsystem fails or on initial power up if the FMC system is not detected.

The menu page displays subsystems (ACARS, DFDAU, etc.) that require control/display functions through the MCDU and provides a means to temporarily access to these subsystems. The active system is indicated by <ACT> displayed next to the system title. A subsystem that requires use of the CDU displays a request message <REQ> next to the subsystem title. The FMC system or a requesting subsystem is accessed by using the line select key next to the title. The FMC can be reselected by selecting the FMC prompt on the MENU page or selecting any mode key (INIT/REF, RTE, etc.). A subsystem can be temporarily placed on hold <HLD> by selecting the subsystem XXXXXX HOLD> line select key returning the CDU display to the currently active FMC page (XXXXXX represents the system name). While the subsystem is on hold the MCDU CALL light is illuminated. To reselect the subsystem on hold, push the subsystem line select key again. When a subsystem is placed on hold a XXXXXX LOGOFF prompt appears to allow for release of the subsystem being held. No more than one subsystem can be selected at a time. If an attempt is made to select more than one subsystem, a FIRST LOGOFF XXXXXX prompt is displayed as a reminder to logoff the currently active subsystem.

### [Option – Liquid crystal display MCDU]



**1 FMC**

Push – selects FMC as the system for which the MCDU will be active in providing control/display function.

**2 Other Aircraft Subsystems (typical)**

Push – selects the subsystem for which the MCDU will be active in providing control/display function.

**3 XXXXX HOLD/LOGOFF**

Push - places active subsystem on hold or logs off subsystem and returns control to the FMC.

Intentionally  
Blank

## Flight Management, Navigation

### FMC Takeoff and Climb

## Chapter 11

### Section 41

#### Introduction

The FMC takeoff phase begins with the selection of takeoff/go-around (TO/GA). Preparation for this phase begins in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when climb thrust is selected. The climb phase continues to the top of climb point, where the cruise phase begins.

During these phases, the following pages are normally used:

- TAKEOFF REF page – to make last minute changes to the departure runway
- DEPARTURES page – to make last minute changes to the SID
- CLIMB 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 selected prior to takeoff. Prior to 50 feet radio altitude, roll command is wings level. At 50 feet radio altitude, if within engagement criteria, LNAV engages and provides roll commands to fly the route leg. VNAV may be engaged to control the climb profile.

**Note:** For LNAV to be armed on the ground, the departure runway must be selected and the course, to the first waypoint, must be within 5 degrees of the runway heading.

## VNAV Armed for Takeoff

### [FMC U10.7 and later]

VNAV may be armed on the MCP prior to takeoff provided the following requirements have been met:

- a valid flight plan has been entered
- performance data has been entered and executed
- both flight director switches have been switched on

Target Speeds will follow the profile listed in the Climb Phase.

To prevent FCC from engaging on-ground in VNAV SPD mode, if FCC engages on-ground the FMC will clear its VNAV Valid discrete, which will force the FCC to disengage. The FMC will retain the last valid MCP speed that was above 60 knots that existed prior to the FCC engaging, and will output that as the FMC speed.

### VNAV Takeoff -One Engine Out

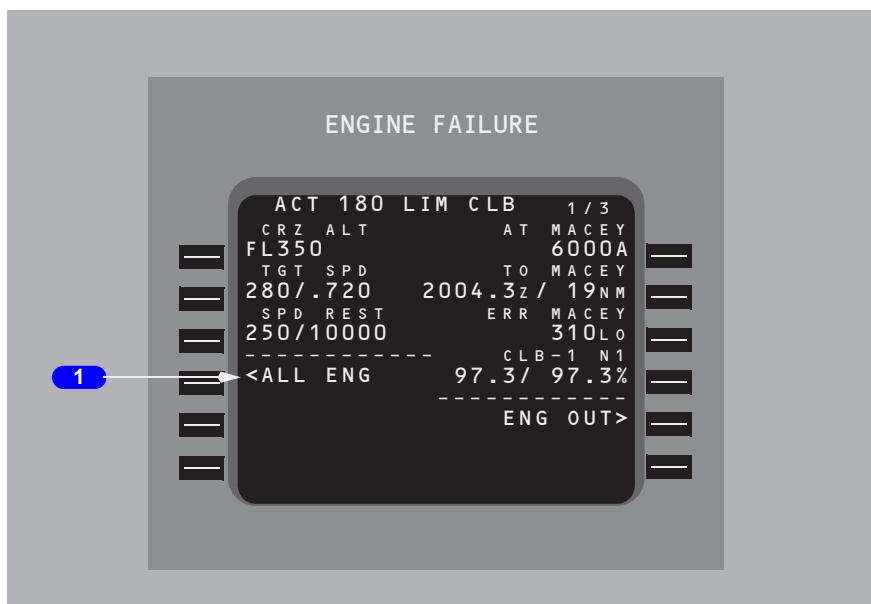
During the all engine takeoff flight phase, VNAV will be enabled to automatically adjust the target airspeed profile upon engine out detection.

A split throttle condition (single engine taxi or throttle split to auto-store the speed brakes) on-ground would result in the FMC engine-out mode. The engine out mode would stay set until either the ALL ENGINES prompt was selected or the FMC is un-powered, and then re-powered. The engine-out mode is inhibited when the speed is 60 knots or less. If the engine-out is set when on-ground, it will be cleared when the speed drops below 60 knots. If the engine-out is set in takeoff or climb, it will be cleared when the airplane enters cruise or descent.

When an engine failure has been detected, the thrust reduction height and the all engine acceleration height specified on TAKEOFF REF page two will be ignored. All waypoint fuel, ETA, Progress page and LEGS page performance predictions will be blanked. Upon exiting the engine out takeoff flight phase, the performance predictions will be displayed.

If an engine failure is detected after the all engine takeoff flight phase is complete, there will be no automatic engine out VNAV function as well as no modification of the Climb page.

**Note:** Prior to the all engine flight phase completion, with an engine failure detected, the Climb page is modified as depicted in the following illustration.



### 1 All Engines

Line select key 4L terminates the engine out takeoff mode and activates the normal climb mode.

## Climb Phase

With VNAV armed during takeoff, VNAV engages at 400 feet and commands acceleration to:

- last MCP speed (V2) + 20 kts until acceleration height
- if an engine failure is detected, target speed will be last MCP speed (V2) + 20 kts if the airplane is at that speed or greater, or the existing speed if the airplane is between V2 and V2 + 20 kts
- the flap placard speed minus 5 kts
- 230 kts or less when leading edge flaps are not fully retracted
- 250 knots with flaps retracted
- the active target speed
- 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.

#### [Option – With automatic thrust reduction after takeoff]

At the climb thrust reduction point, the FMC commands a reduction to the selected climb thrust. 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.

#### [Option – With quiet climb]

When cutback mode is selected ON, the FMC calculates and commands a cutback thrust rating at the required cutback altitude. A new N1 is calculated during climb and normal climb thrust is restored at the RESTORE altitude. 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.

When the speed profile causes an anticipated violation of a waypoint speed constraint, the FMC displays the CDU scratchpad message UNABLE YYY KNOTS AT XXXXX, where speed is YYY and waypoint is XXXXX. When a waypoint speed constraint greater than 10 kts above the predicted speed at the waypoint exists, the FMC displays the CDU scratchpad message DRAG REQUIRED AFTER XXXXX where waypoint is XXXXX.

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 Page

The climb page is used to evaluate, monitor, and modify the climb path. The data on the climb page comes from preflight entries made on the route and performance pages.

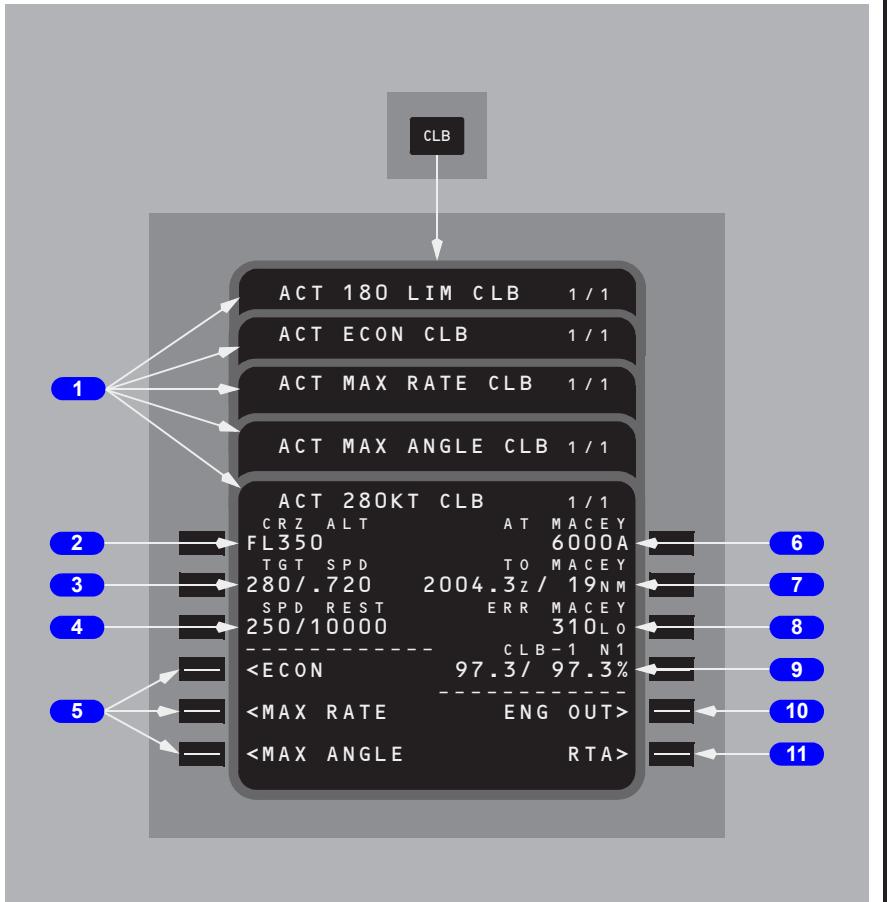
#### [Option – FMC U10.3 and later]

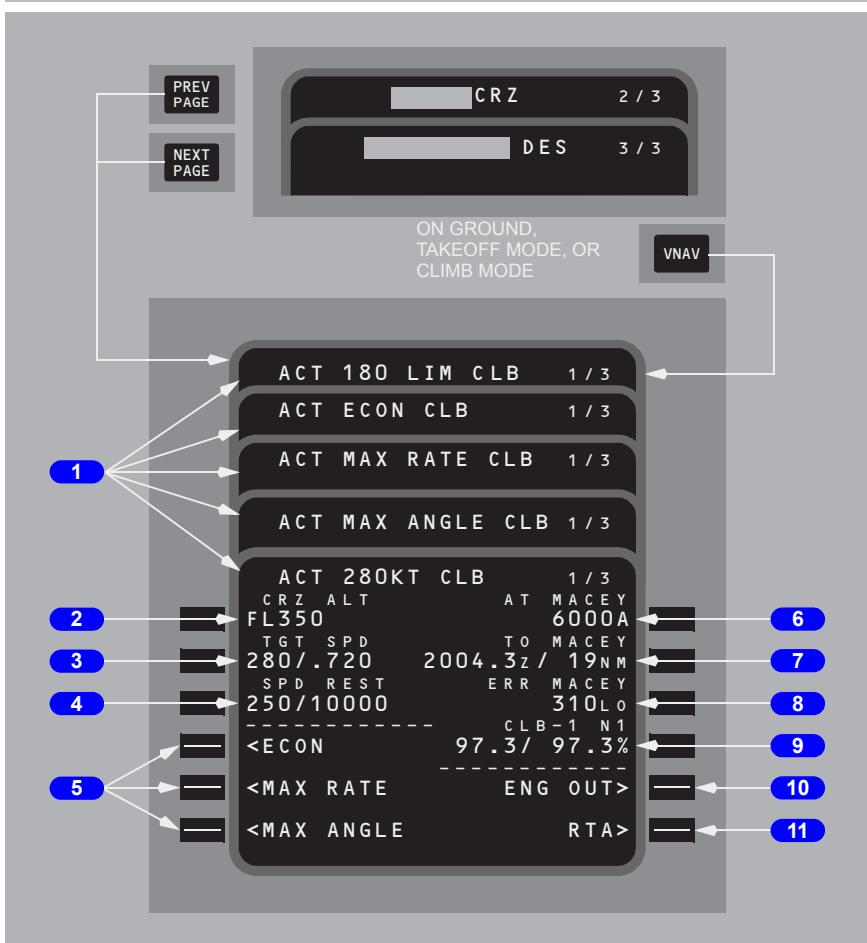
The climb page is automatically selected by pushing the CLB function key on the ground and during takeoff and climb. The TAKEOFF REF page automatically transitions to the climb page after takeoff.

**[Option – FMC U10.3 and later with FANS MCDU]**

The climb page is automatically selected by pushing the VNAV function key on the ground and during takeoff and climb. The climb page is the first of the three pages selected with the VNAV function key. Access from other performance pages is via the NEXT/PREV PAGE key. The TAKEOFF REF page automatically transitions to the climb page after takeoff.

The FMC climb mode can be economy or fixed speed. In either mode, 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. Fixed speed climbs modify the title.

XXX LIM CLB indicates the limit speed, XXX, is based on leading or trailing edge flaps:

- target speed is 5 knots below trailing edge flap placard speed
- speed is limited to 230 kts if leading edge devices are not completely retracted

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. Reasons for fixed speeds 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.

### [Option – With speed and altitude intervention]

The cruise altitude from the PERF INIT page is displayed. The altitude can be changed by two methods:

- a new altitude can be manually entered from the CDU at any time. Changing the altitude in this manner creates a modification.
- setting the MCP altitude above the current FMC CRZ altitude, provided no intermediate altitude constraints exist between the current airplane altitude and the MCP target altitude. Selecting the new altitude on the MCP and pushing the altitude intervention button places the new altitude in the CRZ ALT data line. Entering a new cruise altitude in this manner does not create a modification.

## **3 Target Speed (TGT SPD)**

Displays computed values or manually entered values for the selected mode.

Displays XXX/MCP when speed intervention is active and plan is active.

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 (dashes displayed when no speed restriction exists for the listed airport)
- waypoint related restriction from the RTE LEGS page if restriction limits climb speed
- a default speed of 250 knots and 10,000 feet for airports not listed in the navigation database (example 250/10000)
- displays XXX/FLAPS if the active speed restriction is lower than the minimum speed for the selected flap setting
- 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.

#### [Option – With quiet climb]

When cutback mode is selected ON, the cutback airspeed and RESTORE altitude is the active speed/altitude restriction. Deletion or modification of the cutback speed/altitude restriction is not allowed.

#### 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 XXXXXX**

Displays ETA and distance to go to waypoint on AT XXXXXX line.

If no waypoint constraint exists, values are for CRZ ALT.

**8 Error (ERR XXXXX)**

Displays predicted altitude undershoot for the waypoint on AT XXXXXX 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 Climb N1 (CLB N1, CLB – X N1)****[Option – FMC U10.3 and later]**

Displays the computed climb N1 value.

**9 Climb N1 (CUTBACK N1, CLB N1, CLB – X N1)****[Option – FMC U10.3 and later with quiet climb]**

Displays the computed climb N1 value.

**10 Engine Out (ENG OUT)**

Push – displays RT ENG OUT and LT ENG OUT prompts. See ENG OUT CLB page description.

**[Option – With engine out SIDS]**

Selection will also load the engine-out SID if the following conditions are true:

- an engine-out SID exists for the ACTIVE departure runway
- an engine-out SID is not already selected for the active route
- the flaps are not up and have not been up since the takeoff was started
- flight phase is takeoff or climb
- the airspeed is greater than 80 kts (airborne).

**[Option – FMC U10.4 and later]**

When the above conditions are met and there is a loss of thrust or split between the thrust levers, the FMC will automatically load the engine-out SID upon detection of the engine-out condition.

**11 Required Time of Arrival (RTA)**

Push – displays the RTA PROGRESS page.

ERASE prompt replaces RTA during a page modification.

## RTA Climb Page

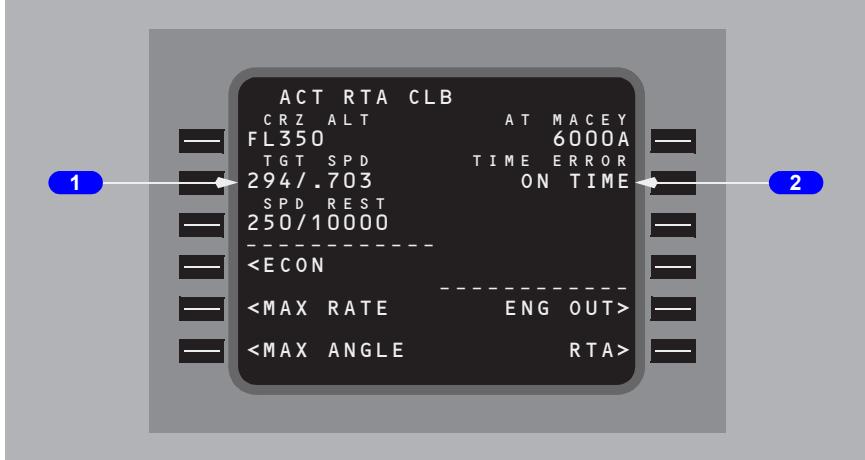
The RTA climb page is displayed when a required time of arrival is active.

The RTA climb page is automatically selected by pushing the CLB function key when RTA is active.

### [Option – With FANS MCDU]

During climb, the RTA climb page is automatically selected by pushing the VNAV 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)

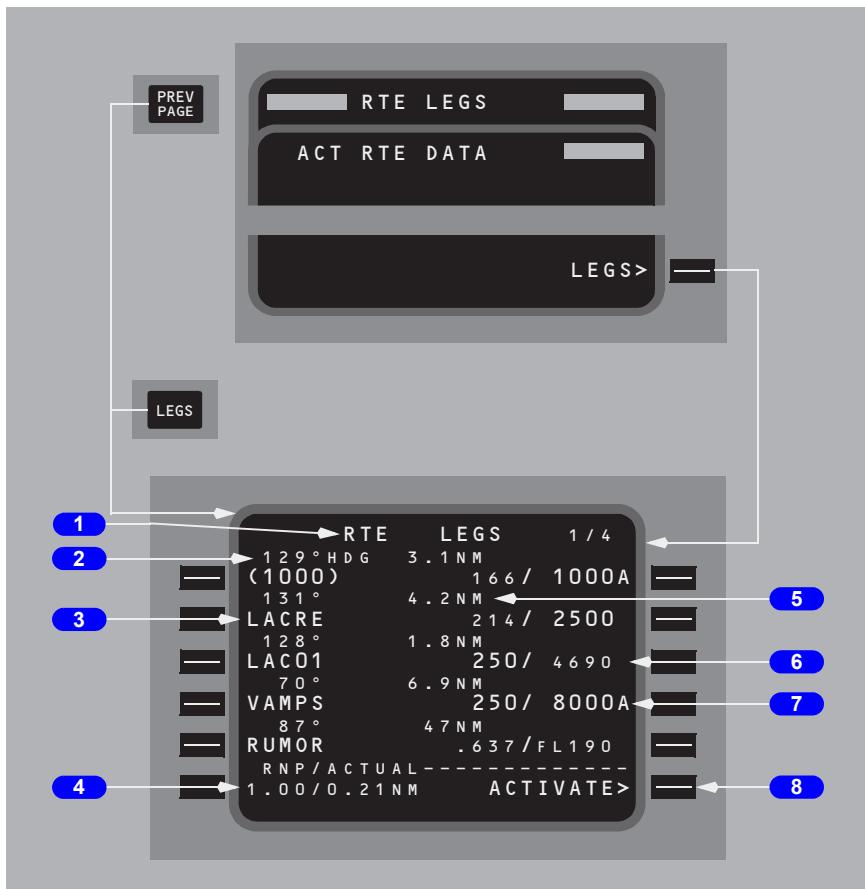
Displays computed speed required to meet entered RTA.

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 route legs page title is displayed with ACT as part of the title. A modified page title displays a reverse video MOD.

### 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). Directions to maintain an arc display the arc distance, the word ARC followed by the direction, and left or right (24 ARC L). 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 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 Required Navigational Position/Actual (RNP/ACTUAL)**

Displays the required navigation accuracy compared to actual navigation accuracy.

Manual entry is allowed.

### **5 Distance to Waypoint**

Displays the distance from the airplane or the waypoint to the next waypoint.

### **6 Calculated Waypoint Speed/Altitude**

Displays the calculated speed or altitude at the waypoint in small font.

### **7 Specified Waypoint Speed/Altitude**

Displays any waypoint speed or altitude constraint in large font.

Manual entry is allowed.

### **8 ACTIVATE, RTE DATA**

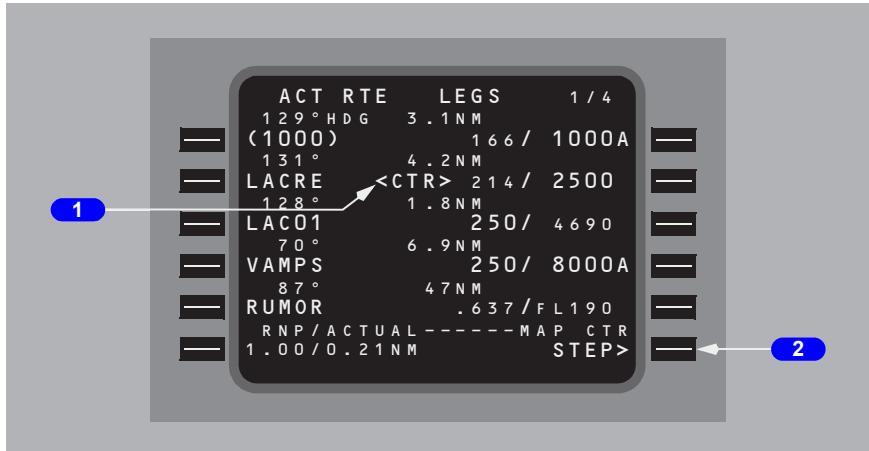
The activate prompt is displayed on the legs page when the route is not active.

Push –

- ACTIVATE arms the execute function. Pushing the EXEC key activates the route and changes the ACTIVATE prompt to RTE DATA
- RTE DATA displays the route data page. The RTE DATA prompt is used to review or modify additional information about the route.

## Map Center Step Display

The map center step prompt replaces ACTIVATE or RTE 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 navigation display. The label <CTR> 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 STEP

Displayed on a CDU when PLAN is selected on the associated EFIS control panel. Replaces the RTE DATA or ACTIVATE prompt.

Push – moves the map center label to the next geographically fixed waypoint in the route.

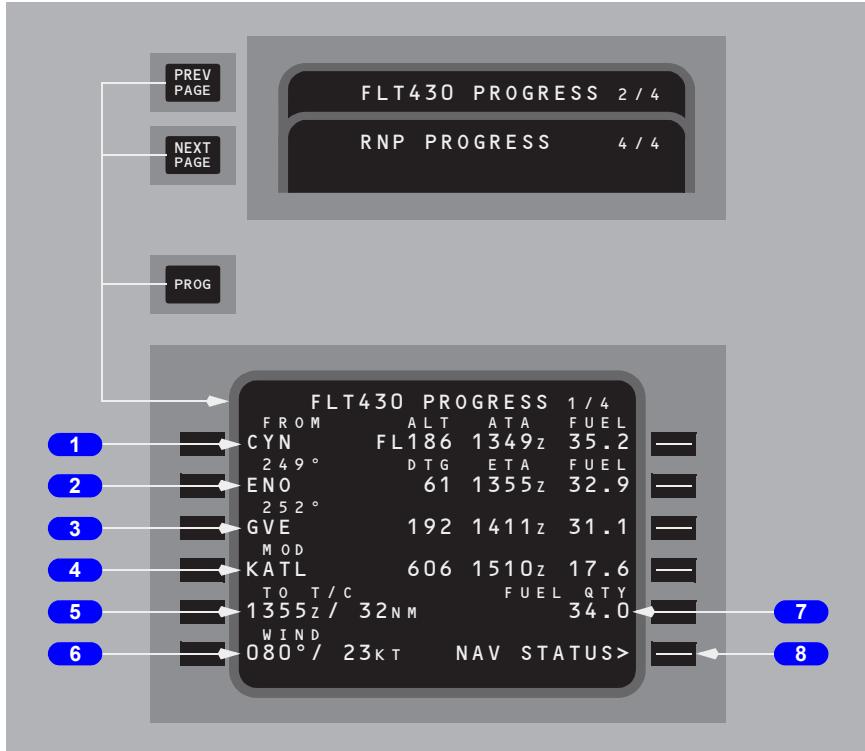
## Progress Page 1/X

The progress page provides general flight progress information along the route of flight such as:

- waypoints (last, active and next)
- waypoint ETA
- waypoint ATA
- distance to go information
- destination information
- altitude change points
- current wind
- fuel quantity

**[Option – With flight number entry]**

The page title displays the company flight number from the RTE page.

**[Option – FMC U10.5 and later with flight number entry]****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 if a path descent is not available.

**6 WIND**

Displays current true wind direction and speed.

**7 Fuel Quantity (FUEL QTY)**

Displays the present total fuel quantity remaining as obtained from the airplane fuel quantity indication system.

**8 NAV STATUS**

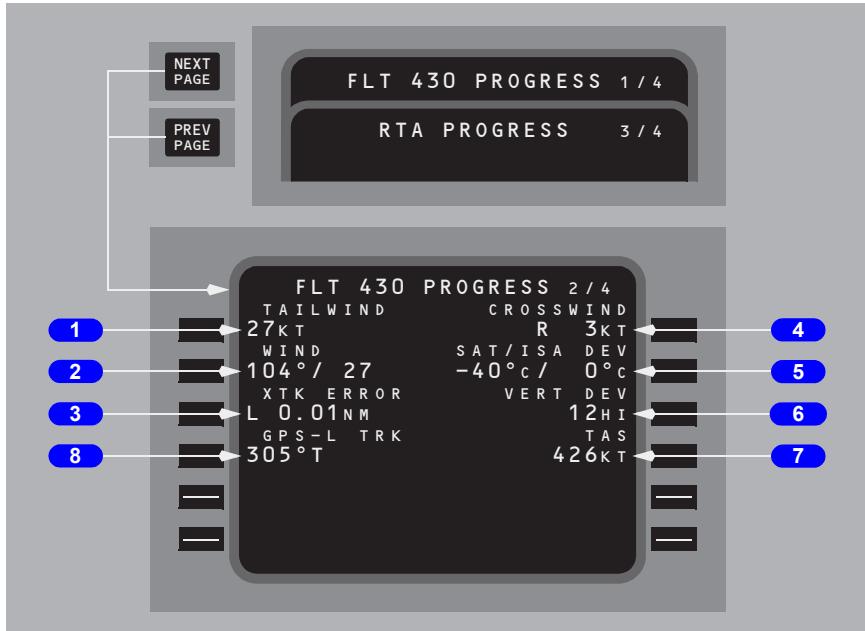
Push – displays the navigation status page.

## Progress Page 2/4

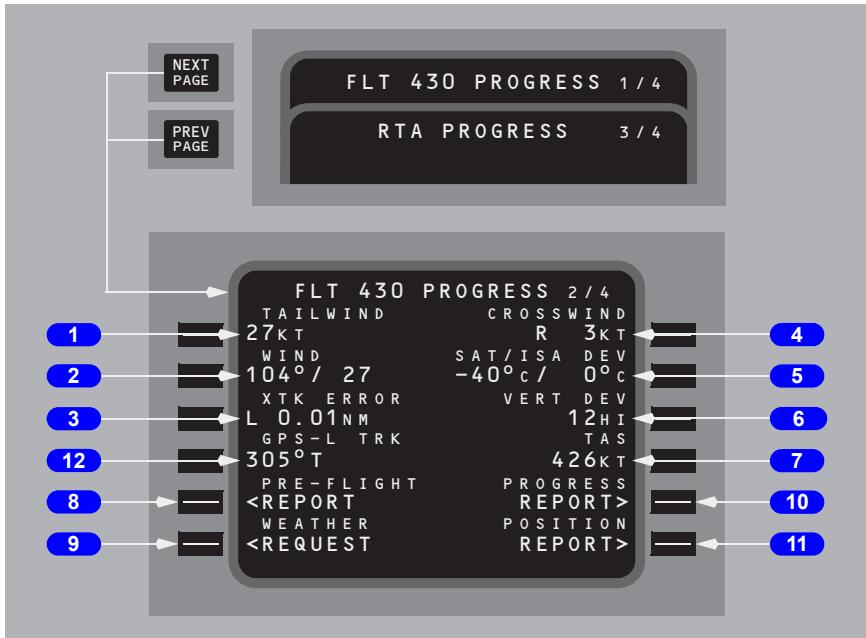
### [Option – FMC U10.5 and later]

The progress page 2/4 displays wind, track, path, temperature, and speed data.

### [Option – U10.5 and later, with flight number entry and GPS]



[Option – FMC U10.5 and later, with flight number entry, company data link and GPS]



### **1 HEADWIND or 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 from the desired LNAV course.

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 Descent Path Deviation (VERT DEV)**

Displays present computed deviation (HI or LO) from the FMC vertical path.

---

Blank if descent not active or path not available.

**7 TAS**

Displays present TAS.

**8 PRE-FLIGHT REPORT**

**[Option – With company data link]**

Push – transmits downlink report of preflight data.

**8 GPS-L TRK**

**[Option – With GPS]**

Displays GPS track.

**9 WEATHER REQUEST**

**[Option – With company data link]**

Push – transmits a data link request for a weather uplink.

**10 PROGRESS REPORT**

**[Option – With company data link]**

Push – transmits a downlink report of progress data.

**11 POSITION REPORT**

**[Option – With company data link]**

Push – transmits a downlink report of position data.

**12 GPS-L TRK**

**[Option – With GPS]**

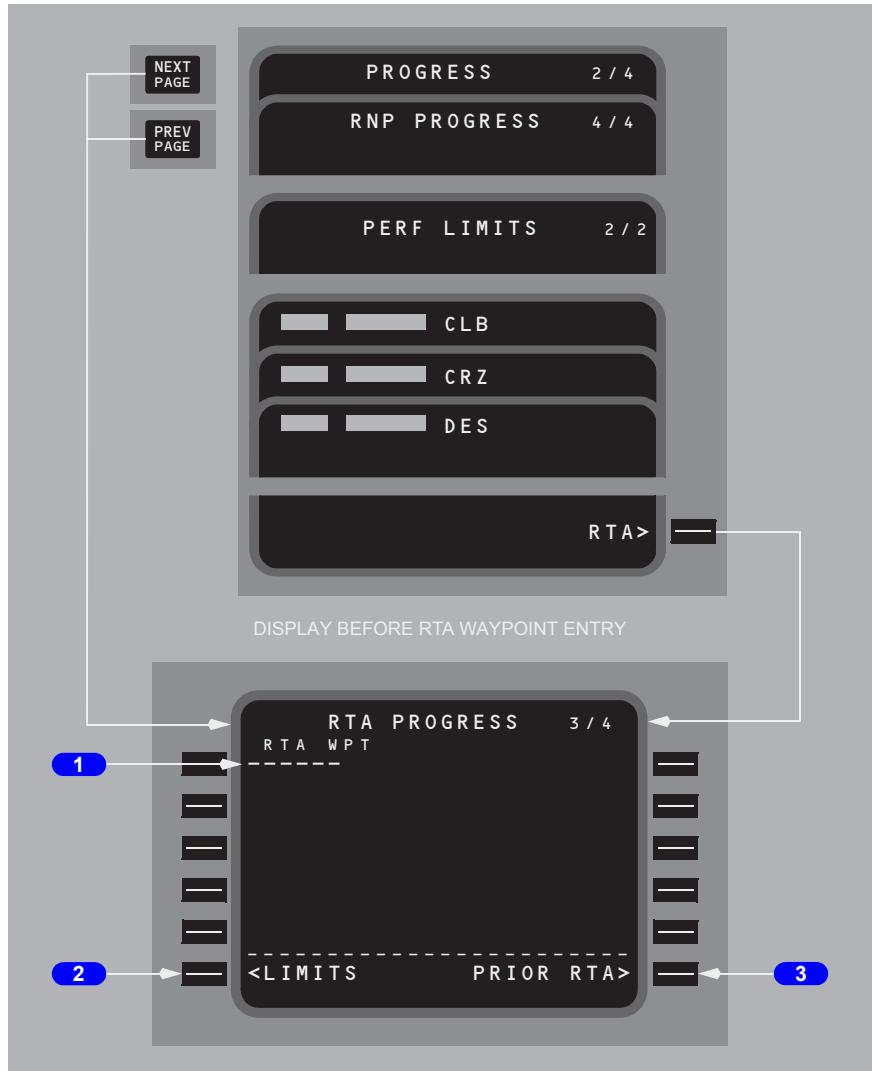
Displays GPS track.

## RTA Progress Page 3/4

### [Option – FMC U10.5 and later]

RTA Progress page is used to initiate the required time of arrival (RTA) mode.

The RTA 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 allowed.

---

## 2 LIMITS

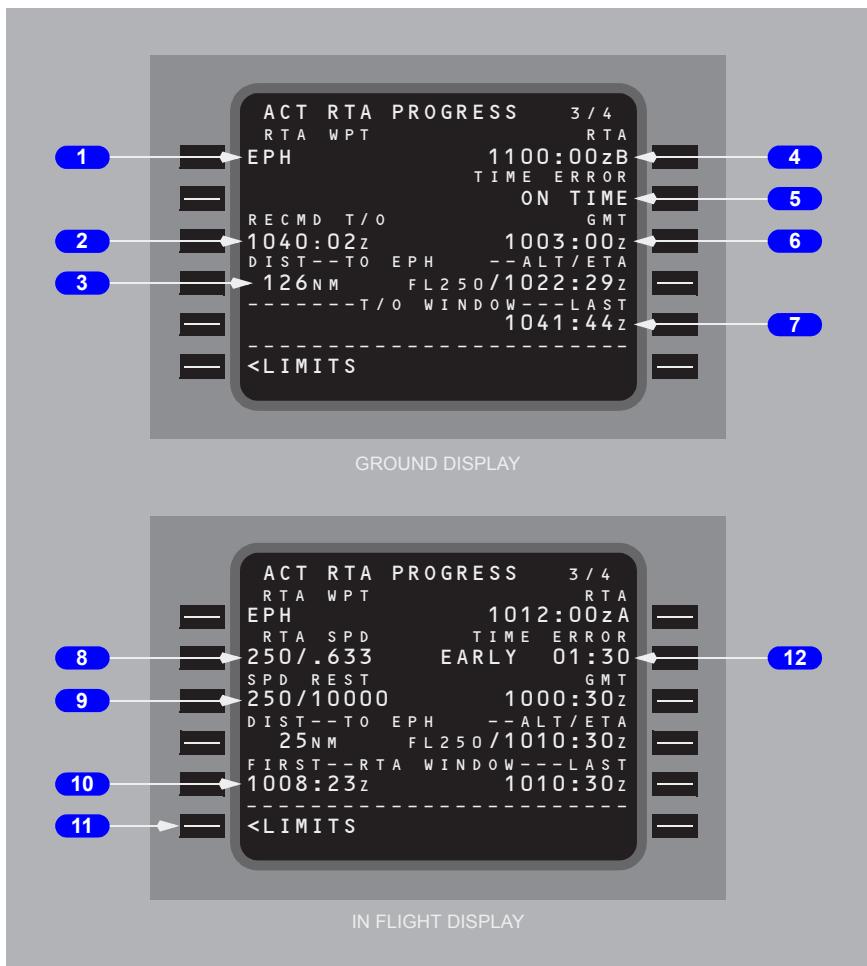
Push – displays the PERF LIMITS page.

### 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 light.

Deletion of the RTA waypoint will create a MOD RTA PROGRESS page with all data blanked and EXEC light illuminated. Execution will exit the RTA mode.

Deletion of the RTA waypoint does not remove the waypoint from the flight plan.

Automatically clears the RTA waypoint and exits the RTA waypoint after sequencing the RTA waypoint out of the flight plan.

## **2 Recommended Takeoff Time (RECMD T/O)**

Displays the recommended takeoff time (brake release time) to meet the planned RTA.

Time is based on entered Cost Index as well as the earliest and latest times to achieve RTA..

## **3 Distance To, Altitude, and ETA at the RTA Waypoint (DIST -- TO XXX -- ALT/ETA)**

Displays the distance to the RTA waypoint.

Displays the predicted altitude at the RTA waypoint.

Displays ETA to the RTA waypoint based on:

- immediate takeoff
- MIN/MAX speeds on PERF LIMITS page
- entered forecast winds.

## **4 Required Time of Arrival (RTA)**

After RTA waypoint entry, initially displays current ETA based on the active flight plan and performance parameters at 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).

Entry of “A” after RTA specifies arrival time of at or after.

Entry of “B” after RTA specifies arrival time of at or before.

## **5 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.

## **6 GMT**

Displays the actual GMT.

**7 Takeoff Window (----- T/O WINDOW --- LAST) or  
(FIRST -- T/O WINDOW -----)**

Displays latest takeoff time to meet the planned RTA.

If the entered RTA time is “At or After” time, only the FIRST field shall be displayed.

If the entered RTA time is “At or Before” time, only the LAST field shall be displayed.

Time is based on minimum and maximum speeds on the PERF LIMITS page.

**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 the SPD REST line.

During cruise, displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

**9 Speed Restriction (SPD REST)**

Displays the current speed restriction affecting RTA progress.

When not in cruise, displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

**10 Arrival Time Window (FIRST -- RTA WINDOW --- LAST)**

Displays earliest and latest 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**

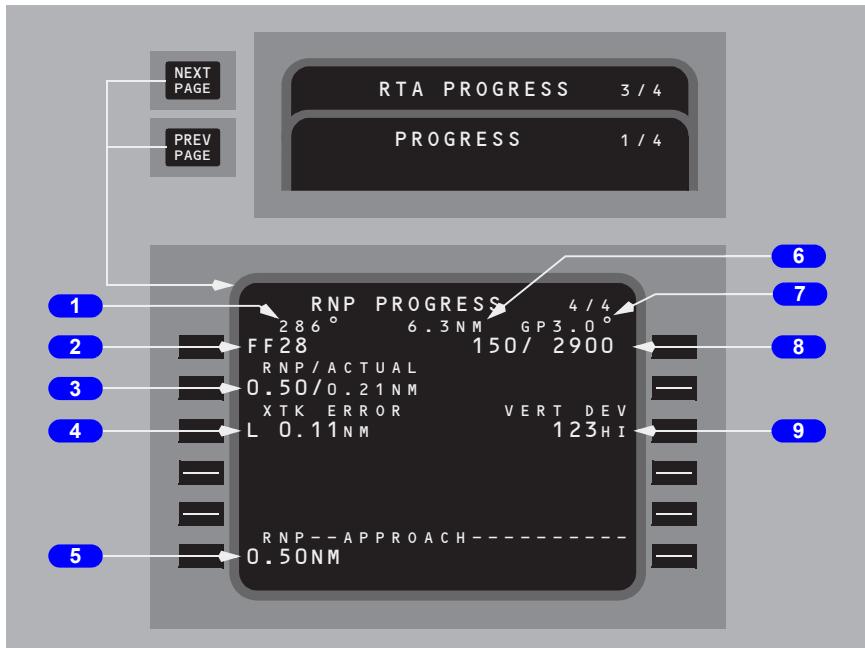
In flight, displays difference between the ETA and the RTA plus the TIME ERROR TOLERANCE on the PERF LIMITS page.

## RNP Progress Page 4/4

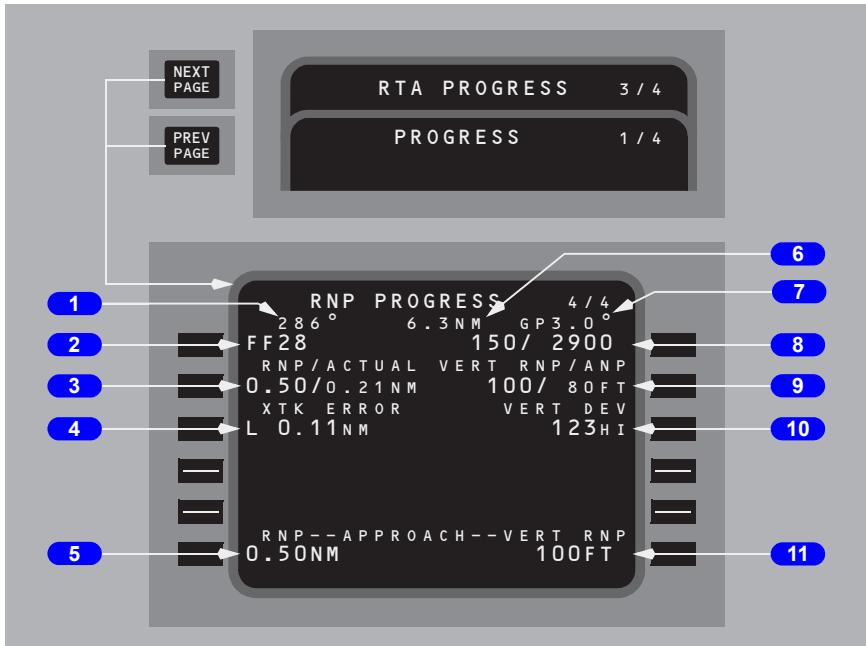
### [Option – FMC U10.5 and later]

Progress page 4/4 displays essential Required Navigation Performance (RNP) information. The items displayed include waypoint identifier, RNP and ANP values, course, distance, glidepath, cross track error, speeds, altitudes and vertical deviation.

### [Option – FMC U10.5 and later]



[Option – FMC U10.5 and later with navigation performance scales enabled and Vertical Required Navigation Performance (Vertical RNP) enabled]



## 1 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). Directions to maintain an arc display the arc distance, the word ARC followed by the direction, and left or right (24 ARC L). 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 PROC TURN.

Display is blank for an undefined course.

## 2 Waypoint Identifier

Displays the next waypoint.

Same as displayed on the RTE LEGS page.

### 3 RNP / ACTUAL

Displays the current FMC RNP / ANP values. The RNP may be overwritten (manual entries are displayed in large font) and affects the approach RNP 6L value. The RNP value displayed is selected from the performance defaults database if not specified in the navigation database.

Same as displayed on the POS SHIFT page.

### 4 Crosstrack Error (XTK ERROR)

Displays present cross-track error from the desired LNAV course.

L or R indicates left or right of course.

Blank if error is greater than 99.9 nm.

### 5 Lateral RNP (Approach)

Displays the lowest applicable RNP for the approach.

Displays in large font for 3L manually entered RNP values.

Displays in small font for values provided by the navigation database.

### 6 Distance To Go

Displays the distance remaining to the next waypoint.

### 7 Glidepath

Displays the FMC computed glidepath for the approach.

### 8 Waypoint Speed/Altitude

Displays waypoint speed or altitude constraints in large font.

Displays FMC predicted values in small font when no restrictions have been specified.

### 9 Vertical Deviation

Displays present vertical deviation from the FMC computed glidepath.

### 9 Vertical Navigation Performance

#### [Option – With navigation performance scales enabled]

Displays both the vertical RNP (Required Navigation Performance) and the vertical ANP (Actual Navigation Performance) for the current leg.

Valid display range for vertical ANP is 0 to 999 feet.

Manual entries are allowed and are displayed in large font.

Valid entries are 10 to 999 feet and may be suffixed with an optional “/”.

Entries are cleared at flight completion.

Values from the navigation database are displayed in small font.

#### **10 Vertical Deviation**

##### **[Option – With navigation performance scales enabled]**

Displays present vertical deviation from the FMC computed glidepath.

#### **11 Vertical RNP (Approach)**

##### **[Option – With navigation performance scales enabled]**

Displays the lowest applicable vertical RNP for the approach.

Manual entries (entered in 2R) are displayed in large font.

Values from the navigation database are displayed in small font.

## N1 Limit Page

### [Option – FMC U10.1 and later]

This section describes the in-flight version of the N1 LIMIT page. See the FMC Preflight section for a description of the preflight version of the N1 LIMIT page.

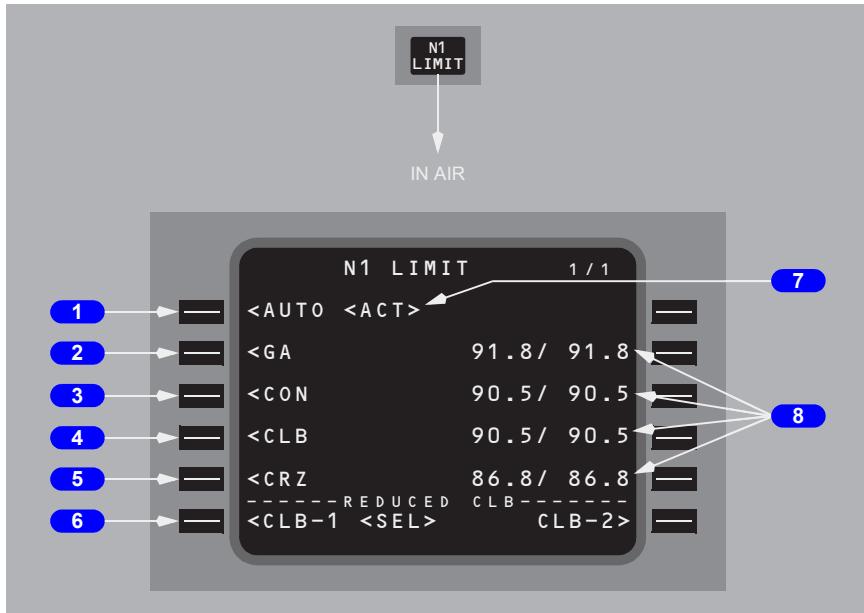
Normally, N1 limits are automatically specified. Pilot selection of other limits is allowed.

Pilot selection of a reduced climb mode does not change the automatic selection for other phases of flight.

Pilot selected mode is automatically replaced by AUTO selection when the autopilot next changes vertical mode.

The active thrust limit is used by the autopilot and is displayed on the thrust mode display.

### [Option – FMC U10.1 and later]



#### 1 AUTO

Push – selects automatic computation of N1 limits for all phases of flight.

#### 2 Go Around (GA)

Push – selects the go-around thrust limit.

**3 Continuous (CON)**

Push – selects the maximum continuous thrust limit.

**4 Climb (CLB)**

Push – changes the thrust mode from AUTO to the active climb thrust, i.e. CLB, CLB–1, or CLB–2.

**5 Cruise (CRZ)**

Push – selects the cruise thrust limit.

**6 Reduced Climb (REDUCED-CLB)**

Push – selects either of two reduced climb thrust modes.

CLB–1 provides a climb limit reduced by 3% N1 (approximately 10% thrust).

CLB–2 provides a climb limit reduced by 6% N1 (approximately 20% thrust).

The reduced climb N1 value is displayed on the CLB pages.

If either mode is <SEL>, deletion allows return to full rated climb thrust.

Any reduced climb selection is automatically deleted above 15,000 feet.

**Note:** If a reduced thrust takeoff has been specified on the TAKEOFF REF page, the FMC will re-compute CLB–1 and CLB–2 values as required to avoid a climb N1 value greater than the reduced thrust takeoff N1 value.

**7 <ACT> STATUS LABEL**

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.

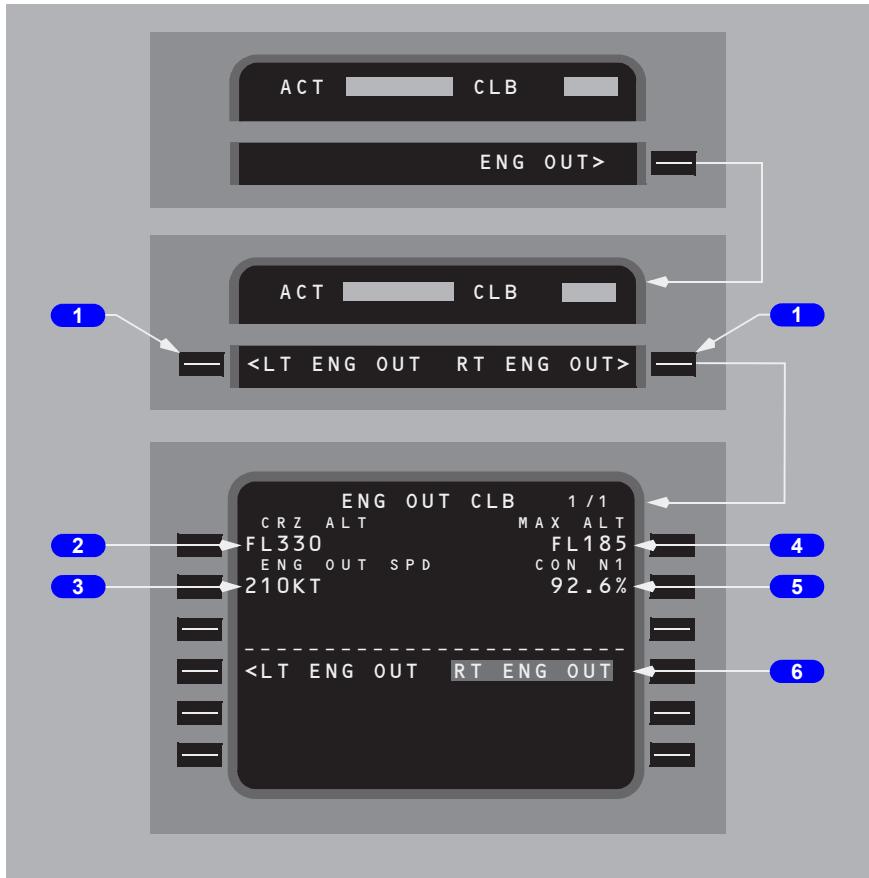
## Engine Out Climb

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. Once the page is selected, it cannot be executed.

[Option – FMC U10.3 and later]



#### 1 Left/Right Engine Out (LT ENG OUT/RT ENG OUT)

Displayed after selection of ENG OUT prompt.

**2 Cruise Altitude (CRZ ALT)****[Option – FMC U10.3 and later]**

Displays the current active cruise altitude. Value is forwarded from either the PERF INIT, CRZ, CRZ CLB, or CRZ DES pages. Manual entry not allowed.

**3 Engine Out Speed (ENG OUT SPD)****[Option – FMC U10.3 and later]**

Displays the minimum drag engine out climb speed.

**4 Maximum Altitude (MAX ALT)**

Displays the maximum altitude at which company specified rate of climb can be achieved using one engine at maximum continuous thrust.

After page selection, the FMC accounts for wing and engine anti-ice, air conditioning and engine bleed of the operating engine.

**5 Continuous N1 (CON N1)****[Option – FMC U10.3 and later]**

Displays the N1 for maximum continuous thrust.

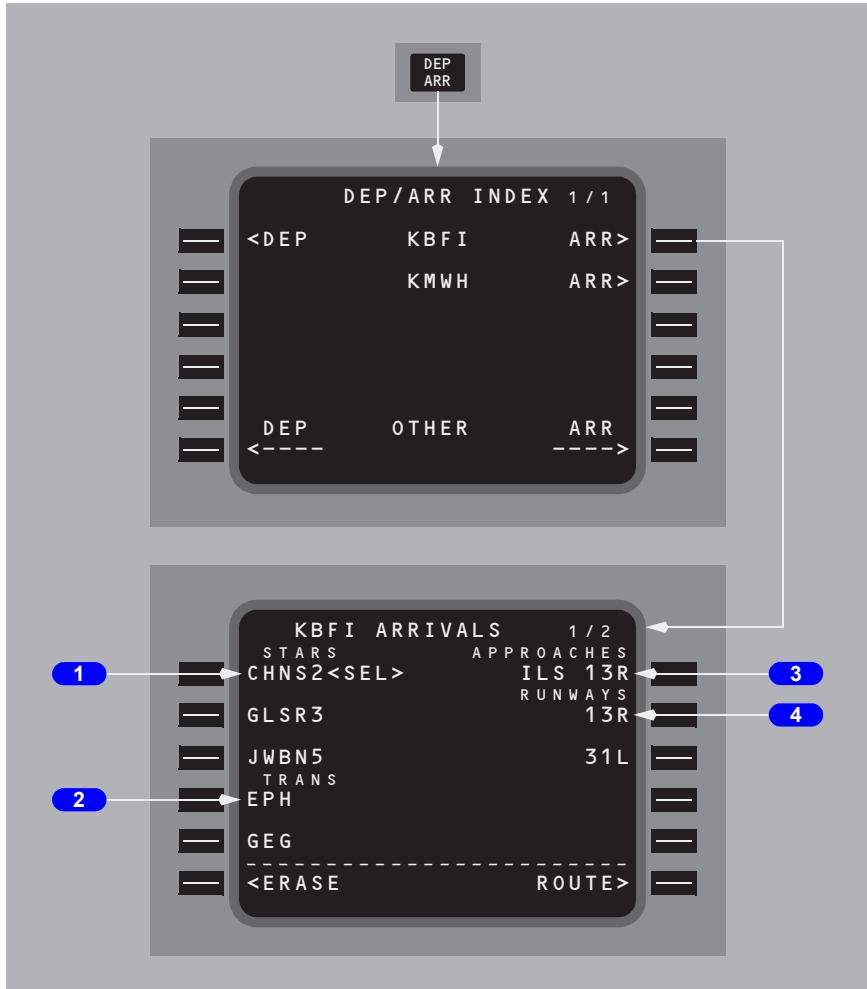
**6 LT ENG OUT/RT ENG OUT**

Selected engine is shown in reverse highlighting.

## Air Turnback

### Arrivals Page

During a turn-back situation, the crew requires quick access to the arrivals information for the origin airport. The departure/arrivals index and arrivals page provide access without changing the destination on the route page. See Chapter 11, Section 43 for additional information on the arrivals page.



#### 1 Standard Terminal Arrival Routes (STARS)

Displays STARS for the origin airport.

**2 Transitions (TRANS)**

Displays transitions for the origin airport.

**3 APPROACHES**

Displays approaches for the origin airport.

**4 RUNWAYS**

Displays runways for the origin airport.

Intentionally  
Blank

## Flight Management, Navigation FMC Cruise

## Chapter 11 Section 42

### Introduction

The cruise phase automatically begins when the top of climb is reached.

During cruise, the primary FMC pages are:

- RTE LEGS
- PROGRESS
- CRZ.

The RTE LEGS pages are used to manage route restrictions and modify the route. The PROGRESS pages display flight progress information. RTA requirements are also specified on the PROGRESS pages. The CRZ pages display VNAV related information. Other pages include:

- POS REF page – verifies the FMC position (refer to Section 40 of this chapter)
- POS SHIFT page – permits selection of preferred position from 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
- 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 WAYPOINT page – permits selection of the desired waypoint from a list of duplicate named waypoints
- NAV STATUS page – displays information about available navigation aids.

The only cruise mode automatic page changes are the transition from climb to cruise at the top of climb point and from cruise to descent at the top of descent point.

### LNAV Modifications

This section presents the normal techniques for modifying the route. The modifications include:

- adding and deleting waypoints
- resequencing waypoints
- linking discontinuities
- intercepting a course.

## RTE LEGS Page Modifications

When modifications are made to the RTE LEGS page, several automatic prompt or identifying features assist in managing and executing the modifications, such as:

- ERASE
- INTC CRS.

### Adding Waypoints

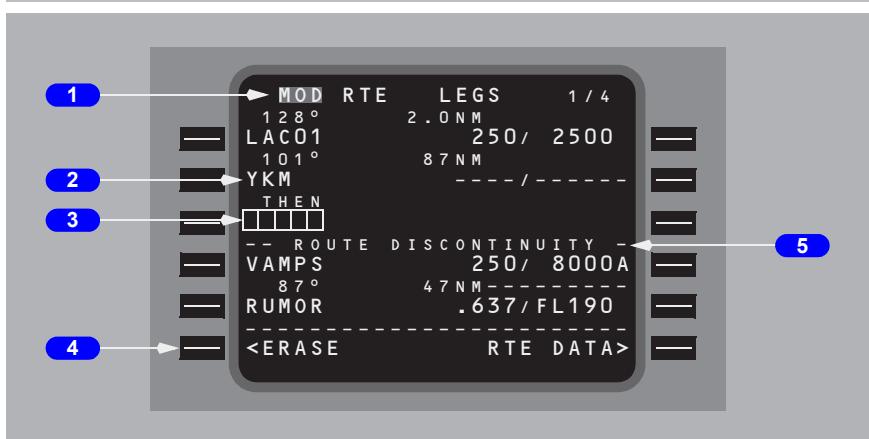
A waypoint can be added to the route whenever necessary.

The new waypoint must first be placed into the CDU scratchpad. Existing waypoints can be copied from a RTE LEGS page into the scratchpad by pushing the line select key adjacent to the desired waypoint.

The new waypoint is then inserted into the route at the desired sequence point by pushing the line select key adjacent to the desired location for the new waypoint. Using the NEXT PAGE/PREV PAGE function keys to select the desired location does not alter the CDU scratchpad. The new entry automatically links to the preceding waypoint via a direct route. Placing the new waypoint into the active waypoint line is a special case and is discussed under Intercept Course in this section.

All new waypoints, except along track 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 highlighting. 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

YKM waypoint is entered into the route between LAC01 and VAMPS. This modification creates a route discontinuity.

## 3 Discontinuity Waypoint

Box prompts indicate the requirement to link the route by entering a route waypoint into the discontinuity waypoint position.

## 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.

Push – removes all modifications and restores all active data.

## 5 Discontinuity Header

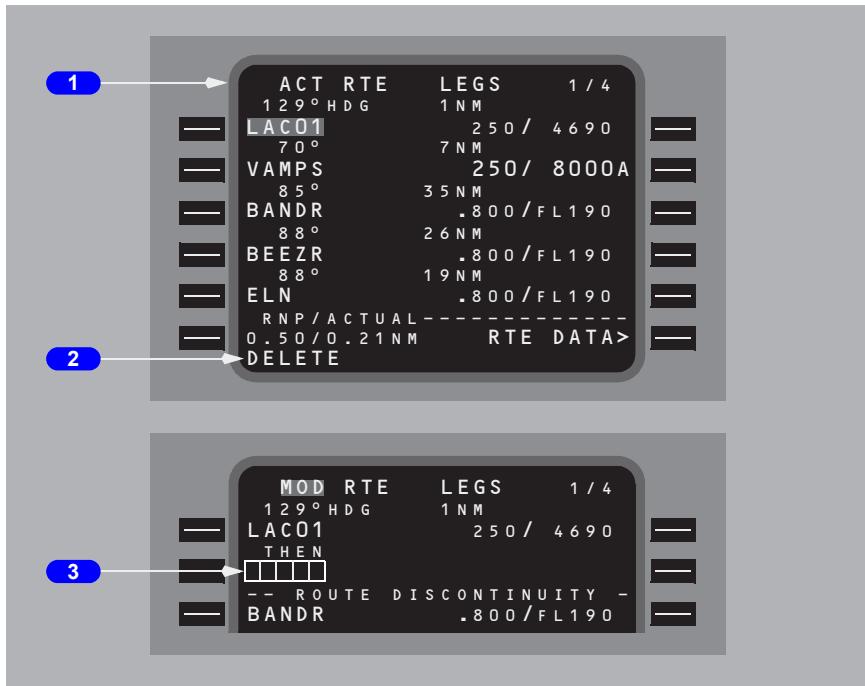
Indicates that the route is not continuous. Distance to destination on the PROGRESS page is not correct.

## Deleting Waypoints

Waypoints can be removed from the RTE LEGS page. There are two normal methods to remove a waypoint:

- delete the waypoint using the DEL function key (not possible for the active waypoint and some 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

The existing route shows VAMPS followed by BANDR, BEEZR, and ELN.

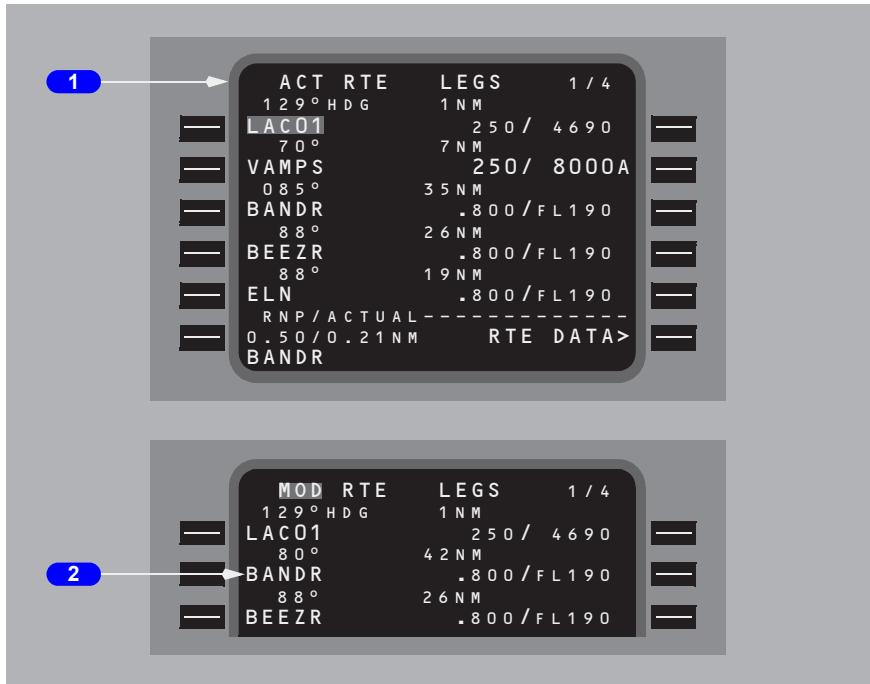
### 2 DELETE Entry

Push the DEL key to arm the delete function. DELETE is displayed in the scratchpad.

### 3 Delete VAMPS

With DELETE displayed in the scratchpad, push the line select key left of VAMPS to delete the waypoint. Box prompts replace VAMPS and a route discontinuity follows the box prompts.

## Resequencing Waypoints



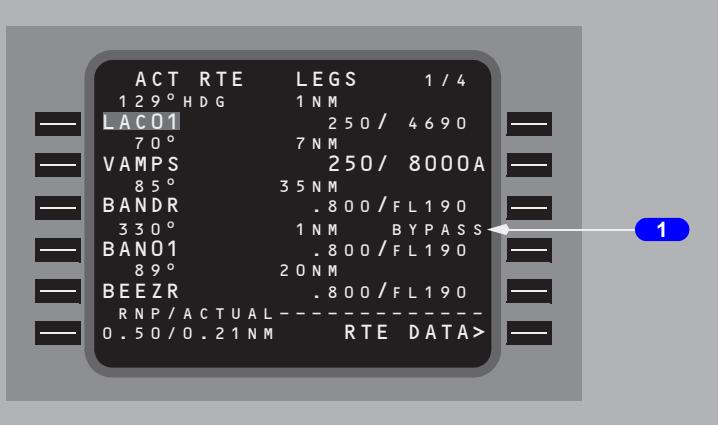
### 1 Active Route

The existing route shows VAMPS followed by BANDR, BEEZR, and ELN. The airplane must fly direct from LAC01 to BANDR. The BANDR waypoint is copied into the scratchpad.

### 2 Resequence BANDR

BANDR is transferred to the waypoint following LAC01. VAMPS is removed, and the route remains continuous.

## Leg Bypass



### 1 Bypass Notification

A waypoint (BAN01) has been entered into the route which is very close to another route waypoint (BANDR). It is impossible for the airplane to turn and capture the leg between BANDR and BAN01, 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.

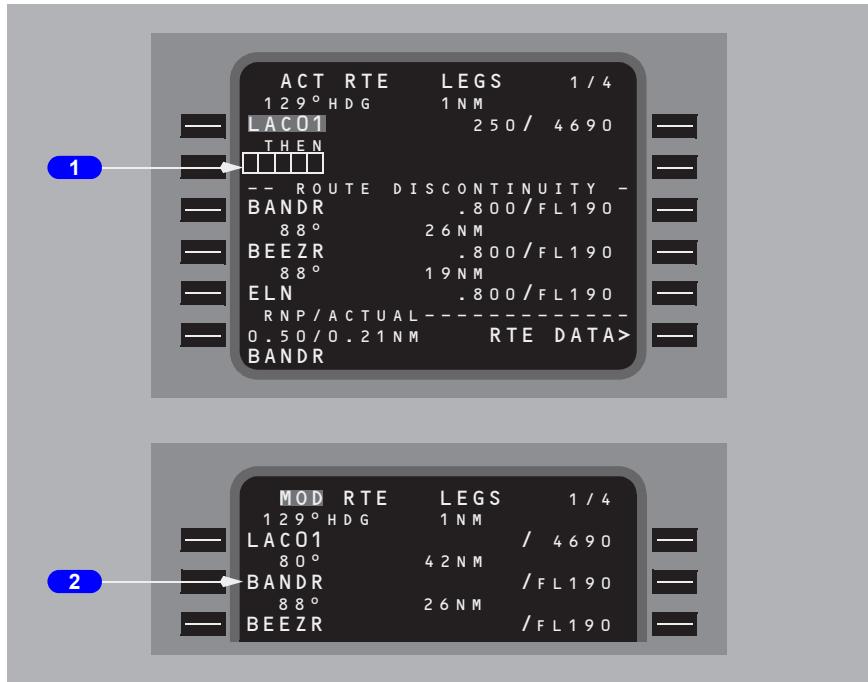
Any mandatory altitude-crossing restriction for the bypass waypoint is still observed if VNAV is engaged, based on passing abeam the waypoint.

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, just as when adding a waypoint.



### 1 ROUTE DISCONTINUITY

The active route shows a discontinuity. The airplane must fly direct from LAC01 to BANDR. The BANDR 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.

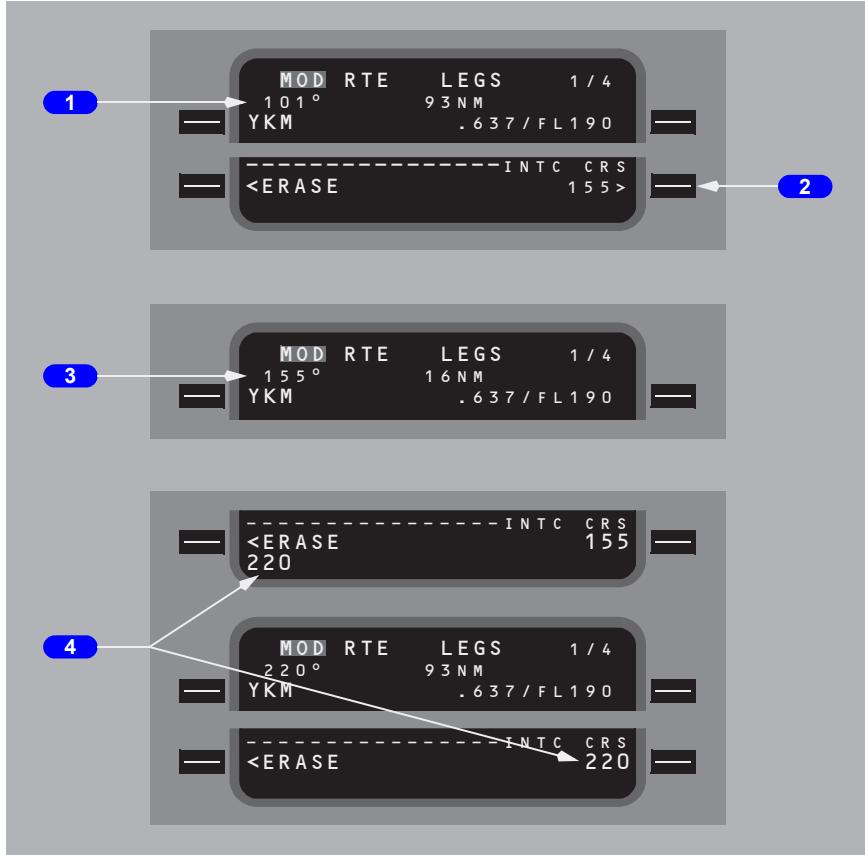
### 2 Continuous Route

BANDR 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 and Intercept Course

To fly direct to a waypoint or intercept a course to a waypoint, enter the waypoint name on RTE LEGS page 1 active waypoint line. The INTC CRS prompt displays in line 6R. The example shows the result with YKM entered into the active waypoint line.



### 1 Direct Course

Direct course from airplane present position to entered waypoint.  
Execute to proceed direct to active waypoint.

### 2 Intercept Course (INTC CRS)

Push – puts displayed course (155) into active waypoint leg direction. Enables intercept course function.

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.

### **3 Leg Direction**

Displays the course inbound to the active waypoint after selecting the course displayed in the INTC CRS line.

### **4 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 220° intercept course to YKM entered in the INTC CRS line.

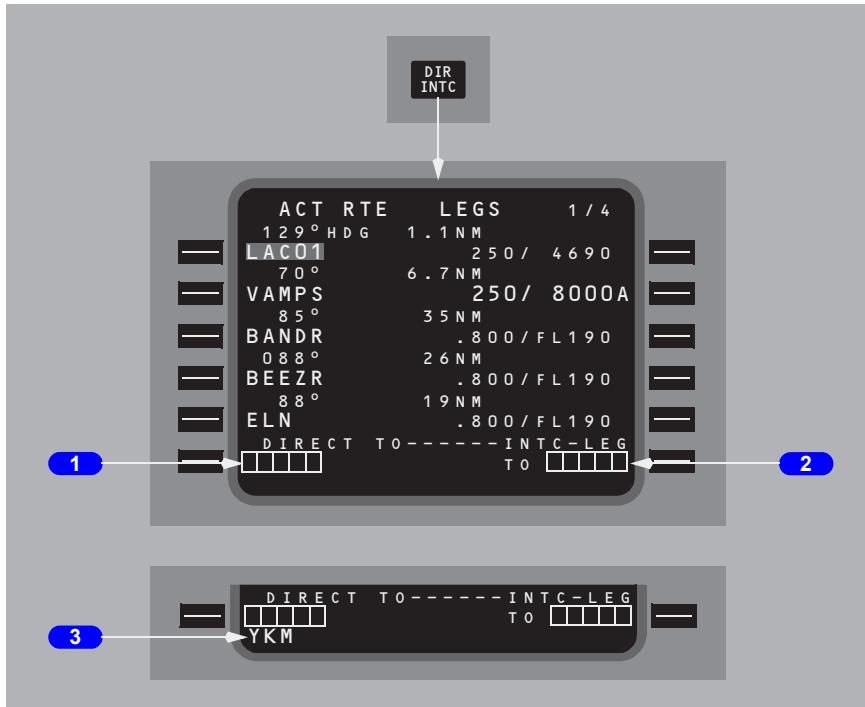
## DIR INTC Key

### [Option – CDU]

Proceeding direct to a waypoint or intercepting a course to a waypoint may also 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. Subsequent operations are identical to those described in the Intercept Course section.



#### 1 Direct To Boxes

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

#### 2 Intercept Leg To Boxes

Entering the desired waypoint in these boxes allows a course to be specified to the waypoint and makes that waypoint the active waypoint.

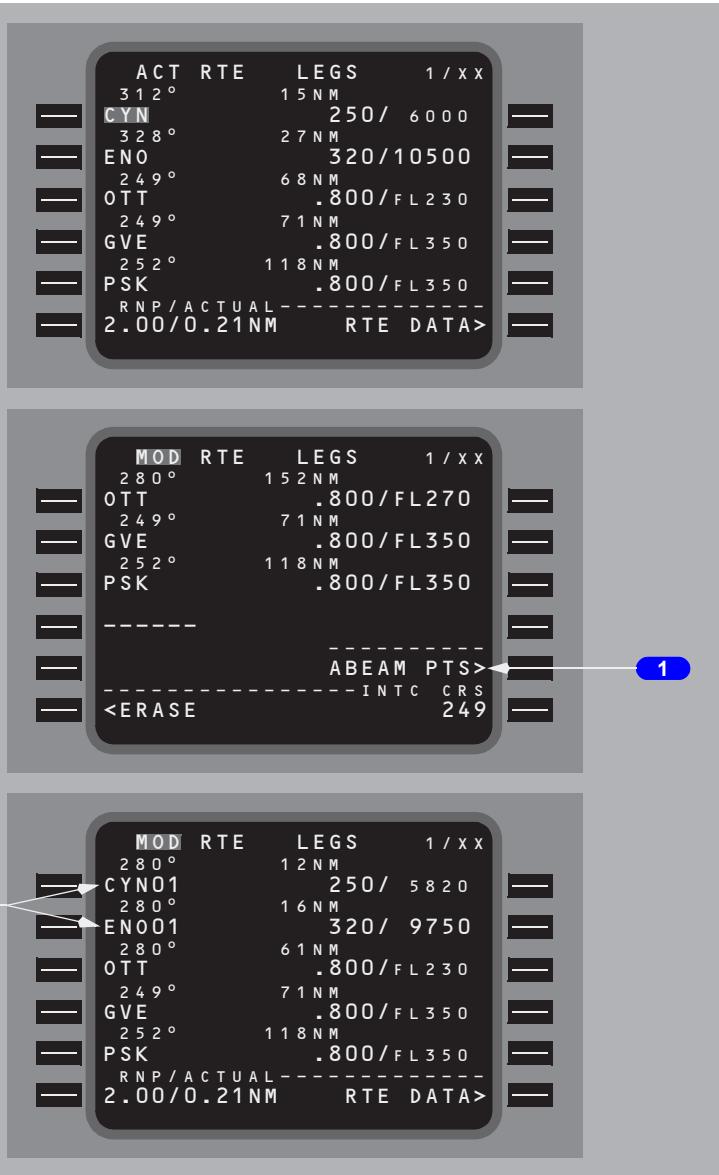
**3 Scratchpad Entry**

The desired waypoint is entered into the appropriate boxes.

## Abeam Points

## [Option]

When a direct-to modification bypasses existing route waypoints, these bypassed points can be projected onto the new route as abeam points. Abeam points are perpendicular to the bypassed waypoints.



## 1 Abeam Points (ABEAM PTS)

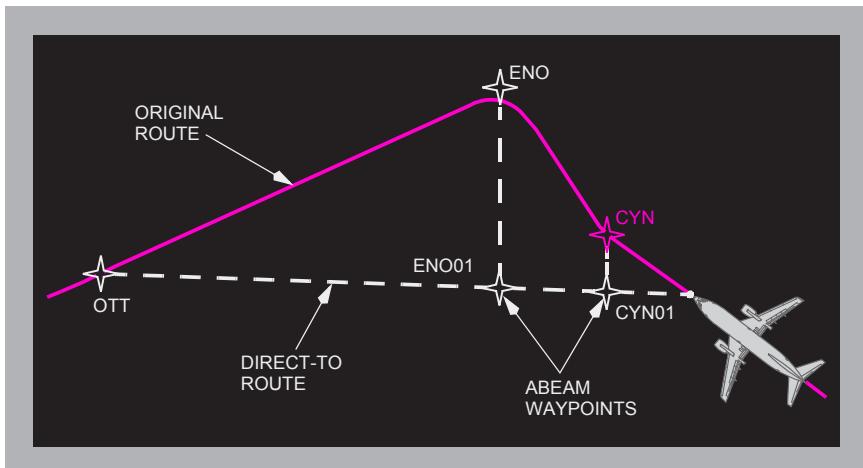
Selecting the prompt permits the retention of waypoints following a direct-to modification. The FMC creates and displays points on the new route which are abeam the waypoints bypassed by the route modification.

In the example, the route has been modified to proceed direct to OTT. This modification bypasses CYN and ENO.

## 2 Abeam Waypoints

CYN01 and ENO01 have been created. Data and status corresponding to the parent waypoints is passed to the abeam waypoints. If abeam distance is less than 100 nm, only the wind data is passed to the abeam waypoint.

The following diagram depicts the situation.



### [Option – FMC U10.3 and later]

The ABEAM PTS prompt will not appear if no abeam waypoints are possible or if selection would increase the total number of waypoints to more than 150.

Abeam waypoints will not be generated for floating (non-fixed) waypoints; if the abeam distance exceeds 700 nm; or if the abeam waypoint would fall within 10 nm of either the present position or the direct-to waypoint.

If two or more identical (within 1 nm of each other) abeam waypoints are generated, only one will be designated.

Abeam waypoints use the same naming conventions as used for place-bearing/distance waypoints. See chapter 11, section 31, “Manually Entered Place-Bearing/Distance or ...” for additional information.

## Select Desired Waypoint Page

When a waypoint identifier is not unique (other database waypoints have the same name), a selection of which latitude/longitude to use must be made before that waypoint can be used in the route.

### [FMC U10.6 and later]

The SELECT DESIRED XXX page is automatically displayed when the FMC encounters more than one identifier for the same waypoint name after a waypoint entry.

### [FMC U10.6 and later]



#### 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 Type

Shows type of navaid.

Available types include VOR, VORTAC, VORDME, NDB, LOC, ILS, DME, ILSDME, LOCDME, APT or WPT.

#### 3 Frequency

Displays the frequency of the navaid.

Blank if the waypoint is not a navaid.

#### 4 Waypoint Name

Displays the name of the waypoint.

Blank if the waypoint is not a navaid.

## 5 Latitude/Longitude

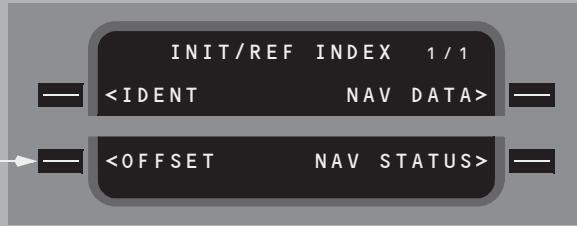
The latitude/longitude is displayed for each duplicate name.

## Lateral Offset

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 LATERAL OFFSET (or ACT LATERAL OFFSET page if an offset already exists).

Some legs are invalid for offset. These include:

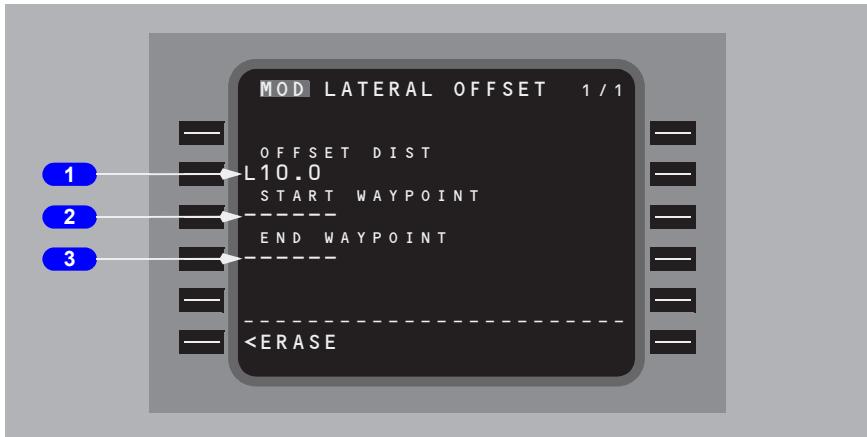
- End of flight plan waypoint
- Discontinuity
- Beginning of approach transition
- Approach procedure
- DME arc
- Heading leg
- Holding pattern (except PPOS)
- Certain legs containing flyover waypoints
- Course change greater than 135 degrees
- Preplanned termination waypoint.



## 1 OFFSET

Push – displays the lateral offset page.

### Lateral Offset Page



**1 Offset Distance (OFFSET DIST)**

The desired lateral offset distance is entered on line 2L 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 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 flight plan until end waypoint is encountered.

Deletion of end waypoint (or no entry) will result in offset propagating until an invalid offset leg is encountered.

## VNAV Modifications

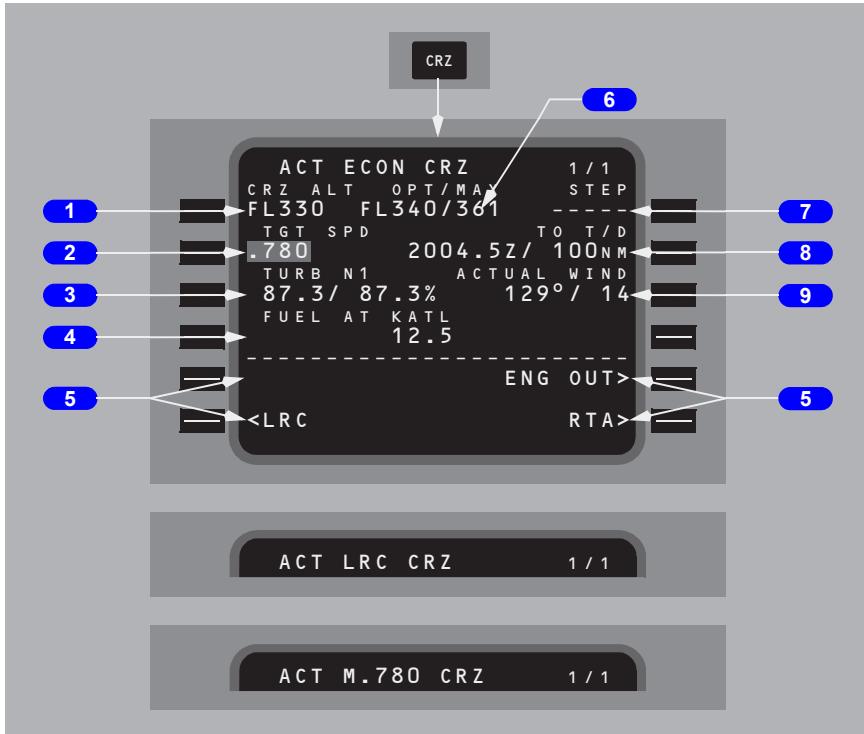
Three primary cruise modes are available – economy (ECON) cruise, long range cruise (LRC), and cruise with a manually selected speed.

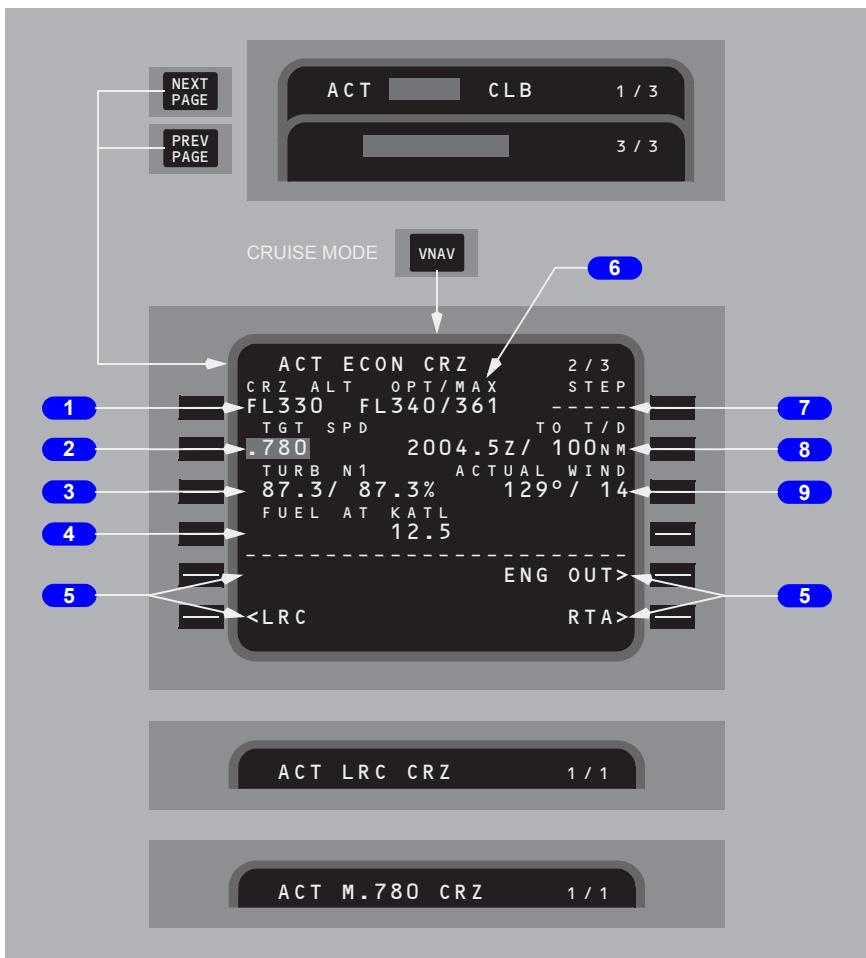
Access to the various cruise pages is obtained by pushing the CRZ mode select key.

### [Option – With FANS MCDU]

Access to the various cruise pages is obtained by pushing the VNAV function key while in cruise. Access from other performance pages is via the NEXT/PREV PAGE key.

## Cruise Page



**[Option – With FANS MCDU]**

**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.

**[Option – With speed and altitude intervention]**

Value may be increased using altitude intervention.

## 2 Target Speed (TGT SPD)

The computed target speed displays one of the following:

- computed or manually selected value for target airspeed or Mach
- XXX/MCP when speed intervention is active and the plan is active
  - deletion or modification of XXX/MCP is not allowed
- XXX/HOLD when decelerating to hold speed prior to the hold entry fix
  - deletion or modification of hold speed is not allowed.

The value is reverse highlighted on an active cruise page.

A manual airspeed or Mach entry will automatically propagate to the descent page TGT SPD field.

## 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 the various cruise pages.

The RTA prompt is replaced with ERASE when a MOD page is displayed.

## 6 Optimum/Maximum Altitude (OPT/MAX)

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).

Also 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 to Altitude Line (STEP)

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 Top of Descent (TO T/D) Line**

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 to altitude has not been entered.

## **9 ACTUAL WIND**

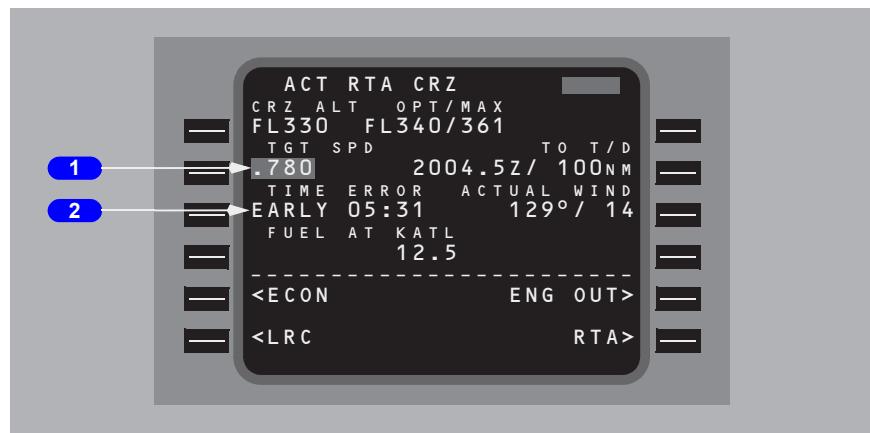
Displays computed or manually entered true wind for present altitude.

A manual entry has priority. The data line title then changes to EST WIND (estimated 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 cruise page will reflect the RTA data.



### **1 Target Speed (TGT SPD)**

Displays the computed speed required to meet the RTA.

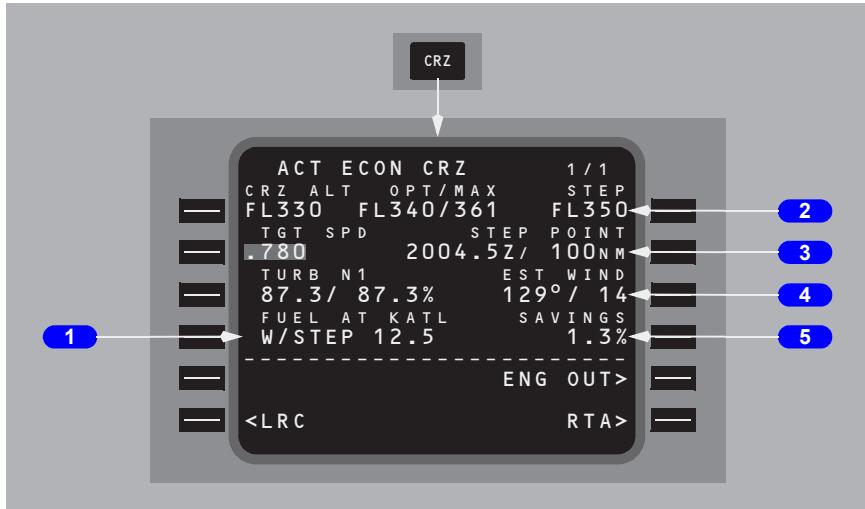
When RTA mode is exited by waypoint sequence or by deletion, this speed becomes the FMC target speed on a manual speed cruise page and the scratchpad message SELECT MODE AFTER RTA is displayed.

### **2 TIME ERROR**

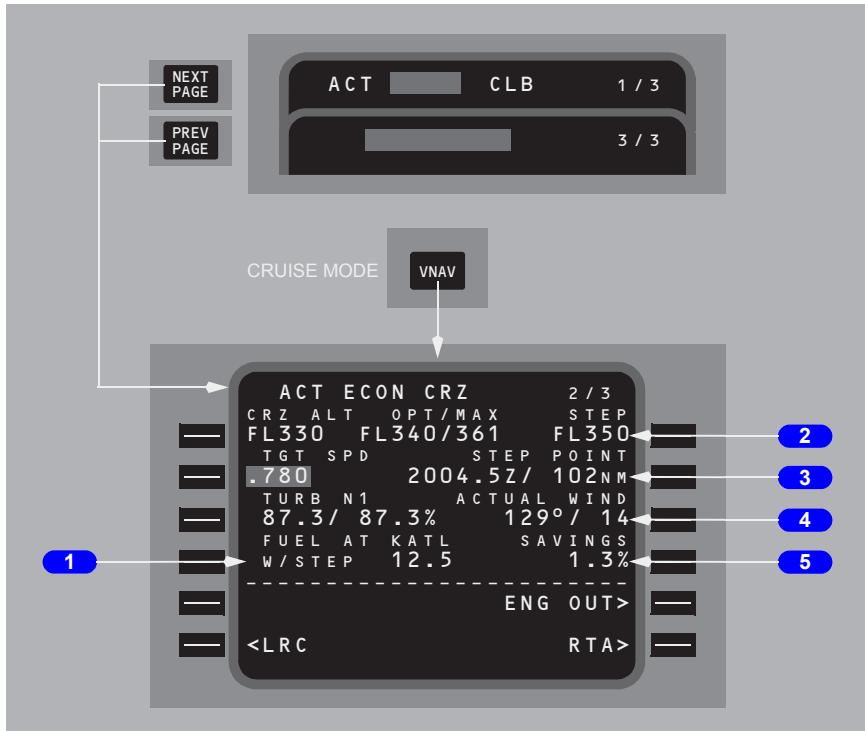
Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

## Cruise with Step Climb



[Option – With FANS MCDU]



**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 To 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.

Blank if no entry on STEP TO line.

**4 Wind (ACTUAL WIND or EST WIND)**

Used as the assumed true wind at the STEP TO altitude for making wind–altitude trade computations.

**5 Savings/Penalty (SAVINGS or 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.

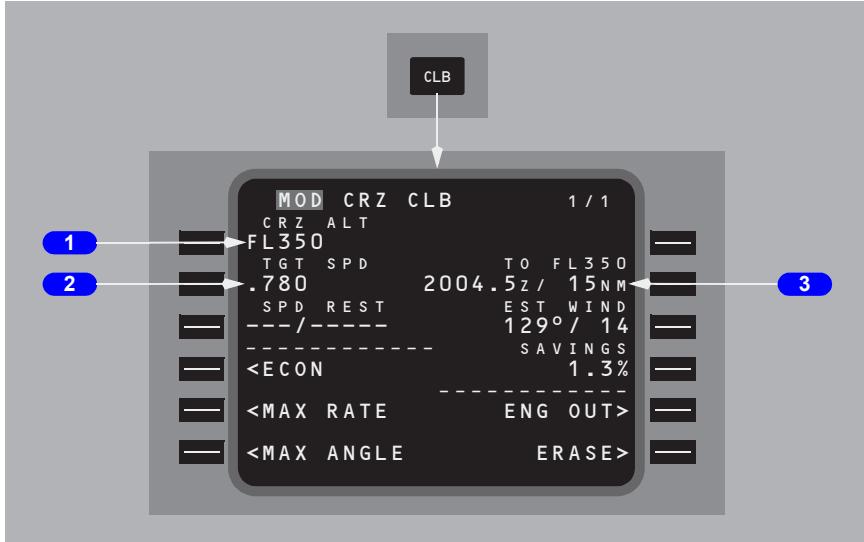
## Cruise Climb

The cruise climb page displays data for a cruise climb to a new altitude.

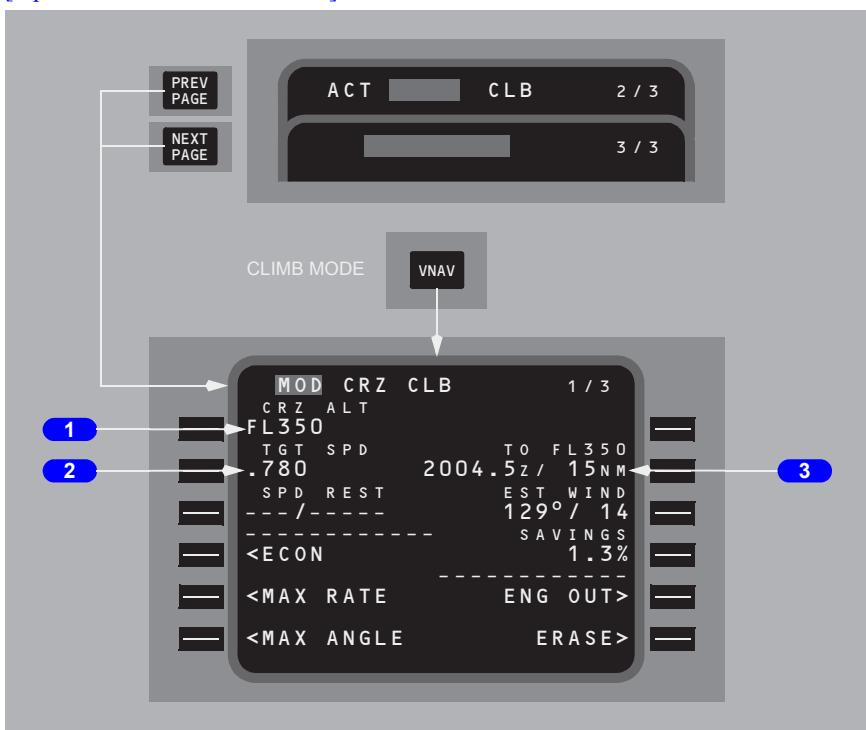
MOD CRZ CLB is automatically displayed during cruise if a higher cruise altitude is entered on the CRZ page.

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.



## [Option – With FANS MCDU]


**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)**

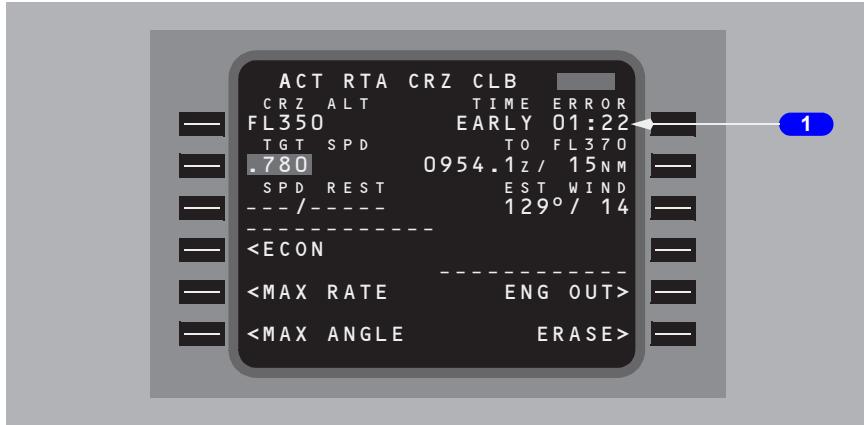
Displays target cruise speed for the displayed cruise altitude.  
 Manual entry may be made.

**3 TO FLXXX**

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

## RTA Cruise Climb

The RTA cruise climb page displays the same data as the cruise climb page except for the TIME ERROR line.



### 1 TIME ERROR

Displays the computed time error at the RTA waypoint.

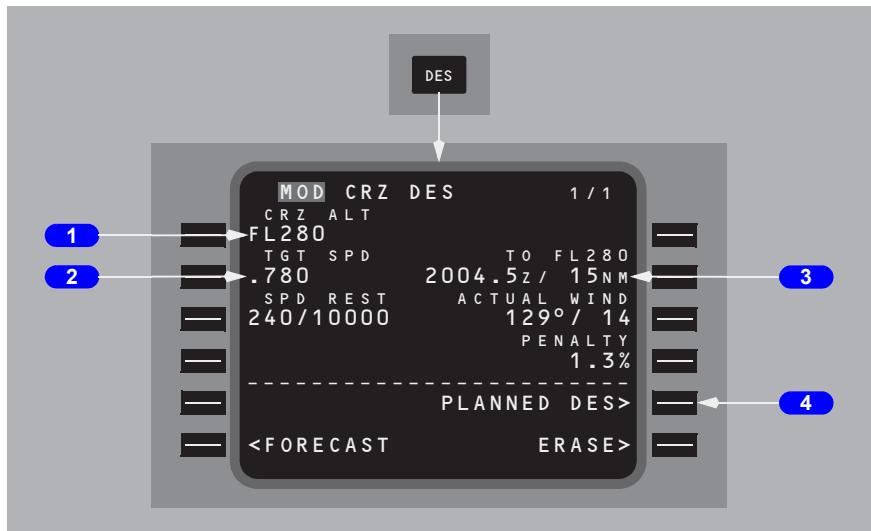
Same as time error on RTA PROGRESS page.

## Cruise Descent

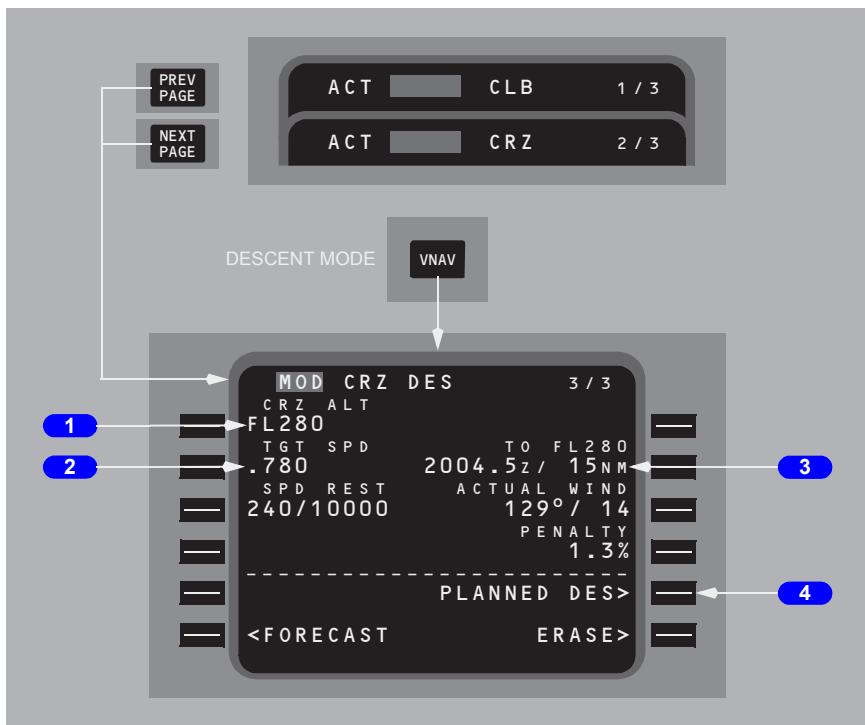
The cruise descent page displays data for a cruise descent to a new altitude.

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.



[Option – With FANS MCDU]



### 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.

Manual CAS or Mach entries are automatically copied to the descent page TGT SPD field.

### 3 TO FLXXX

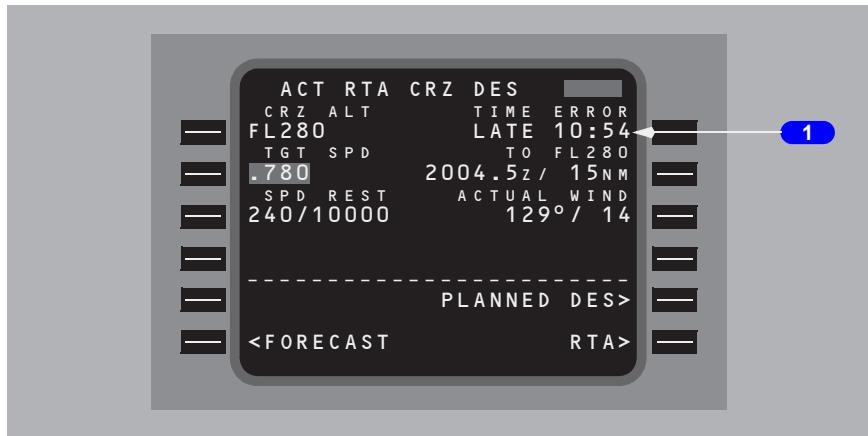
Displays ETA at, and distance to, the displayed cruise altitude.

### 4 Planned Descent (PLANNED DES)

Push – displays the planned DES page and allows access to the planned standard descent mode.

## RTA Cruise Descent

The RTA cruise descent page displays the same data as the cruise descent page except for the TIME ERROR line.



### 1 TIME ERROR

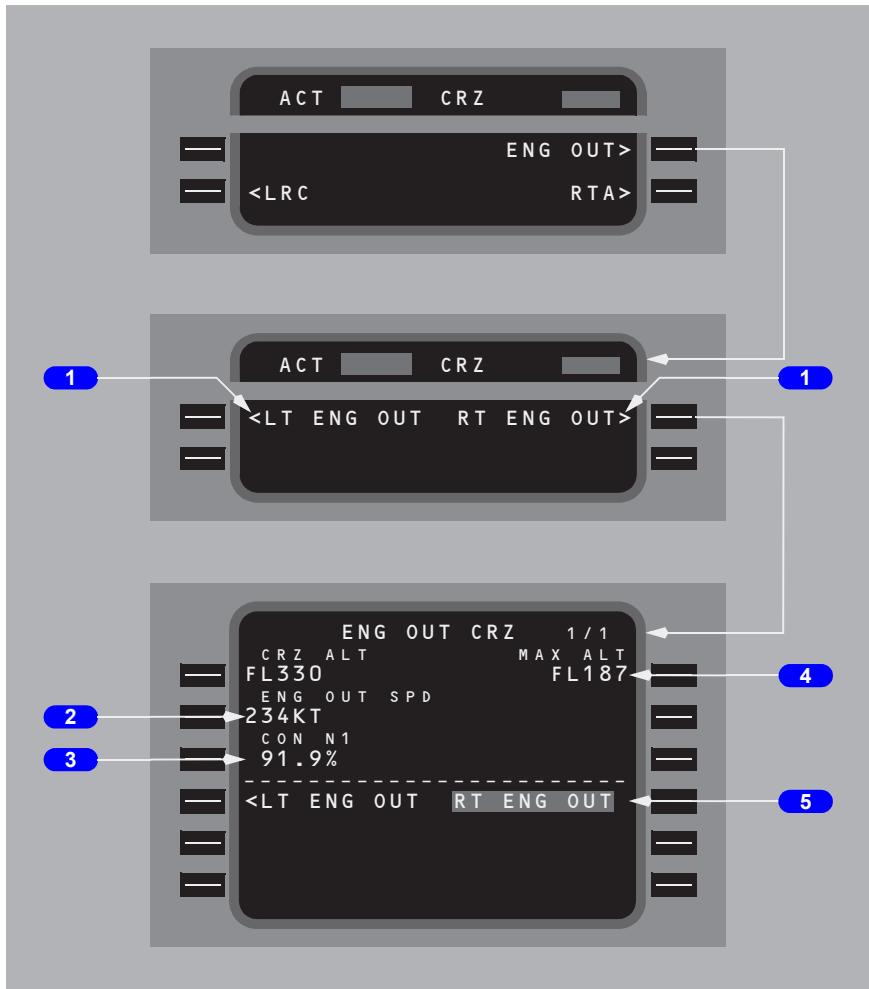
Displays the computed time error at the RTA waypoint.

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 cruise page. The page displays advisory data for a one engine inoperative condition.

[Option – FMC U10.3 and later]



### 1 Left/Right Engine Out (LT ENG OUT/RT ENG OUT)

[Option – FMC U10.3 and later]

Selection changes display to ENG OUT CRZ page. The ENG OUT CRZ page is information only.

## 2 Engine Out Speed (ENG OUT SPD)

### [Option – FMC U10.3 and later]

Displays the optimum speed based on minimum drag.

## 3 Continuous N1 (CON N1)

### [Option – FMC U10.3 and later]

Displays N1 for maximum continuous thrust.

N1 is computed using actual bleed conditions.

## 4 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).

After page selection, the FMC accounts for wing and engine anti-ice, air conditioning, and the engine bleed of the operating engine.

## 5 LT ENG OUT/RT ENG OUT

Selected engine 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 path descent the DES NOW prompt will not be displayed until a descent path is established. Once executed, the autothrottle adjusts thrust to maintain 1000 feet per minute until intercepting the descent path.

For a speed descent, the autothrottle retards to idle and pitch maintains target speed.



**1 Descend Now (DES NOW)**

Selecting the PATH DES page before reaching the top of descent displays the normal descent page with the prompt DES NOW on the bottom right of the page. Selecting and executing the DES NOW 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.

**[Option – FMC U10.6 or later and Common VNAV]**

Selecting the DES page before reaching the top of descent displays the normal descent page with the prompt DES NOW on the bottom right of the page. Selecting and executing the DES NOW 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.

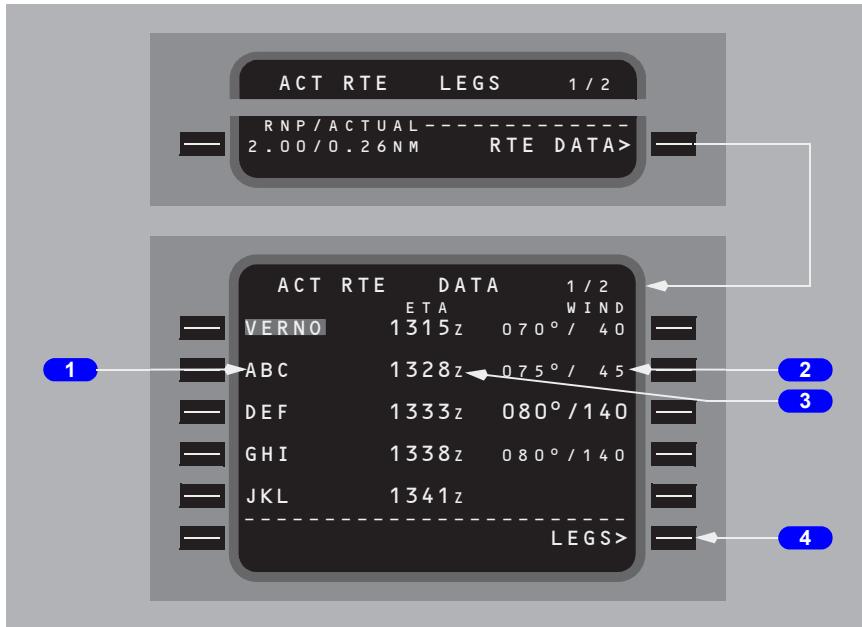
Selecting the SPD DES page and executing the DES NOW prompt initiates a VNAV descent at idle thrust and target speed.

---

**Route and Waypoint Data****Route Data (RTE DATA) Page**

The RTE DATA page displays ETA 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.



[Option – With company data link]



## 1 Waypoint

Displays the identifier for the waypoint from the ACT RTE LEGS page.

## 2 WIND

Used for entry and/or display of the true winds 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 (ABC to GHI 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°/140 at DEF 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 2000 feet of a cruise altitude. Biased values are not displayed.

---

Blank for non-cruise waypoints (VERNO and JKL are depicted). Entry is inhibited.

**3 Estimated Time of Arrival (ETA)**

Displays the FMC calculated waypoint ETA.

**4 LEGS**

Push – displays the RTE LEGS page.

**5 WINDS REQUEST**

**[Option – With company data link]**

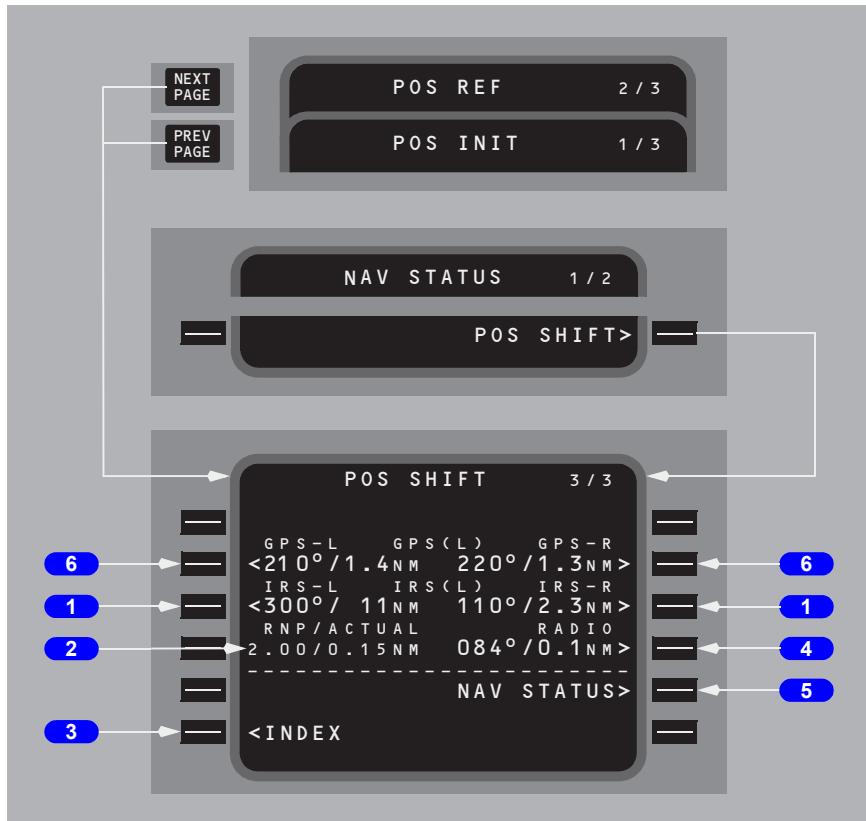
Push – transmits a data link request for winds uplink.

## Position Shift Page 3/3

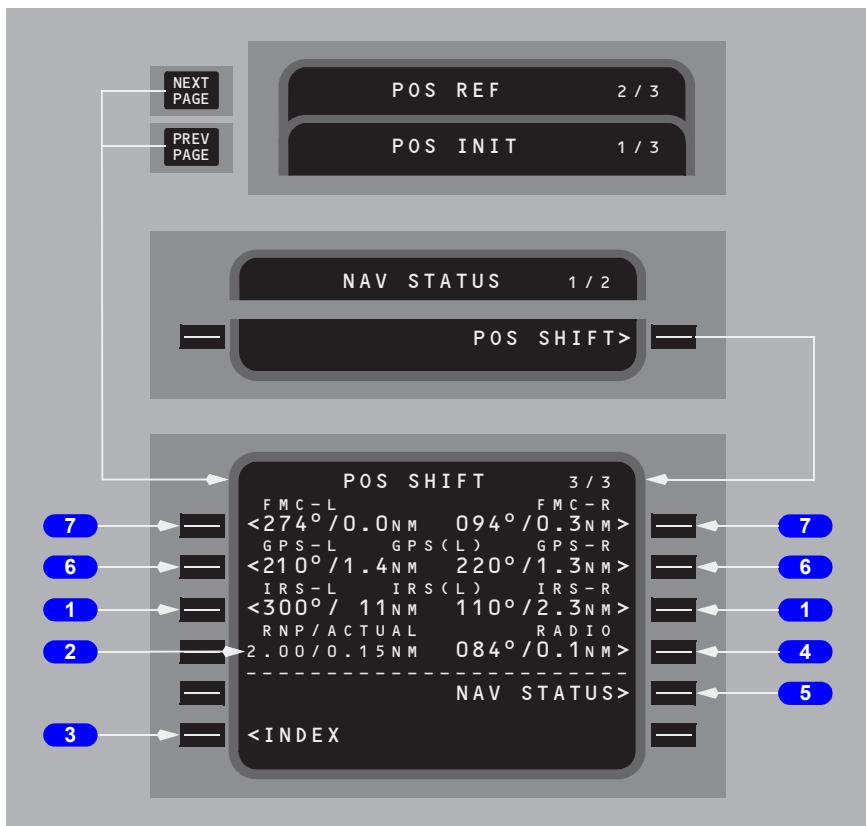
On the POS SHIFT page, each prompt indicates the bearing and distance of the indicated system relative to the FMC position. FMC position is displayed on line 1R of POS REF page 2/3. The entries with parentheses in the center of the page show the active position references.

Data fields are blank when on the ground.

[Option – Single FMC with GPS]



[Option – Dual FMC with GPS]



**1 IRS Position L/R**

Displays left and right IRS position 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.

**2 Required Navigation Position/Actual (RNP/ACTUAL)**

Displays the required navigation accuracy compared to actual navigation accuracy.

Manual entry is allowed.

**3 INDEX**

Push – displays the INIT/REF INDEX page.

**4 RADIO Position**

Displays 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.

**5 Navigation Status (NAV STATUS)**

Push – displays the NAV STATUS page.

**6 GPS Position L/R****[Option – With GPS]**

Displays left and right GPS position relative to FMC position using current mag/true reference. Blank if GPS position is invalid.

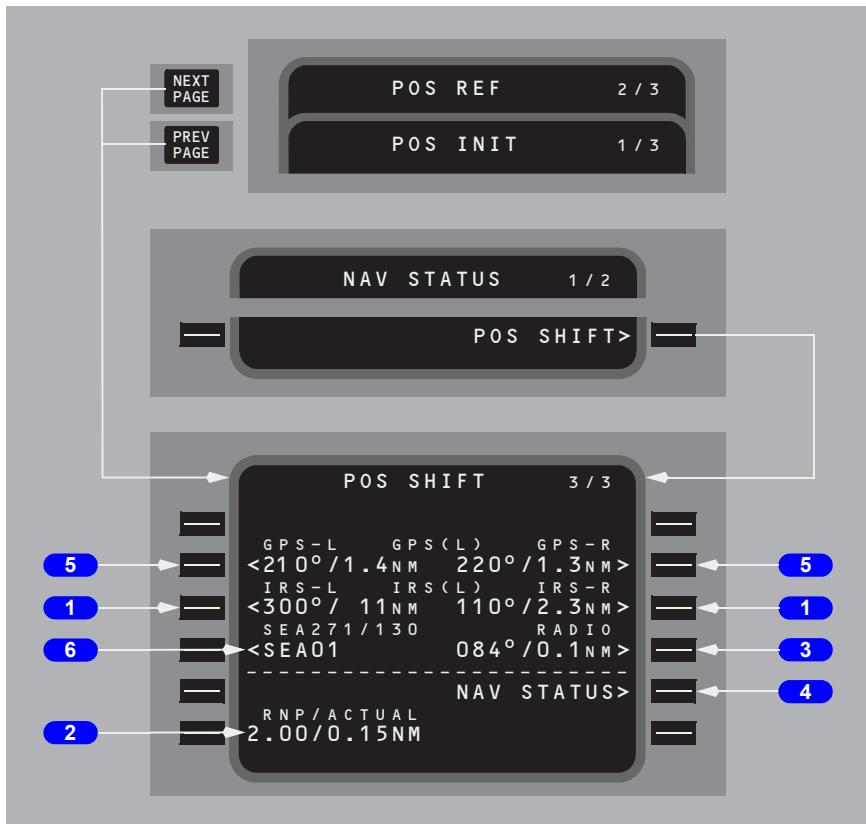
Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

**7 FMC Position L/R****[Option – With dual FMC]**

Displays left and right FMC position relative to FMC position using current mag/true reference. Blank if FMC position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

[Option – Single FMC with GPS, U10.6 or later with manual position update]



## 1 IRS Position L/R

Displays left and right IRS position 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.

## 2 Required Navigation Position/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

Manual entry is allowed.

## 3 RADIO Position

Displays 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 Navigation Status (NAV STATUS)**

Push – displays the NAV STATUS page.

**5 GPS Position L/R****[Option – With GPS]**

Displays left and right GPS position relative to FMC position using current mag/true reference. Blank if GPS position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

**6 Manual FIX****[Option – Single FMC with GPS, U10.6 or later with manual position update]**

Displays manually entered fix (position).

The fix may be a waypoint, navaid, airport, place bearing/distance, latitude/longitude, or place bearing/place bearing. If the aircraft is within 50NM of the fix, the fix is prefixed with a caret (“<”).

Push – highlights the line, removes caret (if displayed), illuminates the EXEC key, and displays the CANCEL prompt.

If EXEC key is pushed, aircraft position will move to the manual fix position and aircraft MAP displays will be updated.

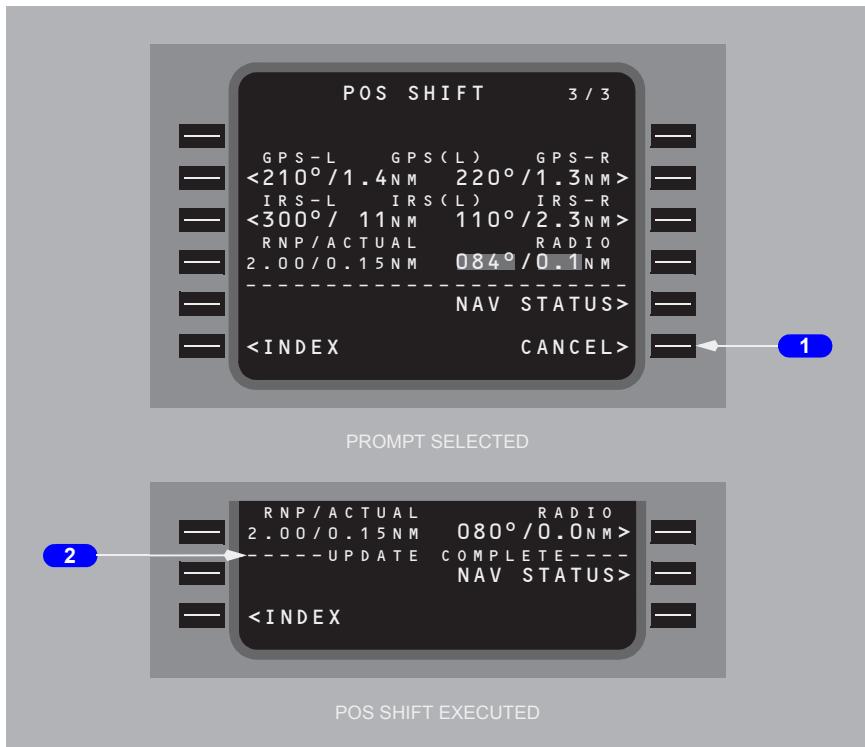
After flight complete or DELETE, the header changes to FIX and field is displayed as dashes.

## Inflight Position Update

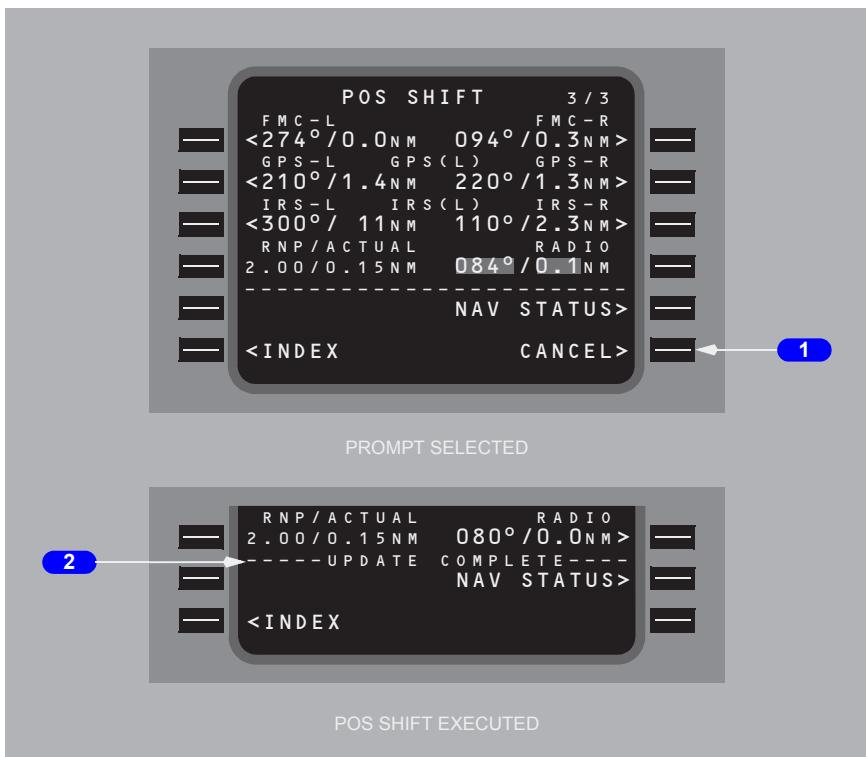
FMC position update is accomplished on the POS SHIFT 3/3 page in flight. Selecting a prompt stops the updating of the relative position. The selection is highlighted, the associated caret is removed, the execute key is illuminated, and the CANCEL prompt is displayed in line 6R.

When the position shift is executed, UPDATE COMPLETE is displayed.

[Option – Single FMC with GPS]



## [Option – Dual FMC with GPS]


**1 CANCEL**

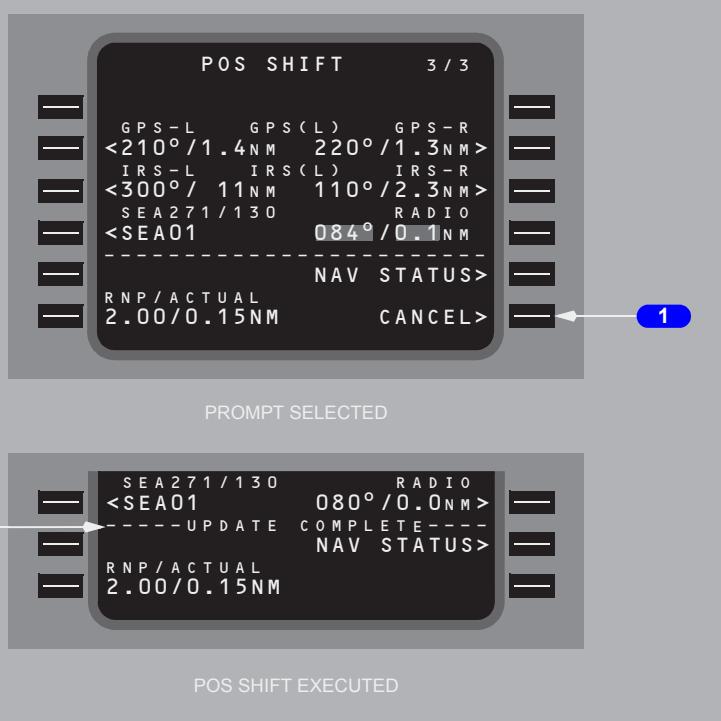
Displayed when a line selection is made for position update.

Push – prior to execution cancels the line selection.

**2 UPDATE COMPLETE**

Displayed after a position shift has been selected and executed.

[Option – Single FMC with GPS, U10.6 or later with manual position update]



## 1 CANCEL

Displayed when a line selection is made for position update.

Push – prior to execution cancels the line selection.

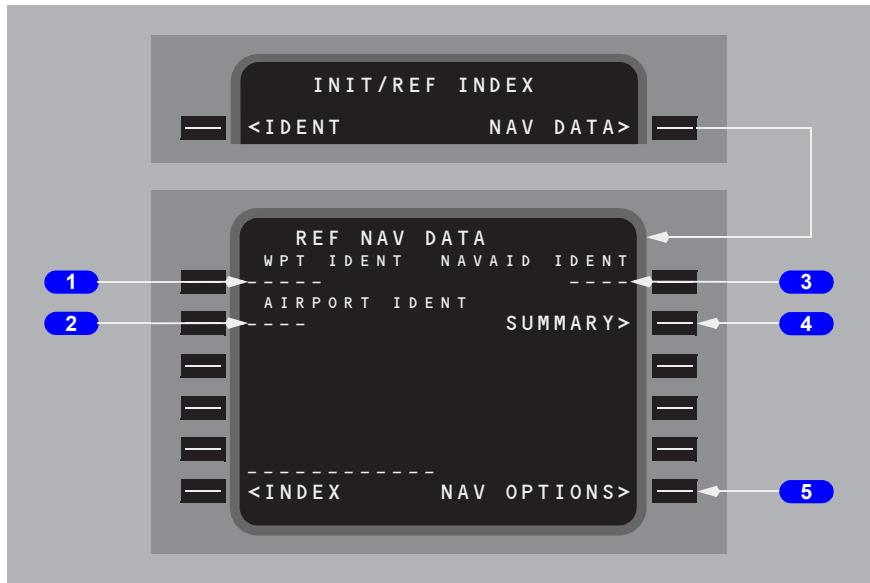
## 2 UPDATE COMPLETE

Displayed after a position shift has been selected and executed.

## **Navigation Data**

## **Reference Navigation Data (REF NAV DATA) Page**

The reference navigation data page provides information about waypoints, navaids, airports, and runways. Entering the appropriate identifier initiates the display. Writing SUPP in the scratch pad prior to selecting NAV DATA results in display of the supplemental navigation data (SUPP NAV DATA) page.



## 1 Waypoint Identifier (WPT IDENT)

Displays dashes initially.

Any waypoint, navaid or runway can be entered.

Format for runway entry is “RWnn” where “nn” is a one or two digit numeric (with or without leading zeros) and “a” is an optional character L, R, or C.

In order to access runway data, an airport must be identified.

## 2 Airport Identifier (AIRPORT IDENT)

Displays dashes initially.

Displays box prompts if runway is entered into 1L prior to airport entry.

An invalid airport/runway pair will result in “NOT IN DATA BASE” displayed in the scratchpad.

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### 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 SUMMARY

Push – displays NAV SUMMARY pages.

Blank if supplemental and temporary databases are empty.

### 5 Navigation Options (NAV OPTIONS)

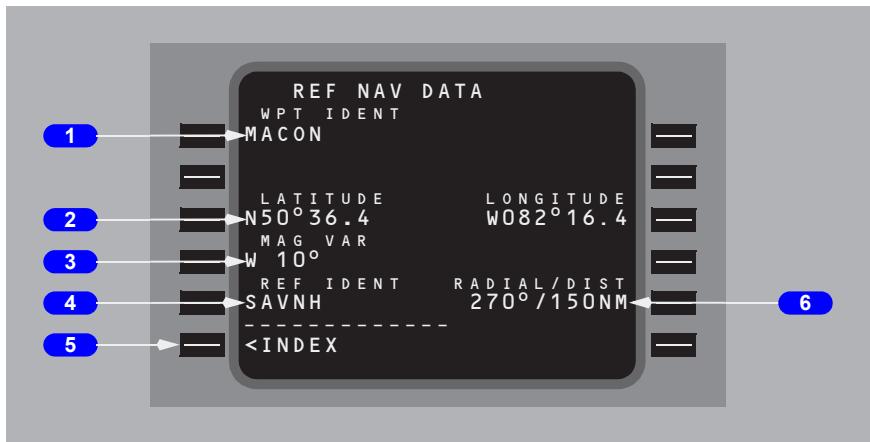
Push – displays NAV OPTIONS page.

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.

## Waypoint Data Display



### 1 Waypoint Identifier (WPT IDENT)

Displays or permits entry of the desired waypoint. When this entry is complete, 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.

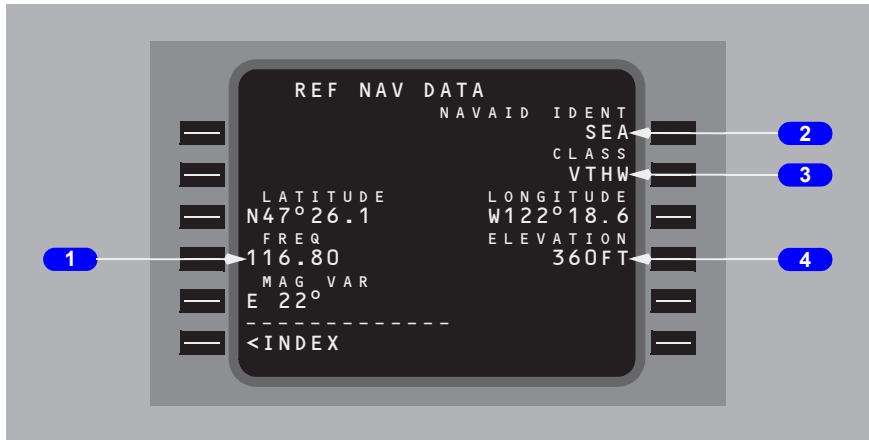
### 5 INDEX

Push – 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.

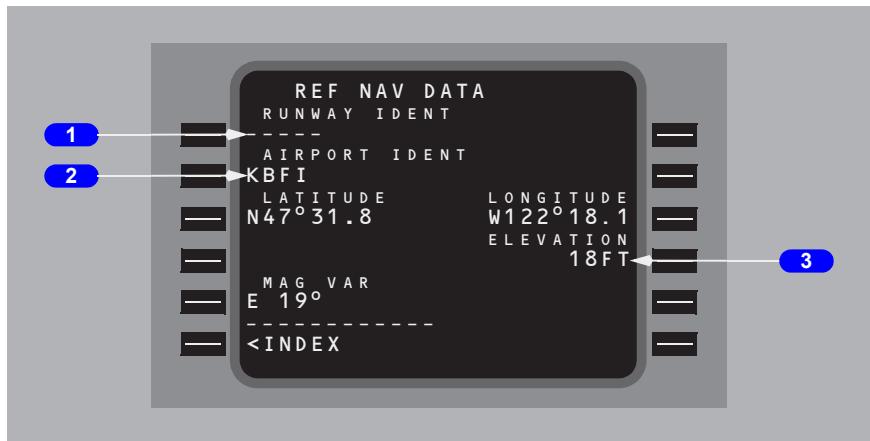
### **3 Classification (CLASS)**

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)

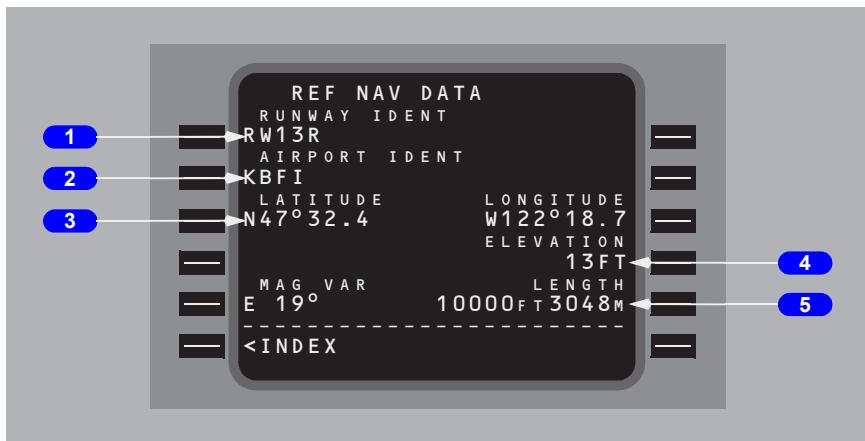
Displays airport identifier.

### 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

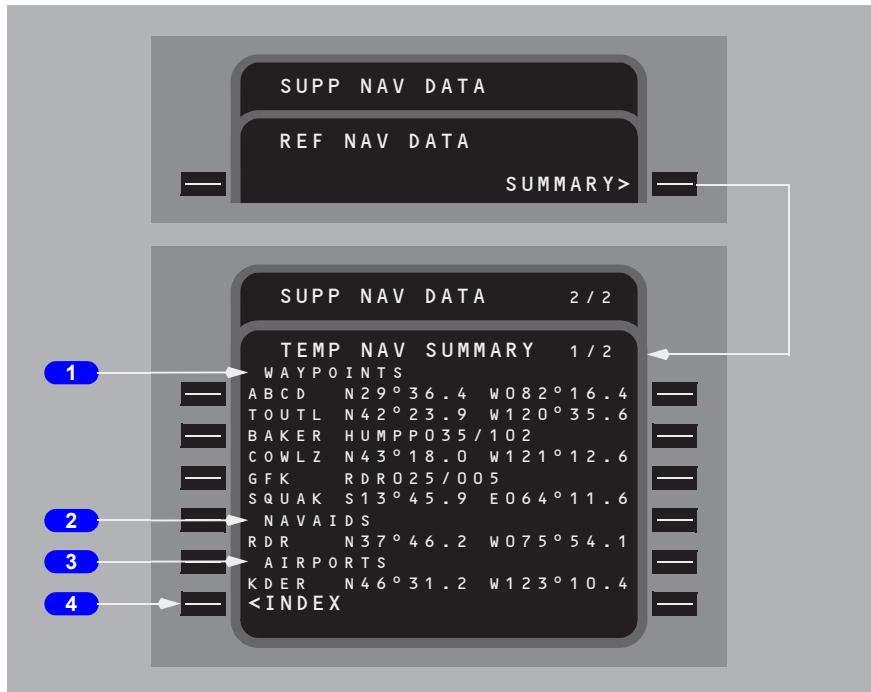
Displays elevation (feet above MSL) of the entered runway.

### 5 Runway Length (LENGTH)

Displays length of entered runway in feet and meters.

## Navigation Summary (NAV SUMMARY)

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 related database.

Waypoints show in defining format.

### 2 NAVAIDS

Shows navaids stored in related database.

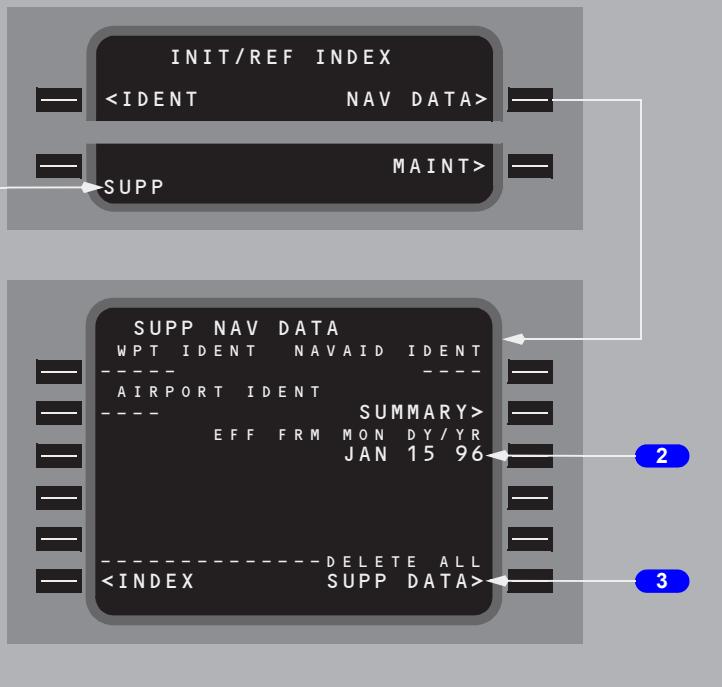
### 3 AIRPORTS

Shows airports stored in related database.

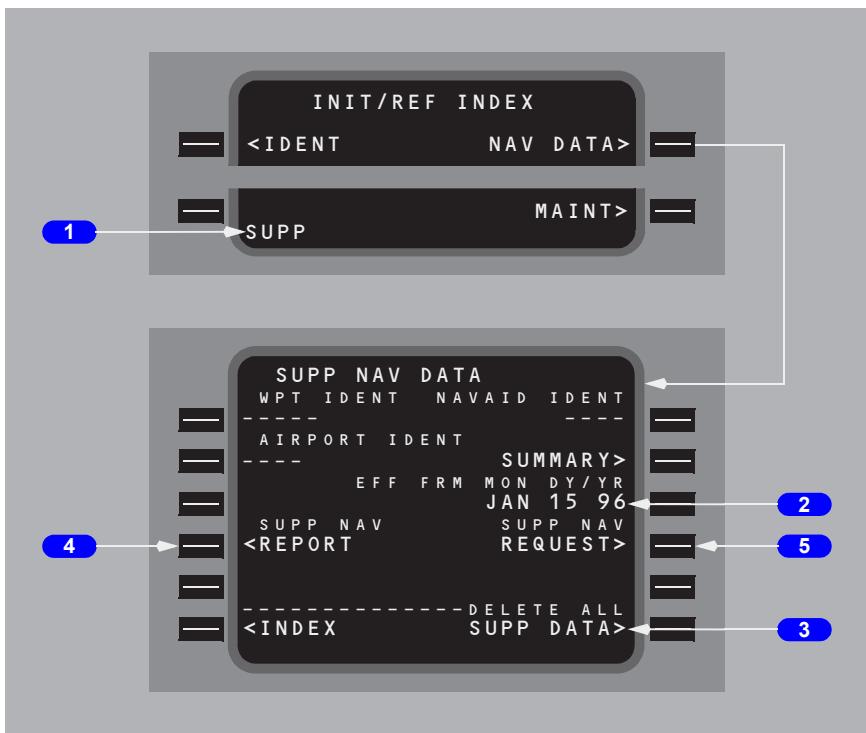
### 4 INDEX

Push – shows page (REF NAV DATA or SUPP NAV DATA) used to access NAV SUMMARY pages.

## Supplemental Nav Data



[Option – With company data link]



### 1 SUPP Scratchpad Entry

The supplemental navigation database is accessed by typing 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 IDENT page 1/2 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.

## 4 SUPP NAV REPORT

### [Option – With company data link]

Push – transmits a copy of supplemental navigation database.

## 5 SUPP NAV REQUEST

### [Option – With company data link]

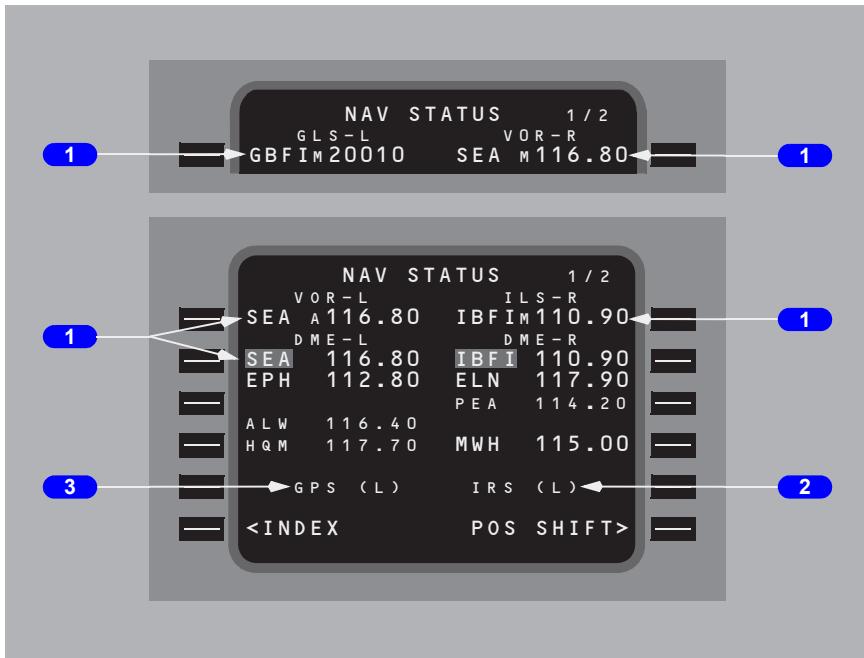
Push – transmits a data link request for a supplemental navigation database uplink.

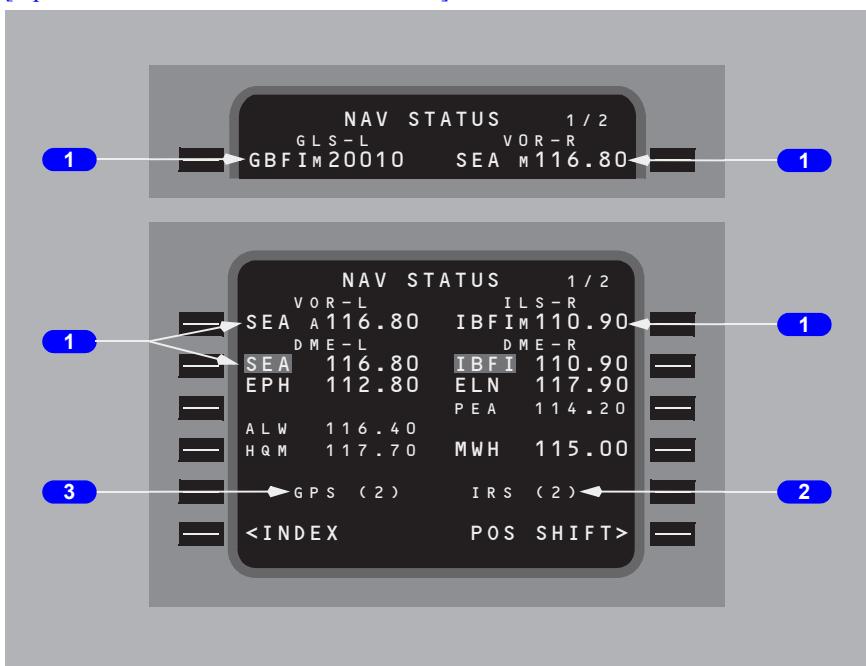
## Navigation Status Display

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 3/3, the PROGRESS page 1/3, and (in flight) the INIT/REF INDEX page or from the NAV OPTIONS page 2/2, NEXT or PREV PAGE.

### [Option – Single FMC, with GPS and GLS]



**[Option – Dual FMC with GPS and GLS]**

**1 VOR, ILS, GLS and DME Lines**
**[Option – FMC U10.4 or later with GLS]**

Lines 1L and 1R display VOR, ILS or GLS 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 scanning 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/GLS 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.

### **[Option – Dual FMC]**

“2” indicates a dual system with both IRSs used in the FMC position calculation.

## **3 GPS Status Display**

### **[Option – With GPS]**

Displays the GPS currently selected for use in navigation. “L” or “R” indicates left or right GPS is being used in the FMC position calculation.

### **[Option – Dual FMC with GPS]**

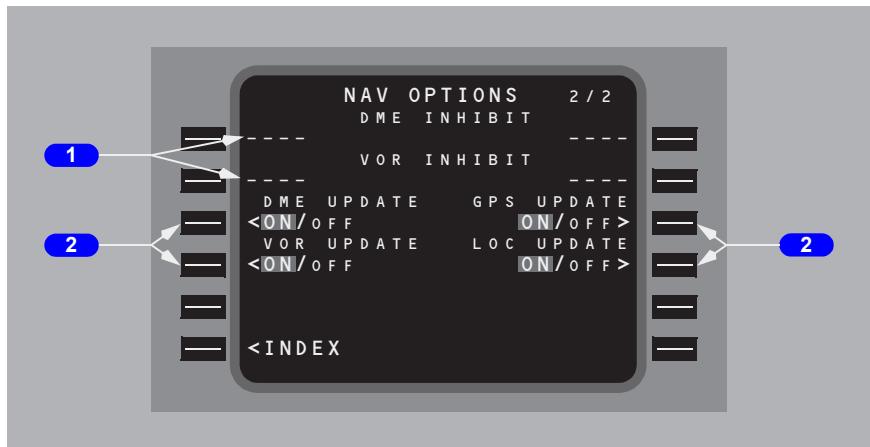
“2” indicates dual system with both GPSs used in the FMC position calculation.

The display will be blank if GPS is inhibited for use in navigation.

## Navigation Options (NAV OPTIONS)

The FMC normally rejects the use of navaids that are not suitable for navigation. However, when the aircrew is aware that unreliable navaids exist (either by NOTAM, ATC, etc.) they should manually exclude these navaids from the FMCs navigation solution. This will prevent the possibility of incorrect position calculations and maximize the FMCs reliability. This is accomplished through the NAV OPTIONS page.

Access to the NAV OPTIONS page may be gained by selecting 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/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.

The FMC normally uses DME from two different ground stations to update its position solution. When two DME stations are not available, the FMC reverts to single station radial-DME updating to determine position. Only two of the four inhibit entries are utilized at any one time depending upon which update mode the FMC is operating in. The DME INHIBIT entries are excluded from the FMCs update solution whenever the FMC is updating from two DME stations. The VOR INHIBIT entries are excluded from the FMCs update solution whenever the FMC is radial-DME updating.

## 2 DME/VOR/GPS/LOC UPDATE

### [Option – With GPS and U10.7]

Push – permits switching between ON and OFF modes for updating FMC position. Default mode is ON. The current mode is highlighted.

### [Option – FMC U10.5A and later with Default DME Off]

Push – permits switching between ON and OFF modes for updating FMC position. Default mode is ON for VOR, GPS and LOC. DME defaults to OFF. The current mode is highlighted.

Selection is reset to ON at flight completion.

### [Option – FMC U10.5A and later with Default DME Off]

Selections are reset to ON at flight completion except for DME which is reset to OFF.

## Fix Information Page

Two identical FIX INFO pages are used to identify waypoint fixes for display on the navigation display map mode. If desired, fix information can be copied into the route. Page access is via the FIX key.

### [Option – FMC U10.6 and later with Additional Fix Pages]

Six identical FIX INFO pages are used to identify waypoint fixes for display on the navigation display map mode. If desired, fix information can be copied into the route. Page access is via the FIX key.

Radial or distance entries from the fix may be made on any line 2L to 4L. Valid format is a three character numeric entry. Slash rule is used to differentiate between radial and distance in the scratch pad.



## 1 FIX Name

Enter the desired fix.

Valid entries are airports, navaids, waypoints or runway identifiers from the navigation database.

The selected fix is displayed on the navigation display map mode and highlighted by a green circle.

## 2 Distance Entry (example)

Enter a distance from the fix. Distances from the fix are displayed on the navigation display map mode 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 is limited to 511 NM or less and may contain 1/10 NM entry
- leading zeros can be omitted for distance
- decimal values can be omitted
- distance only entries must start with a /.

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 (example)**

Enter a radial from the fix. Radials are displayed on the navigation display map mode 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 or xxx/.

### **4 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.

### **5 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.

### **6 Radial/Distance From Fix (RAD/DIS FR)**

Displays the radial and distance from the fix to the airplane. This information is continually updated as the airplane position changes.

## Flight Management, Navigation

### FMC Descent and Approach

## Chapter 11

### Section 43

---

#### Introduction

The descent phase begins at the top of descent point and continues to the end of descent point. Planning for the descent phase begins during cruise.

The approach phase begins at the end of descent point and continues to touchdown or go-around. When a go-around is accomplished, the FMC enters the cruise phase.

The only automatic page change provided in the descent/approach modes is the transition from cruise to descent at the top of descent.

---

#### Early Descent

Early descent may be commenced prior to reaching the top of descent by using the DES NOW 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.

#### [Option – With alternate destination prediction]

Other pages which support descent are:

- DES FORECASTS page – to enter forecast wind data to aid descent planning
- ALTERNATE DESTS page – to manage the selection of alternate airports and diversions.

## 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 crew must select a manual speed descent mode.

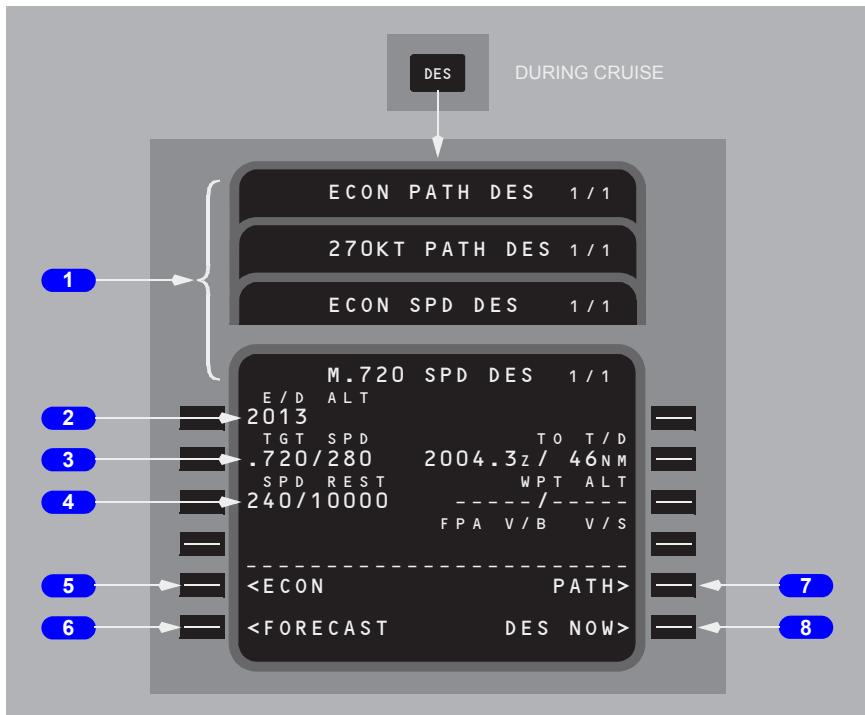
### [Option – FMC U10.6 or later with Common VNAV]

The descent page is used to monitor, revise, or select the descent path. Descent modes are economy (ECON) path and manual path and speed. The default VNAV descent mode is ECON path. The crew must select a manual speed descent mode.

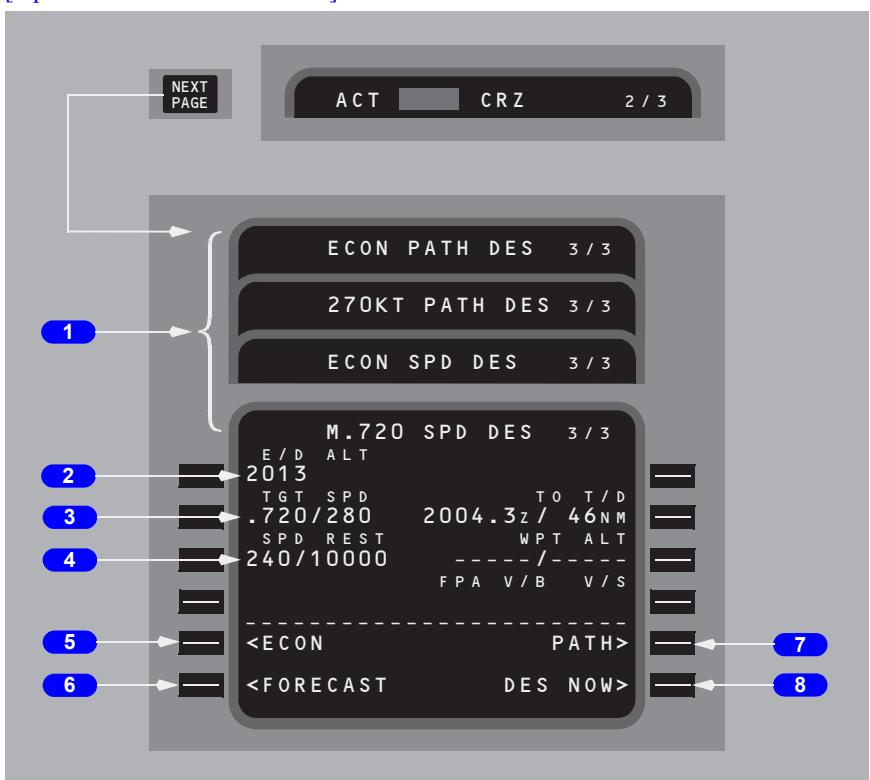
The page title reflects the VNAV descent mode. The path mode controls descent to fly a vertical path which complies with altitude and speed restrictions in the flight plan. The speed mode controls descent at a fixed speed and complies with altitude and speed restrictions in the flight plan.

### [Option – FMC U10.6 or later with Common VNAV]

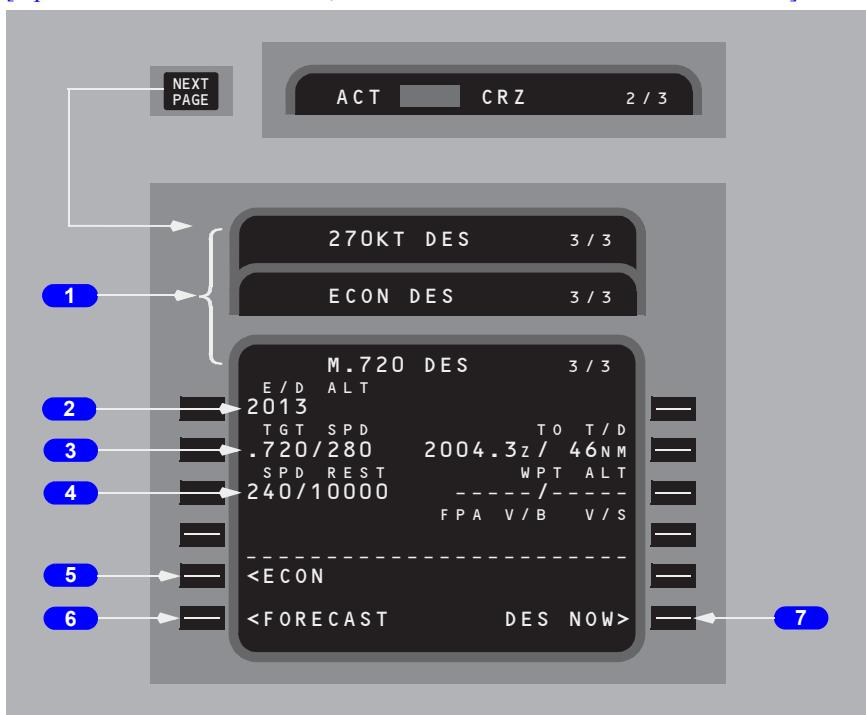
The page title reflects the type of VNAV path descent. The path mode controls descent to fly a vertical path which complies with altitude and speed restrictions in the flight plan.



## [Option – With FANS MCDU]



[Option – With FANS MCDU, FMC U10.6 or later and Common VNAV]



## 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 Altitude (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 the altitude restriction for the E/D waypoint, if an E/D waypoint is present
- for a DES page, displays the altitude restriction for the E/D waypoint, blank if a path descent is not available
- if an approach is selected which ends at RWXXX, the E/D altitude will be Threshold Crossing Height (TCH), 50 feet above the runway.

---

**[Option – FMC U10.6 or later]**

The end of descent altitude is the altitude constraint or predicted altitude of the last descent waypoint. End of descent may follow a lateral discontinuity. If a lateral discontinuity exists, the FMC will construct a great circle path across the discontinuity and VNAV shall be valid while flying the discontinuity.

---

**3 Target Speed (TGT SPD)**

Displays the command speed maintained by VNAV while descending to waypoints, constraints, or speed restrictions.

Displays XXX/MCP when speed intervention is active.

On ECON PATH or ECON SPD DES pages, displays the computed values for target Mach and airspeed. Speeds are performance limited.

The ECON DES page displays the computed values for target Mach and airspeed. Speeds are performance limited.

Manual entries may be made and cause the manual PATH or manual SPD DES page for that value to display (M.720 SPD DES is depicted).

Manual entries may be made and cause the manual DES page for that value to display (M.720 DES is depicted).

Blank for any PATH DES page if a path descent is not available.

Blank for any DES page if a path descent is not available.

Manual CAS or Mach entries are automatically copied to the descent page TGT SPD field.

---

**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.

Push – selects the corresponding ECON 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.

**7 Descend Now (DES NOW)**

Displayed on the standard DES pages whenever descent is not ACT or MOD.

Blank for any DES page if a path descent is not available.

Push – arms the DES NOW function and illuminates the EXEC light.

On a DES page, execution allows early initiation of a path descent at 1000 fpm until intercepting the computed path.

**8 Descend Now (DES NOW)**

Displayed on the standard DES pages whenever descent is not ACT or MOD.

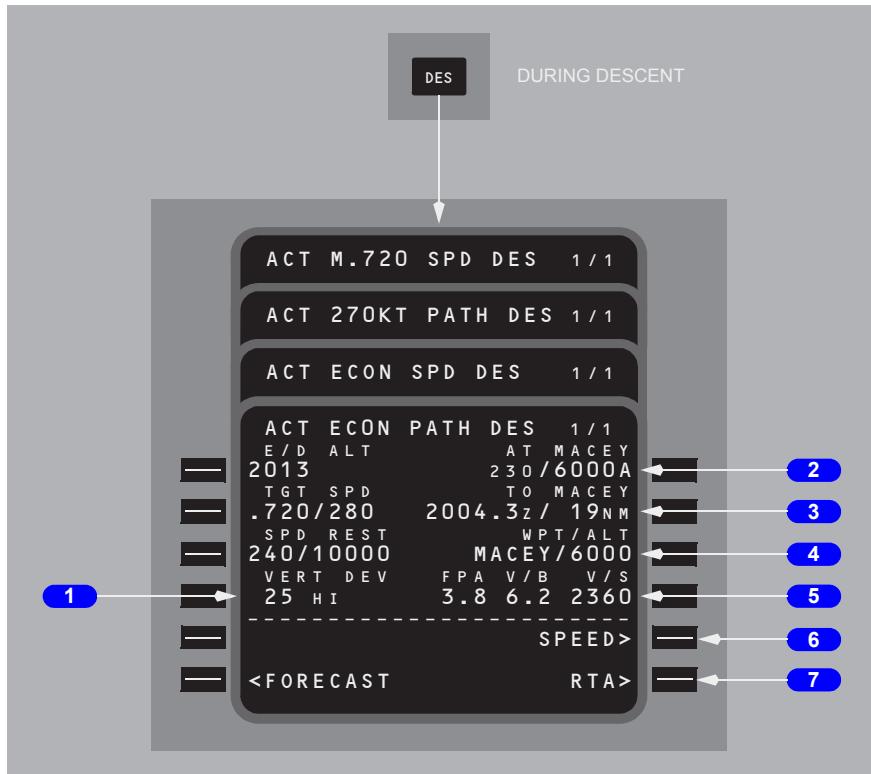
Blank for any PATH DES page if a path descent is not available.

Push – arms the DES NOW function and illuminates the EXEC light.

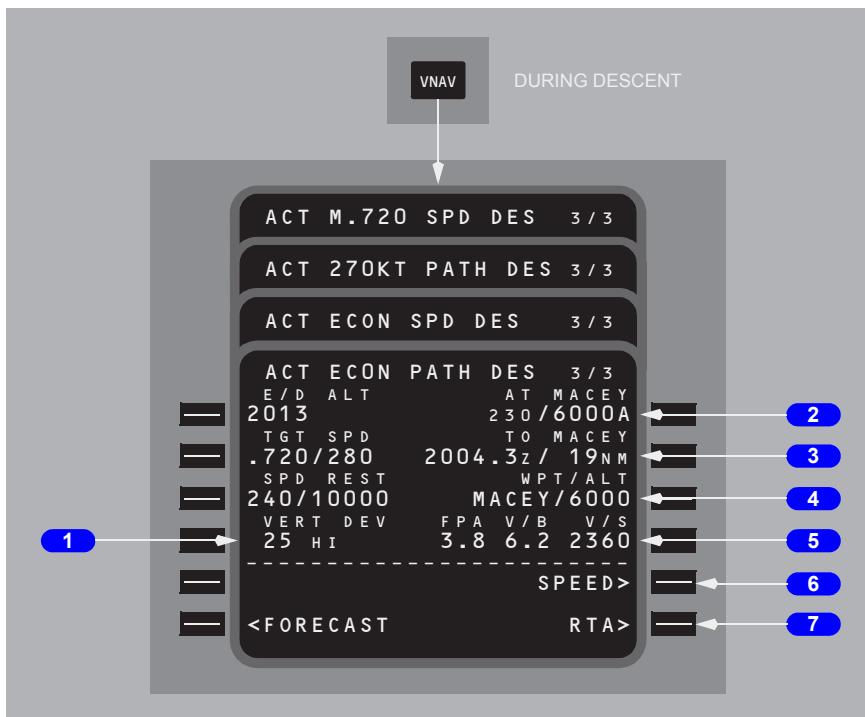
On a PATH DES page, execution allows early initiation of PATH descent at 1000 fpm until intercepting the computed path. On a SPD DES page, execution allows early initiation of a SPD descent at the specified speed (ECON or manual).

## Descent Page (During Descent)

Display when any descent mode is active after beginning of descent.



## [Option – With FANS MCDU]

**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).

The deviation is always in relation to the path descent profile.

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.

The display is blank when no constraint exists, or for any 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 DES NOW 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.

#### [Option – FMC U10.5 and later]

A runway identifier may be entered for a runway at the destination airport of the displayed flight plan. Format may be either RWXX/, RWXXX/, RWXX/AA, or RWXXX/AA where XX or XXX is the runway designation and AA is the altitude. When RWXX/ or RWXXX/ is used the altitude will automatically be set to runway elevation plus threshold crossing height.

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.

## 6 RTA

Displayed when DES NOW or ERASE prompt is not displayed.

Push – selects the RTA PROGRESS page.

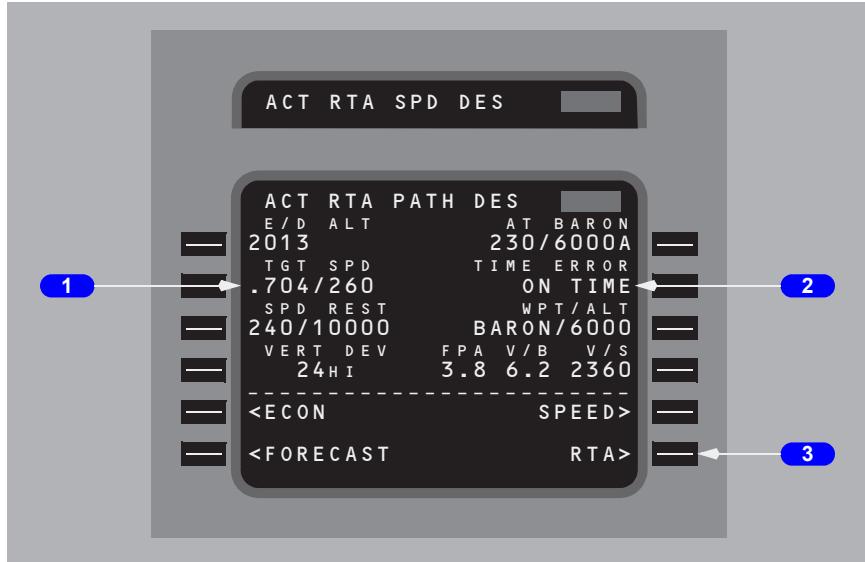
## 7 RTA

Displayed when DES NOW or ERASE prompt is not displayed.

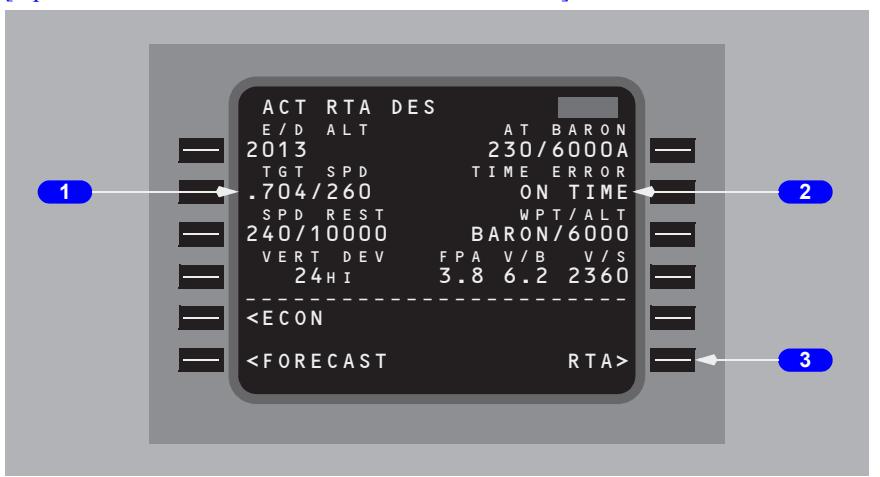
Push – selects the RTA PROGRESS page.

### 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.



[Option – FMC U10.6 or later and Common VNAV]



### **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.

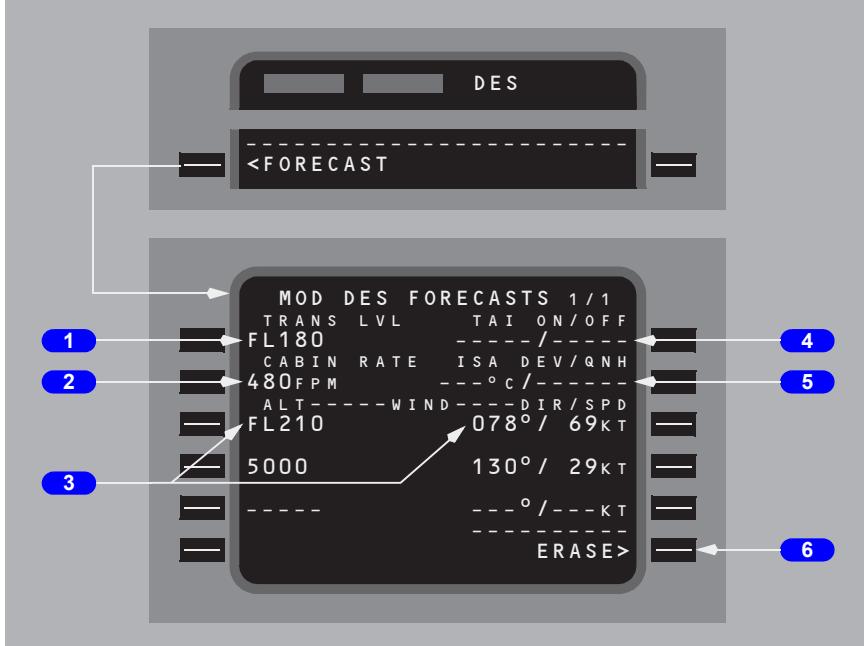
### **3 RTA**

Push – selects the RTA PROGRESS page.

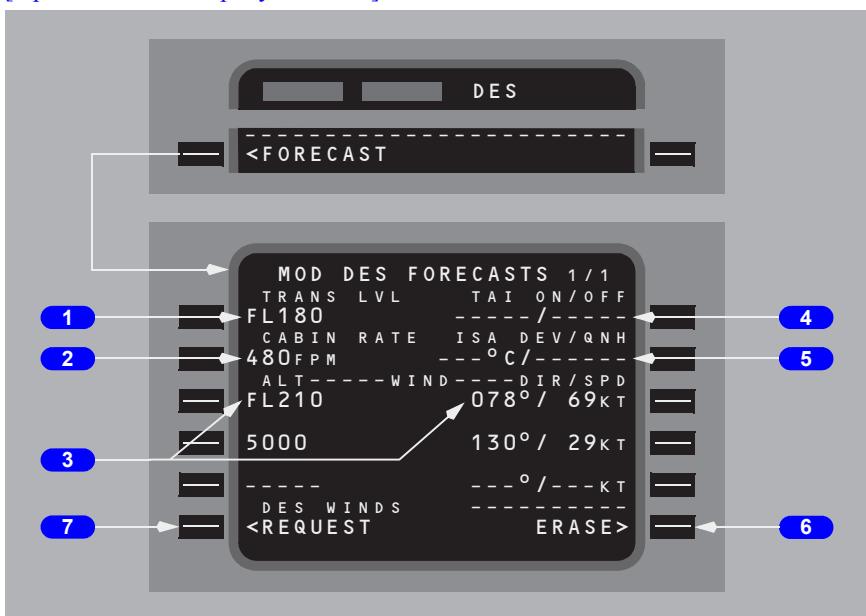
## Descent Forecast Page

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.



[Option – With company data link]



### **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 allowed and takes priority.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

### **2 CABIN RATE**

Displays the predicted cabin rate of descent required by the flight plan descent profile.

### **3 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.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

#### **4 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.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

#### **5 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.

Data may be up-linked via ACARS message. The up-linked value will appear in small font until EXECuted at which time it will be displayed in large font.

#### **6 ERASE**

Push – deletes modification and returns page to previously displayed descent page.

#### **6 ERASE or LOAD**

Push – (ERASE) deletes modification and returns page to previously displayed descent page.

Push – (LOAD) initiates the loading of ACARS up-linked descent forecasts data.

LOAD is displayed when ACARS descent forecasts has the highest load priority and no EXECutes or ACCEPT/REJECTs are pending.

#### **7 DES WINDS REQUEST**

##### **[Option – With company data link]**

Push – transmits a data link request for descent winds.

#### **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:

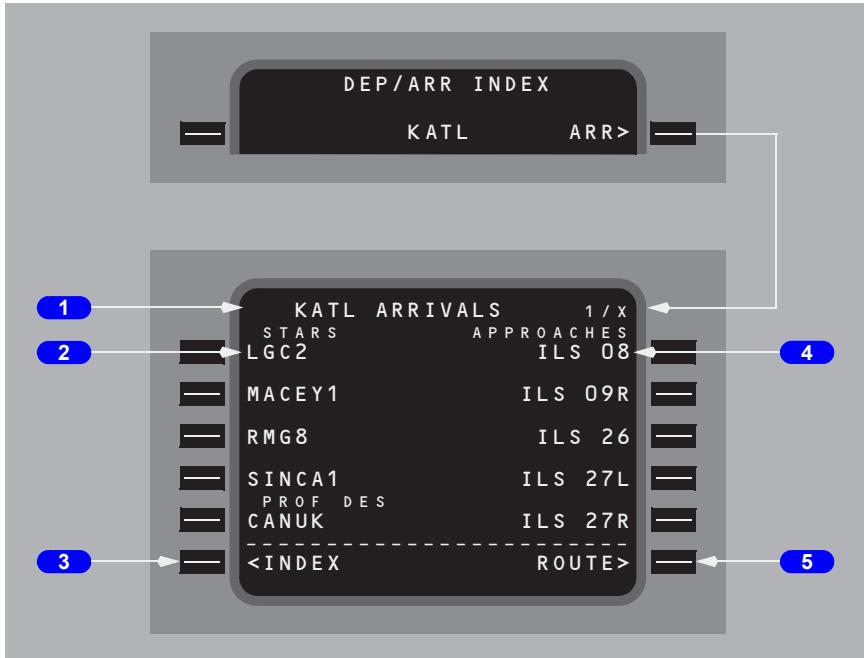
- APPROACH REF page – to select the approach VREF
- ARRIVALS page – to select the desired arrival and approach procedures
- HOLD page – to manage holding patterns.

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. Only 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)**

Upon initial page display, an alphabetical listing of all approaches for the airport, followed by a numerical listing of all runways, is displayed.

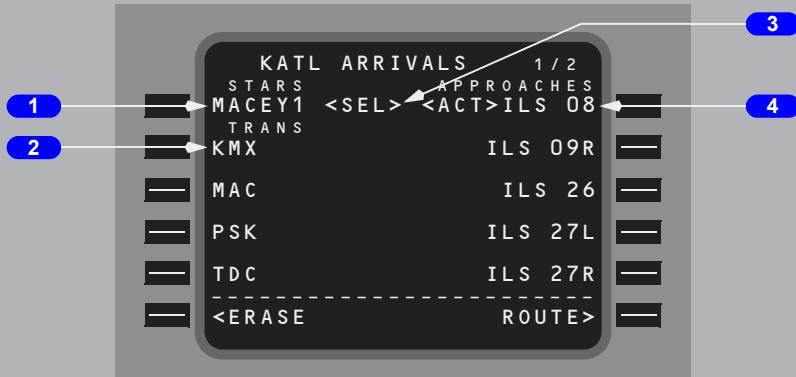
Selection of the desired approach or runway deletes all other approaches/runways.

**5 ROUTE**

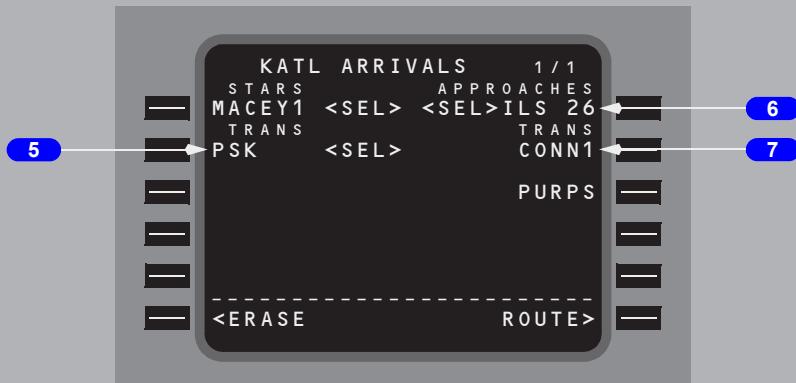
Push – displays the RTE page.

## Arrivals Page during approach selection

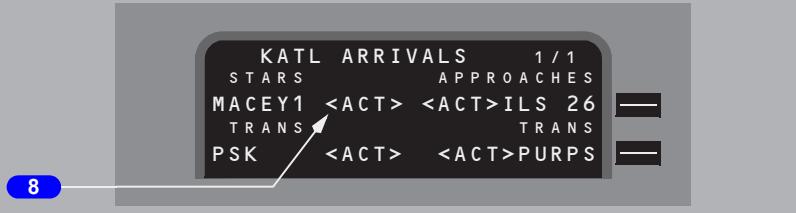
DISPLAY AFTER STAR SELECTED



DISPLAY AFTER STAR TRANSITION AND APPROACH/RUNWAY SELECTED

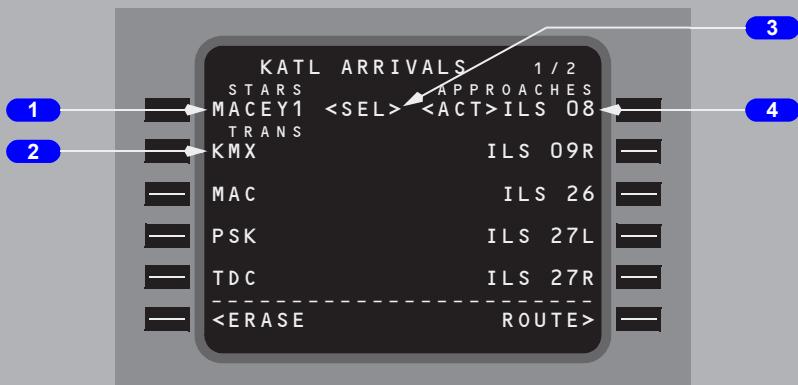


DISPLAY AFTER EXECUTING

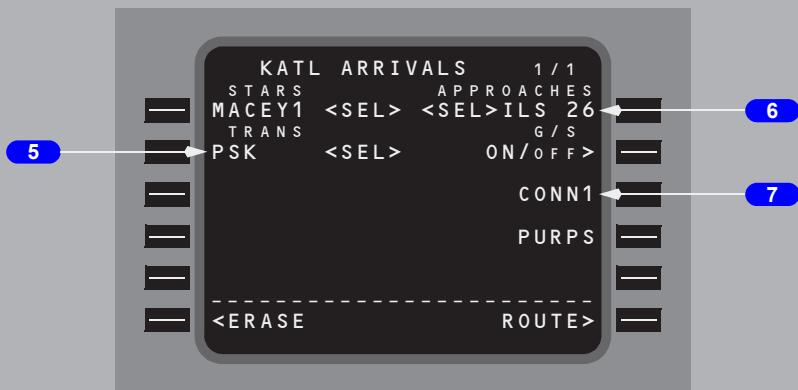


[Option – FMC U10.5 and later with integrated approach navigation]

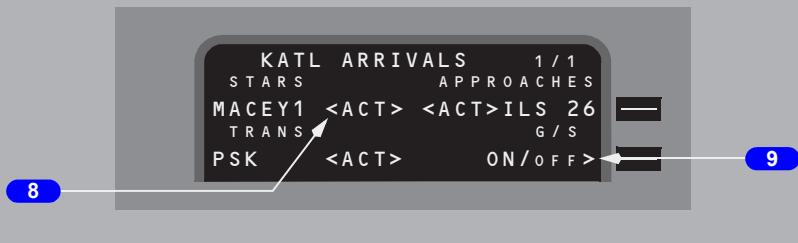
DISPLAY AFTER STAR SELECTED



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 Approach and Runway (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.

## 9 Glideslope (G/S)

### [Option – FMC U10.5 and later with integrated approach navigation]

Toggles glideslope ON and OFF for the selected or active approach.

When an ILS or IGS approach is selected in the FMC, G/S defaults to ON.



---

When a LOC, SDF, LDA or BCS approach is selected in the FMC, G/S defaults to OFF.

---

## Arrivals Page – Runway Extension Fix and Flight Path Angle

[FMC U10.6 and later]

INITIAL DISPLAY



DISPLAY AFTER RUNWAY 09 SELECTED



DISPLAY AFTER RUNWAY 09 EXTENSION FIX AND FPA INSERTED AND EXECUTED



**1 Runway Extension (RWY EXT)**

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

Desired extension distance is entered in scratch pad, then inserted on RWY EXT line. Valid entries are between 1 and 25 NM (.1 NM resolution). This creates a waypoint on the extended runway centerline at the specified distance from the runway threshold.

Waypoint is identified on the RTE and RTE LEGS pages as RX–YYY, where YYY is the runway designation.

A speed/altitude constraint may be entered for the RWY EXT fix from the RTE LEGS page.

**2 Flight Path Angle (FPA)**

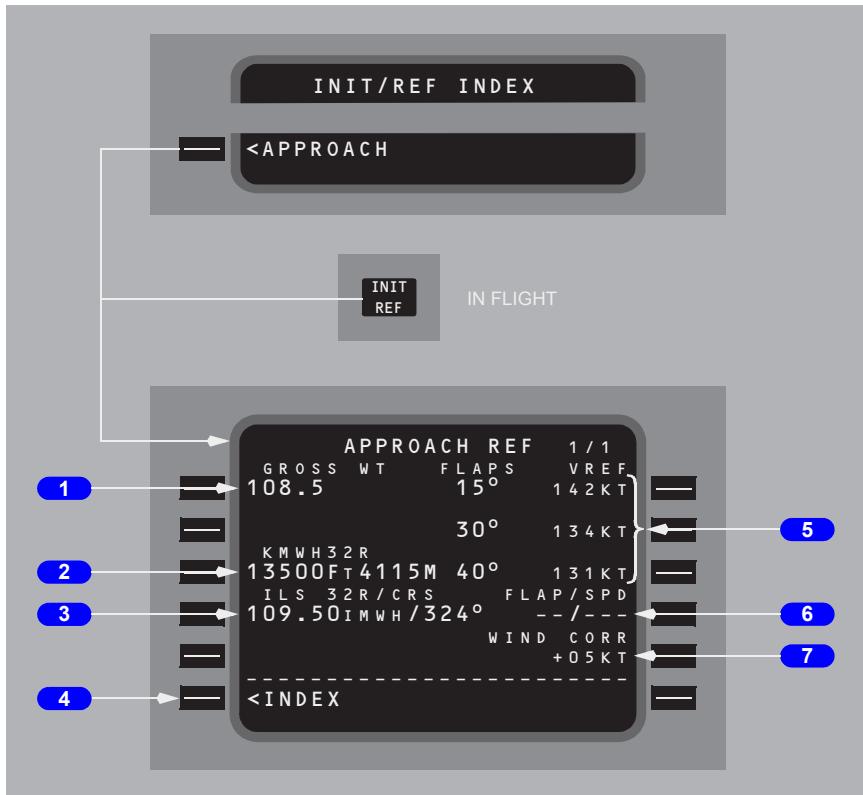
Permits optional entry of a flight path angle between the runway threshold and the runway extension fix. Default is 3.0 degrees. Valid entries are from 2.0 to 5.5 degrees.

**Note:** Dashes (---) are displayed on the DEP/ARR page when the default is used.

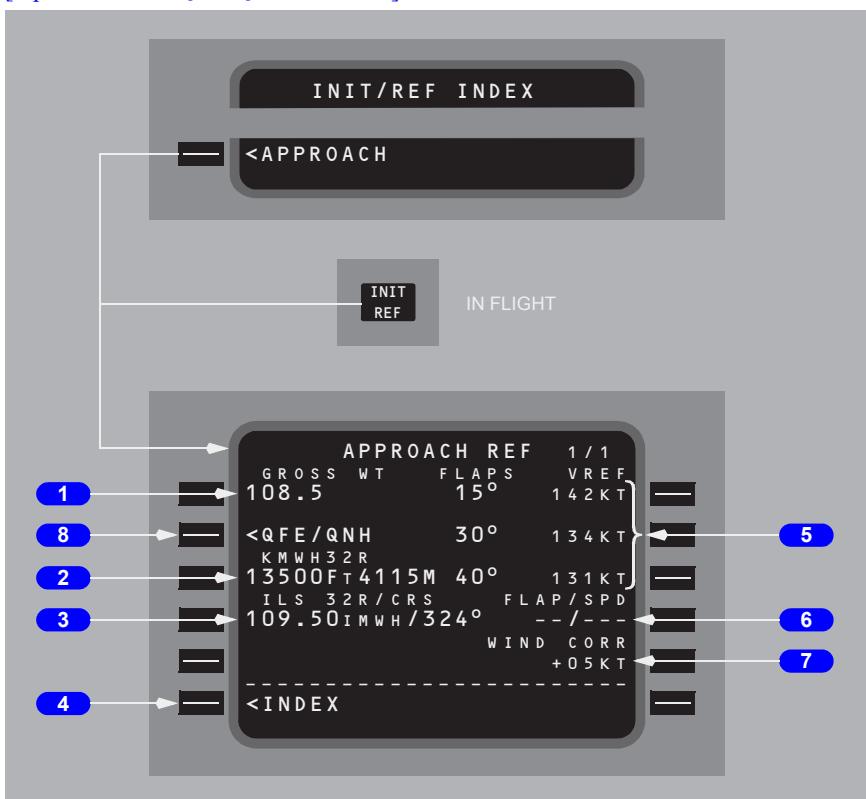
## Approach Reference Page

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.

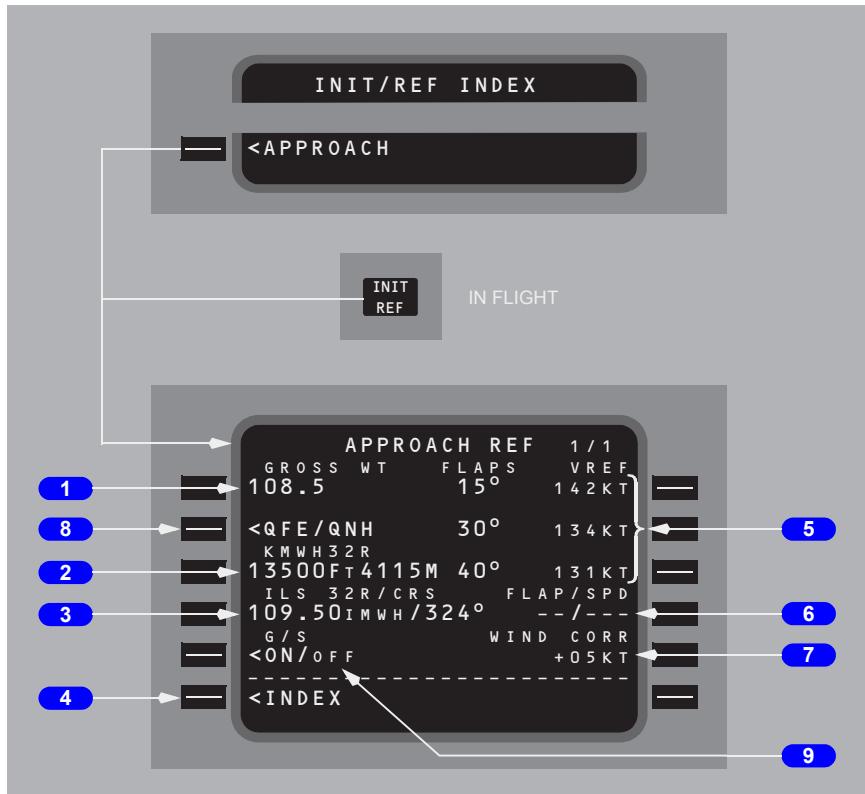
[Option – FMC U10.4 and later]



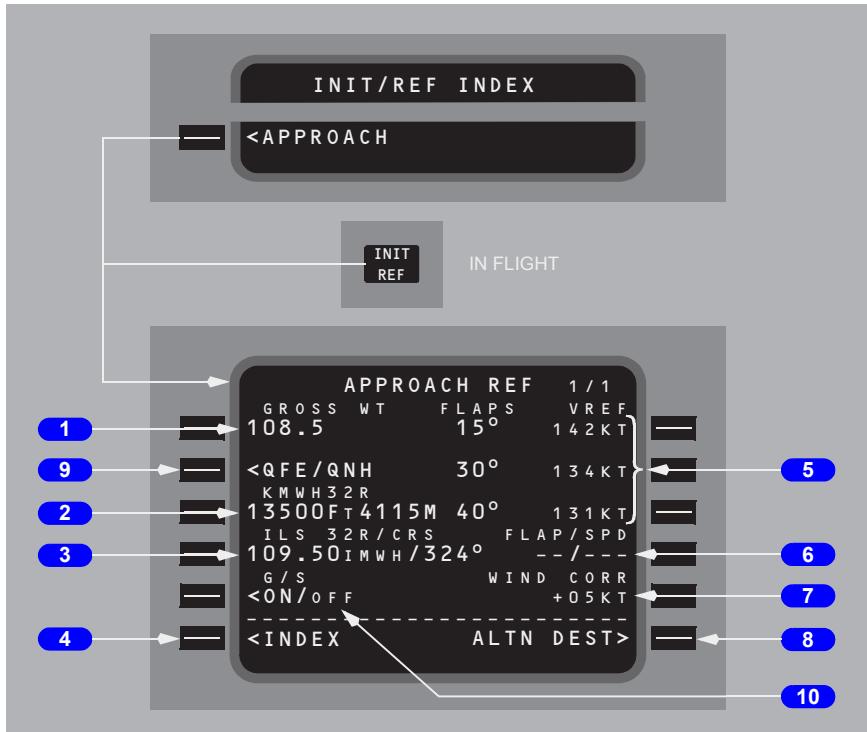
[Option – With QFE/QNH selection]



[Option – FMC U10.5 and later with QFE/QNH selection and integrated approach navigation]



[Option – FMC U10.5 and later with QFE/QNH selection, alternate destination prediction, and integrated approach navigation]



## 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 Runway Length

Displays the length in feet and meters of the referenced runway.

Blank if no runway has been entered and executed.

### 3 Approach Information

#### [Option – FMC U10.5 and later with GLS]

Displays the runway number, associated ILS frequency (GLS channel) and approach identifier for the ILS, LOC, LDA, SDF, GLS or back course approach in the active flight plan.

Displays front course in large font, if a localizer based or GLS based approach is displayed on 4L. If the course is true displays is suffixed with “T”.

Blank if no localizer or GLS based approach has been executed.

### 4 INDEX

Push – selects the INIT/REF INDEX page.

### 5 Vref (FLAPS --- VREF)

Displays landing Vref for three flap settings as computed by the FMC. Displayed in small size characters.

Selection causes the flap and VREF speed to be placed in 4R.

Double line selection of a displayed Vref, or manual entry of another value, causes the flap and VREF speed to be placed in 4R and causes Vref to be displayed on the airspeed display. CDU display changes to large size characters.

Speeds are based on displayed gross weights.

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.

### 6 Flap/Speed (FLAP/SPD)

Displays selected approach reference flap and speed setting.

Manual input of desired flap and/or speed settings may be made.

Valid entry format is FF/SSS, SSS, /SSS, FF/ or F/, where F or FF is a flap setting of 0, 1, 2, 5, 10, 15, 25, 30, 40 and SSS is a speed within the range allowed in 1R to 3R.

Entries may be deleted and are blanked at flight completion..

### 7 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.

**8 Alternate Destination (ALTN DEST)****[Option – With alternate destination prediction]**

Push – selects alternate Destination page.

**8 Landing Reference (LANDING REF)****[Option – With QFE/QNH selection]**

Push – Toggles altimeter reference between QFE and QNH.

Default is QNH.

Resets to QNH at flight complete.

Reflects TAKEOFF REF selection on TAKEOFF REF page 2.

Active altimeter reference is highlighted.

During descent with QFE selected, the PFD altitude indications show zero feet at the arrival runway. The PFD altitude indication background colors change to green.

If QFE is the current altimeter reference, and the EFIS control panel STD switch is pushed, The takeoff reference automatically toggles to QNH.

**9 Landing Reference (LANDING REF)****[Option – With QFE/QNH selection]**

Push – Toggles altimeter reference between QFE and QNH.

Default is QNH.

Resets to QNH at flight complete.

Reflects TAKEOFF REF selection on TAKEOFF REF page 2.

Active altimeter reference is highlighted.

During descent with QFE selected, the PFD altitude indications show zero feet at the arrival runway. The PFD altitude indication background colors change to green.

If QFE is the current altimeter reference, and the EFIS control panel STD switch is pushed, The takeoff reference automatically toggles to QNH.

**9 Glideslope (G/S)****[Option – With integrated approach navigation]**

Toggles glideslope on and off for the selected or active approach.

When an ILS or IGS approach is selected in the FMC, G/S defaults to ON.

---

When a LOC, SDF, LDA or BCS approach is selected in the FMC, G/S defaults to OFF.

## **10 Glideslope (G/S)**

**[Option – With QFE/QNH selection, alternate destination prediction, and integrated approach navigation]**

Toggles glideslope on and off for the selected or active approach.

When a localizer based approach is selected or active, and an FMC generated glidepath (G/P) is to be flown, glideslope (G/S) must be turned off.

## Alternate Airport Diversions

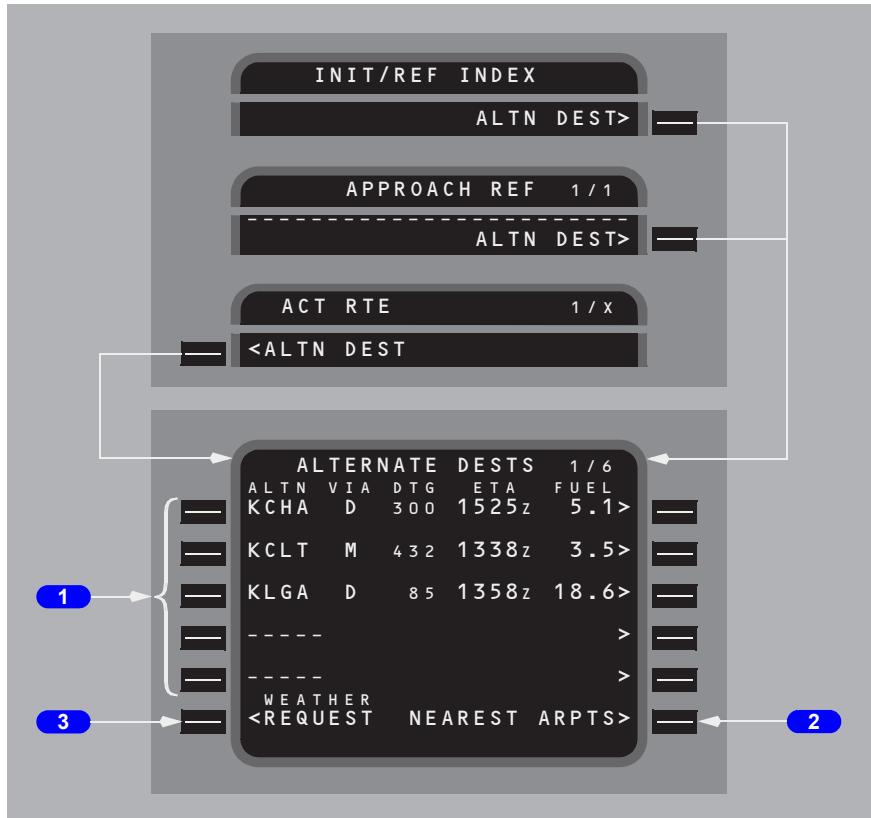
[Option – With alternate destination prediction]

### Alternate Dests Page 1/X

The alternate destinations pages allow the selection of alternate airports and the display of data about the alternates.

The ALTERNATE DESTS page 1/X allows entry and display of up to five alternate airports. Pages 2 through 6 allow entry and display of data related only to the selected alternate.

[Option – With company data link]



#### 1 Alternate Airports (ALTN)

Allows entry of alternate destination. Valid entries are airports, navaids, or waypoints.

Related data (VIA, DTG, ETA, FUEL) is automatically displayed.

---

Push – selects page 2/X–6/X for data on selected alternate.

The DELETE function key can be used to remove manually entered alternates.

## **2 Nearest Airport (NEAREST ARPTS)**

Push – commands FMC to search navigation database for the five airports nearest to the airplane's present position. The following actions occur:

- any alternates already entered are saved
- page title changes to NEAREST ARPTS
- the five nearest airports are displayed on lines 1L to 5L
- the NEAREST ARPTS prompt is replaced with PREVIOUS prompt
  - selection of the PREVIOUS prompt returns the display to the ALTERNATE DESTS page.

Selection cannot be overwritten or deleted.

## **3 WEATHER REQUEST**

### **[Option – With company data link]**

Push – transmits data link request for alternate destination weather uplink.

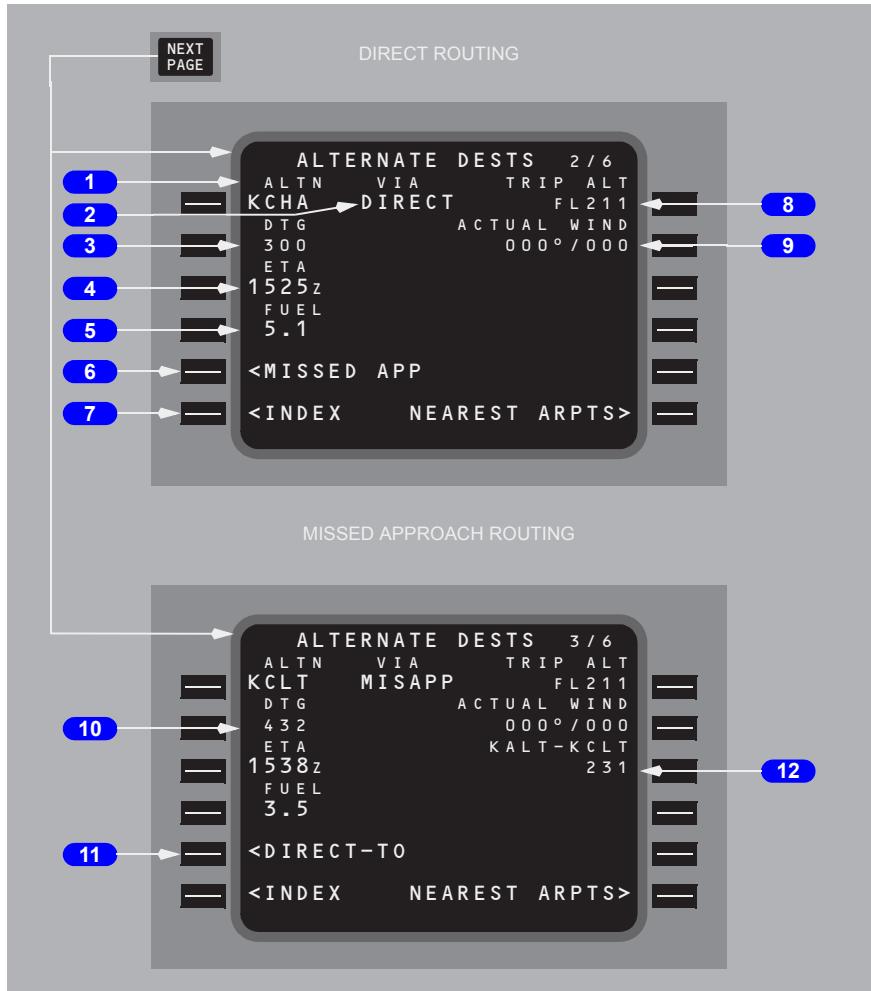
## Alternate Dests Page X/X

The ALTERNATE DESTS pages 2 through 6 display specific information about alternate airports and the route used for diversion. All data on the page is related to the alternate airport displayed in the page title.

Two routes to the airport can be selected:

- DIRECT-TO
- MISSED APP

The calculation of ETA and fuel remaining are based on the selected route.



## **1 Alternate (ALTN)**

Allows entry of alternate destination. Alternate and related information will also display on page 1/6.

## **2 VIA**

Displays routing method used for alternate predictions.

## **3 Distance To Go (DTG)**

Displays distance to go to alternate.

Manual entry allowed if DIRECT method is selected. Entered value will be displayed in large font.

## **4 Estimated Time of Arrival (ETA)**

Displays estimated time of arrival at alternate.

## **5 FUEL**

Displays fuel remaining at alternate.

## **6 Missed Approach (MISSED APP)**

Push – changes routing method to missed approach for alternate predictions.

## **7 INDEX**

Push – displays ALTERNATE DESTS Page 1/X.

## **8 Trip Altitude (TRIP ALT)**

Displays computed optimum cruise altitude..

Manual entry is allowed and will be displayed in large font. If manual entry is unsuitable, display will show UNABLE.

## **9 ACTUAL WIND**

Displays current wind direction and velocity..

If manual entry is made, heading will change to EST WIND.

## **10 Distance To Go (DTG)**

Displays distance to go. Manual entry not allowed for missed approach routing.

## **11 DIRECT-TO**

Push – changes routing method to direct to for alternate predictions.

## 12 Destination–Alternate

Displays computed distance from destination to alternate when missed approach is selected. Distance includes missed approach procedure plus great circle distance from last waypoint in missed approach to alternate.

Manual entry is displayed in large font.

## Holding

The FMC computes holding patterns with constant radius turns based on current winds and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30 degree bank angle. Strong winds or airspeed in excess of FAA or ICAO entry speeds may result in the airplane flying outside the protected airspace.

With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

- the angle between the flight plan leg into the holding fix and the holding inbound course determines the entry method used (parallel, teardrop or direct entry)
- the airplane flies the initial outbound leg for a specified time (1.0 minute at or below 14,000 feet and 1.5 minutes above 14,000 feet)
- teardrop entries use an FMC calculated offset angle designed to intercept the outbound leg at the point where the inbound turn begins
- parallel and teardrop entries may cause the airplane to fly beyond the displayed holding pattern; however, the airplane remains in protected FAA or ICAO limits.

## 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.

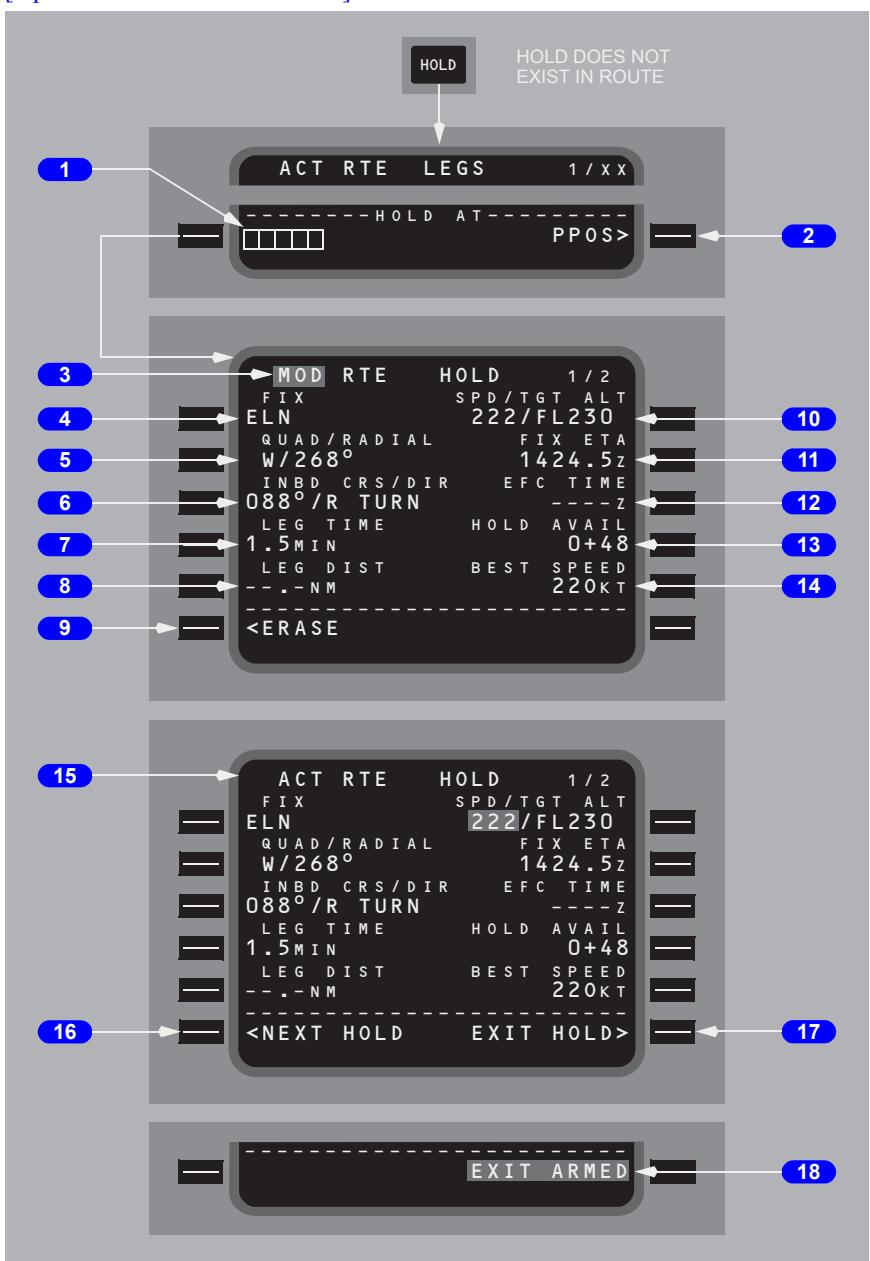
Active holding patterns are magenta on the navigation display.

---

[Option – FMC U10.2 and later]

**Note:** During FMC guided entrance to a hold, portions of the LNAV magenta holding pattern on the navigation display may not show. This may only occur when the holding pattern is within 5000 feet of the FMC computed MAX ALT, and after the UNABLE HOLD AIRSPACE scratchpad message shows. LNAV hold entry guidance will function normally.

[Option – FMC U10.2 and later]



## 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.

Only displayed during flight when not in a holding pattern.

## 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 Quadrant/Radial (QUAD/RADIAL)

Displays holding pattern quadrant and radial.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

### [Option – FMC U10.4 and later]

The default holding pattern inbound course and turn direction are in small font. Crew entered or holding patterns extracted from the database are in large font.

Valid entry is XXX (radial) or XX/XXX (quadrant/radial). Valid quadrant entry is N, NE, E, SE, S, SW, W, NW.

Quadrant shall be determined by the resulting inbound course.

## 6 Inbound Course/Direction (INBD CRS/DIR)

Displays holding inbound course and turn direction.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

**[Option – FMC U10.4 and later]**

The default holding pattern inbound course and turn direction are in small font. Crew entered or holding patterns extracted from the database are in large font.

Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction).

Automatically changes QUAD/RADIAL to agree.

For a flight crew-entered holding pattern, the inbound course is initially the same as the preceding leg to the fix.

For a flight crew-entered holding pattern, if no entry is made, the FMC assumes right turns.

**[Option – With color]**

Magenta when the holding fix is the active waypoint.

**7 LEG TIME**

Displays holding pattern leg time.

Valid entry is XXX.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.

**[Option – FMC U10.4 and later]**

The default leg times are displayed in small font. Crew entered or holding patterns extracted from the database are displayed in large font.

**[Option – FMC U10.4 and later]**

The holding pattern will automatically be resized when climbing or descending through 14,000 feet if the holding pattern size is not defined in the database or has not been manually entered.

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 Speed/Target Altitude (SPD/TGT ALT)

Displays current speed and altitude (small font).

Speed or altitude constraint may be entered. Manual entries are in large font and propagate to LEGS page.

**Note:** When a cruise hold exists, cruise speed changes propagate around the hold but have no effect on holding speed.

## 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.

**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.

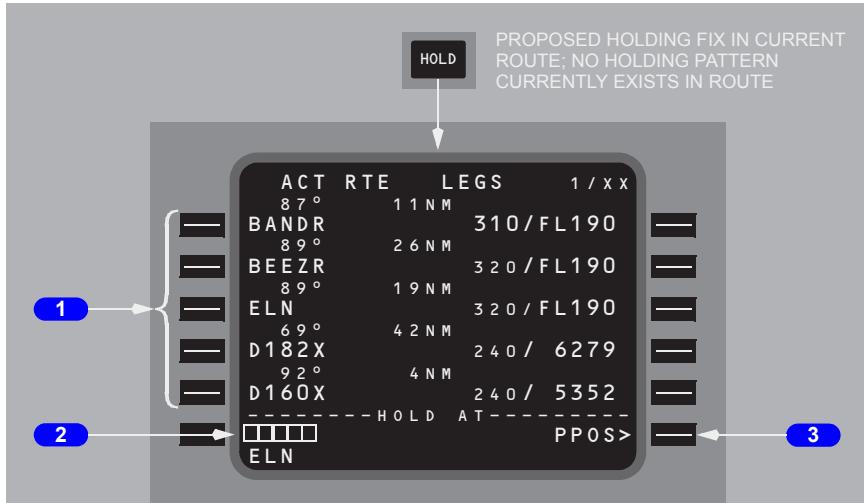
Highlighted in reverse video after execution.

## RTE LEGS HOLD AT (Fix in Route)

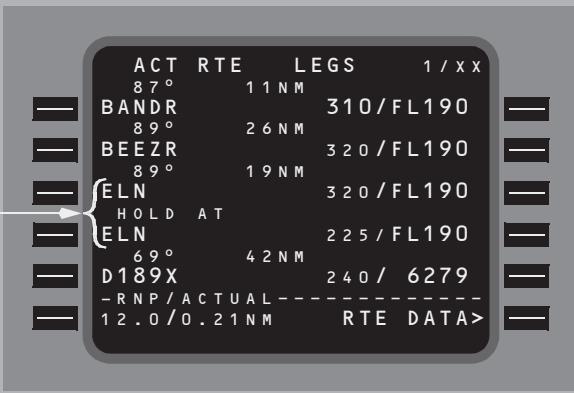
Used to enter proposed fix for racetrack holding pattern at either present position or any waypoint.

A maximum of five holding patterns may exist at one time.

Two holding patterns may exist at the same waypoint if one is in the route and the other is in the missed approach.



AFTER EXECUTING ROUTE HOLD AT DOWNTACK WAYPOINT



### 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.

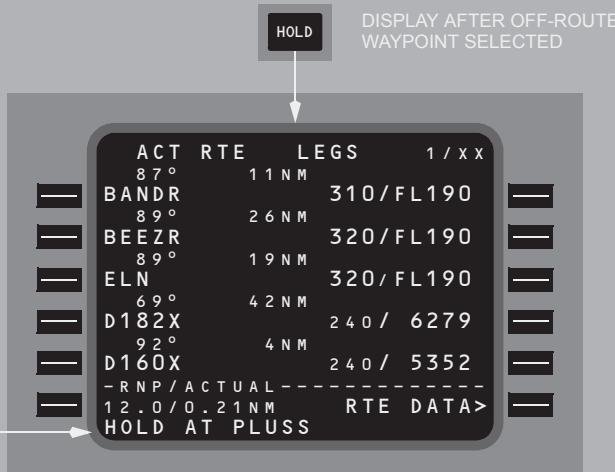
Default parameters are a standard holding pattern on the inbound leg.

**4 Hold at Waypoints (HOLD AT)**

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

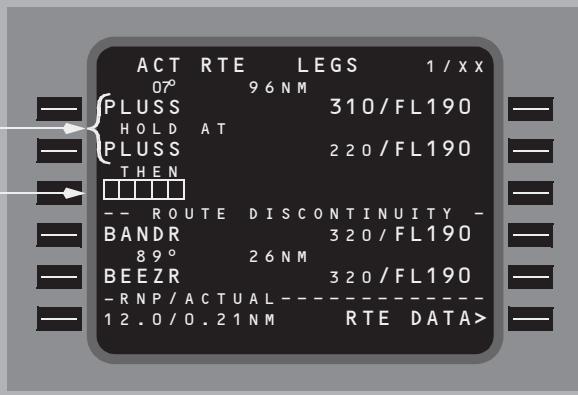
Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

## RTE LEGS HOLD AT (Fix not in Route)



1

AFTER LINE SELECTING THE DESIRED LEGS PAGE SEQUENCE AND EXECUTING THE OFF ROUTE HOLD



### 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

### FMC Messages

## Chapter 11

### Section 60

#### 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.

#### [Option – With company data link]

- FMC data link messages (alerting and advisory)

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 |
|------------------|-------|-------------------|
|------------------|-------|-------------------|

### [U10.4 and later]

|  |  |                    |
|--|--|--------------------|
| CRZ ALT CHANGED TO<br>XXXXX<br>(U10.4 and later) | During a missed approach a STAR or approach has been selected that conflicts with the cruise altitude. | Clear the message. |
|--|--|--------------------|

### [U10.5 and later]

|                                    |   |                    |
|------------------------------------|---|--------------------|
| CHECK ALT TGT<br>(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. |
|------------------------------------|---|--------------------|

### [U10.6 and later]

|                                       |  |   |
|---------------------------------------|--|---|
| CUTBACK DISARMED<br>(U10.6 and later) | Cutback turned off as a result of changing or deleting the flight plan runway while on the ground. | Clear the message.<br>Re-arm as required. |
|---------------------------------------|--|---|

| ALERTING MESSAGE                              | CAUSE  | CORRECTIVE ACTION   |
|---|--|---|
| <b>[U10.3 and later]</b>                      |  |   |
| CUTBACK UNAVAILABLE<br>(U10.3 and later)      | The FMC is unable to compute a Cutback N1 value.   | 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. |
| 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 triple waypoint BYPASS. | Select the RTE or RTE LEGS pages and modify the waypoints for a continuous route.   |
| DISCONTINUITY                                 | Passing the last waypoint in the route prior to a ROUTE DISCONTINUITY (LNAV disengages) or pressing LNAV while in a discontinuity.       | Select the RTE LEGS page. Enter the desired active waypoint into the box prompts. Correct any ROUTE DISCONTINUITY and EXECute. Reengage LNAV.   |
| <b>[U10.7 and later]</b>                      |  |   |
| DRAG REQ AFTER XXXXX<br>(U10.7 and later)     | A waypoint speed constraint greater than 10 knots above the predicted speed exists at waypoint XXXXX.                                    | Modify flight plan as required.<br>Clear the message.   |

| ALERTING MESSAGE     | CAUSE  | CORRECTIVE ACTION   |
|----------------------|--|---|
| DUAL FMC OP RESTORED | Dual FMC operation has been successfully restored. (Dual FMC as installed) | Clear message and set FMC source select switch to NORMAL.   |
| END OF OFFSET        | Two minutes prior to passing offset leg termination.                       | Confirm 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. |

**[U10.3 and later]**

|                                      |   |                    |
|--------------------------------------|---|--------------------|
| ENG OUT SID MOD<br>(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 scratchpad 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. |
|--------------------|---|--|

**[U10.5 and later]**

|  |   |  |
|--|---|--|
| FMC APP/TUNE DISAGREE<br>(U10.5 and later) | An approach that utilizes FMC generated glidepath is in the active flight plan but an approach navaid (ILS/GLS) has been tuned with G/S ON. | Confirm the tuned frequency and approach selected in the FMC are both consistent with the actual approach intended to be flown. Resolve tuning or approach selection inconsistency. Clear the message. |
|--|---|--|

| ALERTING MESSAGE | CAUSE | CORRECTIVE ACTION |
|------------------|-------|-------------------|
|------------------|-------|-------------------|

**[U10.5 and later]**

|  |  |  |
|--|--|--|
| FMC APP MODE<br>UNAVAIL-QFE<br>(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. |
|--|--|--|

**[U10.6 and later]**

|                                   |   |   |
|-----------------------------------|---|---|
| FMC DISAGREE<br>(U10.6 and later) | During approach or on the ground, monitored parameters required for dual FMC operation are in disagreement. (Dual FMC as installed) | Monitor FMCs closely. Both FMCs remain online. Limit approaches to single FMC only. If desired, revert to SINGLE FMC OPERATION in this section. |
|-----------------------------------|---|---|

**[U10.7 and later]**

|   |  |  |
|---|--|--|
| FMC POS/RW<br>DISAGREE<br>(U10.7 and later) | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |
|---|--|--|

**[U10.7 and later]**

|   |   |  |
|---|---|--|
| GPS-L INVALID<br>GPS-R INVALID<br>(U10.7 and later) | FMC is no longer receiving information from the displayed GPS system. | Refer to FMC Navigation Check supplementary procedure. |
|---|---|--|

|                   |  |  |
|-------------------|--|--|
| INSUFFICIENT FUEL | A change in conditions or flight plan route causes predicted fuel at destination to be 900 kilograms/2000 lbs or less. | Modify the route plan or cruising altitude, or divert for additional fuel. |
| IRS MOTION        | IRS has automatically restarted the alignment due to detection of excessive motion.                                    | Clear message and attempt to reduce airplane movement, if practicable.     |

| ALERTING MESSAGE                             | CAUSE  | CORRECTIVE ACTION   |
|--|--|---|
| <b>[U10.8]</b>                               |  |   |
| INVALID INACTIVE PLAN<br>(U10.8 and later)   | An exception has occurred in the INACTIVE plan prior to execution and it has been deleted as a result.   | Reenter a new version of the INACTIVE plan.   |
| <b>[U10.8]</b>                               |  |   |
| INVALID MOD PLAN<br>(U10.8 and later)        | An exception has occurred in the MOD plan and it has been deleted as a result.   | Reenter a new version of the MOD plan.  |
| <b>[U10.7 and later]</b>                     |  |   |
| IRS POS/ORIGIN DISAGREE<br>(U10.7 and later) | Position information is contradictory.   | Refer to FMC Navigation Check Supplementary Procedure.  |
| <b>[U10.6 and later]</b>                     |  |   |
| LNAV BANK ANGLE LIMITED<br>(U10.6 and later) | LNAV is engaged and the airplane is not on a lateral offset and is not near or in an orbit or hold and the airplane is within 5 minutes or less from an LNAV guided course change, and will exceed the airway/route boundaries for non-flyover turns less than or equal to 135 degrees due to performance limited bank angle. This message does not apply to fixed radius turns. | Review the LNAV course change. If course change exceeds airway/route boundary, consider flight plan change. |
| MAX ALT FLXXX<br>(flight level value)        | Altitude intervention (as installed) attempt to raise cruise altitude when MCP altitude is above maximum altitude.   | Clear the message.  |

| ALERTING MESSAGE                           | CAUSE  | CORRECTIVE ACTION   |
|--|--|---|
| MISSED CAPTURE                             | Proper localizer capture maneuver was performed, but the AFDS did not capture.         | Clear the message.  |
| MODEL/ENG DATA INVALID                     | A valid performance database is not available.   | Contact maintenance personnel.  |
| NAV DATA OUT OF DATE                       | Effectivity dates of nav database do not agree with date input from clock.             | Check the IDENT page and reverse the dates for ACTIVE NAV DATA if required. |
| NAV INVALID-TUNE XXXXX (navaid identifier) | FMC is unable to auto-tune or receive the navaid for a RNAV or VOR approach procedure. | Cross-check radios and manually tune the desired navaid.                    |

**[U10.2 and later]**

|   |   |  |
|---|---|--|
| OVERSPEED DISCONNECT<br>(U10.2 and later) | During path descent and above or below the speed restriction altitude, VNAV disengages when airspeed exceeds FMC speed restriction by more than 15 knots. | Manually reduce speed and reengage VNAV. |
|---|---|--|

**[U10.3 and later]**

|   |  |                                |
|---|--|--------------------------------|
| PARTIAL ROUTE LOADED<br>(U10.3 and later) | A route is loaded which references data not contained in the database. | Clear the message.             |
| PERF DEFAULTS INVALID                     | Validity check of performance defaults database has failed.            | Contact maintenance personnel. |

| ALERTING MESSAGE                             | CAUSE   | CORRECTIVE ACTION   |
|--|---|---|
| <b>[U10.5A and later]</b>                    |   |   |
| RESET MCP ALT<br>(U10.5A and later)          | During the FMC cruise phase with VNAV engaged, when within 5 NM of the top-of-descent point without selecting a lower altitude on the AFDS MCP. | Select lower MCP altitude values as clearances permit.  |
| <b>[U10.4 and later]</b>                     |   |   |
| RW/APP TUNE<br>DISAGREE<br>(U10.4 and later) | During approach, manual tuned approach frequency or channel does not match active flight plan.  | Enter an achievable RTA or discontinue the RTA mode of navigation. Adjust parameters to meet the RTA. |
| <b>[U10.4 and later]</b>                     |   |   |
| RW/APP CRS ERROR<br>(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.  |
| SCANNING DME FAIL                            | Inputs from both frequency scanning DME radios have failed.   | Clear the message and check position. Radio updating of FMC position is not available.                |
| SELECT MODE AFTER<br>RTA                     | RTA mode has been discontinued due to sequencing of RTA waypoint or RTA waypoint has been removed from the flight plan.                         | Select alternate performance mode. (ECON, manual speed, etc.)   |

| ALERTING MESSAGE     | CAUSE   | CORRECTIVE ACTION  |
|----------------------|---|--|
| SINGLE FMC OPERATION | The primary FMC has determined that the secondary FMC is not available. (Dual FMC as installed) | If the FMC source selector switch is in the "Normal" position, move to "BOTH ON L". No action is required if the FMC source selector switch is already positioned to "BOTH ON L" or "BOTH ON R". |

**[U10.6 and later]**

|   |   |  |
|---|---|--|
| TAKEOFF SPEEDS DELETED<br>(U10.6 and later) | A change to runway, runway data, takeoff thrust selection or performance data is made after the V speeds have been selected, or entered V speeds fail to meet relative value check. | Reselect new V speeds and clear message. |
|---|---|--|

**[U10.5 and later]**

|                                      |   |  |
|--------------------------------------|---|--|
| THRUST REQUIRED<br>(U10.5 and later) | Airplane is in an underspeed condition. | Clear the message. Increase airspeed to within 15 knots of speed target. |
|--------------------------------------|---|--|

**[U10.2 and later]**

|   |  |   |
|---|--|---|
| UNABLE HOLD AIRSPACE<br>(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. |
|---|--|---|

**[U10.4 and later]**

|   |   |  |
|---|---|--|
| UNABLE NEXT ALTITUDE<br>(U10.4 and later) | Unable to meet the next flight plan altitude constraint in a VNAV 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 |
|------------------|-------|-------------------|
|------------------|-------|-------------------|

**[U10.6 and later]**

|   |  |   |
|---|--|---|
| UNABLE PROC AIRSPACE<br>(U10.6 and later) | Minimum procedure turn built by guidance exceeds the allowable excursion distance. | Modify flight plan as required.<br><br>Clear the message. |
|---|--|---|

**[U10.7 and later]**

|  |   |   |
|--|---|---|
| UNABLE YYY KTS AT XXXXX<br>(U10.7 and later) | Next waypoint speed restriction (speed YYY, at waypoint XXXXX) cannot be met. | Modify flight plan as required.<br><br>Clear the message. |
|--|---|---|

**[U10.3 and later]**

|   |  |   |
|---|--|---|
| UNABLE REQD NAV PERF-RNP<br>(U10.3 and later) | FMC actual navigation performance is not sufficient for the displayed RNP. | During approach: Refer to UNABLE REQD NAV PERF - RNP non-normal checklist in the QRH.<br><br>During other phases of flight: Refer to the FMC Navigation Check supplementary procedure in SP.11. |
|---|--|---|

|                    |   |   |
|--------------------|---|---|
| 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.<br><br>Shows if 30 minutes have elapsed since last manual entry.<br><br>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. |
|--------------------|---|---|

**[U10.7 and later]**

|  |  |  |
|--|--|--|
| VERIFY POS: FMC-FMC<br>(U10.7 and later) | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |
|--|--|--|

| ALERTING MESSAGE                         | CAUSE                                  | CORRECTIVE ACTION                                      |
|--|--|--|
| <b>[U10.7 and later]</b>                 |  |  |
| VERIFY POS: FMC-GPS<br>(U10.7 and later) | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |

**[U10.7 and later]**

|   |  |  |
|---|--|--|
| VERIFY POS:<br>FMC-RADIO<br>(U10.7 and later) | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |
|---|--|--|

**[U10.7 and later]**

|  |  |  |
|--|--|--|
| VERIFY POS: IRS-FMC<br>(U10.7 and later) | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |
|--|--|--|

**[U10.7 and later]**

|  |  |  |
|--|--|--|
| VERIFY POS: IRS-IRS<br>(U10.7 and later) | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |
|--|--|--|

**[U10.7 and later]**

|   |  |  |
|---|--|--|
| VERIFY POS:<br>IRS-RADIO<br>(U10.7 and later) | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |
|---|--|--|

|                 |  |  |
|-----------------|--|--|
| VERIFY POSITION | Position information is contradictory. | Refer to FMC Navigation Check Supplementary Procedure. |
|-----------------|--|--|

**[U10.3 and later]**

|                                 |   |                        |
|---------------------------------|---|------------------------|
| VERIFY RNP<br>(U10.3 and later) | Underlying RNP value is less than manually entered value. | Enter appropriate RNP. |
|---------------------------------|---|------------------------|

| ALERTING MESSAGE      | CAUSE   | CORRECTIVE ACTION  |
|-----------------------|---|--|
| VERIFY TAKEOFF SPEEDS | A PERF INIT change has been made after takeoff speeds were specified. | On TAKEOFF REF page 1, accept previous V speeds, or reject previous V speeds and enter new V speeds. |

**[U10.5 and later]**

|                                      |  |  |
|--------------------------------------|--|--|
| VERIFY VERT RNP<br>(U10.5 and later) | During an active descent with CDS navigation performance scales enabled, a manually entered vertical RNP is greater than the default vertical RNP. | Clear CDU message. Enter appropriate vertical RNP. |
|--------------------------------------|--|--|

**[U10.4 and later]**

|                                      |  |                                     |
|--------------------------------------|--|-------------------------------------|
| VNAV DISCONNECT<br>(U10.4 and later) | The criteria for VNAV engagement is not satisfied (VNAV disengages).<br><br>On approach, with VNAV engaged, the FCC has switched to LVL CHG. | Manually control the vertical path. |
|--------------------------------------|--|-------------------------------------|

**[U10.8]**

|  |  |  |
|--|--|--|
| VNAV INVALID-PERF<br>(U10.8 and later) | If the exception effects both the MOD and the ACT flight plan, the CI will be replaced with box prompts on the PERF INIT page and the message will result. LNAV is still valid and can navigate the airplane laterally but VNAV will disconnect. | Pilot should reenter the CI using either the previous CI displayed or enter a new CI. Reengage VNAV when change has been EXECuted. |
|--|--|--|

## FMC Entry Error Messages

These messages relate to incorrect scratchpad 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. |

**[U10.3 and later]**

|  |  |   |
|--|--|---|
| DUPPLICATE FLIGHT PLAN ID<br>(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 scratchpad entry, and repeat the entry with the correct data. |

| ENTRY ERROR MESSAGE | CAUSE | CORRECTIVE ACTION |
|---------------------|-------|-------------------|
|---------------------|-------|-------------------|

**[U10.2 and later]**

|                                   |  |  |
|-----------------------------------|--|--|
| INVALID QUAD<br>(U10.2 and later) | Attempted HOLD page QUAD entry has incorrect format or range.  | Clear the message and revise the QUAD entry.   |
| 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.  |

**[U10.3 and later]**

|  |  |  |
|--|--|--|
| SUPP RTE DATA BASE FULL<br>(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 quantity indications 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. |

| ADVISORY MESSAGE   | CAUSE  | CORRECTIVE ACTION   |
|--|--|---|
| <b>[U10.5 and later]</b>   |  |   |
| FMC APP MODE UNAVAIL–GP<br>(U10.5 and later)                         | The approach selected in the FMC does not have a specified glidepath angle for final approach. The FMC approach mode cannot be used for this approach. | Select an alternate approach. Clear the message.                                    |
| INVALID OFFSET   | Desired offset does not meet FMC offset criteria.  | Clear the message and amend the entry.  |
| KEY/FUNCTION INOP  | A mode key is pressed for which an FMC function has not been implemented or has not been enabled.<br>(FANS MCDU only)                                  | Clear the message or select another CDU page for display.                           |
| LOC CAP ACTIVE   | The airplane is approaching its turn onto the localizer or GLS 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<br>MACH .XXX<br>OR<br>MAX CAS .XXX/MIN<br>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.     |
| NO DES PATH AFTER<br>XXXXXX (waypoint)                               | FMC is unable to construct a PATH DES that satisfies all altitude restrictions after XXXXXX.   | Modify speed or altitude restrictions on the RTE LEGS pages.                        |

| ADVISORY MESSAGE            | CAUSE   | CORRECTIVE ACTION  |
|-----------------------------|---|--|
| NOT ON INTERCEPT<br>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. (lateral offset as installed)                   | Clear the message and amend the route.                                 |
| OFST ENDS ABEAM<br>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<br>DELETED    | Performance database has been automatically deleted due to conflict with performance database limits.             | Contact maintenance personnel.   |

**[U10.6 and later]**

|  |  |                    |
|--|--|--------------------|
| POS SHIFT OVER 50NM<br>(U10.6 and later) | A viable position shift is currently selected that will result in an FMC position shift in excess of 50nm when executed. | Clear the message. |
|--|--|--------------------|

|                       |   |  |
|-----------------------|---|--|
| 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.        |  |
| RESET MCP ALT         | Normal FMC operation would require flying away from MCP altitude. | Select a MCP altitude value in the proper direction (higher for climb, lower for descent). |

| ADVISORY MESSAGE                        | CAUSE   | CORRECTIVE ACTION  |
|---|---|--|
| <b>[U10.5 and later]</b>                |   |  |
| RESET MCP APP MODE<br>(U10.5 and later) | A change in the expected approach is made with an FCC approach mode armed or engaged.   | Clear and rearm FCC approach mode. Clear the message.                                  |
| RUNWAY N/A FOR SID                      | The selected runway is not applicable to the selected departure procedure.              | Clear the message and check selections on the DEPARTURES page. Modify as required.     |
| SELECT ACTIVE WPT/LEG                   | Power-up restart or insertion of a different flight plan while airborne.                | EXECute a direct-to or leg intercept to tell the FMC which leg of the route is active. |
| STEEP DESCENT AFTER XXXXXX              | An excessive vertical discontinuity exists after point XXXXXX.                          | Check routing.   |
| TAI ON ABOVE 10°C                       | Airplane is operating with anti-icing with TAT above +10°C.                             | Clear the message and check the use of anti-icing for engines and/or wings.            |
| UNABLE CRZ ALT                          | FMC predicts that no cruise time is possible at the entered CRZ ALT.                    | Clear the message and review the CRZ ALT selection.                                    |
| UNABLE MACH .XXX                        | The entered cruise Mach is unattainable based on present gross weight.                  | Select a smaller Mach number or wait until gross weight is reduced sufficiently.       |
| UNABLE TO OFFSET                        | A valid offset cannot be constructed due to geometric limitations.                      | Clear the message and amend the route.   |
| USING RSV FUEL                          | Predicted fuel remaining at DEST is less than the RESERVES entry on the PERF INIT page. | Clear the message and change routing if required.                                      |

| ADVISORY MESSAGE        | CAUSE   | CORRECTIVE ACTION                               |
|-------------------------|---|---|
| V SPEEDS<br>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. |
| VERIFY RNP VALUE        | 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.      |

[U10.5 and later]

|   |  |   |
|---|--|---|
| VERIFY VERT RNP<br>VALUE<br><br>(U10.5 and later) | With CDS navigation performance scales enabled, a manually entered vertical RNP is greater than the default vertical RNP or manually entered vertical RNP is less than vertical ANP. | Clear the message. Change or delete the manually entered RNP. |
|---|--|---|

|                            |  |  |
|----------------------------|--|--|
| 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 scratchpad. | Enter the MCP altitude value on the appropriate target altitude data line. |

---

## FMC Data Link Messages

### [Option – With company data link]

These messages relate to FMC data link message status. FMC data link alerting and advisory messages function the same as the alerting and advisory messages described above:

## FMC Data Link Alerting Messages

| ALERTING MESSAGE                        | CAUSE   | CORRECTIVE ACTION  |
|---|---|--|
| ALTN DEST UPLINK                        | An FMC alternate destinations uplink message has been loaded on the ALTERNATE DESTS page, and is ready for flight crew review.<br>(Alternate destinations as installed) | Review the alternate destinations uplink.  |
| CRZ WIND UPLINK LOADING                 | An FMC cruise wind uplink message is loading (after LOAD selected on the RTE DATA page).  | Wait for load to complete.   |
| CRZ WIND UPLINK READY                   | An FMC cruise wind uplink message has been received and is available for loading on the RTE DATA page.  | Select RTE DATA page, LOAD cruise wind, and execute or ERASE.                      |
| CRZ WIND XXXXX (cruise altitude) UPLINK | An FMC cruise wind uplink message has been loaded on the RTE DATA page, and is ready for flight crew review.  | Review the cruise wind uplink, and execute or ERASE.                               |
| DATALINK CONFIG INVALID                 | Validity check of the FMC datalink configuration file has failed.   | Contact maintenance personnel.   |
| DESCENT FORECASTS UPLINK                | An FMC descent forecasts uplink message has been loaded on the DESCENT FORECASTS page, and is ready for flight crew review.   | Review the descent forecasts uplink, and execute or ERASE.                         |
| FORECASTS UPLINK READY                  | An FMC descent forecasts uplink message has been received and is available for loading on the DESCENT FORECASTS page.   | Select DESCENT FORECASTS page, LOAD descent forecasts winds, and execute or ERASE. |

| ALERTING MESSAGE   | CAUSE  | CORRECTIVE ACTION  |
|--|--|--|
| INVALID TAKEOFF XXX/YYY (runway or runway/intersection identifier) | Runway (RTE page) or runway/intersection (TAKEOFF REF page) has been entered that matches runway takeoff data in FMC memory. However, the airplane is performance limited for the selected runway. | Clear the message. Enter correct takeoff data, request new takeoff data uplink, or enter new runway or runway/intersection identifier. |
| NAV DATA LOADING   | An FMC supplemental navigation data uplink message has been received and is loading.   | Wait for load to complete.   |
| NAV DATA UPLINK  | An FMC supplemental navigation data uplink message has been loaded on the SUPP NAV DATA page, and is ready for flight crew review.   | Review the supplemental navigation data uplink, and execute or ERASE.  |
| PARTIAL ALTN DEST UPLINK   | An FMC alternate destinations uplink message has been loaded on the ALTERNATE DESTS page, but errors were encountered during the loading process.<br>(Alternate destinations as installed)         | Review the alternate destinations uplink, and execute or ERASE.  |
| PARTIAL FORECASTS UPLINK   | An FMC descent forecasts uplink message has been loaded on the DESCENT FORECASTS page, but errors were encountered during the loading process.   | Review the descent forecasts uplink, and execute or ERASE.   |
| PARTIAL LIMITS UPLINK  | An FMC performance limits uplink message has been loaded on the PERF LIMITS page, but errors were encountered during the loading process.  | Review the performance limits uplink, and execute or ERASE.  |

| ALERTING MESSAGE         | CAUSE   | CORRECTIVE ACTION  |
|--------------------------|---|--|
| PARTIAL NAV DATA UPLINK  | An FMC supplemental navigation data uplink message has been loaded on the SUPP NAV DATA page, but errors were encountered during the loading process. | Review the supplemental navigation data uplink, and execute or ERASE.              |
| PARTIAL PERF INIT UPLINK | An FMC performance initialization uplink message has been loaded on the PERF INIT page, but errors were encountered during the loading process.       | Review the performance initialization uplink, and execute or ERASE.                |
| PARTIAL ROUTE UPLINK     | An FMC route uplink message has been loaded on the RTE page, but errors were encountered during the loading process.                                  | Review the route uplink, and execute or ERASE.                                     |
| PERF INIT UPLINK         | An FMC performance initialization uplink message has been loaded on the PERF INIT page, and is ready for flight crew review.                          | Review the performance initialization uplink, and execute or ERASE.                |
| PERF INIT UPLINK READY   | An FMC performance initialization uplink message has been received and is available for loading on the PERF INIT page.                                | Select PERF INIT page, LOAD performance initialization data, and execute or ERASE. |
| PERF LIMITS UPLINK       | An FMC performance limits uplink message has been loaded on the PERF LIMITS page, and is ready for flight crew review.                                | Review the performance limits uplink, and execute or ERASE.                        |
| PERF LIMITS UPLINK READY | An FMC performance limits uplink message has been received and is available for loading on the PERF LIMITS page.                                      | Select PERF LIMITS page, LOAD performance limits, and execute or ERASE.            |

| ALERTING MESSAGE     | CAUSE  | CORRECTIVE ACTION                                  |
|----------------------|--|--|
| RESEND MESSAGE       | An FMC downlink message was attempted, but the FMC was unable to deliver the message to the ACARS MU.    | Re-send the downlink message.                      |
| ROUTE DATA UPLINK    | An FMC route uplink message has been loaded on the RTE page, and is ready for flight crew review.        | Review the route uplink, and execute or ERASE.     |
| ROUTE UPLINK LOADING | An FMC route uplink message is loading (after LOAD selected on the RTE page).                            | Wait for load to complete.                         |
| ROUTE UPLINK READY   | An FMC route uplink message has been received and is available for loading on the RTE page.              | Select RTE page, LOAD route, and execute or ERASE. |
| RTA DATA UPLINK      | An FMC RTA uplink message has been loaded on the RTA PROGRESS page, and is ready for flight crew review. | Review the RTA uplink, and execute or ERASE.       |

| ALERTING MESSAGE    | CAUSE  | CORRECTIVE ACTION  |
|---------------------|--|--|
| RTA UPLINK READY    | An FMC RTA uplink message is has been received and is available for loading on the RTA PROGRESS page.  | Select RTA PROGRESS page, LOAD RTA data, and execute or ERASE.   |
| TAKEOFF DATA LOADED | Uplink takeoff data matching Runway (RTE page) or runway/intersection (TAKEOFF REF page) has been loaded on the TAKEOFF REF page, and is ready for flight crew review. | Select TAKEOFF REF page, accept or reject takeoff data.  |
| TAKEOFF DATA UPLINK | An FMC takeoff data uplink message containing one or more sets of runway takeoff data has been received and loaded in FMC memory.                                      | Enter appropriate runway (RTE page) or runway/intersection (TAKEOFF REF page) to access runway takeoff data. |

## FMC Data Link Advisory Messages

| ADVISORY MESSAGE         | CAUSE  | CORRECTIVE ACTION  |
|--------------------------|--|--------------------|
| INVALID ALTN DEST UPLINK | An FMC alternate destinations uplink message was received, but was rejected due to errors.       | Clear the message. |
| INVALID CRZ WIND UPLINK  | An FMC cruise wind uplink message was received, but was rejected due to errors.                  | Clear the message. |
| INVALID FORECASTS UPLINK | An FMC descent forecasts uplink message was received, but was rejected due to errors.            | Clear the message. |
| INVALID LIMITS UPLINK    | An FMC performance limits uplink message was received, but was rejected due to errors.           | Clear the message. |
| INVALID NAV DATA UPLINK  | An FMC supplemental navigation data uplink message was received, but was rejected due to errors. | Clear the message. |
| INVALID PERF INIT UPLINK | An FMC performance initialization uplink message was received, but was rejected due to errors.   | Clear the message. |
| INVALID ROUTE UPLINK     | An FMC route uplink message was received, but was rejected due to errors.                        | Clear the message. |
| INVALID RTA UPLINK       | An FMC RTA uplink message was received, but was rejected due to errors.                          | Clear the message. |
| INVALID TAKEOFF UPLINK   | An FMC takeoff data uplink message was received, but was rejected due to errors.                 | Clear the message. |

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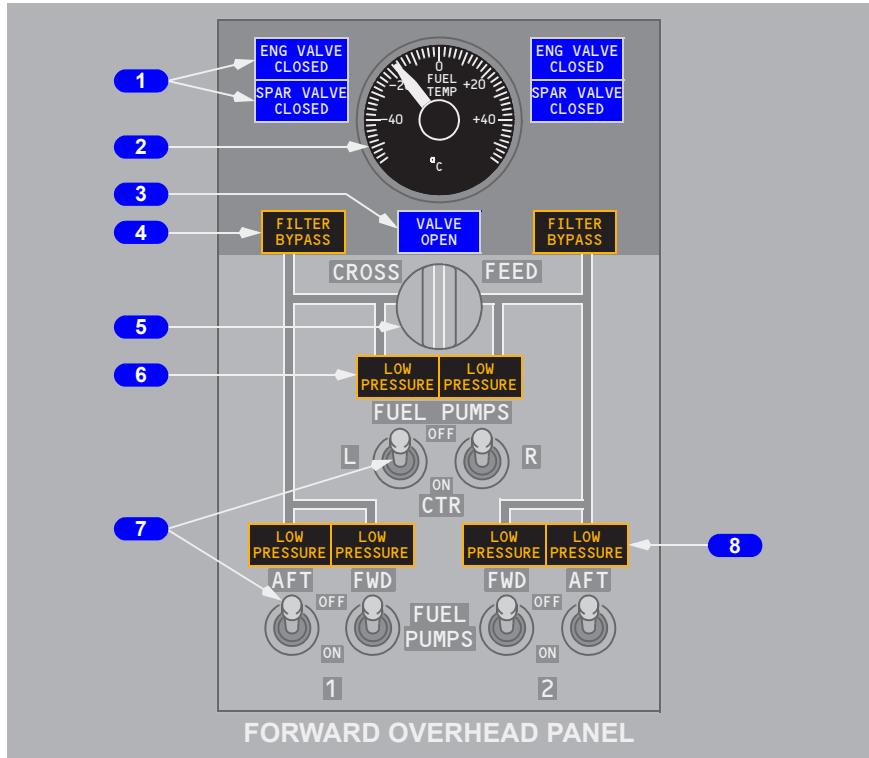
## Fuel

### Controls and Indicators

## Chapter 12

### Section 10

#### Fuel Control Panel



**FORWARD OVERHEAD PANEL**

#### **1 Engine Valve Closed (ENG VALVE CLOSED) and SPAR VALVE CLOSED Lights**

Extinguished – related engine or spar fuel shutoff valve is open.

Illuminated (blue) –

- bright – related engine or spar fuel shutoff valve is in transit, or valve position and engine start lever or engine fire switch disagree.
- dim – related engine or spar fuel shutoff valve is closed.

#### **2 FUEL Temperature (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 Lights

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 Lights

#### [Option - without Center Tank Fuel Pump Auto-shutoff]

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 illuminate 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.

**6 Center Tank FUEL PUMP LOW PRESSURE Lights****[Option - with Center Tank Fuel Pump Auto-shutoff]**

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

**Note:** With the Center (CTR) tank FUEL PUMP switches ON, continuous illumination of one LOW PRESSURE light for 10 seconds illuminates MASTER CAUTION and FUEL system annunciation lights.

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

**7 FUEL PUMP Switches**

ON – activates fuel pump.

OFF – deactivates fuel pump.

**[Option - with Center Tank Fuel Pump Auto-shutoff]**

**Note:** When a center tank fuel pump switch is set to OFF, the auto shutoff logic for that pump is reset. When the center tank fuel pump switch is set to ON after being OFF, the pump will again activate until the switch is set to OFF or auto shutoff logic deactivates it.

**8 Main Tank FUEL PUMP LOW PRESSURE Lights**

Illuminated (amber) – fuel pump output pressure is low, or FUEL PUMP switch is OFF.

**Note:** Two LOW PRESSURE lights illuminated in same tank illuminate MASTER CAUTION and FUEL system annunciation lights. One LOW PRESSURE light causes MASTER CAUTION and FUEL system annunciation lights to illuminate on MASTER CAUTION light recall.

Extinguished – fuel pump output pressure is normal.

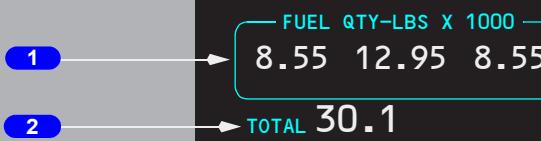
## Fuel Quantity Indications

[Option - Side By Side display, lbs]



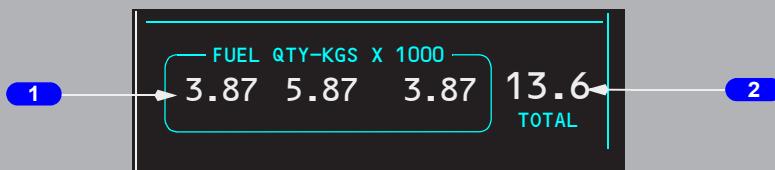
UPPER DISPLAY UNIT

[Option - Over/Under display, TOTAL fuel, lbs]



UPPER DISPLAY UNIT

[Option - Side By Side display, TOTAL fuel, kgs]



UPPER DISPLAY UNIT

### 1 FUEL Quantity Indicators

Displayed (white) – indicates usable fuel in related tank:

- standby AC power is required.

### 2 Total Fuel Quantity Indicator

Displayed (white) - indicates total useable fuel.

## Fuel Alert Indications

[Option - Side By Side display, lbs]



[Option - Over/Under display, TOTAL fuel, lbs]



UPPER DISPLAY UNIT

[Option - Side by Side, TOTAL fuel, kgs]



## 1 Fuel LOW Alert

Displayed (amber) –

- fuel quantity less than 2000 lbs in related main tank
- display remains until fuel tank quantity is increased to 2500 lbs

[Option - LOW Alert below 1000 lbs/453 kgs]

- fuel quantity less than 1000 lbs/453 kg in related main tank
- display remains until fuel tank quantity is increased to 1250 lbs/567 kgs

The fuel quantity digits on tank(s) with low fuel quantity turn amber.

## 2 Fuel Configuration (CONFIG) Alert

Displayed (amber) –

- either engine running
- center fuel tank quantity greater than 1600 lbs/726 kgs; and

[Option - CONFIG Alert Prior to L/N 1494]

- both center fuel tank pumps producing low or no pressure

[Option - CONFIG Alert, L/N 1494 and On]

- both center fuel tank pump switches positioned OFF

The quantity digits on the center tank fuel quantity indicator turn amber.

Display remains until –

- both engines not running
- center fuel tank quantity less than 800 lbs/363 kgs

[Option - CONFIG Alert Prior To L/N 1494]

- one center fuel tank pump producing high pressure

[Option - CONFIG Alert, L/N 1494 and On]

- one center fuel tank pump switch ON

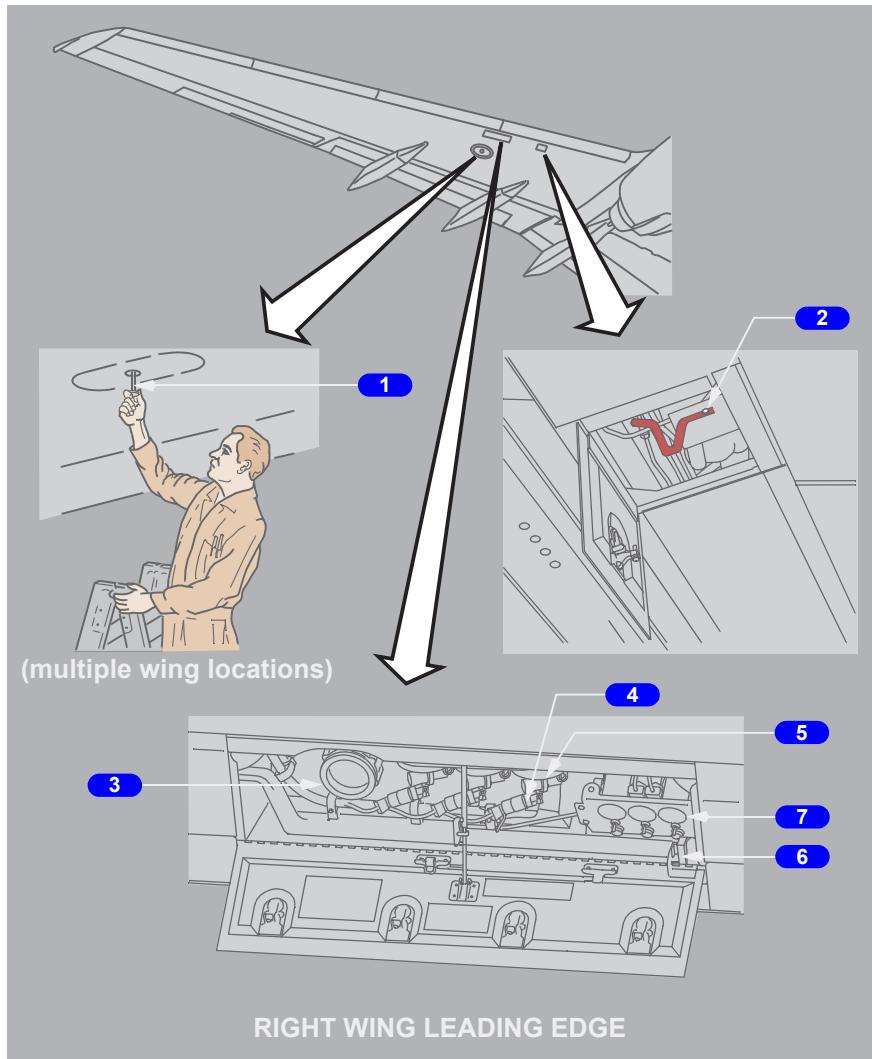
The quantity digits on the center tank fuel quantity indicator return to normal.

### **3 Fuel Imbalance (IMBAL) Alert**

Displayed (amber) –

- main tanks differ by more than 1000 lbs/453 kgs
- displayed below main tank with lower fuel quantity
- inhibited when airplane is on ground
- inhibited by fuel LOW indication when both indications exist
- displayed until imbalance is reduced to 200 lbs/91 kgs

The fuel quantity digits on tank with lower fuel quantity turn amber.

**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:

- six fuel measuring sticks are installed in each main tank and four are installed in center tank
- reading is obtained by withdrawing measuring stick from tank and latching it magnetically to an internal float. Fuel depth is read where stick passes through wing skin.

## 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 Fueling Receptacle

Hose connection receptacle for single point fueling.

## 4 Solenoid Override

Mechanically opens solenoid operated valve. Fuel valve opens if fuel pressure is available.

## 5 Fueling Valves

With the battery switch ON, and the refueling door open, fuel pressure opens valve.

## 6 Refueling Power Control Relay

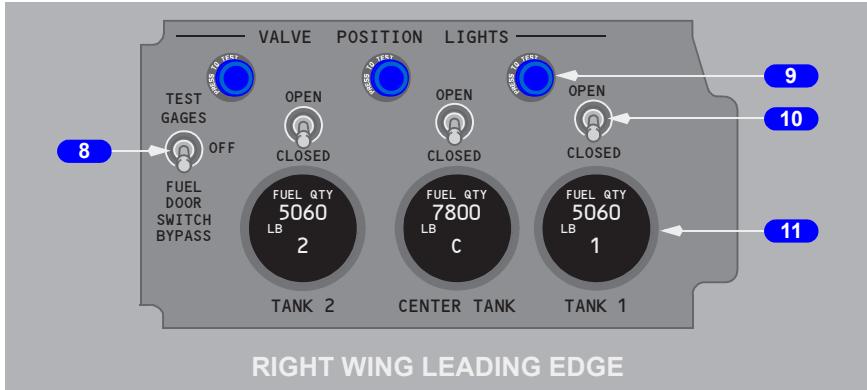
Door closed – proximity sensor deactivates power to fueling system.

Door open – the fueling system is powered and panel lights illuminate.

## 7 Test Gages & Fueling Panel

## Test Gages and Fueling Panel

[Option - lbs]



[Option - Fuel Quantity Selector, kg]



### 8 FUELING INDICATION TEST SWITCH

(spring-loaded to OFF position)

TEST GAGES – checks operation of fuel quantity indicators.

FUEL DOOR SWITCH BYPASS – energizes fueling panel if refueling power control relay fails.

### 9 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.

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## **10 Fuel Valve Switches**

OPEN – energizes fueling valve in related tank.

CLOSED – de-energizes fueling valve in related tank.

## **11 FUEL Quantity (QTY) Indicators**

Indicates total usable fuel tank quantity in related tank.

## **12 Fuel Quantity Selectors**

### **[Option]**

Rotate – sets total fuel quantity desired in related tank.

## Fuel

### System Description

## Chapter 12

### Section 20

#### 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 Chapter 7, Engines, APU, 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 cooled and lubricated by fuel passing through the pump. Center tank pumps produce higher pressure than main tank pumps. 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.

##### [Option - with Center Tank Fuel Pump Auto-shutoff]

Each center tank pump will automatically shut off, after a short delay, when that pump's sensor detects low output pressure.

**Note:** Fuel pump LOW PRESSURE lights may flicker when tank quantity is low and the airplane is in a climb, descent, or on the ground with a nose-down attitude.

#### 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

Spar fuel shutoff valves are located at the engine-mounting wing stations. The valves are DC motor operated from the hot battery bus. The engine fuel shutoff valves are fuel actuated, solenoid controlled valves powered from the battery bus. Both the spar fuel shutoff valve and the engine fuel shutoff valve close whenever their respective engine fire switch is pulled or engine start lever is placed to CUTOFF.

## Center Tank Fuel Scavenge Jet Pump

With the main tank fuel pump No. 1 FWD Switch ON, the center tank fuel scavenge jet pump operates automatically to transfer any remaining center tank fuel to main tank No. 1. Fuel transfer begins when main tank No. 1 quantity is about one-half. Once the fuel scavenge process begins, it continues for the remainder of the flight.

---

## 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.

### [Option - APU DC Fuel Pump]

A DC operated APU fuel boost pump is installed to ensure positive fuel pressure to the APU fuel control unit. During APU start and operation, the pump operates automatically when the APU fuel control unit senses low fuel pressure. The pump shuts off automatically when an AC fuel pump pressurizes the fuel manifold.

## 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 upper display unit and on the fueling station panel.

### [Option - Fuel Densitometer]

The system provides a correction for variance in fuel density.

## 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.

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 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.

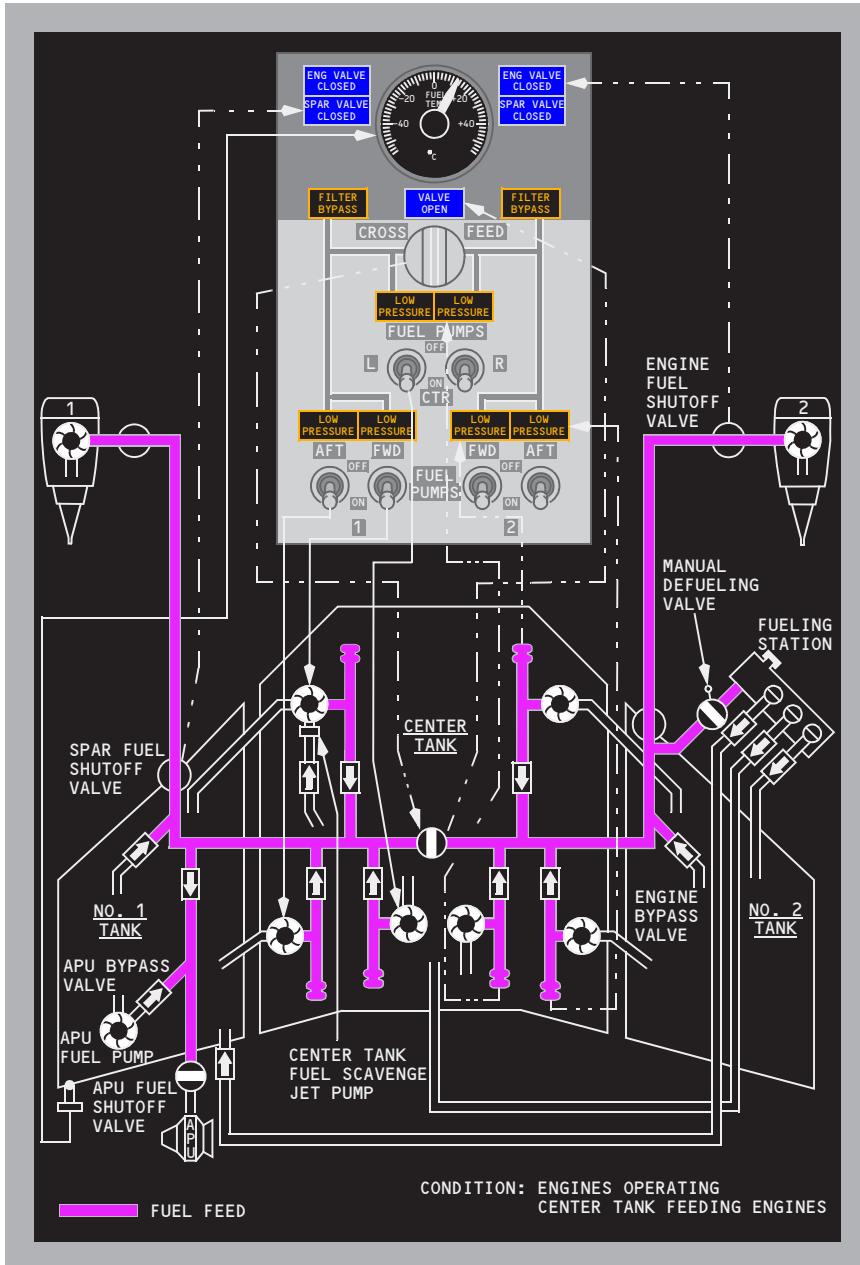
These figures represent approximate amounts of usable fuel. The appropriate weight and balance control and loading manual gives exact figures for all conditions.

| TANK   | GALLONS | POUNDS* | LITERS | KILOGRAMS* |
|--------|---------|---------|--------|------------|
| NO. 1  | 1,288   | 8,630   | 4,876  | 3,915      |
| NO. 2  | 1,288   | 8,630   | 4,876  | 3,915      |
| CENTER | 4,299   | 28,803  | 16,273 | 13,066     |
| TOTAL  | 6,875   | 46,063  | 26,025 | 20,896     |

\*Usable fuel at level attitude, fuel density = 6.7 pounds per U.S. Gallon/0.8029 kilograms per liter.

## Fuel Schematic

[Option - APU DC Fuel Pump]



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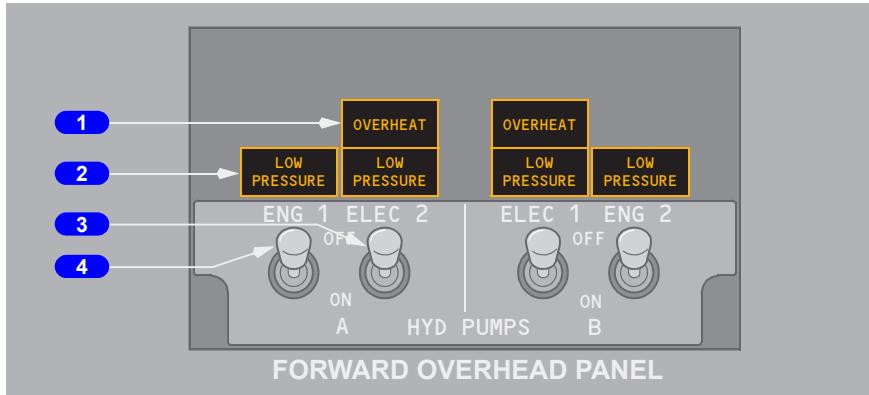
## Hydraulics

### Controls and Indicators

## Chapter 13

### Section 10

#### Hydraulic Panel



#### 1 Electric Hydraulic Pump OVERHEAT Lights

Illuminated (amber) – Hydraulic fluid used to cool and lubricate the corresponding electric motor driven pump has overheated or the pump itself has overheated.

#### 2 Hydraulic Pump LOW PRESSURE Lights

Illuminated (amber) – output pressure of associated pump is low.

**Note:** When an engine fire switch is pulled, the 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

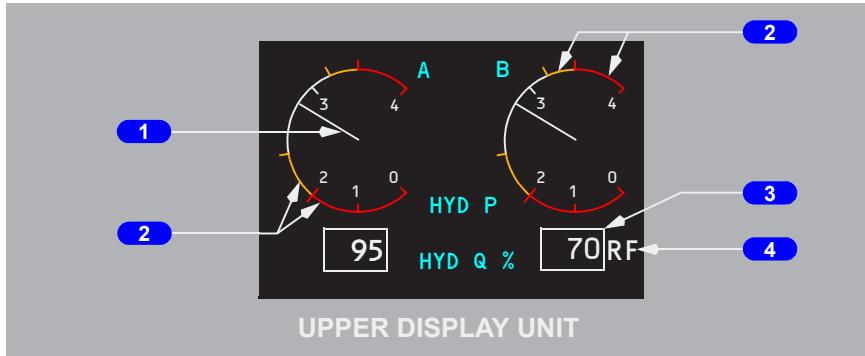
ON – de–energizes blocking valve in pump to allow pump pressure to enter system.

**Note:** Should remain ON at shutdown to prolong solenoid life.

OFF – energizes blocking valve to block pump output.

## Hydraulic Indications

[Option - Side by Side display]



### 1 HYDRAULIC System PRESSURE Indications

Indicates system pressure:

- displayed (white) - normal operating range
- displayed (amber) - caution range
- displayed (red) - operating limit reached.

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

### 2 Hydraulic Pressure Amber Bands/Redlines

Displayed (amber) - low/high hydraulic pressure caution range.

Displayed (red) - low/high hydraulic pressure operating limit.

### 3 HYDRAULIC System QUANTITY Indications

Indicates digital percentage (0% to 106%) of hydraulic quantity.

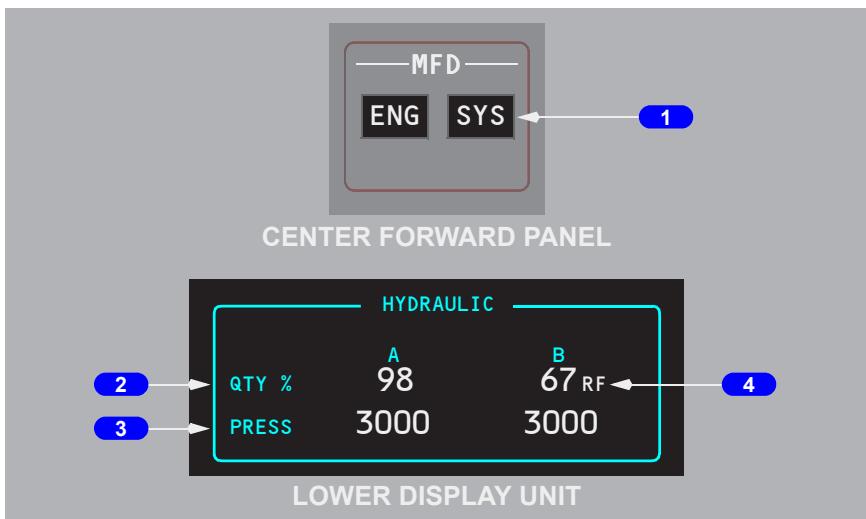
**Note:** Quantity also displayed at each reservoir.

### 4 REFILL Indication (RF) (white)

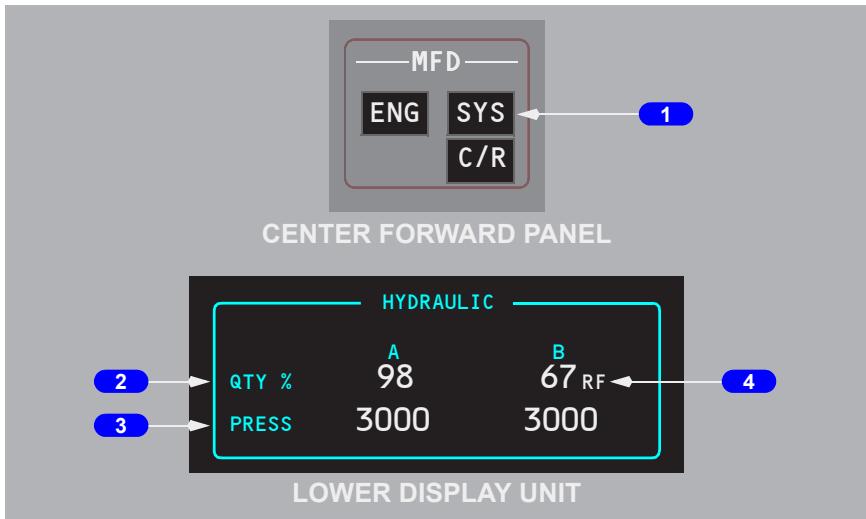
Illuminated (white) – hydraulic quantity below 76%.

**Note:** Valid only when airplane is on ground with both engines shutdown or after landing with flaps up during taxi-in.

## [Option - Over/Under display]



## [Option - Over/Under display]


**1 MFD System (SYS) Switch**

Push – SYS

- displays hydraulic indications on lower DU; or the inboard DU if the MAIN PANEL DUs switch is placed to the INBD MFD position.
- second push removes indications from the respective DU.

---

**2 HYDRAULIC System QUANTITY Indications (white)**

Indicates digital percentage (0% to 106%) of hydraulic quantity.

**Note:** Quantity also displayed at each reservoir.

**3 HYDRAULIC System PRESSURE Indications (white)**

Indicates system pressure:

- Normal pressure – 3000 psi
- Maximum pressure – 3500 psi.

**Note:** When both pumps for a system are OFF, the indication may read hydraulic system reservoir pressure, normally less than 100 psi.

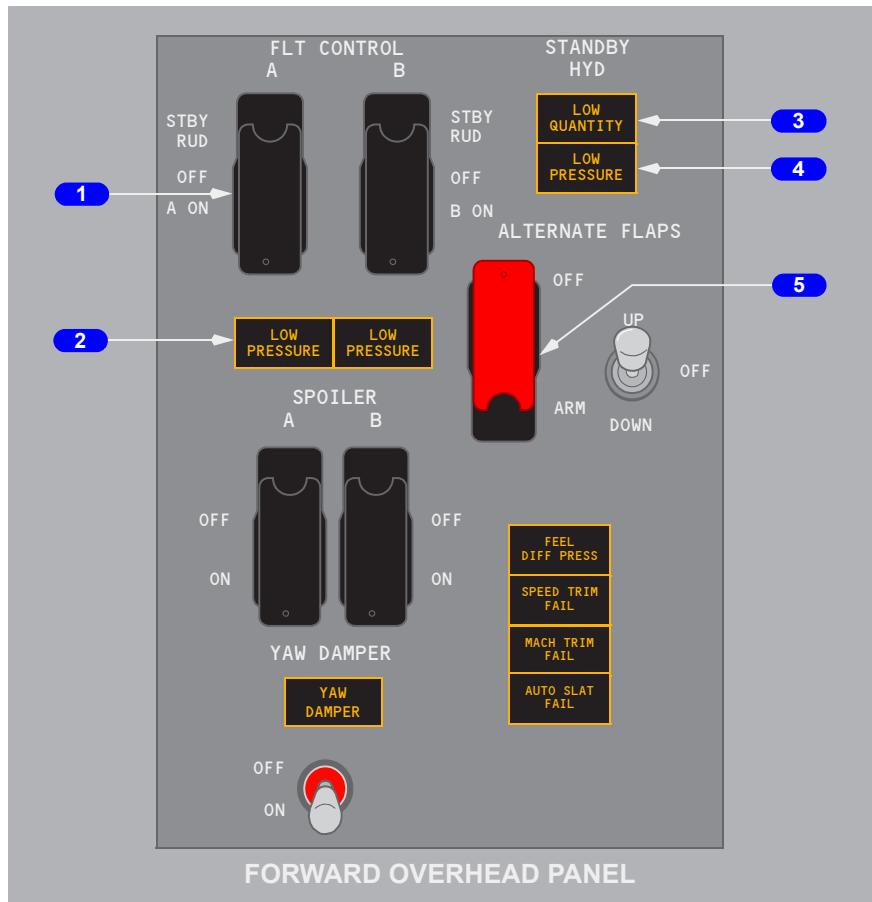
**4 REFILL Indication (RF) (white)**

Illuminated (white) – hydraulic quantity below 76%.

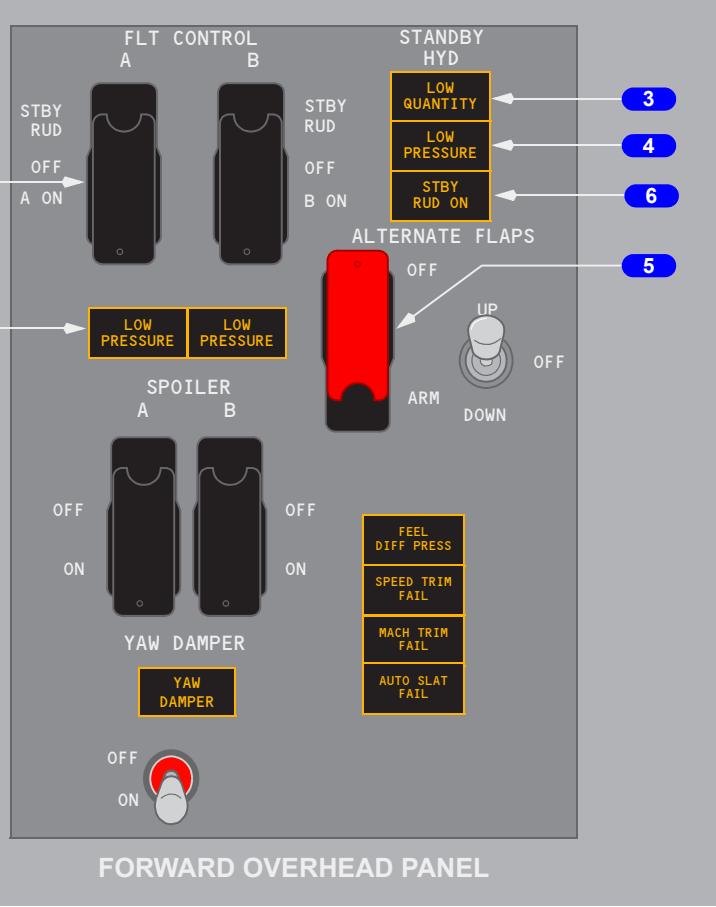
**Note:** Valid only when airplane is on ground with both engines shutdown or after landing with flaps up during taxi-in.

## Flight Control Panel

[737 modified rudder - not installed]



## [737 modified rudder - installed]

**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.

**3 STANDBY HYDRAULIC LOW QUANTITY Light**

Illuminated (amber) –

- indicates low quantity in standby hydraulic reservoir
- always armed.

**4 STANDBY HYDRAULIC LOW PRESSURE Light**

Illuminated (amber) –

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

**5 ALTERNATE FLAPS Master Switch**

OFF (guarded position) – normal operating position.

ARM – closes trailing edge flap bypass valve, activates standby pump, and arms ALTERNATE FLAPS position switch.

**6 STBY RUD ON Light****[737 modified rudder - installed]**

Illuminated (amber) - indicates the standby hydraulic system is commanded on to pressurize the standby rudder power control unit.

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## Hydraulics

### System Description

## Chapter 13

### Section 20

#### Introduction

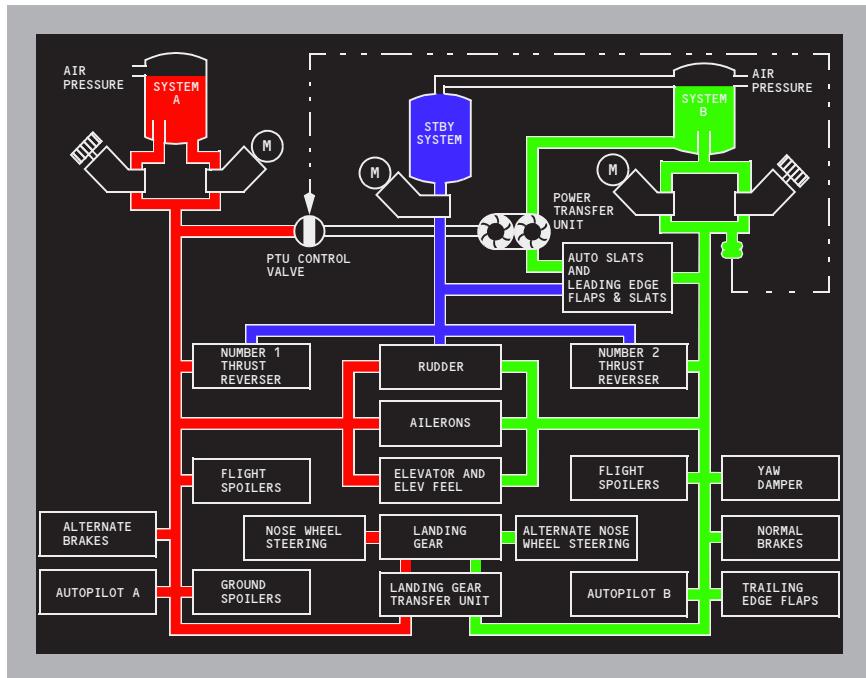
The airplane has three hydraulic systems: A, B and standby. The standby system is used if system A and/or B pressure is lost. The hydraulic systems power the following airplane systems:

- flight controls
- leading edge flaps and slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose wheel steering
- thrust reversers
- autopilots.

Either A or B hydraulic system can power all flight controls with no decrease in airplane controllability.

Each hydraulic system has a fluid reservoir located in the main wheel well area. System A and B reservoirs are pressurized by bleed air. The standby system reservoir is connected to the system B reservoir for pressurization and servicing. Pressurization of all reservoirs ensures positive fluid flow to all hydraulic pumps.

#### Hydraulic Power Distribution Schematic



## A and B Hydraulic Systems

Components powered by hydraulic systems A and B are:

- | <b>System A</b>                         | <b>System B</b>                         |
|---|---|
| • ailerons                              | • ailerons                              |
| • rudder                                | • rudder                                |
| • elevator and elevator feel            | • elevator and elevator feel            |
| • flight spoilers<br>(two on each wing) | • flight spoilers<br>(two on each wing) |
| • ground spoilers                       | • leading edge flaps and slats          |
| • alternate brakes                      | • normal brakes                         |
| • No. 1 thrust reverser                 | • No. 2 thrust reverser                 |
| • autopilot A                           | • autopilot B                           |
| • normal nose wheel steering            | • alternate nose wheel steering         |
| • landing gear                          | • landing gear transfer unit.           |
| • power transfer unit (PTU)             | • 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 4 times the fluid volume of the related electric motor-driven hydraulic pump.

The ENG 1 (system A) or ENG 2 (system B) pump ON/OFF switch controls the engine-driven pump output pressure. Positioning the switch to OFF isolates fluid flow from the system components. However, the engine-driven pump continues to rotate as long as the engine is operating. Pulling the engine fire switch shuts off the fluid flow to the engine-driven pump and deactivates the related LOW PRESSURE light.

### [Option - Abex electric motor driven hydraulic pumps]

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.

**[Option - Vickers electric motor driven hydraulic pumps]**

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, power is removed from the pump and the LOW PRESSURE 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 motor–driven 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 motor–driven pumps is 760 kgs/1675 lbs in the related main tank.**

Pressure switches, located in the engine–driven and electric motor–driven pump output lines, send signals to illuminate the related LOW PRESSURE light if pump output pressure is low. A check valve, located in each output line, isolates the related pump from the system. The related system pressure transmitter sends the combined pressure of the engine–driven and electric motor–driven pump 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 20% 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**

If a leak develops in either pump, line or component of system B, the quantity decreases until it indicates approximately zero and system B pressure is lost. The system B reservoir has one standpipe which supplies fluid to both the engine–driven pump and the electric motor–driven pump. However, with fluid level at the top of the standpipe, 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:

- system B engine–driven pump hydraulic pressure drops below limits
- airborne
- flaps are less than 15 but not up.

## Landing Gear Transfer Unit

The purpose of the landing gear transfer unit is to supply the volume of hydraulic fluid needed to raise the landing gear at the normal rate when system A engine–driven pump volume is lost. The system B engine–driven pump supplies the volume of 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 and uses a single electric motor–driven pump to power:

- thrust reversers
- rudder
- leading edge flaps and slats (extend only)
- standby yaw damper.

## 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.

**[737 modified rudder- installed]**

- illuminates the STBY RUD ON, Master Caution, and Flight Controls (FLT CONT) lights.

Positioning the ALTERNATE FLAPS master switch to ARM, (refer to Chapter 9, Flight Controls for a more complete explanation):

- activates the standby electric motor–driven pump
- closes the trailing edge flap bypass valve
- arms the ALTERNATE FLAPS position switch
- allows the standby system to power the leading edge flaps and slats and thrust reversers.

## Automatic Operation

Automatic operation is initiated when the following conditions exist:

- loss of system A or B, and
- flaps extended, and
- airborne, or wheel speed greater than 60 kts, and
- FLT CONTROL switch A or B Hydraulic System ON

**[737 modified rudder- installed]**

OR:

- the main PCU Force Fight Monitor (FFM) trips

Automatic operation:

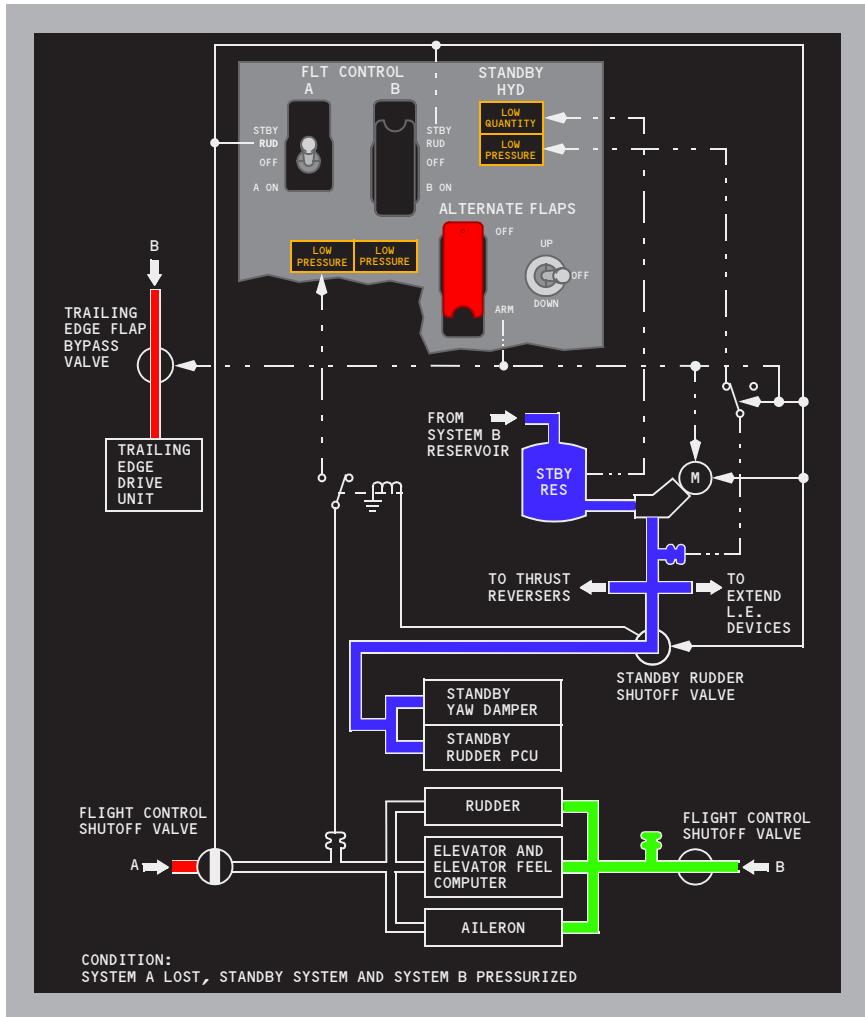
- activates the standby electric motor–driven pump
- opens the standby rudder shutoff valve
- allows the standby system to power the rudder and thrust reversers.

**[737 modified rudder- installed]**

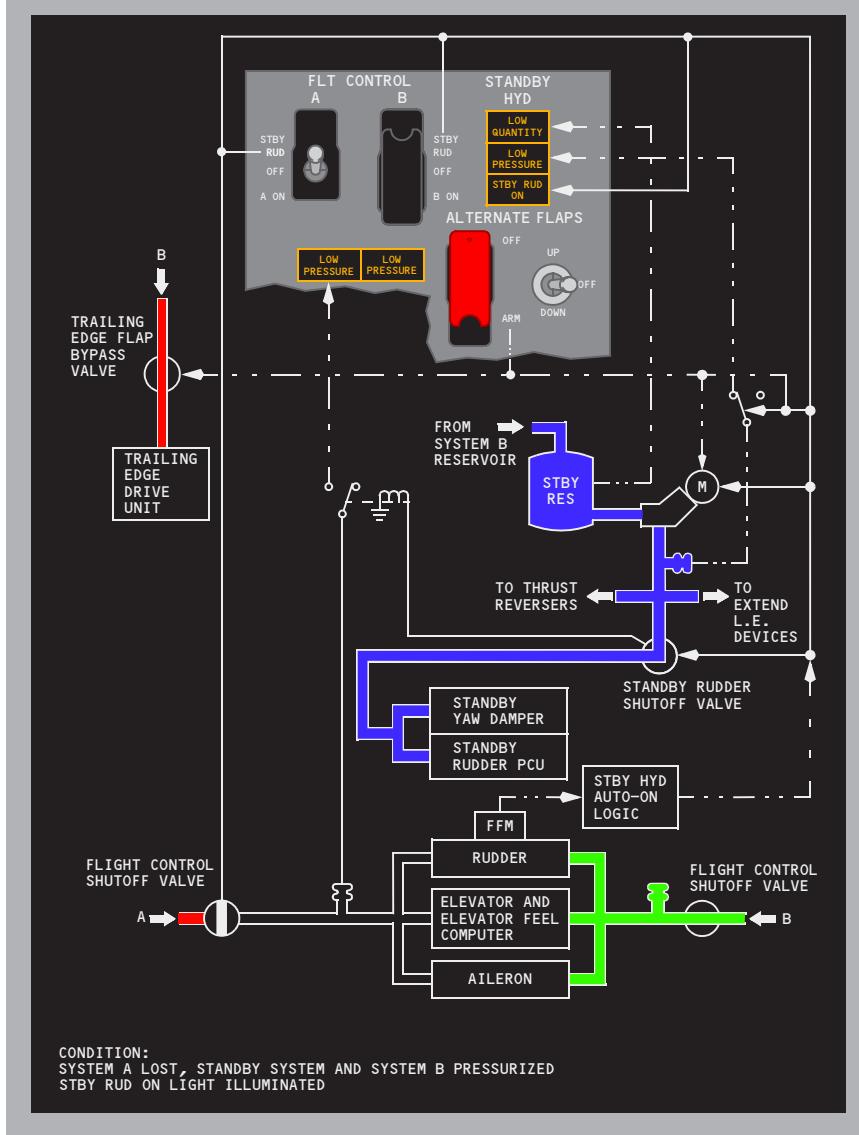
- illuminates the STBY RUD ON, Master Caution, and Flight Controls (FLT CONT) lights.

## Standby Hydraulic System Schematic

[737 modified rudder - not installed]



## [737 modified rudder - installed]



## 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 72% 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.

**Landing Gear****Table of Contents****Chapter 14****Section 0**

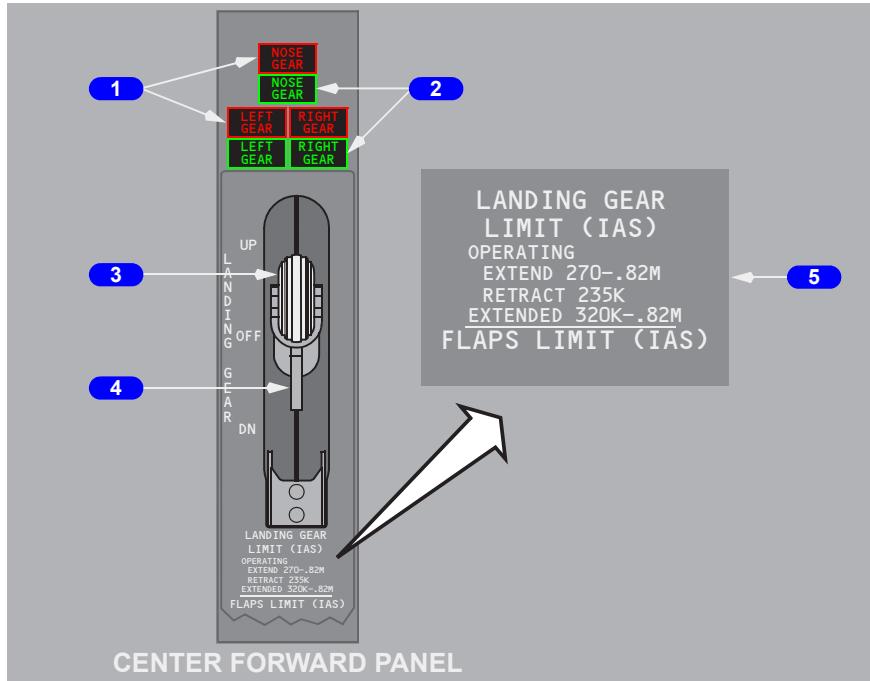
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## Landing Gear Controls and Indicators

## Chapter 14 Section 10

### Landing Gear Panel



#### 1 Landing Gear Indicator Lights (top)

Illuminated (red) –

- landing gear is not down and locked (with either or both forward thrust levers retarded to idle, and below 800 feet AGL).
- related landing gear is in disagreement with LANDING GEAR lever position (in transit or unsafe).

Extinguished -

- landing gear is up and locked with landing gear lever UP or OFF
- landing gear is down and locked with landing gear lever DN.

## 2 Landing Gear Indicator Lights (bottom)

Illuminated (green) – related gear down and locked.

**Note:** Landing gear warning horn is deactivated with all gear down and locked.

**Note:** Landing gear is down and locked as long as one green landing gear indicator light (center panel or overhead panel) for each gear is illuminated.

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

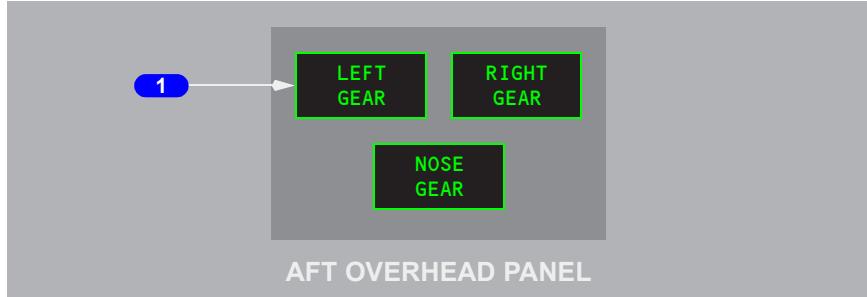
Allows LANDING GEAR lever to be raised, bypassing the landing gear lever lock.

## 5 LANDING GEAR LIMIT Speed Placard

Indicates maximum speed while operating landing gear and after gear extension.

## Landing Gear Indicator Lights

This is a redundant but separate set of landing gear indicator circuits and lights.



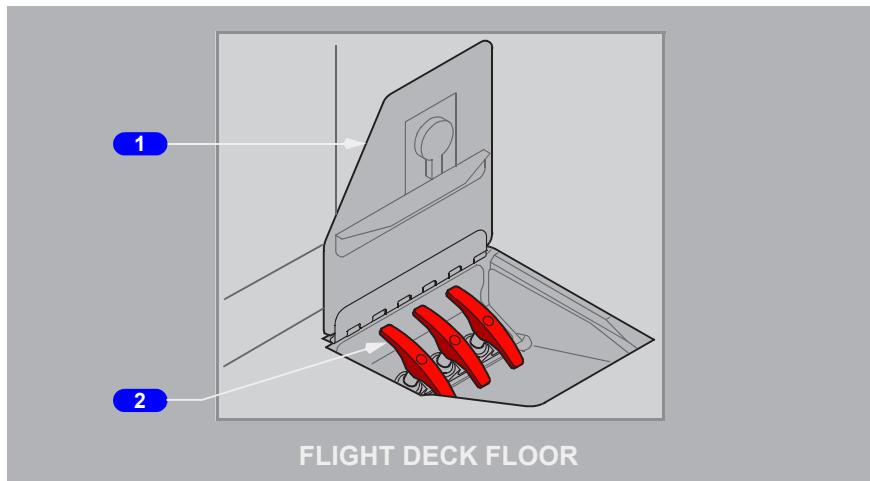
**1 Landing Gear Indicator Lights (overhead)**

Illuminated (green) – related gear down and locked.

**Note:** Landing gear warning horn is deactivated with all gear down and locked.

**Note:** Landing gear is down and locked as long as one green landing gear indicator light (center panel or overhead panel) for each gear is illuminated.

Extinguished – landing gear is not down and locked.

**Manual Gear Extension****1 Manual Extension Access Door**

Open –

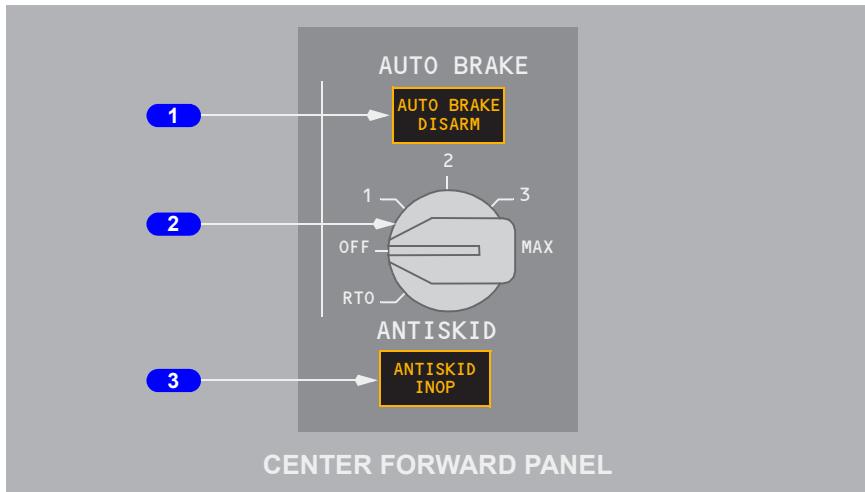
- manual landing gear extension is possible with landing gear lever in any position
- normal landing gear extension is still possible if hydraulic system A pressure is available
- landing gear retraction is disabled.

Closed – landing gear operate normally.

**2 Manual Gear Extension Handles**

Right main, nose, left main – Each landing gear uplock is released when related handle is pulled to its limit, approximately 24 inches (61 cm).

## Autobrake and Antiskid Controls



### **1 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.

Extinguished –

- AUTO BRAKE select switch set to OFF
- autobrake armed.

### **2 AUTO BRAKE Select Switch**

OFF – autobrake system deactivated.

1, 2, 3, or MAX –

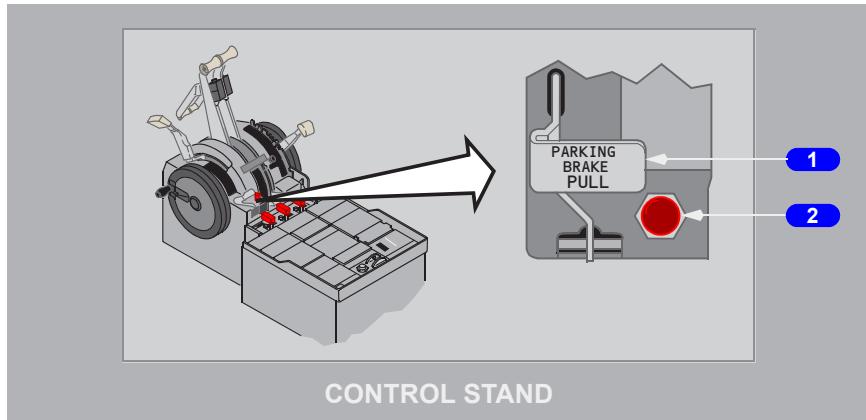
- selects desired deceleration rate for landing
- switch must be pulled out to select MAX deceleration.

RTO – automatically applies maximum brake pressure when thrust levers are retarded to idle at or above 90 knots.

**3 Antiskid Inoperative (ANTISKID INOP) Light**

Illuminated (amber) – a system fault is detected by antiskid monitoring system.

Extinguished – antiskid system operating normally.

**Parking Brake****1 PARKING BRAKE Lever**

Forward – parking brakes released.

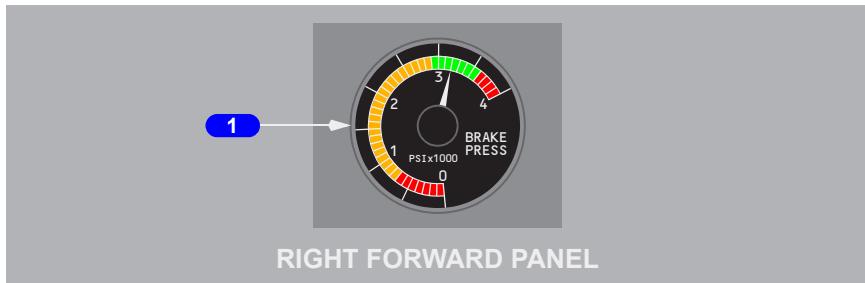
Aft – sets parking brakes when either Captain's or First Officer's brake pedals are fully depressed.

**2 Parking Brake Warning Light**

Illuminated (red) – parking brake is set (light operates from battery power).

Extinguished – parking brake is released.

## Hydraulic Brake Pressure Indicator



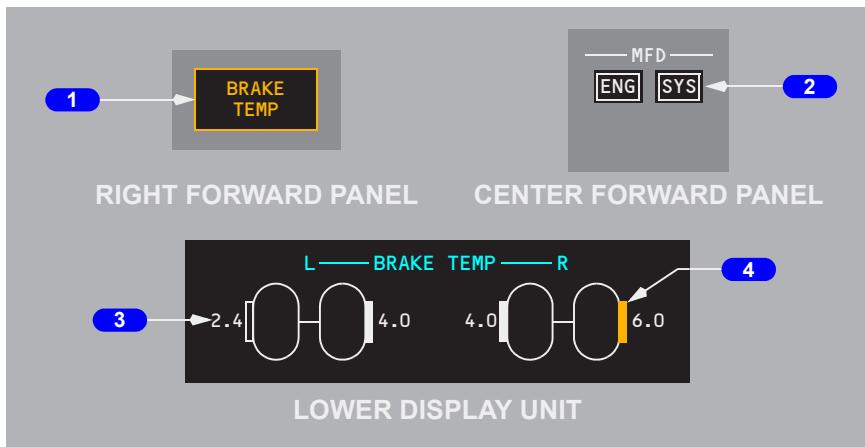
### 1 Hydraulic Brake Pressure (HYD BRAKE PRESS) Indicator

Indicates brake accumulator pressure:

- normal pressure – 3000 psi
- maximum pressure – 3500 psi
- normal precharge – 1000 psi.

## Brake Temperature Indicator

[Option]



### 1 Brake Temperature (BRAKE TEMP) Light

Illuminated (amber) -

- temperature of one or more brakes exceed 4.9
- extinguishes when a hot brake condition is no longer indicated on the display unit.

## 2 MFD System (SYS) Switch

Push – SYS

- displays brake temperature indications on lower DU; or the inboard DU if the MAIN PANEL DUs switch is placed to the INBD MFD position.
- second push removes indications from the respective DU.

## 3 Brake Temperature

Indicates a relative value of wheel brake temperature

- values range from 0.0 to 9.9
- displayed (white) - normal brake temperature range, 0.0 to 4.9
- displayed (amber) - high brake temperature, exceeds 4.9.

## 4 Brake Symbol

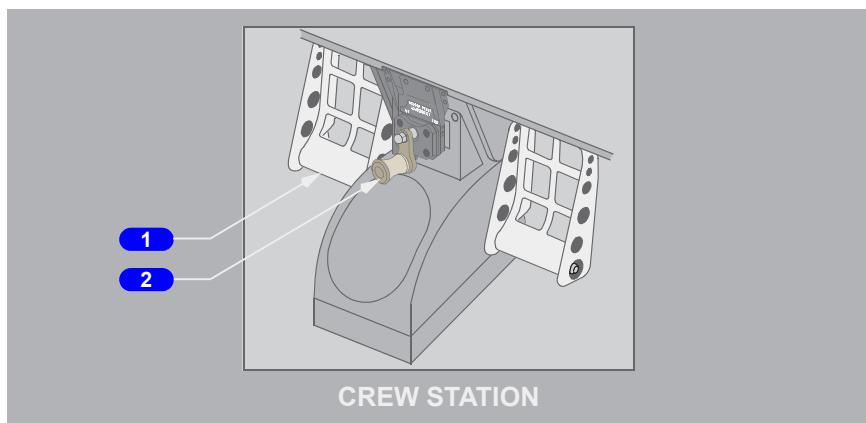
Displayed (blank) - indicates any brake less than 2.5.

Displayed (solid white) - indicates the hottest brake on each main gear truck, within the range of 2.5 to 4.9.

Displayed (solid amber) - indicates brake overheat condition on each wheel within the range of 5.0 to 9.9. Symbol remains until value is less than 3.5.

---

## Rudder/Brake Pedals



### 1 Rudder/Brake Pedals

Push full pedal – turns nose wheel up to 7 degrees in either direction.

Push top of pedal only – activates wheel brakes.

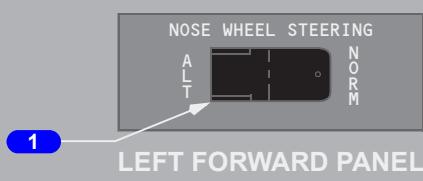
Refer to Chapter 9 Flight Controls for rudder description.

## 2 RUDDER PEDAL ADJUSTMENT Crank

AFT (counter-clockwise) – adjusts rudder pedals aft.

FWD (clockwise) – adjusts rudder pedals forward.

## Nose Wheel Steering Switch



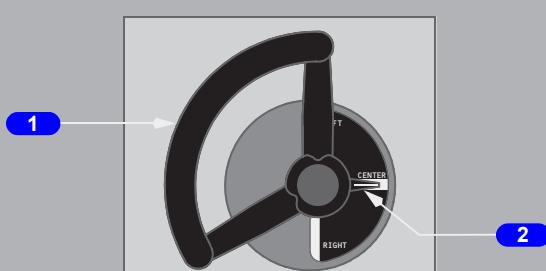
1 LEFT FORWARD PANEL

## 1 NOSE WHEEL STEERING Switch

ALT – hydraulic system B provides power for nose wheel steering.

NORM (guarded position) – hydraulic system A provides power for nose wheel steering.

## Nose Wheel Steering Wheel



CAPTAIN SIDE PANEL

## 1 Nose Wheel Steering Wheel

Rotate –

- turns nose wheel up to 78 degrees in either direction.

**Note:** Refer to Chapter 1 for effective steering angle and turning radius.

- 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.

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## Landing Gear System Description

## Chapter 14 Section 20

### Introduction

The airplane has two main landing gear and a single nose gear. Each main gear is a conventional two-wheel landing gear unit. 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.

#### [Option]

A brake temperature monitoring system displays each main landing gear brake temperature on the lower DU.

### 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.

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 gear.

Hydraulic pressure is removed from the landing gear system with the LANDING GEAR lever in the OFF position.

If a main landing gear tire is damaged during takeoff, it is possible that braking of the main gear wheels during retraction may be affected. A spinning tire with a loose tread must be stopped prior to entering the wheel well or it can cause damage to wheel well components. When a spinning tire with loose tread impacts a fitting in the wheel well ring opening, that gear stops retracting and free falls back to the down position. The affected gear cannot be retracted until the fitting is replaced.

## **Landing Gear Transfer Unit**

Hydraulic system B pressure is available for raising the landing gear through the landing gear transfer unit. 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.

## **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 remain 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.

With the manual extension access door open:

- manual landing gear extension is possible with the LANDING GEAR lever in any position
- normal landing gear extension is possible if hydraulic system A pressure is available
- landing gear retraction is disabled.

Following a manual extension, the landing gear may be retracted normally by accomplishing the following steps:

- close the manual extension access door
- move the LANDING GEAR lever to DOWN with hydraulic system A pressure available, and then
- position the LANDING GEAR lever to UP.

## 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. Nose wheel steering is powered by hydraulic system B when the NOSE WHEEL STEERING switch is placed to ALT. Nose wheel steering is powered only when the airplane is on the ground. In the event of a hydraulic leak downstream of the Landing Gear Transfer Unit, resulting in a loss of hydraulic system B fluid in the reservoir, a sensor closes the Landing Gear Transfer Valve and alternate steering will be lost.

Primary steering is controlled through the nose wheel steering wheel. Limited steering control is available through the rudder pedals. A pointer on the nose steering wheel assembly shows nose wheel steering position relative to the neutral setting. Rudder pedal steering is deactivated as the nose gear strut extends.

A lockout pin may be installed in the towing lever to depressurize nose wheel steering. This allows airplane pushback or towing without depressurizing the hydraulic systems.

## Brake System

Each main gear wheel has a multi-disc hydraulic powered brake. The brake pedals provide independent control of the left and right brakes. The nose wheels have no brakes. The brake system includes:

- normal brake system
  - alternate brake system
  - brake accumulator
  - antiskid protection
  - autobrake system
  - parking brake
- [Option]
- brake temperature indication

### 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 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.

Both normal and alternate brake systems provide skid, locked wheel, touchdown and hydroplane protection.

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.

With RTO selected, if the takeoff is rejected prior to wheel speed reaching 90 knots autobraking is not initiated, the AUTO BRAKE DISARM light does not illuminate and the RTO autobrake function remains armed. 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.

The RTO mode is automatically disarmed when both air/ground systems indicate the air mode. The AUTO BRAKE DISARM light does not illuminate and the AUTO BRAKE select switch remains in the RTO position. To reset or manually disarm the autobrake system, position the selector to OFF. If a landing is made with RTO selected (AUTO BRAKE select switch not cycled through OFF), no automatic braking action occurs and the AUTO BRAKE DISARM light illuminates two seconds after touchdown.

## 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
- the main wheels spin-up.

**Note:** Landing autobrake settings may be selected after touchdown prior to decelerating through 30 kts of ground speed. Braking initiates immediately if the above conditions are met.

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 deceleration level can be changed (without disarming the system) by rotating the selector. 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), except during the first 3 seconds after touchdown for landing
- 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 HYD BRAKE PRESS 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 CONFIG lights illuminate and the takeoff configuration warning horn sounds if either forward thrust lever is advanced for takeoff with the parking brake set.

## Air/Ground System

In flight and ground operation of various airplane systems are controlled by the air/ground system.

The system receives air/ground logic signals from six sensors, two on each landing 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 |
|----------------------|---|--|-------------|
| Emergency Exit Doors | Flight locks engaged when either engine N2 is more than 50% and 3 or more Entry/Service doors are closed. | Flight locks disengaged when either thrust lever is set below approximately 53 degrees.  | 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 automatic modes.  | Allows pressurization only at high power settings.   | 2           |

| SYSTEMS                    | NORMAL INFLIGHT OPERATION   | NORMAL ON GROUND OPERATION   | REFER TO CH |
|----------------------------|---|--|-------------|
| Ram Air                    | Ram Air fans operate whenever air conditioning packs operate.                                 | Ram Air fans 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           |
| Engine Idle Control        | Enables minimum flight idle.  | Enables minimum ground idle.   | 7           |
| Thrust Reverser            | Thrust reverse disabled.  | Thrust reverse enabled.  | 7           |
| APU Fire Horn              | Wheel well horn disabled.   | Wheel well horn enabled.   | 8           |
| Cargo Fire Protection      | Second extinguishing bottle timer enabled.  | Second extinguishing bottle timer disabled.  | 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           |

| SYSTEMS                    | NORMAL INFLIGHT OPERATION  | NORMAL ON GROUND OPERATION   | REFER TO CH |
|----------------------------|--|--|-------------|
| Flight Recorder            | Operates anytime electrical power is available.                        | Operates anytime electrical power is available and either engine is operating.                               | 10          |
| FMC                        | FMC position updated from GPS, DME or VOR/DME.                         | FMC position updated from GPS.   | 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 or alternate brakes for touchdown protection.          | Allows normal antiskid braking after wheel spin-up.  | 14          |
| Autobrake                  | Allows selection of landing mode.                                      | RTO mode available and landing mode may be selected after touchdown if wheel speed is greater than 30 knots. | 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          |

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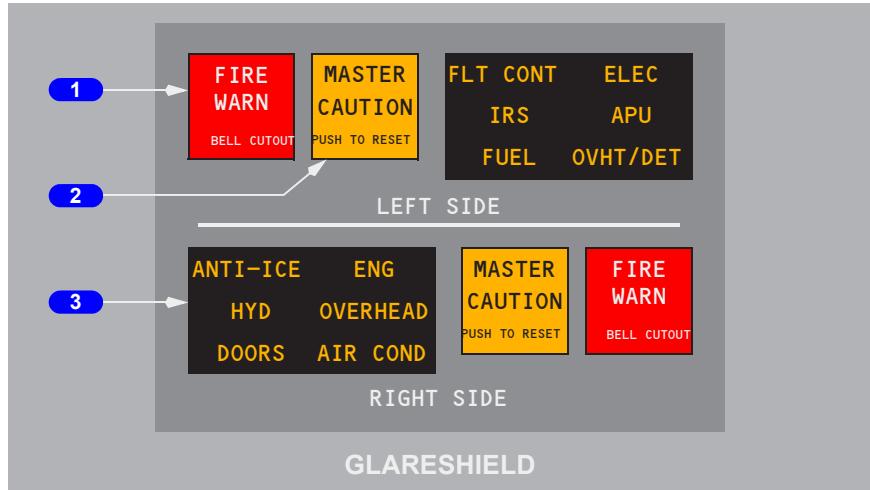
## Warning Systems

### Controls and Indicators

## Chapter 15

### Section 10

### Fire Warning and Master Caution System



#### 1 Master Fire Warning (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.

## Proximity Switch Electronic Unit Light

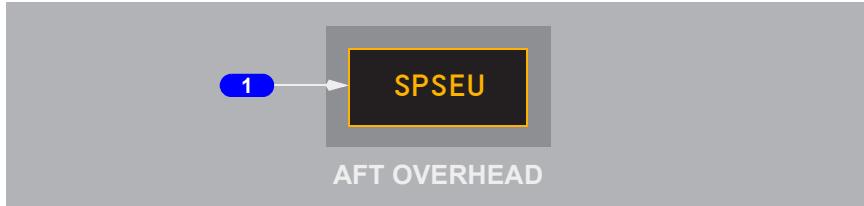


### 1 Proximity Switch Electronic Unit (PSEU) Light

Illuminated (amber) –

- on the ground –
  - a fault is detected in the PSEU, or
  - an overwing exit flight lock fails to disengage when commanded.
- in-flight –
  - inhibited from thrust lever advance for takeoff until 30 seconds after landing.

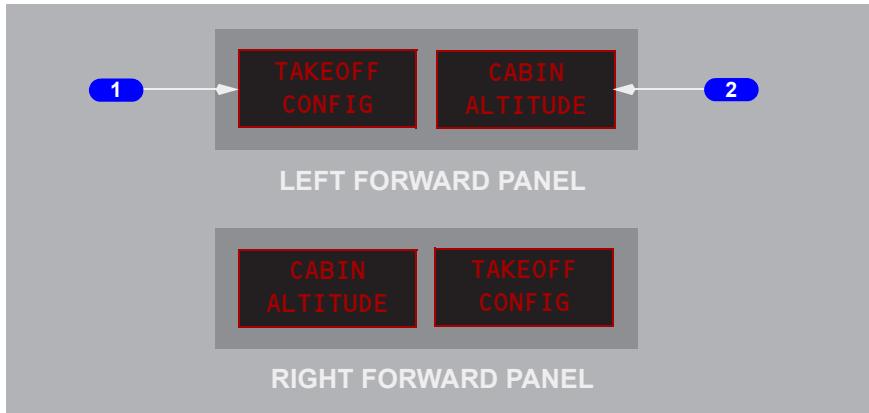
## Supplemental Proximity Switch Electronic Unit Light



## 1 Supplemental Proximity Switch Electronic Unit (SPSEU) Light

Illuminated (amber) – a mid-exit flight lock fails to respond when commanded.

## Takeoff Configuration and Cabin Altitude Warning Lights



### 1 Takeoff Configuration Warning Light

Illuminated (red) –

- activates on the ground as the throttles are advanced if the airplane is not configured correctly for takeoff
- activation is simultaneous with aural warning intermittent horn for TAKEOFF CONFIGURATION alert.

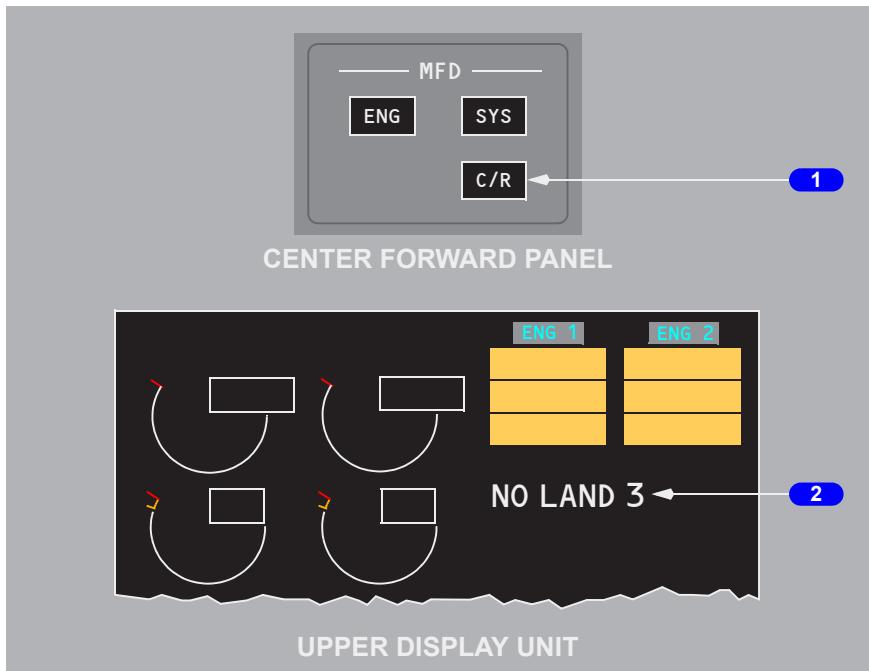
### 2 Cabin Altitude Warning Light

Illuminated (red) –

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

## Autoland Advisory Message Display

[Option – Fail-Operational Autoland Capability]



### 1 MFD Cancel/Recall (C/R) Switch

Push (once) – Cancels autoland advisory messages.

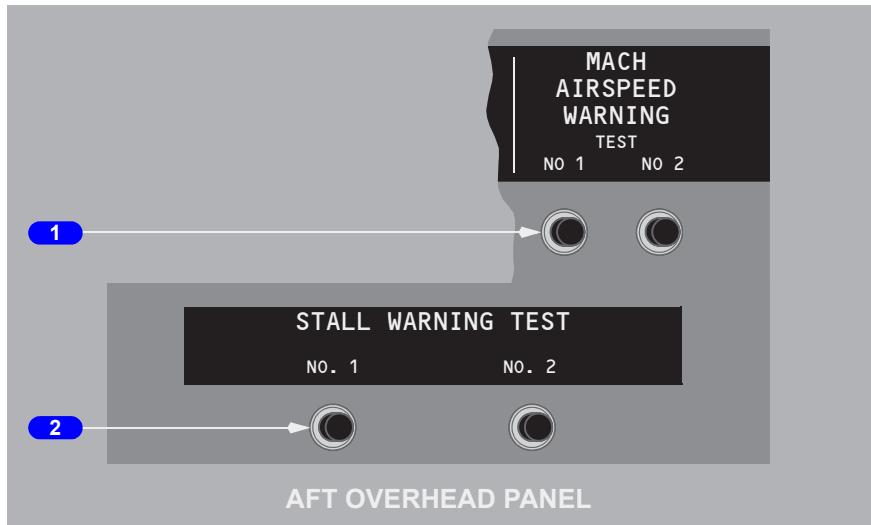
Push (again) – Recalls autoland advisory messages.

### 2 Autoland Advisory Message

An amber autoland advisory message appears on the upper engine display when a system fault affects autoland status. Two advisories are available:

- NO LAND 3 – the system is still capable of continuing to a safe landing. A system failure has occurred above Alert Height, and a green LAND 2 status annunciation appears on the Capt and F/O outboard display unit.
- NO AUTOLAND – the system is not capable of performing an automatic landing. A system failure has occurred above Alert Height, and an amber NO AUTOLAND status annunciation appears on the Capt and F/O outboard display unit.

## Mach/Airspeed Warning and Stall Warning Test Switches



### **1 MACH AIRSPEED WARNING TEST Switches**

Push – tests respective mach/airspeed warning system

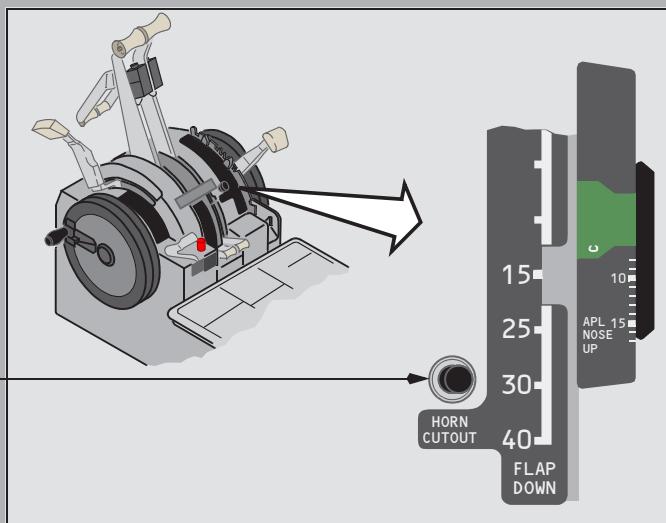
- clacker sounds
- inhibited while airborne.

### **2 STALL WARNING TEST Switches**

Push – on ground with AC power available: each test switch tests its respective stall management yaw damper (SMYD) computer. No.1 SMYD computer shakes Captain's control column, No.2 SMYD computer shakes First Officer's control column. Vibrations can be 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 up through 10 and above 200 feet RA.

**Note:** The aural indication cannot be silenced with the cutout switch at flaps greater than 10.

## Altitude Alert

[Option - EFIS/MAP]

1

ALT ALERT

ABOVE EACH PILOT'S  
ALTIMETER

### **1** Altitude Alert (ALT ALERT) Annunciation

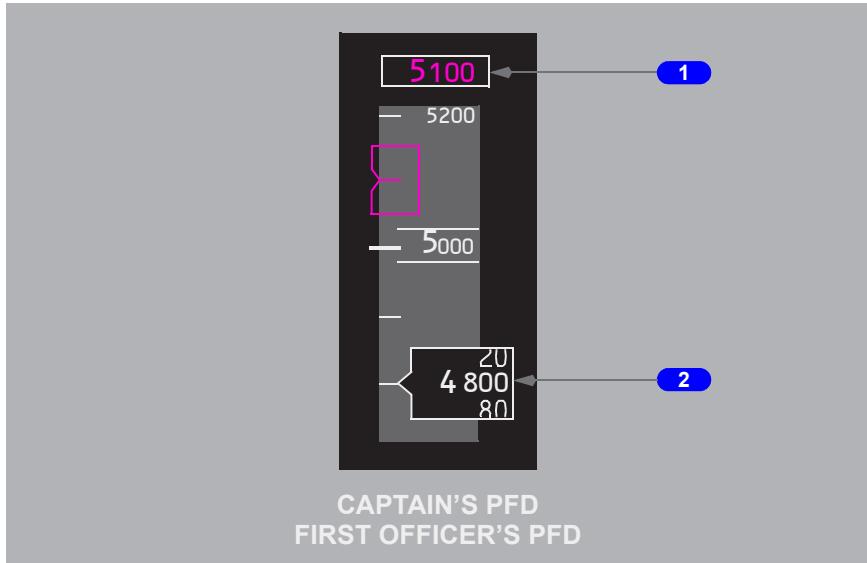
[Option - 300/900 Altitude alert]

One on each pilot's primary display above altimeter.

Displayed (amber):

- steady – acquisition alert:
  - 900 feet from MCP selected altitude
  - momentary tone also sounds
  - 300 feet from MCP selected altitude, ALT ALERT annunciation no longer shows.
- flashing – deviation alert:
  - deviation more than 300 feet from MCP selected altitude
  - 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.

[Option - PFD/ND]



### 1 Selected Altitude Alert

[Option - 300/900 Altitude alert]

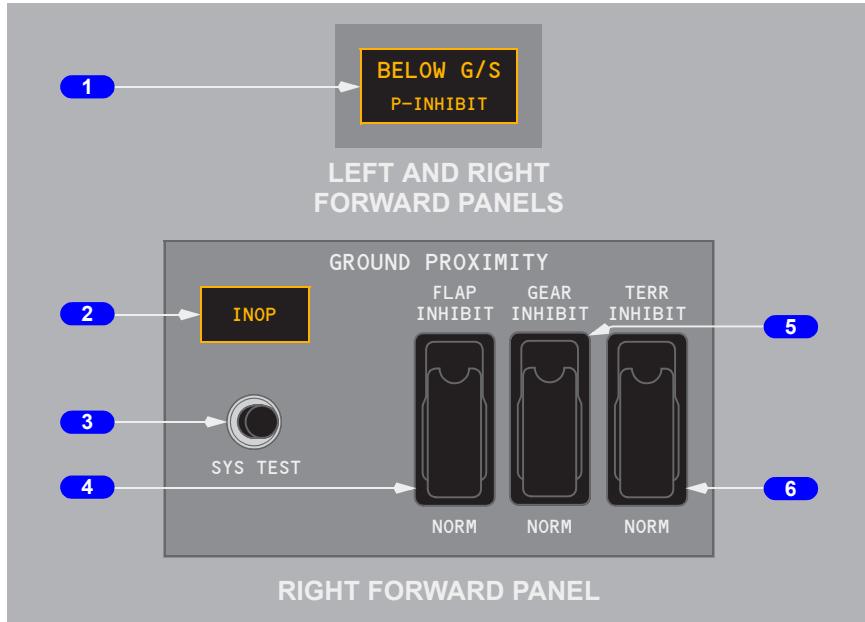
A white box shows around the selected altitude display between 900 feet and 300 feet before reaching the selected altitude.

**2 Current Altitude Alert****[Option - 300/900 Altitude alert]**

The white box around the current altitude display becomes bold between 900 feet and 300 feet before reaching the selected altitude.

The box turns amber and flashes for 300 feet to 900 feet deviation from the selected altitude.

---

**Ground Proximity Warning System (GPWS)****GPWS Controls****[Option - With gear inhibit switch]****1 BELOW Glide Slope (G/S) light**

Illuminated (amber) – below glide slope alert is active.

Push – inhibits ground proximity GLIDE SLOPE alert when below 1,000 feet radio altitude.

**2 Inoperative (INOP) light**

Illuminated (amber) – GPWS computer malfunction or power loss

- invalid inputs are being received from radio altimeter, ADIRU, ILS receiver, IRS, FMC, stall management computers, or EFIS control panel.

### 3 Ground Proximity System Test (SYS TEST) Switch

Push –

- momentarily on ground:
  - BELOW G/S and GPWS INOP lights illuminate
  - TERR FAIL and TERR TEST show on navigation displays
  - PULL UP and WINDSHEAR alerts illuminate
  - GLIDE SLOPE, PULL UP, and WINDSHEAR aurals sound
  - terrain display test pattern shows on navigation displays
  - CAUTION TERRAIN aural sounds and TERRAIN caution message shows on navigation displays.
- until self-test aurals begin, on ground, above indications always occur first, followed by these additional aurals, as described in section 15-20:
  - radio altitude based alerts
  - bank angle alert
  - approach callouts
  - windshear alert
  - look ahead terrain alerts
- system test inhibited in-flight.

### 4 Ground Proximity FLAP INHIBIT Switch

FLAP INHIBIT – inhibits ground proximity TOO LOW FLAPS alert.  
 NORM (guarded position) – Normal TOO LOW FLAPS alert active.

### 5 Ground Proximity GEAR INHIBIT Switch

**[Option - With gear inhibit switch]**

GEAR INHIBIT – inhibits ground proximity TOO LOW GEAR alert.  
 NORM (guarded position) – Normal TOO LOW GEAR alert active.

### 6 Ground Proximity Terrain Inhibit (TERR INHIBIT) Switch

TERR INHIBIT – inhibits look-ahead terrain alerts and terrain display.  
 NORM (guarded position) – Normal terrain alerts and terrain display active.

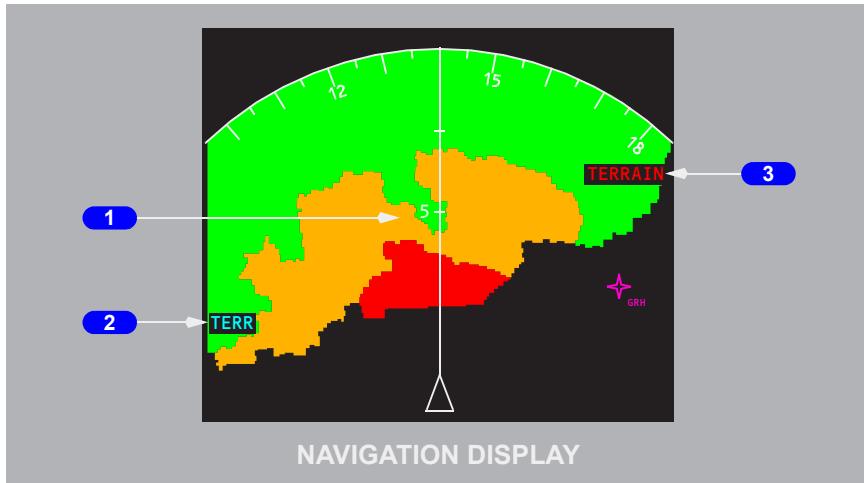
#### GPWS Terrain Display Select Switch



**1 Terrain (TERR) Display Select Switch**

Push –

- shows terrain data in expanded MAP, center MAP, expanded VOR, and expanded APP modes
- arms terrain data in PLN, center VOR, and center APP modes
- deselects weather radar display regardless of mode selector position
- second push deselects terrain display.

**Terrain Display****[Option - PFD/ND]****1 Terrain Display**

Color and density vary based on terrain height vs. airplane altitude:

- dotted green: terrain from 2,000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude
- dotted amber: terrain 500 feet (250 feet with gear down) below to 2,000 feet above the airplane's current altitude
- dotted red: terrain more than 2,000 feet above airplane's current altitude
- dotted magenta: no terrain data available
- solid amber: look-ahead terrain caution active
- solid red: look-ahead terrain warning active.

**Note:** In areas without terrain data, look-ahead terrain alerting and display functions not available. Radio altitude based terrain alerts function normally.

**Note:** Terrain more than 2,000 feet below airplane altitude or within 400 feet of nearest airport runway elevation does not show.

Automatically shows when:

- a look-ahead terrain alert occurs, and
- neither pilot has the terrain display selected, and
- in expanded MAP, center MAP, expanded VOR, or expanded APP modes.

Updates with a display sweep, similar to weather radar display.

## 2 Terrain Mode Annunciation

TERR (cyan) – Terrain display enabled (manual or automatic display).

## 3 TERRAIN Annunciation

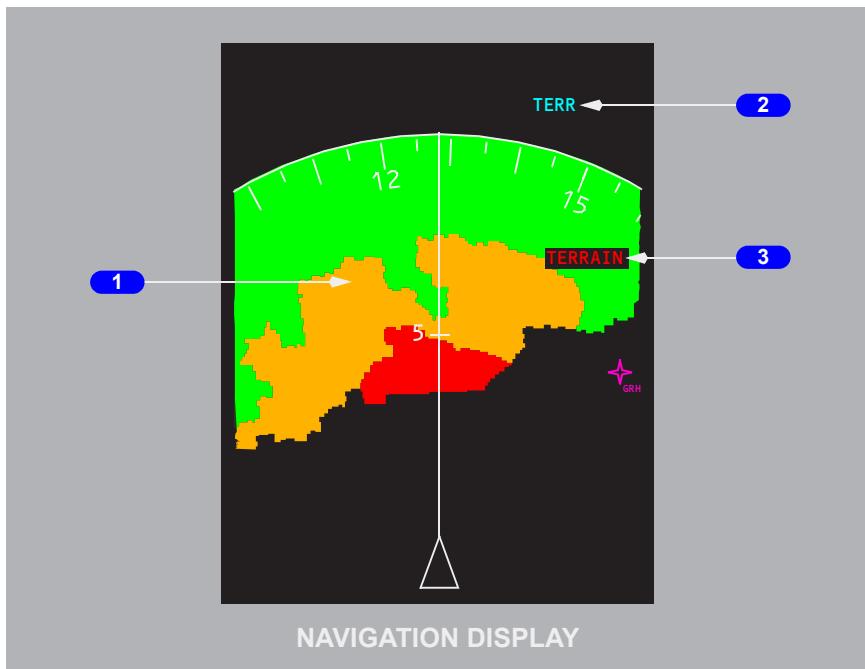
TERRAIN (amber) – look-ahead terrain caution alert active.

TERRAIN (red) – look-ahead terrain warning alert active.

Shows in all navigation display modes.

## Terrain Display

[Option - EFIS/MAP]



## 1 Terrain Display

Color and density vary based on terrain height vs. airplane altitude:

- dotted green: terrain from 2,000 feet below to 500 feet (250 feet with gear down) below the airplane's current altitude
- dotted amber: terrain 500 feet (250 feet with gear down) below to 2,000 feet above the airplane's current altitude
- dotted red: terrain more than 2,000 feet above airplane's current altitude
- dotted magenta: no terrain data available
- solid amber: look-ahead terrain caution active
- solid red: look-ahead terrain warning active.

**Note:** In areas without terrain data, look-ahead terrain alerting and display functions not available. Radio altitude based terrain alerts function normally.

**Note:** Terrain more than 2,000 feet below airplane altitude or within 400 feet of nearest airport runway elevation does not show.

Automatically shows when:

- a look-ahead terrain alert occurs, and
- neither pilot has the terrain display selected, and
- in expanded MAP, center MAP, expanded VOR, or expanded APP modes.

Updates with a display sweep, similar to weather radar display.

## 2 Terrain Mode Annunciation

TERR (cyan) – Terrain display enabled (manual or automatic display).

## 3 TERRAIN Annunciation

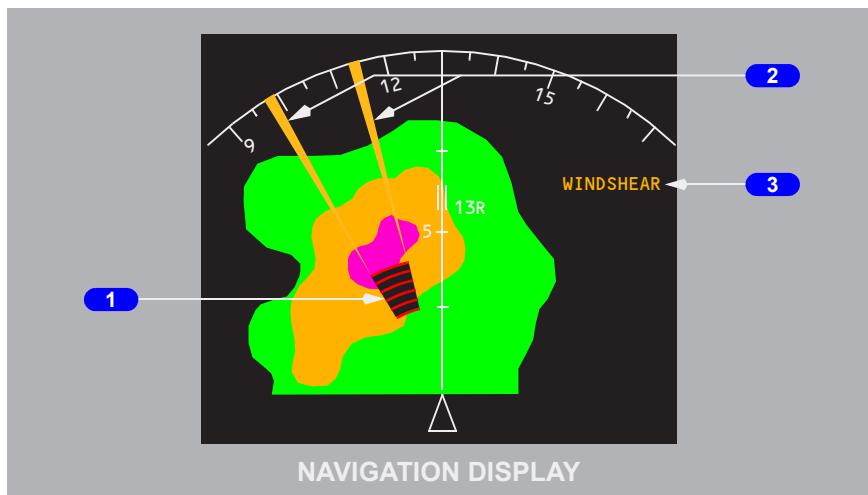
TERRAIN (amber) – look-ahead terrain caution alert active.

TERRAIN (red) – look-ahead terrain warning alert active.

Shows in all navigation display modes.

## Predictive Windshear Display and Annunciations

[Option - PFD/ND]



### 1 Predictive Windshear Symbol

Displayed (red and black) – Predictive windshear alert active.

Shows windshear location and approximate geometric size (width and depth).

Symbol, radials, and weather radar returns automatically show when:

- predictive windshear alert occurs, and
- neither pilot has WXR display selected, and
- in expanded MAP, center MAP, VOR, or APP modes.

When terrain display is active, weather radar display replaces terrain display.

### 2 Predictive Windshear Symbol Radials

Displayed (amber) – Predictive windshear alert active.

Extend from predictive windshear symbol to help identify location of windshear event

### 3 WINDSHEAR Annunciation

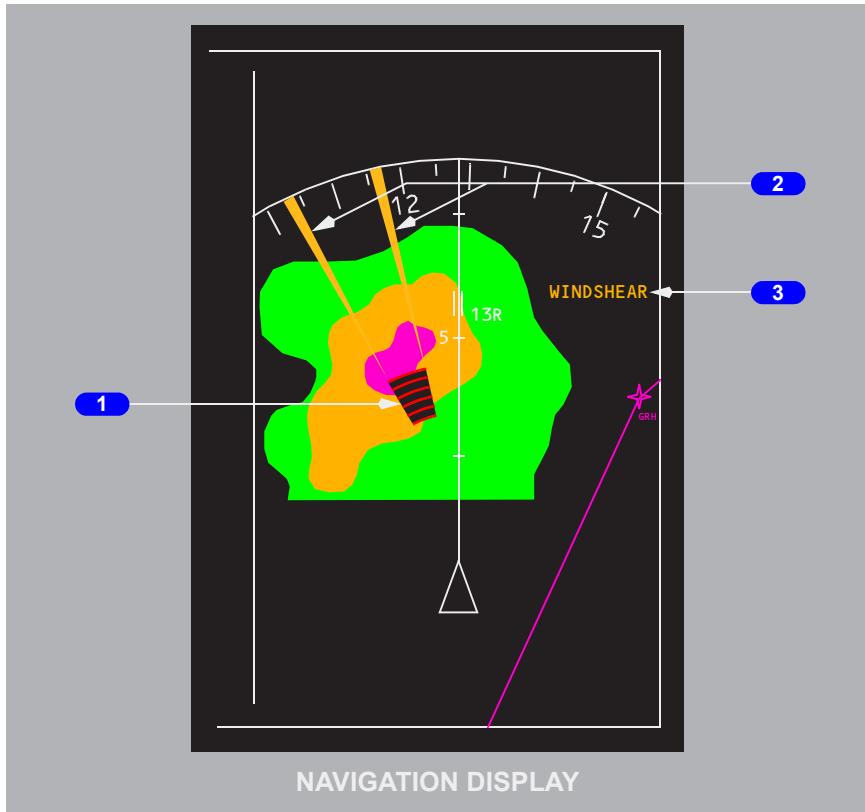
WINDSHEAR (amber) – predictive windshear caution active.

WINDSHEAR (red) – predictive windshear warning active.

Shows in all navigation display modes.

## Predictive Windshear Display and Annunciations

### [Option - EFIS/MAP]



#### **1 Predictive Windshear Symbol**

Displayed (red and black) – Predictive windshear alert active.

Shows windshear location and approximate geometric size (width and depth).

Symbol, radials, and weather radar returns automatically show when:

- predictive windshear alert occurs, and
- neither pilot has WXR display selected, and
- in expanded MAP, center MAP, VOR, or APP modes.

When terrain display is active, weather radar display replaces terrain display.

#### **2 Predictive Windshear Symbol Radials**

Displayed (amber) – Predictive windshear alert active.

Extend from predictive windshear symbol to help identify location of windshear event.

### 3 WINDSHEAR Annunciation

WINDSHEAR (amber) – predictive windshear caution active.

WINDSHEAR (red) – predictive windshear warning active.

Shows in all navigation display modes.

## TCAS Controls (Transponder Panel)

[Option - AlliedSignal 071-01503-2601 Transponder Panel]



AFT ELECTRONIC PANEL

[Option - Gables G6992-02 Transponder Panel]



AFT ELECTRONIC PANEL

### 1 Transponder Mode Selector

TA (traffic advisory) – enables the display of traffic advisory (TA) targets.

TA/RA (resolution advisory) – enables the display of traffic advisory (TA) and resolution advisory (RA) targets.

Intentionally  
Blank

## Warning Systems

### System Description

## Chapter 15

### Section 20

#### Introduction

Aural, tactile and visual warning signals alert the flight crew to conditions requiring action or caution in the operation of the airplane. The character of the signals varies, depending upon the degree of urgency or hazards involved. Aural, tactile, and visual signals are used singularly or in combination to simultaneously provide both warnings and information regarding the nature of the condition.

Mach/airspeed warnings, landing gear warnings, takeoff configuration warnings, windshear warnings, and ground proximity warnings are discussed in this section. Cabin altitude warning is discussed in this section and in the Air Systems chapter, and autopilot and autothrottle disconnect warnings are discussed in the Automatic Flight chapter. The conditions which excite the fire warning bell are discussed in the Fire Protection chapter.

Conditions which require the immediate attention of the flight crew are indicated by red warning lights located in the area of the pilots' primary field of vision. These lights indicate engine, wheel well, cargo, or APU fires; autopilot, autothrottle disconnects; and landing gear unsafe conditions.

Conditions which require the timely attention of the flight crew are indicated by amber caution lights.

Blue lights inform the flight crew of electrical power availability, valve position, equipment status, and flight attendant or ground communications. Blue lights are for information and do not require immediate flight crew attention. Some system blue lights indicate a transitional state by illuminating bright as valves or components reposition, then returning to a dim blue when the required configuration is reached.

Green lights indicate a fully extended configuration, e.g., landing gear and leading edge devices.

For specific information regarding red, amber, blue, and green lights refer to the appropriate systems chapters.

Stall warning is provided by a control column shaker on each control column.

Various aural signals call attention to warnings and cautions. An aural warning for airspeed limits is given by a clacker, the autopilot disconnect by a warning tone, takeoff configuration and cabin altitude by an intermittent horn, and landing gear positions by a steady horn. The fire warning by a fire warning bell. Ground proximity warnings and alerts, and 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.

When the MASTER CAUTION recall is pressed, all twelve system lights should illuminate while the press-to-test feature is held. If a system annunciator light does not illuminate, refer to the dispatch deviation procedures guide (DDPG).

## **System Annunciator Lights**

Two system annunciator light panels are located on the glare shield. The annunciator light panels include only those systems located on the forward overhead, aft overhead, and fire control panels. If a caution condition exists, the appropriate system annunciator(s) and MASTER CAUTION lights illuminate.

**System Annunciators and Related Amber Lights – Left Side**

| FLT CONT        |  |  | ELEC              |
|-----------------|--|--|-------------------|
| LOW QUANTITY    |  |  | DRIVE             |
| LOW PRESSURE    |  |  | STANDBY PWR OFF   |
| FEEL DIFF PRESS |  |  | TRANSFER BUS OFF  |
| SPEED TRIM FAIL |  |  | SOURCE OFF        |
| MACH TRIM FAIL  | <b>FLT CONT</b><br><b>IRS</b><br><b>FUEL</b> |  | TR UNIT           |
| AUTO SLAT FAIL  | <b>ELEC</b><br><b>APU</b><br><b>OVHT/DET</b> |  | BATTERY DISCHARGE |
| YAW DAMPER      |  |  | ELEC              |
| STBY RUD ON     |  |  |                   |
| IRS             |  |  | APU               |
| FAULT           |  |  | LOW OIL PRESSURE  |
| ON DC           |  |  | FAULT             |
| DC FAIL         |  |  | OVERSPEED         |
| GPS             |  |  |                   |
| FUEL            |  |  | OVHT/DET          |
| LOW PRESSURE    |  |  | ENGINE 1 OVERHEAT |
| FILTER BYPASS   |  |  | ENGINE 2 OVERHEAT |
|                 |  |  | APU DET INOP      |

**System Annunciators and Related Amber Lights – Right Side**

[Option - 737-800/900, ICE DETECTOR, AIRSTAIR, ELT, HIGH ALTITUDE LANDING - INOP, lavatory SMOKE detector]

|  |                           |          |   |
|--|---------------------------|----------|---|
| ANTI-ICE   |                           |          | ENG   |
| WINDOW OVERHEAT<br>PITOT HEAT<br>COWL ANTI-ICE<br>ICE DETECTOR                                   |                           |          | REVERSER<br>EEC ALTN MODE<br>ENGINE CONTROL   |
| HYD  |                           |          | OVERHEAD  |
| OVERHEAT<br>LOW PRESSURE   | ANTI-ICE                  | ENG      | ELT<br>EQUIP COOLING-OFF<br>EMER EXIT<br>LIGHTS-NOT ARMED<br>FLIGHT<br>RECORDER-OFF<br>PASS OXY-ON<br>PSEU<br>SMOKE                             |
| DOORS  | HYD                       | OVERHEAD | AIR COND  |
| FWD/AFT ENTRY<br>AIRSTAIR<br>EQUIP<br>FWD/AFT CARGO<br>FWD/AFT SERVICE<br>LEFT/RIGHT<br>OVERWING | RIGHT SIDE<br>GLARESHIELD |          | ZONE TEMP<br>DUAL BLEED<br>PACK<br>WING-BODY<br>OVERHEAT<br>BLEED TRIP OFF<br>AUTO FAIL<br>OFF SCHED DESCENT<br>HIGH ALTITUDE<br>LANDING - INOP |

## Warning Systems

### Intermittent Cabin Altitude/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 warning horn sounds if:

- trailing edge flaps are not in the flaps 1 through 25 takeoff range, or
- trailing edge flaps are in a skew or asymmetry condition, or have uncommanded motion, or
- leading edge devices are not configured for takeoff or have uncommanded motion, or
- speed brake lever is not in the DOWN position, or
- spoiler control valve is open providing pressurized hydraulic fluid to the ground spoiler interlock valve, or
- parking brake is set, or
- stabilizer trim not set in the takeoff range.

The Cabin Altitude Warning Horn activates when cabin altitude exceeds 10,000 feet. An intermittent warning horn is heard. The Cabin Altitude Warning Horn may be silenced by momentarily pressing the ALT HORN CUTOUT switch on the Cabin Altitude Panel.

**WARNING: The Cabin Altitude and Takeoff Configuration Warnings use the same intermittent tone when activated.**

### 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, and below 800 feet AGL).

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 a landing is attempted 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 up through 10 –

- altitude below 800 feet RA, when either forward thrust lever set between idle and approximately 20 degrees thrust lever angle or an engine not operating and the other thrust lever less than 34 degrees. The landing gear warning horn can be silenced (reset) with the landing gear warning HORN CUTOUT switch
- if the airplane descends below 200 feet RA, the warning horn cannot be silenced by the warning HORN CUTOUT switch.

Flaps 15 through 25 –

- either forward thrust lever set below approximately 20 degrees or an engine not running, and the other thrust lever less than 34 degrees; the landing gear warning horn cannot be silenced with the landing gear warning HORN CUTOUT switch.

Flaps greater than 25 –

- 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.

## Proximity Switch Electronic Unit (PSEU)

The PSEU monitors the following systems:

- takeoff configuration warnings
- landing configurations warnings
- landing gear
- air/ground sensing.

The PSEU, its sensors, and its input signals are monitored for internal faults. When designated faults are detected, a PSEU light on the aft overhead panel illuminates, and the OVERHEAD system annunciator light and MASTER CAUTION lights illuminate. The PSEU light can be reset following a maintenance BITE check or repair of the cause of the fault.

The PSEU light is inhibited:

- in flight
- when the thrust levers are advanced toward takeoff power
- for 30 seconds after landing.

## 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.

### [Option - Airspeed Indicator, 737-600/700/800/900]

The airspeed indicator displays red warning bands indicating maximum and minimum airspeeds. Amber bands indicate maximum and minimum maneuvering airspeeds. The top of the lower amber band indicates the minimum maneuver speed. It is the slowest speed that provides full maneuvering: 0.3 g maneuver margin ( $40^\circ$  bank) to stick shaker (below approximately 20,000 ft.) or initial buffet (above approximately 20,000 ft.).

### [Option - Airspeed Indicator, 737-900ER]

The airspeed indicator displays red warning bands indicating maximum and minimum airspeeds. Amber bands indicate maneuver capability. The top of the lower amber band indicates the minimum maneuver speed for full maneuver capability. This speed provides 0.3 g maneuver margin ( $40^\circ$  bank) to stick shaker (below approximately 20,000 feet) or initial buffet (above approximately 20,000 feet). As airspeed is decreased below the top of the amber band, maneuver capability decreases. In 1 g flight, the speed in the middle of the amber band provides adequate capability ( $30^\circ$  bank). The bottom of the amber band (top of the barber pole) corresponds to stick shaker or initial buffet onset speed, and increases with g loading.

When either an overspeed condition or a system test occurs, the ADIRU transmits a signal to the aural warning module, sounding the clacker. The system can only be tested on the ground.

## 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 stall management yaw damper (SMYD) computers determine when stall warning is required based upon:

- alpha vane angle of attack outputs
- ADIRU outputs

- anti-ice controls
- wing configurations
- air/ground sensing
- thrust
- FMC outputs.
- mach compensation

The SMYD computers provide outputs for all stall warning to include stick shaker and signals to the pitch limit indicator and airspeed displays and 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.

## Autoland Advisory Messages

### [Option – Fail-Operational Autoland Capability]

When a system failure is detected that affects autoland status, an advisory message is displayed on the upper engine display. Two advisories, NO LAND 3 and NO AUTOLAND, are available. Only one advisory message can be displayed at one time. A cancel/recall switch, located on the MFD panel, controls the display and recall of the advisory messages.

The NO LAND 3 advisory will be annunciated when a failure has occurred above Alert Height and the system is still capable of continuing to a safe landing. With this advisory, LAND 2 will be the resulting autoland status annunciation displayed following dual autopilot engagement on approach.

The NO AUTOLAND advisory is displayed any time above the Alert Height to notify the crew a failure has occurred and the system is unable to perform an automatic landing.

---

## Altitude Alerting System

### [Option - EFIS/MAP, 300/900 altitude alert]

Altitude alerting occurs when approaching or departing the MCP-selected altitude. Altitude alerting is inhibited when trailing edge flaps are extended to 25 or greater, or while G/S is captured.

## Acquisition Alerting

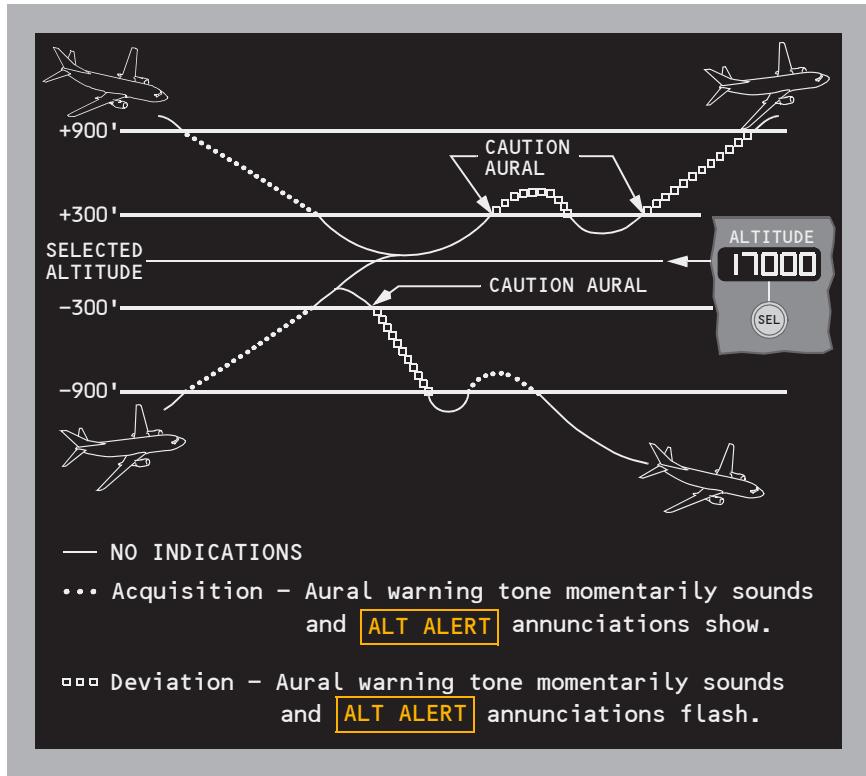
900 feet before reaching the selected altitude, both ALT ALERT annunciations show and a momentary tone sounds. At 300 feet from selected altitude, the ALT ALERT annunciations no longer show.

## Deviation Alerting

When deviating by 300 feet from the selected altitude, a momentary tone sounds and the ALT ALERT annunciations 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



## Altitude Alerting System

### [Option - PFD/ND, 300/900 altitude alert]

Altitude alerting occurs when approaching or departing the MCP-selected altitude. Altitude alerting is inhibited when trailing edge flaps are extended to 25 or greater, or while G/S is captured.

## Acquisition Alerting

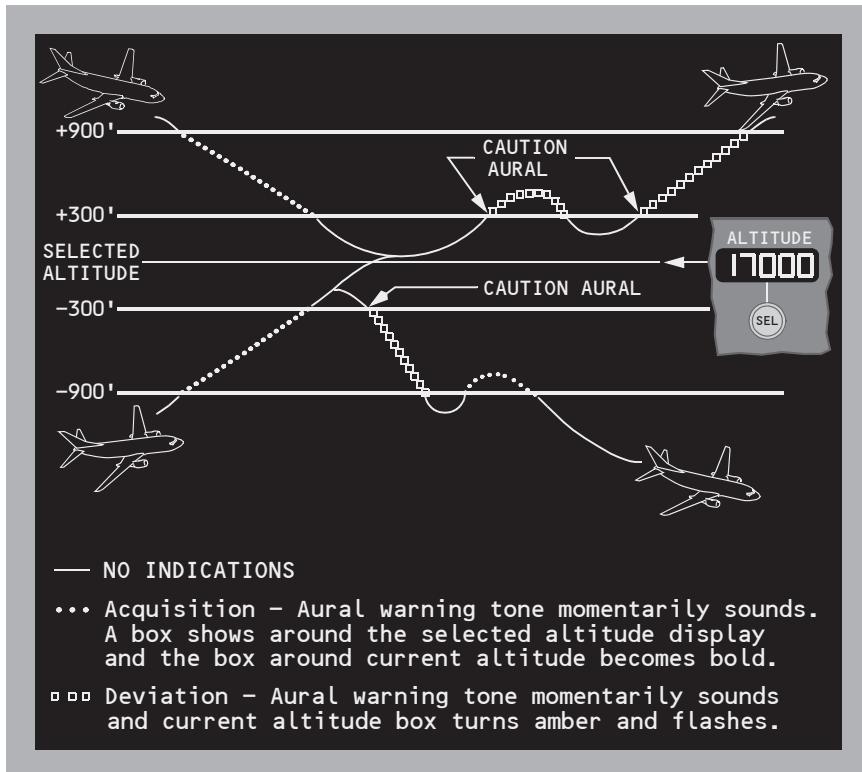
900 feet before reaching the selected altitude, a white box shows around the selected altitude display and the box around the current altitude becomes bold. A momentary tone sounds. At 300 feet from selected altitude, the selected altitude box no longer shows.

## Deviation Alerting

When deviating by 300 feet from the selected altitude, a momentary tone sounds and the current altitude box turns amber and begins to flash. The amber 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 Alerts

The GPWS provides alerts for potentially hazardous flight conditions involving imminent impact with the ground.

The GPWS monitors terrain proximity using an internal world wide terrain data base. Proximate terrain data shows on the navigation display. If there is a potential terrain conflict, alerts are provided based on estimated time to impact. These alerts are "look-ahead terrain alerts."

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

- excessive descent rate
- excessive terrain closure rate
- altitude loss after takeoff or go-around
- unsafe terrain clearance when not in the landing configuration
- excessive deviation below an ILS glide slope

### [Option - IAN]

- excessive deviation below glidepath

These alerts are "radio altitude based alerts."

Ground proximity alerts are accompanied by voice aural alerts and the PULL UP annunciation on the attitude indicators or, for deviation below glide slope alert, the BELOW G/S light.

**Note:** Terrain ahead of the airplane may exceed available climb performance. A ground proximity alert does not guarantee terrain clearance.

Look-ahead terrain alerts and radio altitude based alerts are prioritized based on the level of hazard and the required flight crew reaction time. Look-ahead terrain alerts and radio altitude based alerts are inhibited by an actual windshear warning (airplane in windshear).

## Look-Ahead Terrain Alerting

The GPWS terrain data base contains detailed terrain data near major airports, and data in lesser detail for areas between airports. Terrain within 2,000 feet of airplane barometric altitude shows on the navigation display. The terrain data is not designed to be an independent navigation aid.

**Note:** The GPWS terrain data base, look-ahead terrain alerting, and terrain display do not account for man made obstructions.

The terrain display is generated from a data base contained in the GPWS computer and correlated to GPS position.

Terrain and weather radar cannot show together on a display. If one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps. All other displays (TCAS, LNAV routing, etc.) can show with terrain data.

Look-ahead terrain alerts are based on the airplane's position, barometric altitude, vertical flight path, and ground speed.

### Look Ahead Terrain Alerts

| AURAL ALERT                   | VISUAL ALERT  | DESCRIPTION   |
|-------------------------------|---|---|
| TERRAIN<br>TERRAIN<br>PULL UP | PULL UP on both attitude indicators<br><br>Red TERRAIN message on navigation display (all modes)<br><br>Solid red terrain on navigation display | 20 to 30 seconds from projected impact with terrain shown solid red on the navigation display (in expanded MAP, center MAP, expanded VOR, or expanded APP modes only).<br><br>Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.   |
| CAUTION TERRAIN               | Amber TERRAIN message on navigation display (all modes)<br><br>Solid amber terrain on navigation displays                                       | 40 to 60 seconds from projected impact with terrain shown solid amber on the navigation display (in expanded MAP, center MAP, expanded VOR, or expanded APP modes only).<br><br>Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert. |
| TOO LOW, TERRAIN              | PULL UP on both attitude indicators   | Descent below unsafe radio altitude while too far from any airport in the terrain database.<br><br>Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.  |

## Radio Altitude Based Alerts

| AURAL ALERT         | VISUAL ALERT                        | DESCRIPTION  |
|---------------------|-------------------------------------|--|
| PULL UP             | PULL UP on both attitude indicators | <p>Follows SINK RATE alert if descent rate becomes severe.</p> <p>Follows radio altitude based TERRAIN alert if excessive terrain closure rate continues and landing gear and/or flaps are not in landing configuration.</p>                           |
| TERRAIN             | PULL UP on both attitude indicators | Excessive terrain closure rate.  |
| DON'T SINK          | PULL UP on both attitude indicators | Excessive altitude loss after takeoff or go-around.  |
| GLIDE SLOPE         | BELOW G/S<br>P-INHIBIT lights       | <p>Deviation below glide slope. Volume and repetition rate increase as deviation increases.</p> <p>Pushing the ground proximity BELOW G/S P-INHIBIT light cancels or inhibits the alert below 1,000 feet RA.</p>                                       |
| SINK RATE           | PULL UP on both attitude indicators | Excessive descent rate.  |
| TOO LOW,<br>FLAPS   | PULL UP on both attitude indicators | <p>Unsafe terrain clearance at low airspeed with flaps not in a normal landing position.</p> <p>Pushing the ground proximity flap inhibit switch to FLAP INHIBIT inhibits the alert.</p>   |
| TOO LOW,<br>GEAR    | PULL UP on both attitude indicators | <p>Unsafe terrain clearance at low airspeed with landing gear not down.</p> <p>Pushing the ground proximity gear inhibit switch to GEAR INHIBIT inhibits the alert.</p>  |
| TOO LOW,<br>TERRAIN | PULL UP on both attitude indicators | Unsafe terrain clearance at high airspeed with either landing gear not down or flaps not in landing position. Follows DON'T SINK if another descent is initiated after initial alert, before climbing to the altitude where the initial descent began. |

## Windshear Alerts

Windshear alerts are available during takeoff, approach, and landing:

- The GPWS provides a warning when the airplane is in a windshear.
- The weather radar provides alerts for excessive windshear ahead of the airplane. These are “predictive windshear alerts.”

Windshear warnings are accompanied by WINDSHEAR on the attitude indicators and voice aural alerts.

Windshear cautions are accompanied by a voice aural alert.

Windshear alerts are prioritized based on the level of hazard and the required flight crew reaction time. Predictive windshear alerts are inhibited by an actual windshear warning (airplane in windshear), look-ahead terrain alerts, or radio altitude based alerts.

### Windshear Warning (Airplane in Windshear)

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

### Predictive Windshear Alerts

The weather radar uses radar imaging to detect disturbed air prior to entering a windshear.

**Note:** The weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter.

**Note:** The weather radar detects microbursts and other windshears with similar characteristics. The weather radar does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.

| AURAL ALERT                | VISUAL ALERT   | DESCRIPTION   |
|----------------------------|--|---|
| WINDSHEAR AHEAD            | Red WINDSHEAR on both attitude indicators<br><br>RED windshear symbol on navigation display<br><br>Red WINDSHEAR message on navigation display (all modes) | Windshear close to and directly ahead of the airplane detected by the weather radar.<br><br>Enabled during takeoff, below 1,200 feet RA.<br><br>Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, expanded VOR or expanded APP modes only).           |
| GO AROUND, WINDSHEAR AHEAD | Red WINDSHEAR on both attitude indicators<br><br>RED windshear symbol on navigation display<br><br>Red WINDSHEAR message on navigation display (all modes) | Windshear within 1.5 miles and directly ahead of the airplane detected by the weather radar.<br><br>Enabled during approach, below 1,200 feet RA.<br><br>Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, expanded VOR or expanded APP modes only).  |
| MONITOR RADAR DISPLAY      | RED windshear symbol on navigation display<br><br>Amber WINDSHEAR message on navigation display (all modes)  | Windshear within 3 miles and ahead of the airplane detected by the weather radar.<br><br>Enabled during takeoff and approach, below 1,200 feet RA.<br><br>Predictive windshear symbol on the navigation display shows windshear position (expanded MAP, center MAP, expanded VOR or expanded APP modes only). |

The weather radar automatically begins scanning for windshear when:

- thrust levers set for takeoff, even if engine is off or IRS not aligned, or
- in flight below 2,300 feet RA (predictive windshear alerts are issued below 1,200 feet RA).

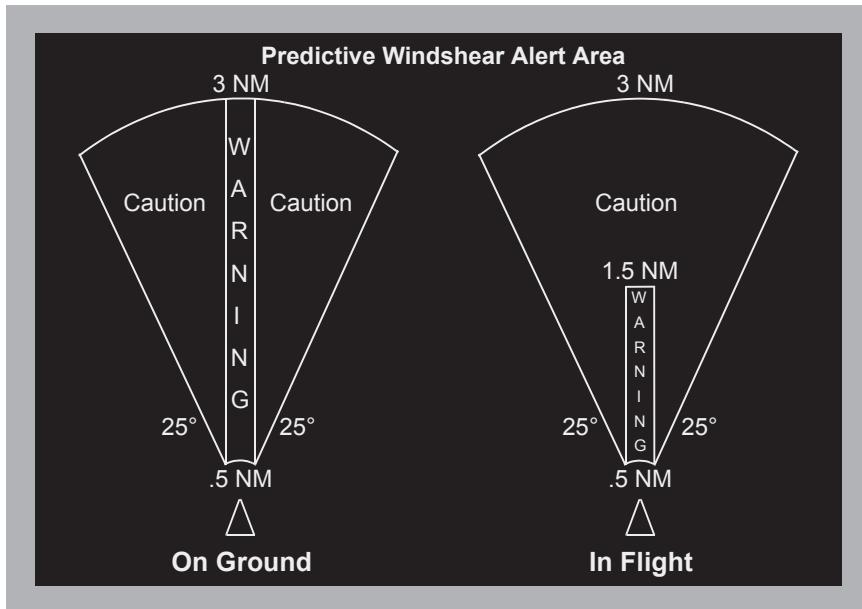
**[Option - Without Collins weather radar 622-5132-632 or 622-5132-633]**

Alerts are available approximately 12 seconds after the weather radar begins scanning for windshear. Predictive windshear alerts can be enabled prior to takeoff by pushing the EFIS control panel WXR switch.

**[Option - With Collins weather radar 622-5132-632 or 622-5132-633]**

Alerts are available approximately 12 seconds after the weather radar begins scanning for windshear. Predictive windshear alerts can be enabled prior to takeoff by pushing the EFIS control panel WXR switch. When PWS is enabled, radar antenna scan sweep is reduced.

If windshear is not detected, weather radar returns show only after pushing the EFIS control panel WXR switch.

**Predictive Windshear Inhibits**

During takeoff and landing, new predictive windshear caution alerts are inhibited between 80 knots and 400 feet RA, and new warning alerts between 100 knots and 50 feet RA. These inhibits do not remove existing predictive windshear alerts. If a warning/caution event occurs before those boundaries, it will remain on the display and the complete aural callout will be annunciated.

**Bank Angle Alert**

The GPWS provides the aural alert BANK ANGLE, BANK ANGLE when roll angle exceeds 35 degrees, 40 degrees, and 45 degrees. Once sounded, the alert is silent for that bank angle (35, 40, or 45 degrees) until the system is reset by decreasing bank angle to 30 degrees or less.

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## Approach Callouts

### Radio Altitude Callouts

#### [Option - Typical]

The GPWS provides the following altitude callouts during approach:

- 2,500 feet – TWENTY FIVE HUNDRED
- 1,000 feet – ONE THOUSAND
- 500 feet – FIVE HUNDRED
- 100 feet – ONE HUNDRED
- 50 feet – FIFTY
- 40 feet – FORTY
- 30 feet – THIRTY
- 20 feet – TWENTY
- 10 feet – TEN.

**Note:** Callouts at 1000 feet and 500 feet are based on barometric altitude above the landing field elevation; callouts at 2,500 feet, and below 500 feet are based on radio altitude.

### DH/MDA Callouts

The GPWS provides height callouts based on the altitude set by the Captain's Minimums selector.

#### [Option - PFD/ND]

Callouts are based on radio altitude when the MINS selector is set to RADIO.

Callouts are based on barometric altitude when the MINS selector is set to BARO:

- DH/MDA plus 100 feet – PLUS HUNDRED
- at DH/MDA – MINIMUMS

#### [Option - EFIS/MAP]

Callouts are based on radio altitude:

- DH/MDA plus 100 feet – PLUS HUNDRED
- at DH/MDA – MINIMUMS

## Traffic Alert and Collision Avoidance System (TCAS)

TCAS alerts the crew to possible conflicting traffic. TCAS interrogates operating transponders in other airplanes, tracks the other airplanes by analyzing the transponder replies, and predicts the flight paths and positions. TCAS provides advisory and traffic displays of the other airplanes to the flight crew. Neither advisory, guidance, nor traffic display is provided for other airplanes which do not have operating transponders. TCAS operation is independent of ground-based air traffic control.

To provide advisories, TCAS identifies a three dimensional airspace around the airplane where a high likelihood of traffic conflict exists. The dimensions of this airspace are based upon the closure rate with conflicting traffic.

TCAS equipment interrogates the transponders of other airplanes to determine their range, bearing, and altitude. A traffic advisory (TA) is generated when the other airplane is approximately 40 seconds from the point of closest approach. If the other airplane continues to close, a resolution advisory (RA) is generated when the other airplane is approximately 25 seconds from the point of closest approach. The RA provides aural warning and guidance as well as maneuver guidance to maintain or increase separation from the traffic.

Non-transponder equipped airplanes are invisible to TCAS. RAs can be generated if the other airplane has a mode C transponder. Coordinated RAs require both airplanes to have TCAS.

### Advisories and Displays

Annunciations associated with TCAS and the traffic displays are discussed further in Chapter 10.

TAs are indicated by the aural "TRAFFIC, TRAFFIC" which sounds once and is then reset until the next TA occurs. The TRAFFIC annunciation appears on the navigation display. 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 annunciation and RA symbol which depicts the traffic's relative bearing, range, altitude, and vertical motion are on the navigation display 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 of the navigation display does not permit the display of a TA or RA an OFFSCALE annunciation appears on the navigation display.

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 navigation display. 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.

TCAS display automatically shows when:

- the transponder mode selector is in TA ONLY or TA/RA, and
- a TCAS TA or RA occurs, and
- neither pilot has the TCAS (TFC) display selected, and
- in MAP, center MAP, VOR, or APP modes.

## Inhibits

### [Option - With TCAS change 7.0 update]

INCREASE DESCENT RAs are inhibited below approximately 1,500 feet radio altitude.

DESCEND RAs are inhibited below approximately 1,100 feet radio altitude.

RAs are inhibited below approximately 1,000 feet radio altitude. Below 1,000 feet when the TA/RA mode is selected on the transponder panel, TA only mode is enabled automatically and the TCAS message TA ONLY displays on the ND.

All TCAS voice annunciations are inhibited below approximately 500 feet radio altitude.

All TCAS alerts are inhibited by GPWS and windshear warnings.

## Mode Control

The TCAS operating mode is controlled from the TCAS/ATC 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.

ATC transponders on TCAS equipped airplanes communicate 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 a RA maneuver.

## Resolution Advisory Aural

The following table identifies the possible callouts associated with RAs and the vertical restrictions or maneuver recommended in each case.

[Option - With TCAS change 7.0 update]

| AURAL ALERTS   | VERTICAL RESTRICTIONS/MANEUVER   |
|--|--|
| MONITOR VERTICAL SPEED                                 | Present pitch attitude is outside the RA pitch command area. Keep pitch attitude away from red area. |
| MAINTAIN VERTICAL SPEED,<br>MAINTAIN                   |  |
| MAINTAIN VERTICAL SPEED,<br>CROSSING MAINTAIN          |  |
| CLIMB, CLIMB   | Climb at the displayed pitch   |
| DESCEND, DESCEND                                       | Descend at the displayed pitch   |
| ADJUST VERTICAL SPEED,<br>ADJUST                       | Reduce climb or descent rate   |
| CLIMB, CROSSING CLIMB,<br>CLIMB, CROSSING CLIMB        | Climb at displayed pitch. Airplane climbs through traffic's altitude.                                |
| DESCEND, CROSSING DESCEND<br>DESCEND, CROSSING DESCEND | Descend at displayed pitch. Airplane descends through traffic's altitude.                            |
| INCREASE CLIMB,<br>INCREASE CLIMB                      | Increase climb rate from initial pitch attitude.   |
| INCREASE DESCENT,<br>INCREASE DESCENT                  | Increase descent rate from initial pitch attitude.   |
| CLIMB – CLIMB NOW,<br>CLIMB – CLIMB NOW                | Reversal maneuver from initial descent RA.   |
| DESCEND – DESCEND NOW,<br>DESCEND – DESCEND NOW        | Reversal maneuver from initial climb RA.   |
| CLEAR OF CONFLICT                                      | RA encounter terminated. Maneuver guidance no longer displayed.                                      |

## Tail Skid

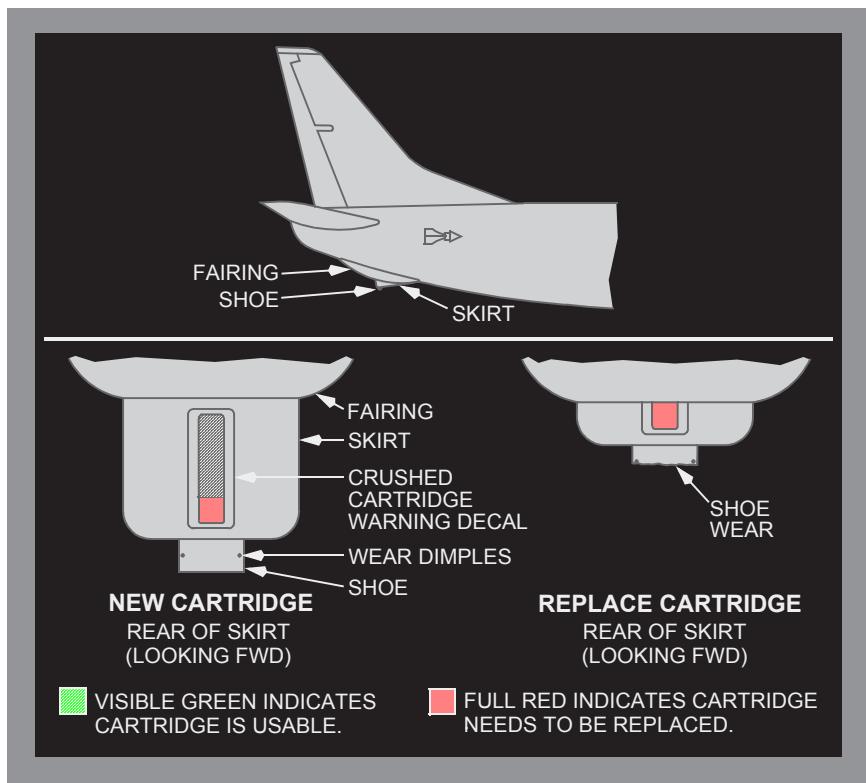
### [737-800/-900]

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



Intentionally  
Blank