



Aircraft general

Warning system

Engines

APU

Fire protection

Electrical system

Fuel system

Hydraulic system

Flight controls

Landing gear & brakes

Bleed air system

Air conditioning system

Pressurisation system

Ice & rain protection

Flight instruments

Automatic flight system

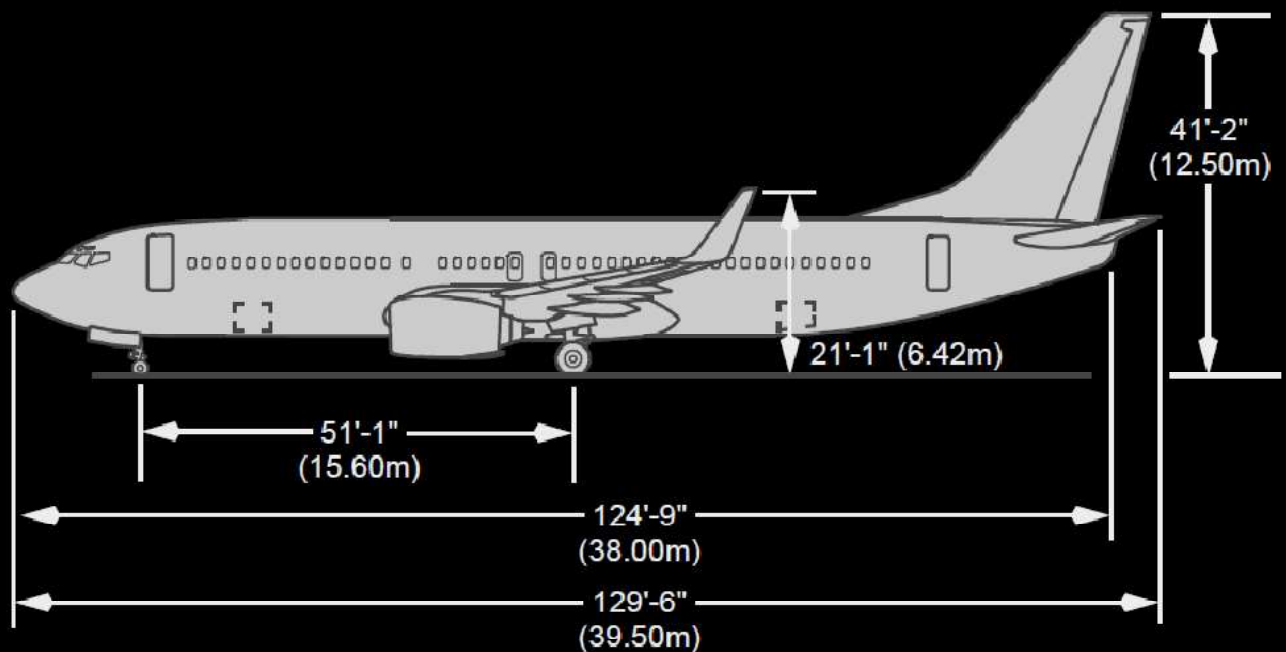
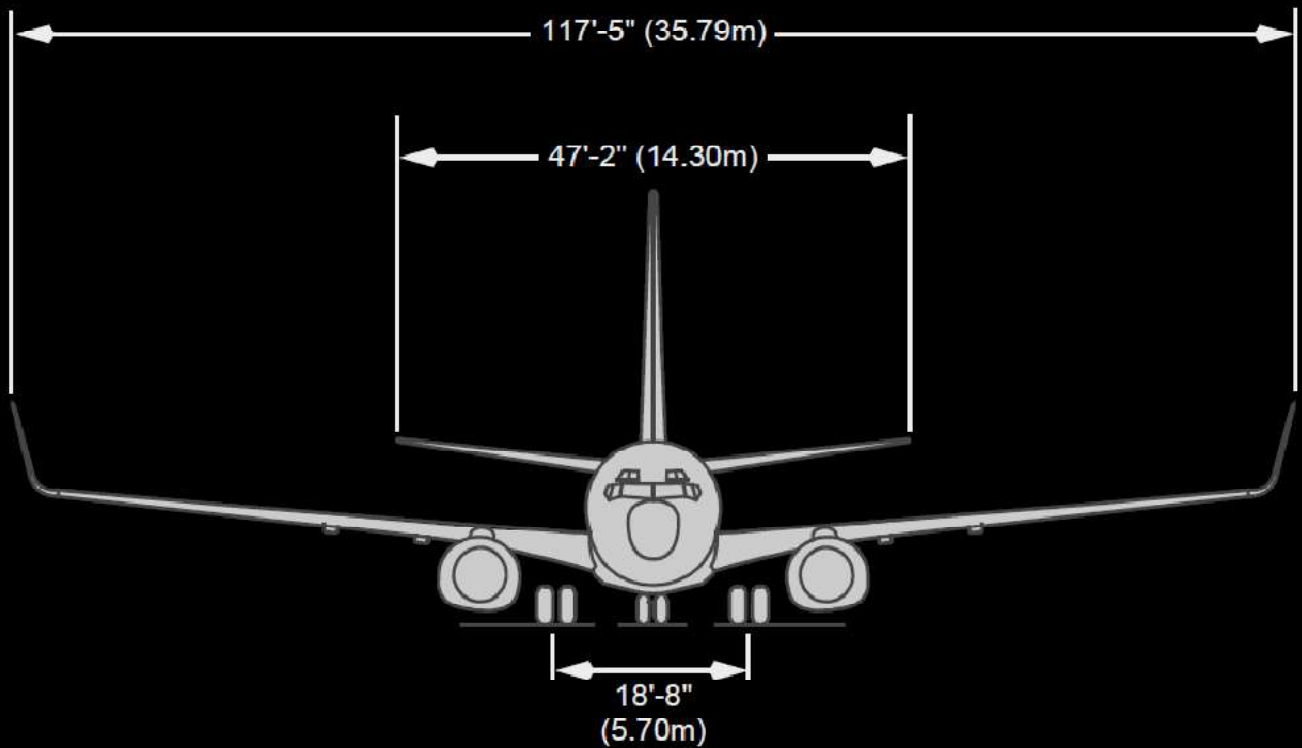
Flight management & navigation systems

Communications system

AIRCRAFT GENERAL

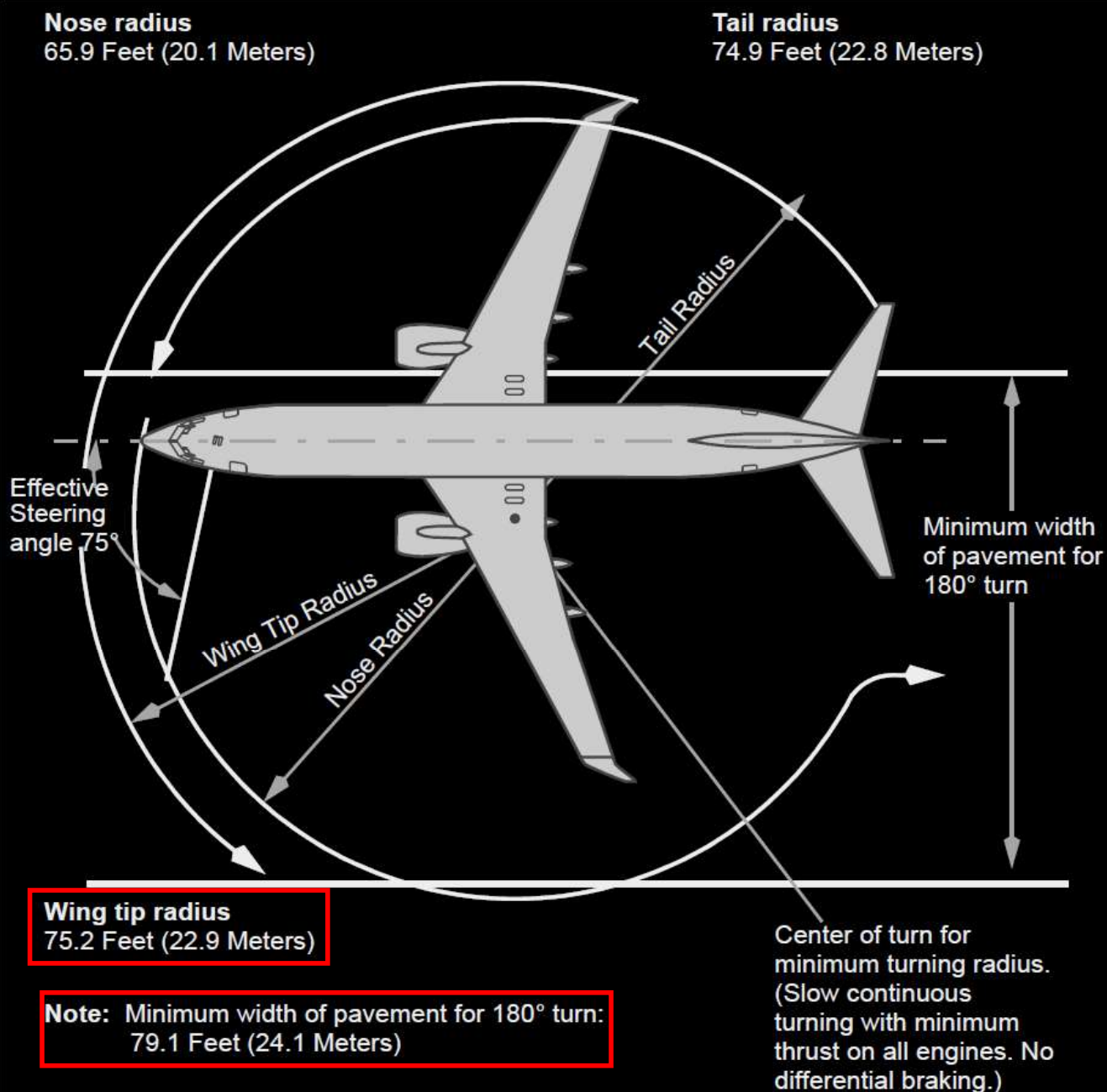
Overview and dimensions

Principal dimension



737-800 With Winglets

Turning radius



Wing tip radius
75.2 Feet (22.9 Meters)

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

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

Instrument panel



Flight Deck Panels:

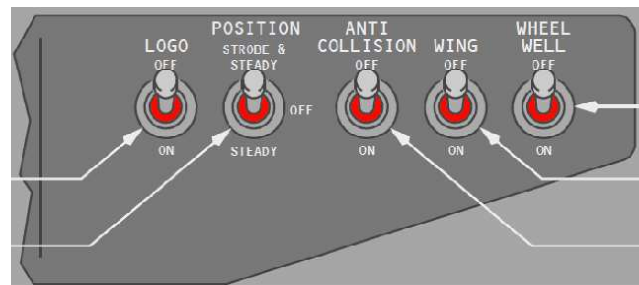
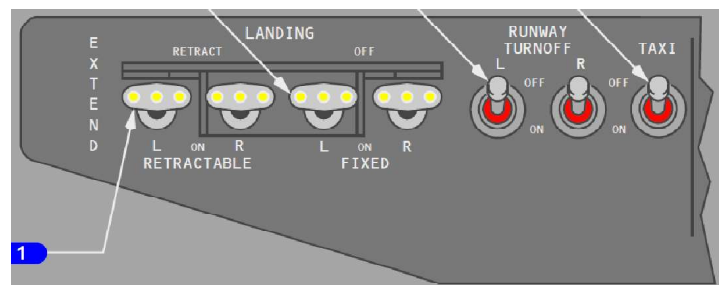
- Overhead Panels
- Glareshield
- Instrument Panels
- Center Instrument Panel
- Forward Electronic Panel
- Control Stand
- Aft Electronic Panel

6 LCDs EFIS screen: 2 PFD, 2 ND, 1 upper DU, 1 lower DU

Lighting

exterior lighting

- landing lights
- runway turnoff lights
- taxi lights
- logo lights
- position lights (navigation + strobe lights)
- anti-collision beacon
- wing illumination lights
- wheel well lights



switches

- 2 fixed landing lights switches
- 2 retractable landing light switches (retractable landing lights can be extended at any speed)
- 2 runway turnoff switches: illuminate the area in front of the gear
- 1 taxi light switch: mounted on the nose wheel strut, points in the same direction of the nose gear. Automatically extinguishes when LG is retracted
- 1 logo light switch: illuminate the tail with airline logo
- 1 position light switch:



strobe & steady: navigation + strobe lights

steady: only navigation lights

- 1 anti-collision light switch
- 1 wing light switch: illuminates wings leading edges
- 1 wheel well light switch: illuminate wheel well

Flight deck

- Dome light: general flight deck flood lighting
- Circuit breaker light: light for CBs panel illumination
- Panel light (overhead): illuminate overhead panel lights and switches



- Panel light (aft console): illuminate aft electronic panel
- Flood light: centre flood light



- Background light: flood light for entire forward panel
- AFDS flood light: light on the AFDS panel (glare shield)



- Main panel light: control brightness (Cpt. illuminate also AFDS panel)
- OUTBD DU BRT: control outer display brightness
- INBD DU BRT:
 - i. Outer knob: inboard display brightness
 - ii. Inner knob: if AWR active in inner display, control brightness of AWR display
- Upper/lower DU BRT: available to Cpt. For lower and upper display brightness



- STBY magnetic compass light



- Light test switch: control FD annunciator lights



TEST: illuminate all annunciator lights

BRT: normal light intensity

DIM: reduced light intensity

- Map and chart light controls: pull out and rotate



MAP BRIGHT: illuminate the area in front of each pilot seat

CHART BRIGHT: illuminate the upper sidewall panel

- Utility light: rotate to activate the light or push and hold for temporary illumination



STBY power system

If normal electrical power is lost, STBY electrical power is automatically provided to the:

- STBY compass light
- Dome lights
- Instrument flood light
- Selected system information and warnings lights

Cabin signs lights

When passengers cabin sign illuminates or extinguishes a low tone sounds on PA

in AUTO position signs:

	FASTEN BELTS	NO SMOKING
Illuminate when	Flaps or LG extended	LG is extended
Extinguish when	Flaps or LG retracted	LG is retracted



Passengers cabin lights

- Exit lights
- Floor path illumination lights
- Interior emergency lights: illuminate the aisle

Exterior emergency lights

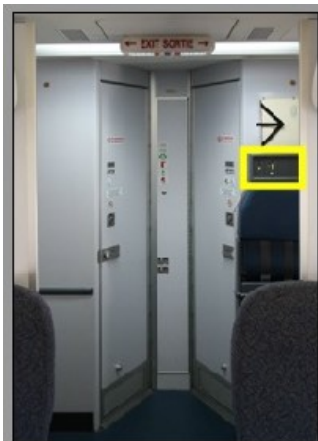
Illuminates the escape slides and over-wing escape routes and ground evacuation area



ARMED (guarded position): emergency exit lights and FD aft dome lights illuminate when:

- Electrical power to DC BUS 1 fails, or
- AC power is OFF

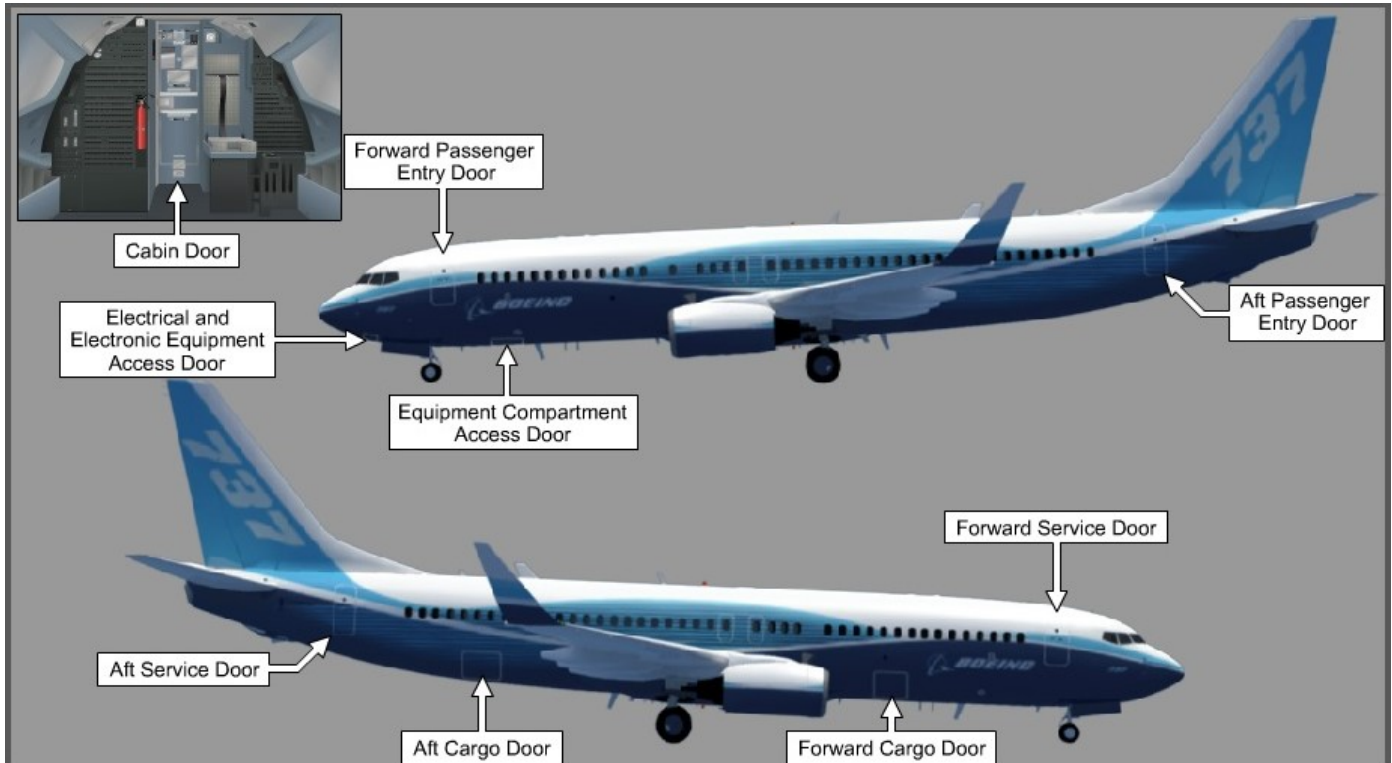
Emergency lighting system (ELS) can be switched ON also by the n°2 CC by a switch in the aft galley



Doors and windows

Overview

- 1 flight deck door
- 2 passenger doors (L1 & L2)
- 2 service doors (R1 & R2)
- 2 cargo doors (right side)
- 1 electrical and electrical equipment access door
- 1 equipment compartment door



Windows

Flight deck n°2 windows can be opened by the flight crew. First officer n°2 window can be opened from outside the airplane.

Cargo compartments

Cargo compartments are designed to completely confine a fire without endangering the safety of the airplane or its occupants. Compartment are sealed and pressurised but do not have fresh air circulation and temperature control.

Pressure equalisation valve keep the pressure nearly the same as the cabin pressure. Blow out panels provide pressure relief in case pressurization is lost.

Cargo doors

2 plug type, inward opening, pressurised doors. Can be opened both from inside and outside the airplane.

Door annunciation

Door light annunciation are illuminated when the related door is not closed and locked.



Flight deck door

The flight deck door lock when electrical power is available and unlock when electrical power is removed. A dead-bolt, provide mechanical locking of the door, either permitting or not the key entry.

The flight deck access system consist of:

- Emergency access panel
- Chime module
- Three position door lock selector with 2 indicator lights
- Access system switch (kill switch)

Emergency access panel



- **RED light:** door is locked
 - **AMBER light:** correct emergency access code has been entered
 - **GREEN light:** door is unlocked
-
- 6 button (1 to 5 + ENT)

Three position door lock selector

“LOCK FAIL” light: door lock has failed or access system switch OFF

“AUTO UNLK” light: the correct emergency access code has been entered (flashes and chime sounds continuously)

After the correct emergency access code has been entered:

“DENY” : prevents further keypad entry for several minutes and keeps the door locked

“UNLKD”: allows entry, door unlocks

“AUTO”: door unlocks after 30 seconds approximately



Access system switch

“OFF”: remove electrical power from door lock (door unlocked)

“NORM” (guarded position): access system is configured for flight

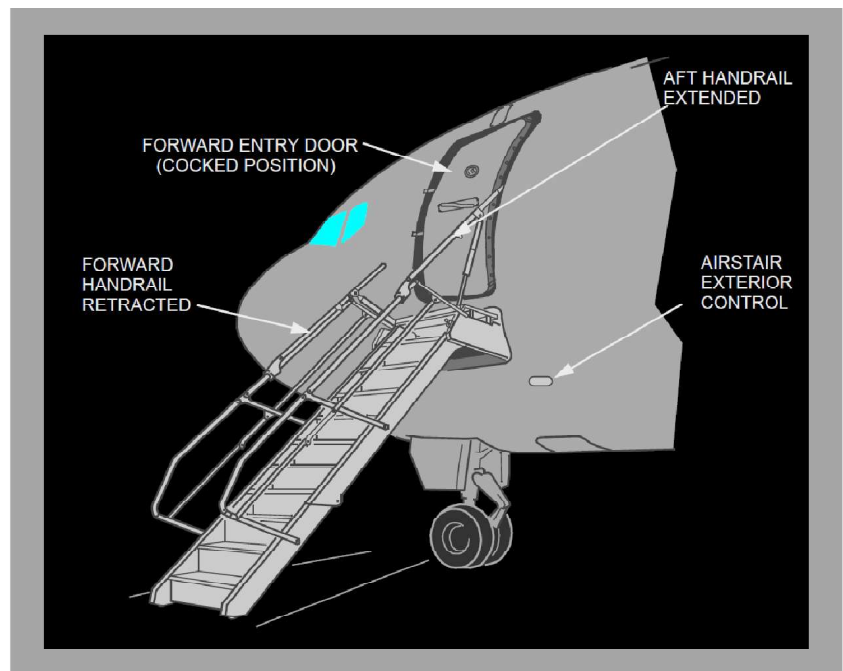


Flight deck door panels

Two pressure sensors that unlock in case of decompression to equalise pressure are provided on the flight deck door. These panels can be opened by manual release pins in case the door is jammed, during an evacuation.

Forward airstair (FCOM2 1.40.39/40)

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 forwards entry door. The compartment has a pressure door that automatically opens before the airstair can operate.



forward airstair interior control

interior control panel is located on the forward attendant panel.

“STAIR OPEN” light: illuminate when the airstair is in transit

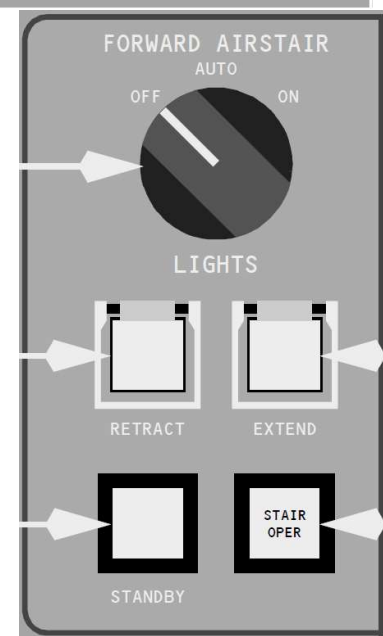
Airstair lights selector (lights on steps):

- AUTO: lights illuminate when airstair fully extended, extinguish when fully retracted

The airstair has 2 modes of operation:

- NORMAL: requires 115 V AC, press RETRACT or EXTEND
- STBY: requires BAT switch ON, press STANBY while depressing RETRACT or EXTEND

Both operating modes require the forward entry door (L1) to be partially open

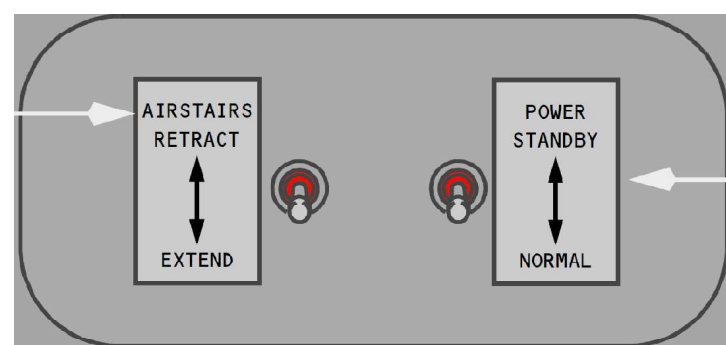


Forward airstair exterior control

When operating the airstair with the exterior control, the forward entry door (L1) need NOT to be open.

There are 2 switches:

- Power source selector (spring loaded to NORMAL):
NORMAL uses 115 V AC, holding the switch on
STANDBY provides DC power from the BAT BUS for
airstair operation (so that BAT switch need NOT to be
ON)
- Control selector: to RETRACT or EXTEND the airstair



indication and safety feature

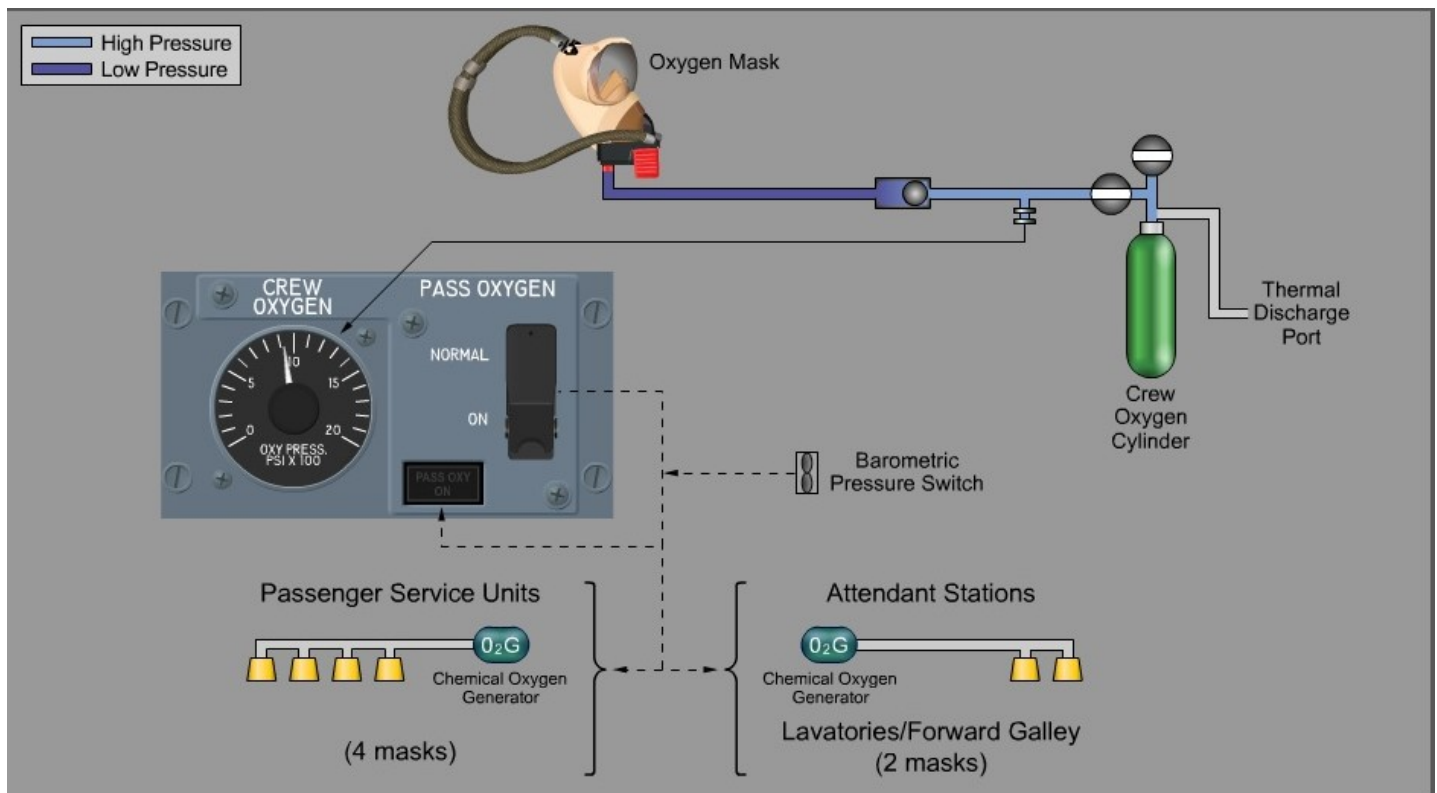
“AIRSTAIR” light: on the overhead door, illuminates when airstair pressure door is unlocked. AIRSTAIR light operate only when DC BUS 1 is powered

“DOORS” and “MASTER CAUTION” light: in the flight deck illuminate when airstair door is unlocked

NORMAL and STANDBY systems prevents the airstair to be retracted with the handrail extended.

Oxygen system

There are 2 independent oxygen system on board, one for flight crew and one for passengers



Flight crew oxygen indication

System pressure indicated by the gauge, maximum oxygen pressure is 1850 PSI

Passengers oxygen switch



NORMAL (guarded position): passengers mask deploys automatically and oxygen system activated when cabin altitude exceeds 14000 ft

ON: if NORMAL fails, drops the masks and activate oxygen system



"PASS OXY ON", "OVERHEAD" and MASTER CAUTION illuminates when passengers oxygen system is operating and the mask have dropped

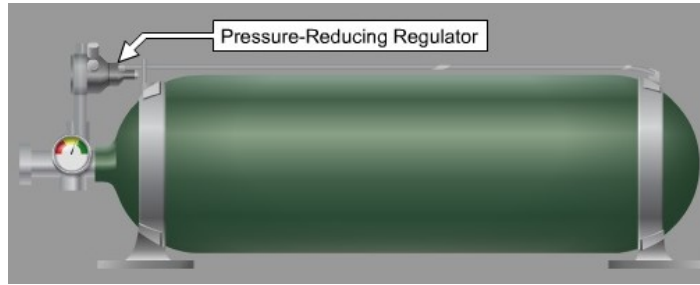
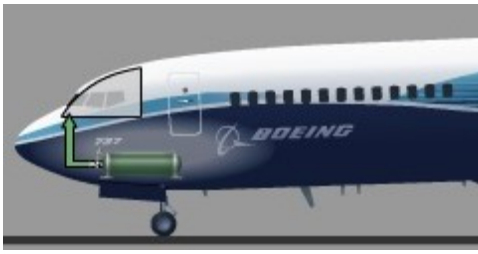
Oxygen masks

Flight deck: quick donning masks provided at each flight crew seat

Cabin: provided for all passengers and cabin crew seats and in the lavatories

Flight crew oxygen system

Flight crew oxygen system is supplied by a single cylinder through a pressure reducing regulator to supply low pressure oxygen.



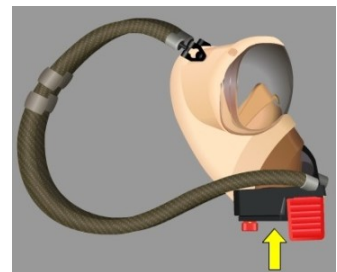
Flight crew mask are automatic pressure breathing mask. Pressure breathing occurs above 27000 ft



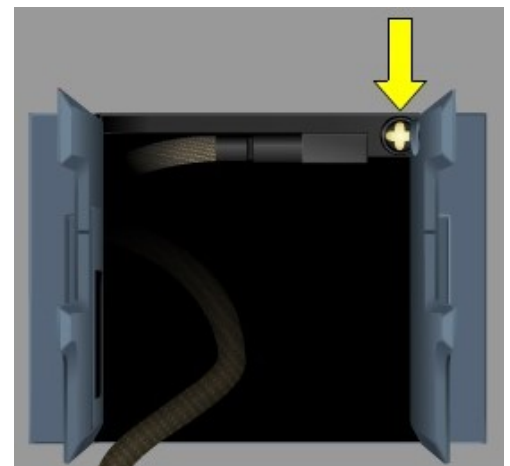
N (normal): automatic diluted oxygen with pressure breathing

100% (push): supply 100% oxygen

EMERGENCY (rotate): supply oxygen under positive pressure

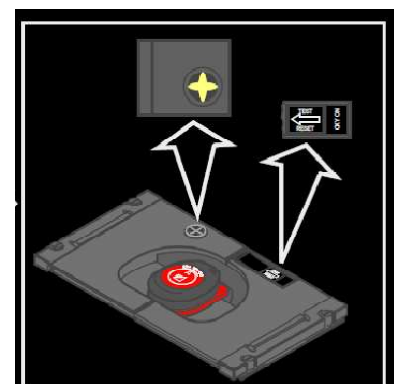


Squeezing the inflation levers and removing the mask from the stow compartment will inflate mask harness and illuminate oxygen flow indicator. Once placed on, the harness contracts to fit the mask the head and face.



Mask stowage

set regulator to 100%. Stow the mask, close the right hand door, the OXY ON flag will slide into view, close the left hand door. Press TEST AND RESET, ensure that OXY ON flag disappear.



Passengers oxygen system

Passengers oxygen is supplied by chemical generator located at each passenger service unit (PSU).

4 masks are supplied to each PSU generator, 2 mask for cabin crew station and lavatories generators.

The generator is activated as soon as one mask is pulled down, causing the oxygen to flow to all mask connected with the relative generator. Only 100% oxygen is available for cabin oxygen. A green line flow indicator is visible when oxygen is flowing. once activated, oxygen is supplied for 12 minutes and cannot be shut off.

If mask stowage at each PSU compartment does not open automatically, it can be opened manually.

First aid and supplemental portable oxygen

First aid and supplemental portable oxygen cylinders are fitted with a pressure gauge, pressure regulator and ON –OFF valve. 2 continuous flow outlets on each cylinder provides:

- One provides 2 litres/min for walk-around
- The other provides 4 litres/min for first aid

Water and lavatory system

Quantity indicator

A quantity indicator is located on the flight attendant panel

System

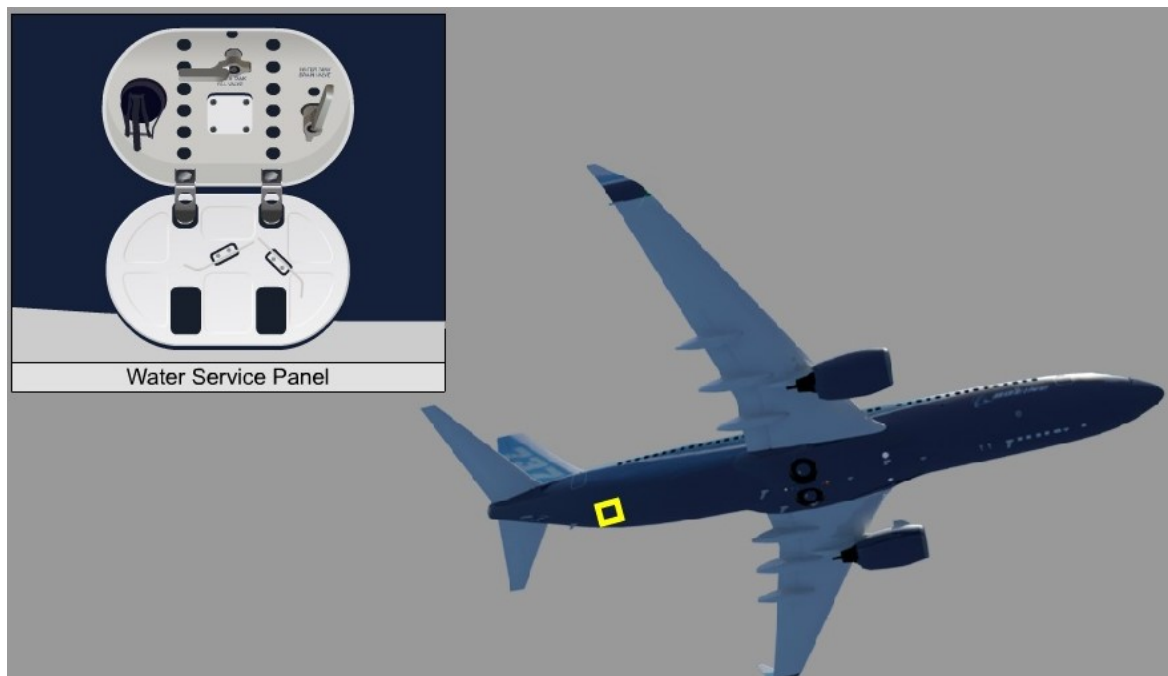
The system is pressurised by engine bleed air or by water system air compressor. Shut-off valve are located on each galley and below the sink in each lavatory

Water heater

Water heater is located below the lavatory sink

System service

The system is serviced from an exterior panel on the bottom right of the fuselage. Pressure filling is required



Emergency equipment

Symbols



CO₂
EXTINGUISHER



WATER
EXTINGUISHER



DRY CHEMICAL
EXTINGUISHER



BCF
EXTINGUISHER



PORTABLE
OXYGEN BOTTLE



PORTABLE
OXYGEN BOTTLE
WITH SMOKE
MASK ATTACHED



DISPOSABLE
OXYGEN MASK



FULL FACE
OXYGEN MASK



PROTECTIVE
BREATHING
EQUIPMENT
(PBE)



EXIT PATH
WITHOUT ESCAPE
STRAP



EXIT PATH
WITH ESCAPE
STRAP



EXIT PATH
WITH ESCAPE
SLIDE



LIFE RAFT



EMERGENCY
TRANSMITTER



LIFE
VEST



PROTECTIVE
GLOVES



SMOKE
GOGGLES



CRASH
AXE



MEGAPHONE



BATON



AED



HANDCUFFS



FLASHLIGHT



EMERGENCY
MEDICAL KIT



FIRST AID
KIT



PORTABLE
EXIT LIGHT

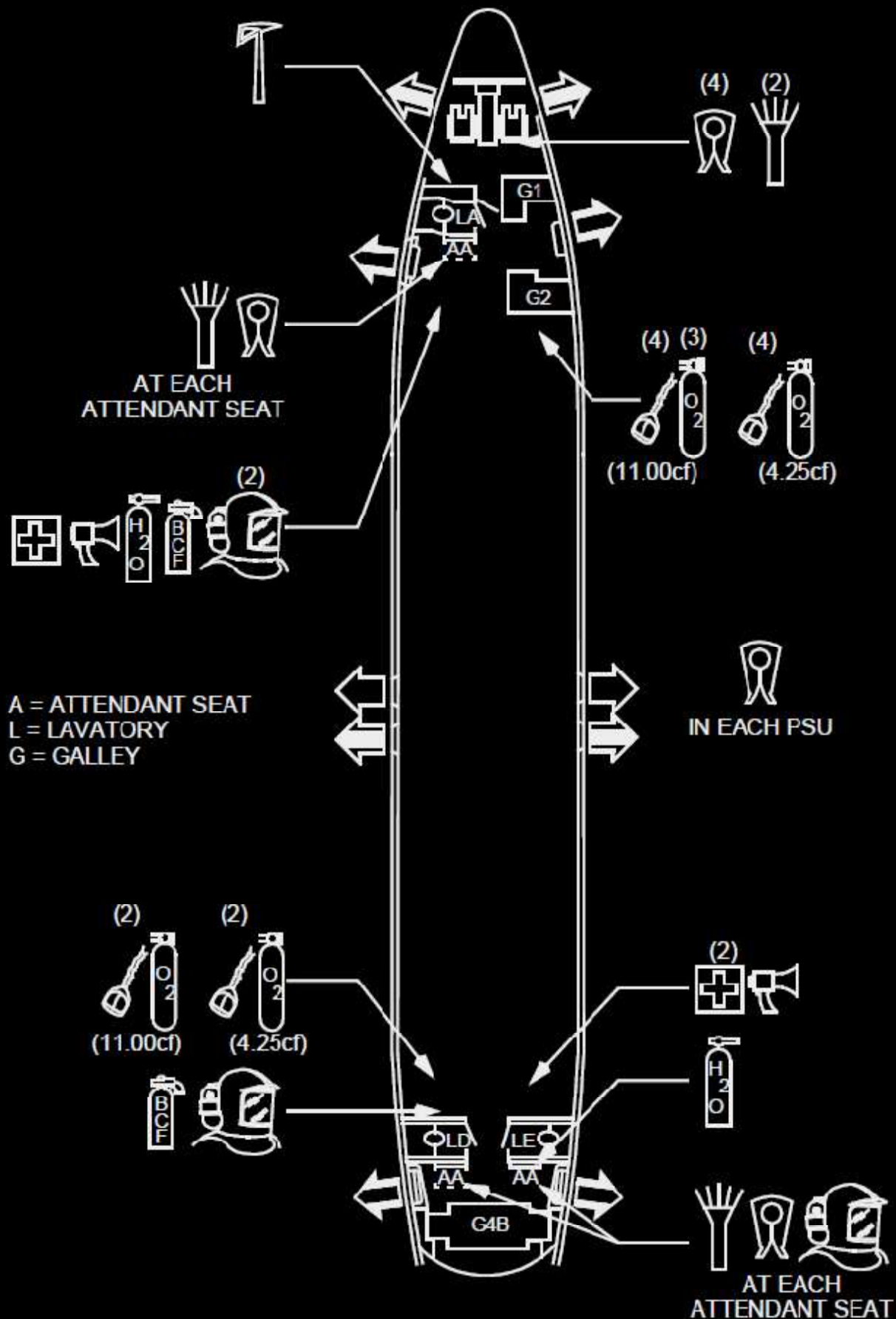


RESUSCITATOR

NOTE: SOME SYMBOLS DO NOT APPLY TO ALL CONFIGURATIONS.

Location

May vary according to A/C and airplane (refer to FCOM2 - 1.40.23/24/25/26). Here is show a typical configuration.



ELT switch (flight deck)



ARM (guarded): ELT transmits automatically when reaches a pre-set G-load limit

ON: manually activated

"ELT" light: illuminates when ELT is activated and simultaneously transmits tone and position data on 121.5, 243.0 and 406.0 MHz

Fire extinguishers

- H₂O glycol extinguisher: suitable for class A fire only. to operate the extinguisher, rotate the handle clockwise to pressurise the extinguisher with the CO₂ cartridge contained in the handle
- HALON (BCF) extinguisher: suitable for all class of fire. To operate the extinguisher, aim at the base of fire at a distance of 6 ft. if HALON fire extinguisher is to be discharged in the flight deck, wear oxygen mask with 100% oxygen with EMERGENCY selected

Limitations

Operational limitation (FCOM1- L.10.2)

MAX demonstrated crosswind: 33 Kts

Runway slope	+/- 2%
# Maximum Takeoff and Landing Tailwind Component Note: The capability of the airplane(s) has been satisfactorily demonstrated for takeoff and manual landing with tailwinds up to 15 knots.	10 kts 15 kts (approved airfields only)
Maximum speeds	Observe gear and flap placards 250 kts below FL100 unless approved by ATC and within class A, B or C airspace.
Maximum Operating Altitude	41,000 ft
Maximum Takeoff and Landing Altitude	8,400 ft

RVSM (FCOM1 – L.10.3)

STBY altimeter do NOT meet RVSM requirements.

Maximum in-flight difference from Cpt. And F/O altimeter in RVSM is ± 200 ft

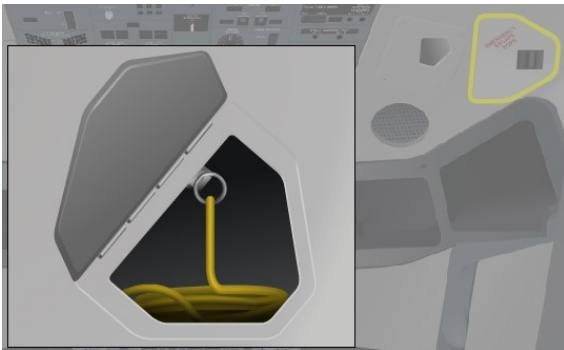
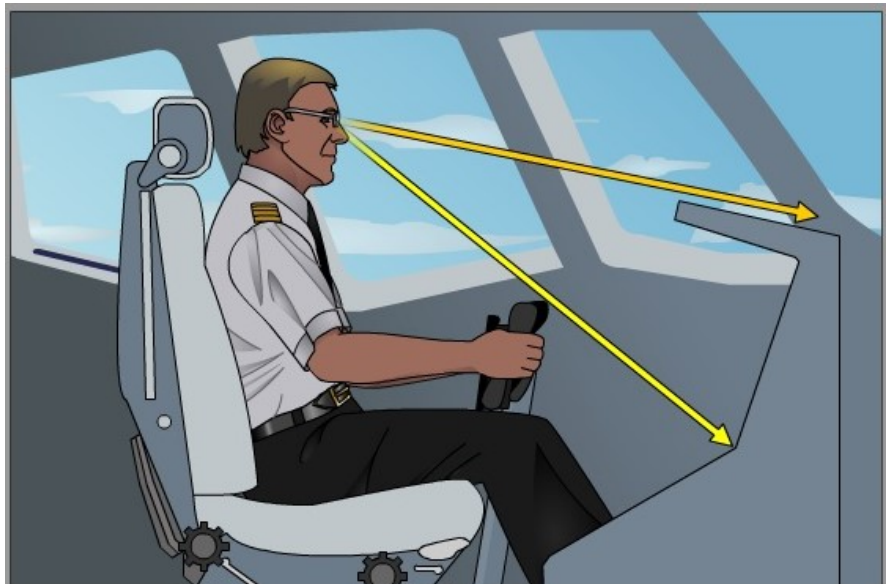
When on ground:

Field Elevation	Max Difference Between Captain & F/O	Max Difference Between Captain or F/O & Field Elevation
Sea Level to 5,000 feet	50 feet	75 feet
5,001 to 10,000 feet	60 feet	75 feet

Flight deck

Seats

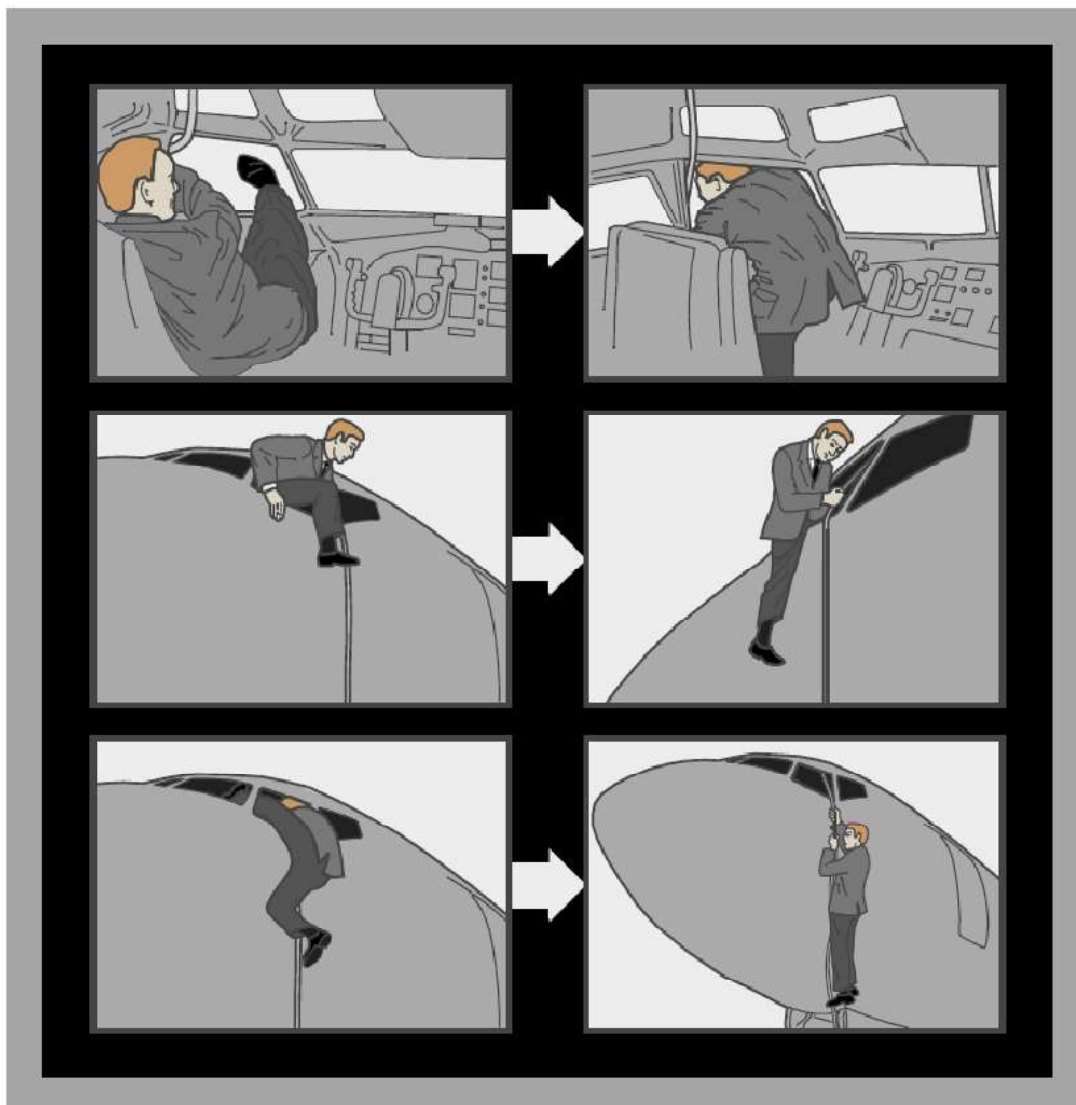
Optimum eye reference position:



Flight deck egress

Escape straps may be used to evacuate flight deck, if the flight deck door and escape panels are jammed. Escape straps are over each pilot seats, attached one end to the aircraft structure

Escape manoeuvre (FCOM2 – 1.40.31):



Passengers egress

Passengers and crews can evacuate through 4 entry/service doors and 4 over-wing escape hatches

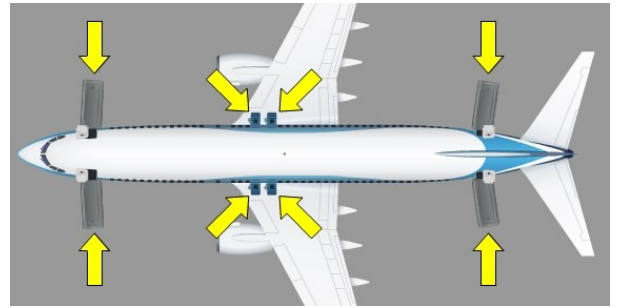
The doors slides will deploy when the doors are opened.

Over-wing exit doors are pressure and mechanical locked. Can be opened both from inside and from outside the aircraft. Escape straps are installed on the aft emergency doors. Emergency doors are locked by the 28 VDC electrical system.

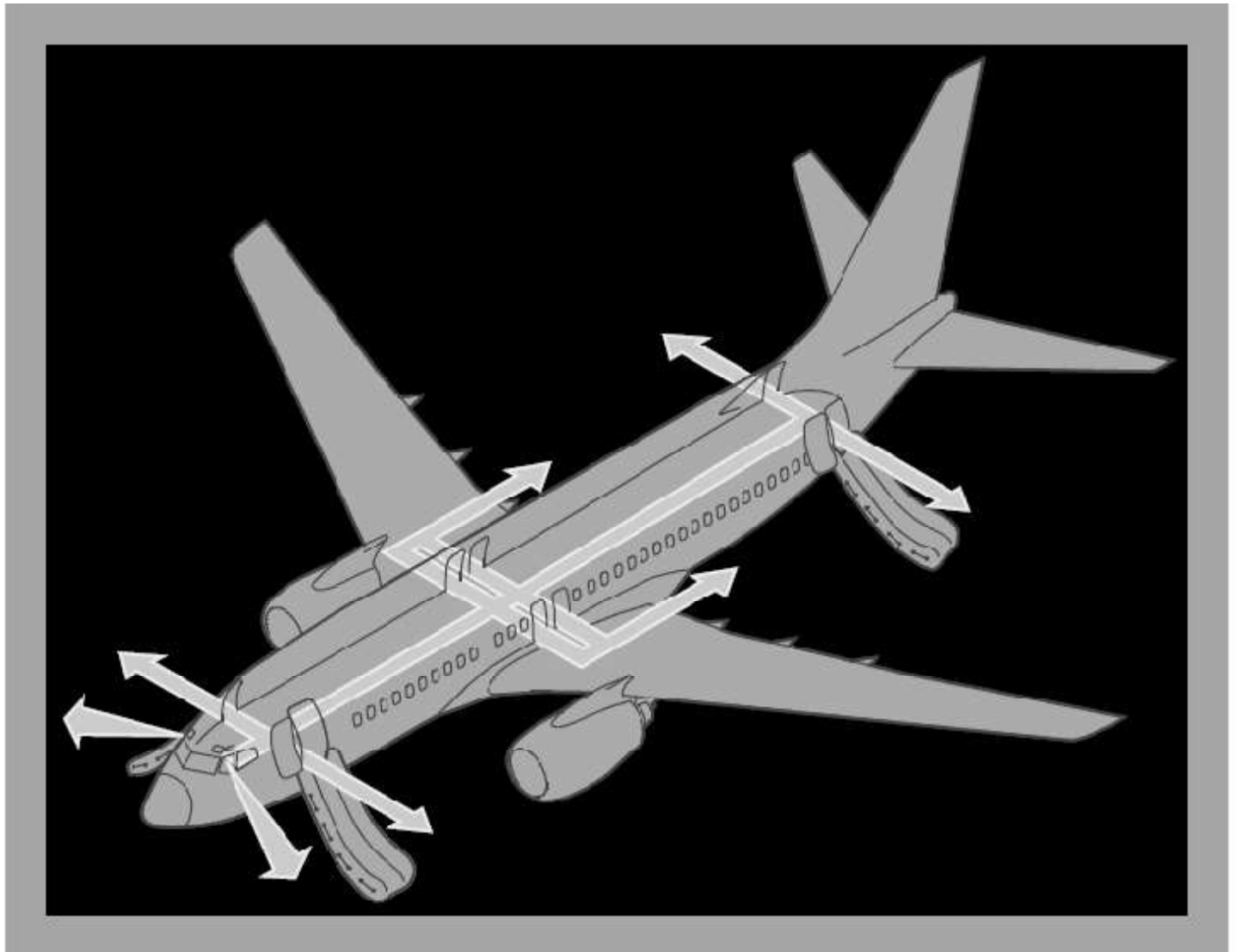
Emergency exits lock when:

- 3 or 4 entry/service doors are closed
- Either engine is running
- Airplane logic indicate that the airplane is in the air or both thrust levers are advanced

they unlock when any of the above is not met, or DC power is lost.



Emergency evacuation routes (FCOM2 – 1.40.30)



WARNING SYSTEM

Warning system overview

Visual signals

RED LIGHTS (WARNING): indicate conditions that require the immediate attention of the flight crew:

- Fire
- Autopilot/autothrottle disconnect
- Landing gear unsafe conditions

AMBER LIGHTS (CAUTION): indicate conditions that require the timely attention of the crew



BLUE LIGHTS (INFORMATION): gives information to the crew about:

- Electric power availability
- Valves position
- equipment status
- CC or ground communication

DIM BLUE: configuration reached

BRIGHT BLUE: transitional state

GREEN LIGHTS: indicate a fully extended configuration

Aural signals

“Clacker”: airspeed limit

“Warning tone”: A/P disconnect

“intermittent horn”: T/O configuration and cabin altitude

“steady horn”: landing gear position

“bell”: fire warning

“voice warning”: used for ground proximity and windshear alerts

Tactile signals

Control column shaker: stall warning

Master warning/caution and annunciator lights system

fire warning

2 master FIRE WARN lights (+ fire “bell”) remains illuminated as long as the fire condition exists

Pushing either master FIRE WARN or fire warning BELL CUTOUT, extinguishes both lights, silences the bell and reset the system for future fire warning



MASTER CAUTION

MASTER CAUTION lights and 2 associated symmetric annunciator panels are located on the glareshield



The annunciator light panel include only those systems located on the forward, aft overhead and fire panel. Caution lights remain illuminated as long as the caution condition persist or when crew reset the system.

Pushing either annunciator panel, recalls all existing fault annunciation. A single fault in certain redundant system or some simple fault will NOT illuminate the **MASTER CAUTION** or system annunciator lights. However these caution are stored in the MASTER CAUTION system, pushing the annunciator panel, will recalls these cautions.

Pushing an annunciator panel will illuminate all the system lights (press-to-test feature)

Cabin altitude and configuration warning

Takeoff configuration warning

Takeoff configuration warning is armed with airplane on the ground and both thrust levers advanced for takeoff, an “intermittent horn” will sound if one of the following is met:

- Trailing edge FLAPs not between 1° to 25°
- FLAPs asymmetry or un-commanded motion
- Leading edge devices NOT in T/O configuration or un-commanded motion
- SPEED BRAKE not DOWN position
- SPOILER control valve is open
- PARKING BRAKE is set
- Stabiliser TRIM not in T/O range

Cabin altitude warning

An “intermittent horn” will sound when cabin altitude exceed 10000 ft.

NOTE: takeoff configuration and cabin altitude warning have the same aural warning (“intermittent horn”)

Altitude warning horn may be silenced by pressing the ALT HORN CUTOUT button on the cabin altitude panel



Landing gear warning

A “steady horn” and landing gear indicator light provide visual and aural warning for landing gear unsafe conditions.

Landing gear warning system source:

- Each gear
- LG lever
- Thrust lever position

A **RED LIGHT** illuminate when:

- Either landing gear is NOT fully DOWN and locked and:
 - i. Thrust lever retarded to IDLE
 - ii. Below 800 ft AGL(RA)
- One or more gear(s) is/are in disagreement with landing gear lever



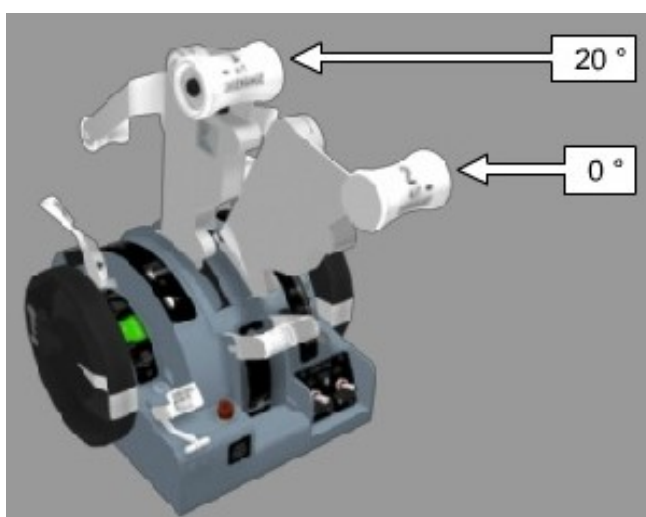
All lights goes OUT when the landing gear is UP and locked and landing gear lever UP or OFF

Landing gear warning “steady horn” is activated when:

FLAPs UP through 10°	FLAPs between 15° and 25°	FLAPs more than 25° *
- Either gear not DOWN and locked - Below 800 ft RA or thrust lever between IDLE and 20°	- Either gear not DOWN and locked - Thrust lever between IDLE and 20° - With OEI thrust lever below 34°*	- Either gear not DOWN and locked

OEI: one engine inoperative; *in these conditions the “steady horn” CANNOT be silenced

Landing gear warning “steady horn” can be silenced with the LG CUTOUT button, only if above 200 ft RA



PSEU (proximity switch electronic unit)

The PSEU monitor:

- Takeoff configuration
- Landing configuration
- Landing gear
- Air/ground sensing



The PSEU, its sensors and input signals are monitored for internal faults, when a fault is detected:

- **PSEU** light illuminate (aft overhead panel)
- **OVERHEAD** annunciation
- **MASTER CAUTION** illuminate

PSEU can be reset:

- Following a maintenance BITE (built in test equipment) check
- Repair of the cause of the fault

PSEU light is inhibited when one of the following is met:

- In flight
- Thrust levers are advanced towards takeoff power
- 30 seconds after landing

For simple fault, **PSEU** light illuminate after landing (after 30 seconds) and is turned OFF when **PARKING BRAKE** is set or both engines are shut down.

Mach/airspeed warning

2 independent Mach/airspeed warning system provide a distinct aural warning ("clacker") any time VMO/MMO is exceeded. Only reducing airspeed below VMO/MMO can silence the warning

Airspeed indicator

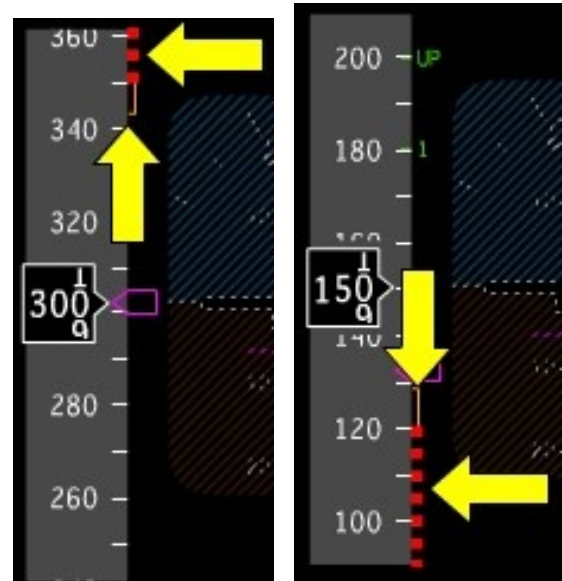
The **RED WARNING BANDS** indicates the MAX and MIN airspeed

The **AMBER CAUTION BANDS** indicates MAX and MIN manoeuvring speed

MIN manoeuvring speed provides 40° bank capability:

- In 1 G flight to stick shaker below 20000 ft, or
- Initial buffet above 20000 ft

The system can only be tested on the ground



Stall warning

Stick shaker is used to provide the required stall warning. There is one stick shaker in each control column.

The system is armed in flight at all times and is deactivated on the ground

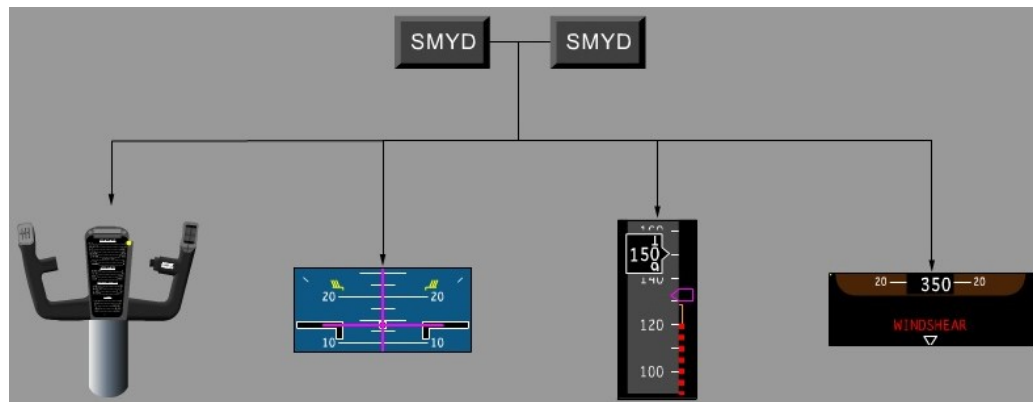
SMYD (stall management yaw damper)

2 independent SMYD determine when a stall warning is required. The warning is based on:

- Alpha vane angle of attack outputs
- ADIRU (air data inertial reference unit) outputs
- Anti.ice controls
- Wing configurations
- Air/ground sensing
- Thrust
- FMC outputs
- Mach compensation

SMYD provides output for all:

- Stall warning stick shaker
- pitch limit indicator
- Airspeed display
- GPWS windshear detection and alert



Stall warning TEST

Stall warning TEST switches are installed in the aft overhead panel. Either TEST switch test the respective stall warning channel, making both column to vibrate

Altitude alerting

Altitude alerting occurs when the aircraft is approaching or departing MCP selected altitude. Is inhibited when:

- FLAPs extender more than 25°
- GS is captured

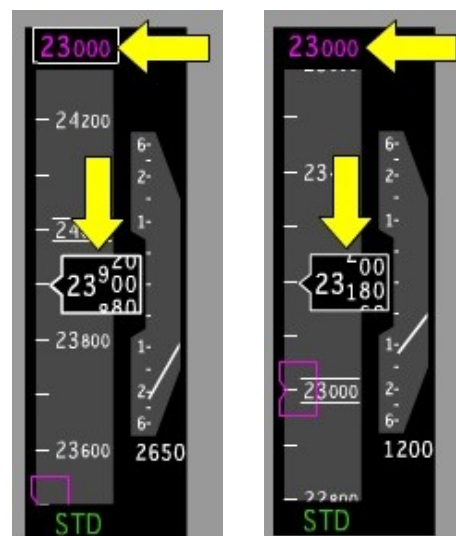
Acquisition alerting

900 ft before reaching the selected altitude:

- A white box shows around selected altitude
- Box around current altitude becomes **bold**
- A momentary "tone" sounds

200* ft before selected altitude:

- Selected altitude box no longer shows

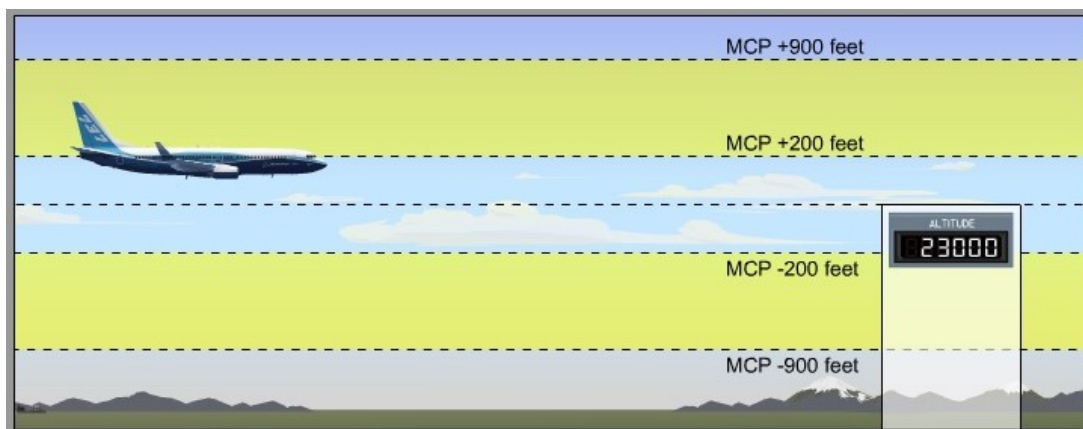


*FCOM2 15.20.9: 300 ft

Deviation alerting

When deviating more than 200 ft from selected altitude:

- A momentary “tone” sounds
- Current altitude box turn **AMBER** and begin to FLASH, **AMBER FLASHING** continues until:
 - i. Altitude deviation becomes less than 200 ft
 - ii. Altitude deviation becomes more than 900 ft
 - iii. New MCP altitude is selected



GPWS (ground proximity warning system)

GPWS incorporate 2 types of alerts:

- RADIO ALTITUDE based
- LOOK-AHEAD based

Radio altitude based alerts

Radio altitude based alerts are based on:

- Radio altitude (RA)
- Barometric altitude
- Airspeed
- **Glide slope (GS) deviation**
- **Airplane configuration**

Radio altitude based provides alerts for:

- Excessive rate of descent (ROD)
- Excessive terrain closure
- Altitude loss after takeoff or go-around
- Unsafe terrain clearance when not in landing configuration
- Excessive deviation below an ILS glide slope

Annunciation consist of:

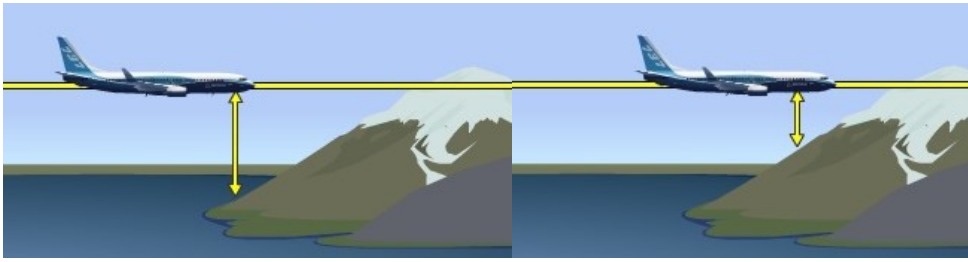
- Aural warning
- Visual warning on PFD or light annunciation



NOTE: terrain ahead may exceed climb capability of the aircraft, therefore GPWS alerts does NOT guarantee terrain clearance

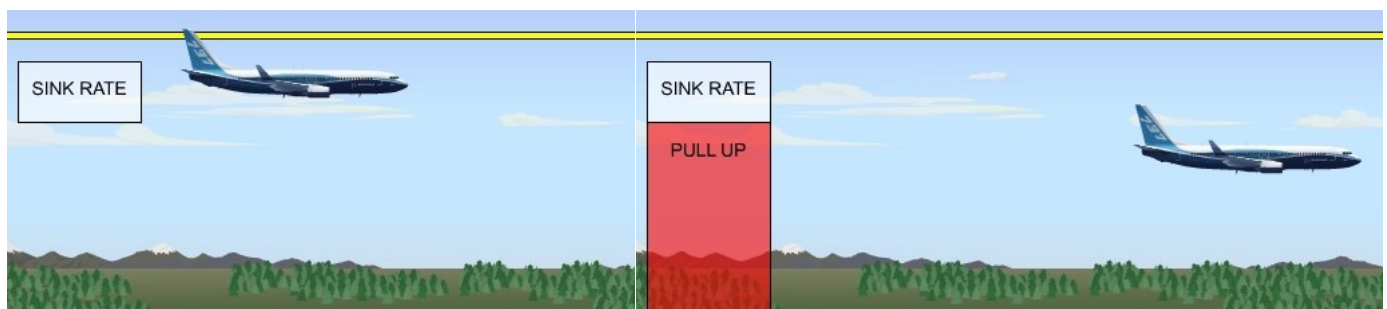
“TERRAIN, TERRAIN” excessive terrain closure

“TERRAIN, TERRAIN” will sound for an excessive terrain closure rate, if the excessive terrain closure rate continues and landing gear and/or FLAPs are not in landing configuration the alerts changes to “PULL-UP, PULL-UP”



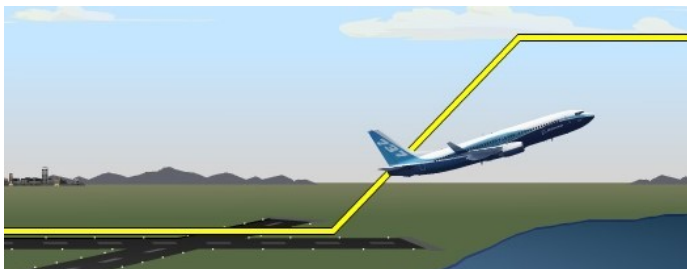
“SINK RATE, SINK RATE” excessive rate of descent (ROD)

“SINK RATE, SINK RATE” sound for an excessive ROD, when the conditions becomes severe changes to “PULL-UP, PULL-UP”



“DON’T SINK, DON’T SINK” excessive altitude loss after T/O or G/A

“DON’T SINK, DON’T SINK” sounds for an excessive altitude loss after takeoff or go-around

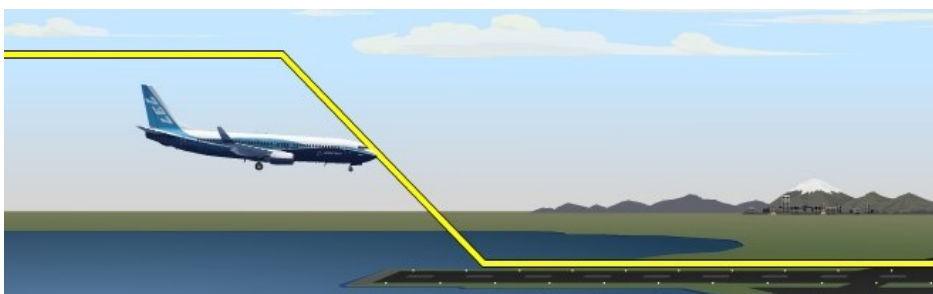


“GLIDESLOPE” excessive deviation below ILS glideslope

“GLIDESLOPE” will sound for an excessive deviation below the glideslope.

The volume and repetition rate increases as the deviation increases

(FCOM2 15.20.12)pushing the ground proximity **BELOW G/S P-INHIBIT** light cancel/inhibit the alert below 1000ft RA



Unsafe terrain clearance when not in landing configuration

- “TOO LOW FLAPS, TOO LOW FLAPS” sounds for unsafe terrain clearance at **low** airspeed, with the FLAPs not in landing configuration. Is inhibited by activating FLAP INHIBIT on the GROUND PROXIMITY switch
- “TOO LOW GEAR, TOO LOW GEAR” sounds for unsafe terrain clearance at **low** airspeed, with landing gear not DOWN and locked. Is inhibited by activating GEAR INHIBIT on the GROUND PROXIMITY switch
- “TOO LOW TERRAIN, TOO LOW TERRAIN” sounds for unsafe terrain clearance at **high** airspeed with either the landing gear not DOWN and locked or FLAPs not in landing configuration.

It follows “DON’T SINK, DON’T SINK” if another descend is initiated after the initial alert, before climbing to the altitude where the initial descent began.

Sum up table

	Visual warning on PFD or light	Associated aural warning		
Excessive rate of descent (ROD)		“SINK RATE, SINK RATE” **“PULL-UP, PULL-UP”		
Excessive terrain closure		“TERRAIN, TERRAIN” **“PULL-UP, PULL-UP”		
Altitude loss after takeoff or go-around		“DON’T SINK, DON’T SINK” **“TOO LOW TERRAIN, TOO LOW TERRAIN”		
Unsafe terrain clearance when not in landing configuration		LOW speed	FLAPs	“TOO LOW FLAPS, TOO LOW FLAPS”
			LG	“TOO LOW GEAR, TOO LOW GEAR”
		HIGH speed	FLAPs or LG	“TOO LOW TERRAIN, TOO LOW TERRAIN”
Excessive deviation below an ILS glide slope	 	“GLIDESLOPE, GLIDESLOPE” **“GLIDESLOPE, GLIDESLOPE, GLIDESLOPE” **“GLIDESLOPE, GLIDESLOPE, GLIDESLOPE, GLIDESLOPE”		

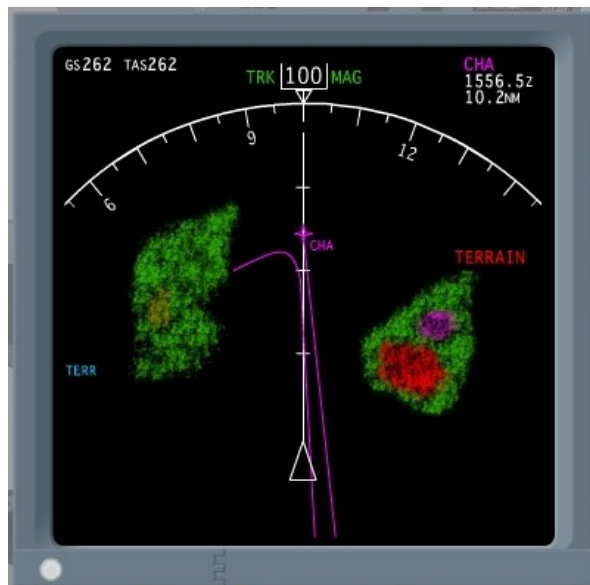
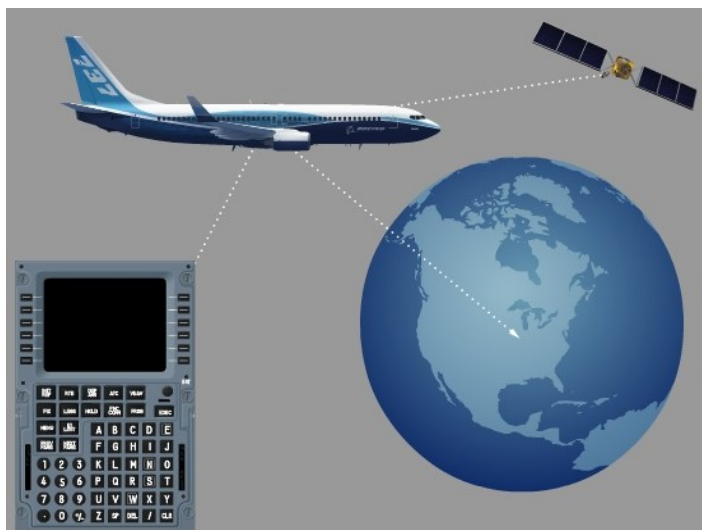
*if the conditions is not corrected, or becomes more severe, the aural will change to:

**if further descending after the initial alert before regaining initial descent altitude

Terrain proximity

GPWS monitors terrain proximity using an internal worldwide terrain database. The terrain display is generated from a database contained in the GPWS computer and correlated to GPS position.

Terrain data affecting the flight shows on ND. If there is a potential terrain conflict, alerts are provided based on the estimated time to impact.



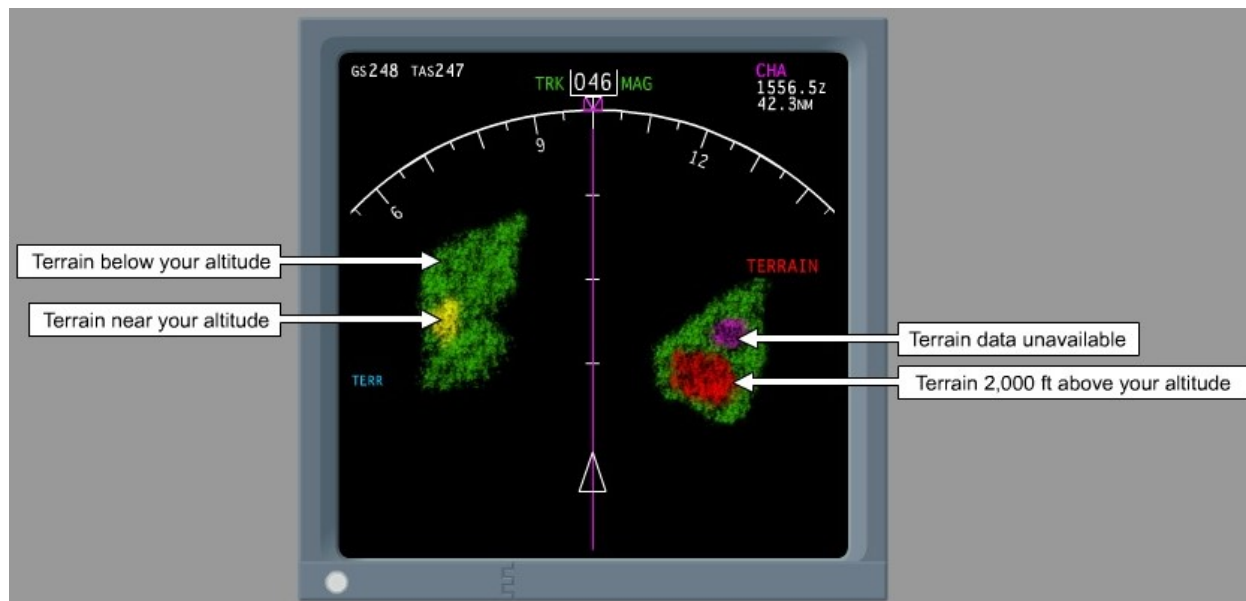
GPWS database

GPWS database contains detailed terrain data near major airports and data in less detail for areas between airports.

Terrain displayed on ND

Only terrain within ± 2000 ft of aircraft barometric altitude is shown on ND.

TERRAIN and WXR cannot be displayed together on the same ND. All other displays (TCAS, LNAV etc...) can be displayed with terrain.



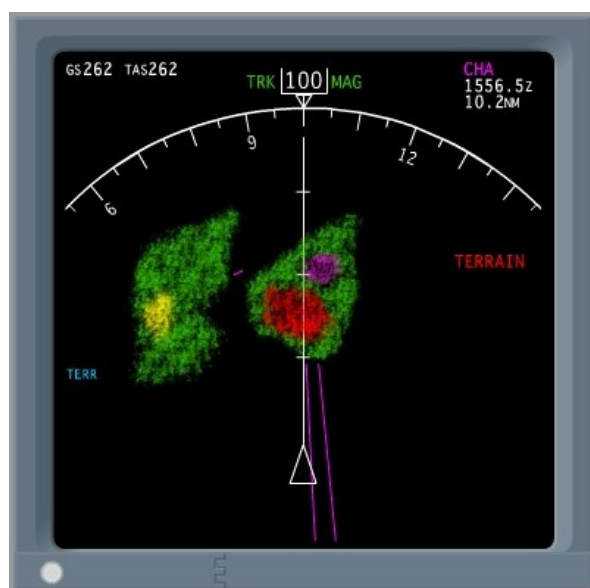
Priority

Radio altitude and look-ahead based alerts are prioritised according to the level of hazard and required reaction time. WINDSHEAR warnings inhibits both look ahead and radio altitude based alerts.

Look-ahead based alerts

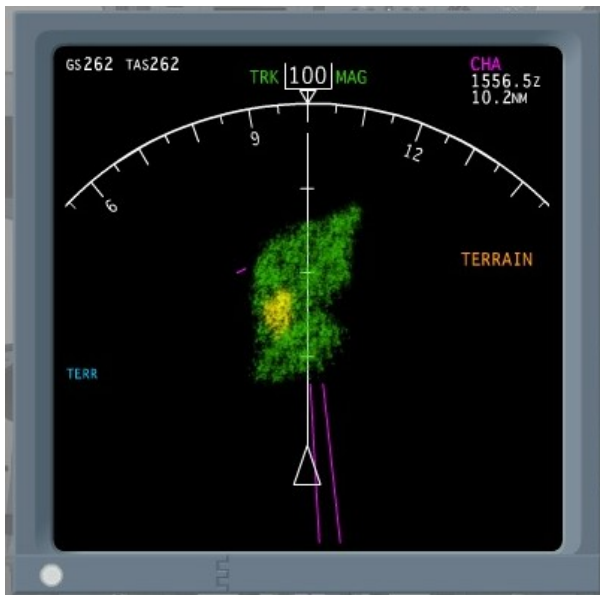
“TERRAIN, TERRAIN, PULL-UP”

“TERRAIN, TERRAIN, PULL-UP” sounds when the aircraft is 20 to 30 seconds from projected impact with the **terrain** shown as solid **RED** on ND. **PULL-UP** appear on PFD and **TERRAIN** on ND.



“CAUTION TERRAIN”

“CAUTION TERRAIN” sounds when the aircraft is 40 to 60 seconds from projected impact with the **terrain** shown as solid **AMBER** on ND. **TERRAIN** appear on the ND.



“TOO LOW TERRAIN”

“TOO LOW TERRAIN” sounds for descend below an unsafe RA while too far from any airport in the terrain database. **PULL-UP** appear on both PFD.

(FCOM2 15.20.13) obstacle alerts – EI-DYL through YW135

Obstacle display and alerting provides caution and warning level alerts for man-made obstacle 100 ft and higher

“OBSTACLE, OBSTACLE, PULL-UP”

“OBSTACLE, OBSTACLE, PULL-UP” sounds when 20 to 30 seconds from projected impact with **obstacle** shown **SOLID RED** on the ND. **PULL-UP** appear on both PFD, and **OBSTACLE** on ND

“OBSTACLE CAUTION”

“OBSTACLE CAUTION” sounds when 40 to 60 seconds from projected impact with **obstacle** shown **SOLID AMBER** on the ND. **OBSTACLE** appear on ND.

Alerts inhibition, GROUND PROXIMITY switches (FCOM2 15.20.11)

- TERR INHIBIT: inhibits all look-ahead and obstacle alerts (“TERRAIN, TERRAIN, PULL-UP” “CAUTION TERRAIN” “TOO LOW TERRAIN” “OBSTACLE, OBSTACLE, PULL-UP” “CAUTION, OBSTACLE”)
- GEAR INHIBIT: inhibits “TOO LOW GEAR, TOO LOW GEAR” alerts
- FLAP INHIBIT: inhibits “TOO LOW FLAPS, TOO LOW FLAPS” alerts



sum up table

Aural alert	PFD alert	ND alert	cause
"TERRAIN, TERRAIN, PULL-UP"			20/30 sec. to impact with SOLID RED terrain
"CAUTION TERRAIN"	//		40/60 sec. to impact with SOLID AMBER terrain
"TOO LOW TERRAIN"		//	Descent below safe RA
"OBSTACLE, OBSTACLE, PULL-UP"		OBSTACLE	20/30 sec. to impact with SOLID RED obstacle
"OBSTACLE CAUTION"	//	OBSTACLE	40/60 sec. to impact with SOLID AMBER obstacle

(FCOM2 15.20.13/14/15/16/17/18/19/20/21) runway awareness and advisory system (RAAS)

The runway awareness and advisory system (RAAS) is an enhancement to the GPWS system. RAAS provides aural callouts along with visual alerts on the ND to assist the flight crew with situational awareness during ground operation, approach to landing and go-around.

For proper operation, RAAS require:

- Terrain and airport database in GPWS computer
- Airplane is on or approaching an airport in the RAAS airport runway database
- GPS and other required signals are available and accuracy meets minimum requirements

In flight callouts and alerts are based on an algorithm than numerically subtracts the landing runway touchdown zone elevation in the GPWS database from the pressure altitude of the airplane (above field elevation AFE).

RAAS callouts and alerts may be inhibited by the runway inhibit switch. In the INHIBIT position the RUNWAY INOP light will be extinguished.

RAAS callouts and alerts have a lower priority than any GPWS alert, including RA callouts.

RAAS advisory and caution

For the following table:

XX is the runway designator

ZZ is runway length in meters

W is the runway width

D is the distance from the runway

GS is the aircraft ground speed

	Aural alert	ND alert	Cause
RAAS – in-flight advisories			
Approaching runway	“approaching XX”	APP XX	Between 300 and 750 ft AFE D < 3 NM Track ± 20° from RWY HDG Within 200 ft + W from RWY CL
RAAS – in-flight cautions			
Approaching short runway	“approaching XX, ZZ available”	APP XX ZZ	As approaching runway , and ZZ < 1900 m
RAAS – on ground advisories			
Approaching runway	“Approaching XX”	APP XX	GS < 40 Kts Within a specified distance from RWY
On runway	“on runway XX”	ON XX	Aircraft enters RWY HDG ± 20° RWY HDG
Extended holding on runway	“on runway XX, on runway XX”	ON XX	Aircraft on runway HDG ± 20° RWY HDG Position has changed less than 100 ft in 3’
RAAS – on ground cautions			
Insufficient runway length	“on runway XX, ZZ remaining”	ON XX ZZ	As on runway Available ZZ < 1900 m
Distance remaining (LDG)	“900/600/300/100 meters remaining”	//	AFE < 100 ft and Over last 1200 m, or On ground, over last 1200 m, GS < 40 Kts
Distance remaining (RTO)	“1200/900/600/300/100 meters remaining”	//	On runway with GS > 40 Kts GS decreased 7 Kts from MAX Over last 1200 m
Runway end	“30 meters remaining”	//	On runway with GS < 40 Kts HDG ± 20° RWY HDG Over last 100 ft (30 m)
RAAS – stabilised approach monitor cautions			
Landing flap	“flaps, flaps”	FLAPS	AFE < 600 ft, D < 3 NM Track ± 20° from RWY HDG Flaps not in LDG configuration
Excessive approach angle	“too high, too high”	TOO HIGH	AFE < 950 ft in LDG configuration, or AFE < 600 ft regardless configuration Track ± 20° from RWY HDG, D < 3 NM Glideslope dev > 2 dots or LOC dev > 1 dot
Excessive approach speed	“too fast, too fast”	TOO FAST	AFE < 950 ft in LDG configuration, or AFE < 600 ft regardless configuration Track ± 20° from RWY HDG, D < 3 NM Excessive speed
RAAS – non-routine caution			
Takeoff flap configuration monitor	“flaps, flaps”	FLAPS	Aircraft enter runway HDG ± 20° RWY HDG Flap not T/O position
Taxiway takeoff	“caution on taxiway, on taxiway”	ON TAXIWAY	GS > 40 Kts Not aligned with the runway
Stabilised approach monitor unstable approach	“unstable, unstable”	UNSTABLE	450 ft > AFE > 300 ft One of the stabilised approach monitor caution has been triggered
Taxiway landing	“caution taxiway, caution taxiway”	TAXIWAY	250 ft > AFE > 150 ft ROC < 450 ft/min D < 5 NM, not aligned
Long landing monitor	“long landing, long landing”	LONG LANDING	100 ft > AFE > 5 ft or weight on wheel false Past 33% of ZZ

Windshear and PWS (predictive windshear)

windshear alerts and PWS are available during takeoff, approach and landing

- GPWS provides warning when the airplane is in windshear (windshear alerts)
- Airborne weather radar (AWR) provides predictive windshear (PWS) alerts for excessive windshear ahead of the aircraft



“WINDSHEAR” warning

“WINDSHEAR” sounds and **WINDSHEAR** appear on PFD. GPS windshear detection begins at rotation and is enabled below 1500 ft RA



Windshear caution

Windshear caution are accompanied by a voice aural alert.

Priority

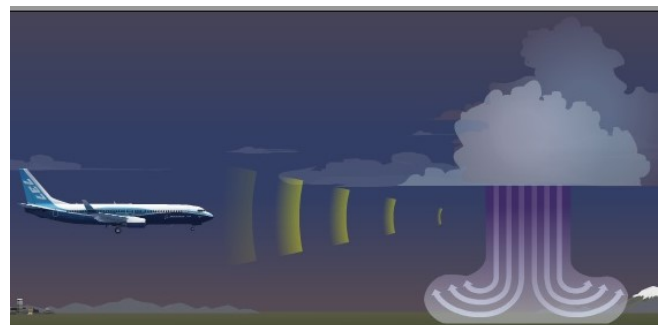
Windshear alerts are prioritised according to the hazard and crew reaction time.

Predictive windshear (PWS) alerts are inhibited by:

- Actual “WINDSHEAR” warning
- Radio altitude based alerts
- Look-ahead terrain alerts

Predictive windshear (PWS)

The airborne weather radar (AWR) uses imaging to detect disturbed air prior to entering a windshear. PWS alerts are only provided for areas containing some level of moisture or particular matter, since a radar echo is required.



“WINDSHEAR AHEAD”

“WINDSHEAR AHEAD” sounds when windshear close to and directly ahead of the airplane is detected by AWR. It enabled below 1200 ft RA. **WINDSHEAR** appear on PFD and ND

“GO-AROUND, WINDSHEAR AHEAD”

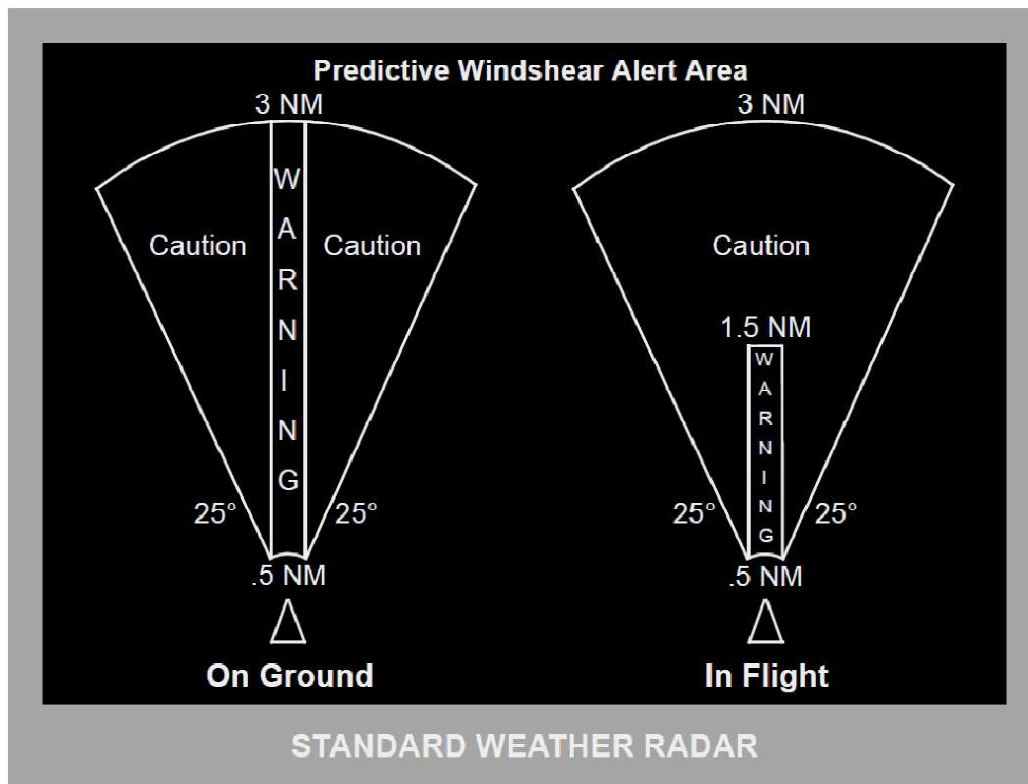
“GO-AROUND, WINDSHEAR AHEAD” sounds when windshear is detected within 1.5 NM directly ahead of the airplane. Is enabled during approach below 1200 ft RA.

WINDSHEAR appear on PFD and ND



“MONITOR RADAR DISPLAY”

“MONITOR RADAR DISPLAY” sounds when windshear is detected within 3 NM ahead of the aircraft. Is enabled during T/O and approach below 1200 ft RA. **WINDSHEAR** appear on PFD and ND



Automatic scanning

AWR automatically begins scanning for windshear:

- When thrust levers are set for takeoff (even if one engine inoperative or IRS not aligned)
- In flight below 2300 ft RA (PWS alerts are issued only below 1200 RA)

PWS availability

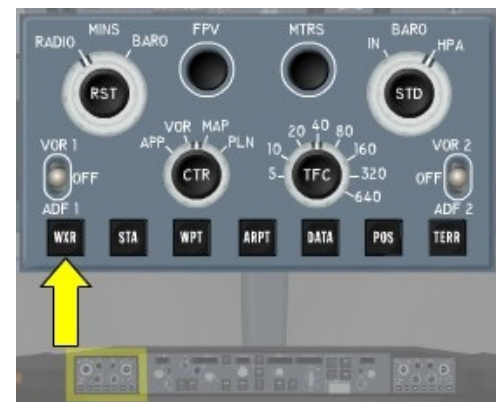
PWS alerts are available 12 seconds after AWR begins scanning. PWS can be enabled prior to takeoff by pushing WXR on EFIS control panel. When PWS is enabled, AWR antenna scan sweep is reduced.

PWS inhibition

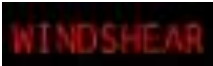
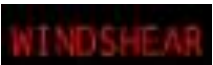
During takeoff and landing:

- New PWS CAUTION alert are inhibited between 80 Kts and 400 ft RA
- New PWS WARNING alerts are inhibited between 100 Kts and 50 RA

These inhibitions do NOT remove existing PWS alerts.



Sum up table

Aural alert	PFD visual alert	ND visual alert	Cause
"WINDSHEAR AHEAD"			WS close and <u>directly</u> ahead of the airplane has been detected
"GO-AROUND, WINDSHEAR AHEAD"			WS <u>directly</u> ahead within 1.5 NM
"MONITOR RADAR DISPLAY"	//		WS ahead within 3 NM

TCAS (traffic in collision avoidance system)

The transponder control panel contains the controls, switches and indicators required for TCAS operation.

Transponder operation

- TEST: perform a test of transponder and TCAS
- STBY: transponder is powered but does not reply from ATC or other TCAS signals
- ALT OFF: enables mode A and S without ALT reporting
- ALT ON: enables mode A, C (ALT rep.) and S
- TA (only): enables transponder and TCAS TA (only). only TA will be displayed. TA (only) selection is normally made in cases where degraded aircraft performance is a factor (ie. Engine failure)
- TA/RA: enables transponder and TCAS TA and RA, with:
 - TFC ON: TA, RA and "proximate intruders" will be displayed
 - TFC OFF: TA, RA will be displayed automatically
- ATC switch: designate the selected transponder to be the master, the other one remains in STBY or back-up mode
- ALT switch: designate which ADIRU (air data inertial reference unit) will be used for altitude reporting



TCAS ND indications

TCAS information are displayed on the ND when TFC is selected. Even if TFC is not selected, TA and RA are automatically displayed

Intruder classification



	Other Traffic
	Proximate Traffic
	Traffic Advisory
	Resolution Advisory

= intruder is further than 6 NM (more than 40 sec.) away

= intruder is within 6 NM (more than 40 sec.) at ± 1200 ft

= intruder impact in less than 40 sec. "TRAFFIC, TRAFFIC"

= intruder impact in less than 25 sec "CLIMB", "DESCENT" etc...

PFD operation

PFD will display RA vertical orders:

- Single RA: one RED area to avoid is displayed
- Multiple RA: two RED areas to avoid are displayed

On the VSI:

- **RED** pointer: present vertical speed incorrect to avoid the traffic
- **WHITE** pointer: present vertical speed is correct to avoid the traffic



Intruder relative altitude and vertical speed

Intruder relative altitude is indicated in 100 ft increments

+02	+02	200 ft Above
-08	-08	800 ft Below
00	00	Same Altitude Traffic Descended to Altitude
00	00	Same Altitude Traffic Climbed to Altitude

An arrow will be displayed if the intruder is climbing/descending with a vertical speed greater than 500 ft/min

 	Traffic Climbing > 500 ft/min
 	Traffic Descending > 500 ft/min

No bearing intruder

If the intruder position for the TA or RA display on ND is not available, range, relative altitude and vertical motion will be displayed as digital figures.



TCAS ND messages

- **TFC**: all intruder will be displayed
- **TCAS FAIL**: TCAS has failed or information cannot be displayed
- **TCAS OFF**: TFC switch has been pushed but TCAS not selected on transponder panel
- **TCAS TEST**: TCAS is on test mode
- **OFFSCALE** (RED or AMBER): **RA** or **TA** out of scale (ND range selected)



TCAS aural messages

Message	Meaning
" TRAFFIC, TRAFFIC "	TA intruders
" MONITOR VERTICAL SPEED "	Keep the pitch attitude outside the red RA region
" MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN "	Pitch attitude and V/S is outside the red RA region
" CLIMB, CLIMB "	Pitch attitude and V/S is inside the red RA region
" CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB "	Pitch attitude and V/S is inside the red RA region
" DESCEND, DESCEND "	Pitch attitude and V/S is inside the red RA region
" DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND "	Pitch attitude and V/S is inside the red RA region
" INCREASE CLIMB, INCREASE CLIMB "	V/S is not sufficient to achieve safe vertical separation with the traffic
" INCREASE DESCENT, INCREASE DESCENT "	V/S is not sufficient to achieve safe vertical separation with the traffic
" ADJUST VERTICAL SPEED, ADJUST "	Adjust V/S to remain outside the red RA region
" DESCEND, DESCEND NOW, DESCEND, DESCEND NOW "	Decrease pitch attitude and V/S to remain outside the red RA region
" CLIMB, CLIMB NOW, CLIMB, CLIMB NOW "	Increase pitch attitude and V/S to remain outside the red RA region
" CLEAR OF CONFLICT "	Range is increasing and the separation is adequate

"CROSSING": means that the airplane will cross traffic altitude

"NOW": means that traffic trajectory has changed

Resolution advisories

- Preventive advisories: actual VS may be maintained
- Corrective advisories: actual VS is within the range to be avoided
- Modified corrective advisories: RA is already displayed, a correction to VS is required due to the intruder changing vertical speed

Preventive Advisory	Corrective Advisory	Modified Corrective Advisory
Example: "MONITOR VERTICAL SPEED" or "MAINTAIN VERTICAL SPEED, MAINTAIN"	Example: "DESCEND, DESCEND" or "CLIMB, CLIMB"	Example: "CLIMB, CLIMB NOW, CLIMB, CLIMB NOW" or "DESCEND, DESCEND NOW, DESCEND, DESCEND NOW"

Other alerts

“BANK ANGLE, BANK ANGLE”

“BANK ANGLE, BANK ANGLE” sounds when bank angle exceeds 35°, 40° and 45°. Once sounded for a given bank angle, the alert is silent for that bank angle, until the system is reset by decreasing the bank angle to 30° or less.

(FCOM2 15.20.25) Radio altitude callouts

- 2,500 feet – TWENTY FIVE HUNDRED
- 1,000 feet – ONE THOUSAND
- 500 feet – FIVE HUNDRED (Smart)
- 50 feet – FIFTY
- 40 feet – FORTY
- 30 feet – THIRTY
- 20 feet – TWENTY
- 10 feet – TEN.

500 ft callout is given if:

- Flight path is not within ± 2 dots of a localizer beam
- Flight path is not within ± 2 dots of a glideslope beam
- Back course approach is detected or glideslope cancel is selected
- Approach other than ILS or GLS is used (valid localizer frequency must be tuned)

(FCOM2 15.20.25/26) Minimums callout

DH/MDH callouts are provided by the GPWS according to the setting on the captain EFIS control panel, at:

- DH/MDA + 100 ft: “PLUS HUNDRED”
- DH/MDA: “MINIMUMS”

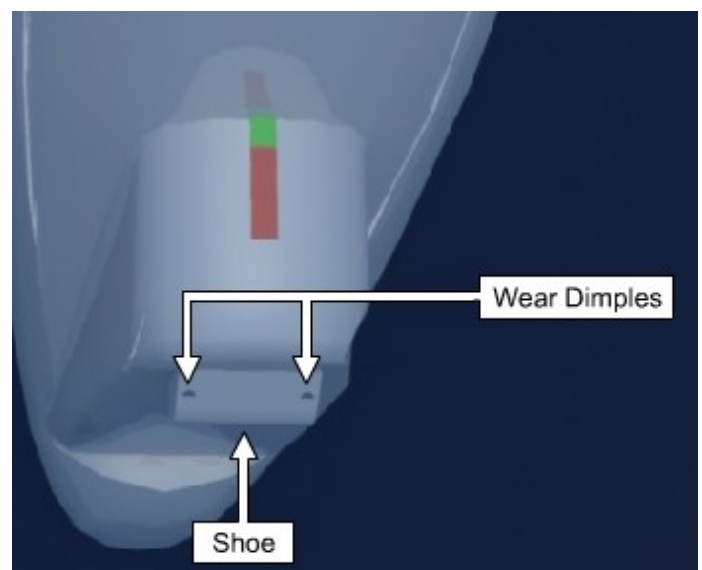
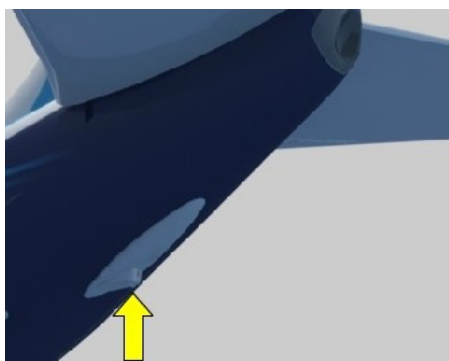
(FCOM2 15.20.25) “AIRSPEED LOW, AIRSPEED LOW”

“AIRSPEED LOW, AIRSPEED LOW” sounds when the current airspeed decreases into the minimum manoeuvre speed amber bar.

Tail skid assembly

- Both GREEN and RED band visible: serviceable
- Only RED visible: cartridge must be replaced

The shoe is what contact the runway in the event of an over rotation

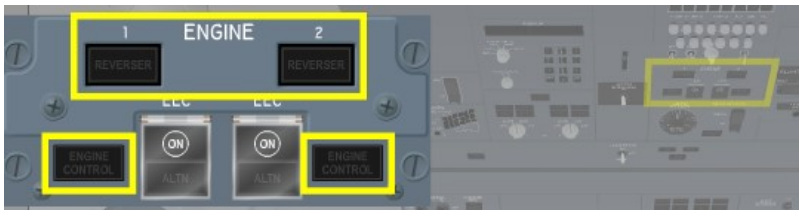


ENGINES – SYSTEM DESCRIPTION

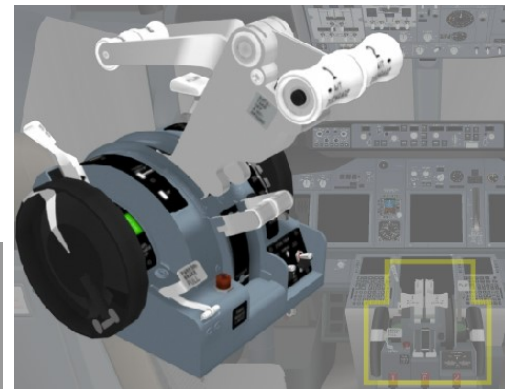
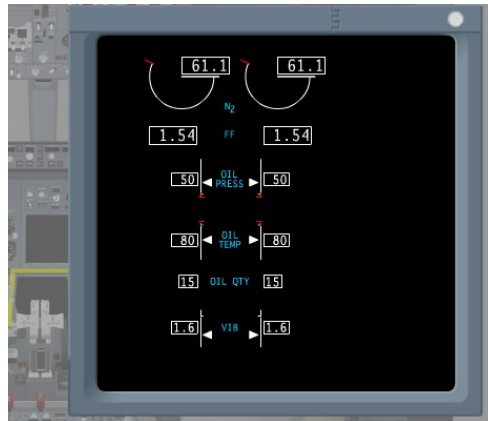
Overview

B737NG is powered by two CFM56-7 high-bypass-ratio turbofan engines. CFM56-7 is a dual rotor (twin spool) axial flow engine, with a rated thrust up to 27300 lbs.

- N1 rotor: consist of fan, low pressure (LP) compressor and LP turbine
- N2 rotor: consist of high pressure (HP) compressor and HP turbine; N2 drives all engine gearboxes while bleed air starter drives N2 for starting
- ENGINE START switches: located on the forward overhead panel
- Ignition (IGN) switch: each engine has 2 igniters plug (L and R) controlled by the IGN switch
- Engine display control panel: located on the centre forward panel
- Engine panels: located on the aft overhead panel



- Engine controls: located on the control stand
- Primary engine indication: displayed on the upper display unit (DU)
- Secondary engine indication: displayed on the lower display unit (DU)



EEC (electronic engine control)

Each engine is controlled by a dual channel EEC. Dual channel ensure reliability in the event of a single channel fault.

Forward and reverse thrust are automatically controlled by each EEC. The EEC uses N1 to set thrust and can operate both in NORMAL (ON) or **ALTN** mode

NORMAL (ON) mode: EEC calculates N1 thrust rating using ambient flight condition and bleed air demand. Commanded and actual N1 values are compared and the EEC automatically adjust fuel flow to achieve the desired thrust.

During most takeoff, thrust lever will not reach the forward stop, maximum rated thrust is always available at the forward stop.

Normal	
	• Flight conditions • Bleed air demand
Alternate	
	• Hard
	• Soft

SOFT ALTN mode (ON and **ALTN** illuminated): EEC automatically changes to SOFT ALTN mode when required signals for NORMAL operation are lost. A change to SOFT mode should occur with no immediate effect on engine thrust as the EEC uses the last valid conditions to control engine parameters. As flight condition changes, a thrust exceedence or short fall can occur.

HARD ALTN mode (**ALTN** illuminated): is activated by:

- Retarding thrust levers to IDLE (ON stays visible)
- Manually selecting **ALTN** on EEC switch

HARD ALTN mode will always provide thrust equal to or greater than that provided in NORMAL mode.

EEC protection

N1 and N2 OVERSPEED protection: provided both NORMAL and ALTN mode

EGT protection: provided **only** for ground starting, after start-up the EEC does NOT provide EGT exceedence protection

IDLE modes

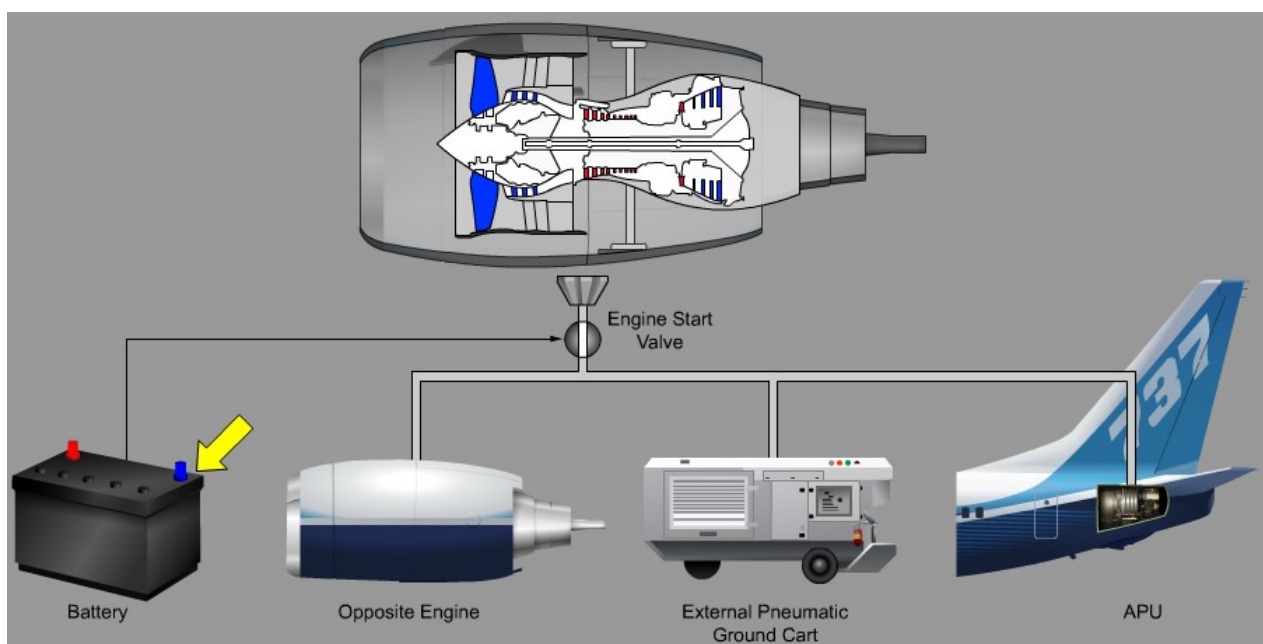
- Ground minimum IDLE: selected during taxi out and after touchdown
- Flight minimum IDLE: selected in-flight (unless in approach minimum IDLE)
- Approach minimum IDLE: selected in-flight when:
 - i. FLAPs in landing configuration, or
 - ii. ANTI-ICE selected ON on either engine
 - iii. (FCOM2 7.20.5) if FLAPs and ANTI-ICE are not received by ECCs, below 15000 ft MSL

Approach idle allows for improved engine acceleration in the event of a go-around

Engine starting

CFM56-7 requires both pressurised BLEED air and electrical power for engine starting.

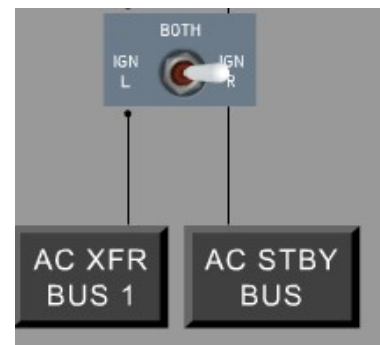
- BLEED air: from APU or external pneumatic ground cart or BLEED from opposite engine
- Electric power: AC is preferred, but only BAT power can be used as well



Ignition selection

EEC will ARM one or BOTH igniters plug according to IGN switch position:

- IGN L: powered by associated AC TRANSFER BUS
- IGN R: powered by AC STBY BUS (IGN R is the only available for BAT start)



Auto-relight

EECs provide auto-relight in the event of engine flame-out. Both igniters are activated automatically when:

- N2 RPM are below IDLE
- Rapid uncommanded N2 RMP drop occurs



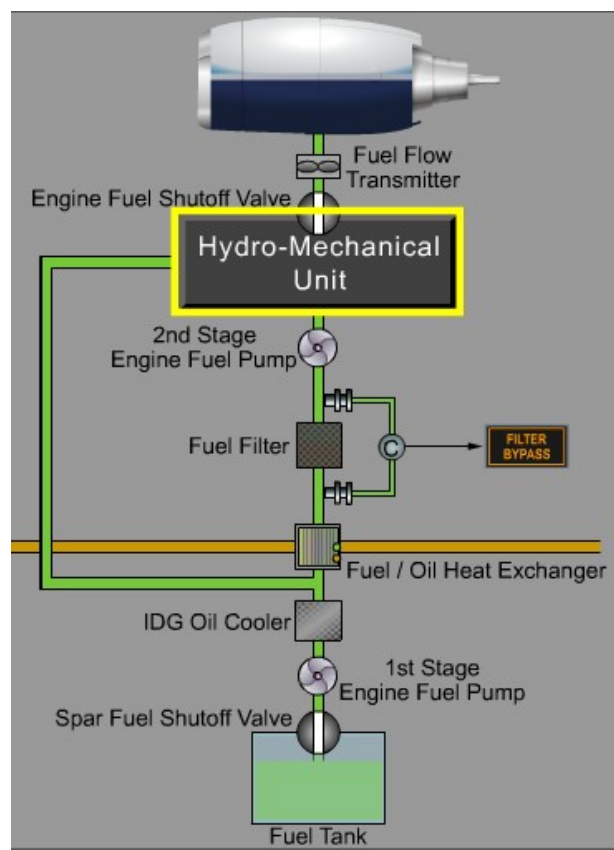
In-flight restart

Windmill and cross bleed (X-BLD) restart are available in flight, however the abnormal ground start protection are not available for in-flight restart. If a cross bleed start is required, X-BLD will appear in over N2 indication.

Fuel system

SPAR fuel SHUT-OFF valve and ENG fuel SHUT-OFF valve control fuel to the engine.

- First stage engine fuel pump: delivers pressurised fuel to the system
- OIL/HEAT exchangers: IDGs and engine oil are used to heat the fuel
- Fuel filter: used to remove contaminant, in case of filter blockage, BYPASS is automatically provided, causing "FILTER BYPASS" light to illuminate
- Second stage engine fuel pump: increases pressure before delivering fuel to the HMU
- Hydro mechanical unit (HMU): is controlled by the EEC in order to meter fuel and obtain required engine thrust

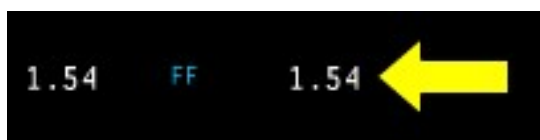


Valves lights

ENG VALVE CLOSED and SPAR VALVE CLOSED lights indicate the position of the associated valve

Fuel flow

A fuel flow transmitter, located after the ENG fuel SHUT-OFF valve, provides information to the FMS and FF display



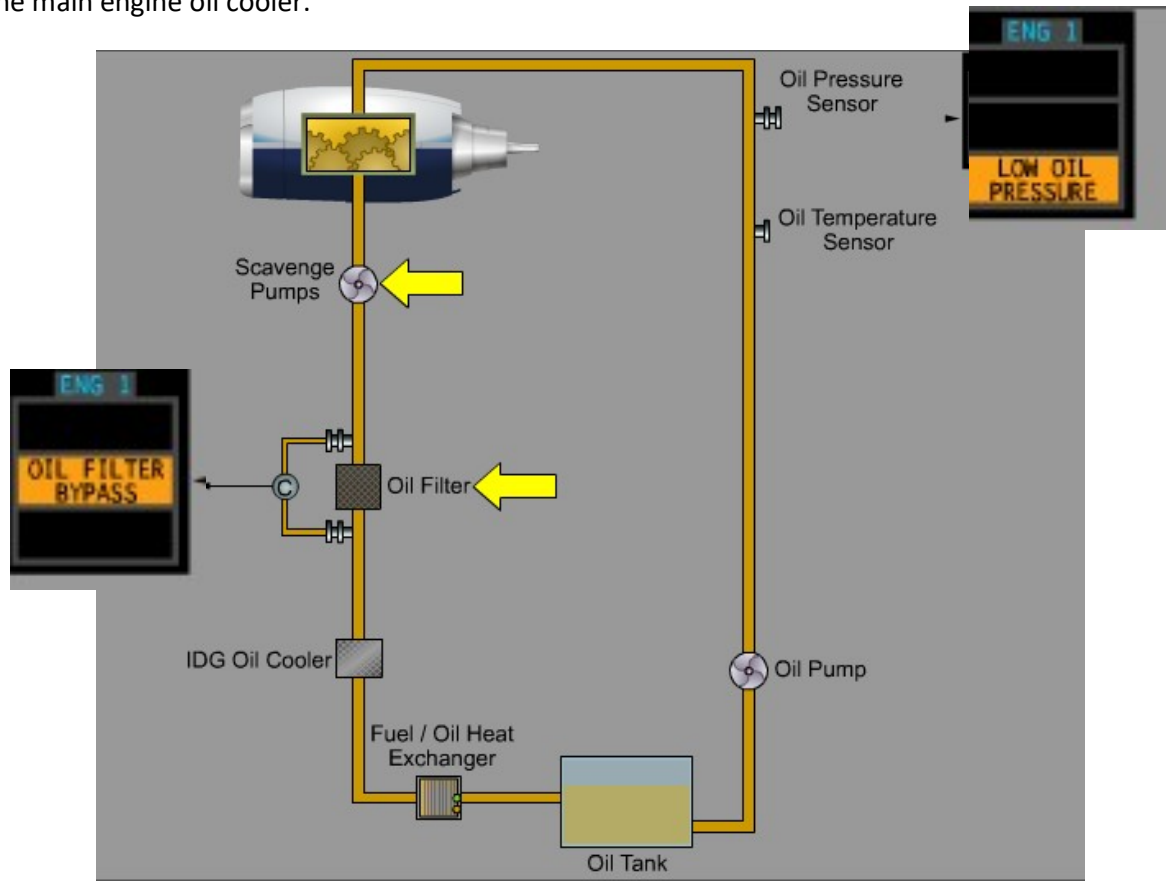
Oil system

Oil temperature and pressure indication are provided.

“LOW OIL PRESSURE” light illuminate when oil pressure is below RED line

scavenge pump: is used to return the oil to the tank, a scavenge filter is provided, should the scavenge filter being bypassed, an “OIL FILTER BYPASS” light will illuminate.

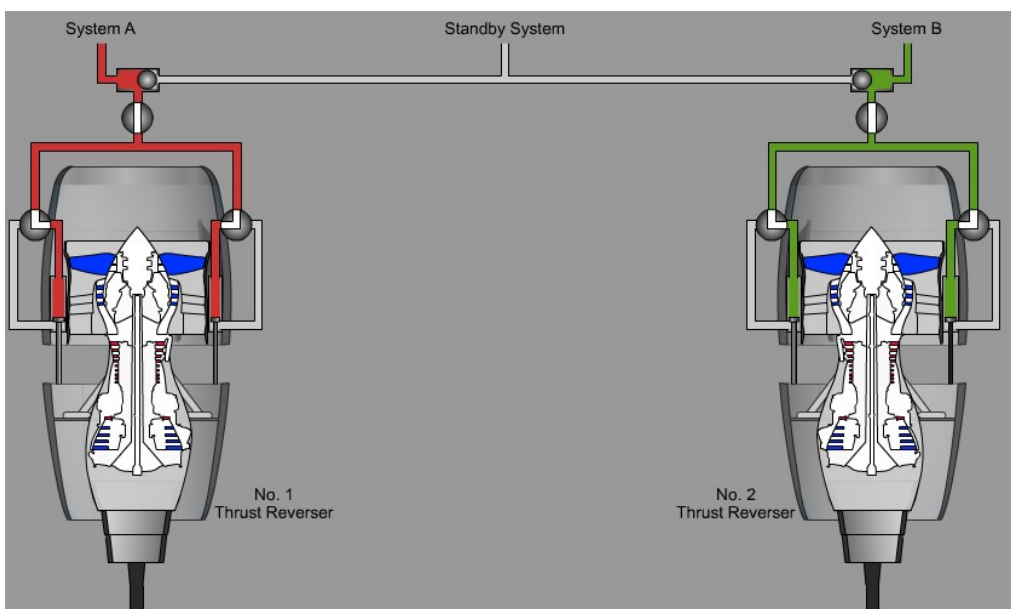
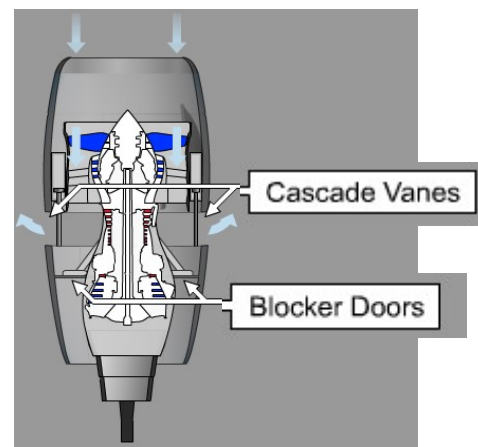
Oil is cooled by the main engine oil cooler.



Reverser

Hydraulically operated thrust reverser are incorporated in each engine.

- HYD system A: operates n°1 reverser
- HYD system B: operates N°2 reverser
- STBY HYD system: allows alternate operation, reverser will be at a slower rate and some thrust asymmetry can be expected



Reverse protection

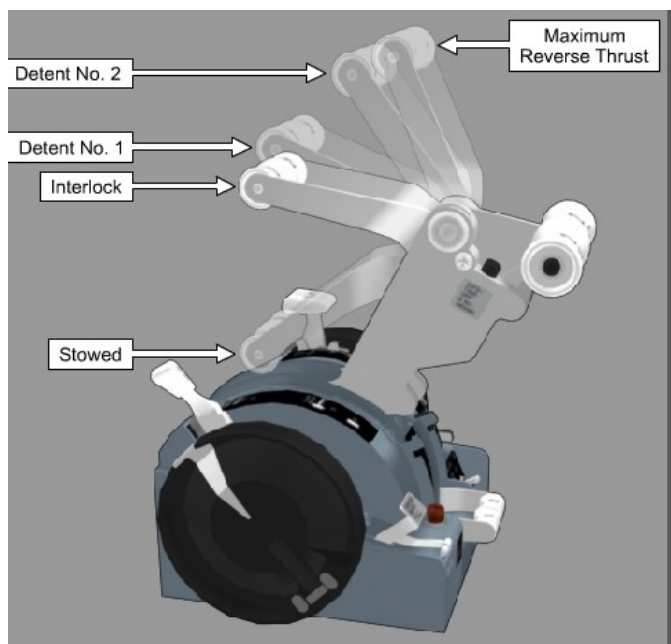
Reverse thrust is prohibited in-flight, protection are incorporated in a way that reverse thrust lever are mechanically restricted from operating until:

- Forward thrust lever are at IDLE, and
- RA below 10 ft or ground mode is sensed

Operation

Reverse deployment begins when the reverse thrust levers are raised to the interlock position. This opens the reverse isolation valve and move thrust reverser control valves to deploy reverser. Interlock position restrict further movements until reverse sleeves are deployed.

Movement of reverser sleeves illuminates "REV" over N1 indication and "REV" once the sleeves have reached the deploy position.



Reverser light

"REVERSER" will illuminate for approximately 10 seconds any time thrust reverser is commanded to stow.

After 12 seconds "MASTER CAUTION" and "ENG" system annunciator will illuminate, indicating a malfunction.



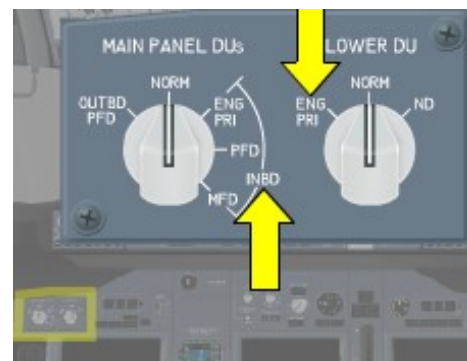
Reverser stowing

Once the reverser sleeves are stowed, motion is inhibited by an electro-mechanical lock. If incomplete stowage is detected, the auto-restow circuit will automatically power hydraulic circuit till when complete stowage is achieved.
Once auto-restow is activated, the reverse isolation valve remains open and the control valves are held in the stowed position, until thrust reverser is commanded to deploy or corrective maintenance action is taken.

Engine displays

Primary indications

N1 and EGT are primary indication and normally displayed on the upper DU (display unit). They will be automatically displayed on lower DU in case of primary DU failure. manual selection through display selector switches allows primary engine indication to be displayed on the inboard DU or lower DU.

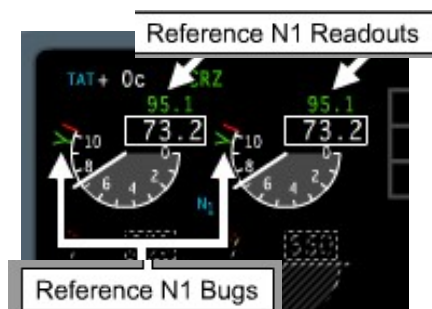


Reference N1 and N1 readouts are displayed according to the position of the N1 **outer knob** on the centre forward panel.

AUTO: FMC sets both reference N1 bugs based on N1 LIMIT page and T/O page.

BOTH/1/2: use **inner knob** to manually set N1 reference/readout bugs

RED line: N1% RMP LIMIT

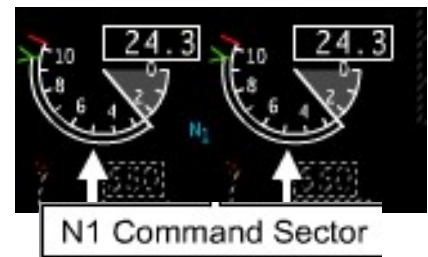


WHITE command sectors: show the difference between commanded and actual N1



WHITE digits: show the normal operating range

RED digits: displayed when a limit is exceeded. After shut-down a RED box will indicate that an exceedence has occurred.



N1 readouts replaced by --- : in AUTO mode if FMC source becomes invalid



Thermal anti-ice indication:

- TAI: cowl ANTI-ICE VALVE open
- TAI: cowl ANTI-ICE VALVE not in position according to ANTI-ICE switch



Thrust Mode Annunciations	
R-TO	Reduced Takeoff
R-CLB	Reduced Climb
TO	Takeoff
TO 1	Derated Takeoff One
TO 2	Derated Takeoff Two
D-TO	Assumed Temperature Reduced Thrust Takeoff
D-TO 1	Derated One and Assumed Temperature Reduced Thrust Takeoff
D-TO 2	Derated Two and Assumed Temperature Reduced Thrust Takeoff
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

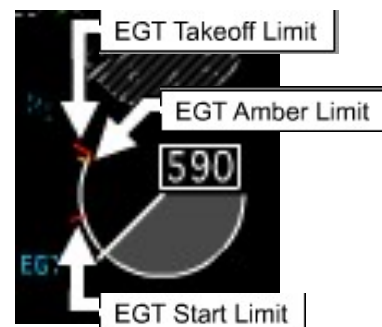
Assumed temperature T/O: selected temperature will be displayed according to the FMC T/O reference page.

A/T LIM indication: FCM is not providing N1 LIMIT to A/T. this indicates that A/T is using a degraded N1 LIMIT provided by the EEC.



EGT limits:

- EGT start limit: RED line displayed until engine reaches a stabilised IDLE (59% N2)
- EGT takeoff limit: RED line
- Maximum continuous EGT: AMBER line
- WHITE figures: displayed in normal operating range
- AMBER figures: maximum continuous EGT exceeded (inhibited for 5 minutes during TO/GA)
- RED figures: EGT limit exceeded
- FLASHING WHITE box: impending HOT start or compressor stall



Engine failure indication are indicated by "ENG FAIL" if:

- Engine start lever IDLE, and
- N2 below sustainable IDLE (50%)

The alerts remains displayed until:

- Engine recovers
- FIRE switch is pulled
- Start lever moved to CUT-OFF

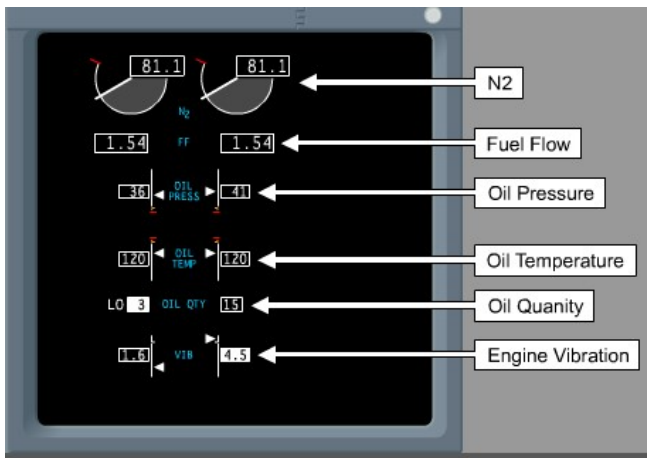


Crew alerts are displayed on the upper DU for:

- "START VALVE OPEN"
- "OIL FILTER BYPASS"
- "LOW OIL PRESSURE"

Crew Alerts	
ENG 1	ENG 2
START VALVE OPEN	START VALVE OPEN
OIL FILTER BYPASS	OIL FILTER BYPASS
LOW OIL PRESSURE	LOW OIL PRESSURE

Secondary indications



secondary engine indication appear any time that:

- The common display system is powered
- MFD engine selection is made
- The start lever is moved to CUT OFF in-flight
- Engine failure occur
- Secondary parameters exceed limits

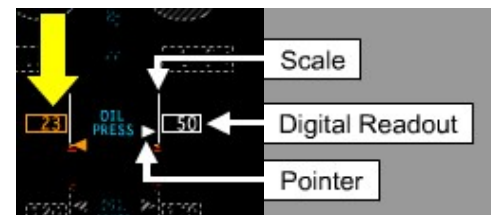
Fuel flow (Kg/h x 1000) is displayed according to FUEL FLOW switch position:

- **RATE** (spring loaded position): display current fuel flow
- **USED**: fuel used since last reset is displayed for 10 seconds
- **RESET**: display fuel USED for 1 seconds and RESET fuel used to 0



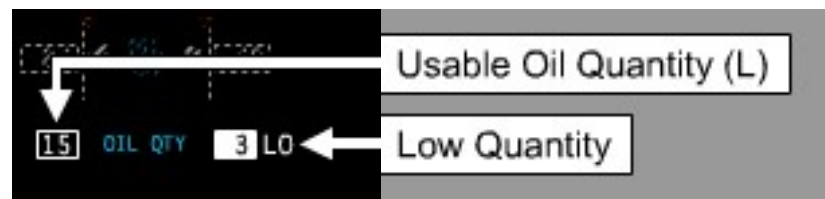
Oil pressure (PSI) indication will be shown in:

- **AMBER**: when in the caution range (unless N2 below 65%)
- **RED**: when limit has been exceeded



Oil temperature (°C) indication will be shown in:

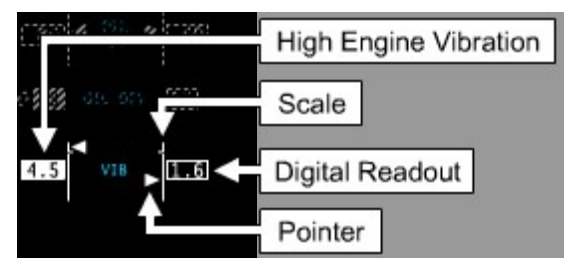
- **AMBER**: when in the caution range
- **RED**: when limit has been exceeded



Oil quantity (liters) is displayed with reversed video* (WHITE background, BLACK figures) when a low quantity condition is detected. Note that the correct oil quantity will be displayed on ground and level flight and:

- Oil quantity may decrease significantly during engine start, takeoff and climb
- Oil quantity as low as zero is normal if windmilling N2 RPM below 8%

Vibration level is displayed with reversed video* if high vibration level is detected



Compact display

Secondary engine indication may be displayed on upper DU together with primary indication when:

- Lower DU fails
- Manual selected

ENGINES – NORMAL OPERATION

Engine start (FCOM1 NP.21.51)

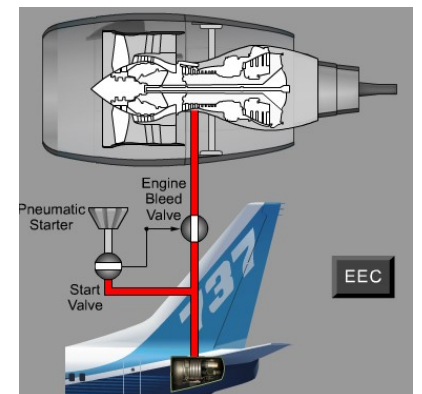
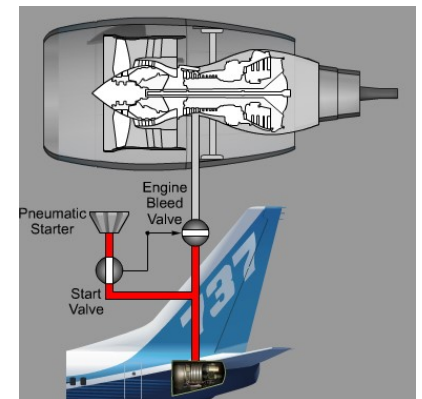
PILOT FLYING	PILOT MONITORING
Announce engine start sequence. Plan to start engines to result in minimum fuel consumption. Normal starting sequence is 2, 1.	
Call "STARTING ENGINE No. ____." Position ENGINE START switch to GRD.	
Verify increase in N2 RPM and call "N2."	
	Verify increase in oil pressure by the time engine is stabilized at idle and call "OIL PRESSURE" when observed.
Verify increase in N1 RPM and call "N1."	
Position engine start lever to IDLE detent when: • N1 rotation is observed and • N2 RPM reaches 25% or (if 25% N2 is not achievable) Max motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.	Start lever IDLE: - Open SPAR and ENG VALVE - EEC supply fuel and ignition
Verify SPAR VALVE CLOSED light transitions from dim, to bright and then extinguishes.	
At 56% N2 RPM, check ENGINE START switch moves to OFF.	
	If ENGINE START switch fails to move to OFF; manually position the ENGINE START switch to OFF.
	Verify fuel flow and EGT indication.
	At starter cutout verify START VALVE OPEN alert extinguishes as the ENGINE START switch moves to OFF and call "STARTER CUTOUT."

GRD selected:

- Open start valve
- Closes bleed valve
- ARM selected IGN
- Allow pressure to starter motor
- Starter rotate N2 through accessory gearbox

START VALVE OPEN

"START VALVE OPEN" illuminate



At 56% N2:

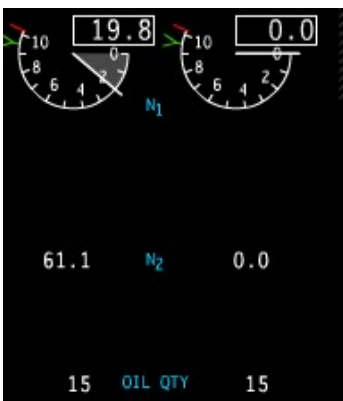
- Power removed from ENGINE START switch solenoid. ENGINE START switch return on OFF (AUTO)
- Engine bleed valve return to selected
- Start valve closes, "START VALVE OPEN" extinguish

NOTE: for ground start only EEC monitors engine parameters for impending:

- Hot start/Engine stall/EGT start limit exceedence:
 - i. Ignition and fuel are automatically SHUT-OFF
 - ii. WHITE box around EGT digits blinks
- Wet start:
 - i. Ignition and fuel are automatically SHUT-OFF 15 seconds after start lever moved to IDLE

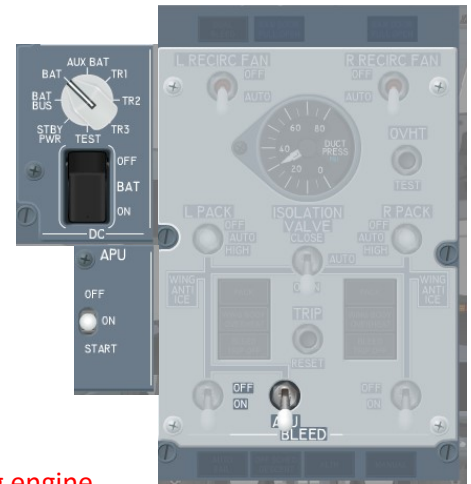
Battery start (refer to FCOM1 SP.7.1)

- Ensure the BAT switch is guarded closed
- Start the APU and ensure APU BLEED air switch is ON (if using APU BLEED for engine start)
- ensure ANTI-COLLISION light is ON
- Both PACK switches OFF
- Select IGN R for battery start



NOTE: starting with battery power, only the following engine indication will be displayed until EECs are powered (15% N2):

- N1 and N2
- OIL QTY



External air start (FCOM1 SP.7.4)

Starting with Ground Air Source (AC electrical power available)

Engine No. 1 must be started first.

When cleared to start:

APU BLEED air switchOFF

Engine No. 1 startAccomplish

Use normal start procedures.

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

Cross bleed (X-BLD) start (FCOM1 SP.7.5)

- Ensure that the area around the operating engine is clear, as thrust will be above IDLE

Engine Crossbleed Start

Do not accomplish a crossbleed start during pushback.

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

Engine BLEED air switches ON

APU BLEED air switch OFF

PACK switches OFF

ISOLATION VALVE switch AUTO

Ensures bleed air supply for engine start.

Engine thrust lever
(operating engine) Advance thrust lever

Advance thrust lever until bleed duct pressure indicates 30 PSI.

Non-operating engine Start

Use normal start procedures with crossbleed air.

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

In-flight start (QRH 7.24)

Engine In-Flight Start

Condition: An engine start is needed and all of the following are true:

- There was **no** engine fire
- There is N1 rotation
- There is **no** abnormal airframe vibration

Note: Oil quantity indication as low as zero is normal if windmilling N2 RPM is below approximately 8%.

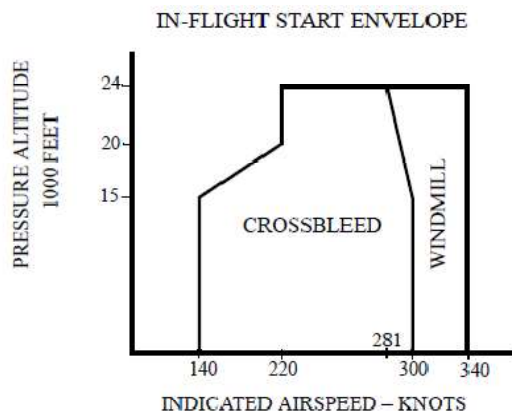
- 1 Do this checklist **only** after completion of the Engine Failure or Shutdown checklist or as directed by the Engine Limit or Surge or Stall checklist or by the Loss of Thrust on Both Engines checklist.
- 2 Check the In-Flight Start Envelope. X-BLD or XB indication may not match the envelope. Starts are not assured outside of the In-flight Start Envelope.

Note: If the N2 is less than 8%, ENGINE START switch must be in CONT to display the EGT.

Note: For engines shut down one hour or more, or if EGT is less than 30°C, attempt a restart:

- At an altitude at or below 20,000 feet
- With airspeed at or above 220 knots
- Using a crossbleed start.

➔ LOW OIL QTY indication is normal



- 3 Thrust lever
(affected engine) Confirm Close
- 4 Engine start lever
(affected engine) Confirm CUTOFF
- 5 Engines can accelerate to idle very slowly,
especially at high altitudes or in heavy
precipitation. If N2 is steadily increasing and EGT
stays within limits, do not interrupt the start.

6 Choose one:

◆ **Windmill start:**

ENGINE START switch
(affected engine) FLT
▶▶ Go to step 7

◆ **Crossbleed start:**

PACK switch (affected side). OFF
DUCT PRESSURE Minimum 30 PSI
Advance the thrust lever to increase
duct pressure if needed.
ENGINE START switch
(affected engine) GRD
▶▶ Go to step 7

7 When N2 is at or above 11%:

Engine start lever
(affected engine) IDLE detent
Monitor EGT to ensure it does not rise rapidly or
exceed the start limit of 725° C during the start
attempt.

8 Choose one:

◆ **EGT increases** within 30 seconds **and** a normal
start occurs:

▶▶ Go to step 10

◆ **EGT does not increase within 30 seconds or
another abort start condition as listed in the
Normal Procedures occurs:**

Engine start lever
(affected engine) . . . Confirm . . . CUTOFF
ENGINE START switch
(affected engine) OFF

Note: If the engine has been shutdown for
more than one hour, multiple start
attempts can be needed.

▶▶ Go to step 9

9 Plan to land at the nearest suitable airport.

Note: Do not use FMC fuel predictions.

▶▶ Go to the One Engine Inoperative Landing ()
checklist on page 7.30

■ ■ ■ ■

- 10 Engine GEN switch (affected side) ON
- 11 PACK switch (affected side) AUTO
- 12 ENGINE START switch As needed
- 13 APU As needed
- 14 Transponder mode selector TA/RA

Abort start condition (FCOM1 NP.21.50):

- No N1 rotation
- No oil pressure indication by the time the engine is
stabilised at IDLE
- No increase in EGT within 10 sec of raising start lever
- no increase or very slow increase in N1, N2 after EGT
indication
- EGT rapidly approaching or exceeding start limit

ENGINES – NON-NORMAL OPERATION

Engine start – non-normal

Aborted engine start (QRH 7.1)

Aborted Engine Start

Condition: On the ground, an aborted engine start is needed.

Objective: To shut down the engine and motor it.

1 Engine start lever (affected engine) CUTOFF

2 Choose one:

◆ENGINE START switch is in **GRD**:

Motor the engine for 60 seconds.

ENGINE START switch
(affected engine) OFF

■ ■ ■ ■

◆ENGINE START switch is in **OFF**:

►► Go to step 3

3 After N2 decreases below 20%:

ENGINE START switch
(affected engine) GRD

Motor the engine for 60 seconds.

ENGINE START switch
(affected engine) OFF

■ ■ ■ ■



→ OFF/AUTO

Start valve open (QRH 7.36)

START VALVE OPEN

Condition: The START VALVE OPEN alert indicates the start valve fails to close.

1 ENGINE START switch OFF

2 Choose one:

◆START VALVE OPEN alert **extinguishes**:

■ ■ ■ ■

◆START VALVE OPEN alert **stays illuminated**:

►► Go to step 3

3 ISOLATION VALVE switch CLOSE

4 PACK switch (affected side) OFF

This causes the operating pack to regulate to high flow in flight with flaps up.

5 Engine BLEED air switch
(affected side) OFF

6 Choose one:

◆START VALVE OPEN alert stays illuminated for **engine 1**:

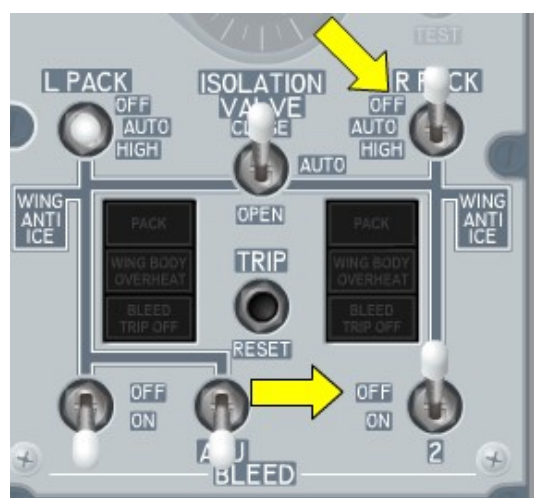
APU BLEED air switch OFF

►► Go to step 7

◆START VALVE OPEN alert stays illuminated for **engine 2**:

►► Go to step 7

START VALVE OPEN



7 Choose one:

◆ **In flight:**

WING ANTI-ICE switch OFF
This prevents possible asymmetrical ice buildup on the wings.
Avoid icing conditions where wing anti-ice is needed.

■ ■ ■ ■

◆ **On the ground:**

Ground air source
(if in use) Disconnect
Engine start lever
(affected engine) CUTOFF

Other engine non-normal operation

EEC ALTN mode (QRH 7.14)

ALTN — **EEC ALTERNATE MODE**
Condition: An EEC operates in the alternate control mode.

1 Autothrottle (if engaged) Disengage

2 Thrust levers (both) Retard to mid position
This prevents exceeding thrust limits when switching to the EEC alternate mode.

3 EEC mode switches (one at a time) ALTN
This ensures both engines operate in alternate mode.

4 Autothrottle (if needed) Engage
Note: Maximum thrust limiting is available with autothrottle engaged.

5 Do not exceed engine limits. Engine limit protection in alternate mode is not the same as in normal mode.



Engine control (QRH 7.16)

ENGINE CONTROL — **ENGINE CONTROL**
Condition: An engine control system fault occurs.

Note: An ENGINE CONTROL light illuminates on the ground only.

1 Do **not** takeoff.

■ ■ ■ ■

→ “ENGINE CONTROL” operates on ground with the engine operating

High engine oil temperature (QRH 7.20)

Engine High Oil Temperature

Condition: The engine oil temperature is high.

1 Choose one:

◆ Temperature is **at or above the redline**:

▶▶ **Go to the Engine Failure or Shutdown () checklist on page 7.17**

■ ■ ■ ■

◆ Temperature is in the **amber band**:

▶▶ **Go to step 2**

2 Autothrottle (if engaged) Disengage

3 Thrust lever (affected engine) Confirm Retard slowly until the engine oil temperature is within the normal operating range or the thrust lever is closed

4 Choose one:

◆ Oil temperature is in the **amber band for 45 minutes or less**:

Note: Run the affected engine at a thrust setting that keeps the engine oil temperature within the normal operating range.

Transponder mode selector TA

This step prevents climb commands which can exceed reduced thrust performance capability.

■ ■ ■ ■

◆ Oil temperature is in the **amber band for more than 45 minutes**:

▶▶ **Go to the Engine Failure or Shutdown () checklist on page 7.17**

Engine low oil pressure (QRH 7.28)

ENGINE LOW OIL PRESSURE

Condition: The engine oil pressure is low. The LOW OIL PRESSURE alert may or may not be illuminated.

1 Choose one:

◆ Engine oil pressure is in the **amber band** with **takeoff thrust** set:

Do **not** takeoff.

■ ■ ■ ■

◆ Engine oil pressure is **at or below the redline**:

▶▶ **Go to the Engine Failure or Shutdown () checklist on page 7.17**

LOW OIL PRESSURE

Engine oil filter bypass (QRH 7.29)

OIL FILTER BYPASS

ENGINE OIL FILTER BYPASS

Condition: The OIL FILTER BYPASS alert indicates oil filter contamination can cause oil to bypass the oil filter.

1 Autothrottle (if engaged) Disengage

2 Thrust lever (affected engine) Confirm Retard slowly until the OIL FILTER BYPASS alert extinguishes or the thrust lever is closed

3 Choose one:

◆ OIL FILTER BYPASS alert **extinguishes**:

▶▶ **Go to step 4**

OIL FILTER BYPASS alert **stays illuminated**:

▶▶ **Go to the Engine Failure or Shutdown () checklist on page 7.17**

■ ■ ■ ■

4 Run the engine at reduced thrust to keep the alert extinguished.

Transponder mode selector TA

This step prevents climb commands which can exceed reduced thrust performance capability.

Reverser (QRH 7.33/34)

REVERSER

REVERSER

Condition: A fault occurs in the thrust reverser system.

Note: Additional system failures may cause in-flight deployment.

- 1 Expect normal reverser operation after landing.

REVERSER UNLOCKED (IN FLIGHT)

Condition: The amber REV indication shows with uncommanded reverse thrust.

Note: Only multiple failures could allow the engine to go into reverse thrust.

Unstowed reverser sleeves produce buffet, yaw, roll and increased airplane drag.

- 1 Check movement of the forward thrust lever on the affected engine.

The EECs prevent power above idle if the related thrust reverser has moved from the stowed position.

Warning! Do not actuate the reverse thrust lever.

- 2 Choose one:

◆ Engine **responds** to forward thrust lever movement **and no** buffet or yaw exists:

Continue normal operation.



◆ Engine does **not** respond to forward thrust lever movement **or** buffet or yaw **exists**:

►► **Go to the Engine Failure or Shutdown () checklist on page 7.17**

APU – SYSTEM DESCRIPTION

APU overview

The APU (auxiliary power unit) is installed in a fireproof compartment located in the tail.

The APU is a self-contained turbine engine that provides independent source of:

- AC electrical power
- BLEED air

APU controls are located on the forwards overhead panel

APU switch

- OFF: normal position when APU is not running
- ON: normal position when APU is running
- START (spring loaded): APU begins automatic starting sequence (switch released to ON)



APU EGT indicator

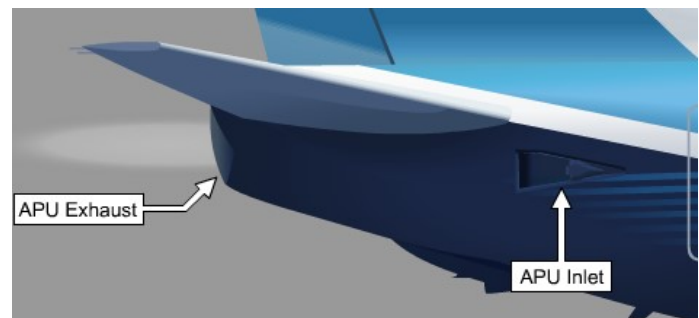
APU EGT indicator remains powered for 5 minutes after APU SHUT-DOWN in order to display residual APU EGT

APU lights

- “**OVER SPEED**”: APU RPM limit exceeded, APU has been SHUT-DOWN automatically
- “**FAULT**”: APU has been automatically SHUT-DOWN due to a malfunction
- “**LOW OIL PRESSURE**”: during APU START remains illuminated until normal OIL PRESSURE is re-established. If the electrical control unit (ECU) senses APU LOW OIL PRESSURE after START, automatic SHUT-DOWN occur and “**LOW OIL PRESSURE**” illuminate.
- “**MAINT**”: APU maintenance related problem has occurred, however APU can still be operated. Light extinguishes when APU switch OFF

APU inlet and exhaust

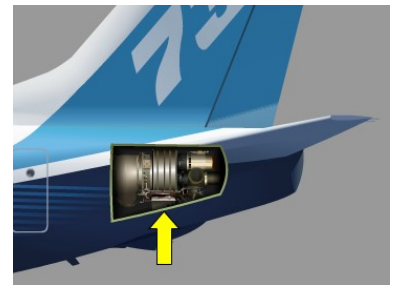
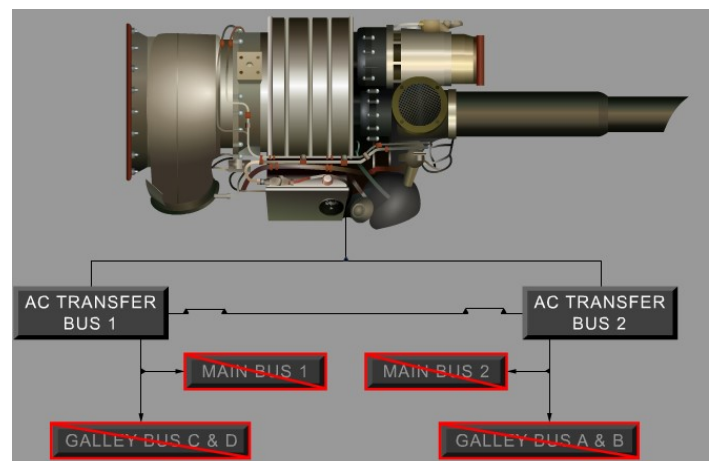
APU inlet is provided by an automatically operated APU air inlet door. APU exhaust is located on the rear tail cone.



ECU (electronic control unit)

ECU provides automatic SHUT-DOWN protection for:

- OVERSPEED
- LOW OIL PRESSURE
- High oil temperature
- APU FIRE
- Fuel control unit failure
- EGT exceedence
- Other system fault



ECU controls APU speed through the fuel control unit. ECU will automatically shed BLEED air and/or ELECTRICAL load to maintain APU speed and EGT margins, in a way that:

- During engine START: maintain BLEED, reduce ELECTRICAL load
- All other occasion: shed BLEED before shedding ELECTRICAL load

In-flight if APU is the only ELECTRICAL power source or on the ground, the APU will attempt to maintain ELECTRICAL load by shedding (if necessary) GALLEY* and then if necessary MAIN BUSSES*.

*manual restoration can be attempted by moving the CAB/UTIL switch to OFF, then back ON

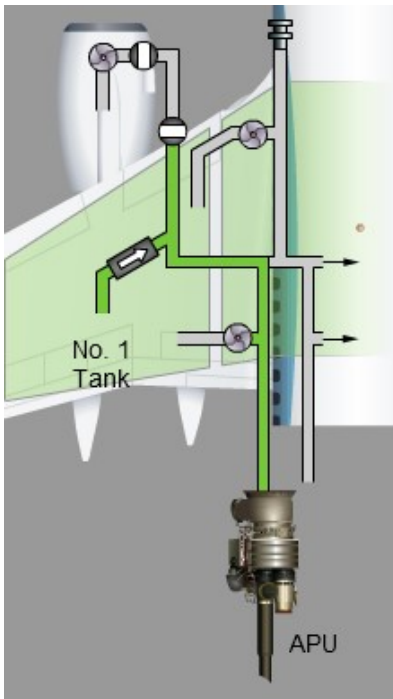
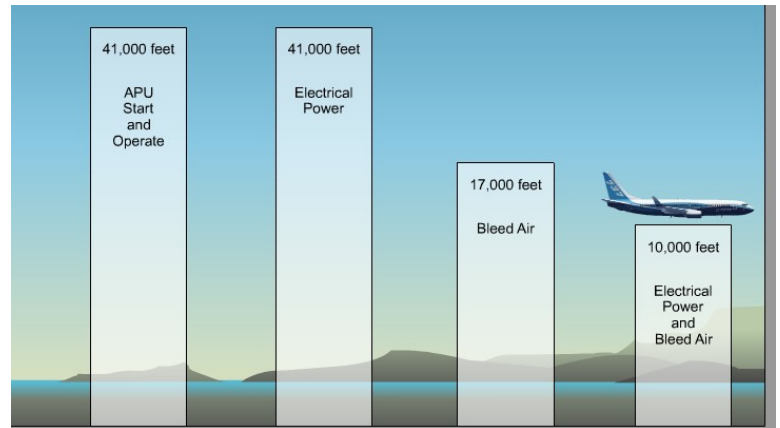
Operating altitude limitation

41000 ft MAX for: - APU START and operation

- APU ELECTRICAL power only

17000 ft MAX for: APU BLEED only

10000 ft MAX for: APU BLEED and ELECTRICAL power

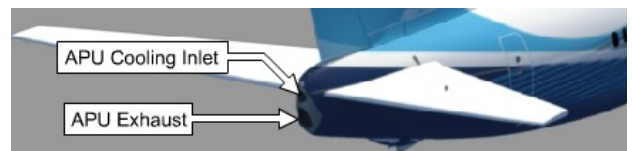


APU – NORMAL OPERATION

APU starting

APU fuel supply

Fuel for APU operation is normally drawn from the left side of the fuel manifold, provided that AC power for fuel pump operation is available; otherwise the APU will suck (suction feed) fuel from n°1 tank.



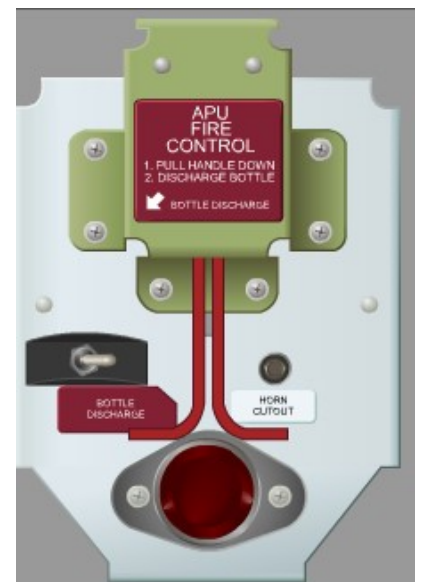
APU cooling air

APU cooling air inlet is located just above APU exhaust. Cooling air circulate through the APU compartment, passes through the oil cooler and then discharge through the APU exhaust.

APU starting

APU operation requires the following:

- APU FIRE HANDLE is IN (APU ground control panel-IN)
- APU fire switch ON (OVERHEAT/FIRE panel-IN)
- BAT switch ON

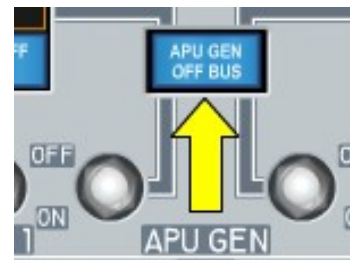


APU can be started by both AC power (preferred) through AC TRANSFER BUS 1 or BAT power.

The ECU is powered only with BAT switch ON. APU will automatically SHUT-DOWN anytime BAT switch OFF.

APU starting sequence:

- APU switch START then release to ON
- APU air inlet OPEN, once fully OPEN sequence continue
- IGNITION and FUEL are provided at designated APU speeds automatically
- When “APU GEN OFF BUS” illuminate, APU is ready to provide ELECTRICAL LOAD
- Wait at least 1 minute before selecting APU BLEED ON (to improve APU life)



(FCOM2 7.30.2) NOTE: during APU start cycle, APU EGT indication may fluctuate between 0° to 1100 °C and the “LOW PRESSURE” light may cycle ON and OFF several times. These indication have no adverse effect on starting APU. It is not necessary to monitor EGT during START.

If “APU GEN OFF BUS” does not illuminate, “FAULT” will illuminate.

APU START cycle can take as long as 120 seconds, if APU fails to achieve proper speed and acceleration limit, starting sequence is terminated automatically, and “FAULT” illuminate.

APU shut-down

Normal SHUT-DOWN procedure include 1 minute without BLEED load (to improve APU life) before commencing SHUT-DOWN sequence(this time delay is automatically met by moving APU switch OFF)

SHUT-DOWN sequence:

- APU switch: OFF
- APU GEN trips OFF
- APU bleed air valve closes
- “APU GEN OFF BUS” extinguish, (complete shut-down occur after 60 seconds from this point)
- Fuel valve and INLET DOOR close automatically as APU speed decrease sufficiently

If fuel valve does not close automatically, “FAULT” illuminate within 30 seconds

APU – NON-NORMAL OPERATION

APU “FAULT”

(QRH 7.11)

FAULT **APU FAULT**

Condition: An APU malfunction occurs.

Note: The APU shuts down automatically.

1 APU switch OFF

If the APU FAULT light extinguishes after 5 minutes, restarts may be attempted.

■ ■ ■ ■

APU “LOW OIL PRESSURE”

(QRH 7.12)

LOW OIL PRESSURE

APU LOW OIL PRESSURE

Condition: The APU oil pressure is low.

Note: The APU shuts down automatically.

1 APU switch. OFF

The LOW OIL PRESSURE light extinguishes in 5 minutes.

■ ■ ■ ■

APU “OVER SPEED”

(QRH 7.12)

OVER SPEED

APU OVERSPEED

Condition: One of these occurs:

- An APU RPM limit exceedance causes automatic shutdown
- During a normal APU shutdown the overspeed shutdown protection logic fails a self-test.

1 APU switch. OFF

The APU OVERSPEED light extinguishes in 5 minutes.

■ ■ ■ ■

FIRE PROTECTION – SYSTEM DESCRIPTION

Fire and overheat – overview

Fire protection system is constituted by:

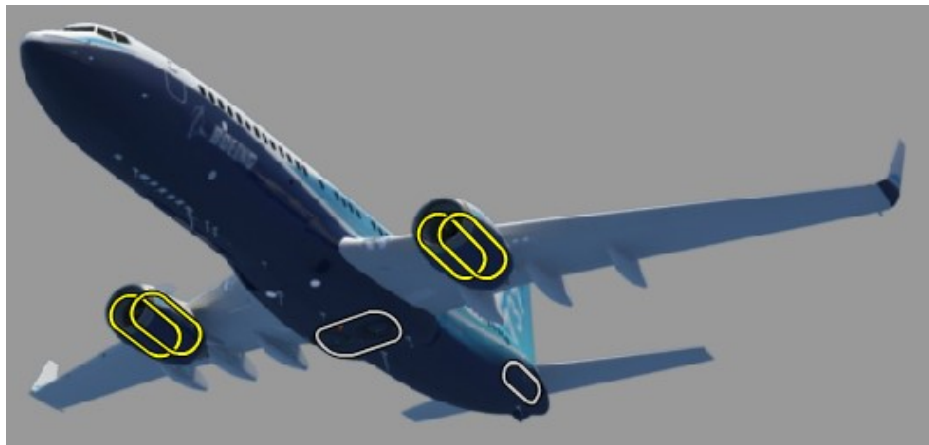
- Fire detection and extinguishing: provided for engines, APU, lavatories
- Fire detection only: provided for main wheel well
- Overheat detection: provided for engines
- Smoke detection and fire suppression: cargo compartment

Power supply

- HOT BATTERY BUS supplies power for engines, APU and cargo extinguishers, this means extinguishing is provided regardless of BAT switch position and AC availability
- BATTERY BUS powers engine OVERHEAT and APU fire detection system
- DC BUS 1 and DC BUS 2 power cargo compartment smoke detection
- AC TRANSFER BUS 2 power main wheel well fire detection
- Lavatory fire extinguishing is heat activated

Engine fire protection

Engine fire protection system includes OVERHEAT, fire detection and fire extinguishing. Two combination of OVERHEAT and fire detector loops are contained in each engine



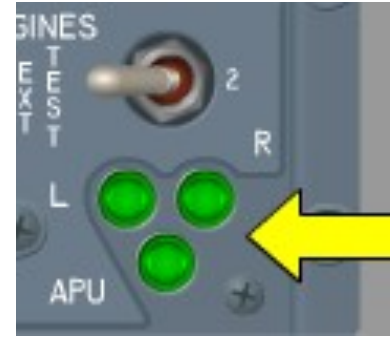
Fire extinguishing is provided by two fire extinguisher bottles, indicator and switches



Controls

Controls of engine fire protection system are:

- 2 engine **fire switches** (1 and 2)
- A fire warning BELL CUTOUT button
- An EXT TEST switch
- A FAULT/INOP and OVHT/FIRE TEST switches
- 2 OVHT DET switches



Lights

When OVHT DET in NORMAL, "**FAULT**" indicates that both detector loops for an engine have failed

when OVHT DET in A or B, "**FAULT**" indicates that the selected loop (A or B) for an engine has failed

"**L BOTTLE DISCHARGE**" and "**R BOTTLE DISCHARGE**" indicate that the respective bottle has been discharged

When the EXT TEST switch is positioned on 1 or 2, illumination of the **extinguisher test light** indicates that the respective circuit continuity is normal

"**MASTER CAUTION**", "**OVHT/DET**" annunciator light and associated "**ENG 1 OVERHEAT**" and/or "**ENG 2 OVERHEAT**" indicate that an engine OVERHEAT has occurred

"**ENG 1 OVERHEAT**" and/or "**ENG 2 OVERHEAT**" + "**OVHT/DET**" + "**MASTER CAUTION**" master "**FIRE WARN**" + related **engine fire switch** + "fire bell" indicate that an engine fire has occurred



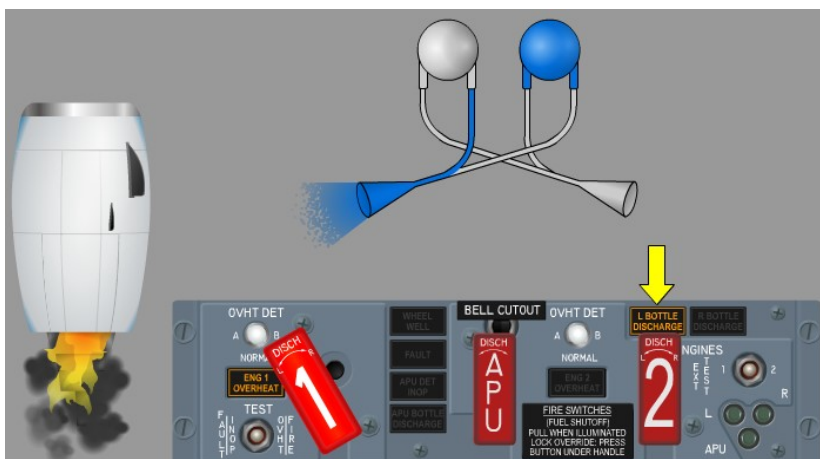
OVERHEAT : displayed when the temperature in both loops has increased to a specified limit

FIRE : displayed when the temperature in both loops has increased to a higher limit

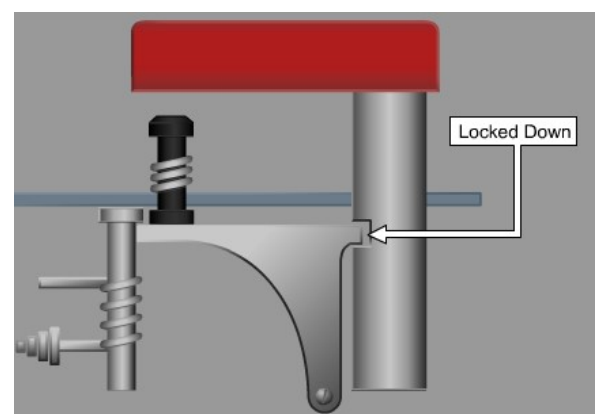
NOTE: normally, both detector loops must sense a fire or OVERHEAT condition to cause an **OVERHEAT** or **FIRE**

Fire bottles

2 engine fire extinguisher bottles are used to put out a fire. Activating an extinguisher bottle requires first pulling the related **fire switch** and then rotating it (L or R) to DISCH the corresponding bottle.



The engine **fire switches** are locked down until an actual **FIRE** or **OVERHEAT** indication appear. However the switches may also be unlocked manually



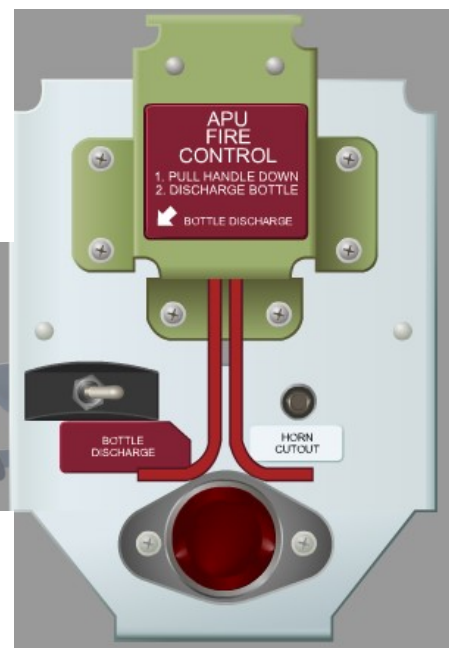
APU fire protection

APU fire protection system includes fire detection and fire extinguishing, one fire loop contained in the APU and one fire extinguisher bottle.

APU fire protection ground control

The right main wheel well contains the APU ground control panel, which contains:

- a fire warning light
- a BOTTLE DISCHARGE switch
- an APU FIRE CONTROL handle
- an HORN CUTOUT button



lights

“APU DET INOP” indicate that APU detector loop has failed

“APU BOTTLE DISCHARGE” indicate that the extinguisher bottle has been discharged

Indication

When APU fire occur:

- “fire bell” sounds
- Master “FIRE WARN” illuminate
- APU fire switch illuminate
- APU is automatically SHUT-DOWN
- Ground indication: “fire horn” fire warning light flashes



Fire extinguishing

To extinguish APU fire, pull and rotate (regardless if L or R) the APU fire switch

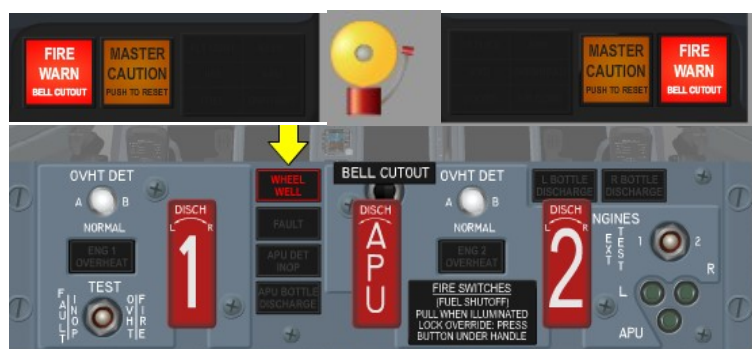
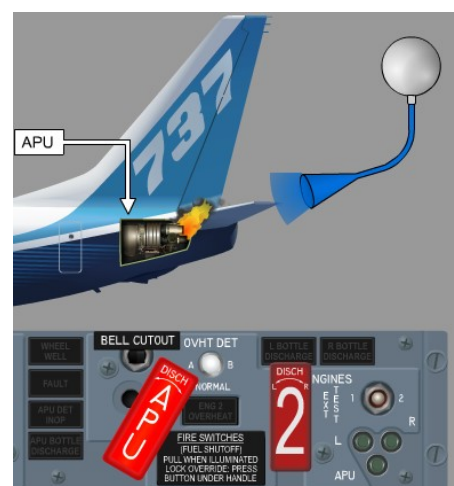
Main wheel well fire protection

Main wheel well fire protection system includes fire detection but no fire extinguishing, one fire detection loop contained in the main wheel well.

Indications

Indications of a main wheel well fire are:

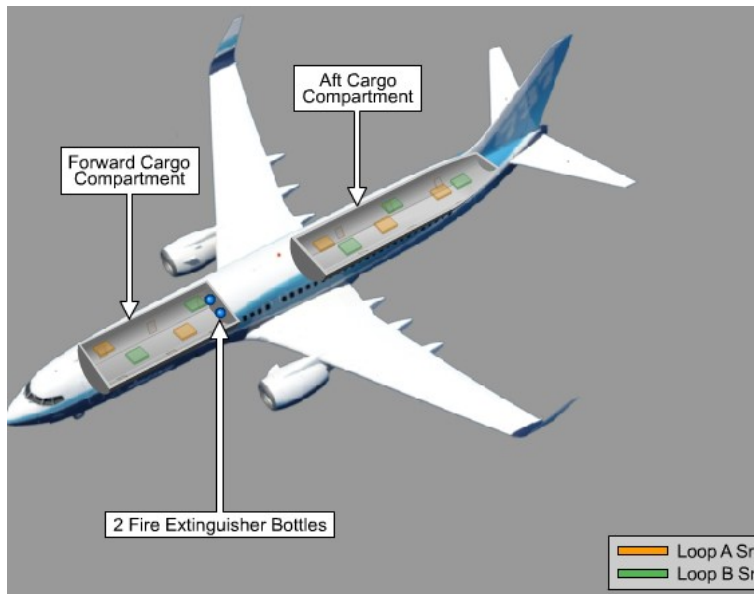
- “fire bell”
- Master “FIRE WARN”
- “WHEEL WELL” light illuminate



Cargo compartment fire protection

Smoke detectors are incorporated in the FWD and AFT cargo compartments. For redundancy, they are arranged in a dual loop configuration. The system includes 2 fire extinguisher bottles.

(FCOM2 8.20.6) a single fire extinguisher bottle is installed in the air conditioning bay



Switches

DET SELECT switches:

- NORM: both loops active
- A or B: only loop selected active

TEST button: tests all the loops and bottle squibs for continuity

“DETECTOR FAULT” indicates that one or more of the selected loops has failed

ARM button: fire ARM button must be pushed to ARM both extinguisher (FCOM: to ARM the extinguisher) ARMED will illuminate once armed.

DISCH: provided the system is armed, DISCH appear on discharge button, pushing it will discharge the first bottle and start the timer to discharge the second bottle 60* minute later (FCOM: pushing DISCH result in the total discharger of the bottle in selected compartment) when the bottle has been fully discharged (approx 30 seconds later) DISCH illuminate.

*the timer stop if the aircraft land or system is disarmed



Smoke detection

- Both loops active: “FWD” or “AFT” indicate that smoke has been detected by at least one detector in each loop
- One loop active: “FWD” or “AFT” indicate that smoke has been detected by at least one detector in the active loop

If one loop suffer from a power failure, the system automatically reconfigure to single loop detection. If a detector fails, the DET SELECT switch can be manually configured for single loop detection.

indications

a cargo compartment fire is indicated by:

- “fire bell”
- Master “FIRE WARN”
- “FWD” or “AFT” or both



cargo compartment fire protection testing

when TEST is pushed:

- “fire bell”
- Master “FIRE WARN” illuminate
- “FWD” and “AFT” illuminate
- EXT test lights illuminate
- DISCH illuminate



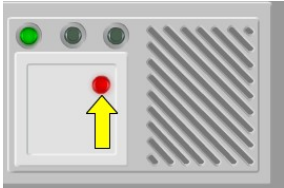
Fire indications sum-up table

	indications		
Engine fire	    	X	2 fire loop 2 fire bottles
APU fire	  + ground indications 	X + GND “horn”	1 fire loop 1 fire bottle APU automatically SHUT-DOWN
Main wheel well fire	 	X	1 fire loop No fire extinguishing
Cargo compartment fire	 	X	1 loop 2 fire bottles (FCOM: 1 fire bottle)

Lavatory fire protection

Lavatory fire protection consist of a smoke detector and an heat activated extinguisher in each lavatory.

When smoke I detected, an aural warning sounds and a RED light illuminate on the detector panel. The system reset when smoke is no longer present. An automatically heat activated fire extinguisher is located under each lavatory sink.

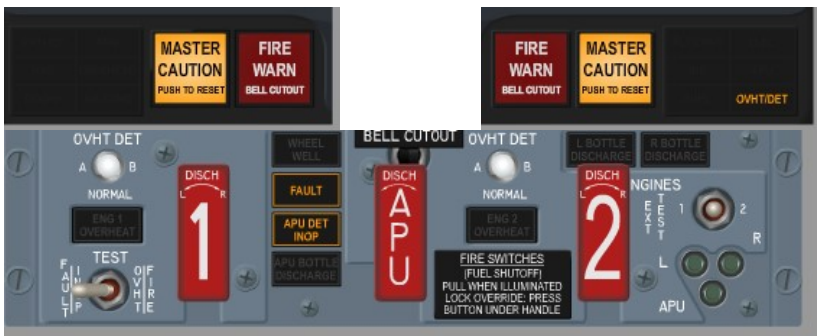


Fire protection system testing

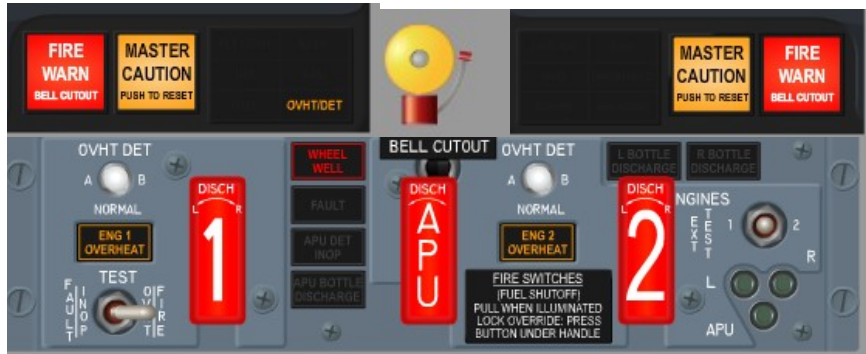
FAULT/INOP and OVHT/FIRE test switch

FAULT/INOP and OVHT/FIRE test switch is spring loaded to centre position, when moved to:

- FAULT/INOP: test fault detection system for engines and APU, resulting in the following indications
 - i. “MASTER CAUTION” with “OVHT/DET” annunciation illuminate
 - ii. “FAULT” illuminates
 - iii. “APU DET INOP” illuminates



- OVHT/FIRE: test overheat and fire detection loops for engines, APU and main wheel well, resulting in the following indications
 - i. “fire bell”
 - ii. “MASTER CAUTION” with “OVHT/DET” annunciation illuminate
 - iii. Master “FIRE WARN” illuminate
 - iv. Engines and APU fire switches illuminate
 - v. “ENG 1 OVERHEAT” and “ENG 2 OVERHEAT” illuminate
 - vi. “WHEEL WELL” illuminate if AC is available
 - vii. APU ground indication: “fire horn” fire warning light flashes



FIRE PROTECTION – NORMAL OPERATION

fire system manual testing

FAULT/INOP testing (FCOM1 NP.21.3)

Fault/Inop detection Check

OVERHEAT DETECTOR switches – NORMAL

TEST switch – Hold to FAULT/INOP

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

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

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

OVHT/FIRE testing (FCOM1 NP.21.4)

Fire/Overheat warning Check

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

TEST switch Hold to OVHT/FIRE

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

Master FIRE WARNING light – Push

Verify master FIRE WARN lights and fire warning bell cancel.

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

If an engine fire warning switch and an ENG OVERHEAT light do not illuminate, a detection loop is inoperative.

EXT TEST (FCOM1 NP.21.4)

EXTINGUISHER TEST switch Check

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

Cargo fire protection system testing (FCOM1 NP.21.5)

CARGO FIRE system Check

DETECTOR SELECT switches – NORM

TEST switch – Push

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

Master FIRE WARN light – Push

Verify master FIRE WARN lights and fire warning bell cancel.

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

Verify DETECTOR FAULT light remains extinguished.

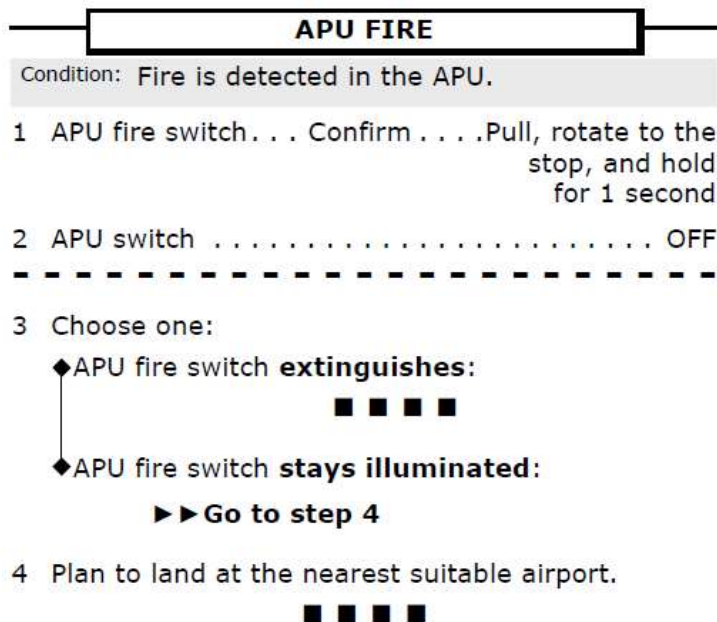
Note: If a cargo fire warning light does not illuminate and the DETECTOR FAULT light illuminates, a detection loop is inoperative.

Verify the green EXTINGUISHER test lights are illuminated.

Verify the cargo fire bottle DISCHARGE light is illuminated.

APU fire extinguishing

APU fire (QRH 8.1)



- ➔ Pulling the APU fire switch:
- Shut-off fuel to APU
 - APU bleed air valve and inlet door close
 - APU GEN and CB trip OFF
 - Allow APU **fire switch** to be rotated
 - ARM APU fire extinguisher bottle
- ➔ APU **fire switch** light extinguish when temperature decrease below the activation limit.

To extinguish APU fire when on the ground, using the APU ground control panel:

- PULL the handle
- Activate BOTTLE DISCHARGE

Cargo fire extinguishing

Cargo fire (QRH 8.13)

CARGO FIRE

FWD

AFT

Condition: Fire is detected in the related cargo compartment.

- 1 CARGO FIRE ARM switch
(affected compartment) . . . Confirm Push,
Verify ARMED
- 2 CARGO FIRE DISCH switch Push and hold
for 1 second

Note: DISCH light may need up to 30 seconds to illuminate.

- 3 Choose one:
- ◆ On the **ground**:

**Warning! Inform ground personnel
NOT to open any cargo door
until all passengers and crew
have exited the airplane and
fire fighting equipment is
nearby.**

■ ■ ■ ■
- ◆ In flight:
 - ▶▶ Go to step 4
- 4 RECIRC FAN switches (both) OFF
- 5 PACK switches (both) HIGH
- 6 Plan to land at the nearest suitable airport.
- 7 **Checklist Complete Except Deferred Items**

Engine overheat/fire extinguishing

Engine overheat (QRH 8.5)

ENGINE OVERHEAT

ENG 1
OVERHEAT

ENG 2
OVERHEAT

Condition: An overheat is detected in the engine.

- 1 Autothrottle (if engaged) Disengage
- 2 Thrust lever
(affected engine) Confirm Close
- 3 **If the ENG OVERHEAT light stays illuminated:**
 - ▶▶ **Go to the ENGINE FIRE or Engine
Severe Damage or Separation ()
checklist on page 8.2**

■ ■ ■ ■
- 4 **If the ENG OVERHEAT light extinguishes:**
 - Run the engine at reduced thrust to keep the
light extinguished.
- 5 Transponder mode selector TA

This step prevents climb commands which can
exceed reduced thrust performance capability.

■ ■ ■ ■

Engine fire (QRH 8.2)

ENGINE FIRE () or Engine Severe Damage or Separation ()

Condition: One or more of these occur:

- Engine fire warning
- Airframe vibrations with abnormal engine indications
- Engine separation.

- 1 Autothrottle (if engaged) Disengage
- 2 Thrust lever
(affected engine) Confirm Close
- 3 Engine start lever
(affected engine) Confirm CUTOFF
- 4 Engine fire switch
(affected engine) Confirm Pull
To manually unlock the engine fire switch, press
the override and pull.
- 5 **If** the engine fire switch or ENG OVERHEAT light is
illuminated:
Engine fire switch Rotate to the stop and
hold for 1 second

If after 30 seconds the engine fire switch or ENG
OVERHEAT light stays illuminated:
Engine fire switch. Rotate to the
other stop and
hold for 1 second

Wheel well fire extinguishing

Wheel well fire (QRH 8.20)

WHEEL WELL

WHEEL WELL FIRE

Condition: Fire is detected in the main wheel well.

- 1  **270K/.82M maximum.**
LANDING GEAR lever DN
This attempts to remove and extinguish the fire
source.
- 2 Plan to land at the nearest suitable airport.
Note: Do **not** use FMC fuel predictions with gear
extended.
- 3 Choose one:
◆ Gear **must be retracted** for airplane
performance:
▶▶ Go to step 4
◆ Gear does **not** need to be retracted for airplane
performance:
■ ■ ■ ■
- 4 **When** the WHEEL WELL light extinguishes:
Wait 20 minutes.
- 5  **235K maximum**
LANDING GEAR lever UP
- 6 **When** the landing gear indicator lights extinguish:
LANDING GEAR lever OFF
■ ■ ■ ■

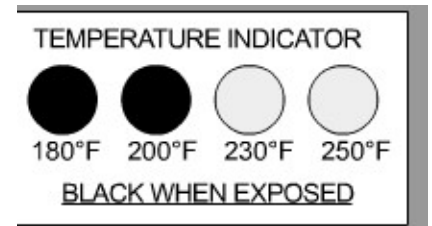
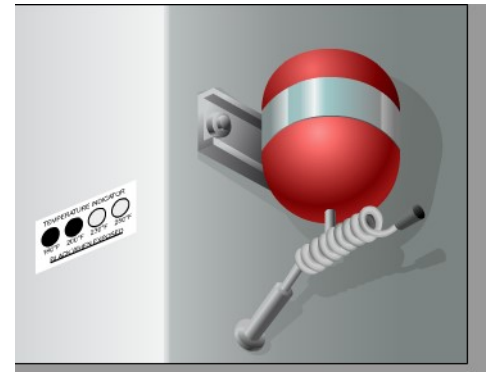
Lavatory fire extinguishing

NOTE: there are no flight deck controls for lavatory fire.

The lavatory extinguisher is heat activated (not controlled by smoke detector). When temperature raises sufficiently, the extinguisher discharge into the towel disposal area.

During the lavatory inspection:

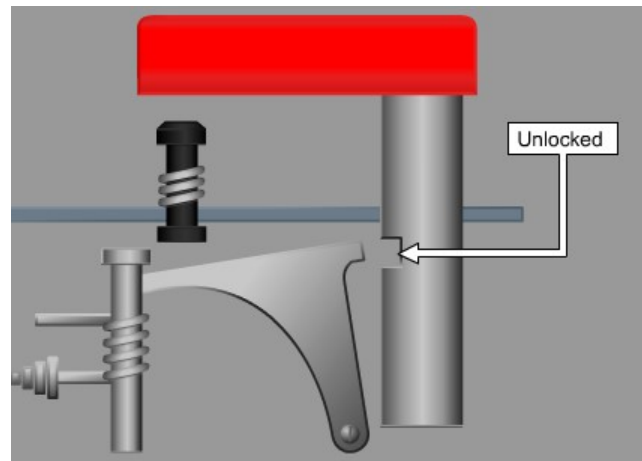
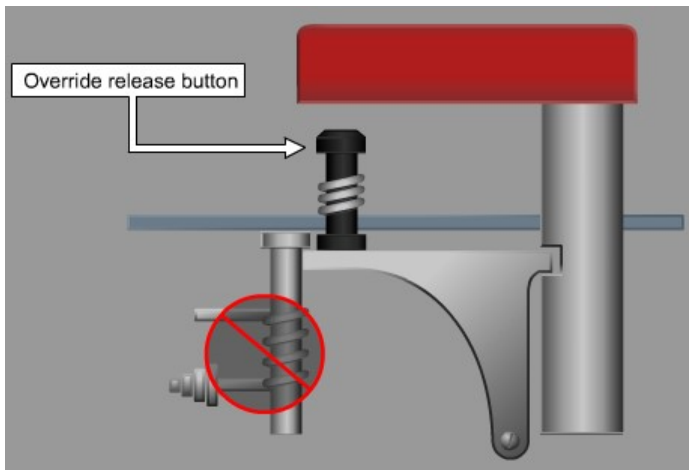
- Check the extinguisher nozzle tip:
 - i. Flat black colour: normal
 - ii. Aluminium colour: the extinguisher has been discharged
- Check temperature indicator:
 - i. WHITE: normal
 - ii. BLACK: temperature reached



FIRE PROTECTION – NON-NORMAL OPERATION

Fire switch override

Fire switch normally unlocks when it becomes illuminated due to a fire signal. If it fails to unlock or if required to be pulled for another procedure, the lock must be manually overridden. To do so, press the override button and simultaneously pull the switch.

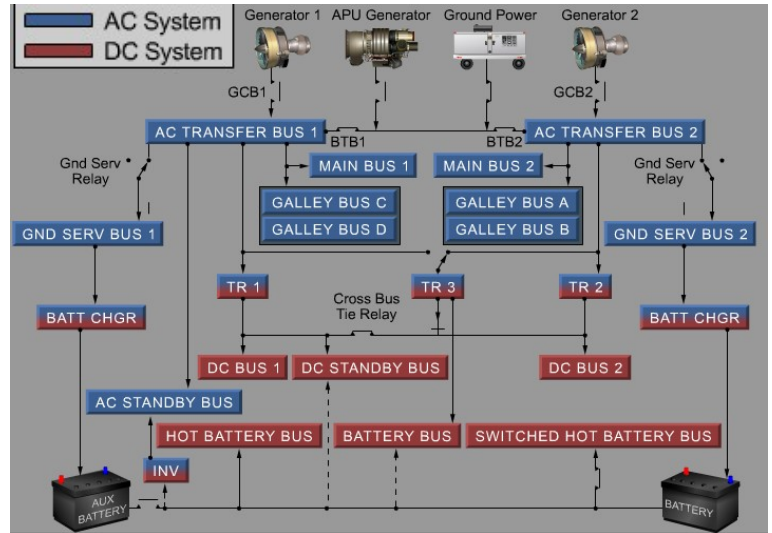


ELECTRICAL – SYSTEM DESCRIPTION

Overview

The electrical system produces and distributes AC, DC and STBY power.

- AC power: obtained from:
 - i. Engines GEN
 - ii. APU GEN
 - iii. GPU (ground power unit)
- DC power: obtained from:
 - i. TR (transformer rectifier)
 - ii. 2 batteries
- STBY power: obtained from the batteries:
 - i. AC via static INV
 - ii. DC directly from batteries



IDG (integrated drive generator)

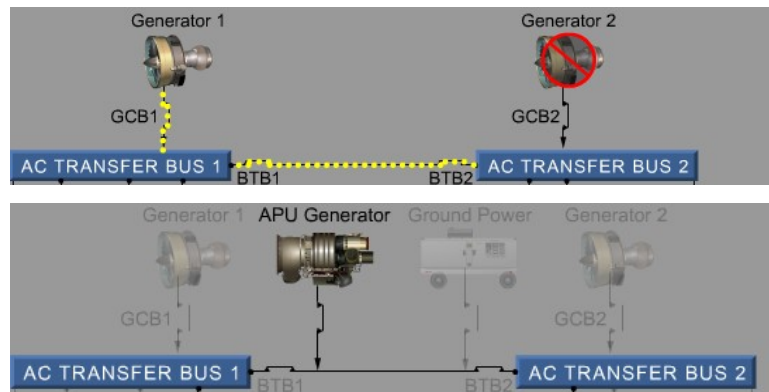
An IDG provide electrical power in the form of 3 phase, 115 V, 400 Hz AC

Each engine IDG supplies its associated AC TRANSFER BUS. When one IDG is inoperative, the other IDG may power the failed IDG BUS.

IDGs are contained in a common housing with an integral electro-mechanical disconnect device, so that the unit can be completely isolated when required.

A self contained oil system provides IDG lubrication and cooling.

APU IDG can power both AC TRANSFER BUS, both in-flight and on ground.



Batteries

Two 24 VDC NI-CD batteries are installed: one is the MAIN battery the other one is the AUXILIARY battery

External AC

External AC receptacle is located in the nose gear well. It can power both AC TRANSFER BUS



Principle of operation

- AC sources cannot be paralleled
- Connecting a different source to the same BUS, automatically disconnect an existing source

Metering panel



SELECTOR: is used to select the components the source of data

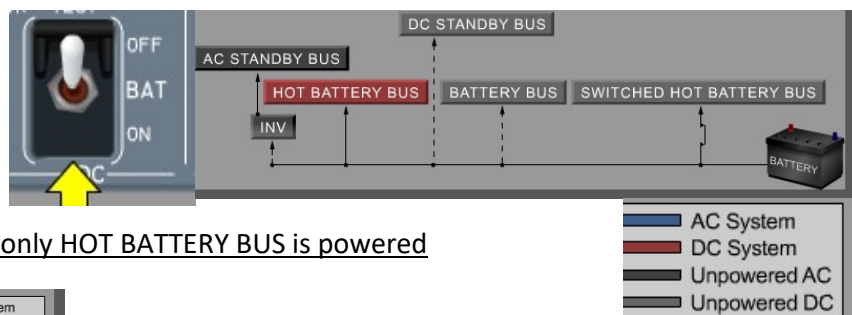
MAINT button (test function): used by the maintenance only

"BAT DISCHARGE" indicate that excessive battery discharge rate has been detected

"TR UNIT" indicate that:

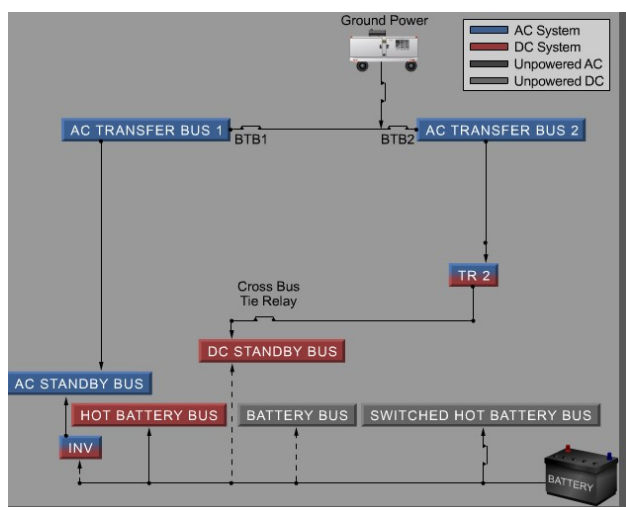
- On ground: any TR has failed
- In-flight: either TR1 or both TR2 and TR3 have failed

"ELEC" illuminate on ground only, indicate there is a fault in the DC or STBY power system



BAT switch

- OFF: with no other source connected, only HOT BATTERY BUS is powered



With one source connected, only BATTERY BUS and SWITCHED HOT BATTERY BUS are un-powered



- ON (guarded): the entire DC system is energized, relays are energized to provide automatic switching of the STBY system to BAT power when normal power is lost

GALLEY switch (CAB/UTIL)



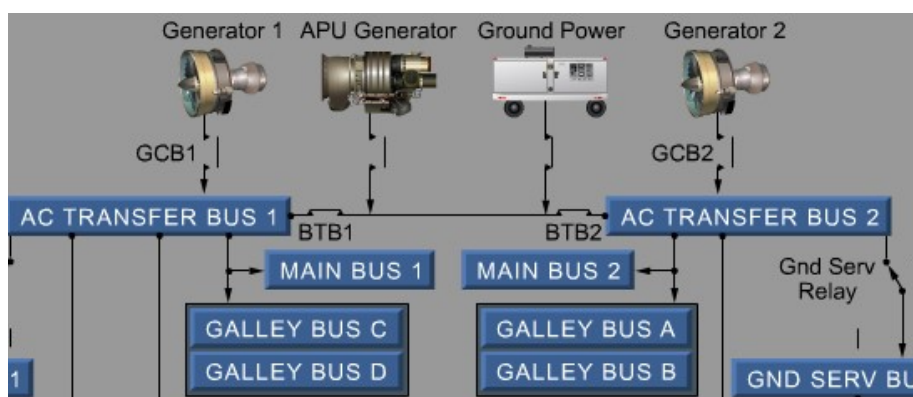
- OFF: electrical power to GALLEY BUS is removed
- ON: when AC TRANSFER BUS are powered, the relative GALLEY BUS are powered



NOTE: two different configuration:

GALLEY = CAB/UTIL

IFE/PASS SEAT (additional) = in-flight entertainment (audio and video)



Generator panel

"DRIVE" indicate:

- That associated IDG has been disconnected (DISCONNECT switch)
- IDG has been automatically disconnected due to high IDG oil temperature
- IDG failure
- Engine has been SHUT-DOWN

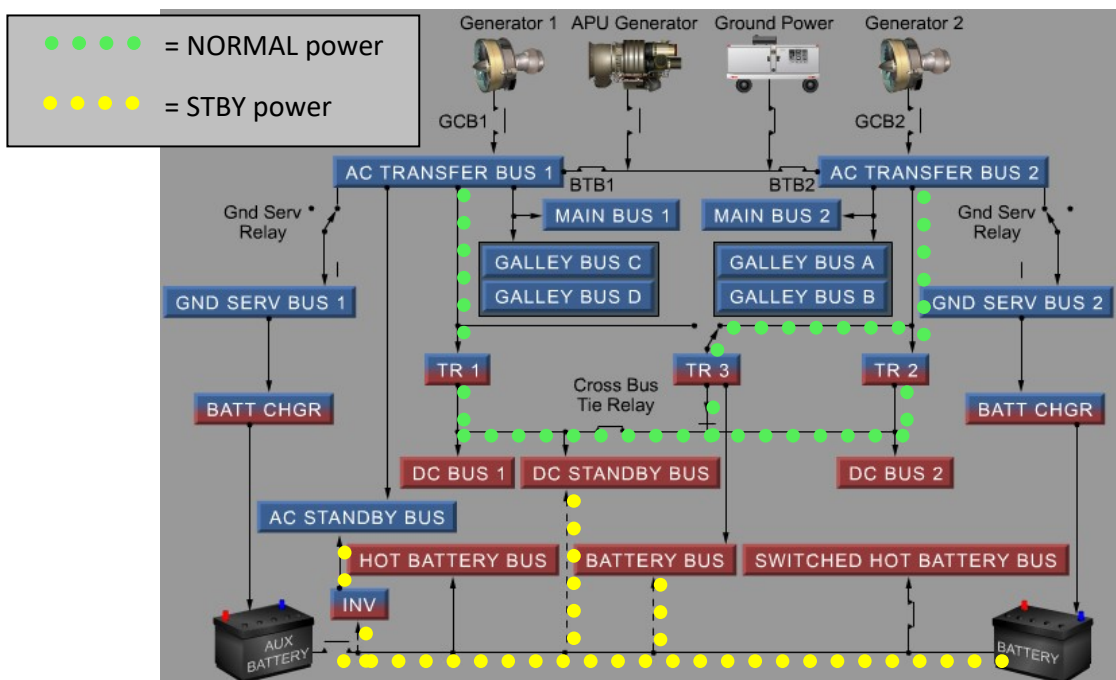
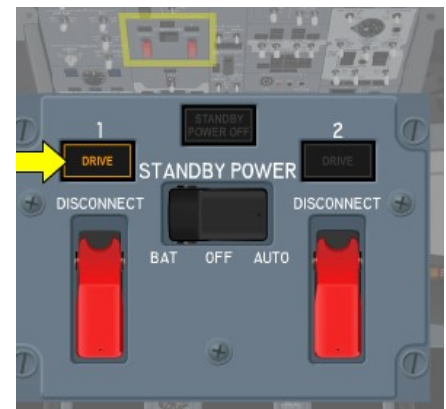
DISCONNECT switch (guarded): disconnect IDG from engine, provide that:

- Power is available
- Engine START lever at IDLE

NOTE: once disconnected, IDG cannot be reconnected in-flight

STANDBY POWER switch:

- AUTO (guarded): AC and DC STANDBY BUS and BATTERY BUS are automatically powered by battery power if AC power fails, in a way that:
 - BATTERY BUS powered directly by battery
 - DC STANDBY BUS powered directly by battery
 - AC STANDBY BUS powered by battery power through INV



- OFF: "STANDBY POWER OFF" illuminate, AC and DC STANDBY BUS are not powered by STANDBY power
- BAT: battery power is delivered manually to STANDBY BUS and BATTERY BUS

"STANDBY POWER OFF" illuminate when one or more of the following is un-powered:

- AC STANDBY BUS
- DC STANDBY BUS
- BATTERY BUS

Ground power panel

“GRD POWER AVAILABLE” illuminate when ground power is connected and of sufficient quality

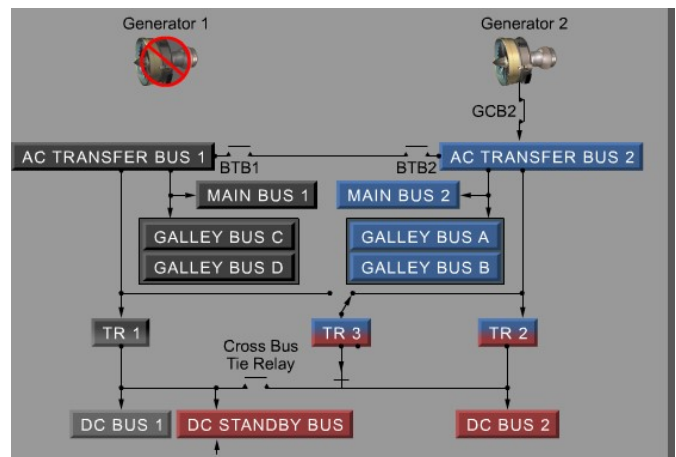
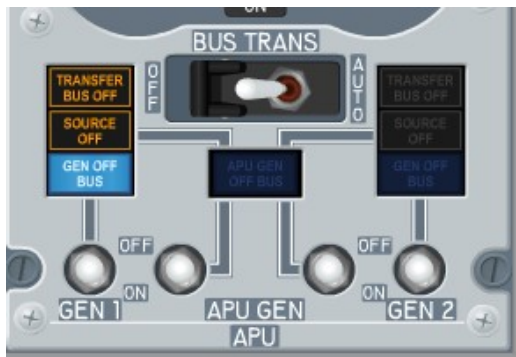
GRD PRW switch (spring loaded to centre position):

- ON: removes other power sources from AC TRANSFER BUS and connect ground power
- OFF: disconnect ground power



BUS TRANS switch

- AUTO (guarded):
 - i. BTBs (bus tie breaker) operate automatically in order to maintain power to AC TRANSFER BUS 1 and 2 from any generator or external power source.
 - ii. Cross bus tie relay operate automatically to provide normal operation of DC BUS 1, 2 and STANDBY
- OFF: (BTBs and cross bus tie relay open)
 - i. isolate AC TRANSFER BUS 1 from AC TRANSFER BUS 2 (if one IDG is supplying power to both busses)
 - ii. isolate DC BUS 1 from DC BUS 2



Generators switches

GEN 1 and GEN 2 switches are spring loaded to centre position, they regulate GCB (generator control breaker):

- OFF (GCB open): disconnect IDG from its related AC TRANSFER BUS
- ON (GCB close): removes other sources from the related AC TRANSFER BUS and connect the related IDG

Generator lights

“TRANSFER BUS OFF” indicate that the associated TRANSFER BUS is not powered

“SOURCE OFF” indicate that:

- No source has been manually selected to power the associate TRANSFER BUS, or
- Manually selected source has been disconnected

“GEN OFF BUS” and “APU GEN OFF BUS” indicate that the related generator is available to provide power, but is not connected to an AC TRANSFER BUS

APU GEN switch

APU GEN switch is spring loaded to centre position,

moving APU GEN: OFF

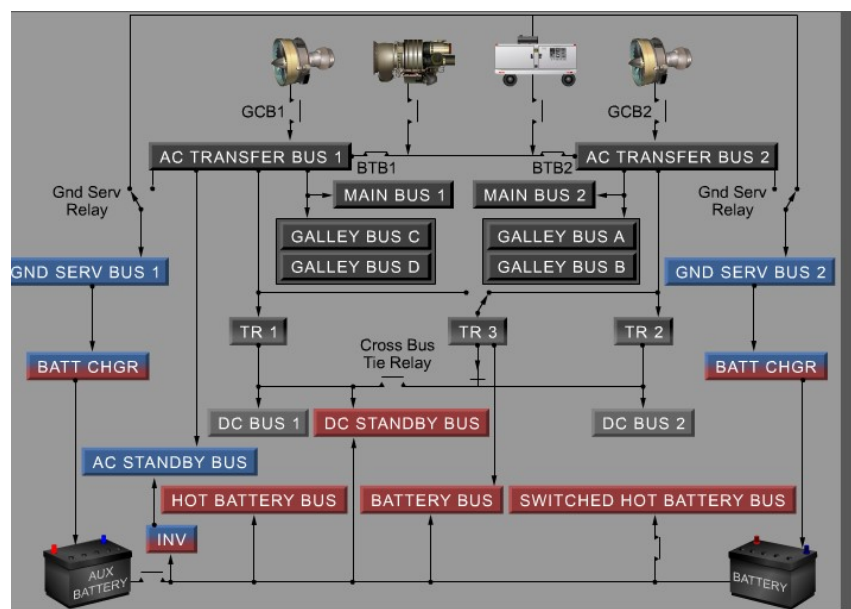
- APU generator powering both AC TRANSFER BUS:
 - i. Moving a single APU GEN switch OFF illuminates related “SOURCE OFF” light (related AC TRANSFER BUS un-powered). APU continues to power other AC TRANSFER BUS.
 - ii. Moving the other APU GEN switch OFF disconnects APU generator from tie bus and remove APU power from the related AC TRANSFER BUS
- APU generator powering one AC TRANSFER BUS, engine IDG powering one AC TRANSFER BUS
 - i. Moving related APU GEN switch OFF disconnects APU generator from tie bus and remove APU power from the related AC TRANSFER BUS. Engine IDG now power both AC TRANSFER BUS

Moving APU GEN: ON

- Neither AC TRANSFER BUS powered by engines IDGs, moving a single APU GEN switch ON:
 - i. Connect both APU generator to tie bus, power related AC TRANSFER BUS
 - ii. Disconnects GRD PWR, if connected
 - iii. Opposite “SOURCE OFF” illuminate until related APU GEN switch ON
- Both AC TRANSFER BUS powered by respective engine IDG, moving a single APU GEN switch ON:
 - i. APU generator powers related AC TRANSFER BUS (IDG removed)
 - ii. Other AC TRANSFER BUS continues to receive power from its IDG

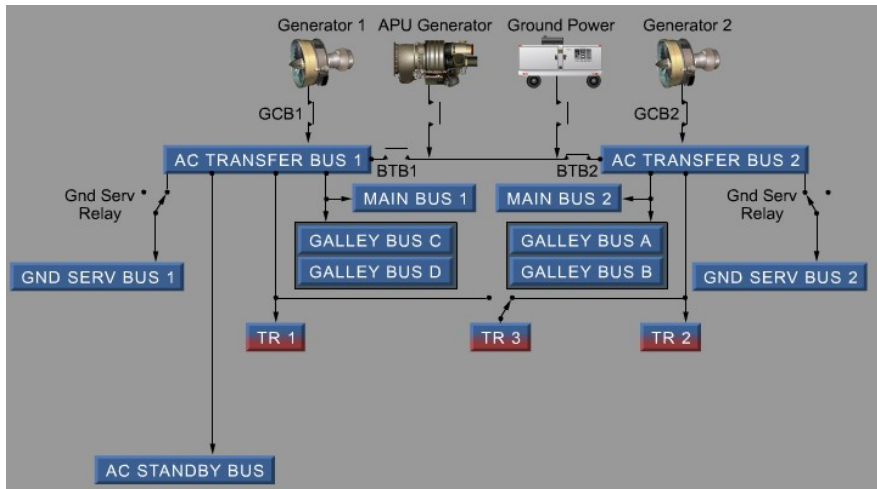
GROUND SERVICE button

Is a momentarily push-button switch. It allows the airplane to be serviced using external power without energizing the AC TRANSFER BUS 1 and 2

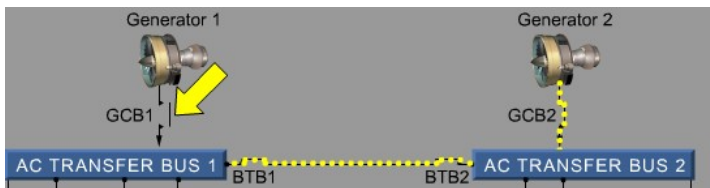


AC system

AC power is provided by: engines IDGs, APU IDG and GRD PWR

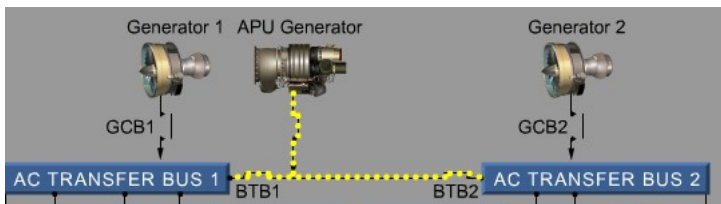


BTBs (bus tie breakers) allow AC STRANSFER BUS 1 and 2 to be powered by any other source when a connected source fails or is disconnected.



Both AC TRANSFER BUS can be powered from one engine GEN or by APU GEN.

NOTE: is NOT possible to power one AC TRANSFER BUS with APU and the other one with GRD PWR



Load shedding

When one engine IDG fails, the system automatically sheds load to meet actual load capacity, with a specific order:

1. GALLEY BUS A and GALLEY BUS B (AC TRANSFER BUS 2), if still in overload:
2. MAIN BUS 1 (AC TRASNFER BUS 1), if still in overload:
3. GALLEY BUS C and GALLEY BUS D (AC TRANSFER BUS 1), if still in overload:
4. MAIN BUS 2 (AC TRANSFER BUS 2), if still in overload:
5. IFE (in-flight entertainment) BUS

Shed loads becomes restored when a second generator (ie. APU GEN) becomes available.

NOTE: GALLEY SWITCH (CAB/UTIL) recycle may be required (OFF then back ON)

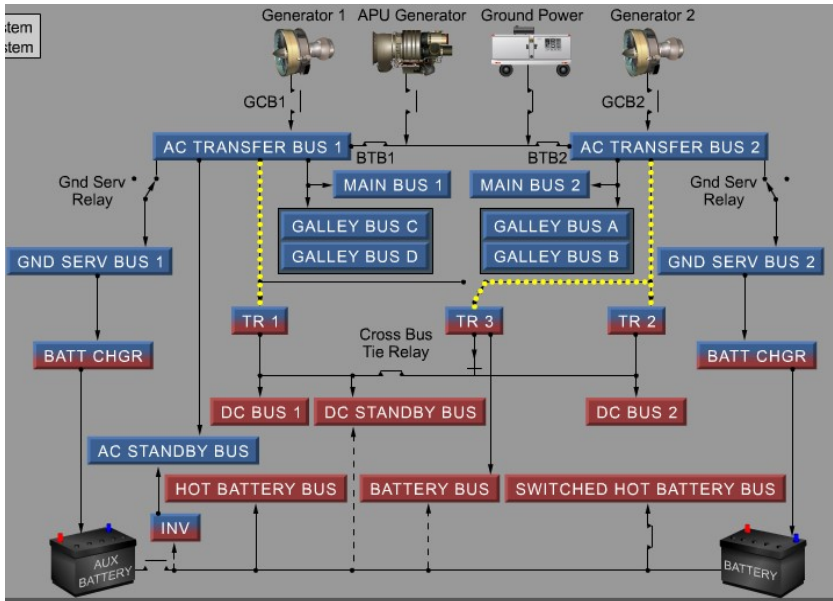
If APU GEN is the only available power source:

- In flight: GALLEY BUS and MAIN BUS are automatically shed, if necessary IFE BUS are shed
- On ground: APU tries to power all system, if load is too high, APU sheds following the normal order (above)

DC system

TRUs (transformer rectifier units)

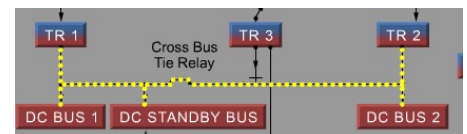
Normal DC power source comes from 3 TRUs that provide 28 VDC power. TRUs are powered by AC TRANSFER BUS. If no other DC power source is available, BAT is used. Total DC load can be supplied by any 2 TRUs



Cross bus tie relay

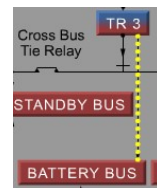
Cross bus tie relay is closed:

- TR1 and TR2 power DC BUS 1, DC BUS 2 and DC STANDBY BUS
- TR3 power BATTERY BUS and is available as a backup for TR1 and TR2



Cross bus tie relay is open:

- TR1 power DC BUS 1 and DC STANDBY BUS
- TR2 power DC BUS 2
- TR3 power BATTERY BUS and is available as backup for DC BUS 2



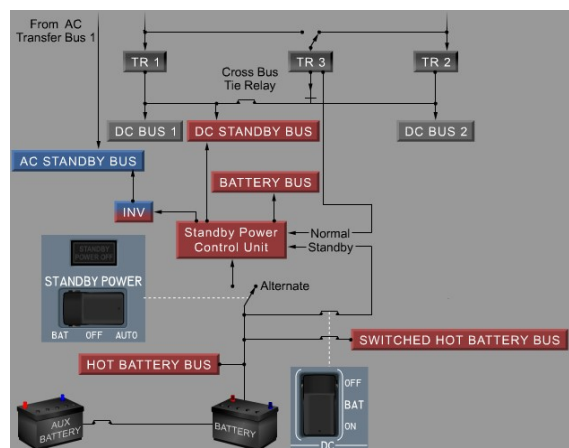
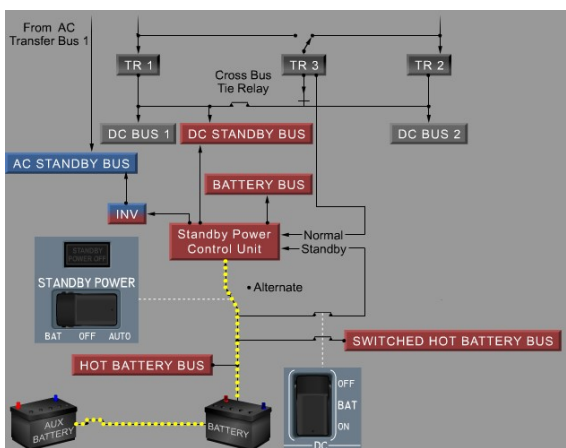
Cross bus tie relay opens when:

- BUS TRANS switch OFF, or
- BUS TRANS switch AUTO, during a F/D or A/P ILS approach after glide slope capture

Batteries

Two 24 VDC NI-CD batteries are located in the electronic compartment.

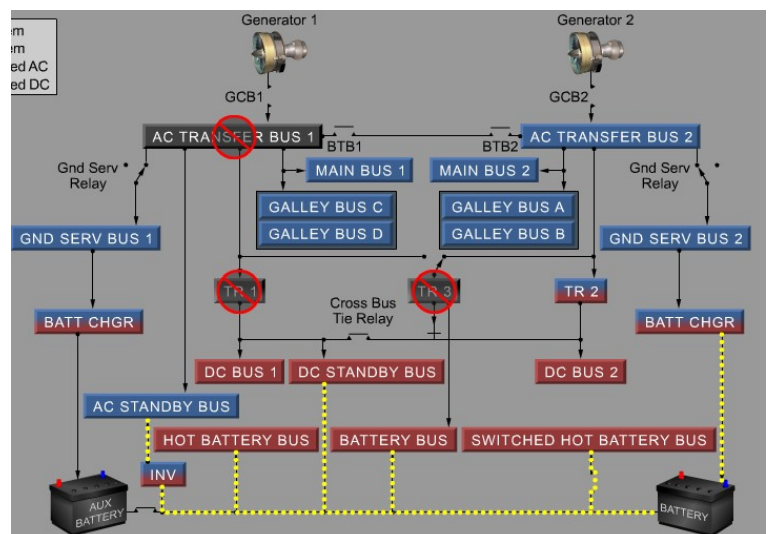
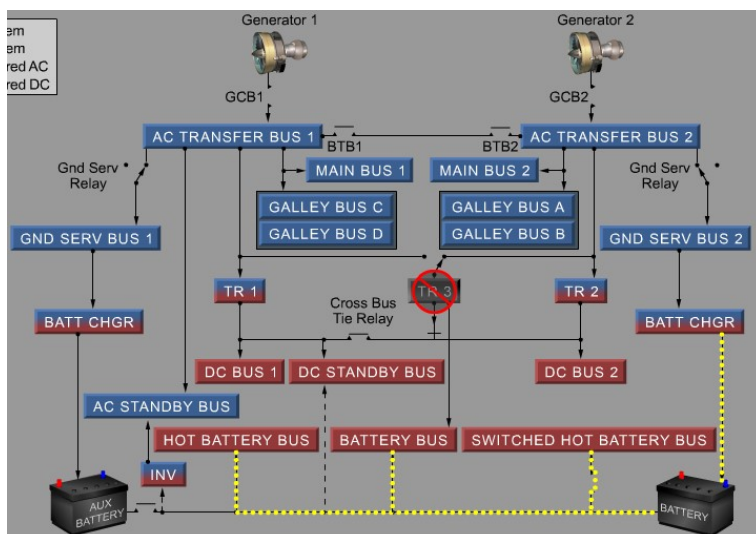
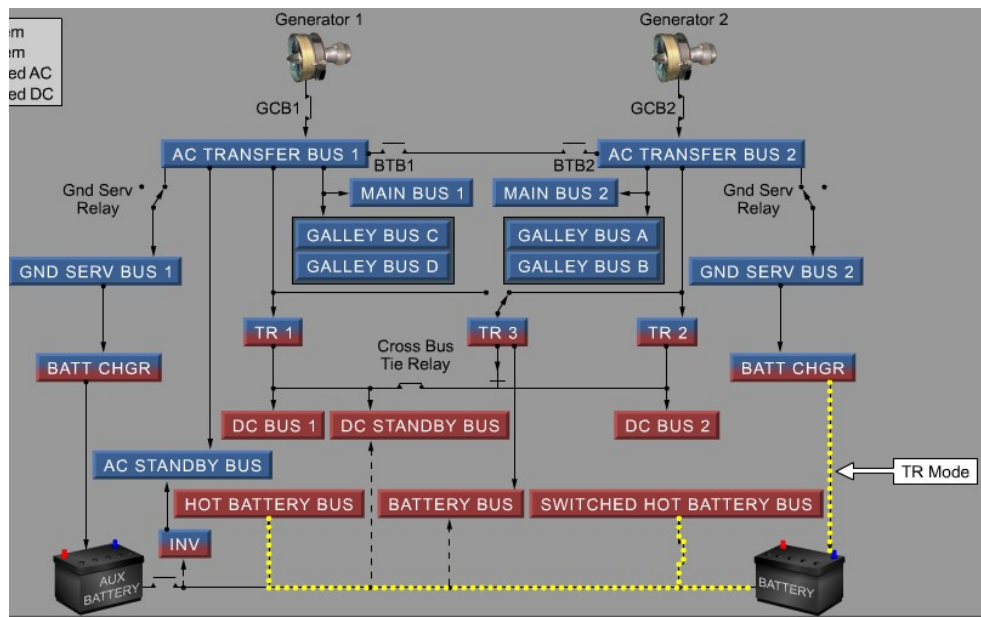
Normally AUXILIARY battery is isolated from the power distribution system. It operates in parallel with the MAIN battery when it is powering the STANDBY system.



HOT BATTERY BUS is always powered by the battery, regardless of the BAT switch position, provided that battery voltage is above a specified minimum.

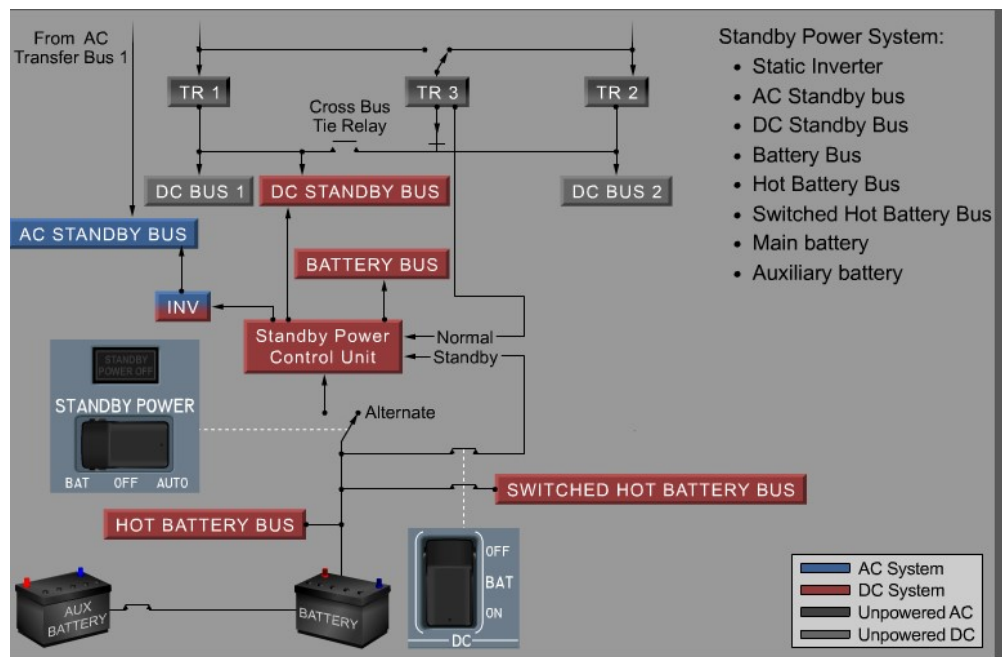
- ## Batteries charging

BATT CHGR output voltage is regulated to bring batteries to full capacity, following completion of the primary charge cycle, the MAIN BATT CHGR reverts to a constant voltage TR mode. In TR mode, it powers loads connected to the HOT BATTERY BUS and SWITCHED HOT BATTERY BUS. The MAIN BATT CHGR 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 BUS are powered by the MAIN and AUXILIARY BATT CHGR.



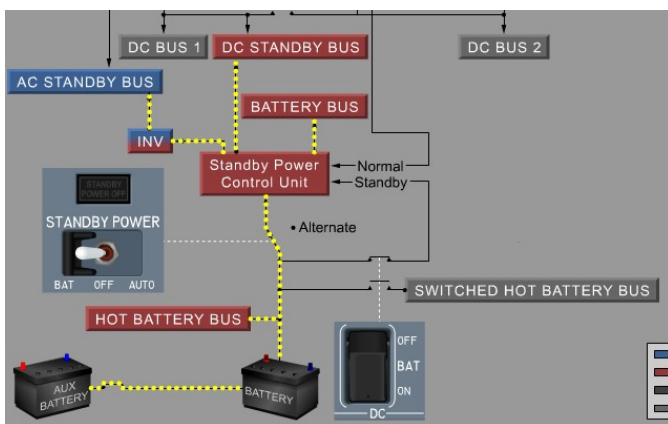
STANDBY system

In case of full or partial power lost, STANDBY system will be capable to provide 115 VAC and 28 VDC power to essential systems. MAIN and AUXILIARY battery are the **alternate power** source for the STANDBY system.

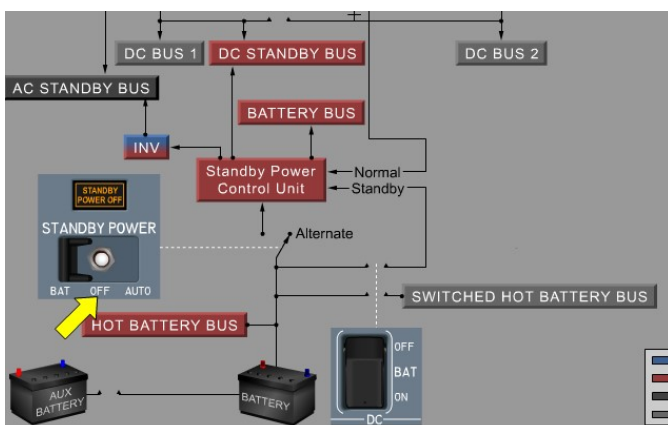


Normally, STANDBY POWER switch is AUTO and BAT switch is ON to provide alternate sources if partial/complete normal power is lost.

With the STANDBY POWER switch on BAT and BAT switch OFF, SWITCHED HOT BATTERY BUS is not powered

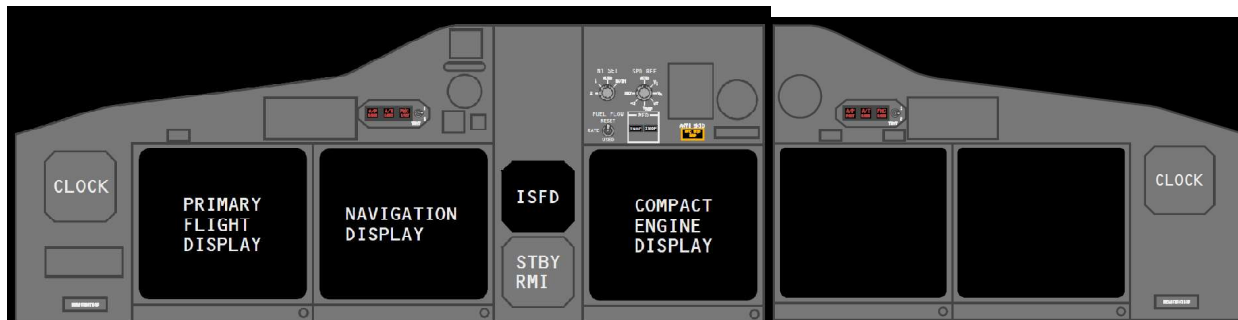


With STANDBY POWER switch OFF, HOT BATTERY BUS and SWITCHED HOT BATTERY BUS (if BAT switch ON) are powered. "STANDBY POWER OFF" will illuminate.



Basic equipment operating

When the batteries are the only source of power available, the basic equipment operating are:



Plus:

- Left FMC/CDU
- VHF NAV 1
- ADF 1
- VHF comm. 1
- Left IRS/GPS

NOTE: refer to FCOM2 6.20.14 for the entire list

ELECTRICAL – NORMAL OPERATION

Pre-flight operation (FCOM1 NP.21.3)

BATTERY switch ON → ensure STANDBY POWER switch AUTO (guarded)

Guard – Down

GROUND POWER switch (if ground power is available) ON

SOURCE OFF lights – Extinguished.

Note: Position lights should be selected on when the aircraft is connected to an AC power source.

APU Start and on busses

Note: To conserve fuel and reduce emissions, start the APU just prior to closing the L1 door unless environmental conditions dictate otherwise.

Note: If APU operation is needed on the ground and the airplane busses are powered by AC electrical power, position an AC powered fuel pump ON. This will extend the service life of the APU fuel control unit.

Note: If fuel is loaded in the center tank, position the left center tank fuel pump switch ON to prevent a fuel imbalance before takeoff.

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

When the APU GEN OFF BUS light is illuminated:

APU GENERATOR bus switches – ON

Verify that the SOURCE OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Note: Position lights should be selected on when the aircraft is connected to an AC power source.

Note: Run the APU for one full minute before using it as a bleed air source.

GENERATORS 1 and 2 switches ON

(FCOM1 NP.21.53)

Verify “GEN OFF BUS” illuminated before turning GEN ON

when “GEN OFF BUS” extinguish, GEN is powering BUS

ELECTRICAL – NON-NORMAL OPERATION

Loss of both engine IDGs (QRH 6.3)

LOSS OF BOTH ENGINE DRIVEN GENERATORS

GEN 1 & 2	GEN 1 & 2	GEN 1 & 2
TRANSFER BUS OFF	SOURCE OFF	GEN OFF BUS

Condition: Both engine driven generators are off.

Note: At high altitude, thrust deterioration or engine flameout can occur.

1 Engine GEN switches (both). . . ON, one at a time

2 Choose one:

◆ **A single SOURCE OFF light stays illuminated:**

▶▶ Go to step 3

◆ **Both SOURCE OFF lights stay illuminated:**

▶▶ Go to step 5

◆ **Both SOURCE OFF lights extinguish:**

YAW DAMPER switch ON

▶▶ Go to step 17

A single SOURCE OFF light stays illuminated

3 YAW DAMPER switch ON

4 Choose one:

◆ APU is **available** for start:

Note: APU start attempts are not recommended above 25,000 feet.

APU START

When APU is running:

APU GEN switch
(affected side) ON

▶▶ Go to step 17

◆ APU is **not** available:

Plan to land at the nearest suitable airport.
Only one main AC power source remains.

▶▶ Go to step 17

Both SOURCE OFF lights stay illuminated

5 Choose one:

◆ APU is **available** for start:

BUS TRANSFER switch OFF

ELEC HYD PUMP switches (both) OFF

Note: APU start attempts are not recommended above 25,000 feet. With both busses off, only one start attempt is recommended. Multiple start attempts reduce standby power capacity.

APU START

▶▶ Go to step 6

◆ APU is **not** available:

▶▶ Go to step 14

6 **When** APU is running:

APU GEN
switches (both) ON,
one at a time

7 Check for the REMOTE CONTROL CB (RCCB Remote P6-SPCU-A-4).

8 Choose one:

◆ RCCB REMOTE circuit breaker **is** tripped:

Reset circuit breaker. Only one reset is allowed.

▶▶ Go to step 9

◆ RCCB REMOTE circuit breaker is **not** tripped:

▶▶ Go to step 9

9 Choose one:

◆ **A single or both SOURCE OFF lights extinguish:**

▶▶ Go to step 10

◆ **Both SOURCE OFF lights stay illuminated:**

▶▶ Go to step 14

10 BUS TRANSFER switch AUTO

This restores power to the remaining transfer bus if one SOURCE OFF light stays illuminated.

11 ELEC HYD PUMP
switches (both) ON, one at a time

12 YAW DAMPER switch ON

13 Plan to land at the nearest suitable airport. Only one main AC power source remains.

▶▶ Go to step 17

Both SOURCE OFF lights stay illuminated

14 Avoid icing conditions.

Note: Flight in icing conditions can result in erroneous flight instrument indications

15 Plan to land at the nearest suitable airport.

Note: Fully charged batteries supply a minimum of 60 minutes of standby power.

16 The right IRS will operate on DC power for 5 minutes.

17 Choose one:

◆ **Both** the captain's and first officer's primary attitude displays are **operative** and ATT flags are **not** shown:

■ ■ ■ ■

◆ **Both** the captain's and first officer's primary attitude displays are **failed**:

▶▶ **Go to step 19**

◆ **Only** the **first officer's** primary attitude display is **failed**:

IRS TRANSFER switch BOTH ON L

Do **not** engage either autopilot.

▶▶ **Go to step 18**

18 Choose one:

◆ **A single** SOURCE OFF light is **illuminated**:

■ ■ ■ ■

◆ **Both** SOURCE OFF lights are **extinguished**:

■ ■ ■ ■

◆ **Both** SOURCE OFF lights are **illuminated**:

The left IRS will operate as long as battery power remains.

Plan to land at the nearest suitable airport.

■ ■ ■ ■

Action is irreversible. Do this step only if **both** the captain's and first officer's primary attitude displays are **failed**.

19 ⚠ IRS MODE selectors (both). ATT

Maintain straight and level, constant airspeed flight until attitude displays recover (approximately 30 seconds).

The primary attitude displays stay failed and the SET IRS HDG prompt on the POS INIT page is blank until the attitude mode alignment is complete.

20 Enter magnetic heading on the POS INIT page or on the overhead IRS display unit by selecting HDG/STS.

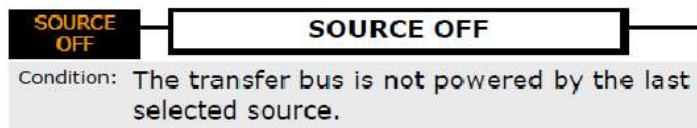
Note: The MAP display is not available.

Note: Periodically enter updated heading on the POS INIT page or on the overhead IRS display unit by selecting HDG/STS.

21 Do **not** engage either autopilot.

■ ■ ■ ■

"SOURCE OFF" (QRH 6.10)



1 Choose one:

◆ Both SOURCE OFF lights are illuminated:

►► Go to the **LOSS OF BOTH ENGINE DRIVEN GENERATORS** checklist on page 6.3

■ ■ ■ ■

◆ Only one SOURCE OFF light is illuminated:

►► Go to step 2

2 Engine GEN switch (affected side) ON

3 Choose one:

◆ SOURCE OFF light **extinguishes**:

■ ■ ■ ■

◆ SOURCE OFF light **stays illuminated**:

►► Go to step 4

4 Choose one:

◆ APU is **available** for start:

APU START

When APU is running:

APU GEN switch
(affected side) ON

►► Go to step 5

◆ APU is **not** available:

Plan to land at the nearest suitable airport.
Only one main AC power source remains.

■ ■ ■ ■

5 Choose one:

◆ SOURCE OFF light **extinguishes**:

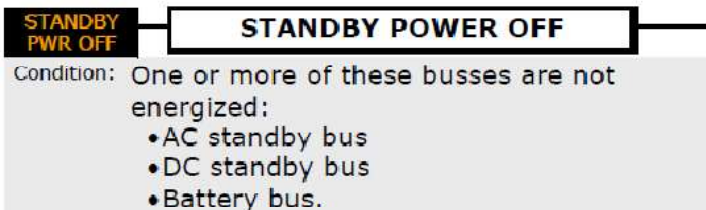
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◆ SOURCE OFF light **stays illuminated**:

Plan to land at the nearest suitable airport.
Only one main AC power source remains.

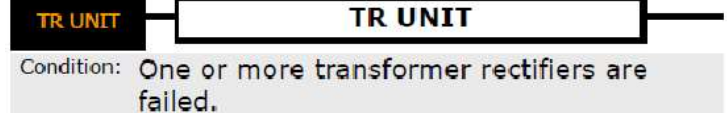
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"STANDBY POWER OFF" (QRH 6.12)



1 STANDBY POWER switch BAT

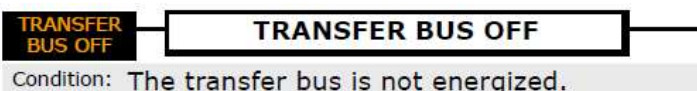
"TR UNIT" (QRH 6.12)



1 Do not use the AFDS approach mode during an ILS approach.

Note: Autoland is not available.

"TRANSFER BUS OFF" (QRH 6.13)



1 Engine GEN switch (affected side) ON

2 Choose one:

◆ TRANSFER BUS OFF light **extinguishes**:

■ ■ ■ ■

◆ TRANSFER BUS OFF light **stays illuminated**:

►► Go to step 3

3 Choose one:

◆ APU is **available** for start:

APU START

When APU is running:

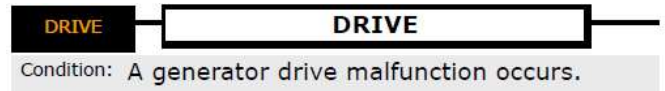
APU GEN switch
(affected side) ON

■ ■ ■ ■

◆ APU is **not** available:

Plan to land at the nearest suitable airport.
Only one main AC power source remains.

"DRIVE" (QRH 6.1)



1 **Action is irreversible.**

1 **Generator drive DISCONNECT switch** (affected side) Confirm Hold in the DISCONNECT position momentarily

This prevents generator drive damage.

2 Choose one:

◆ APU is **available** for start:

APU START

When APU is running:

APU GEN switch
(affected side) ON

■ ■ ■ ■

◆ APU is **not** available:

Plan to land at the nearest suitable airport.
Only one main AC power source remains.

■ ■ ■ ■

FUEL SYSTEM – SYSTEM DESCRIPTION

Overview

Tanks, tanks capacity and fuel feeding

Fuel is available for engine feeding from all the 3 tanks.

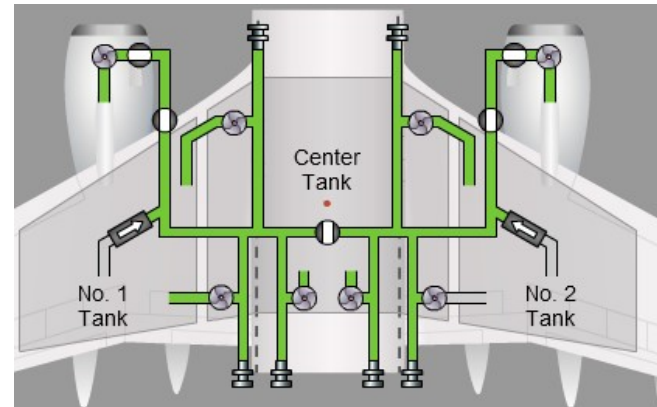
APU draws fuel from:

- With AC fuel pump operating: left side of the fuel manifold
- Without AC fuel pump: n°1 tank with suction feeding

Cross-feeding is available through a cross-feed valve.

Centre tanks pumps supply fuel at a slightly higher pressure, so that centre tank fuel is consumed first.

Check-valves (non-return-valves) ensure correct fuel flow and prevent inadvertent fuel transfer between tanks



Fuel Locations and Capacities		
Tank	Liters	Kilograms*
No. 1	4,876	3,915
No. 2	4,876	3,915
Center	16,273	13,066
Total	26,025	20,896

* Usable fuel at level attitude, fuel density = 0.8029 Kg/L

Engine valve and valves lights

“ENG VALVE CLOSED” and “SPAR VALVE CLOSED” indicate that:

- Extinguished: Valve is open
- Dim blue: valve is CLOSED
- Bright blue: valve is in transit or in disagreement with commanded position

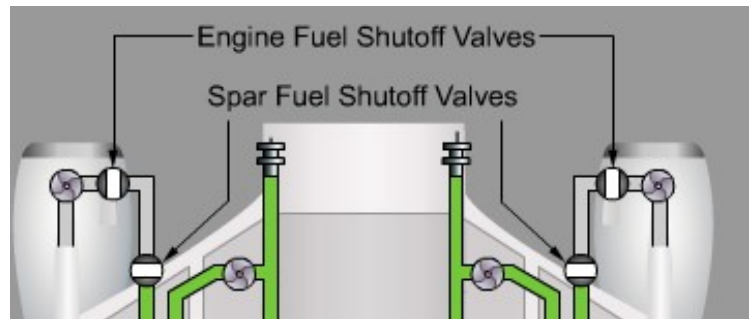


NOTE: both ENG and SPAR VALVE close when:

- associated engine START lever is CUT-OFF
- engine fire switch is pulled

Cross-feed

Cross-feed selector controls a DC operated fuel cross-feed valve. “VALVE OPEN” (extinguished, dim or bright) as for ENG and SPAR VALVES lights.



Filter bypass

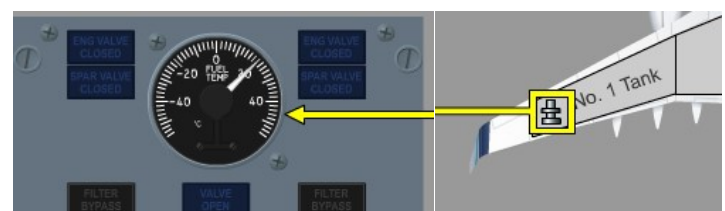
“FILTER BYPASS” illuminate when the fuel filter is being bypassed due to contaminated or clogged filter.



Fuel QTY and temperature display

Usable fuel remaining is normally displayed on the upper DU.

Provided that AC power is available, fuel temperature in tank n°1 is displayed on the fuel panel



Fuel alert indications



“LOW” alert: fuel tank quantity is less than 453 Kg, remain illuminated as long as there are less than 567 Kg

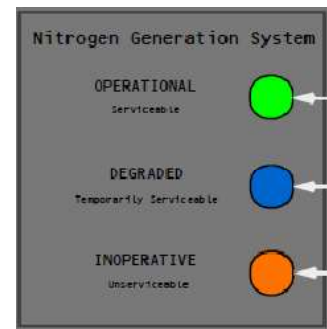
“CONFIG” alert, is displayed when:

- both engine are running
- centre tank is more than 726Kg and both CTR pump are OFF

“IMBAL” alert, is displayed when main tanks differ by more than 453 Kg

(FCOM2 12.20.1) nitrogen generation system (NGS) EI-DYL through YW135

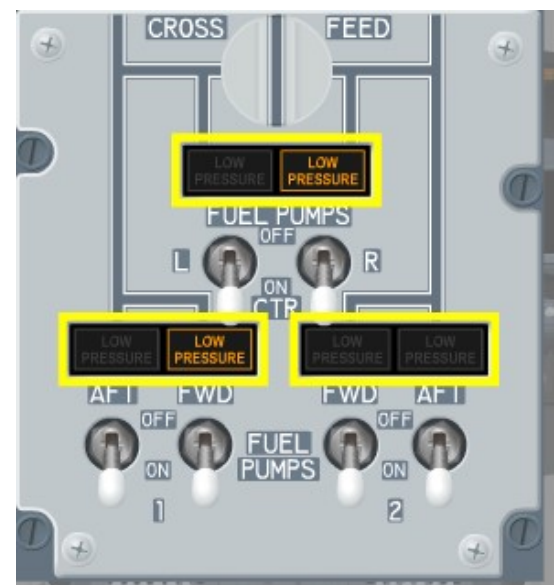
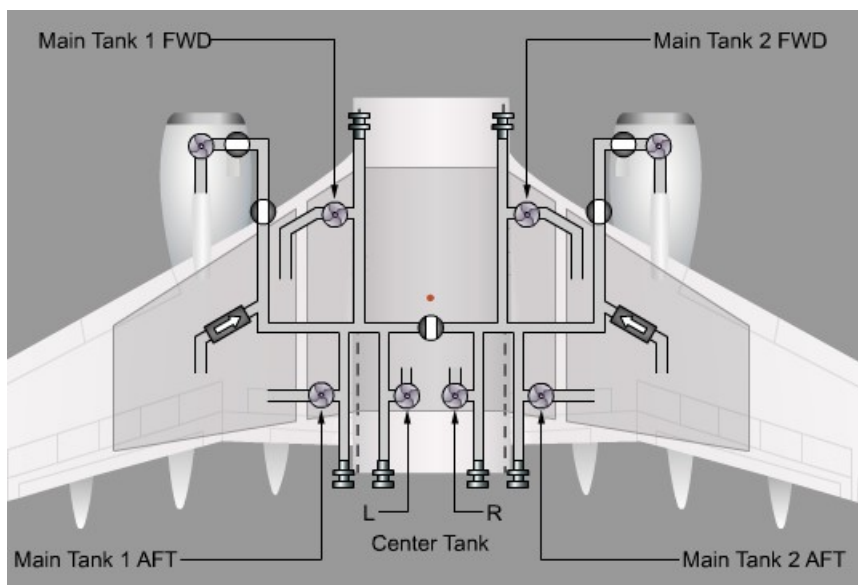
The NGS converts bleed air to nitrogen-enriched air (NEA) during all phases of flight. The NEA is delivered to the centre fuel tank to reduce flammability of the tank. NGS operation does not require any action from the crew. The NGS has an operability indicator located on the main wheel well, adjacent to the APU fire control.



Fuel pumps

There are 2 AC operated fuel pumps in each tank. Fuel provides cooling and lubrication for the pumps.

Associated sensors monitor each pump output



Fuel is normally pressure fed to engine, however each engine can draw fuel from its corresponding tank main tank using engine pumps (suction feed) if AC pumps fail. Suction feed is not possible from centre tank.

As the airplane climb, with engine in suction feed, thrust deterioration or flame out may occur due to dissolved air from fuel. Dissolved air will deplete at altitude so that may be possible to operate engine at cruise power normally.

CTR tank fuel scavenge jet pump

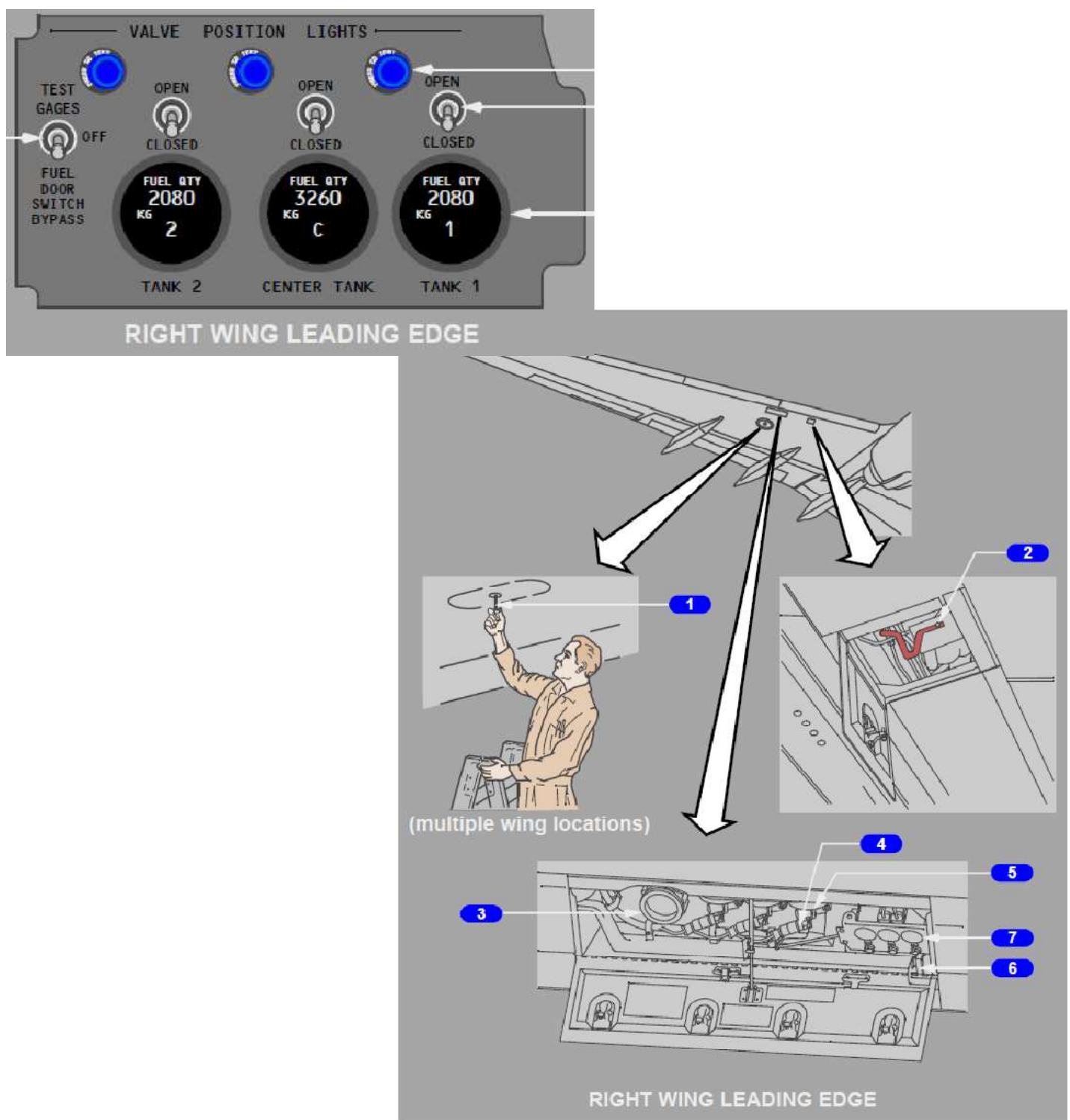
With the main fuel pump n°1 FWD switch ON, the centre tank fuel scavenge jet pump operates automatically to transfer any remaining centre tank fuel to main tank n°1. Once the fuel scavenge process begins, it continues for the remainder of the flight.

Fuelling/defueling/ground transfer

Rapid fuelling and defueling is accomplished at the single-point pressure fuelling station in the right wing. The fuelling station is also used for the ground transfer of fuel between tanks.

A manual defueling valve, interconnects the engine feed system and the fuelling station. It is opened for defueling and tank to tank transfer operation.

A SHUT-OFF system is used during fuelling to automatically close the fuelling valve in each fuel tank when the tank is full.



FUEL SYSTEM – NORMAL OPERATION

Pre-flight check (FCOM1 NP.21.21)

Before start (FCOM1 NP.21.21)

Fuel system KGS & 4/6 pumps ON

FUEL PUMPS switches (for tanks containing fuel) – ON

CROSSFEED selector – Verify operation

ENGINE VALVE CLOSED lights – Illuminated dim

SPAR VALVE CLOSED lights – Illuminated dim

FILTER BYPASS lights – Extinguished

CROSSFEED selector – Closed

VALVE OPEN light – Extinguished

Fuel quantity – Check

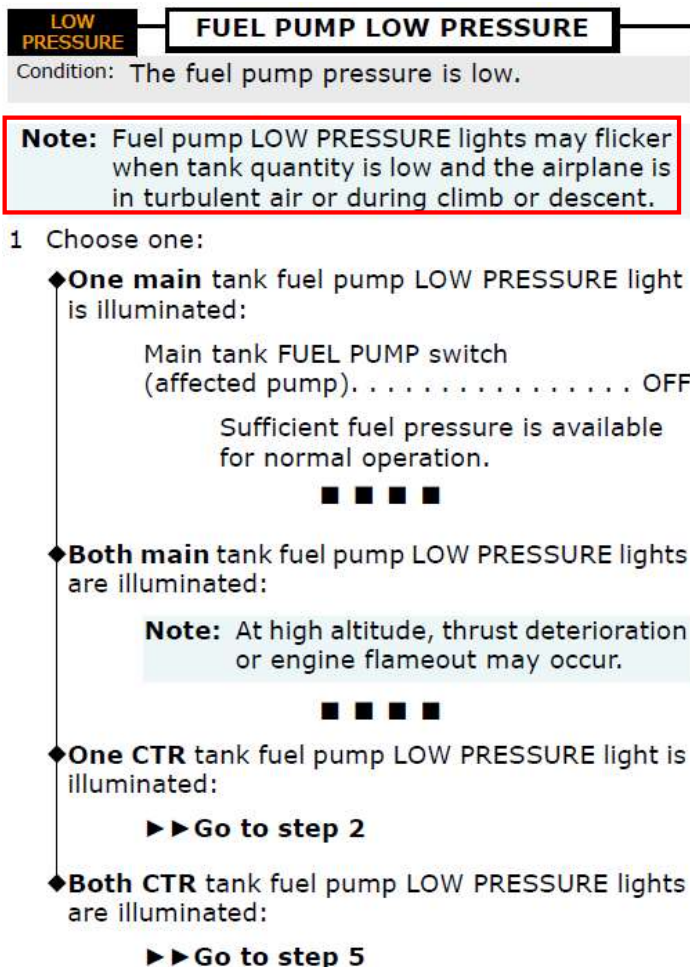
Verify total fuel quantity meets dispatch requirements. Block Fuel + kgs. (The PM will crosscheck the fuel in the tanks against the BLOCK FUEL on the OFP.)

Center tank fuel pump switches should be positioned ON only if the fuel quantity in the center tank exceeds 453 kgs. If the Captain deems that the amount of fuel in the center tank is not sufficient to keep the fuel low pressure lights out during takeoff then he may elect to leave the center tank pump switches off until passing FL 100. The flight deck must be manned whenever center tank fuel pump switches are on.

LOW PRESSURE lights – Extinguished

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

Climb/cruise CTR “LOW PRESSURE” (QRH 12.12)



- 2 CROSSFEED selector. Open
This prevents fuel imbalance.
 - 3 CTR FUEL PUMP switch (affected side) OFF
 - 4 **When** the other CTR tank fuel pump LOW PRESSURE light illuminates:
CROSSFEED selector Close
Remaining CTR FUEL PUMP switch OFF

■ ■ ■ ■
-
- Both CTR tank fuel pump LOW PRESSURE lights are illuminated**
- 5 CTR FUEL PUMP switches (both) OFF
 - 6 Fuel CONFIG alert may show with fuel in the center tank.
 - 7 Center tank fuel is unusable. Main tank fuel may not be sufficient for the planned flight.

■ ■ ■ ■

Fuel imbalance (QRH 12.15)

IMBAL

Condition: There is a fuel imbalance between the main tanks.

Objective: To decide if a fuel leak is suspected. To balance fuel if a fuel leak is not suspected.

- 1 If an engine has low fuel flow and unusual engine indications, the IMBAL alert may show due to an engine malfunction instead of a fuel leak.
- 2 The IMBAL alert may be caused by a fuel leak, an inoperative crossfeed valve or a fuel imbalance.
- 3 A fuel leak should be suspected if one or more of the following are true:

The total fuel remaining is less than the planned fuel remaining

An engine has excessive fuel flow.

- 4 Choose one:

◆ A fuel leak is **suspected**:

▶▶ Go to the **Fuel Leak Engine checklist** on page 12.6

■ ■ ■ ■

◆ A fuel leak is **not** suspected:

▶▶ Go to step 5

- 5 CROSSFEED selector Open

Verify that the VALVE OPEN light illuminates bright, then dim. This indicates that the crossfeed valve is operating correctly.

- 6 Choose one:

◆ Crossfeed valve is operating **correctly**:

▶▶ Go to step 7

◆ Crossfeed valve is **not** operating correctly:

▶▶ Go to the **CROSSFEED SELECTOR INOPERATIVE checklist** on page 12.2

■ ■ ■ ■

- 7 Choose one:

◆ **Main tank 1** quantity is low:

Main tank 1 FUEL PUMPS switches (both) OFF

This allows fuel from the higher quantity tank to feed both engines.

▶▶ Go to step 8

◆ **Main tank 2** quantity is low:

Main tank 2 FUEL PUMPS switches (both) OFF

This allows fuel from the higher quantity tank to feed both engines.

▶▶ Go to step 8

- 8 **When** fuel balancing is complete:

Main tank FUEL PUMPS switches (all) ON

CROSSFEED selector Close

■ ■ ■ ■

FUEL SYSTEM – NON-NORMAL OPERATION

Engine fuel leak

engine fuel leak (QRH 12.6)

Additional Information

Reasons that an engine fuel leak should be suspected:

- A visual observation of fuel spray
- The total fuel quantity is decreasing at an abnormal rate
- An engine has excessive fuel flow
- The fuel IMBAL alert shows
- The fuel LOW alert shows
- The USING RSV FUEL message shows on the FMC CDU
- The INSUFFICIENT FUEL message shows on the FMC CDU
- The CHECK FMC FUEL QUANTITY message shows on the FMC CDU.

Fuel Leak Engine

Condition: An engine fuel leak is suspected for the reasons listed in the Additional Information section of this checklist.

Objective: To confirm there is an engine fuel leak and shut down the affected engine if needed. This checklist does not address the unlikely possibility of a tank leak.

- 1 A diversion may be needed.
- 2 Main tank FUEL PUMPS switches (all) ON
- 3 CROSSFEED selector Close
- 4 CTR FUEL PUMPS switches (both) OFF
The fuel CONFIG alert may show with fuel in the center tank.

The following steps check for an engine fuel leak

- 5 Record the main tank fuel quantities and the current time.
- 6 An engine fuel leak is confirmed if one or both of the following are true:

Fuel spray is observed from an engine or strut
A change in fuel imbalance of 230 kgs within 30 minutes or less

- 7 Choose one:

◆ Engine fuel leak is **confirmed**:

▶▶ Go to step 11

◆ Engine fuel leak is **not** confirmed:

▶▶ Go to step 8

- 8 Choose one:

◆ The center tank **contains** usable fuel:

▶▶ Go to step 9

◆ The center tank does **not** contain usable fuel:

▶▶ Go to step 10

- 9 CTR FUEL PUMPS switches (both) ON

- 10 Resume normal fuel management.

■ ■ ■ ■

An engine fuel leak is confirmed

- 11 The following steps shut down the engine to stop an engine fuel leak.
- 12 The engine to be shut down is the engine on the side where the fuel quantity decreased faster.
- 13 Autothrottle Disengage
- 14 Thrust lever
(affected engine) Confirm Close
- 15 **When** the affected engine is at idle thrust:
Engine start lever
(affected engine) Confirm CUTOFF

This closes the spar valve and stops an engine fuel leak.

- 16 PACK switch (affected side) OFF

This causes the operating pack to regulate to high flow in flight with the flaps up.

- 17 Choose one:

◆ APU is **available** for start:

APU START

When APU is running:

APU GEN switch
(affected side) ON

▶▶ Go to step 18

◆ APU is **not** available:

▶▶ Go to step 18

- 18 Transponder mode selector TA

This prevents climb commands which can exceed single engine performance capability.

- 19 ISOLATION VALVE switch. Verify AUTO

This ensures bleed air is available to both wings if wing anti-ice is needed.

20 Choose one:

◆ Fuel LOW alert is **shown**:

▶▶ Go to step 21

◆ Fuel LOW alert is **not** shown:

▶▶ Go to step 23

21 CROSSFEED selector. Open

This ensures that all fuel is available to the running engine.

22 FUEL PUMPS switches (all). ON

This ensures that all fuel is available for use.

23 Plan to land at the nearest suitable airport.

Note: Balance fuel as needed. All remaining fuel can be used for the running engine.

Note: Do not use FMC fuel predictions.

▶▶ Go to the One Engine Inoperative Landing () checklist on page 7.30

■ ■ ■ ■

Other non-normal

“CONFIG” fuel alert (QRH 12.1)

CONFIG

Condition:

All of these occur:

- Both center tank fuel pump switches are off
- There is more than 726 kgs of fuel in the center tank
- An engine is running.

➔ “CONFIG” will extinguish when:

- Both engine are SHUT-DOWN
- CTR tank quantity is less than 363 Kg
- One CTR pump is turned ON

1 Do not accomplish this procedure until established in a level flight attitude.

2 CTR FUEL PUMP switches (both). ON

Verify that the LOW PRESSURE lights extinguish.

3 Resume normal fuel management.

■ ■ ■ ■

“LOW PRESSURE” fuel alert (QRH 12.12)

LOW PRESSURE

FUEL PUMP LOW PRESSURE

Condition: The fuel pump pressure is low.

Note: Fuel pump LOW PRESSURE lights may flicker when tank quantity is low and the airplane is in turbulent air or during climb or descent.

1 Choose one:

◆ **One main** tank fuel pump LOW PRESSURE light is illuminated:

Main tank FUEL PUMP switch (affected pump) OFF

Sufficient fuel pressure is available for normal operation.

■ ■ ■ ■

◆ **Both main** tank fuel pump LOW PRESSURE lights are illuminated:

Note: At high altitude, thrust deterioration or engine flameout may occur.

■ ■ ■ ■

◆ **One CTR** tank fuel pump LOW PRESSURE light is illuminated:

►► Go to step 2

◆ **Both CTR** tank fuel pump LOW PRESSURE lights are illuminated:

►► Go to step 5

2 CROSSFEED selector Open
This prevents fuel imbalance.

3 CTR FUEL PUMP switch (affected side) OFF

4 **When** the other CTR tank fuel pump LOW PRESSURE light illuminates:

CROSSFEED selector Close

Remaining CTR FUEL PUMP switch OFF

■ ■ ■ ■

Both CTR tank fuel pump LOW PRESSURE lights are illuminated

5 CTR FUEL PUMP switches (both) OFF

6 Fuel CONFIG alert may show with fuel in the center tank.

7 Center tank fuel is unusable. Main tank fuel may not be sufficient for the planned flight.

■ ■ ■ ■

Fuel temperature (QRH 12.14)

Fuel Temperature Low

Condition: Fuel temperature is near the minimum.

1 **When** fuel temperature is approaching the fuel temperature limit (3° C / 5° F above the fuel freeze point or - 43° C / - 45° F whichever is higher):

Increase speed, change altitude and/or deviate to a warmer air mass to achieve a TAT equal to or higher than the fuel temperature limit.

TAT will increase approximately 0.5 to 0.7° C for each 0.01 Mach increase in speed. In extreme conditions, it may be necessary to descend as low as FL250.

■ ■ ■ ■

"LOW" fuel alert (QRH 12.18)

LOW

Condition: The fuel quantity is low in a main tank.

Objective: To decide if a fuel leak is suspected. To ensure that all fuel is available for use.

Note: Avoid high nose up attitude. Make thrust changes slowly and smoothly. This reduces the possibility of uncovering fuel pumps.

- 1 The fuel LOW alert may be caused by a fuel leak or low fuel.
- 2 A fuel leak should be suspected if one or more of the following are true:

The total fuel remaining is less than the planned fuel remaining.

An engine has excessive fuel flow.

One main tank is abnormally low compared to the other main tank and to the expected fuel remaining in the tanks.

- 3 Choose one:

◆ A fuel leak is **suspected**:

▶▶ Go to the Fuel Leak Engine checklist on page 12.6

■ ■ ■ ■

◆ A fuel leak is **not** suspected:

▶▶ Go to step 4

- 4 CROSSFEED selector. Open

This ensures that fuel is available to both engines if the low tank empties.

- 5 FUEL PUMPS switches (all). ON

This ensures that all fuel is available for use.

- 6 Plan to land at the nearest suitable airport.

■ ■ ■ ■

HYDRAULICS – SYSTEM DESCRIPTION

Overview

Hydraulic system is made by 3 system: A, B and STBY system

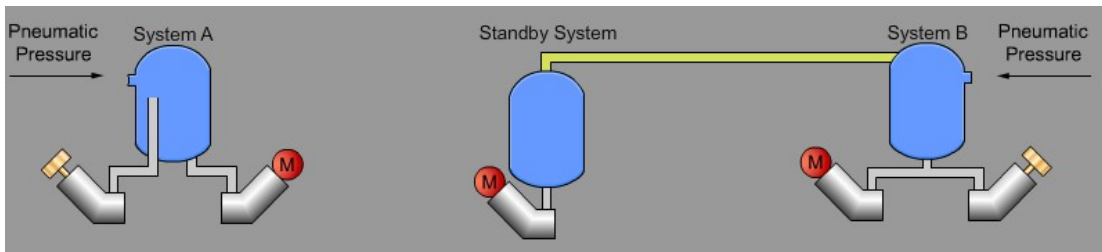
Systems that use hydraulic as power source are:

- Flight controls
- Leading edge flaps and slat
- Trailing edge flaps
- Landing gear
- Wheel brakes
- Nose wheel steering
- Thrust reverser
- Autopilot



Hydraulic fluid reservoir

Hydraulic fluid reservoirs are located in the main wheel well area. A and B reservoir incorporate a standpipe that may prevent total loss of system fluid in case of leak. Each reservoir is pressurised by the bleed air system to ensure positive flow. STBY is serviced and pressurised through system B reservoir.



Hydraulic system panel / flight control panel

system A and B quantity and pressure indication are displayed on the lower DU by pushing the MFD (multi function display)SYS (system)button.



“QTY %” indicate remaining fluid quantity in percentage from 0 to 106%

“PRESS” normal system pressure is 3000 PSI, MAX 3500 PSI

If QTY is below 76%, RF (re-fill) indication appear. This indication is only accurate with the aircraft on the ground and engine SHUT-DOWN or during taxi-in with FLAPs UP



Systems A and B

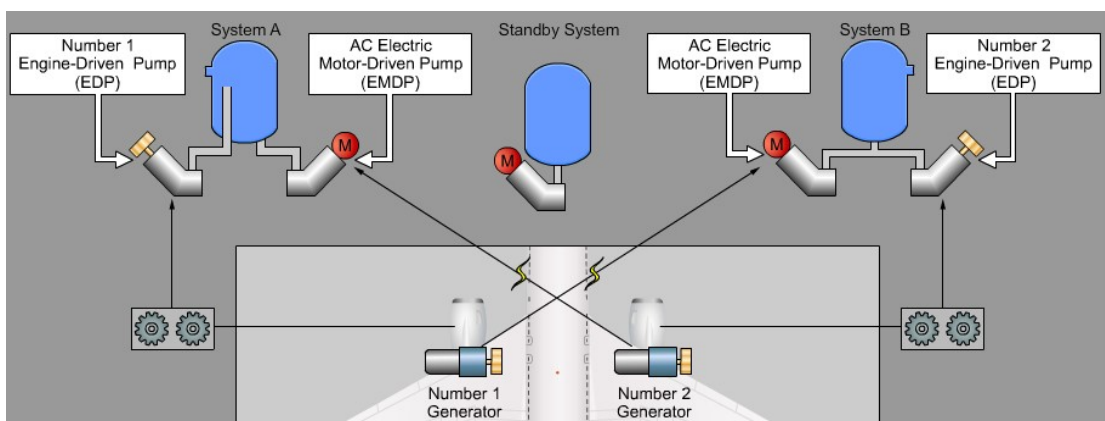
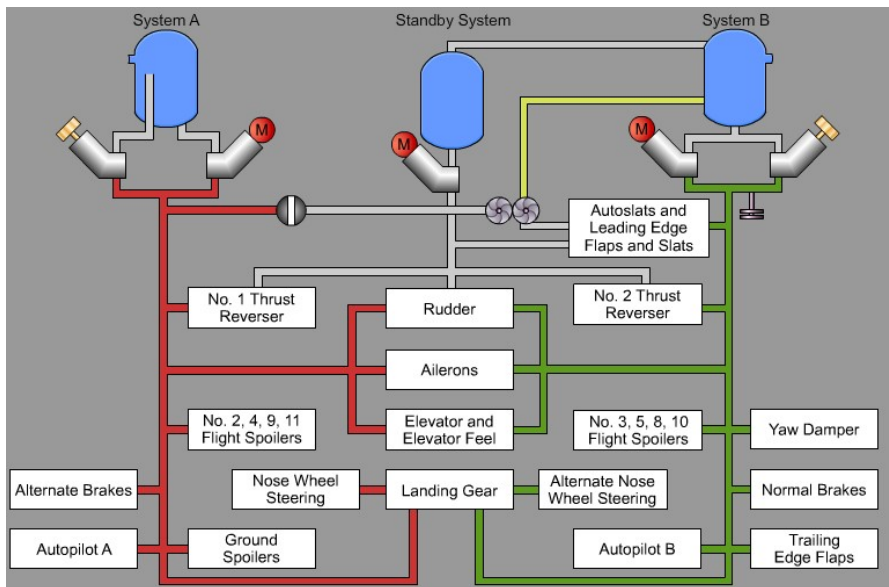
Systems A and B are powered by both engine driven (ENG) and electric (ELEC) pumps.
Engine driven pumps provide 4 to 6 times the flow rate of electric pump.

Engine 1 drives:

- ENG pump system A
- ELEC pump system B

Engine 2 drives:

- ENG pump system B
- ELEC pump system A



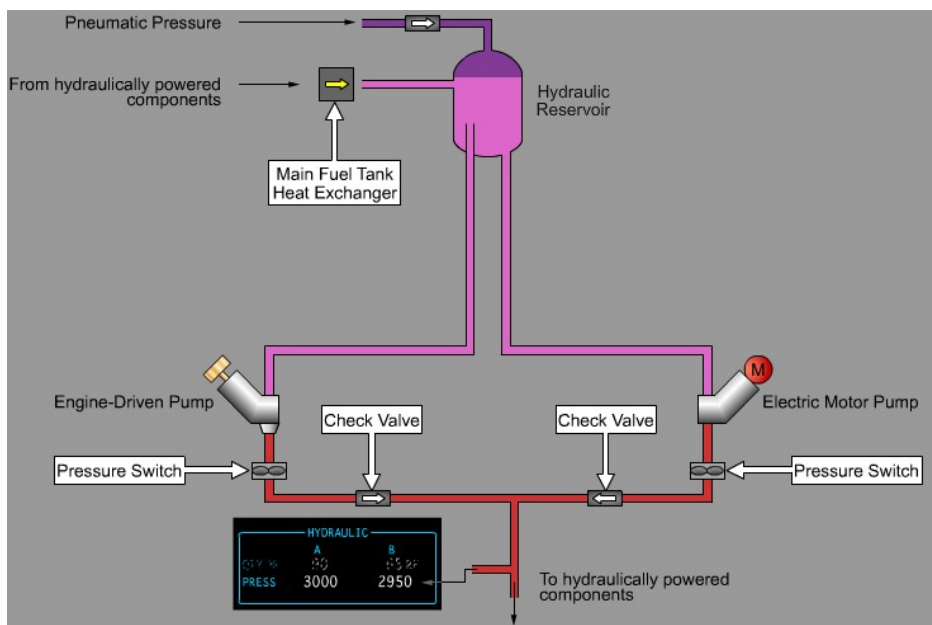
Pump and hydraulic fluid cooling

Pumps are cooled and lubricated by hydraulic fluids, which then passes through a heat exchanger located in the main tank.

- System A: heat exchanger in tank n°1
- System B: heat exchanger in tank n°2

NOTE: A minimum amount of 760 Kg of fuel in the related tank is required for operation of ELEC pump.

Check-valves (non-return-valves) isolates pump from system.



Pressure sensing

Pressure switches send signal to "LOW PRESSURE" lights while separate transmitters send combined ENG and ELEC pumps output pressure to SYS indication on MFD.



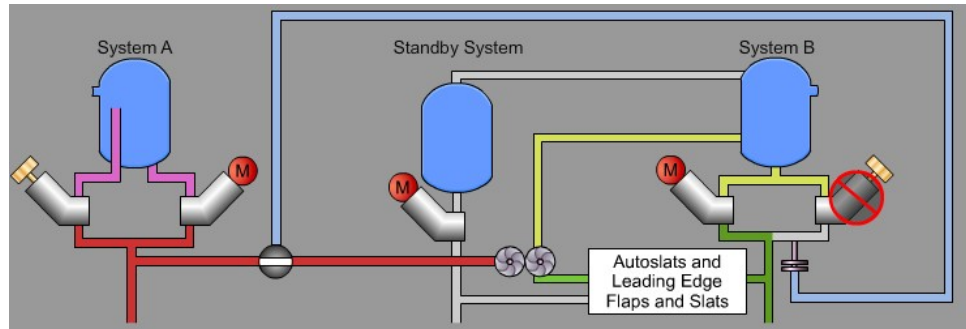
Pumps control panel

- ENG switches: ON / positioning the switch to OFF (or pulling the related **fire switch**) isolates fluid flow from the system components, however the pump continues to rotate as long as the engine is operating
- ELEC switches: ON/OFF control the operation of the ELEC pump itself
- "OVERHEAT" indicate that the associated ELEC has overheated
- "LOW PRESSURE" indicate low output pressure. ELEC "LOW PRESSURE" may blink during flight to indicate an heavy demand

(PTU) power transfer unit

The PTU automatically supplies additional volume of hydraulic fluid to:

- Auto-slat system
- Leading edge flaps and slats system



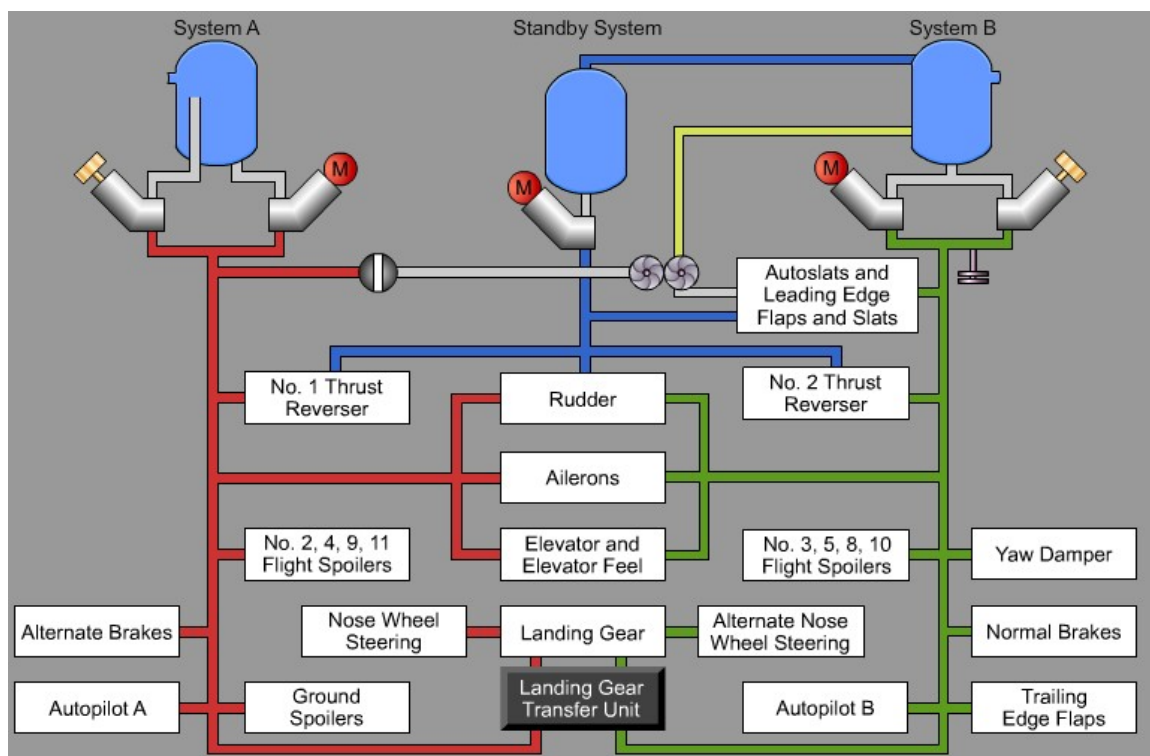
PTU operate when system B ENG pump volume is lost. The PTU then uses pressure from system A to power an hydraulic motor driven pump which pressurize system B. PTU will operate only when:

- Aircraft is airborne, and
- "LOW PRESSURE" is sensed for system B ENG pump, and
- FLAPs less than 15°, but not UP

Landing gear transfer unit

Landing gear transfer unit uses system B pressure to raise the landing gear when system A ENG pump pressure is low. Landing gear transfer unit operate only when:

- Aircraft is airborne, and
- N°1 engine PRM is low, and
- Landing gear lever UP position
- Either main landing gear is not UP and locked

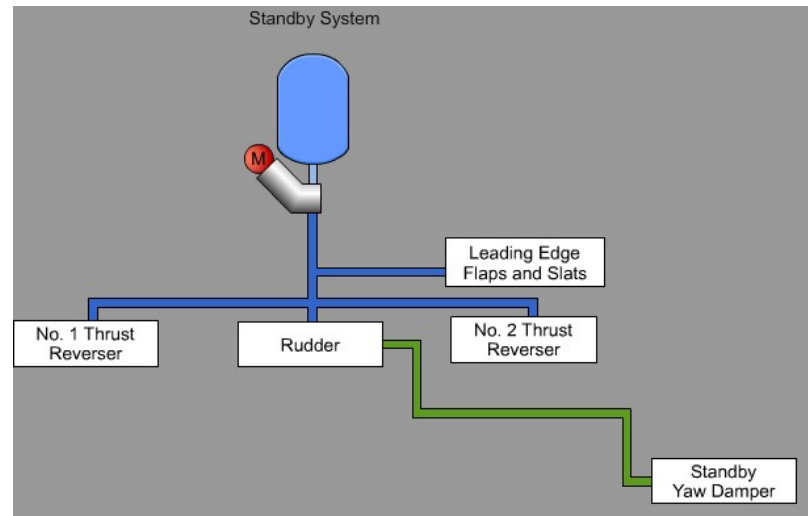
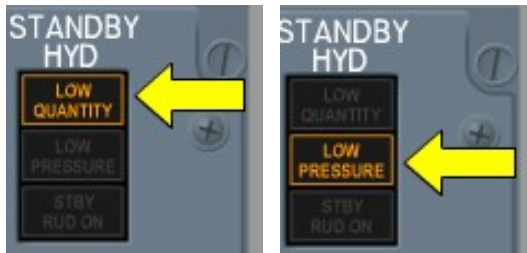


STBY system

The STBY system acts as a backup should system A and/or B pressure fall. It operates both automatically and manually. The STBY system is powered by a single ELEC pump, can power:

- Thrust reverser
- Rudder (STBY RUD)
- Leading edge flaps and slats (extension only)
- STBY yaw damper

STBY system lights



“LOW QUANTITY” indicates a low quantity of fluid remaining in the STBY reservoir

“LOW PRESSURE” indicates a low output pressure, is armed only when STBY pump operation has been selected or automatic STBY function is activated

HYDRAULICS – NORMAL OPERATION

System A and B

ELEC pump “OVERHEAT” (QRH 13.2)

OVERHEAT **HYDRAULIC PUMP OVERHEAT**

Condition: The hydraulic pump temperature is high.

- ELEC HYD PUMP switch (affected side) OFF

Note: One pump supplies sufficient pressure for normal system operation.

- MFD SYS switch Push
- Choose one:
 - ♦ Affected side hydraulic pressure is 3300 psi or less:

■ ■ ■ ■
 - ♦ Affected side hydraulic pressure is greater than 3300 psi:

ENG HYD PUMP switch (affected side) OFF

▶▶ Go to step 4
- Choose one:
 - ♦ System A HYD PUMPS switches are OFF:

▶▶ Go to the LOSS OF SYSTEM A checklist on page 13.4

■ ■ ■ ■
 - ♦ System B HYD PUMPS switches are OFF:

▶▶ Go to the LOSS OF SYSTEM B () checklist on page 13.8

■ ■ ■ ■

Pre-flight procedure (FCOM1 NP.21.22)

Hydraulic pump switches ON

Note: Prior to switching on the hydraulic system pump switches, ensure ground personnel are clear of the tow bar or the bypass pin is installed. Do not proceed with the checklist until the hydraulic systems are in the normal configuration.

Note: Alert ground personnel before pressurizing hydraulic systems.

System A HYDRAULIC PUMPS switches – ON

System B HYDRAULIC PUMPS switches – ON

Electric pump LOW PRESSURE lights – Extinguished

Brake pressure – 2800 PSI minimum

EI-DAC through EI-FRT
MFD SYSTEM switch – Push

System A and B pressure – 2800 PSI minimum

Quantity indicators – No RF indication displayed

Hydraulic Accumulator Pressure Indicator - Green band

Shut down procedure (FCOM1 NP.21.127)

ELECTRIC HYDRAULIC PUMP switches OFF

CAUTION: To avoid unwanted control column movement during gusty tailwind conditions, leave the B electric hydraulic pump switch ON until completing the Secure procedure.

→ ENG pumps are leaved on to improve solenoid life

Hydraulic fluid quantity and foaming

Hydraulic fluid quantity vary during flight, normal system is not affected by these variations.

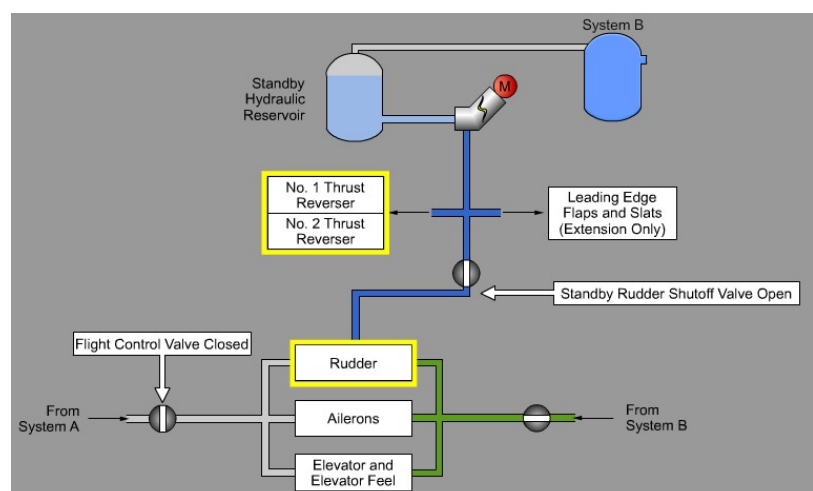
Hydraulic fluid foaming may occur at high altitude, in this case ENG and ELEC “LOW PRESSURE” flashes and pressure indication fluctuates.

STBY system

STBY RUD

Moving the FLT CONTROL switch on STBY RUD cause:

- STBY ELEC pump activates
- Flight control valve closes, “LOW PRESSURE”
- STBY RUD valves open, “STBY RUD”
- STBY system is powering rudder and reverser
- “MASTER CAUTION” + “FLT CONT” annun.



ALTERNATE FLAP (QRH 13.12)

Alternate Flap Extension

During flap extension, set the flap lever to the desired flap position.

230K maximum during alternate flap extension.
⚠️ **ALTERNATE FLAPS master switch ARM**

Note: The landing gear configuration warning may sound if the flaps are between 10 and 15 and the landing gear are retracted.

Note: The amber LE FLAPS TRANSIT light will stay illuminated until the flaps approach the flaps 10 position.

Note: Operation within the lower amber airspeed band may be needed until the LE FLAPS TRANSIT light extinguishes.

⚠️ **If flap asymmetry occurs, release the switch immediately. There is no asymmetry protection.**
ALTERNATE FLAPS
position switch Hold DOWN
to extend flaps
to 15 on schedule

As flaps are extending, slow to respective maneuvering speed.



Moving the ALTERNATE FLAP switch to ARM causes:

- Trailing edge flap bypass valve closes
- Arm alternate flap position switch
- Activate STBY ELEC pump
- Allow STBY system to power leading edge devices and reverser

Automatic STBY system activation

Automatic operation of the STBY system occur when the main PCU force flight monitor (FFM) trips or all of these are met:

- Loss of system A or B
- Flaps extended
- Aircraft is airborne or wheel speed higher than 60 Kts
- System A or B FLT CONTROL switch ON

Automatic operation of STBY system causes:

- Activation of the STBY ELEC pump
- STBY RUD shut-off valve opens
- Allow STBY system to power rudder and reverser
- “STBY RUD ON” + “MASTER CAUTION” + “FLT CONT” annunciation

HYDRAULICS – NON-NORMAL OPERATION

“LOW PRESSURE” (QRH 13.1)



Condition: The hydraulic pump pressure is low.

1 HYD PUMP switch (affected side) OFF

Note: Loss of an engine-driven hydraulic pump and a high demand on the system may result in an intermittent illumination of the LOW PRESSURE light for the remaining electric motor-driven hydraulic pump.

Loss of system A (QRH 13.4)

LOSS OF SYSTEM A

FLT CONTROL

A HYD PUMPS

A

ENG 1

ELEC 2

LOW
PRESSURE

LOW
PRESSURE

LOW
PRESSURE

Condition: Hydraulic system A pressure is low.

- 1 System A
FLT CONTROL switch Confirm STBY RUD
- 2 System A
HYD PUMP switches (both). OFF
- 3 Check the Non-Normal Configuration Landing
Distance table in the Advisory Information section
of the Performance Inflight chapter.
- 4 NOSE WHEEL STEERING switch ALT
- 5 Plan for manual gear extension.

Note: When the gear has been lowered manually, it cannot be retracted. The drag penalty with gear extended may make it impossible to reach an alternate field.

Note: Inoperative Items

Autopilot A inop

Autopilot B is available.

Flight spoilers (two on each wing) inop

Roll rate and speedbrake effectiveness may be reduced in flight.

Normal landing gear extension and retraction inop

Manual gear extension is needed.

Ground spoilers inop

Landing distance will be increased.

Alternate brakes inop

Normal brakes are available.

Engine 1 thrust reverser normal hydraulic pressure inop

Thrust reverser will deploy and retract at a slower rate and some thrust asymmetry can be anticipated during thrust reverser deployment.

Normal nose wheel steering inop

Alternate nose wheel steering is available.

- 6 Checklist Complete Except Deferred Items



Allow system B to power nose wheel steering



Loss of system B (QRH 13.8)

LOSS OF SYSTEM B ()		
FLT CONTROL	B HYD PUMPS	
B	ELEC 1	ENG 2
LOW PRESSURE	LOW PRESSURE	LOW PRESSURE

Condition: Hydraulic system B pressure is low.

- 1 System B
FLT CONTROL switch. . . . Confirm STBY RUD
- 2 System B
HYD PUMP switches (both). OFF
- 3 Plan a flaps 15 landing.
- 4 Set VREF 15 or VREF ICE.

Note: If any of the following conditions apply, set VREF ICE = VREF 15 + 10 knots:

- Engine anti-ice will be used during landing
- Wing anti-ice has been used any time during the flight
- Icing conditions were encountered during the flight and the landing temperature is below 10° C.

Note: When VREF ICE is needed, the wind additive should not exceed 10 knots.

- 5 Plan to extend flaps to 15 using alternate flap extension.

Note: The drag penalty with the leading edge devices extended may make it impossible to reach an alternate field.

- 6 Check the Non-Normal Configuration Landing Distance table in the Advisory Information section of the Performance Inflight chapter.
- 7 Do **not** arm the autobrake for landing. Use manual braking.

Note: Inoperative Items

Autopilot B inop

Autopilot A is available.

Flight spoilers (two on each wing) inop

Roll rate and speedbrake effectiveness may be reduced in flight.

Yaw damper inop

Trailing edge flaps normal hydraulic system inop

The trailing edge flaps can be operated with the alternate electrical system. Alternate flap extension time to flaps 15 is approximately 2 minutes.

Leading edge flaps and slats normal hydraulic system inop

The leading edge flaps and slats can be extended with standby pressure. Once extended, they can not be retracted.

Autobrake inop

Use manual braking.

Normal brakes inop

Alternate brakes are available.

Engine 2 thrust reverser normal hydraulic pressure inop

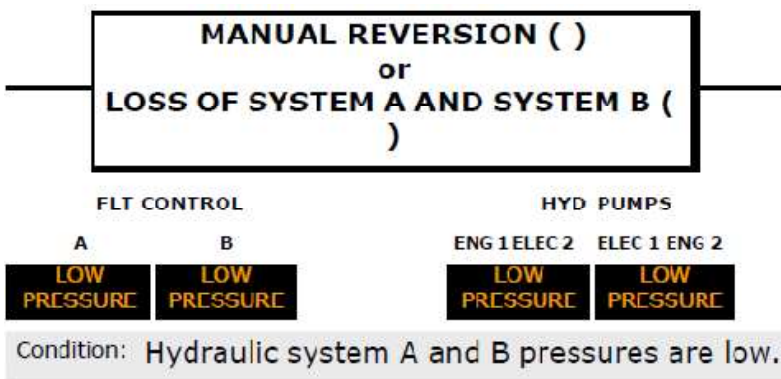
Thrust reverser will deploy and retract at a slower rate and some thrust asymmetry can be anticipated during thrust reverser deployment.

Alternate nose wheel steering inop

Normal nose wheel steering is available.

8 Checklist Complete Except Deferred Items

loss of both system A and system B (manual reversion) (QRH 13.14)



Note: Inoperative Items

Autopilots A and B inop

All flight spoilers inop

Roll rate will be reduced and speedbrakes will not be available in flight.

Trailing edge flaps normal hydraulic system inop

The trailing edge flaps can be operated with the alternate electrical system. Alternate flap extension time to flaps 15 is approximately 2 minutes.

Leading edge flaps and slats normal hydraulic system inop

The leading edge flaps and slats can be extended with standby hydraulic pressure. Once extended, they can not be retracted.

Normal landing gear extension and retraction inop

Manual gear extension is needed.

Autobrake inop

Ground spoilers inop

Landing distance will be increased.

Normal and alternate brakes inop

Inboard and outboard brakes have accumulator pressure only. On landing, apply steady brake pressure without modulating the brakes.

Both thrust reversers normal pressure inop

Thrust reversers will deploy and retract at a slower rate.

Nose wheel steering inop

Do not attempt to taxi the airplane after stopping.

- 1 System A and B FLT CONTROL switches (both) Confirm. STBY RUD
- 2 YAW DAMPER switch ON
- 3 System A and B HYD PUMPS switches (all) OFF
- 4 Plan to land at the nearest suitable airport.
- 5 Plan a flaps 15 landing.
- 6 Set VREF 15 or VREF ICE.

Note: If any of the following conditions apply, set VREF ICE = VREF 15 + 10 knots:

- Engine anti-ice will be used during landing
- Wing anti-ice has been used any time during the flight
- Icing conditions were encountered during the flight and the landing temperature is below 10° C.

Note: When VREF ICE is needed, the wind additive should not exceed 10 knots.

- 7 Plan to extend flaps to 15 using alternate flap extension.

Note: The drag penalty with the leading edge devices extended may make it impossible to reach an alternate field.

- 8 Plan for manual gear extension.

Note: When the gear has been lowered manually, it cannot be retracted. The drag penalty with gear extended may make it impossible to reach an alternate field.

- 9 Check the Non-Normal Configuration Landing Distance table in the Advisory Information section of the Performance Inflight chapter.

Note: The crosswind capability of the airplane is greatly reduced.

- 10 Do **not** arm the autobrake for landing.

- 11 Do **not** arm the speedbrakes for landing.

- 12 On touchdown, apply steady brake pressure without modulating the brakes.

- 13 Do not attempt to taxi the airplane after stopping.

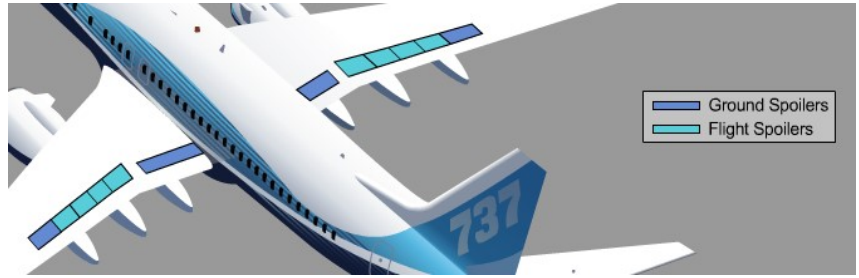
FLIGHT CONTROLS – SYSTEM DESCRIPTION

Overview

Primary flight controls: aileron, elevator, rudder

Secondary flight controls:

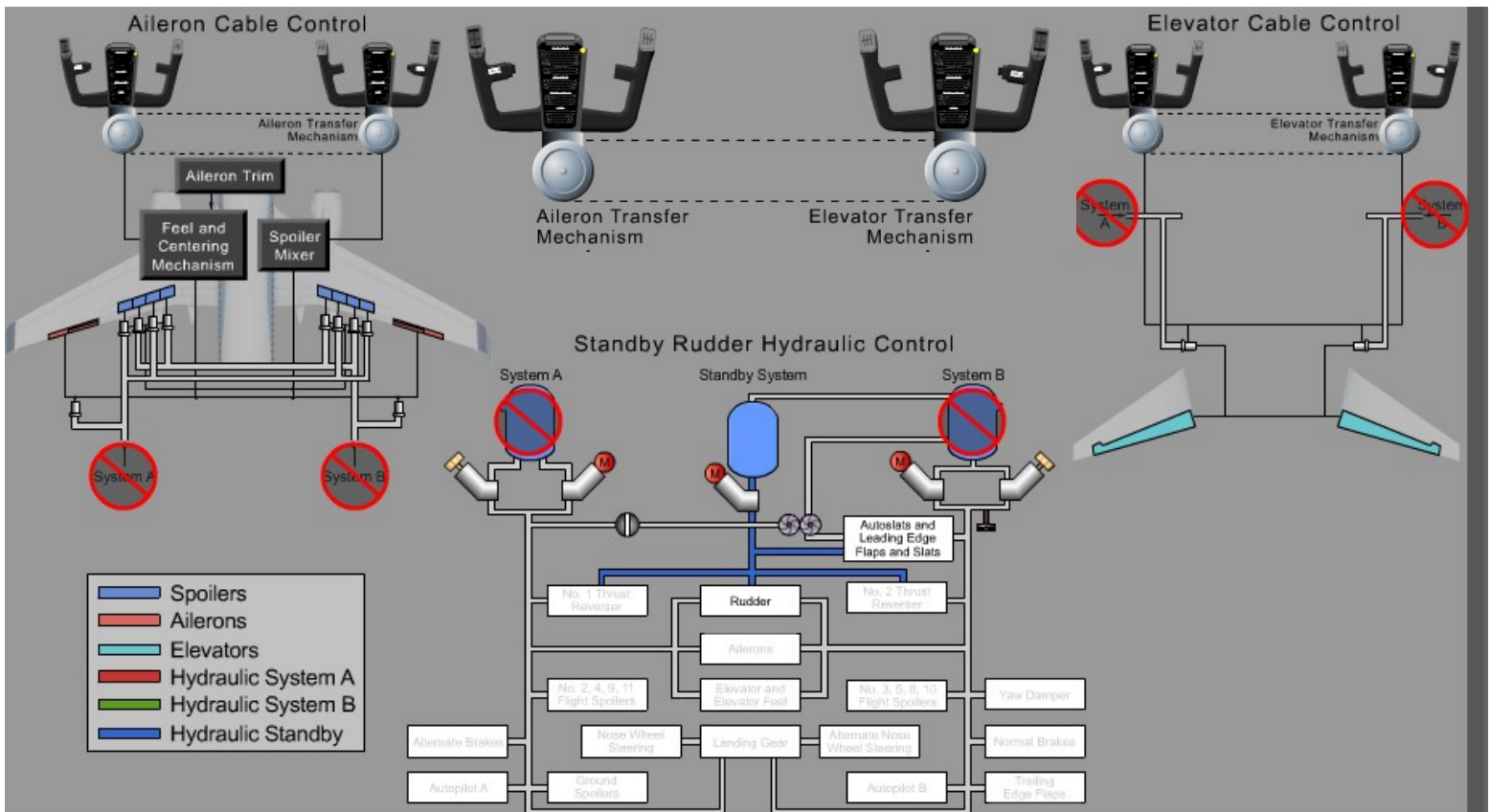
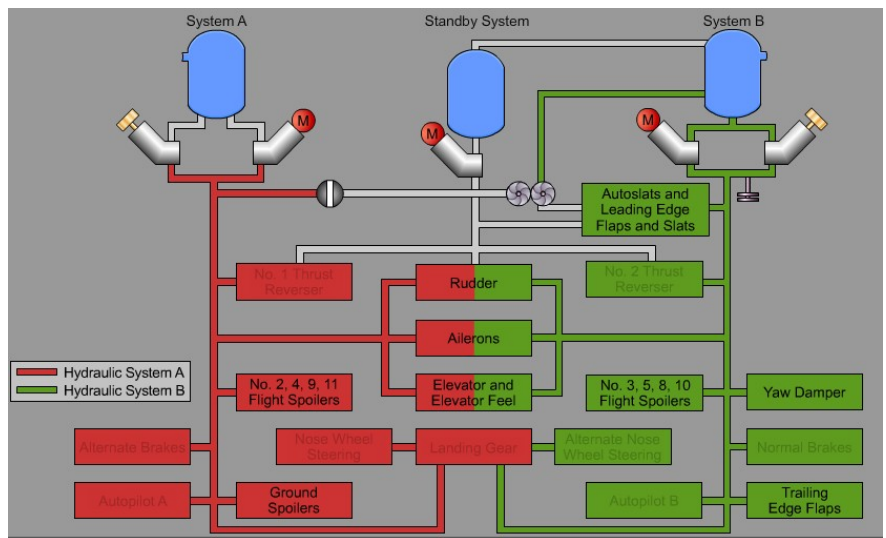
- Spoiler: FLIGHT spoiler and GND spoiler (speedbrake and spoiler system)
- High lift devices:
 - i. Inboard and outboard trailing edge flaps
 - ii. Leading edge flaps inboard of the engines
 - iii. Leading edge slats outboard of the engines



Power sources

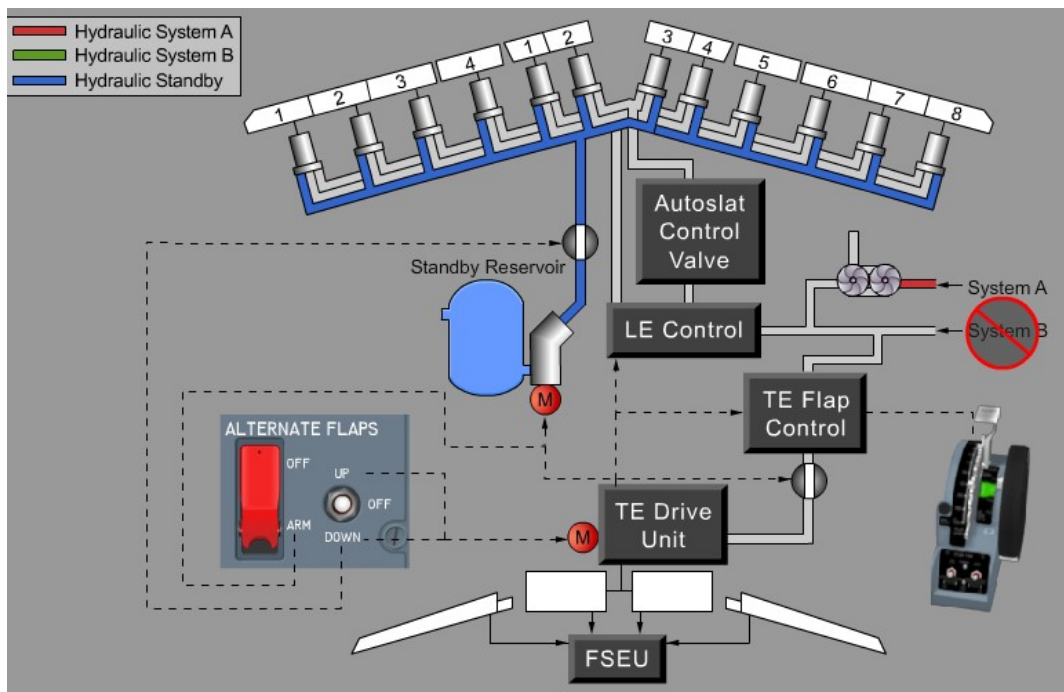
Primary flight controls are powered by more hydraulic systems (redundancy). Furthermore, aileron and elevator may be operated manually via a cable system (manual reversion), A transfer mechanism for control column wheels allows the pilots to bypass a jammed control or surface.

The rudder can be powered by STBY hydraulic system. Rudder pedals have a rigid interconnection



The hydraulic system B power leading edge and trailing edge flaps and slats. In case of:

- System B partial failure: PTU (power transfer unit) assist system B to retract leading edge devices
- System B complete failure:
 - i. Trailing edge flaps are operated electrically (both extension and retraction)
 - ii. Leading edge devices are operated hydraulically, may **only** be extended



FLT CONTROL panel

- **STBY RUD**: activates STBY hydraulic system pump and opens the STBY RUD shut-off valve. This pressurise the **STBY RUD power control unit (PCU)**
- **OFF**: hydraulically isolates aileron, elevator and rudder from the associated hydraulic system
- **ON (guarded)**
- **“LOW PRESSURE”** indicate low hydraulic system pressure to aileron, elevator and rudder. **Light goes out** when FLT CONTROL switch moved to STBY RUD and STBY RUD shut-off valve opens.



Roll control

roll control is provided primarily by aileron which are assisted by FLIGHT spoiler.

Cables connect the captain control wheel to the spoiler PCU via the aileron feel and centring unit.

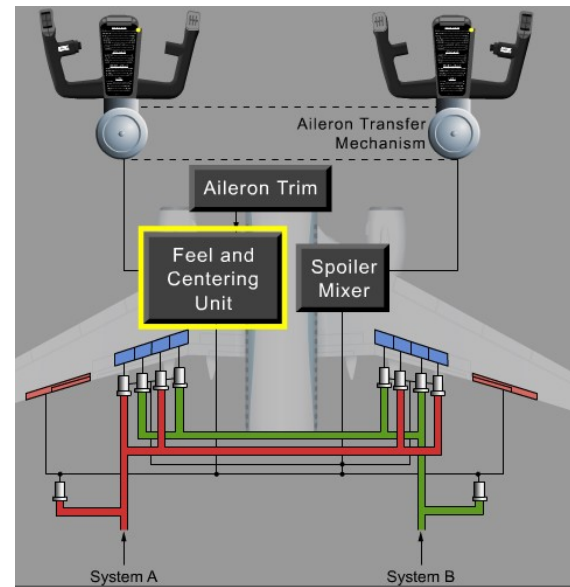
Cables connect the first officer control wheel to the spoiler PCU via the spoiler mixer, which extends spoiler in proportion to aileron movement.

A cable drive system connects the two control wheel (aileron transfer mechanism). This permits either control wheel to activate both the aileron and the spoiler.

with either the aileron or spoiler jammed, force applied to the control wheel will serve to identify which system has failed:

- **Aileron jammed:**
 - i. First officer wheel provide roll control through spoiler
 - ii. **Captain wheel is inoperative**
- **Spoiler jammed:**
 - i. First officer wheel is inoperative
 - ii. Captain wheel provide roll control through aileron

In case of manual reversion (both hydraulic system A and B failure) ailerons remain controllable through cables control, however the force required will be substantially high.



Aileron trim

Aileron trimming is accomplished through 2 aileron trim switches. This causes the aileron feel and centring unit to reposition and the control wheel to rotate. A scale on the control column indicates the amount of aileron trim. Aileron trimming is overpowered by the autopilot when engaged, so the control column doesn't move. Applying aileron trim with autopilot engaged can cause an abrupt roll when autopilot is disconnected.

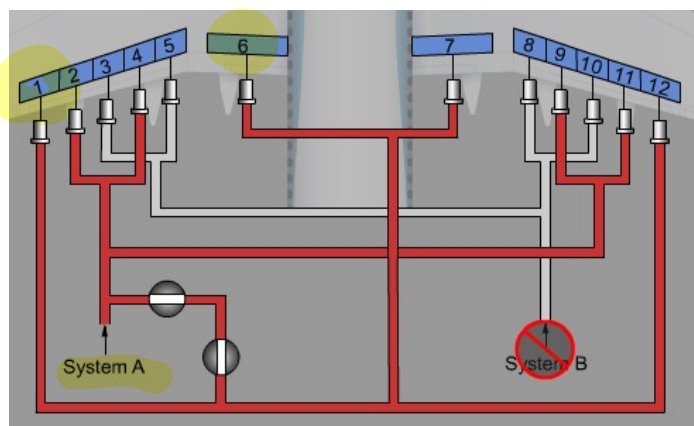
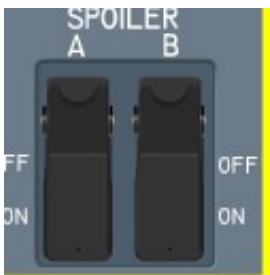


FLIGHT spoiler (2.3.4.5 and 8.9.10.11)

4 FLIGHT spoiler are provided on each wing. Hydraulic power is spitted, so that in case of a single hydraulic system failure symmetric FLIGHT spoiler operation is provided.

2 spoiler switches control hydraulic pressure through shut-off valves.

NOTE: deflection of spoiler does not start until the control wheel is displaced more than 10°



Pitch control

pitch control is provided by:

- Elevator: is hydraulically operated, controlled by control column
- Stabiliser: is electrically operated, controlled by autopilot or manual trim

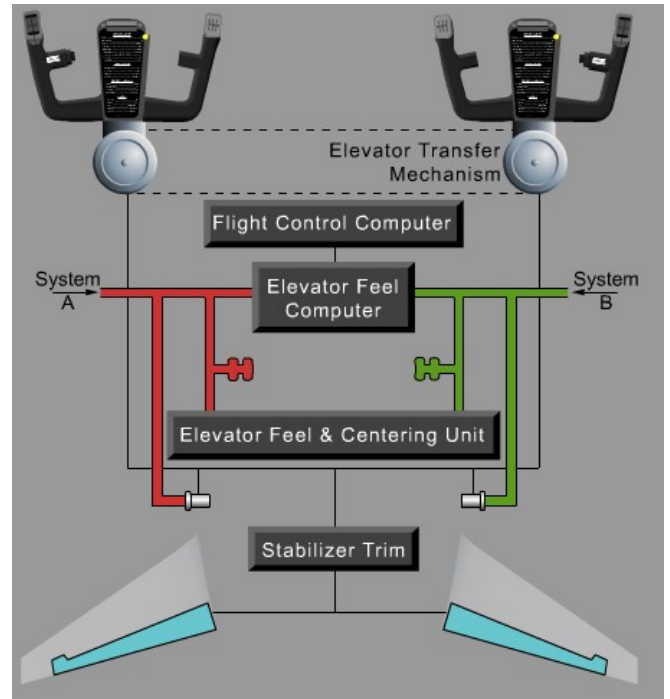
Elevator controls

Cables connect pilots control column to the elevator PCUs (power control units) which hydraulically operate the elevator. A torque tube interconnects left and right elevator. Should both hydraulic systems fail, manual reversion is required to operate the elevator.

If one control column jams, applying force against the jammed column will override the transfer mechanism, physically separate the 2 control column, letting the column which moves freely to be used for elevator control.

However total available elevator control is significantly reduced and forces required are higher than that experienced during manual reversion.

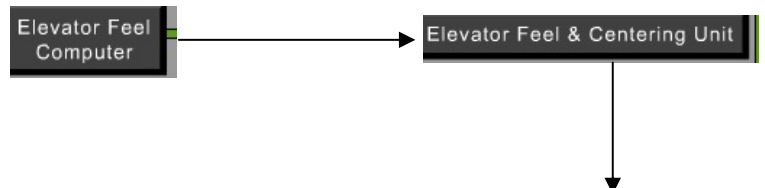
NOTE: there is still sufficient elevator control for landing flare, using the stabiliser trim can help in controlling the pitch.



Elevator feel

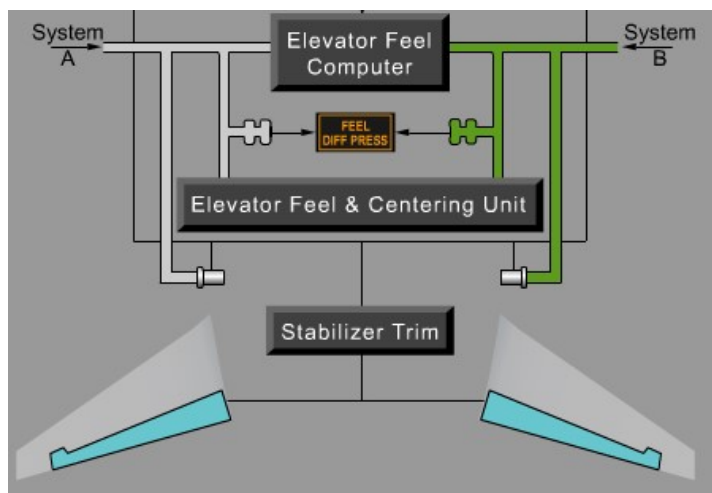
Elevator FEEL COMPUTER and elevator FEEL AND CENTRING UNIT use pressure from hydraulic system A or B whichever is higher. The elevator FEEL COMPUTER compute the feel force to be applied on the column, which is then transmitted to the FEEL AND CENTRING UNIT which applied this force on the control column. This feel force is calculated according to:

- Airspeed from Pitot system (dynamic pressure)
- Stabiliser position



“FEEL DIFF PRESS” indicate:

- An excessive difference in hydraulic pressure between system A and B sensed in the FEEL COMPUTER
- Failure of the elevator FEEL PITOT system



Mach trim

A Mach trim system provides stability above Mach .615, as speed increases, the elevator is adjusted with respect to the stabiliser. The flight control computer use Mach information from the ADIRU (air data inertial reference unit) to compute a Mach trim actuator position. The Mach trim actuator reposition the elevator FEEL AND CENTRING unit which adjust the control column neutral position.

Stabiliser trim

A single electric motor is used to trim the stabiliser.

With the autopilot engaged, stabiliser trim is accomplished through the autopilot stabiliser trim circuit. The MAIN ELEC and AUTOPILOT stabiliser trim have two speed modes:

- High speed: when flap retracted
- Low speed: when flap extended

When autopilot is engaged, actuating either pair of stabiliser trim switches, disengage the autopilot.

STAB TRIM MAIN ELEC and AUTOPILOT CUTOUT switches allow the autopilot or main electric trim inputs to be disconnected from the stabiliser trim motor.

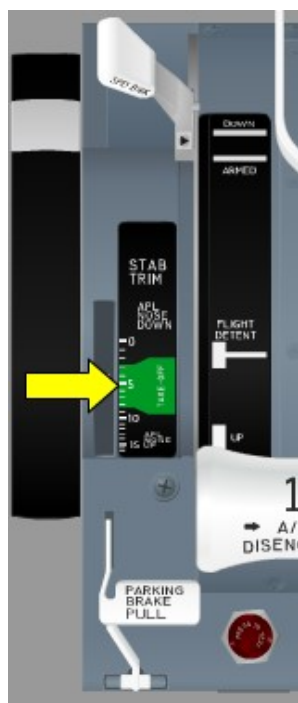
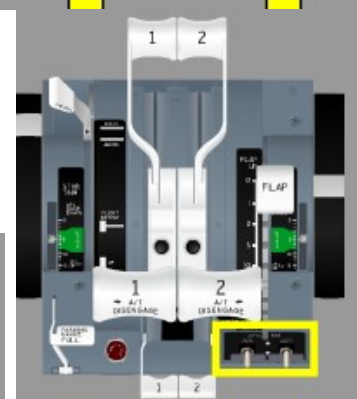
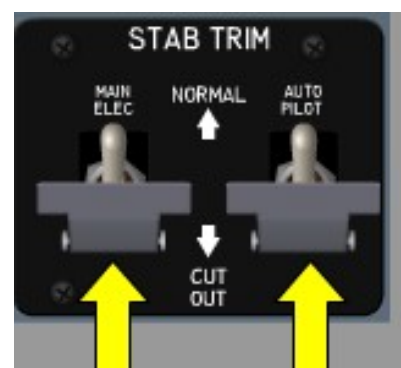
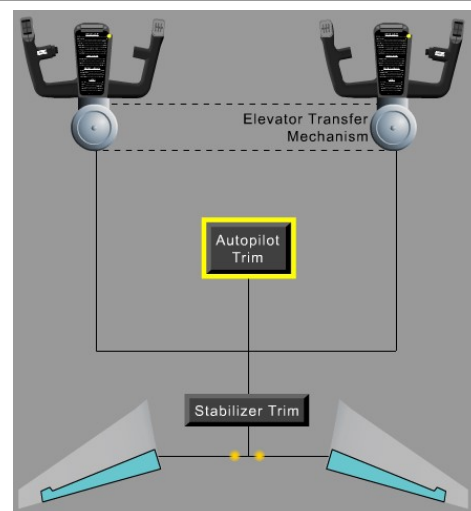
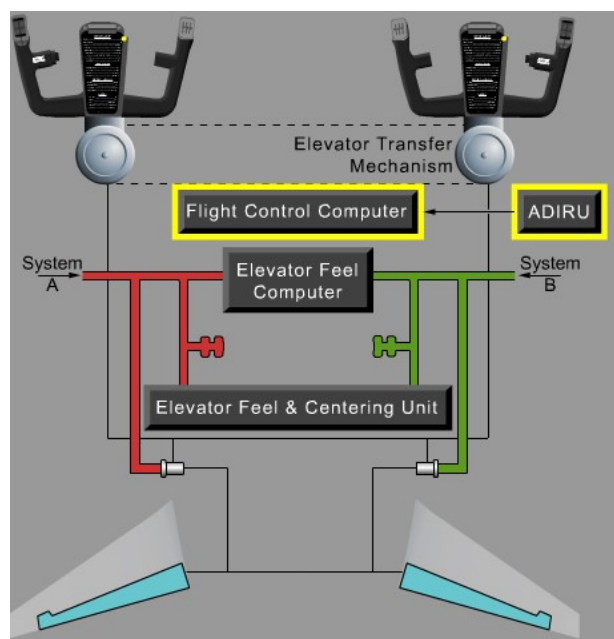
NOTE: operating the AUTOPILOT CUTOUT switch will disengage autopilot

Moving the control column opposite to the direction of MAIN ELEC or AUTOPILOT trimming action will actuate the control column actuated stabiliser trim cut-out which stops MAIN ELEC or AUTOPILOT trimming.

The OVRD (override) position of STAB TRIM switch, allow MAIN ELEC trimming regardless of the control column position.

Stabiliser trim wheel overrides any other trim inputs. Additional trim capability is available with trim wheel compared to other trimming sources.

“STAB OUT OF TRIM” indicate that the autopilot is not trimming properly (armed only with autopilot engaged)



Stabiliser trim indicator displays stabiliser position in units of trim and shows the takeoff GREEN band indication (takeoff stabiliser range). Takeoff configuration warning “horn” will sound if a takeoff is attempted with the stabiliser trim outside this range.



Speed trim system (STS)

The STS is a speed stability segmentation system designed to improve flight characteristics during operation with:

- Low gross weight
- Aft CG
- Autopilot not engaged

The speed trim system (STS) return the aircraft to a trimmed speed by commanding a stabilizer opposite to the speed change. The STS provide increased force to cause the aircraft to go back towards the trimmed speed.

STS operates more frequently during takeoffs, climbs and go-around. Conditions for STS operation are:

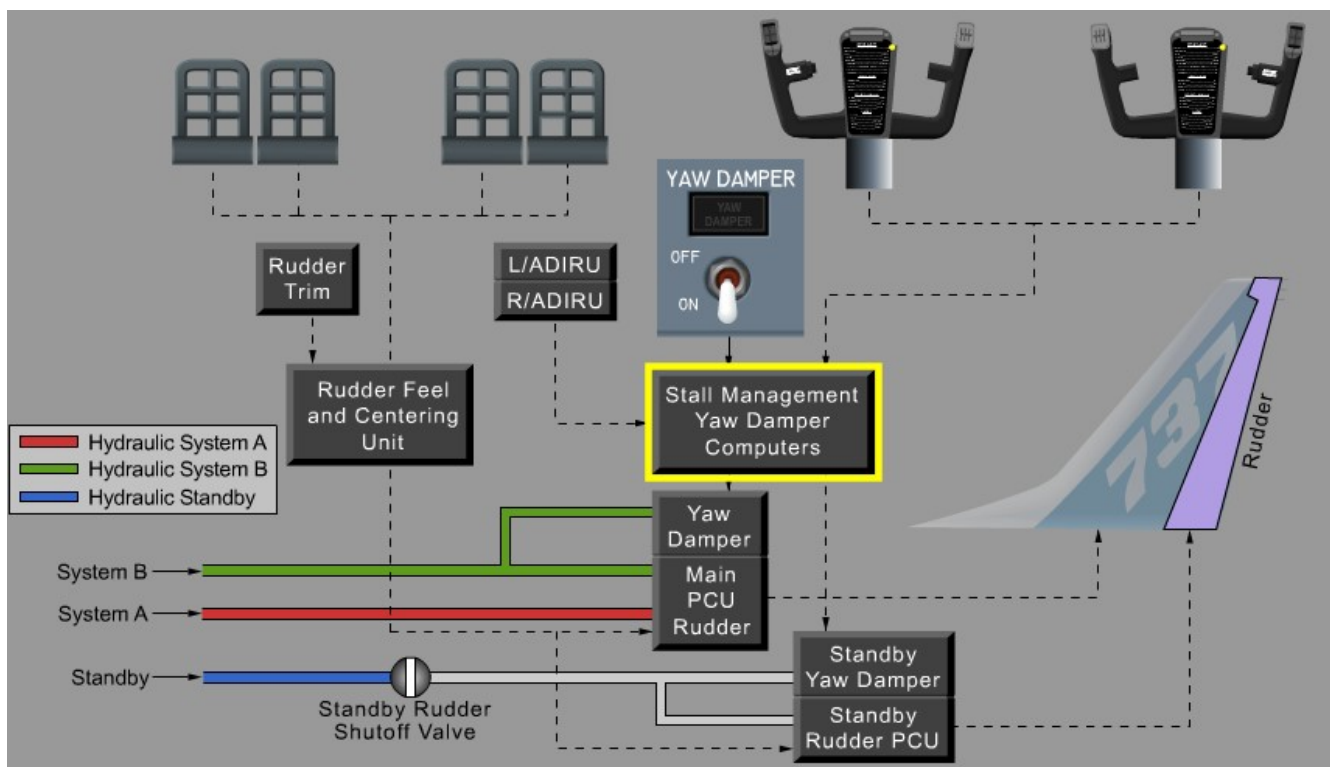
- Between KIAS 100 Kts and Mach .60
- 10 seconds after takeoff
- 5 seconds following release of trim switch
- Autopilot not engaged
- Sensing of trim requirements

Stall

Yaw damper, elevator feel shift (EFS) and speed trim system (STS) work together to aid stall identification and control

Approaching a stall:

- STS trims stabiliser nose down
- the SMYD (stall management yaw damper) reduces yaw damper commanded rudder movement.
- EFS increases system A pressure to the elevator FEEL AND CENTRING unit, since this will double column forces, the EFL is inhibited when:
 - On ground
 - Radio altitude (RA) less than 100 ft
 - Autopilot engage

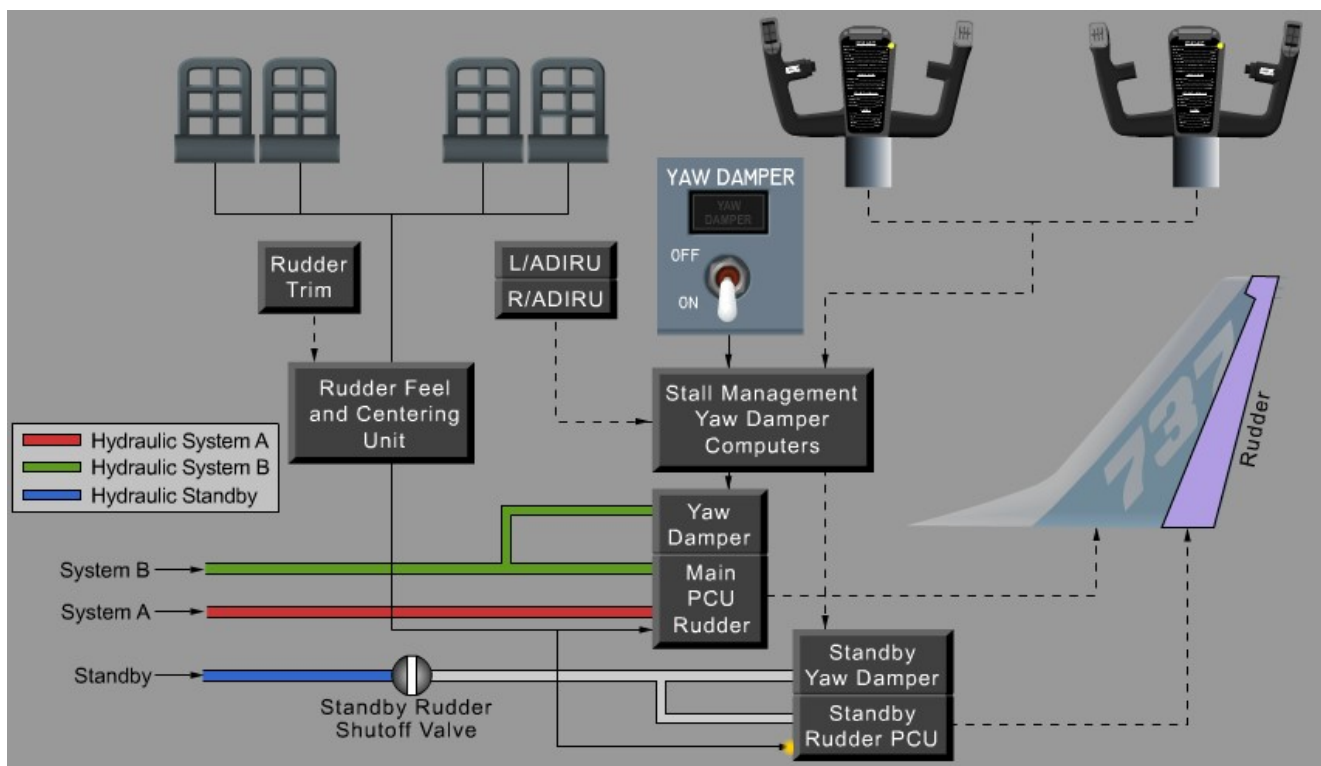


Yaw control

Hydraulically powered rudder and digital yaw damper provide yaw control.

- SMYD: controls yaw damper
- MAIN PCU (hydraulic system A and B): control rudder with:
 - i. 2 independent input rods
 - ii. 2 individual control valves
 - iii. 2 separate actuator (one for A and one for B)
- STBY PCU (STBY hydraulic system): control rudder with:
 - i. A separate* input rod
 - ii. A separate* control valve

*separate from MAIN PCU rods and valves



If one input rod or its associated hardware jams, a jam override mechanism allows input to continue to be transferred to the remaining free input rods.

Above 135 Kts, full rudder authority is limited by reducing system A and B pressure in the PCU by 25%.

A force fight monitor (FFM) in the main PCU detects opposing pressure between A and B actuators, should this occur, the FFM:

- Automatically turns STBY pump ON
- Opens STBY rudder shut-off valve, pressurizing the STBY PCU
- "STBY RUD ON", "MASTER CAUTION" + "FLT/CONT" annunciation

Rudder trim

Rudder trim system electrically reposition the rudder feel and centring unit, adjusting the rudder neutral position and rudder pedals are displaced proportionally. Rudder trim position is indicated in unit.



Yaw damper

MAIN and STBY yaw damper are controlled by SMYD computer, inputs to SMYD are from:

- Both left and right ADIRU
- Control wheels
- Yaw damper switch



SMYD provide input to (output from SMYD) MAIN and STBY PCUs.

Yaw damper system provides:

- Dutch roll prevention
- Gust damping
- Turn coordination

During yaw damper operation there is no rudder pedal movement, only MAIN yaw damper inputs. Any yaw damper inputs is overridden by rudder pedal and rudder trim movement.

(only EI-EMA through YW135)

The YAW DAMPER switch automatically turns OFF and cannot be reset ON and “**YAW DAMPER**” illuminate when:

- SMYD senses a fault
- SMYD senses that the yaw damper does not responds to a commands
- B FLT CONTROL switch is positioned OFF or STBY RUD*

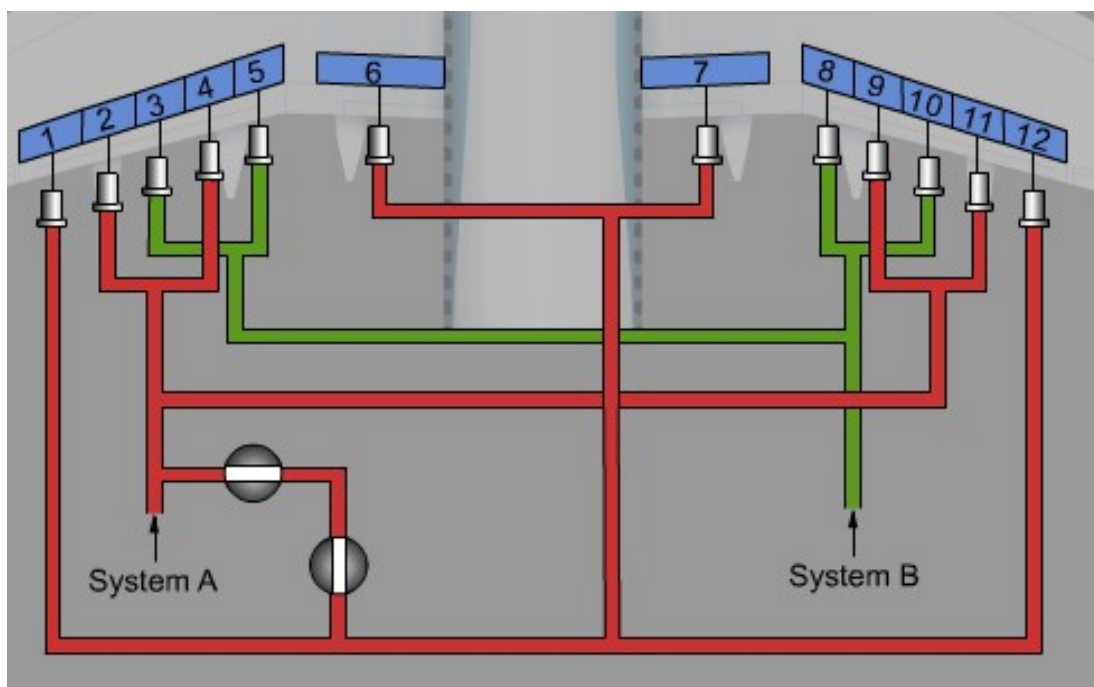
*During manual reversion (loss of both A and B) both FLT CONTROL switches are positioned STBY RUD. In this case, YAW DAMPER switch can be reset ON and STBY hydraulic system power the STBY yaw damper.

During STBY yaw damper operation, movement of the control wheel send signal to the STBY RUD PCU, this allow the rudder to help turning the aircraft when aileron control is through manual reversion

Spoiler and speedbrakes

Speedbrake system consist of:

- 2 GND spoiler panels on each wing (1,6/7,12) powered by system A
- 4 FLIGHT spoiler panels on each wing, (2,4/9,11) powered by system A, (3,5/8,10) powered by system B



Spoiler switch:

- ON (guarded): normal position
- OFF: for maintenance purposes only

The SPEEDBRAKE lever controls the spoiler:

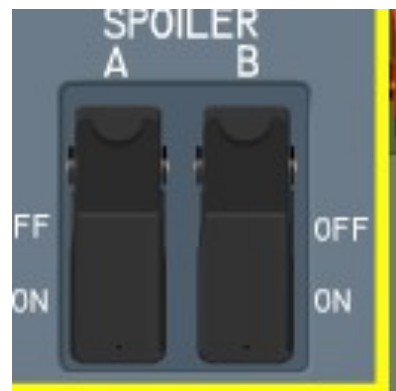
- On ground: all panels extend
- In-flight: only FLIGHT spoiler extends

"SPEEDBRAKE EXTENDED" illuminate when:

- In-flight:
 - i. SPEEDBRAKE lever beyond armed position, and
 - ii. Trailing edge flaps more than 10°
- OR
- iii. Below 800 ft radio altitude (RA)
- On ground:
 - i. SPEEDBRAKE lever in DOWN detent, and
 - ii. Ground spoiler not stowed

NOTE: is forbidden to move the SPEEDBRAKE lever beyond FLIGHT DETENT in flight, due to the resultant buffeting

NOTE: deploying FLIGHT spoiler during a turn, or in an intermediate position increases significantly roll rates



Ground operation (FCOM2 9.20.14)

During landing, the auto speedbrake system operates when these conditions occur:

- SPEEDBRAKE lever ARMED
- "SPEED BRAKE ARMED" illuminated
- Less than 10 ft RA
- Landing gear strut compresses on touchdown*
- Thrust levers retarded at IDLE
- Main landing gear wheels spin up more than 60 Kts

*compression of any gear deploys flight spoiler, compression of right main gear deploy ground spoiler

When the above are met and auto speedbrake deployment commence SPEED BRAKE lever moves to UP and spoiler deploys (if no main wheel spin up, only FLIGHT spoiler deploy)

If SPEEDBRAKE lever is DOWN, auto speedbrakes on landing or RTO will deploy spoiler when:

- Main wheel spin up more than 60 Kts
- Both thrust levers IDLE
- Reverse lever positioned for reverse thrust

If after landing or RTO:

- Thrust levers are advanced, or
- SPEEDBRAKE lever moved to DOWN detent

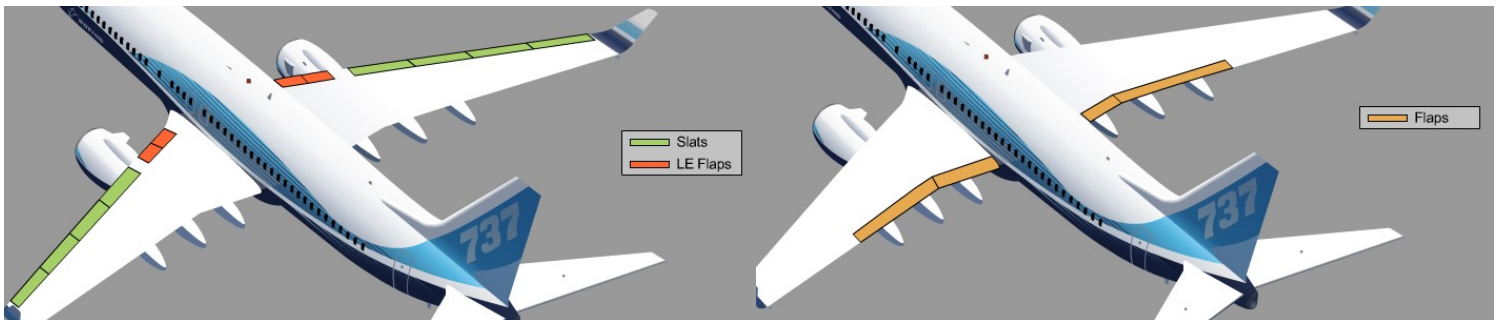
All spoiler will retract and SPEEDBRAKE lever will move to DOWN (if not DOWN)

Flaps and slats

Flap and slat system consist of:

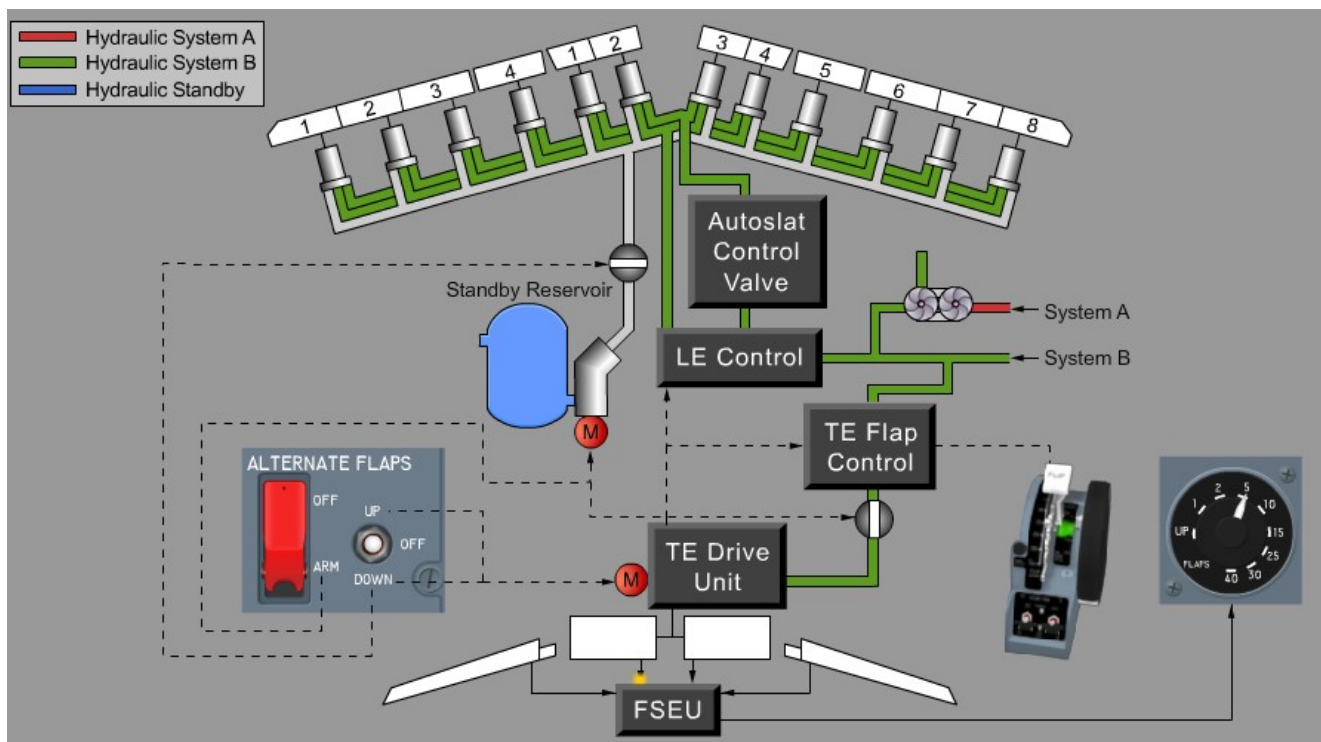
- Leading edge devices (LE):
 - i. 2 LE flaps on each wing (engine inboards section)
 - ii. 4 LE slats on each wing (engine outboard section)
- Trailing edge devices (TE): double-slotted flaps inboard and outboard of the engines, providing:
 - i. From 1° to 15°: increased lift
 - ii. From 15° to 40°: increased lift and drag (normal landing flap: 30° and 40°)

NOTE: flap extension above 20000 ft should not be attempted, due to excessive structural loads (too high Mach)



Flap controls and indications

FLAP lever select the position of flap control valve, which then direct pressure to the TE drive unit.



Position of LE devices changes in sequence with TE flaps position:

TE flaps	1°	2°	5°	10°	Beyond 10°
LE flaps	Full extended	Full extended	Full extended	Full extended	Full extended
LE slats	intermediate	intermediate	intermediate	intermediate	Full extended

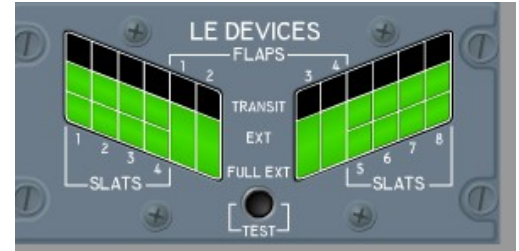
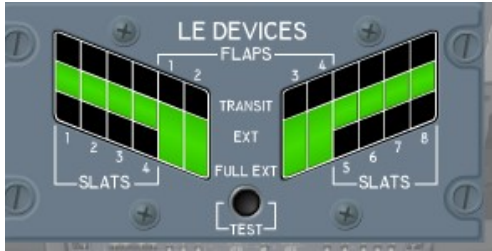
SPF $\Rightarrow$ TE $> 25^\circ$ i.e. 30 or 40
then only fully extended

Flap indicator display LEFT and RIGHT wing flap position, it may indicate a flap asymmetry

LE devices annunciator panel shows:

- Light extinguished: related LE is retracted or not fully extended
- Light illuminated **GREEN**: related LE is fully extended or intermediate position
- Light illuminated **AMBER**: related LE is in transit

TEST button: test all annunciator panel light



"LE FLAPS TRANSIT" illuminate when:

- any LE is in transit
- Any LE is not in the programmed position according to TE devices
- A LE skew condition exist (slats 2 trough 7 only)
- During ALTERNATE FLAP extension until:
 - LE fully extended
 - TE reach 10°



During auto-slat operation **"LE FLAPS TRANSIT"** is inhibited

"LE FLAPS EXT" illuminate when:

- TE up to 5°: all LE flaps extended and all slats in the programmed intermediate position
- TE 10° and beyond: all LE devices fully extended

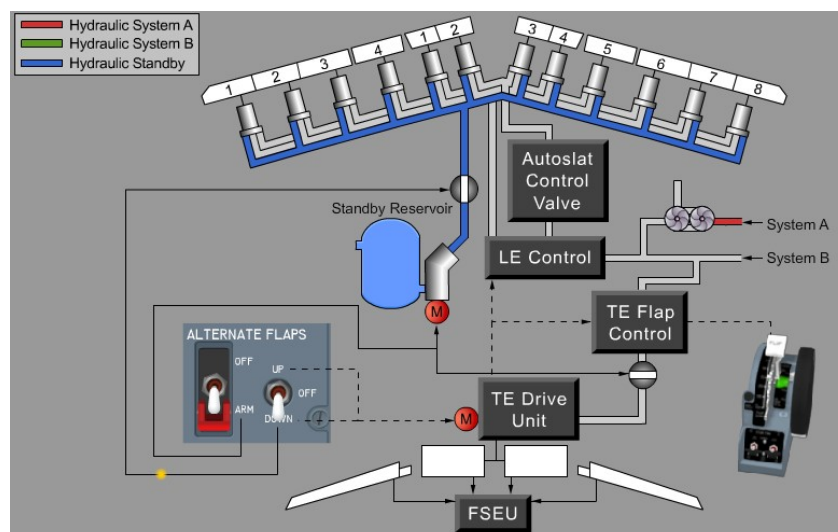
Hydraulic power

During normal operation, the normal power source is the hydraulic system B, alternate sources are provided to:

- Extending LE (STBY hydraulic system)
- Extending and retracting TE (electric motor)

ALTERNATE FLAP switch:

- Controls an electric motor which extends and retracts TE flaps
- Activate STBY hydraulic system to power LE devices actuator for extension

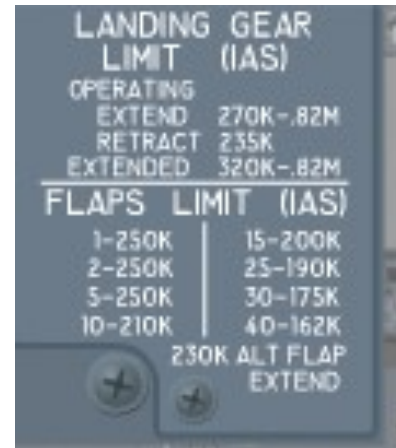


Load relief system

SPE → also flaps + 10 kt

A load relief system is provided for TE devices by the FSEU (flap/slat electronic unit). Its operation depends on the aircraft model (FCOM2 9.20.18), from EI-FZX through YW135:

Flap setting →	40°		30°		25°		15°		10°	
Retract (°/speed)	30°	163	25°	176	15°	191	10°	201	5°	211
Re-ext. (°/speed)		158		171		186		196		206



Autoslat system

Autoslat system provide automatic slat extension to increase stall margin:

- If the airplane approaches a stall condition, autoslat fully extend all slats prior to stick shaker
- When the stall prone condition is recovered, slats are automatically retracted from fully extended position to the appropriate position according to TE position.

Conditions for autoslat operation varies according to aircraft model. In general TE flaps must be extended to at least 1° to allow autoslat to operate.

FLIGHT CONTROLS – NORMAL OPERATION

Flap and slat – ALTERNATE mode

ALTERNATE FLAPS switch: ARM

- Closes flap bypass valve
- Energises STBY pump
- Arms alternate flap position switch



Alternate flap position switch (held till flap reach required position)

- DOWN (even momentarily):
 - i. Extends TE flaps with electric motor
 - ii. STBY system automatically drive LE devices to fully extended position
- UP: retract TE flaps

NOTE: there is no asymmetry nor skew protection with ALTERNATE FLAP operation

NOTE: extension from UP to 15° takes up to 2 minutes

Using ALTERNATE FLAP extension flaps can extends only up to 15°

If the switch is released before reaching the required configuration, wait 15 seconds before operating the switch again (this avoid damage to flap motor clutch). After a complete cycle (UP to 15° then back to UP) allow 5 minutes cooling for the motor.

Asymmetry and skew protection

Definition

Asymmetry: TE/LE does not align with the symmetrical flap on the other wing

Skew: TE/LE does not operate at the same rate

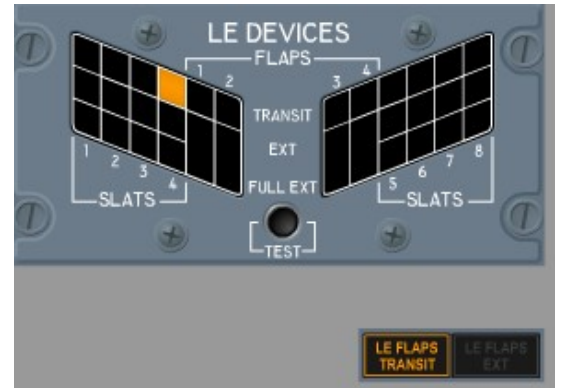
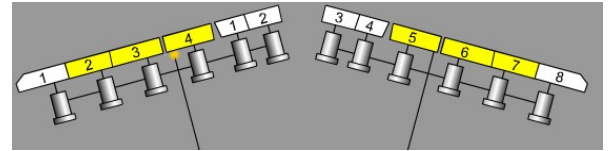
Operation

FSEU (flaps/slats electronic unit) monitor flaps and slats for improper position

- All TE are monitored for asymmetry and skew
- Slats 2, 3, 4, 5, 6, 7 are monitored for improper position and skew (inhibited during auto-slat operation)
- LE flaps and slats 1, 8 are NOT monitored (no protection)

When asymmetry/skew is detected, the FSEU:

- For TE:
 - i. Closes TE flap bypass valve
 - ii. Displays a needle split on flaps indicator
- For LE:
 - i. "LE FLAPS TRANSIT" remains illuminated
 - ii. Incorrect lights may illuminate on LE annunciator panel
 - iii. May be no light illuminated at all



Flaps and slats uncommanded motion

FSEU provide protection for uncommanded motion, an uncommanded motion occur when:

- If no TE flaps or auto-slat command and:
 - i. 2 LE flaps move on one wing , or
 - ii. 2 or more LE slats move on one wing
 - In this case the FSEU will:
 - i. Shut down LE control
 - ii. "LE FLAPS TRANSIT" illuminate
 - iii. Maintain pressure on retraction hydraulic lines
 - iv. Depressurise extension hydraulic lines
- If no TE flaps or load relief command and:
 - i. TE move away from commanded position, or
 - ii. Continue to move after reaching a commanded position, or
 - iii. Move opposite to that command
 - In this case FSEU will:
 - i. Shut down TE drive unit, by closing the TE bypass valve*

NOTE: once these valve are closed they cannot be reopened, ALTERNATE FLAP should be used, there will be a disagreement between flap lever and indication.

FLIGHT CONTROLS – NON-NORMAL OPERATION

Runaway stabilizer (QRH 9.1)

Runaway Stabilizer ()

Condition: Uncommanded stabilizer trim movement occurs continuously.

- 1 Control column. Hold firmly
- 2 Autopilot (if engaged) Disengage
Do **not** re-engage the autopilot.
Control airplane pitch attitude manually with control column and main electric trim as needed.
- 3 Autothrottle (if engaged) Disengage
Do **not** re-engage the autothrottle.
- 4 **If the runaway stops** after the autopilot is disengaged:

■ ■ ■ ■
- 5 **If the runaway continues** after the autopilot is disengaged:
 STAB TRIM CUTOUT switches (both) CUTOUT
If the runaway continues:
 Stabilizer trim wheel Grasp and hold

- - - - -
- 6 Stabilizer. Trim manually
- 7 Anticipate trim requirements.

FLT CONTROLS “LOW PRESSURE” (QRH 9.7)

LOW PRESSURE

FLIGHT CONTROL LOW PRESSURE

Condition: Hydraulic system pressure to the ailerons, elevators and rudder is low.

Objective: To activate the standby hydraulic system and standby rudder PCU.

- 1 FLT CONTROL switch (affected side) Confirm. STBY RUD
“SPEED BRAKE EXTENDED” (QRH 9.20)

SPEEDBRAKES EXTENDED

SPEEDBRAKES EXTENDED

Condition: In flight, the speedbrakes are extended beyond the ARMED position and one or more of these occur:

- The radio altitude is below 800 feet
- The flap lever setting is more than flaps 10.

On the ground, the SPEED BRAKE lever is down and the speedbrakes are extended.

- 1 Choose one:
 - ◆ **In flight:**
 SPEED BRAKE lever ARMED

■ ■ ■ ■
 - ◆ **On the ground:**
 SPEED BRAKE lever DOWN detent
Note: If the light stays illuminated, do **not** takeoff.

■ ■ ■ ■

“STAB OUT OF TRIM” (QRH 9.22)

STABILIZER OUT OF TRIM

STAB OUT OF TRIM

Condition: The autopilot does not set the stabilizer trim correctly.

Note: Momentary illumination of the STAB OUT OF TRIM light during large changes in trim requirements is normal.

- 1 Choose one:
 - ◆ Stabilizer is **trimming**:
 Continue normal operation.

■ ■ ■ ■
 - ◆ Stabilizer is **not** trimming:
►► Go to step 2
- 2 Control column. Hold firmly
- 3 Autopilot Disengage
- 4 Autothrottle (if engaged) Disengage
- 5 Stabilizer trim As needed

- 6 Choose one:
 - ◆ Stabilizer **responds** to electric trim inputs:
 Do **not** re-engage the autopilot or autothrottle.

■ ■ ■ ■
 - ◆ Stabilizer does **not** respond to electric trim inputs:
►► Go to the Stabilizer Trim Inoperative () checklist on page 9.24

■ ■ ■ ■

Stabiliser trim inoperative (QRH 9.24)

Stabilizer Trim Inoperative ()

Condition: Both of these occur:

- Loss of electric trim through the autopilot
- Loss of electric trim through the control wheel switches.

Objective: To land the airplane using manual trim or, if manual trim is not available, to land the airplane using elevator control only.

- 1 STAB TRIM CUTOUT switches (both) . . . CUTOUT
The autopilot is not available.
- 2 Apply steady pressure on the manual trim handles until the needed trim is attained.

Use sufficient force to disengage the disconnect clutch. Approximately 1/2 turn of the stabilizer trim wheel may be needed.

Note: A maximum two-pilot effort on the trim wheels will not cause a cable or system failure.

The handle(s) should be folded inside the stabilizer trim wheel when manual trim is no longer needed.

If the failure could be due to ice accumulation, descend to a warmer temperature and attempt again.

- 3 Choose one:

◆ Stabilizer **can** be trimmed manually:

▶▶ Go to step 4

◆ Stabilizer **can not** be trimmed manually:

▶▶ Go to step 8

- 4 Maintain in-trim airspeed until the start of the approach.
- 5 Use an airspeed which results in an in-trim condition. This will reduce the force that is needed to move the stabilizer.
- 6 Continue to trim manually for the rest of the flight.
- 7 Establish the landing configuration early.
- ▶▶ Go to step 10
- 8 Anticipate higher than normal elevator forces during approach and landing.
- 9 The thrust reduction at flare will cause a nose down pitch.

Note: Elevator control is sufficient to safely land the airplane regardless of stabilizer position.

- 10 Plan a flaps 15 landing.

- 11 Set VREF 15 or VREF ICE.

Note: If any of the following conditions apply, set VREF ICE = VREF 15 + 10 knots:

- Engine anti-ice will be used during landing
- Wing anti-ice has been used any time during the flight
- Icing conditions were encountered during the flight and the landing temperature is below 10° C.

Note: When VREF ICE is needed, the wind additive should not exceed 10 knots.

- 12 Check the Non-Normal Configuration Landing Distance table in the Advisory Information section of the Performance Inflight chapter.

- 13 Checklist Complete Except Deferred Items

“YAW DAMPER” (QRH 9.46)

YAW DAMPER

YAW DAMPER ()

Condition: The yaw damper is disengaged.

Note: Pilot flying must guard the flight controls prior to selecting the YAW DAMPER switch ON or OFF.

- 1 YAW DAMPER switch OFF then ON
- 2 Choose one:
 - ◆ YAW DAMPER light **extinguishes**:
■ ■ ■ ■
 - ◆ YAW DAMPER light **stays illuminated**:
YAW DAMPER switch OFF
▶▶ Go to step 3
 - ◆ Abnormal YAW/ROLL encountered:
YAW DAMPER switch OFF
▶▶ Go to step 3

- 3 Avoid areas of predicted moderate or severe turbulence. If turbulence is encountered and passenger comfort becomes affected, reduce airspeed and/or descend to a lower altitude.
- 4 Do not exceed flaps 30 if the crosswind exceeds 30 knots.

Note: Yaw Damper required for Flaps 40 autoland operations.

■ ■ ■ ■

LANDING GEAR – SYSTEM DESCRIPTION

Overview

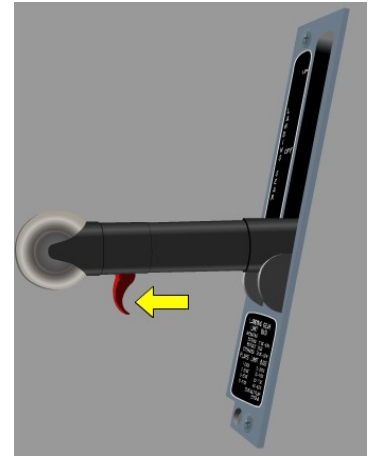
The landing gear is composed by: 2 main gear and 1 nose gear, each one incorporates 2 wheels

Landing gear lever

The landing gear lever has 3 position:

- UP: retract the landing gear
- DN: extends the landing gear
- OFF: remove hydraulic pressure from the system

The landing gear lever incorporates an override trigger, which permits the landing gear lock to be bypassed and the gear to be raised.



Landing gear indications

RED lights:

- illuminate when:
 - i. One or more of the gear is in disagreement with lever position (which is normal when the landing gear is in transit), or
 - ii. Below 800 ft RA and thrust retarded to IDLE if landing gear not down and locked
- Extinguished when:
 - i. Landing gear is UP and locked and landing gear lever is UP or OFF
 - ii. Landing gear is DN and locked and landing gear lever is DN

GREEN lights:

- Illuminate when the relative gear is DN and locked
- Extinguished when the relative gear is not DN and locked

On the aft overhead panel there is another set of lights.

These operates from a separate circuit and show **GREEN** when associated gear is DN and locked.

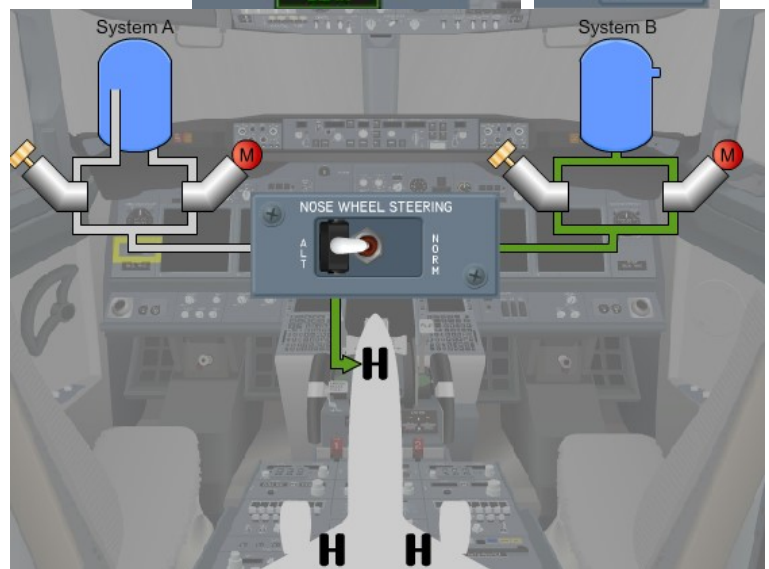
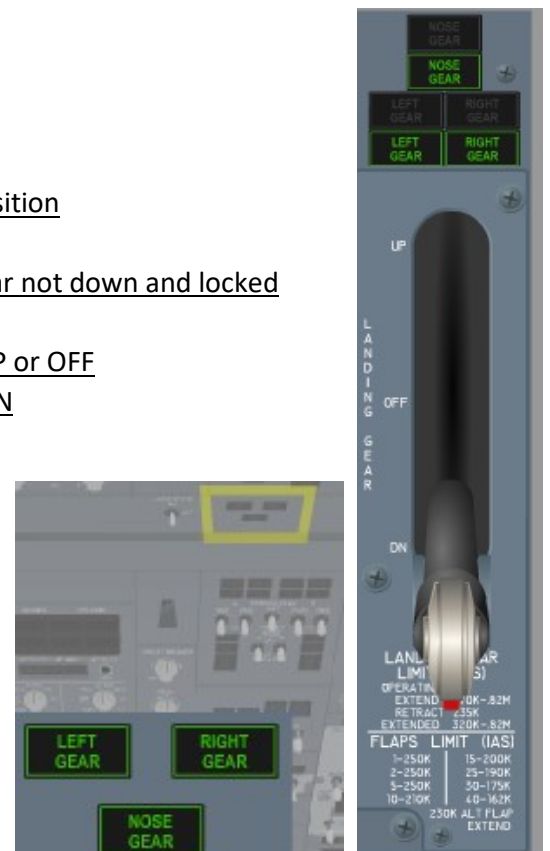
NOTE: landing gear is DN and locked as long as one **GREEN** landing gear indicator light (centre panel or overhead panel) for each gear is illuminated.

Hydraulic power

Landing gear retraction and extension system receives power from hydraulic system A. an alternate source of hydraulic power is available for nose wheel steering. If necessary all landing gears may be lowered manually.

Normal brake system is powered by system B, while alternate brake is powered by system A.

Both system provide antiskid protection, auto-brake is available only with normal brake system.



Air/ground sensing

The aircraft state (in-flight or on ground) is sensed by logic signals from air/ground system. 6 sensors are used, 2 on each gear.

system	In-flight sensed	On-ground sensed
Emergency exit door	Locked when: - Either N2 below 50% - 3 entry/service doors closed	Unlocked when: - Either thrust lever retarded below 53°
Pack valves	PACK automatically HIGH: - Other PACK OFF - Flaps UP	PACK automatically HIGH: - Both Engine bleed air OFF - APU BLEED is ON
Wing anti-ice	With WING ANTI-ICE switch ON: - Control valves open	With WING ANTI-ICE switch ON: - Valves cycle open/close - Switch trips OFF at lift-off
autothrottle	Enables go-around below 2000 ft RA	Enables takeoff mode Disengages 2 seconds after landing
TO/GA switch	Flight director engages go-around mode	Flight director engages takeoff mode
Engine idle control	Enables minimum FLIGHT IDLE	Enables minimum GROUND IDLE
Thrust reverser	disabled	Enabled
APU wheel well “horn”	Disabled	Enabled
Auto SPEED BRAKE	Can be ARMED	- Deploy speedbrakes on landing (if ARMED) - RTO feature available - Drives to DOWN if thrust lever advanced
Auto-slat	enabled	Disabled
FMC position	Updated using GPS, DME, VOR/DME	Updated using GPS
STBY hydraulic	Pump automatically operates when: - Flaps extended - A or B pressure loss	Pump automatically operates when: - Wheel speed greater than 60 Kts
antiskid	Touchdown protection (releases brake)	Allow normal antiskid braking, after wheel spin-up
Auto-brake	- Landing mode can be selected - RTO cannot be selected	- RTO mode available - Landing mode available after touch down at speed higher than 30 Kts
Landing gear lever lock	Lever lock released	Lever lock engaged
Landing gear transfer unit	Enabled	disabled
Stall warning	Enabled	Disabled
Takeoff configuration warning	disabled	Enabled

Nose wheel steering

Power

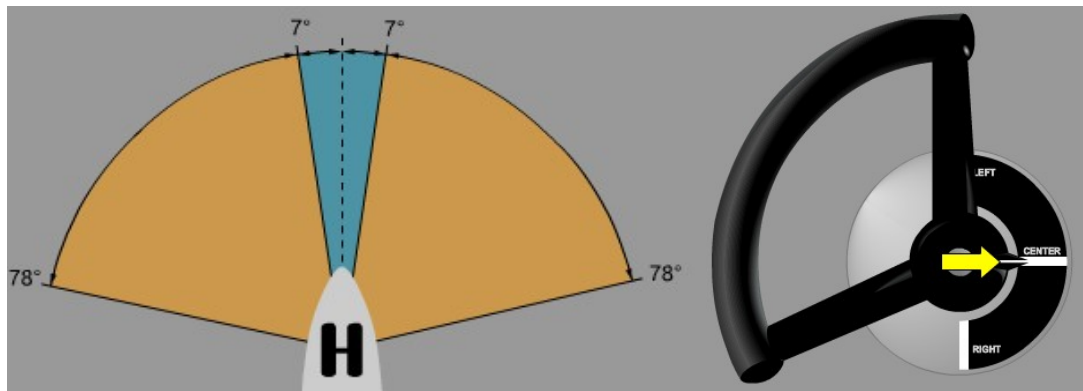


Normal hydraulic power to the nose wheel steering system is hydraulic system A. when NOSE WHEEL STEERING switch is moved to ALT position, power is supplied by system B. if system B is lost due to a leak downstream of the landing gear transfer unit, a sensor closes the landing gear transfer valve. In this case ALT steering is not available.

NOTE: the aircraft must be on ground for the nose wheel steering to be powered

Control

Primary control for nose wheel steering is provided through the nose wheel steering wheel that allows 78° turning in each direction and override pedal steering inputs, that allows only 7° turning in each direction. A pointer on the nose wheel steering wheel shows the nose wheel steering position



Nose wheel steering inhibition

On takeoff, as the nose gear strut extends, the nose wheel steering is inhibited.

On the ground, a lockout pin will depressurise nose wheel steering, allowing the nose wheel to turn freely, thus allowing push-back and towing

Brake system

Power

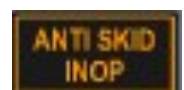
Normal brake power is supplied by hydraulic system B, while alternate brake power is from system A. System A automatically power alternate brake when system B fails or low pressure is sensed.

An hydraulic accumulator pressurised by system B, can provide several brake application in case of both system A and B loss, or can be used to set the parking brake.

Antiskid

Antiskid system provide for both normal and alternate brake: skid, locked wheel, touchdown and hydroplaning protection.

- Normal brake: anti-skid provided for each individual main wheel
- Alternate brake: anti-skid provided for main wheel pairs (instead of individual)



If skid is detected, brake pressure is released on the affected wheel until skid stops. Antiskid protection is available even with loss of both hydraulic systems, "ANTI SKID INOP" illuminate

Auto-brake system

Hydraulic system B power the auto-brake system. Auto-brake operates only when normal brake is functioning. Auto-brake provides preselected deceleration rates for landing and maximum deceleration rate for rejected takeoff. When auto-brake is operating, also antiskid is provided.

auto-brake landing selection (1, 2, 3 and MAX)

when a landing selection is made, a turn-on-self-test is performed. "AUTO BRAKE DISARM" illuminate if the test is not successful.

After landing, auto-brake application begins when:

- Both thrust levers are retarded to IDLE, and
- The main wheel spins up

NOTE: also with MAX selected, the deceleration rate is lower than with full manual braking

NOTE: deceleration rate can be changed before speed decreases below 30 Kts

Rejected takeoff selection (RTO)

RTO can be selected only on the ground, when selected "AUTO BRAKE DISARM" will illuminate momentarily to indicate proper operation of the self test.

RTO is armed only if:

- Airplane on ground
- Antiskid and auto-brake are operational
- Switch on RTO
- Wheel speed less than 60 Kts
- Thrust lever positioned to IDLE

RTO engages when:

- RTO selected
- Wheel speed higher than 90 Kts
- Thrust levers at IDLE

Rejecting a takeoff below 90 Kts will NOT engage auto-brake, however it remains armed.

RTO is automatically disarmed when becoming airborne, "AUTO BRAKE DISARM" will NOT illuminate and switch will remain in RTO position. The switch must be turned OFF to reset or manually disarm the system.

NOTE: landing with RTO selected will NOT engage auto-brake, "AUTO BRAKE DISARM" illuminate 2 seconds after touchdown.

Auto-brake termination

If the crew do not terminate auto-brake, the aircraft will stop on the runway. To terminate (disarm) auto-brake:

- Move switch OFF (no light)
- Move SPEED BRAKE lever to DOWN detent, "AUTO BRAKE DISARM" illuminate
- Advance one or both thrust lever, "AUTO BRAKE DISARM" illuminate
- Apply manual brake, "AUTO BRAKE DISARM" illuminate



Parking brake

The parking brake may be set using both system A and B hydraulic pressure.

If both system are unable to provide pressure, parking brake pressure is maintained by the hydraulic accumulator. Accumulator pressure is shown on the HYD BRAKE PRESS indicator.

In order to set the parking brake is necessary to depress brake pedal and pull parking brake lever. Rudder pedal are latched in place and parking brake valve closes.

Pressing rudder pedal is sufficient to release the parking brake.

A fault in the parking brake system is indicated by “ANTISKID INOP” light.



LANDING GEAR – NORMAL OPERATION

Landing gear retraction

Moving the landing gear lever to UP retracts the landing gear. **GREEN** lights extinguish, **RED** lights illuminate and will then extinguish when the gear is UP and locked.

As the landing gear retract:

- Main gear wheel rotation is blocked by brakes application
- Nose gear wheel rotation is blocked by snubbers

NOTE: if a spinning wheel impacts a fitting in the wheel well, retraction is stopped and gear free falls down.

Once retracted, mechanical up-locks hold the gear retracted, moving the landing gear lever no to OFF will remove hydraulic pressure from the system.

Landing gear transfer unit

Hydraulic pressure from hydraulic system B is available for raising the landing gear through the landing gear transfer unit at a normal rate should system A fail or pressure being insufficient for normal rate retraction. To operate the landing gear transfer unit, the following should be met:

- In-flight
- N°1 engine RPM drops below a limit value
- Landing gear lever positioned on UP
- Either main landing gear is not up and locked

Landing gear extension

Moving the landing gear lever to DN will cause the following:

- Hydraulic pressure is used to remove the mechanical up-lock, **RED** lights illuminates
- Hydraulic pressure, gravity and air load together will extend the landing gear
- Once extended, the landing gear is locked down by an over-centre mechanical and hydraulic lock, **GREEN** lights illuminate, **RED** lights extinguish.

Manual extension

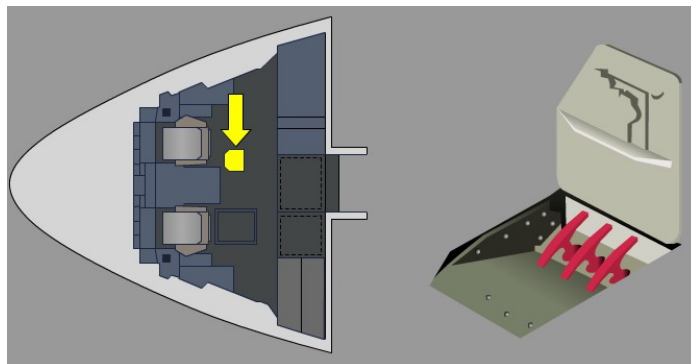
Landing gear manual extension is required if system A pressure is lost. Manual gear releases on the flight deck are used to release up-lock, the gear will then free fall under gravity and air loads force.

With the manual extension access door open:

- Manual extension is possible, regardless of landing gear lever position
- Normal extension with system A pressure is possible
- Landing gear retraction is disabled

After a manual extension, the landing gear may be retracted (if system A pressure is available) by:

- Closing the manual extension access door
- Recycling the landing gear lever (DN then UP)



LANDING GEAR – NON-NORMAL OPERATION

Lever lock override

Lever lock prevents landing gear retraction on ground and allow retraction in flight. Should this lock jam and prevents retraction in flight, the override trigger bypasses the lever lock.

(QRH 14.14)

Landing Gear Lever Will Not Move Up After Takeoff ()

Condition: The LANDING GEAR lever cannot be moved to the UP position due to one of the following:

- Failure of the landing gear lever lock solenoid
- Failure of the air/ground system
- Failure of the ground spoiler bypass valve to close.

Note: Do not use FMC fuel predictions.

- 1 LANDING GEAR lever DN
- 2 Retract the flaps on schedule.
- 3 Choose one:

◆ Intermittent cabin altitude/configuration warning horn **stays silent** and the TAKEOFF CONFIG lights (if installed and operative) do **not illuminate** after the flaps are fully retracted and the thrust levers are advanced beyond the vertical position:

Note: This indicates a failure of the landing gear lever lock solenoid.

►► Go to step 4

◆ Intermittent cabin altitude/configuration warning horn **sounds** or the TAKEOFF CONFIG lights (if installed and operative) **illuminate** when the flaps are fully retracted:

Note: This indicates either a failure of the air/ground system or a failure of the ground spoiler bypass to close.

Do **not** retract the gear.

►► Go to step 8

- 235K maximum.
- 4 ⚠ LANDING GEAR override trigger Pull
 - 5 LANDING GEAR lever UP
 - 6 **When** the landing gear indicator lights extinguish:
LANDING GEAR lever OFF
 - 7 Continue normal operation.
■ ■ ■ ■
 - 8 LANDING GEAR
TAKEOFF WARNING CUTOFF
circuit breaker (P6-3:C18) Pull

Note: The intermittent cabin altitude/configuration warning horn may still sound and the TAKEOFF CONFIG lights (if installed and operative) may still illuminate depending on thrust lever and flap position.

Caution! Do not use the speedbrakes in flight.

- 9 Plan to land at the nearest suitable airport.
- 10 Do **not** arm the autobrake for landing. Use manual braking.
- 11 Do **not** arm the speedbrakes for landing. Manually deploy the speedbrakes immediately upon landing.
- 12 **Checklist Complete Except Deferred Items**

Gear failure

Manual gear extension (QRH 14.18)

Manual Gear Extension

Condition: One of these occurs:

- Any landing gear is not down and locked when the LANDING GEAR lever is down
- The LANDING GEAR lever is jammed in the OFF position.

Note: If a green landing gear indicator light is illuminated on either the center main panel or the overhead panel, the related landing gear is down and locked.

- 1 LANDING GEAR lever OFF (if possible)
- 2  **270K/.82M maximum.**
Manual gear extension handles (affected gear) Pull
The uplock is released when the handle is pulled to its limit. The related red landing gear indicator light illuminates, indicating uplock released.
- 3 **Wait** 15 seconds after the last manual gear extension handle is pulled:
LANDING GEAR lever DN (if possible)
- 4 Check landing gear indicator lights.

Note: If the LANDING GEAR lever is in the OFF position, the red landing gear indicator lights will also be illuminated.

- 5 Choose one:
- ◆ **All** landing gear **indicate** down and locked:
▶▶ **Go to step 6**
 - ◆ **One or more** landing gear do **not** indicate down and locked:
▶▶ **Go to the Partial or All Gear Up Landing () checklist on page 14.20**
■ ■ ■ ■
- 6 Choose one:
- ◆ LANDING GEAR **lever** is in the **DN** position:
Land normally.
■ ■ ■ ■
 - ◆ LANDING GEAR **lever** is in the **OFF** position:
GROUND PROXIMITY GEAR
INHIBIT switchGEAR INHIBIT
Land normally.
Note: Nose wheel steering is not available.
■ ■ ■ ■

Partial/all gear up landing (QRH 14.20)

Partial or All Gear Up Landing ()

Condition: All landing gear are not down and locked after attempting manual gear extension.

- 1 Choose one:
 - ◆ Manual gear extension **has** been attempted:
▶▶ **Go to step 2**
 - ◆ Manual gear extension has **not** been attempted:
▶▶ **Go to the Manual Gear Extension checklist on page 14.18**
■ ■ ■ ■
- 2 Brief the crew and passengers on emergency landing and evacuation procedures.
- 3 Burn off fuel to reduce touchdown speed.
- 4 Plan a flaps 40 landing.
- 5 Set VREF 40.
- 6 LANDING GEAR
AURAL WARN circuit breaker (P6-3:D18) Pull

This prevents the landing gear warning horn with gear retracted and landing flaps selected.
The flight deck chime for an incoming call from the cabin crew is unavailable.
- 7 FLIGHT CONTROL
AUTO SPEED BRAKE
circuit breaker (P6-2:B9) Pull
This prevents inadvertent deployment of ground spoilers after landing.
- 8 Do **not** arm the autobrake for landing. Use manual braking.
- 9 Do **not** arm the speedbrakes for landing.
- 10 **Checklist Complete Except Deferred Items**

Brakes

Antiskid failure (QRH 14.1)

**ANTISKID
INOP**

ANTISKID INOPERATIVE ()

Condition: An antiskid system fault occurs.

Caution! Locked wheel protection is not available.

- 1 AUTO BRAKE select switch. OFF

The autobrake system is inoperative.

- 2 Do **not** arm the speedbrakes for landing. Manually deploy the speedbrakes immediately upon landing.

Automatic speedbrake extension may be inoperative.

- 3 Check the Non-Normal Configuration Landing Distance table in the Advisory Information section of the Performance Inflight chapter.

- 4 **Checklist Complete Except Deferred Items**

Deferred Items

Landing Procedure Review

Use minimum braking consistent with runway length and conditions to reduce the possibility of a tire blowout.

Do **not** apply the brakes until the nose wheel is on the ground and the speedbrakes have been manually deployed.

Brake initially using light steady pedal pressure. Increase pressure as ground speed decreases. Do **not** pump the brakes.

Auto-brake failure (QRH 14.3)

**AUTO BRAKE
DISARM**

AUTO BRAKE DISARM ()

Condition: The autobrake system disarms after being set.

- 1 Choose one:

◆ On the **ground**:

AUTO BRAKE select switch OFF

▶▶ Go to step 2

◆ In flight:

▶▶ Go to step 3

- 2 Choose one:

◆ AUTO BRAKE DISARM light **extinguishes**:

■ ■ ■ ■

◆ AUTO BRAKE DISARM light **stays illuminated**:

Do not takeoff.

■ ■ ■ ■

- 3 AUTO BRAKE select switch. . . . OFF, then reselect

- 4 Choose one:

◆ AUTO BRAKE DISARM light **stays extinguished**:

■ ■ ■ ■

◆ AUTO BRAKE DISARM light **illuminates again**:

AUTO BRAKE select switch OFF

Use manual brakes for landing.

▶▶ Go to step 5

- 5 **Checklist Complete Except Deferred Items**

BLEED AIR – SYSTEM DESCRIPTION

Overview

Normal bleed air sources are the engines, APU and external air cart. APU and external air cart can supply bleed air for engine starting, once started, engines are the normal bleed air source for the flight.

Bleed air is used by:

- Air conditioning and pressurization
- Wing and engine thermal anti-ice
- Engine starter motors
- Hydraulic fluid reservoirs pressurisation
- Water tank pressurisation
- Aspirated TAT probe (if installed)

Bleed air switch:

- OFF: bleed air valve is closed
- ON: bleed air valve opens if engine is running

ISOLATION VALVE switch:

- OPEN: ISOLATION VALVE opens
- CLOSE: ISOLATION VALVE closes
- AUTO:
 - ISOLATION VALVE closes if:
 - i. Both engine bleed ON, and
 - ii. Both PACK in AUTO or HIGH
 - ISOLATION VALVE opens if:
 - i. Either engine bleed OFF, or
 - ii. Either pack is OFF



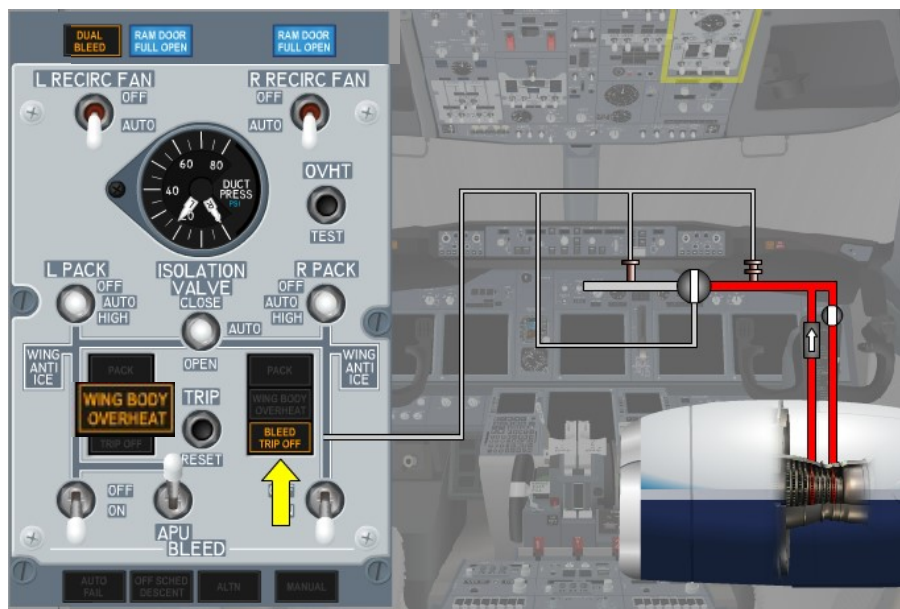
“BLEED TRIP OFF” illuminates if excessive bleed air temperature or pressure is sensed. The related engine bleed air valve closes automatically.

TRIP RESET button resets:

- “BLEED TRIP OFF”
- “PACK”
- “WING BODY OVERHEAT”

If normal conditions are re-establish, these lights will extinguish.

OVHT TEST button is used to TEST the overheat detection circuit and should illuminate both “WING BODY OVERHEAT” lights



“DUAL BLEED” indicates that an engine and APU are both supplying pressure to the pneumatic manifold, when:

- APU BLEED is ON and engine n°1 bleed is ON, or
- APU BLEED is ON and engine n°2 bleed air is ON and ISOLATION VALVE is OPEN

“WING BODY OVERHEAT” illuminate when:

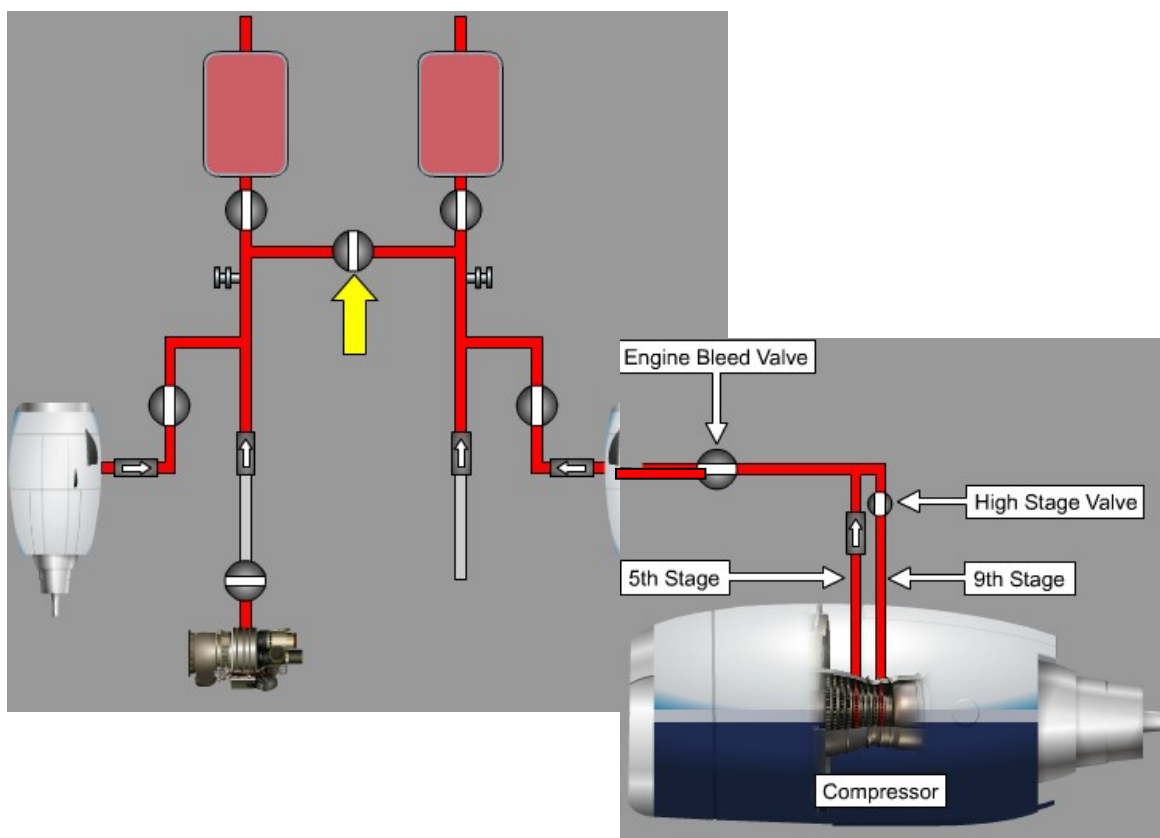
Left WING-BODY OVERHEAT Light	Right WING-BODY OVERHEAT Light
Overheat from a duct leak in:	
• Left engine strut • Left inboard wing leading edge • Left air conditioning bay • Keel beam • APU bleed air duct	• Right engine strut • Right inboard wing leading edge • Right air conditioning bay



DUCT PRESS indicator display pressure in both L and R bleed air duct

Bleed air supply

Bleed air is sourced from each engine 5th and 9th compressor stages, usually the 5th stage bleed air is sufficient, if not (ie. Both engine at IDLE) the high stage valve opens and air is spilled from the 9th stage as well.



Engine bleed air valve is DC activated and operated by bleed air pressure. It acts both as a shut-off valve and pressure regulator when engine bleed air is ON. It will reduce outflow in respond to high bleed air temperature.

APU bleed valve is DC controlled and operated by bleed air pressure. It will close automatically when APU is shut-down. With engines at IDLE thrust, APU bleed can cause a back pressure in the engine bleed duct, causing the high stage bleed air valve to close (9th line has no check-valve)

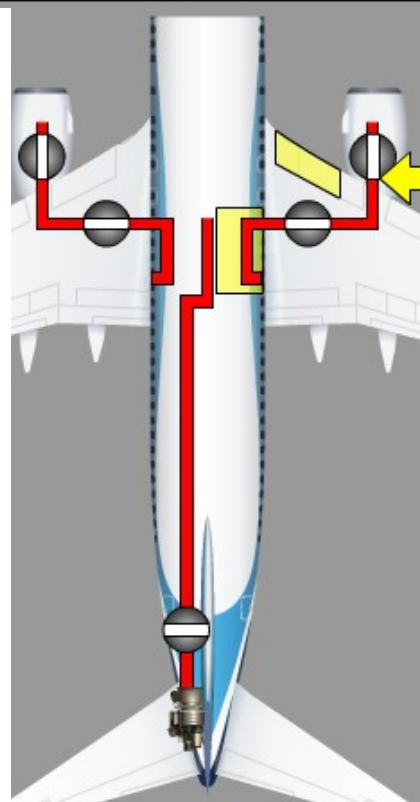
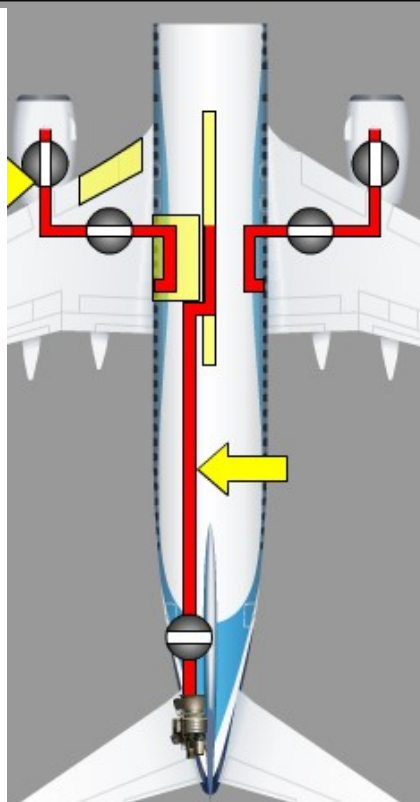
ISOLATION VALVE is AC operated, isolates the left and right ducts during normal operation.

Duct pressure and overheat detection

Pressure transmitter in L and R ducts provide information to L and R pointer of the AC operated DUCT PRESS indicator. Difference between L and R are normal, provided that there is adequate flow for cabin pressurization.

“WING BODY OVERHEAT” indicate a possible air duct leakage. There are 8 overheat detector

Left WING-BODY OVERHEAT Light	Right WING-BODY OVERHEAT Light
Overheat from a duct leak in:	
• Left engine strut • Left inboard wing leading edge • Left air conditioning bay • Keel beam • APU bleed air duct	• Right engine strut • Right inboard wing leading edge • Right air conditioning bay



BLEED AIR – NON-NORMAL OPERATION

“BLEED TRIP OFF” (QRH 2.8)

BLEED TRIP OFF **BLEED TRIP OFF ()**

Condition: One or more of these occur:

- An engine bleed air overheat
- An engine bleed air overpressure.

- 1 WING ANTI-ICE switch OFF
- 2 TRIP RESET switch Push

The BLEED TRIP OFF light extinguishes if the bleed air temperature has cooled below limits.

- 3 Choose one:

◆BLEED TRIP OFF light **stays illuminated**:

PACK switch (affected side) OFF

This causes the operating pack to regulate to high flow in flight with flaps up.

Avoid icing conditions where wing anti-ice is needed.

Note: When the aircraft is operated above FL250 following a failure to reset a bleed trip, the pressurisation panel shall be monitored for correct indications during a descent. Increased thrust may be required to maintain pressurisation.

Note: If the BLEED cannot be reset and the aircraft is operating above FL250, consider descending to a lower altitude to reduce the load on the operating BLEED if destination fuel requirements allow.

■ ■ ■ ■

◆BLEED TRIP OFF light **extinguishes**:

►►Go to step 4

- 4 WING ANTI-ICE switchAs needed

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

■ ■ ■ ■

“DUAL BLEED” (QRH 2.15)

DUAL BLEED **DUAL BLEED**

Condition: The APU bleed valve is open and one of these occurs:

- BLEED 1 air switch is on
- BLEED 2 air switch is on and the ISOLATION VALVE is open.

Objective: To prevent possible backpressure of the APU.

- 1 Limit engine thrust to idle while the light is illuminated.

- 2 **After** engine start:

APU BLEED air switch OFF

■ ■ ■ ■

“WING BODY OVERHEAT” (QRH 2.22)

WING-BODY OVERHEAT

WING-BODY OVERHEAT

Condition: An overheat from a bleed duct leak occurs.

Objective: To isolate the bleed duct leak.

1 ISOLATION VALVE switch. CLOSE

2 Choose one:

◆ **Both** WING-BODY OVERHEAT lights illuminated:

TRIM AIR switch OFF

Note: Passenger cabin temperature control may be less accurate.

■ ■ ■ ■

◆ **Only right** WING-BODY OVERHEAT light illuminated:

►► **Go to step 3**

◆ **Only left** WING-BODY OVERHEAT light illuminated:

►► **Go to step 8**

3 R PACK switch OFF

This causes the operating pack to regulate to high flow in flight with the flaps up.

4 BLEED 2 air switch OFF

5 WING ANTI-ICE switch OFF

This prevents possible asymmetrical ice buildup on the wings.

6 Avoid icing conditions where wing anti-ice is needed.

7 Choose one:

◆ WING-BODY OVERHEAT light **extinguishes**:

■ ■ ■ ■

◆ WING-BODY OVERHEAT light **stays illuminated**:

TRIM AIR switch OFF

Note: Passenger cabin temperature control may be less accurate.

■ ■ ■ ■

8 L PACK switch OFF

This causes the operating pack to regulate to high flow in flight with the flaps up.

9 BLEED 1 air switch OFF

10 WING ANTI-ICE switch OFF

This prevents possible asymmetrical ice buildup on the wings.

11 Avoid icing conditions where wing anti-ice is needed.

12 Choose one:

◆ WING-BODY OVERHEAT light **extinguishes**:

■ ■ ■ ■

◆ WING-BODY OVERHEAT light **stays illuminated**:

►► **Go to step 13**

13 Choose one:

◆ APU is **running**:

►► **Go to step 14**

◆ APU is **not** running:

TRIM AIR switch OFF

Note: Passenger cabin temperature control may be less accurate.

■ ■ ■ ■

14 Choose one:

◆ **APU BLEED** air switch is **ON**:

APU BLEED air switch OFF

This stops the flow of bleed air from the APU to the left side of the pneumatic ducting.

►► **Go to step 15**

◆ **APU BLEED** air switch is **OFF**:

APU switch OFF

►► **Go to step 16**

15 Choose one:

◆ WING-BODY OVERHEAT light **extinguishes**:

►► **Go to step 17**

◆ WING-BODY OVERHEAT light **stays illuminated**:

APU switch OFF

►► **Go to step 16**

16 Choose one:

◆ WING-BODY OVERHEAT light **extinguishes**:

►► **Go to step 17**

◆ WING-BODY OVERHEAT light **stays illuminated**:

TRIM AIR switch OFF

Note: Passenger cabin temperature control may be less accurate.

■ ■ ■ ■

17 ISOLATION VALVE switch. AUTO

18 BLEED 1 air switch ON

19 L PACK switch AUTO

20 WING ANTI-ICE switch As needed

21 Choose one:

◆ WING-BODY OVERHEAT light **stays extinguished**:

►► **Go to step 22**

◆ WING-BODY OVERHEAT light **illuminates again**:

►► **Go to step 23**

22 Choose one:

◆APU switch is **ON**:

The APU can be used during the rest of the flight, as an electrical source only, if needed.

■ ■ ■ ■

◆APU switch is **OFF**:

Do **not** start the APU for the rest of the flight.

■ ■ ■ ■

23 ISOLATION VALVE switch CLOSE

24 L PACK switch OFF

25 BLEED 1 air switch OFF

26 WING ANTI-ICE switch OFF

27 Avoid icing conditions where wing anti-ice is needed.

28 The APU can be used during the rest of the flight, as an electrical source only, if needed.

■ ■ ■ ■

AIR CONDITIONING – SYSTEM DESCRIPTION

Overview

Conditioned air may be provided by the air conditioning system or by a ground source connected through the mix manifold. The system processes bleed air to provide temperature controlled air.

The left PACK provide air directly to the flight deck, excess air flows to the mix manifold. Right PACK air and air coming from recirculation system flows to the mix manifold and in then redirected to the cabin.

Pack valves controls the bleed air flow to the PACKs, normally:

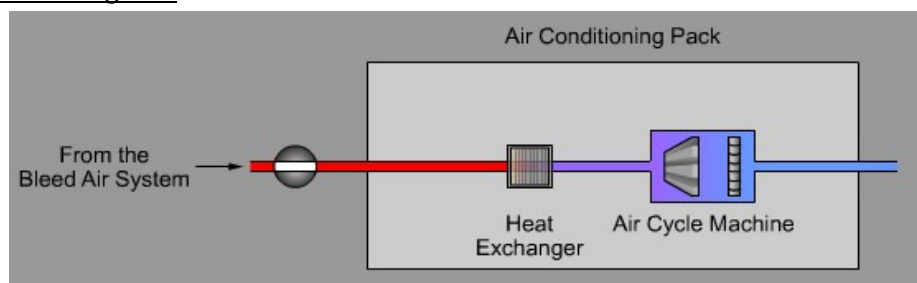
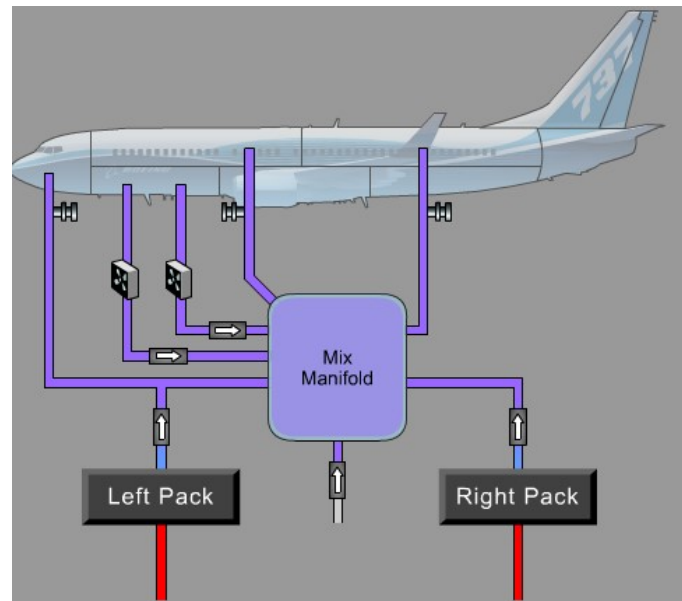
- Bleed air from engine n°1 flows to L PACK
- Bleed air from engine n°2 flows to R PACK

A single PACK, operating in HIGH flow, is capable to provide pressurization and acceptable temperature control throughout the entire aircraft envelope.

APU BLEED can provide normal operation for:

- 2 PACKs on ground
- 1 PACK in flight

NOTE: a single engine must not be used to operate 2 PACKs simultaneously



Air temperature indicator and selector

Air temperature selector provide choices of reading:

- From SUPPLY DUCT: AFT, FWD and CONT CAB temperature
- From PASS CAB: FWD and AFT temperature
- From PACK: L or R PACK temperature

Temperature selector

Provides temperature selection for CONT CAB, FWD CAB and AFT CAB:

- AUTO: provide automatic temperature control
- Rotate clockwise (→H): increase temperature
- Rotate anticlockwise (→): decrease temperature

CONT CAB “ZONE TEMP” illuminates in case of:

- Duct temperature overheat
- Failure of both flight deck primary and standby temperature control

FWD and/or AFT “ZONE TEMP” illuminates in case of duct temperature overheat



Trim air switch

Open/close the pressure regulating and shut-off valves

Air control panel

L and R RECIRC FAN switches AUTO: fan operation is dependent on the PACK setting

TRIP RESET button reset (provided that the fault has been corrected):

- Bleed trip off
- "PACK" and/or "ZONE TEMP", related valves opens

"PACK" indicate that the PACK or both pack control (primary/secondary) have failed

"RAM DOOR FULL OPEN" indicates relative ram air door position

Equipment cooling switch

Provides fan selection for both SUPPLY and EXHAUST cooling air:

NORM: activates normal fan

ALTN: activates alternate fan

"OFF" indicate no flow detected from the relative fan

Distribution

In the flight deck air flows from: floor, ceiling and foot outlets providing warming and defogging

In the passenger cabin air flow from overhead distribution ducts

AIR CONDITIONING – NORMAL OPERATION

Packs flow

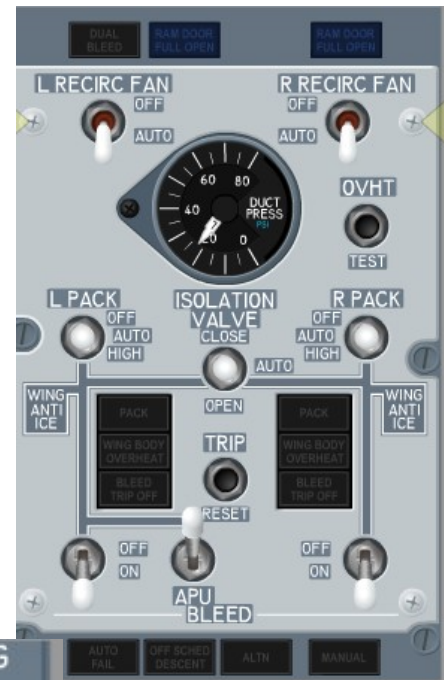
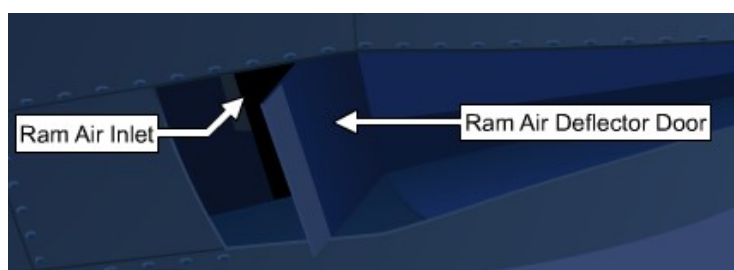
PACKs provide normal air flow when both are operating in AUTO. If one PACK ceases to operate, the other switch automatically to HIGH flow. This won't happen (in order to provide adequate power for single-engine operation):

- On ground
- With FLAPs extended in flight

NOTE: when the only bleed air source is APU, the operating PACK switch to HIGH regardless of other conditions

PACKs ram air inlet doors open/close automatically depending on cooling requirements, on ground or during slow flight with FLAPs not fully retracted, the doors fully opens, "RAM DOOR FULL OPEN" illuminates.

To prevent FOD (foreign object damage), electrical activated deflector doors are installed forward of the ram air inlet, they operate prior to lift-off or after touchdown according to air/ground sensing.



Packs operation

Bleed air passes first through an heat exchanger to start cooling cycle, then into an air cycle machine for refrigeration. Some hot air bypasses the air cycle machine and is then combined with processed cold air to obtain the required air temperature. An high pressure water separator remove moisture, then air flows to the mix manifold.

If an overheat is sensed, the pack valve closes and “PACK” illuminate.

Pack temperature control valve regulates hot bypasses air flow according to the discharge flow required by the pack controller. Should the primary pack controller fail, the other pack controller (standby controller) takes over.

Should both pack controller (primary and standby) fail to control a pack, the pack will continue to operate unless excessive temperature causes the pack to trip off.

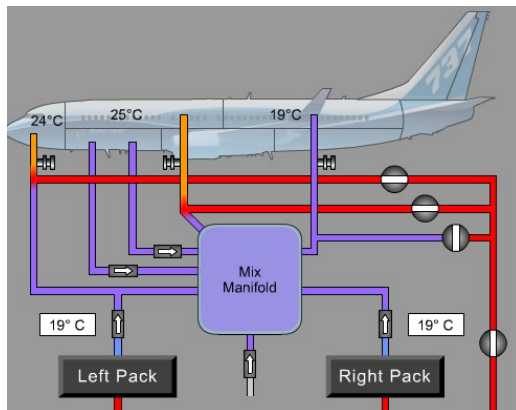
In both cases (single and double pack controller failure) associated “PACK” light and “MASTER CAUTION” + “AIR COND” annunciation will illuminate



Zone temperature control

zone temperature selector provide temperature range from 18° to 30 °C.

the zone which requires **most cooling** causes the pack to modulate in order to satisfy this zone. Trim air (hot air) is introduced to satisfy temperature of other zones, by modulating individual valves in zone supply ducts.



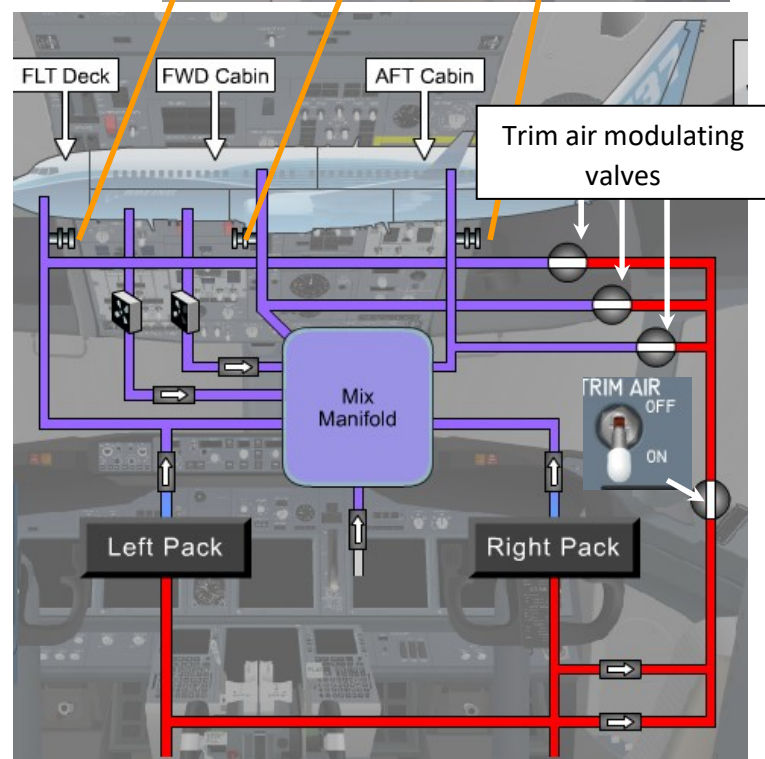
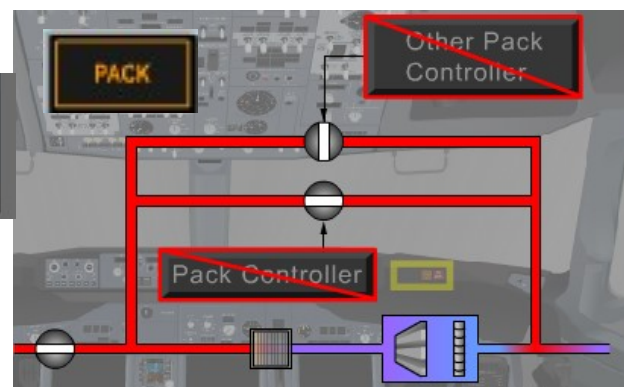
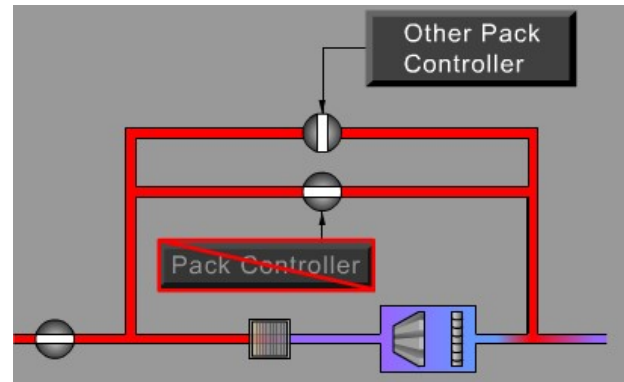
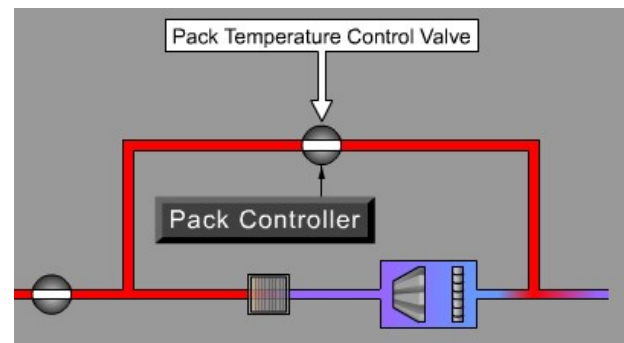
With a single pack failure:

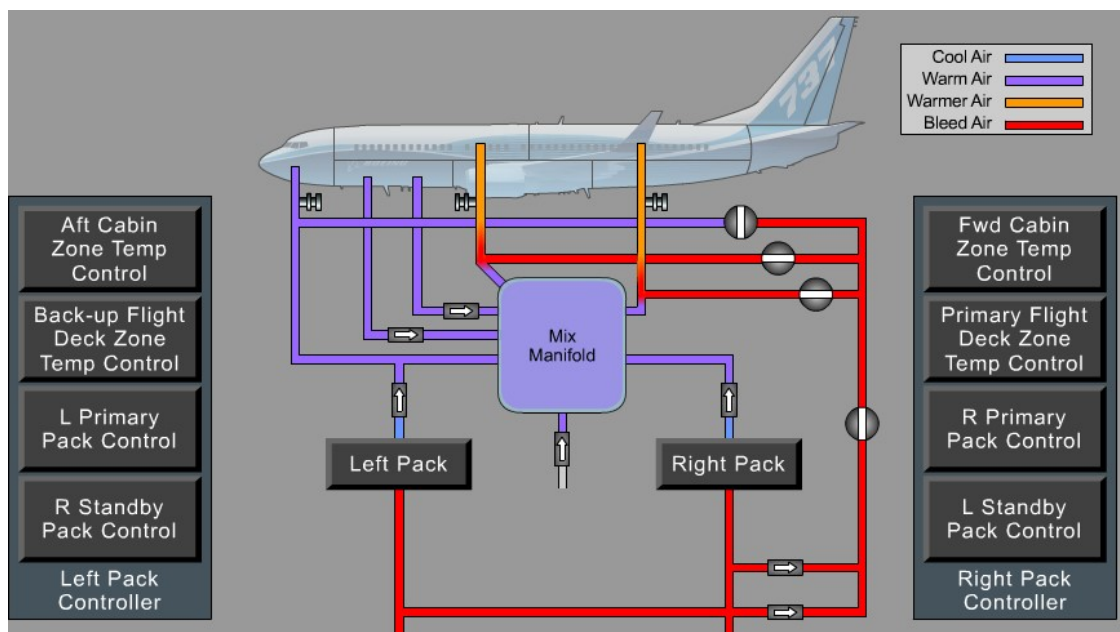
- TRIM AIR ON: the other pack will operate as during 2 packs operation
- TRIM AIR OFF: the other pack will try to satisfy the average temperature demand.

A duct overheat causes:

- Associated modulating valve closes
- “ZONE TEMP” illuminate

After duct cooling, pushing TRIP RESET will reopen the valve and extinguish “ZONE TEMP”



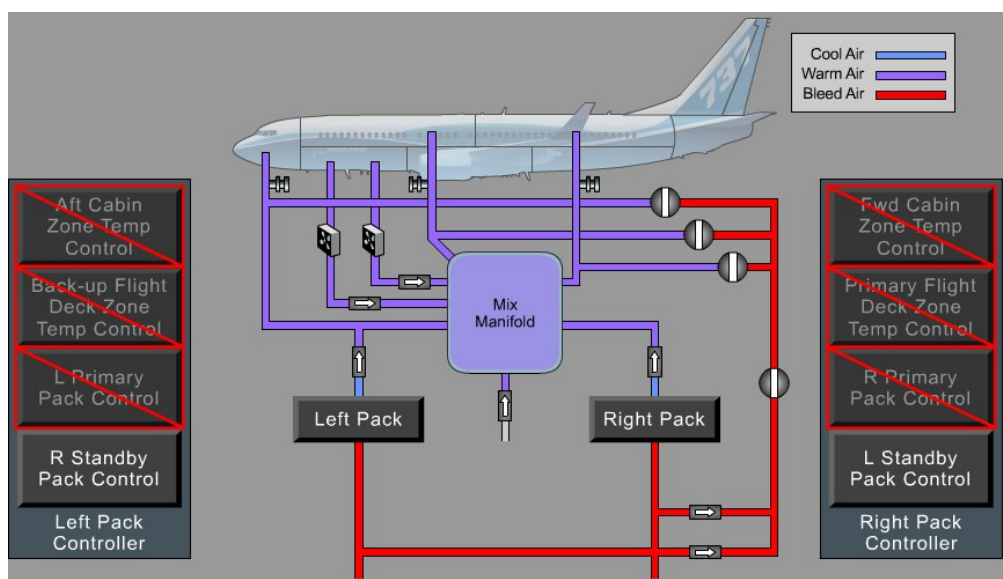


If PRIMARY FLIGHT DECK ZONE TEMP CONTROLLER fails (R pack controller) the BACK-UP FLIGHT DECK ZONE TEMP CONTROLLER takes control (L pack controller). Should both fail, CONT CAB “ZONE TEMP” + “MASTER CAUTION” + “AIR COND” annunciation illuminates

If either FWD or AFT CABIN ZONE TEMP CONTROL fails, related TRIM AIR modulating valve close and temperature is then averaged

A failure of TRIM AIR causes temperature control to control both packs independently

STANDBY PACKS control operates PACKS to satisfy average temperature demand of the cabin if all other control fail. TRIM AIR valves close, CONT CAB temperature selector has no effect on temperature.



If all temperature selector are moved OFF:

- L pack maintain 24 °C at the pack temperature sensor
- R pack maintain 18 °C at the pack temperature sensor

Recirculation system



The purpose of the recirculation system is to reduce air condition packs and bleed air demand. Air flows from the cabin and electronic equipment bay to the forward cargo bay, where it is filtered and sent to the mix manifold.

In order to operate, RECIRC FAN switch must be in AUTO, with both switch in AUTO:

RECIRC FAN →	In flight		On ground	
	L	R	L	R
Both PACK in AUTO	ON	ON	ON	ON
Either PACK in HIGH	OFF	ON	ON	ON
Both PACK in HIGH	OFF	OFF	OFF	ON

Equipment cooling

Cooling air is provided to:

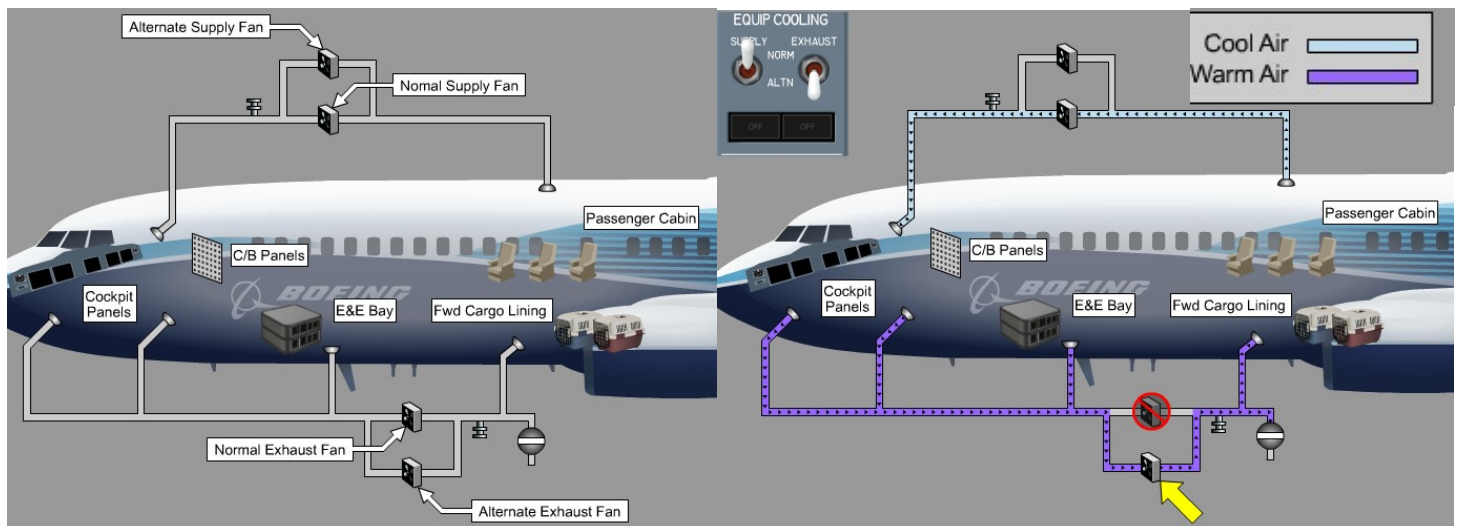
- Flight deck displays
- E & E bay
- Overhead and aft electronic panels
- Circuit breaker panel



2 ducts provide cooling air supply and exhaust, in each duct 2 fans are provided (NORM and ALTN fans).

If a fan fails, "OFF" illuminate due to the loss of airflow, once the ALTN fan is selected, the resulting flow should extinguish the light in about 5 seconds.

Exhaust line of the cooling system provide additional heating fro FWD cargo lining, provided that overboard exhaust valve is closed.



AIR CONDITIONING – NON-NORMAL OPERATION

Equipment cooling “OFF” (QRH 2.16)

OFF

EQUIPMENT COOLING OFF

Condition: The equipment cooling supply or exhaust fan is failed.

- EQUIP COOLING SUPPLY or EXHAUST switch (affected side) ALTN

Note: Illumination of the EQUIP COOLING SUPPLY or EXHAUST OFF light may be an indication of a pressurization problem. Ensure the pressurization system is operating normally.

- No further action is necessary in flight if the equipment cooling OFF light does not extinguish.

■ ■ ■ ■

“ZONE TEMP” (QRH 2.28)

ZONE TEMP

ZONE TEMP

Condition: One or more of these occur:

- A zone duct overheat
- Flight deck temperature control is failed.

- Temperature selector (affected cabin) Select a cooler temperature

This prevents the trim air modulating valve from returning to an overheat condition.

- TRIP RESET switch Push

The ZONE TEMP light extinguishes if the duct temperature has cooled below limits.

- Monitor duct temperature.

If the duct temperature increases rapidly, set the TRIM AIR switch to OFF.

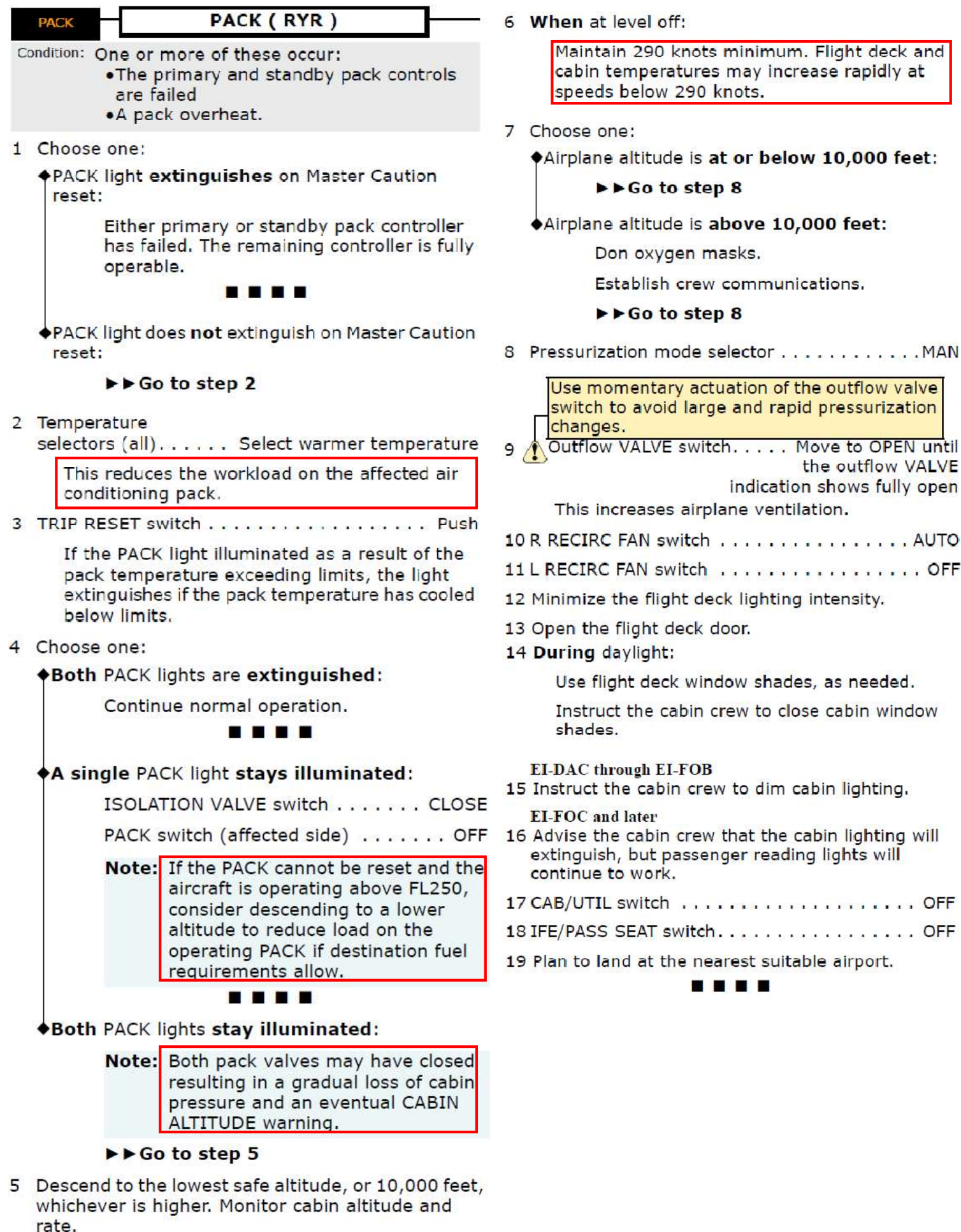
- Choose one:

- ◆ Affected cabin temperature is excessively high:
 - Go to the Cabin Temperature Hot checklist on page 2.11
- ◆ Affected cabin temperature is normal:

■ ■ ■ ■

■ ■ ■ ■

"PACK" (QRH 2.18)

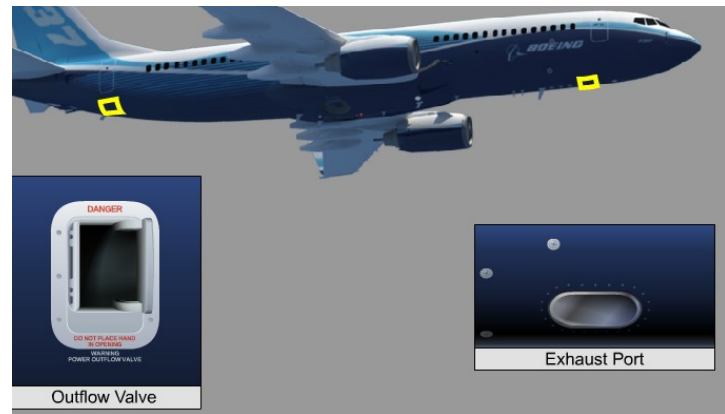


PRESSURISATION – SYSTEM DESCRIPTION

Overview

Pressurisation system provide cabin pressurisation throughout all phases of flight. It uses bleed air routed through air conditioning packs.

Pressurisation and cabin ventilation are primarily controlled by outflow and overboard exhaust valves.



Controls and indications

Pressurisation mode selector allow selection of pressurisation system mode of operation:

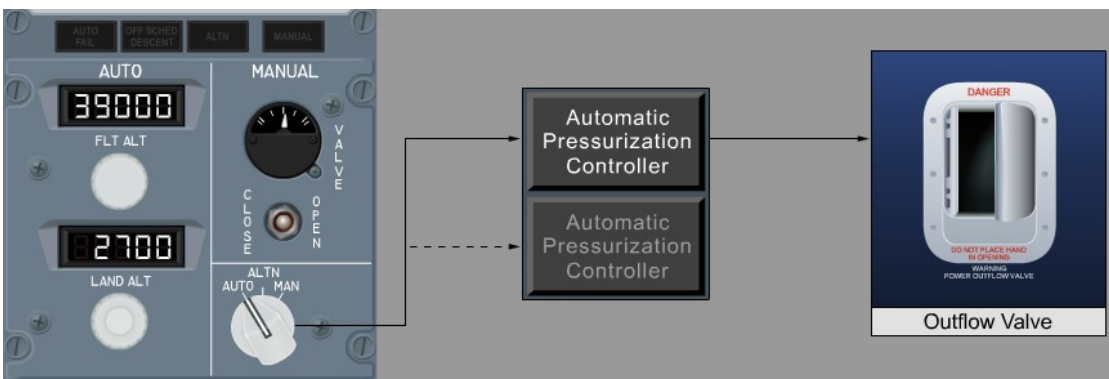
- AUTO: automatic pressurisation control through 2 identical automatic pressurisation controllers
- ALTN: automatic pressurisation control, alternate mode of operation, “ALTN” illuminate
- MAN: manual control of the system, “MANUAL” illuminate



Outflow valve are operated by a DC motor and controlled either:

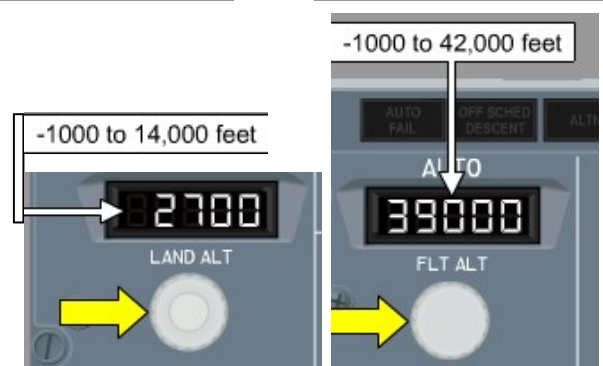
- Automatically in AUTO or ALTN mode
- Manually in MAN mode, through the valve switch (spring loaded to centre position)

outflow valve position indicator shows outflow valve position for all modes of operation



FLT ALT and LAND ALT should be set prior to takeoff:

- FLT ALT setting:
 - Every knob click adjust by 500 ft
 - Selection range is – 1000 to 42000 ft
- LAND ALT setting:
 - Every knob click adjust by 50 ft
 - Selection range is – 1000 to 14000 ft



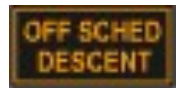
In case of a single pressure controller failure, secondary pressure controller automatically takes over, “AUTO FAIL” and “ALTN” illuminate.



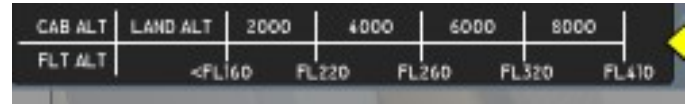
In case of a dual pressure controller failure, manual mode is required, only “AUTO FAIL” illuminate.



"OFF SCHED DESCENT" illuminate if the aircraft descends prior to reach preselected FLT ALT



A CAB ALT/FLT ALT placard is provided to determine appropriate cabin altitude when operating in MAN mode.



The cabin altimeter shows:

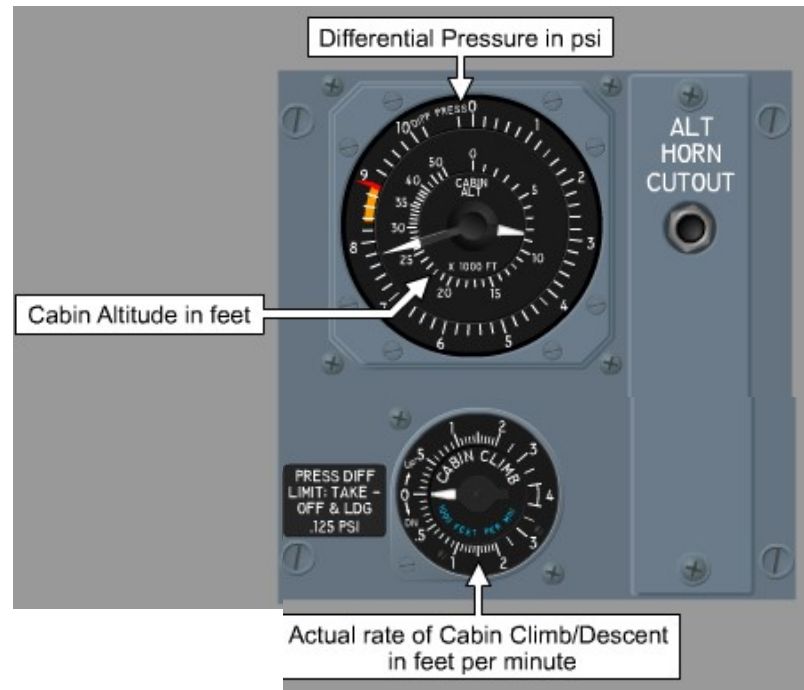
- On the inner scale: cabin altitude in ft
- On the outer scale: pressure differential in PSI

Cabin rate of climb indicator shows actual cabin rate of climb/descent in ft/min

Cabin altitude warning "horn" sounds when cabin altitude exceeds 10000 ft

ALT HORN CUTOUT button silence cabin altitude warning "horn"

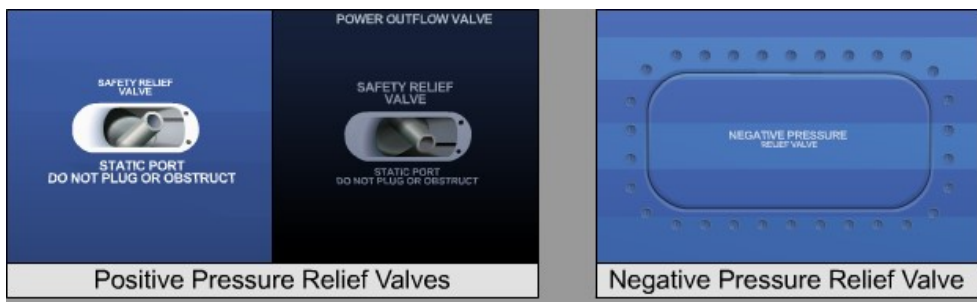
NOTE: under normal condition CABIN ALT indicate 8000 ft at 41000 ft flight altitude



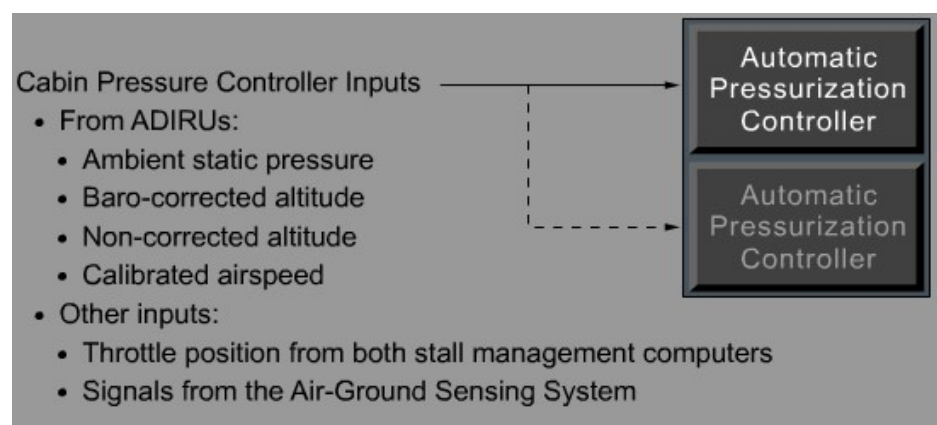
Pressure relief valves

Negative and positive pressure protection is provided by:

- Positive pressure protection is provided by 2 relief valve that limit maximum pressure differential to 9.1 PSI
- Negative pressure protection is provided by 1 relief valve that operates when external pressure is higher than internal pressure (ie. During a rapid descent)



Cabin automatic pressure controller



Air outflow

Cabin air exits the cabin through the foot level grills, is then routed to the AFT cargo compartment to provide heating, finally is exhausted through the outflow valves. Some air exits through sinks and galleys along with normal seal leakage around the doors.

The overboard exhaust valve opens and closes depending on pressure differential:

- Low pressure differential: the valve is normally open, warm air from E & E bay is discharged overboard
- High pressure differential: the valve is normally closed, exhaust air is diffused through lining of FWD cargo

NOTE: if either PACK is operating in HIGH flow and R RECIRC FAN is OFF (smoke removal configuration) the overboard exhaust valve opens to provide increased ventilation



PRESSURISATION – NORMAL OPERATION

AUTO/ALTN control

in either AUTO and ALTN mode, FLT ALT and LAND ALT must be entered before the flight.

Ground operation (before takeoff)

On the ground the pressure controller constantly receives a takeoff altitude input in the form of cabin altitude which is kept in memory. At low power setting, the outflow valves drive fully open to depressurise the cabin, at higher power setting the outflow valve are closed to pressurise the cabin, making the transition to pressurised flight more gradual, thus improve system response and passenger comfort.

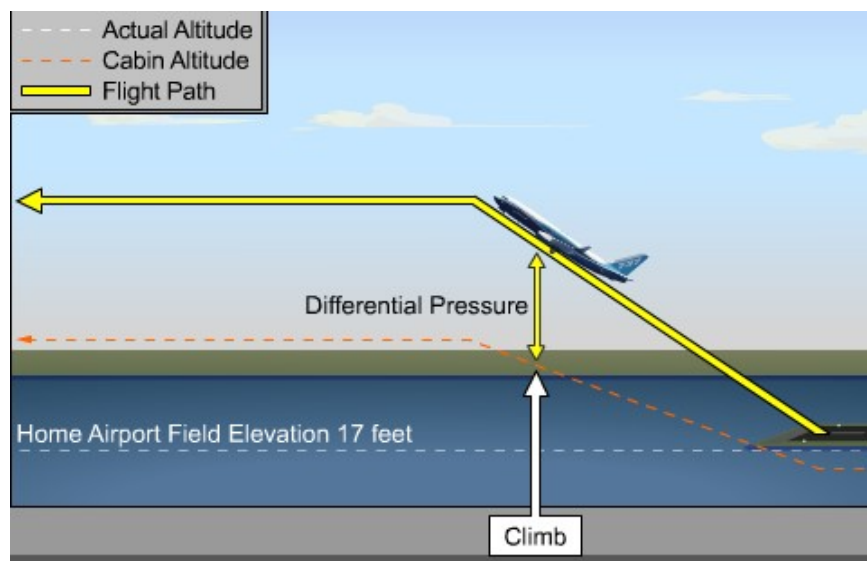
Climb operation

During climb, the cabin rate of climb is kept to the minimum required as a function of the aircraft rate of climb.

In case a descent is initiated before reaching the preselected FLT ALT, the takeoff altitude (which has been kept in memory by the pressure controller) is automatically taken as reference landing altitude without crew inputs, "OFF SCHED DESCENT" illuminate.

NOTE: takeoff altitude is erased by the memory of the pressure controller if:

- FLT ALT is changed
- FLT ALT is reached



Cruise operation

The cruise pressurisation mode is activated when the aircraft climb to within 0.25 PSI of the FLT ALT. during cruise the pressurisation control tries to maintain the lowest possible cabin altitude according to the maximum cabin differential limits (table below).

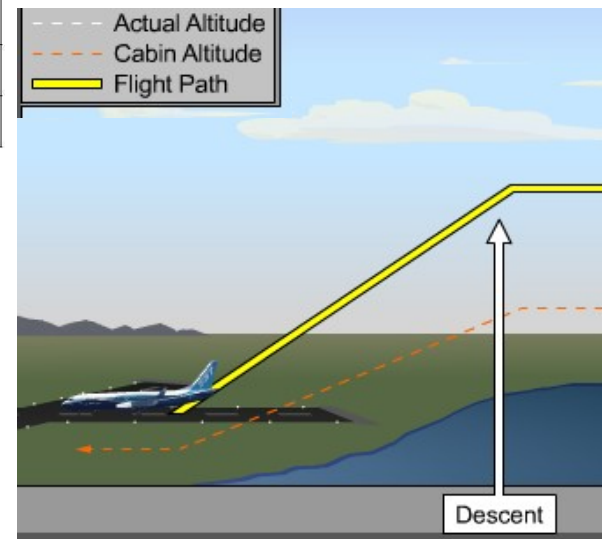
If the LAND ALT is higher than the target cabin altitude, the pressure control aims to a cabin altitude slightly below the LAND ALT.

The controller will then try to keep constant the cabin altitude, small altitude variation will cause the pressure differential to change.

Selected FLT ALT	Differential Pressure Limit
At or below 28,000 feet	7.45 psid
28,000 feet to 37,000 feet	7.80 psid
Above 37,000 feet	8.35 psid

Descent operation

Descent mode is activated when the aircraft descends 0.25 PSI below FLT ALT. the pressure controller will then keep a proportional descent to slightly below the LAND ALT, in order to land with the cabin slightly pressurised so that rapid changes of altitude during the approach results in minimum pressure changes

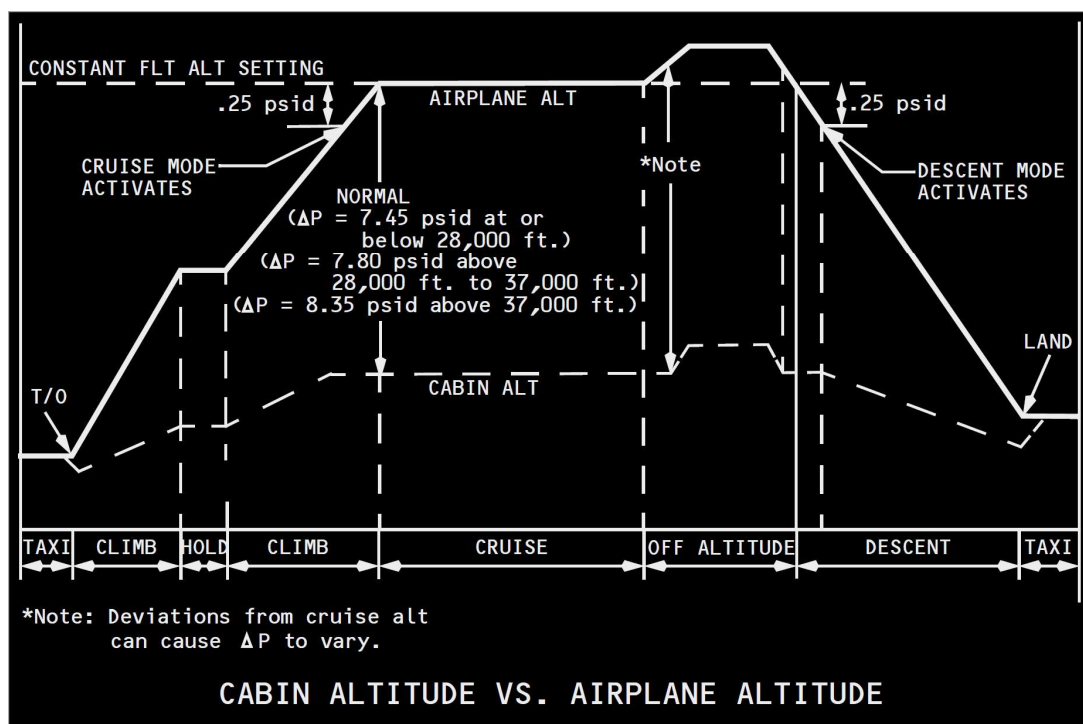


Ground operation (after landing)

After landing the controller drives the outflow valve slowly to full open position, depressurising the cabin slowly.

Pressurisation cycle sum up

	Taxi-out	climb	0.25 < cruise < 0.25	descent	Taxi-in
Target CAB ALT	< takeoff ALT	Lowest	Lowest or < LAND ALT	< LAND ALT	depressurise
operation	With high power, outflow valve close	Proportional to A/C ROC	Keeps target constant	Proportional to A/C ROD	Slowly



“**AUTO FAIL**” illuminates whenever:

- DC power is lost
- Controller or outflow valve fault
- Pressure differential > 8.75 PSI
- Rate of climb/descent > 2000 MSL ft/min
- Cabin altitude > 15800 ft (if controller is not responding properly)
- In case of double or single source failure (single source “**ALTN**” illuminate*)

*selecting ALTN will extinguish “**AUTO FAIL**”

Manual mode

MAN mode must be used if both AUTO and ALTN modes fail.

Moving the selector on MAN will illuminate “**MANUAL**”.

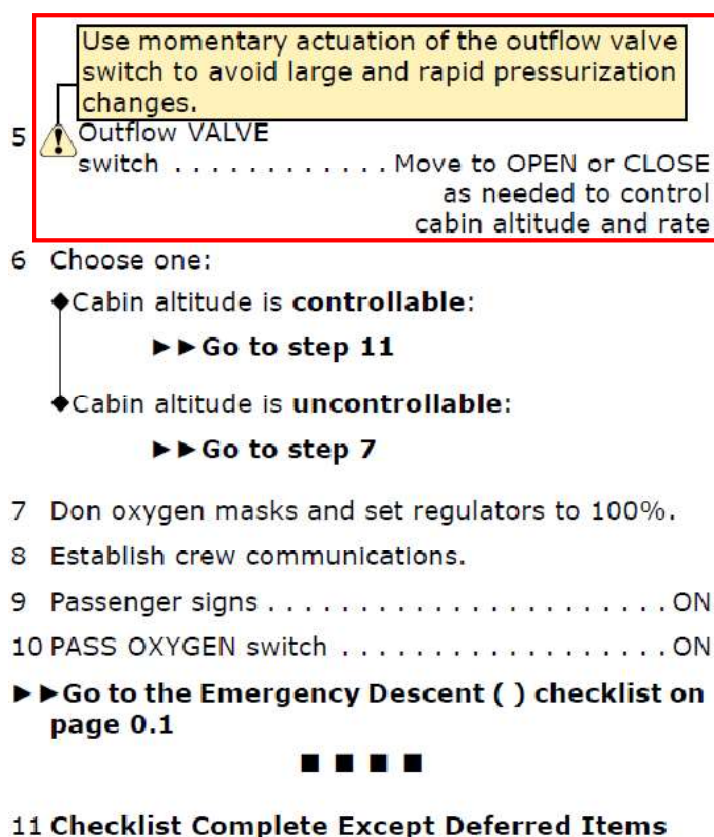
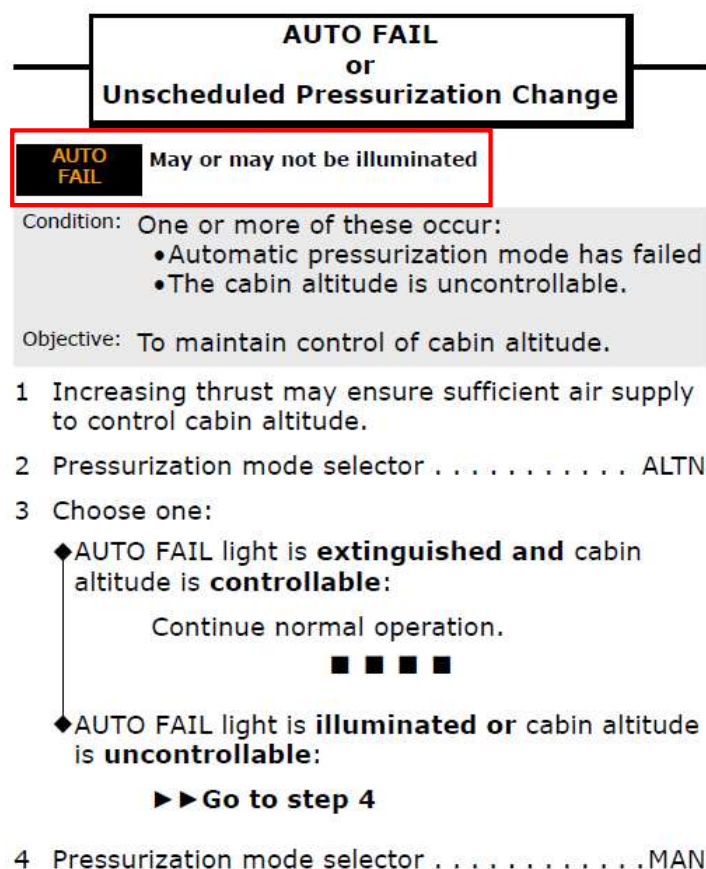
Use the outflow valve position switch to control the outflow valve DC motor to open or close the outflow valves.
Use the placard to know the cabin altitude setting.

NOTE: outflow valve will drive at a slower rate than during AUTO or ALTN mode, it can take up to 20 seconds to drive an outflow valve fully open.

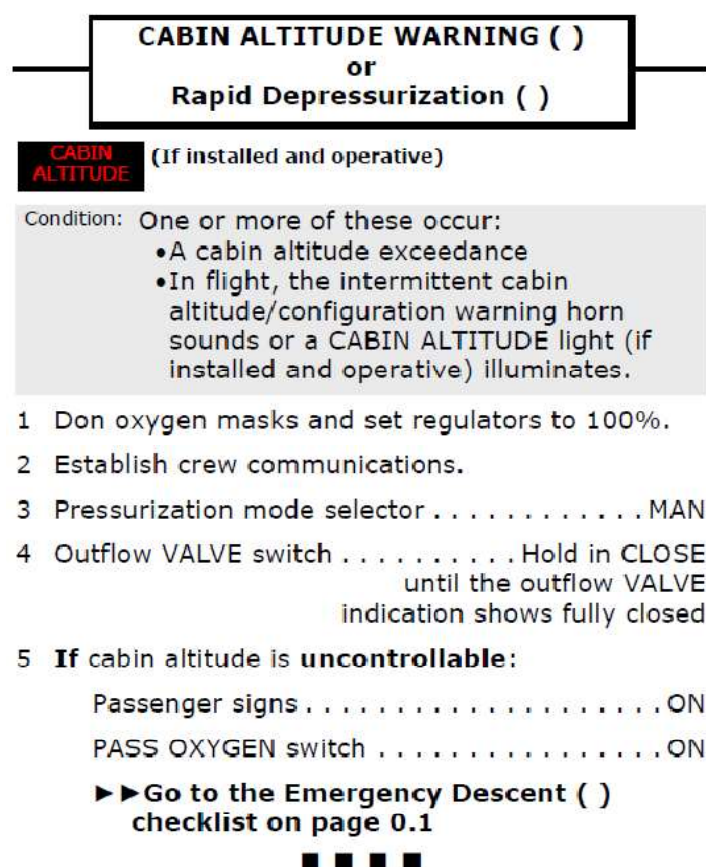


PRESSURISATION – NON-NORMAL OPERATION

“AUTO FAIL” (QRH 2.4)



“RAPID DEPRESSURISATION” (QRH 2.1)



- 6 If cabin altitude is **controllable**:
- Continue manual operation to maintain correct cabin altitude.
- When** the cabin altitude is at or below 10,000 feet:
Oxygen masks may be removed.
- 7 Checklist Complete Except Deferred Items

ICE & RAIN PROTECTION – SYSTEM DESCRIPTION

Overview

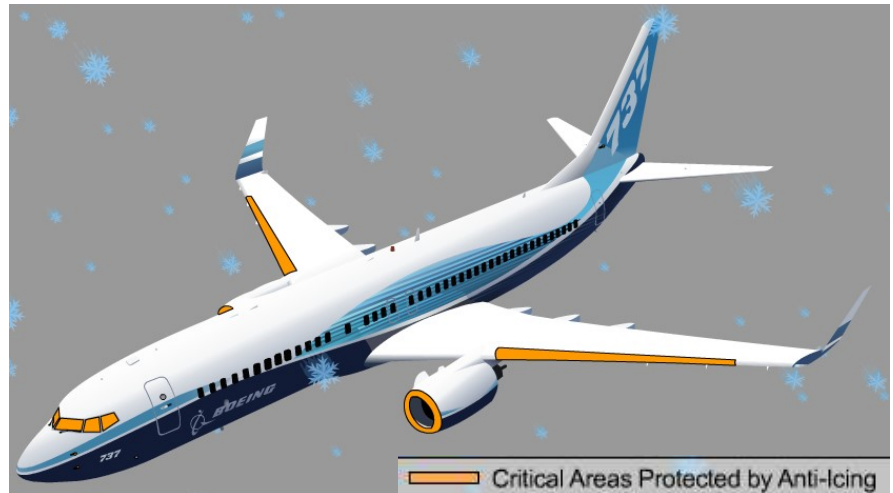
Thermal and electrical anti-ice and windshield wiper system protect the aircraft critical area from ice and rain.

These systems are:

- Engine anti-ice
- Wing anti-ice
- Flight deck window heat
- Probe and sensors heat
- Windshield wipers

Controls and indications

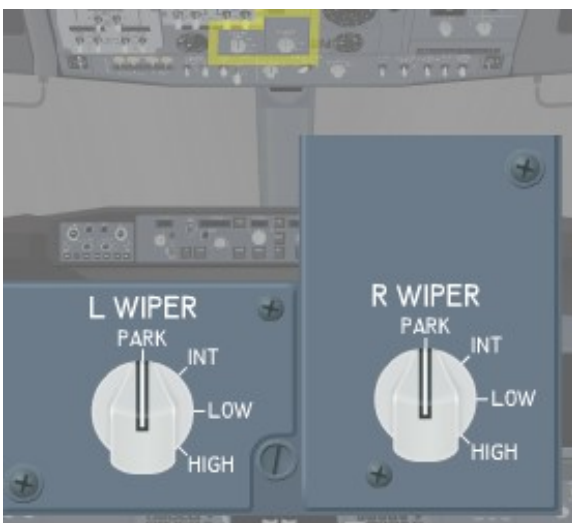
Window heat panel



Windshield air: provide conditioned air to n°1 windows for defogging



Windshield wipers



probe heat panel



Engine anti-ice panel: indicate and control bleed air flow to engines cowl



Wing anti-ice panel: controls and indicate bleed air flow to leading edge slats

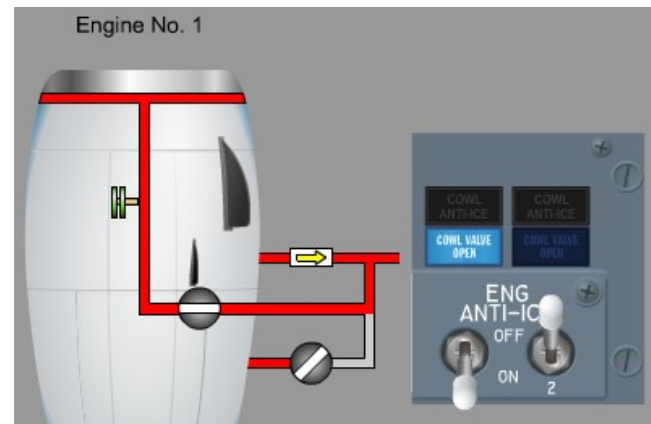


Engine anti-ice system

Bleed air from associated engine is used to prevent ice formation on the cowl lip. Each engine has its own ENG ANTI-ICE switch, which may be operated both in flight and on ground:

- Moving the switch ON will
 - i. Open engine anti-ice valve
 - ii. Set stick shaker logic for icing condition, this changes airspeed indicator RED and AMBER bars
- Moving the switch OFF will:
 - i. Close engine anti-ice valve
 - ii. Set back to normal stick shaker logic

Engine anti-ice valves are electrically controlled and operated by bleed air pressure



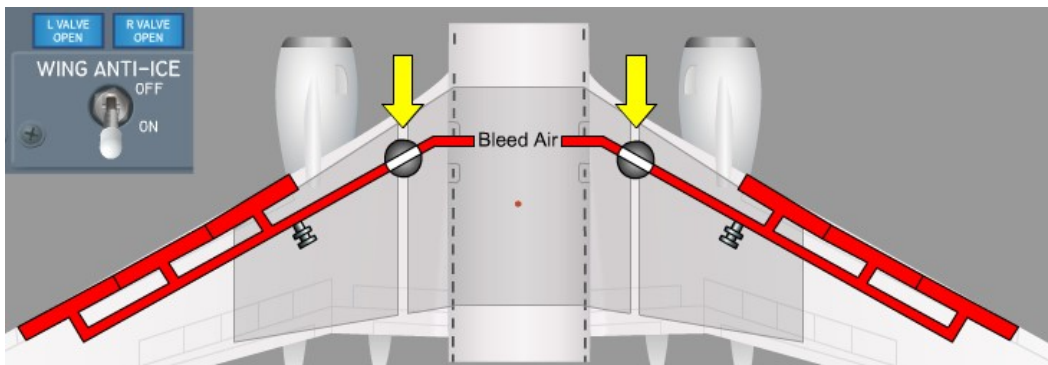
Wing anti-ice

Bleed air spilled from bleed air duct is used to provide wing anti-ice.

Valves for wing anti-ice are operated by AC motors and controlled by WING ANTI-ICE switch:

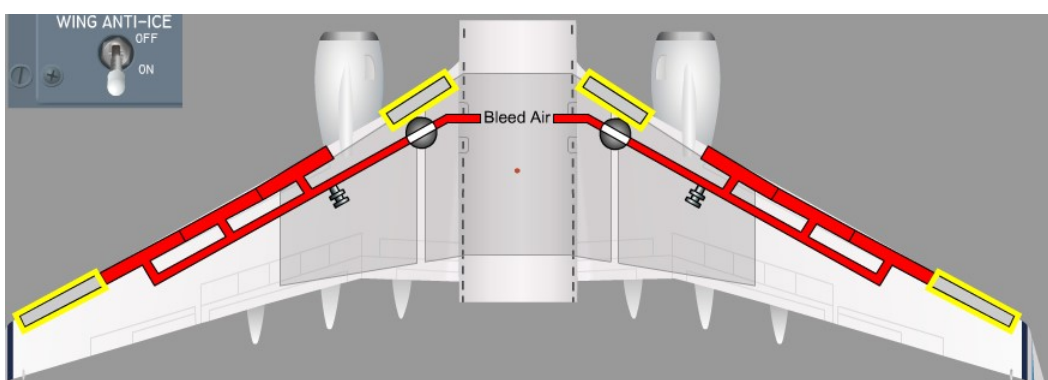
- Moving switch OFF will close wing anti-ice valves
- Moving the switch ON will:
 - In flight: open wing anti-ice valves and set stick shaker logic for ice condition
 - On ground:
 - i. open/close wing anti-ice valves according to thrust setting and duct temperature
 - ii. trip off WING ANTI-ICE switch at lift-off

NOTE: stick shaker logic can remain set for icing condition for the remainder of the flight once wing snit-ice are ON



Whenever the wing anti-ice valves are open, bleed air will flow to the 3 inboard leading edge slats on each wing, then is exhausted overboard. Wing anti-ice is effective regardless of slats position.

NOTE: the system does not comprise first outboard slats and leading edge flaps



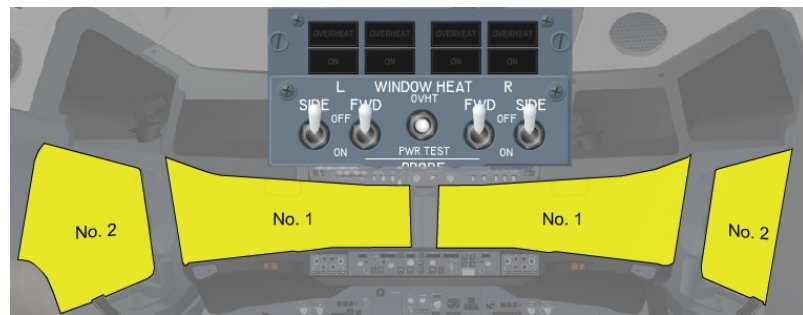
Window heat system

N°1 and n°2 (FWD and SIDE) windows are heated.
N°1 windows are also defogged with conditioned air.

N°1 and n°2 windows are provided with a conductive coating on the outer glass layer, when activated this heats and prevents ice accretion and fogging.

Maintaining an ideal temperature of the windows will also gives them maximum strength in case of a bird impact, maintaining this ideal temperature is accomplished by temperature controllers. If an overheat condition is sensed, power is removed and “OVERHEAT” illuminates on the relative window light.

Window heat should be selected at least 10 minutes prior to takeoff.



Window heat panel

The TEST switch (spring loaded to centre position) will:

- On OVHT: simulates an overheat condition (all light illuminate)
- On PWR TEST: perform a confidence test, all “ON” illuminate

“OVERHEAT” indicate that:

- Overheat is detected, or
- Electrical power to associated window is lost

“ON” indicates that window heat is applied to the associated window, its extinguished when:

- Switch is OFF
- Overheat is detected (power is removed)
- A system failure occur
- System is at the correct temperature



Windshield wipers and probe heat systems

Rain protection

Rain protection is accomplished by a rain repellent coats over the extenar windows and by windshield wipers.
Windshield wipers must not be operated on a dry window since this will scratch the rain repellent coating.

Individual wiper controls are provided:

- PARK: blade are stowed and motor turned off
- INT: operates wipers at 7 seconds intervals
- LOW / HIGH: operates wipers continuously at selected speed



Probes heat

Electrical heating is provided to:

- Pitot probes
- TAT probes
- Alpha vanes probes

NOTE: static ports are not heated

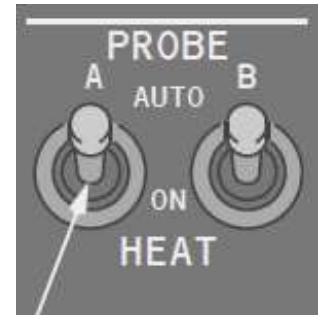


A unique switch for each side probes heat is provided.

Relative **AMBER** indicates that the associated probe is **NOT** heated.

When operating with STBY electrical power:

- There is no indication of system status
- Auxiliary Pitot probe is not heated
- Captain Pitot is the only heated probe (no indication if it fails)



EI-DAC through EI-ENC and EI-ENE through YW135

Switch AUTO position: power is automatically supplied to both A and B probes when either engine is running

ICE & RAIN PROTECTION – NORMAL OPERATION

Engine anti-ice

Indications

“COWL VALVE OPEN” indicates:

- **BRIGHT**: valve is in transit
- **DIM**: valve is open



“TAI” appear over N1 indications whenever cowl anti-ice valve is open

“TAI” appear whenever cowl anti-ice valve disagree with switch position

“COWL ANTI-ICE” indicates an overpressure condition in duct downstream of engine cowl anti-ice valve



Operation

Engine anti-ice are to be used in icing condition, icing condition exists when:

- OAT or TAT below +10 °C
- Visible moisture:
 - i. In clouds or precipitation
 - ii. Visibility less than 1500 m
 - iii. Taxiway contaminated by slush, snow or water

NOTE: do not use engine anti-ice when OAT/TAT > +10 °C

Wing anti-ice

indications

“L / R VALVE OPEN” indicates:

- **BRIGHT:**
 - i. Related wing anti-ice valve in transit
 - ii. Related wing anti-ice valve disagree with switch position
- **DIM:** related wing anti-ice valve is open

Operation

On ground above takeoff warning power setting of thrust levers or high duct temperature, wing anti-ice valve will close automatically, when this situation no longer occur, the valves reopen automatically

NOTE: wing anti-ice is not an alternative to ground de-icing procedures

In flight ice accumulation will be noted in the windshield area. Normally, ice is permitted to accumulate before turning wing anti-ice ON, this will provide the cleanest airfoil.

NOTE: do not use wing anti-ice when OAT/TAT > + 10 °C

ICE & RAIN PROTECTION – NON-NORMAL PROCEDURES

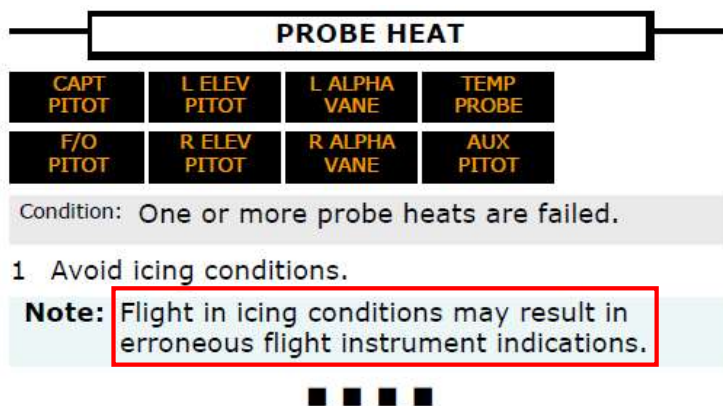
“COWL ANTI-ICE” (QRH 3.1)

COWL ANTI-ICE	ENGINE COWL ANTI-ICE
Condition: An engine cowl anti-ice duct overpressure occurs.	
Objective: To reduce cowl duct pressure by reducing thrust.	
1 Reduce thrust only when flight conditions allow. 2 Autothrottle (if engaged). Disengage 3 Thrust lever (affected engine) . . . Confirm . . . Retard until the COWL ANTI-ICE light extinguishes 4 Run the engine at reduced thrust to keep the light extinguished. 5 Transponder mode selector TA	
This step prevents climb commands which can exceed reduced thrust performance capability.	

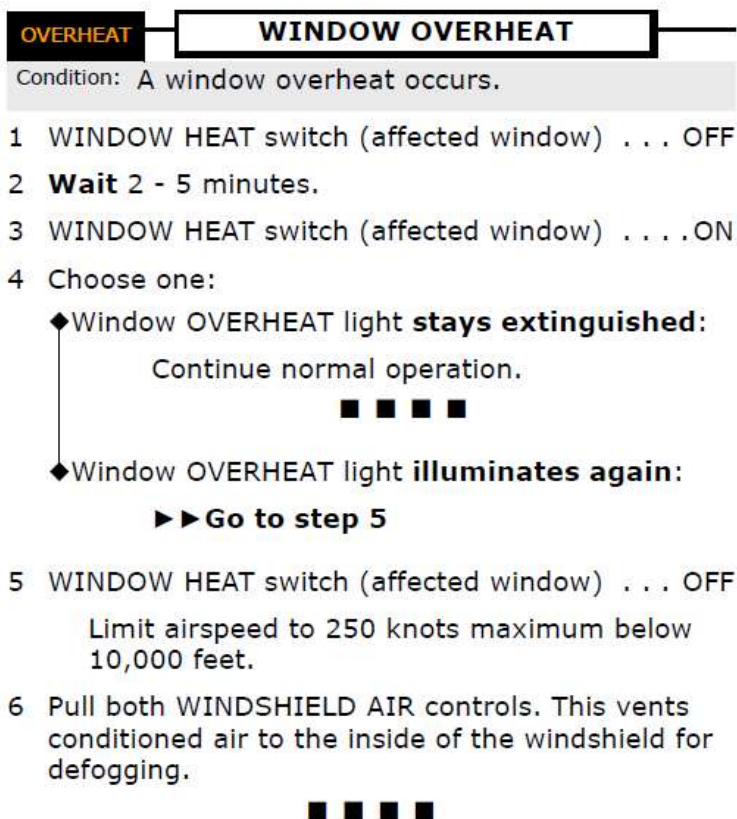
“COWL VALVE OPEN” or TAI indication (QRH 3.2)

COWL VALVE OPEN	ENGINE COWL VALVE OPEN OR TAI INDICATION
Condition: One or both of the following occurs: • An engine COWL VALVE OPEN light stays illuminated bright blue • An amber TAI indication is shown.	
1 Choose one: ◆ ENG ANTI-ICE switch is ON: The cowl anti-ice valve is failed closed. Avoid icing conditions. ■ ■ ■ ■ ◆ ENG ANTI-ICE switch is OFF: The cowl anti-ice valve is failed open. If TAT is above 10°C, limit thrust on the affected engine to 80% N1 if possible. ■ ■ ■ ■	

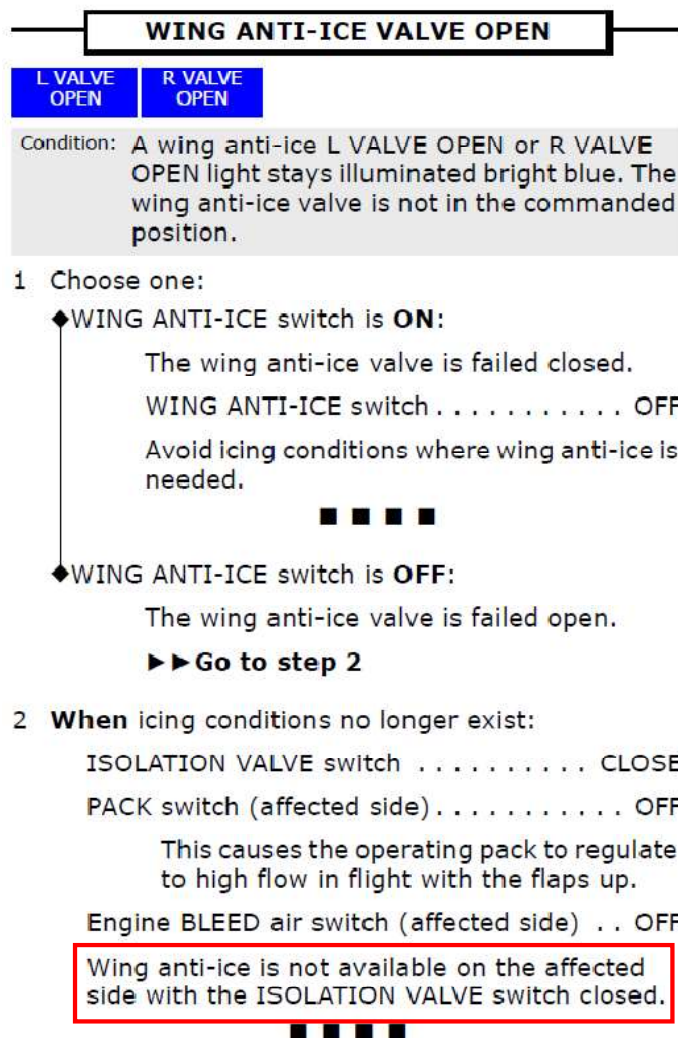
"PROBE HEAT" (QRH 3.5)



Window "OVERHEAT" (QRH 3.6)



wing "L or R VALVE OPEN" (QRH 3.8)



FLIGHT INSTRUMENTS – SYSTEM DESCRIPTION

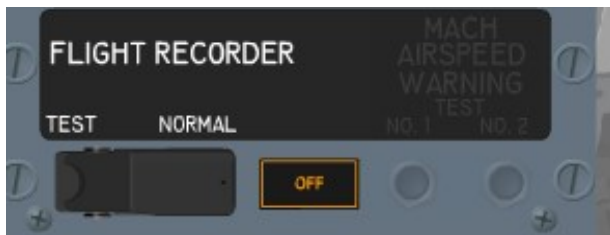
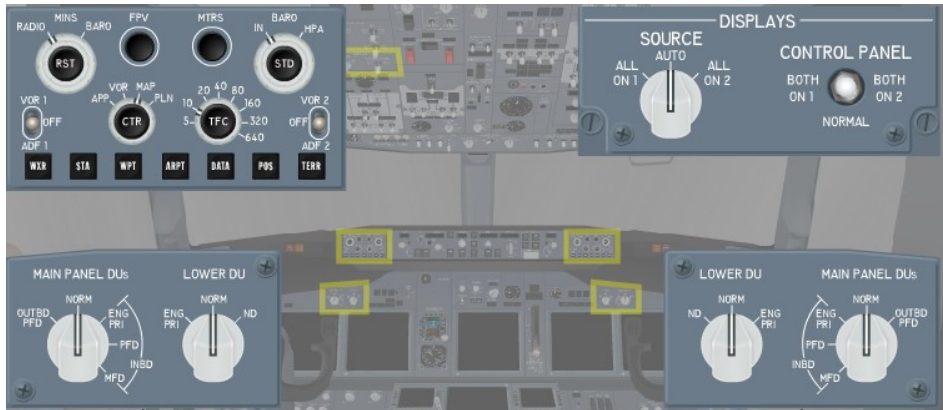
Overview

Inboard and outboard DUs (display units) present all primary and navigation information.

Upper and lower DUs present all primary and secondary engine indications.

The ISFD (integrated standby flight display) displays attitude, airspeed, altitude, ILS and magnetic heading information.

Instrument control is provided by: EFIS control panel, display source panel and display select panel, speed reference selector and display brightness control



Flight data recorder and indications are located on AFT overhead panel.

Display selection and control

EFIS control panel

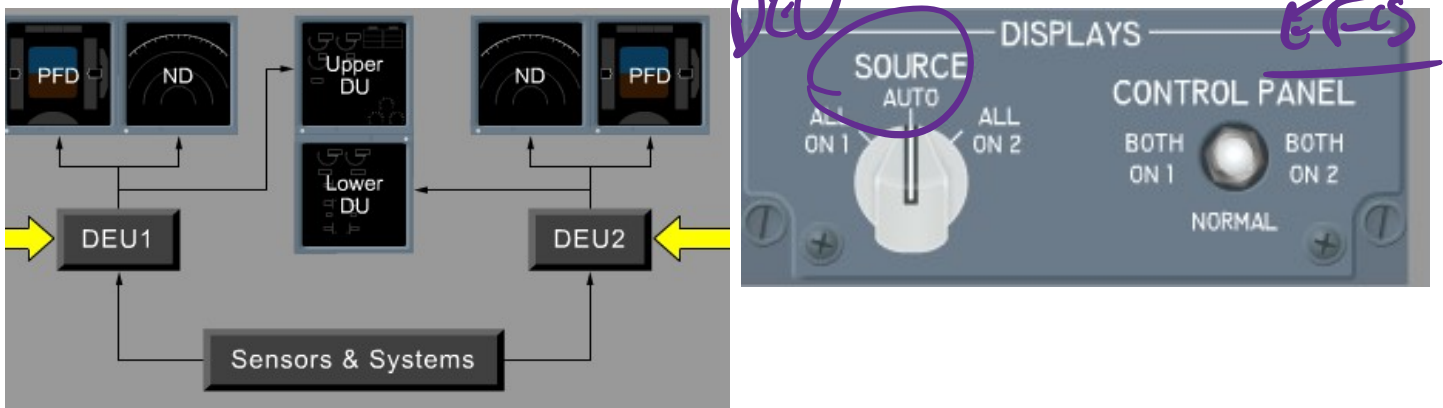
EFIS control panel is located on the glareshield, it controls display options, mode and range for related pilot's DUs.

If an EFIS control panel fails, the display can be controlled by the remaining control panel by using the control panel switch on the DISPLAYS SOURCE panel.



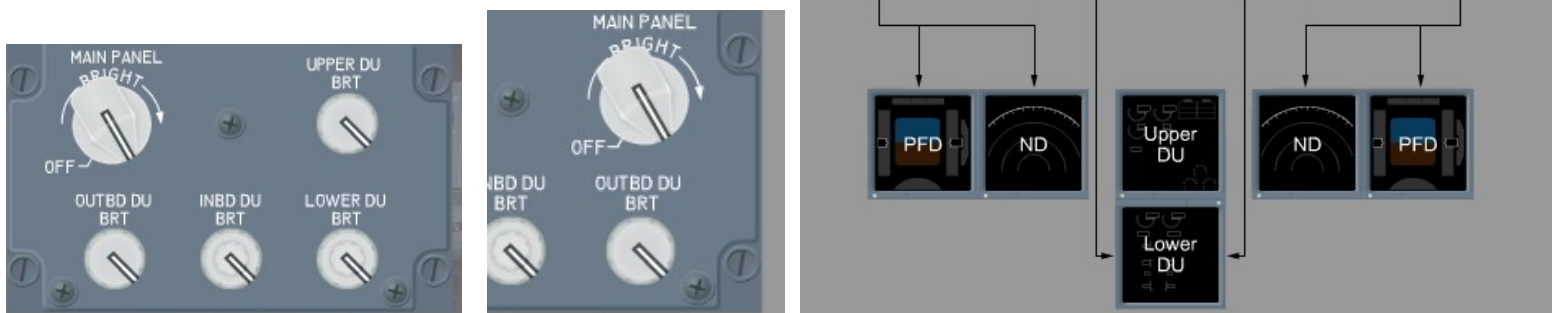
DISPLAY SOURCE and CONTROL PANEL

DISPLAY SOURCE and CONTROL PANEL provide EFIS control and source selection for the display electronic units (DEUs). 2 DEUs receive data from sensors and airplane systems and supply data to the DUs.



Display select panel

Display select panels are located on the left and right forward panels, they control the display on inboard, outboard and lower DUs. During normal operation, all selectors are in NORM position. If a DU fails, automatic display switching ensures that critical information remains available to the pilots. If the system detects an operational failure on an outboard DU, PFD is automatically moved to the inboard DU. The OUTBD/INBD selector no longer has control over that DU. If the upper DU fails, primary engine display automatically move on the lower DU.



Brightness control

Adjustment of the brightness of each DU is controlled automatically by a combination of light sensors and manually by brightness controls. Left INB DU BRT and LOWER DU BRT inner knobs control and adjust weather radar and terrain display brightness (when show on relative DU)

Standby flight instruments

ISFD (integrated standby flight display) EI-EBM through YW135

The ISFD:

- Is connected directly to the auxiliary Pitot and alternate static source
- An internal inertial sensor provides attitude information
- Heading information come from the same captain PFD source

The ISFD is powered by the battery, moving BAT switch ON provides power to the ISFD which illuminate after 10 seconds, then initialisation sequence begins and can take up to 90 seconds. Attitude information are displayed by the end of initialisation. Initialisation require the aircraft to be stationary, an excessive aircraft movement will interrupt initialisation sequence.



"WAIT ATT" (attitude blank) it indicate a momentary out-of-limit condition

"ATT RST" requires to push ATT RST button for at least 2 seconds, this will align the attitude horizon with airplane symbol, resetting takes approximately 10 seconds.

- On-ground: it is necessary to keep the aircraft stationary
- In-flight: "ATT 10s" appear when ATT RST is pushed. it is then necessary to keep the aircraft with wings level, un-accelerated flight, otherwise "ATT RST" will reappear.

"APP" indicates that approach mode has been selected (LOC and G/S deviation scales are displayed)

"BCRS" indicate a reverse sensing of LOC for back-course approach (only LOC scale)



APP button:

1. Push: will select approach mode, "APP" appear
2. Push: will select back-course approach, "BCRS" appear
3. Push: blanks annunciation (no mode selected)

+ and – buttons: control brightness

HP/IN button: select the barometric unit

BARO knob:

- rotating the knob selects the barometric setting.
- Pushing the knob:
 1. Push: set STD setting (1013, 29.92), "STD" appear
 2. Push: reset previous barometric setting



Airspeed is shown when above 30 Kts

Standby attitude, altimeter, airspeed indicators EI-DAC through EI-EBL

The standby attitude indicator provides attitude information independent of the primary attitude indicator. The indicator is powered by the battery. The gyro reach operational speed 60 seconds after power is applied. The indicator required 3 minutes to achieve accuracy requirements.

Standby altitude and airspeed are displayed on a single instrument. Auxiliary Pitot and standby static port are used as pressure source. Current altitude is displayed digitally with a range from – 1000 to 50000 ft.



Standby radio magnetic indicator

The standby RMI is powered by AC STANDBY BUS.

Standby compass

The standby compass is a liquid-damper magnetic compass. A card located nearby provides heading correction values. Compass light provide compass illumination.

Clocks

2 electronic digital display clocks are provided.

Upper clock area display UTC time, UTC date, manual time and manual date.

Lower clock area display ET (elapsed time) or CHR (chronograph)

Clocks are powered by the BATTERY BUS and revert to HOT BATTERY BUS (standby power) when BATTERY BUS power is not available.

During HOT BATTERY BUS operation, clocks keep the time base but does not provide power for the display or output of clock data, clock reverts to manual mode.

Once GPS data is restored, UTC can be manually selected by pushing TIME/DATE button (UTC doesn't display automatically on restart)

CHR button override ET display (ET will continue running in background) and provide start, stop and reset function of the chronograph. A remote button on the glareshield operate as CHR

ET button will start, hold and continue function of ET.

Pushing ET for 2 seconds set ET to zero and clear display.

When ET is active, "ET", "RUN" or "HLD" appear on the bottom left corner of the clock.



TIME/DATE button selects UTC time, UTC date, manual time and manual date. During normal operation UTC time and date from GPS are shown. Manual display comes from the clock.

“UTC” or “MAN” appear on the top right corner of the clock to indicate operation mode.

SET button is used along with + and – buttons in order to manually set clocks time and date. Before any changes can be made, TIME/DATE must be used to display “MAN” time and date.

Procedure:

- To set time: push TIME/DATE to show MAN time, push SET, use + / - to set hours, push SET, use + / - to set minutes, push SET: new time is running now
- To set date: push TIME/DATE to show MAN date, push SET, use + /- to set day, push SET, use + / - to set month, push SET, use + / - to set year, push SET: new date is running now

NOTE: if time or date setting is not completed in 1 minute, the clock reverts to the previous time or date setting.

Other

Digital flight data recorder (DFDR)

The digital flight data recorder (DFDR) provides a permanent record of operational and system information.

Operational and system information are automatically recorded whenever the flight recorder is powered.

The DFDR has the following feature:

- Continuously records the most recent flight data, saving the most current data for the last 25 hours
- Contains a locator beacon operable for 30 days
- Has a receptacle for downloading and copying data for analysis

Aircraft conditions monitoring system (ACMS) EI-DAC through EI-FEI

The aircraft conditions monitoring system (ACMS) contains software that provides the operator useful reports on the condition of the airframe, engines, trend monitoring and maintenance.

Display system information sources

ADIRS (air data reference system)

ADIRS produces flight data as:

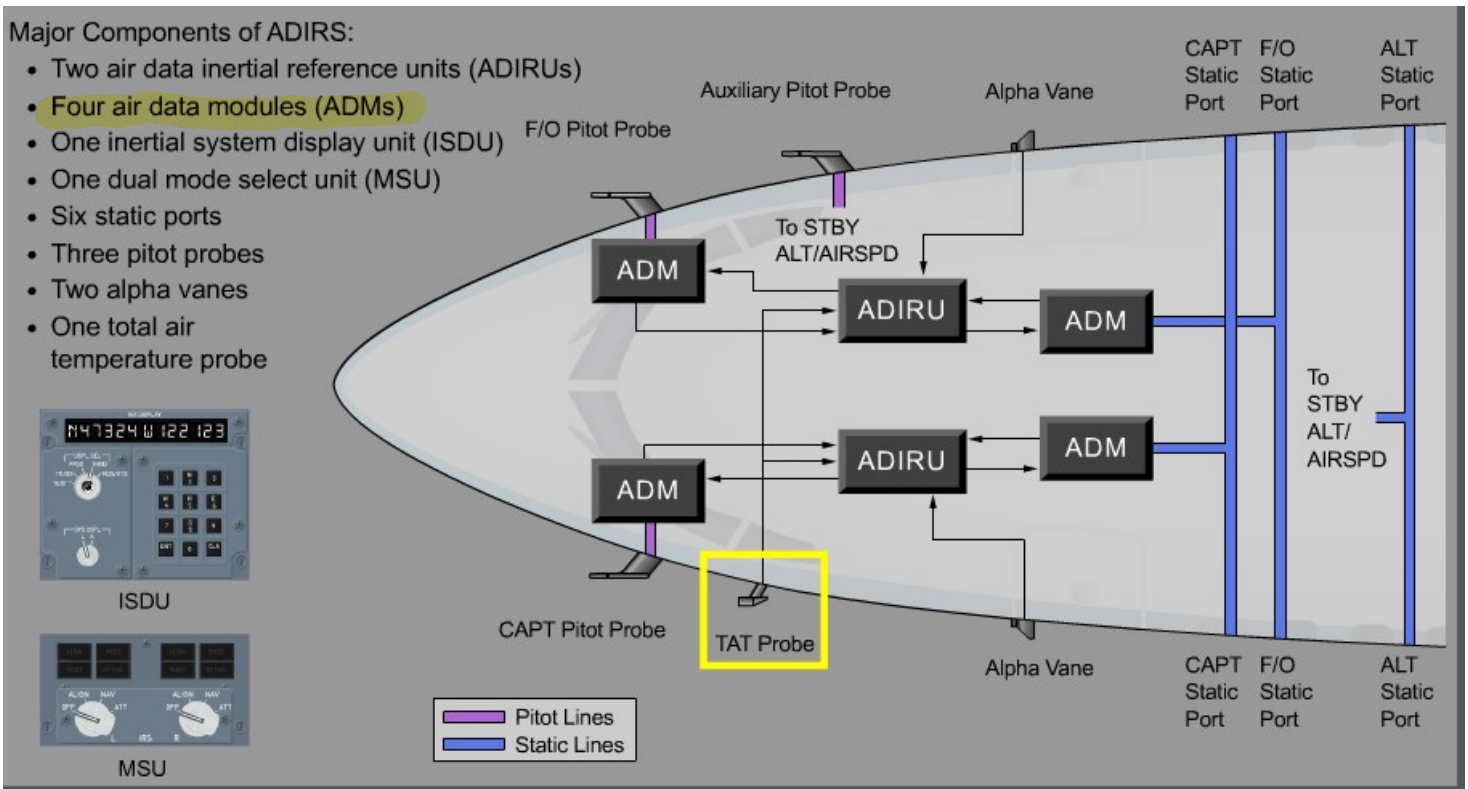
- Position
- Speed
- Altitude
- Attitude

Used by:

- Flight displays
- FMC
- Flight and engine controls
- All other system requiring inertial and air data

Major Components of ADIRS:

- 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



ADIRUs (air data inertial reference units)

ADIRUs provide:

- Inertial position and track to FMC
- Attitude, altitude and airspeed to DUs

Pitot-static system

Pitot-static system is composed by:

- **3 separate Pitot probes**
- **6 static ports**

2 Pitot probes (Cpt. And F/O) and 4 static ports (Cpt. And F/O) interface with ADMs

1 Pitot probe (auxiliary) and 2 static ports (auxiliary) provide information to standby instruments

ADM (air data modules)

Air data modules convert pneumatic pressure into electrical signals for ADIRUs.

Each ADM is connected to his on-side Pitot, there is no cross-connection

Alpha vanes

2 alpha vanes are provided, one on each side of the forward fuselage. Alpha vanes measure angle of attack and send angle of attack information to the respective ADIRU.

TAT probe

TAT probe provides TAT information to ADIRUs, TAT information is approximated and should not be used in lieu of OAT for takeoff performance calculation. SAT displayed on CDU progress page, comes from ADIRUs TAT information.

Primary flight display

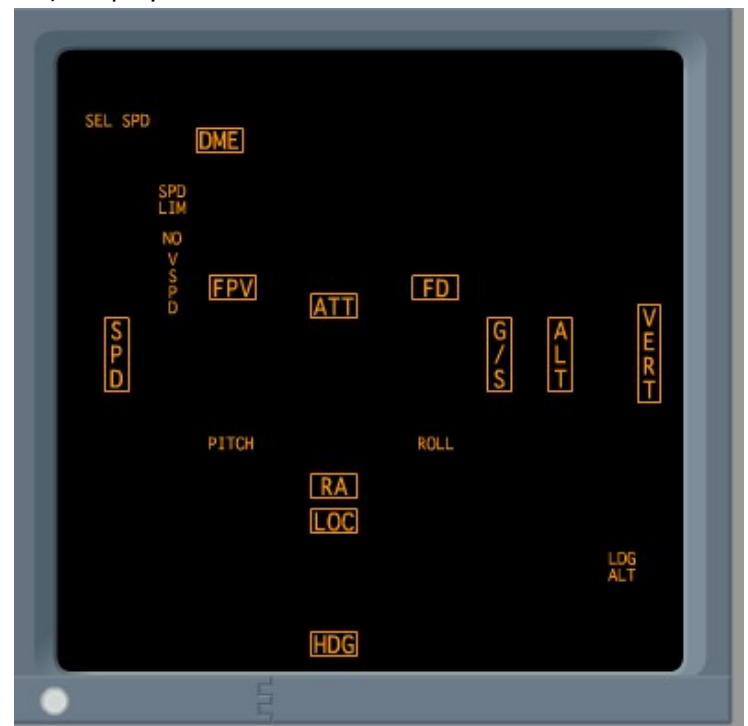
PFDs display all parameters necessary for flight path control.

Failure flags

Failure flags are displayed for system failures. Displayed information is removed or replaced by dashes if no info is available (because out of range of malfunctioning navigation aids). Displays are removed when a source fails or when no system source is available.

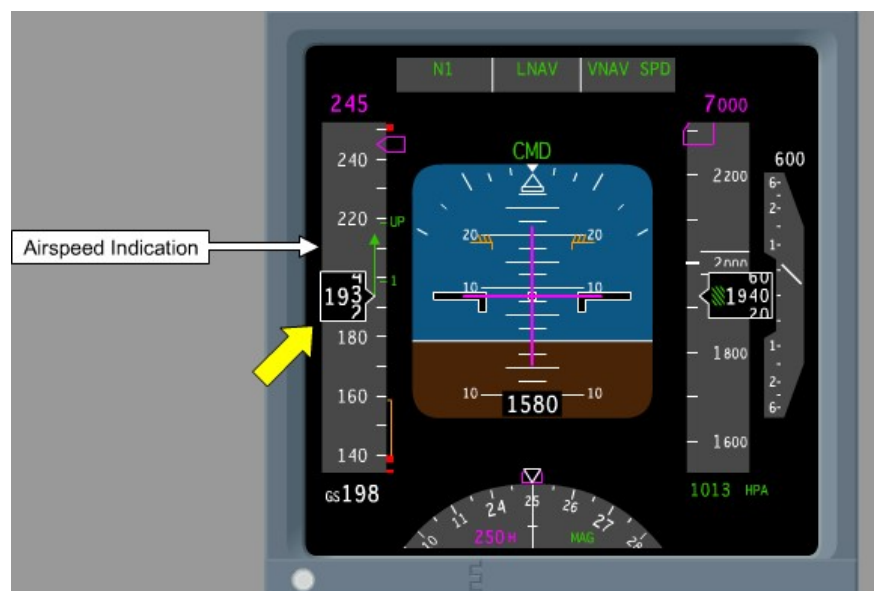
FMA (flight mode annunciator)

flight mode annunciations are displayed at the top of PFD.



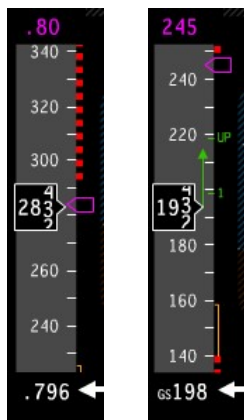
Airspeed/Mach indicator

Airspeed/Mach indicator display ADIRS and other system related airspeeds



Below the speed tape:

Above Mach .4 Mach is displayed
Below Mach .4 ground speed (GS) is displayed.



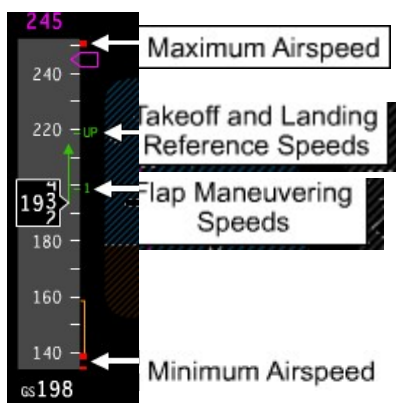
Airspeed vector shows predicted
airspeed in 10 seconds.

Selected airspeed is displayed
above the airspeed tape



- Takeoff V-speeds,
- landing reference speed
- flap manoeuvring speeds
- maximum/minimum speeds

are shown along the speed tape

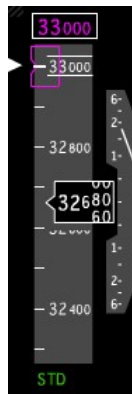


altitude indicator

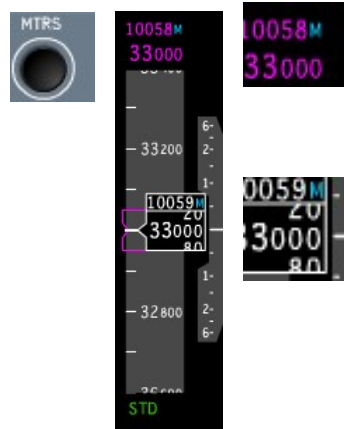
altitude indicator displays ADIRS
and other system related
information

selected altitude is shown above
altitude tape on a bug.

A white box appears approaching
selected altitude.



When MTRS is pushed on EFIS
control panel, current and
selected altitude in metres is
displayed above selected and
current altitude in ft.



Selected barometric approach
minimum is displayed with a
triangle and a line, when BARO is
selected.



Landing altitude reference bar is
displayed left to altitude tape,
indicates altitude above
touchdown:

- WHITE: 500 ft → 1000 ft
- AMBER: GND → 500 ft



Landing altitude is indicated as a
crosshatched area and indicates
FMC altitude for:

- DEST RWY
- DEP RWY: until 400 NM or half
distance (DEP-DEST) whichever
occur first

Current radio altitude is
displayed below altitude when
below 2500 ft, turns AMBER
below RA minima.

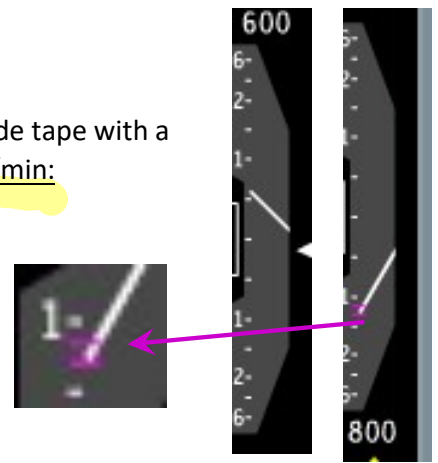


Vertical speed

Vertical speed indicator displays ADIRS instantaneous vertical speed right of the altitude tape with a pointer. Digital vertical speed readout is provided when vertical speed exceeds 400 ft/min:

- Above vertical speed tape when climbing
- Below vertical speed tape when descending

Selected vertical speed bug shows selected MCP vertical speed when V/S is selected.



Attitude

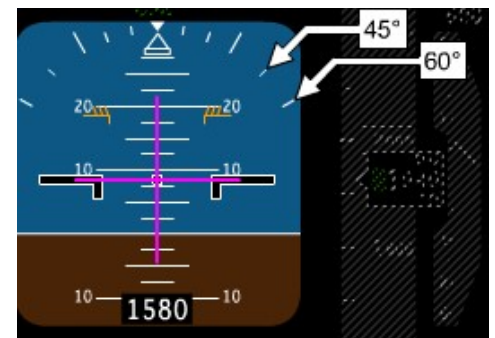
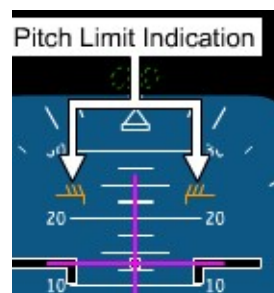
Attitude indicator displays ADIRS attitude.

Pitch scale is in 2.5° increments. A sky pointer indicates bank angles of: 10°, 20°, 30°, 45° and 60°.

A small rectangle below the sky pointer indicates slip and skid conditions.

Pitch limit indication are shown when:

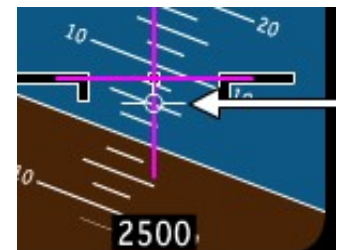
- are shown at all times when flaps are not up
- with flaps UP are shown when airspeed approaches stick shaker



flight director command bars are shown when associated F/D is ON

FPV (flight path vector) shows:

- FPA (flight path angle) [“bird”] vertically, relative to the horizon line
- Drift angle laterally, relative to pitch scale centre



FPV uses inertial and barometric altitude inputs.

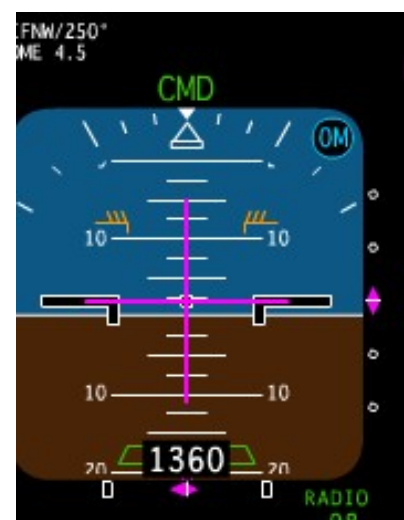
FPV is displayed when FPV is pushed on the EFIS control panel and is:

- DIM: when either F/D command bars or TCAS RA is displayed
- BRIGHT: when F/D is OFF and no TCAS RA

ILS

ILS indicator displays:

- Localizer (LOC) and glide slope (G/D) deviation bars
- Frequency or identification / Course
- DME (if available)
- Marker beacon indication



Marker beacon marker are:

- OM (outer marker)
- MM (middle marker)
- IM (inner marker)



G/S pointer is displayed when:

- A valid signal is received
- Back-course is NOT detected (track and MCP difference is greater than 90°)

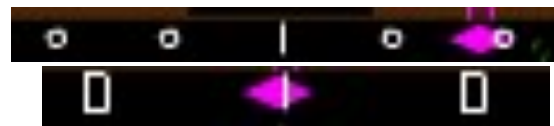
At low radio altitude with A/P engaged, G/S scale turns AMBER and pointer flashes to indicate an excessive G/S deviation



LOC pointer is displayed when a valid signal is received.

An expanded scale appear when

- course deviation is slightly more than ½ dot
- LOC engage
- Track is within $\pm 5^\circ$ of MCP course



LOC scale turns AMBER and pointer flashes if:

- At low radio altitude with A/P engaged to indicate excessive LOC deviation
- Below 1000 ft RA with LNAV engaged and LOC armed to indicate that the LOC has not been captured

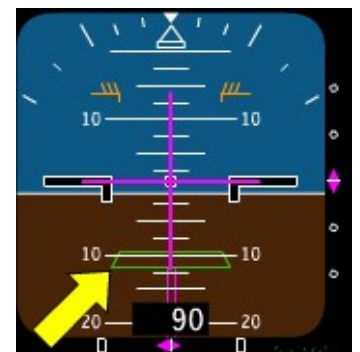


NOTE: each pilot deviation alerting system self-test, upon becoming armed at 1500 ft RA, generate a 2 seconds LOC and G/S deviation alerts on each attitude indicator.

(both LOC and G/S deviation scale turn AMBER and pointer flashes)

Rising runway

Below 2500 ft RA, with LOC pointer in view, rising runway symbol appear. At 200 ft RA, the symbol rises towards airplane symbol. Rising runway symbol is used to provide lateral guidance.



Minimum settings

Selected RADIO or BARO minimums are displayed near the bottom left of altitude tape



Heading and track

Heading and track indicator displays FMC ADIRS heading and track.

Current heading is displayed under a white triangular pointer.

MCP selected heading is displayed as a **magenta** bug and digitally on the left half of the compass rose.

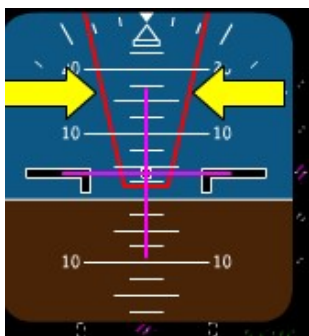
Heading reference, **MAG** or **TRU** is displayed on the right half of the compass rose.

A white line depicts current track.



TCAS RA

In case of a TCAS RA, a **RED** area to be avoided is displayed on attitude indicator

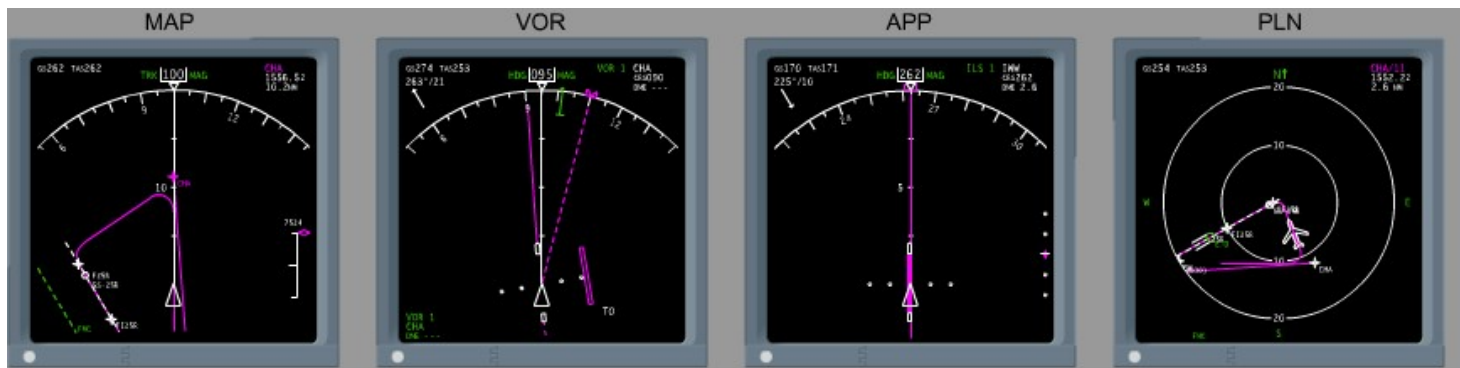


GPWS warning

In case of GPWS warning, **PULL UP** is displayed just below attitude indicator

Navigation display

Navigation display modes are: MAP, VOR, APP and PLN



MAP, VOR and APP can be switched between:

- Expanded mode with a partial compass rose
- Centred mode with a full compass rose



MAP mode

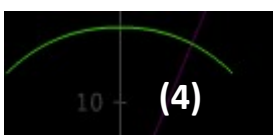
MAP mode shows airplane relative to the flight route against a moving background with TRK UP.

Displayed information include:

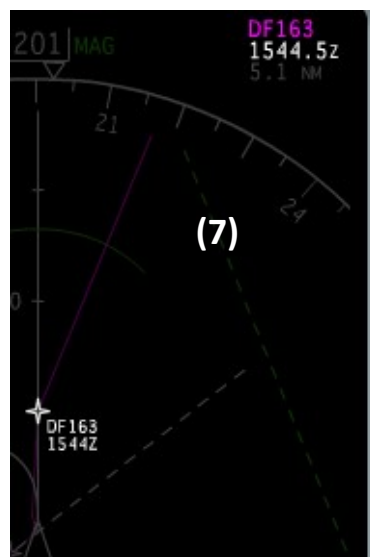
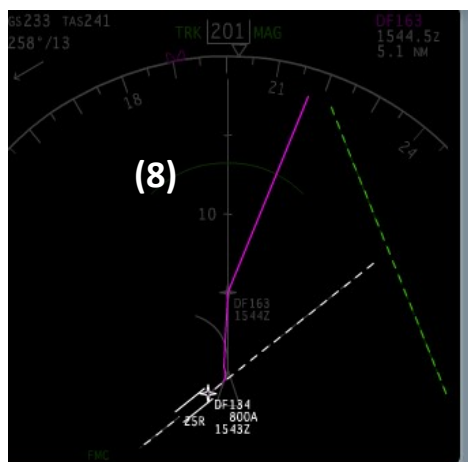
1. Current track
2. Selected and current heading



3. Position trend vector
4. Range to MCP altitude



5. MAP range scale
6. Ground speed (GS) / true airspeed (TAS)
Wind direction / wind speed
7. Next waypoint, distance, ETA
8. Selected navigation data points

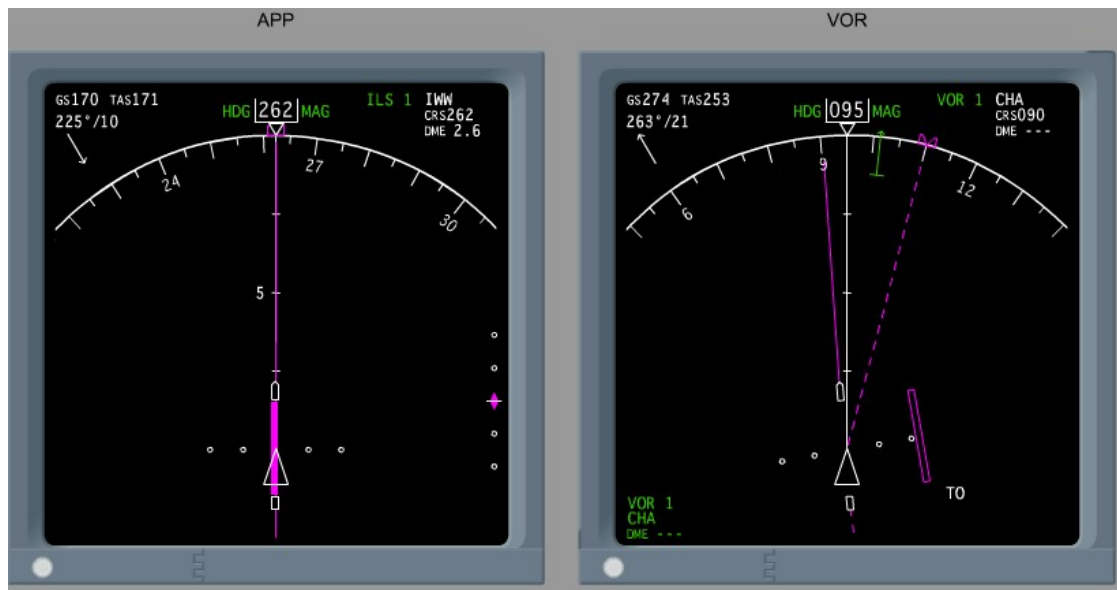


Additional navigation facility, waypoint, airport, route progress and position data are available in both expanded and MAP CTR mode.



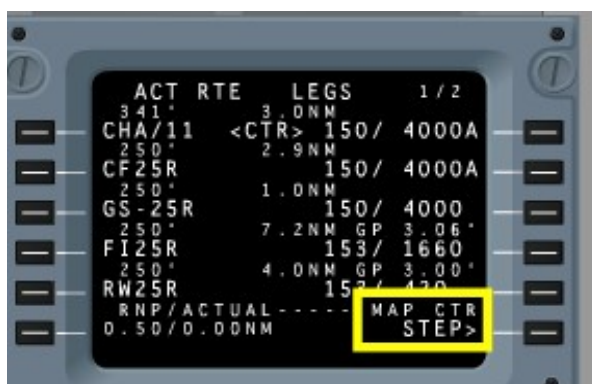
VOR and APP mode

VOR and APP modes are presented HDG UP. VOR and APP display track, heading and wind speed and direction.



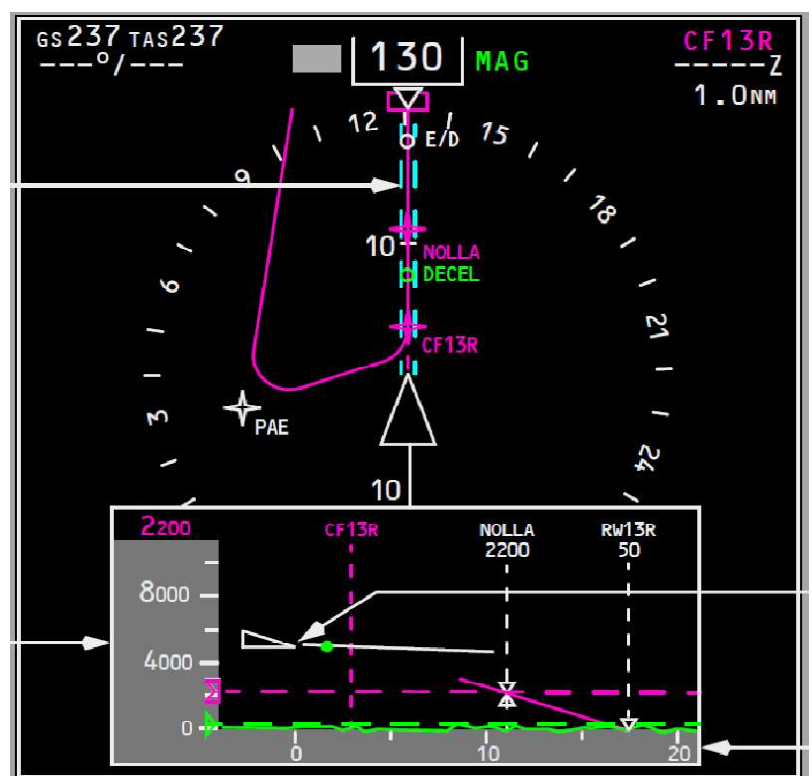
PLN mode

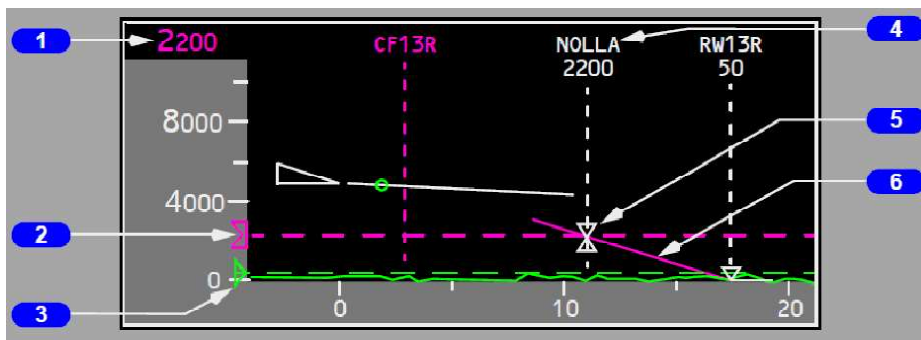
PLN mode is presented true north UP. In PLN mode, active route may be viewed using the step prompt on CDU LEGS pages.



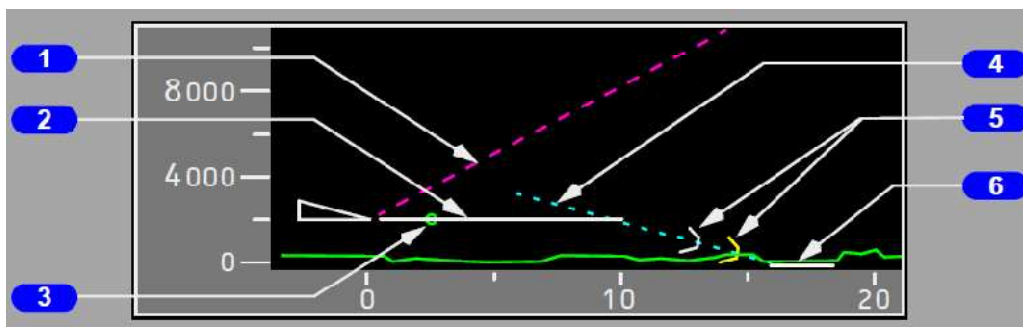
VSD (vertical situation display)

The VSD represents a profile view of the aircraft and its environment along with the current track. Information shown within the cyan dashed lines (en-route corridor on ND) is shown in profile on the VSD.

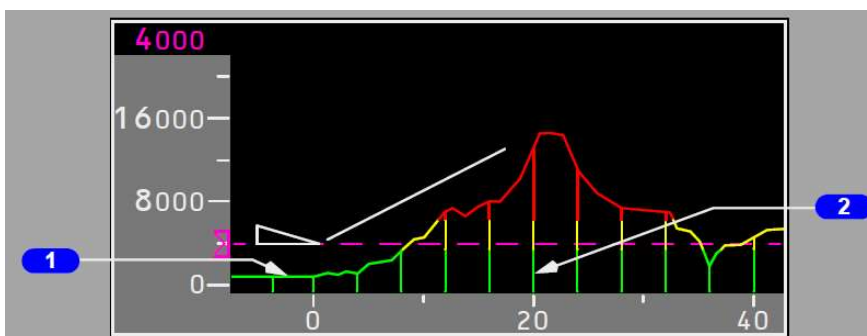




- (1) MCP selected altitude
- (2) MCP altitude bug
- (3) BARO minimum, turns **AMBER** when descending below. If RADIO minimum is selected only the pointer displays
- (4) Waypoint name and altitude constrain
- (5) Constrain symbol
- (6) FMC approach glide path angle, extends to 10 NM



- (1) MCP selected V/S
- (2) Vertical flight path vector, length fixed at half VSD range
- (3) Range to target speed:
 - Dot is blanked within 5 Kts of target speed
 - Do not reappears if speed increase 10 Kts faster than target speed
 - Replaced with an unfilled dot at vector end if target speed will not be achieved within length of flight path vector line.
- (4) Degree reference line, displayed for approaches that do not have a designated approach angle, extends for 10 NM, is for reference only
- (5) Decision gates, displayed on FMC approach glide path of 3° at 1000 ft and 500 ft AGL
- (6) Runway



- (1) Terrain profile line, represent the highest obstacle in the en-route corridor. Same colour code of GPWS terrain is used:
- GREEN: terrain is more than 500 ft below airplane (*250 ft when gear is down)
 - AMBER: terrain is between *500 ft below to 2000 ft above airplane
 - RED: terrain is more than 2000 ft above the airplane

ND inputs

Inputs to ND are:

- Heading: from FMC or ADIRS
- Track: from FMC during normal operation
- Traffic information: from TCAS
- Weather information: from AWR (airborne weather radar)

NOTE: compass rose can be referenced to magnetic or true north

Failure flags

Failure flags are displayed for system failure or invalid information. Indication are removed or replaced by dashes when source system information is not available.

“EXCESS DATA” is displayed when the amount of information exceeds ND capability. When this occurs, primary display system removes information from the outer edge of the display.

“EXCESS DATA” can be removed by:

- Reducing information
- Reducing ND range
- Deselecting one or more MAP modes EFIS control panel

Colour code

WHITE = present status and range scales

GREEN = dynamic conditions

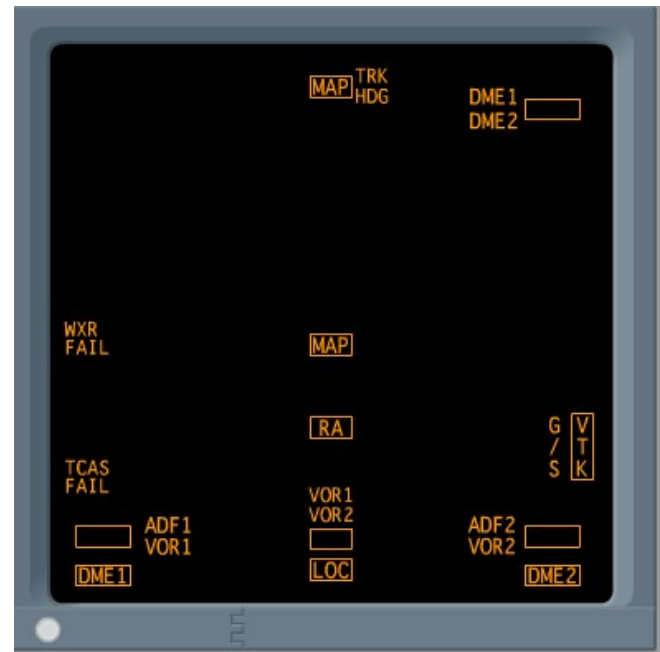
MAGENTA = command information, pointers, symbols and fly conditions

CYAN = non-active or background information

AMBER = caution, faults and/or flags

RED = warnings

BLACK = blank area or OFF condition



FLIGHT INSTRUMENTS – NORMAL PROCEDURE

EFIS control panel

EFIS control panel controls display options, mode and range for the related pilot DU.

MINS selector

Outer knob:

- RADIO: select radio altitude (RA) as minimums reference
- BARO: select barometric altitude as minimums reference

Inner knob: adjust the minima value

RST button: when pushed resets the alerts, the alert annunciation and blanks minimum display if an alert is not active



FPV (flight path vector) button

Display/remove FPV symbol on attitude indicator



MTRS button

Display/remove metres displays

BARO selector

Outer knob:

- IN: selects in/Hg as barometric reference
- HPA: select hPa as barometric reference

Inner knob: adjust barometric settings

STD button: set STD pressure / set preselected barometric setting



VOR/ADF switch

OFF: removes VOR/ADF display

VOR: displays selected VOR (1 or 2) bearing pointer, frequency or identification and DME

ADF: display selected ADF pointer and ADF frequency or identification

NOTE: information is displayed in all modes except PLN



Range selector

Outer knob: select range in NM for the available modes

TFC (traffic) button: displays TCAS info on ND



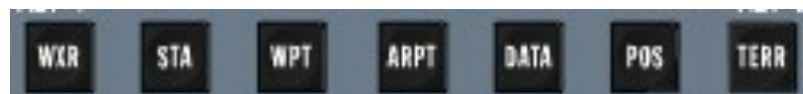
Mode selector

Rotating the outer knob desired display mode can be selected:



- APP: displays LOC and G/S, ILS receiver frequency or identification, ILS course and DME in a heading up format. TFC and WXR are not displayed in APP CTR
- VOR: displays VOR TO/FROM information, VOR frequency or identification, VOR course and DME in a heading up format
- MAP: displays FMC generated route and MAP information, aircraft position and track, waypoint (including active waypoint) within selected range, VNAV path deviation in a track up format.
- PLN: is a non-moving, true north up, route depiction. It allow route step through using CDU LEGS pages. WXR and TFC are not displayed.

CTR button: display full compass rose for APP, VOR and MAP. Subsequent pushes alternate between expanded and centre display.



MAP buttons

MAP buttons are used to add/remove background data and/or symbols to MAP and MAP CTR modes. Displays can be selected simultaneously:

- WXR: energises AWR and displays weather radar returns in:
 - i. MAP and MAP CTR
 - ii. Expanded VOR
 - iii. Expanded APP

NOTE: weather returns are limited to 320 NM

- STA: display FMC database:
 - i. Navigation aids on 5, 10, 20, 40 NM range only
 - ii. High altitude navigation aids on 80, 160, 320, 640 NM range only
- WPT: display FMC database waypoint which are not in the flight plan route on 5, 10, 20 and 40 NM range
- ARPT: displays all viewable airports stored in FMC database viewable in MAP area
- DATA: displays altitude constrain and ETA for each active route waypoint visible on active route
- POS: displays IRS and GPS position and VOR bearing vectors extended from the airplane to the station
- TERR: displays GPWS generated terrain in MAP, MAP CTR, VOR and APP modes

Source select panel

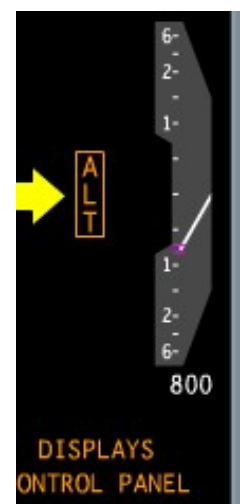
CONTROL PANEL switch

- NORMAL (spring loaded):
 - i. Left EFIS control panel controls Cpt. DUs
 - ii. Right EFIS control panel controls F/O DUs
- BOTH ON 1/BOTH ON 2: both Cpt. And F/O DUs are controlled by a single EFIS control panel



"DISPLAYS CONTROL PANEL" appear when CONTROL PANEL switch NORMAL on PFD to indicate a failure of the relative EFIS control panel, altitude information is removed

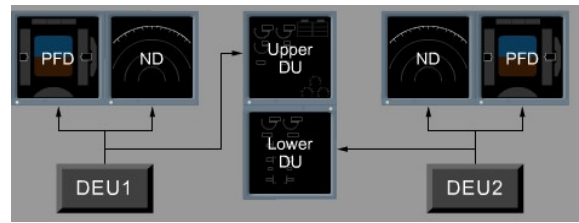
≠ DISPLAY SOURCE



SOURCE selector

SOURCE selector provides EFIS source control and DEUs (display electronic units) source control.

NOTE: 2 DEUs receive data from sensors and systems, then supply these data to DUs

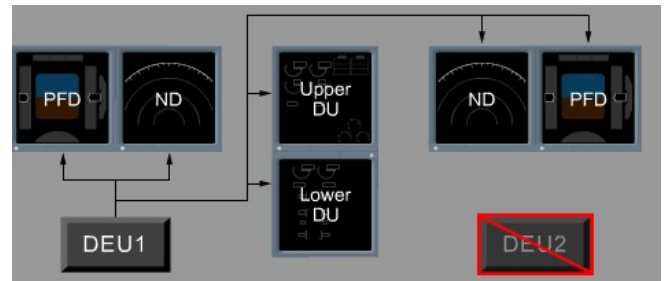


AUTO:

- DEU 1 supply data to Cpt. PFD/ND and upper DU
- DEU 2 supply data to F/O PFD/ND and lower DU

If a DEU fails, the remaining DEU automatically supply all 6 DUs

NOTE: since each DEU receives data from both ADIRUs, a single DEU failure will continue to supply each pilot with flight instrument information from independent sources.



ALL ON 1 / ALL ON 2: are used on ground for maintenance purpose, all manual selection of either DEU for all 6 DUs

"DSPLY SOURCE" appear on PFD if the display are manually or automatically switched to a single DEU



Display select panels

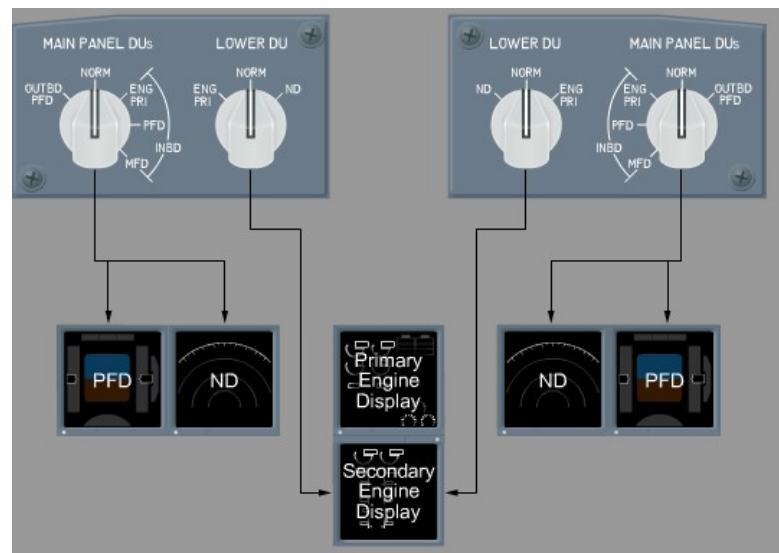
Display source panel control display on inboard, outboard and lower DUs.

NORM (normal operation)

- Both OUTBD on PFD
- Both INBD on ND
- Upper DU on primary engine indication
- Lower DU on secondary engine indication

NOTE: in NORM position all critical information remains available to all pilot at all time:

- OUTBD DU failure: PFD moves automatically to INBD DU (OUTBD blanks)
- OUTBD/INBD selector no longer has control on this DU
- Upper DU failure: primary engine indications automatically moves to lower DU

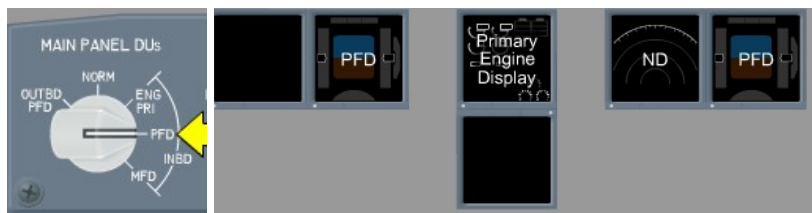
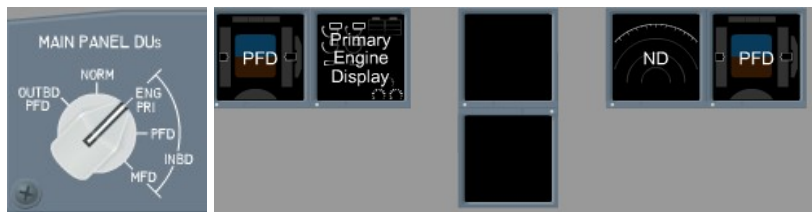
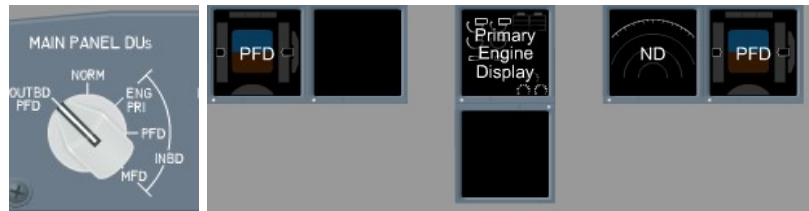


MAIN PANEL DUs selector

MAIN PANEL DUs selector is available in case of undetected malfunction.

		Outboard DU	Inboard DU
INBD	NORM	PFD	ND
	OUTBD PFD	PFD	BLANK
	ENG PRI	PFD	PRIMARY ENGINE INDICATION
	PFD	BLANK	PFD
	MFD	PFD	BLANK* SYS or ENG*

*stay BLANK until SYS or ENG is selected on MFD engine control panel



LOWER DU selector

NORM: lower DU is normally blank or displays MFD format selected (SYS or ENG)

ENG PRI: blanks upper DU, primary engine indications moves to lower DU

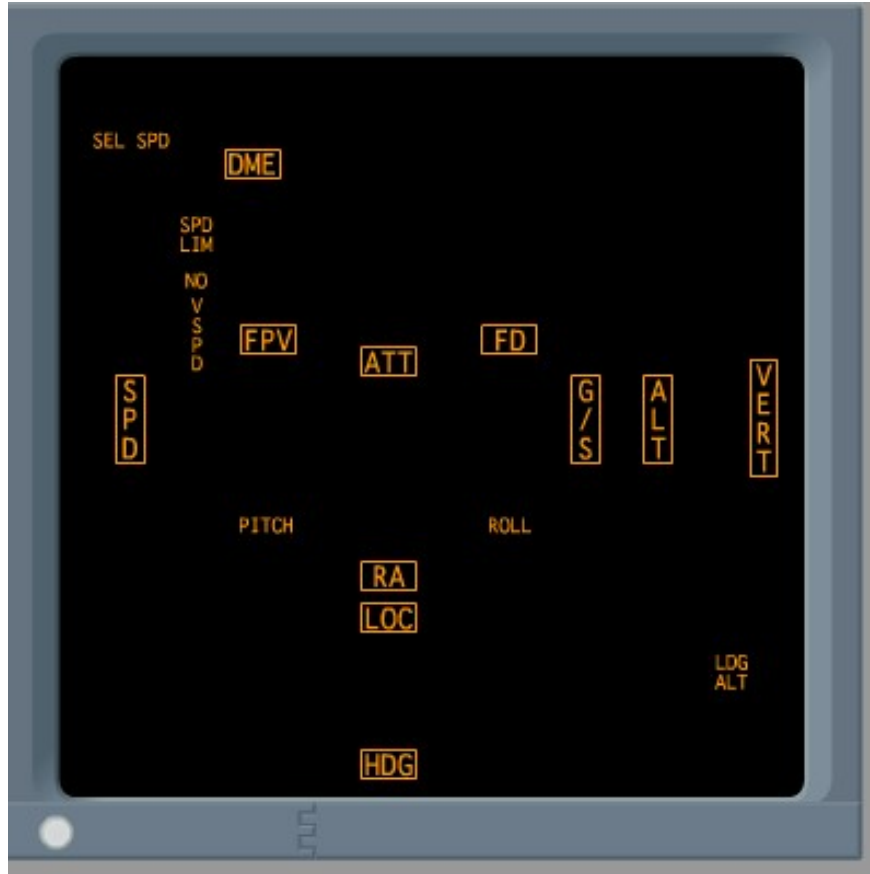
ND: ND shows on lower DU



FLIGHT INSTRUMENTS – NON-NORMAL OPERATION

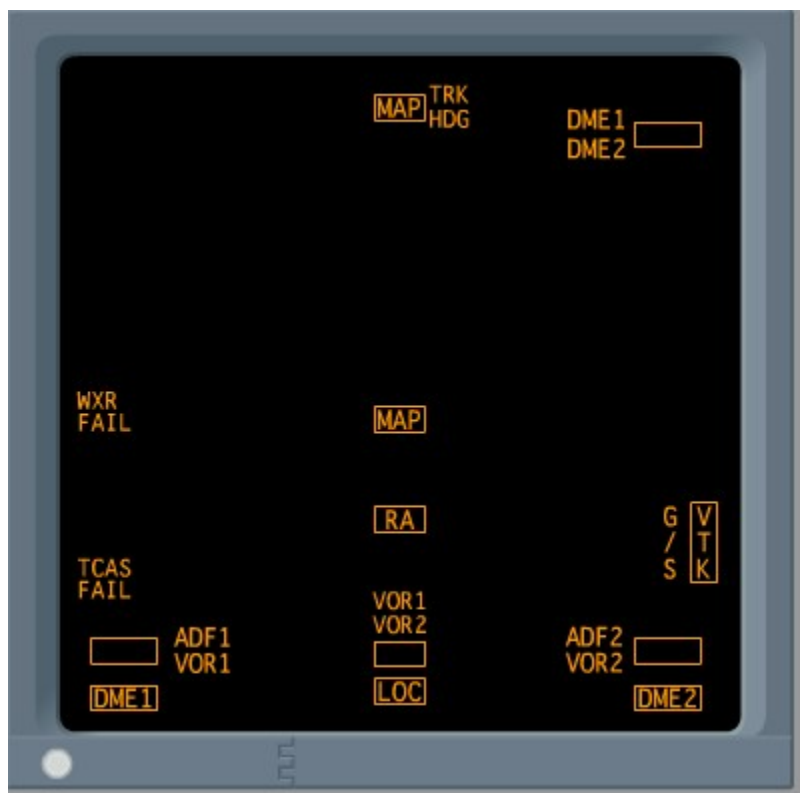
PFD and ND failure indications and flags

PFD failure flags



- "DME": DME system has failed
- "SEL SPD": selected airspeed data is invalid
- "SPD LIM": stick shaker and/or maximum airspeed displays have failed (RED bar is removed from PFD)
- "SPD": speed indication inoperative (airspeed tape is removed)
- "PITCH" (flash 10 sec. then steady): Cpt. And F/O pitch displays differ by more than 5°
- "ROLL" (flash 10 sec. then steady): Cpt. And F/O roll displays differ by more than 5°
- "RA": radio altitude has failed
- "LOC": ILS frequency is tuned, but localiser deviation display has failed
- "G/S": ILS frequency is tuned, but G/S deviation display has failed
- "HDG": heading information has failed
- "FPV": FPV selected but has failed (de-selection of FPV removes the flag)
- "FD": flight director has failed
- "ALT": altitude has failed (altitude tape is removed)
- "VERT": vertical speed has failed (vertical speed tape is removed)
- "ATT": attitude has failed (attitude indicator is removed)
- "LDG ALT": landing altitude is not available or is invalid
- "NO VSPD": V-speeds (V1 and VR) are not valid or set below 80 Kts
- "AOA DISAGREE": left and right alpha vanes information have disagreed more than 10° for more than 10 sec.
- "DSPLY SOURCE": a single DEU is supplying all 6 DUs
- "CDS MAINT": dispatch-able CDS fault has occurred (*appear only on ground prior to start the second engine)
- "CDS FAULT": non-dispatch-able CDS fault has occurred, *
- "INSTR SWITCH": both Cpt. And F/O DUs are using the same IRS source (appear when IRS switch not in NORMAL)
- "ALT DISAGREE": Cpt. And F/O altitude indication have disagreed more than 200 ft for more than 5 sec.
- "IAS DISAGREE": Cpt. And F/O airspeed indication have disagreed more than 5 Kts for more than 5 sec.

ND failure flags



- "EXCESS DATA": too great amount of information sent to ND
- "MAP RANGE DISAGREE": selected range is different from MAP displayed range
- "WXR RANGE DISAGREE": selected range is different from WXR displayed range
- "MAP/WXR RANGE DISAGREE": selected range is different from WXR and MAP displayed range
- "EFIS MODE/NAV FREQ DISAGREE": APP is selected with a VOR frequency tuned and vice-versa
- "TERR FAIL": look-ahead alerting and display have failed
- "TERR POS": look-ahead alerting and display unavailable due to position uncertainty
- "TERR INHIBIT": GPWS switch is in TERRAIN INHIBIT position
- "TERR RANGE DISAGREE": terrain display is enabled, terrain range disagree with selected range
- "MAP/TERR RANGE DISAGREE": terrain display is enabled, terrain and MAP range disagree with selected range
- "PWS FAIL": predictive windshear alerting and display have failed

Flight instruments

Airspeed unreliable (QRH 10.1)

Airspeed Unreliable

Condition: Airspeed or Mach indications are suspected to be unreliable. (Items which might indicate unreliable airspeed are listed in the Additional Information section.)

Objective: To identify a reliable airspeed indication, if possible, or to continue the flight using the Flight With Unreliable Airspeed table in the Performance Inflight chapter.

10 Choose one:

◆ **Captain's or First Officer's** airspeed indication is **reliable**:

▶▶ Go to step 11

◆ **Only the standby airspeed** indication is **reliable**:

Note: Do not re-engage the autothrottle.

▶▶ Go to step 16

11 Flight director switch (reliable side) ON

12 Autopilot (reliable side) Engage

13 Transponder selector. Select reliable side

Note: Do not re-engage the autothrottle.

▶▶ Go to step 16

14 Set pitch attitude and thrust from the Flight With Unreliable Airspeed table in the Performance Inflight chapter for the airplane configuration and phase of flight, as needed.

Note: Maintain visual conditions if possible.

Establish landing configuration early.

Radio altitude reference is available below 2,500 feet.

Use electronic and visual glideslope indicators, where available, for approach and landing.

Do not use TO/GA for a go-around or missed approach.

15 Transponder mode selector TA

16 Choose one:

◆ Altitude is **reliable**:

■ ■ ■ ■

◆ Altitude is **unreliable**:

Transponder mode

selector ALT OFF

■ ■ ■ ■

Additional Information

One or more of the following may be evidence of unreliable airspeed or Mach indications:

- Speed/altitude information not consistent with pitch attitude and thrust setting
- SPD failure flag
- SPD LIM failure flag
- IAS DISAGREE alert
- Blank or fluctuating airspeed display
- Variation between captain and first officer airspeed displays
- Radome damage or loss
- Overspeed warning
- Simultaneous overspeed and stall warnings.

1 Autopilot (if engaged) Disengage

2 Autothrottle (if engaged) Disengage

3 F/D switches (both) OFF

4 Set the following gear up pitch attitude and thrust:

Flaps extended 10° and 80% N1

Flaps up 4° and 75% N1

5 PROBE HEAT switches Check ON

6 The following are **reliable**:

Attitude

N1

Ground speed

Radio altitude

Note: Stick shaker, overspeed warning and AIRSPEED LOW (as installed) alerts may sound erroneously or simultaneously.

Note: The Flight Path Vector and Pitch Limit Indicator may be unreliable.

7 Refer to the Flight With Unreliable Airspeed table in the Performance Inflight chapter and set the pitch attitude and thrust setting for the current airplane configuration and phase of flight.

8 When in trim and stabilized, cross check the captain, first officer and standby airspeed indicators. An airspeed indication that differs by more than 20 knots or 0.03 Mach from the airspeed shown in the table should be considered **unreliable**.

9 Choose one:

◆ Reliable airspeed indication can be **determined**:

Use the most reliable airspeed source for the remainder of the flight.

▶▶ Go to step 10

◆ Reliable airspeed indication can **not** be determined:

▶▶ Go to step 14

"ALT DISAGREE" (QRH 10.6)

ALT DISAGREE

Condition: The ALT DISAGREE alert indicates the captain's and first officer's altitude indications disagree by more than 200 feet.

- 1 Check all altimeters are set to correct barometric setting for phase of flight.
- 2 Choose one:
 - ◆ ALT DISAGREE alert **extinguishes**:
Continue normal operation.
■ ■ ■ ■
 - ◆ ALT DISAGREE alert **stays illuminated**:
▶▶ Go to step 3
- 3 Airplane does not meet RVSM airspace requirements.
- 4 Standby altimeter is available.
- 5 Transponder altitude received by ATC may be unreliable.
- 6 Do **not** use the flight path vector.
- 7 Maintain visual conditions if possible.
- 8 **Checklist Complete Except Deferred Items**

AUTOMATIC FLIGHT – SYSTEM DESCRIPTION

Overview

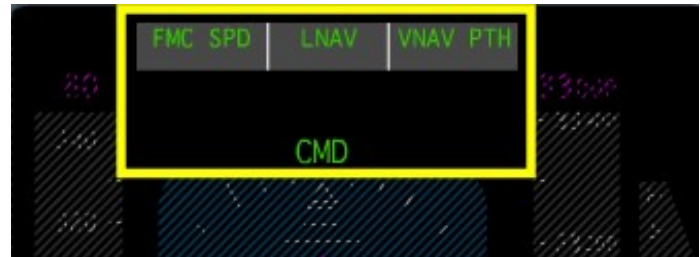
The automatic flight system (AFS) consist of the autopilot flight director system (AFDS) and the auto-throttle (A/T).

AFDS and A/T are controlled by the MCP (mode control panel) and FMC (flight management computer)

The FMC provides:

- N1 limit
- Target N1
- Command airspeed for A/T
- Command airspeed for AFDS

AFS mode status is displayed on each pilot's PFD.



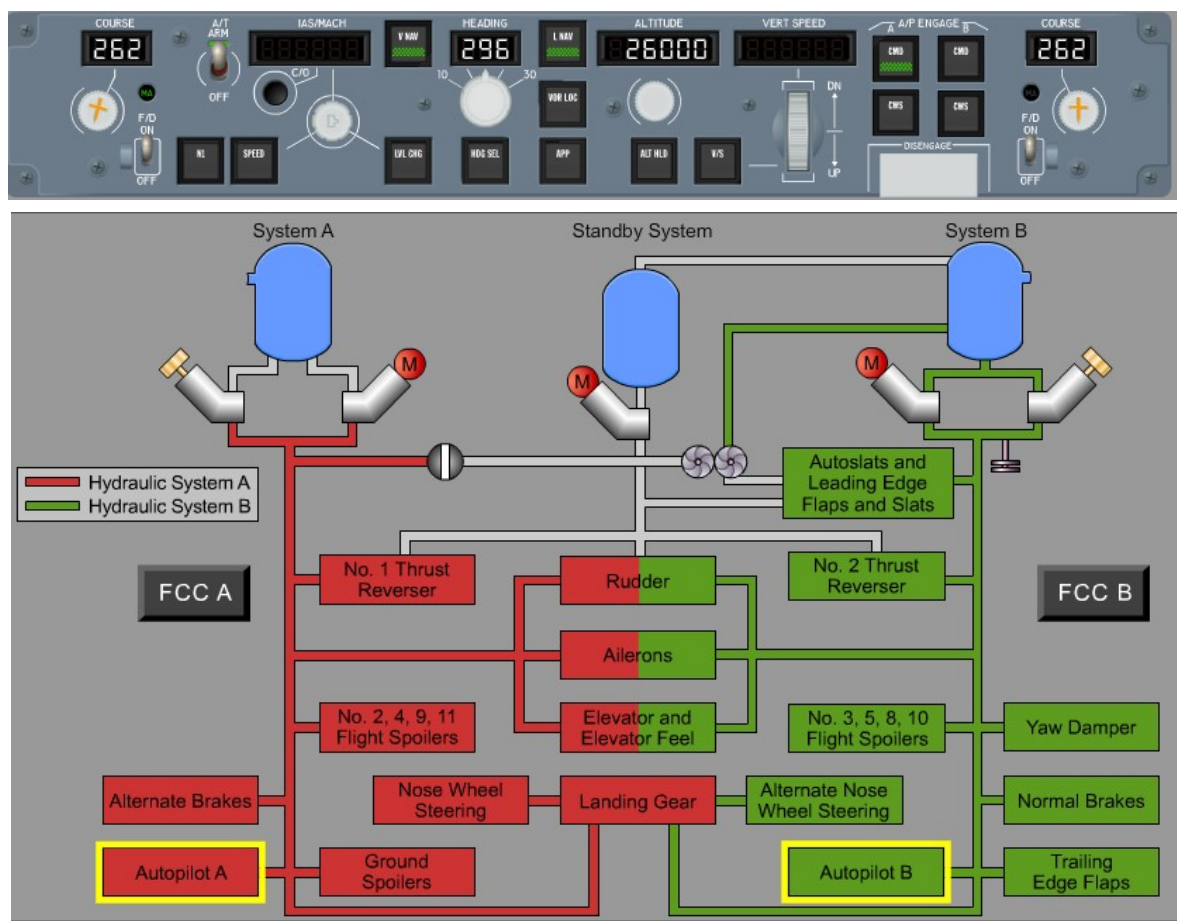
AFDS (autopilot flight director system)

General operation

The AFDS is a dual system, consisting of 2 individual FCC (flight control computer) and a single MCP.

FCC-A and FCC-B send control commands to their respective pitch and roll hydraulic servos, which operates the flight control through 2 separate hydraulic system (A and B).

For F/D (flight director) operation, each FCC position the F/D command bars on the respective attitude indicator.



MCP mode engagement/disengagement

MCP switches are pushed to select desired command modes for AFDS and A/T. the switch illuminate to indicate mode selection, 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
- Disengaging A/P (auto-pilot)
- **Turning F/D OFF**

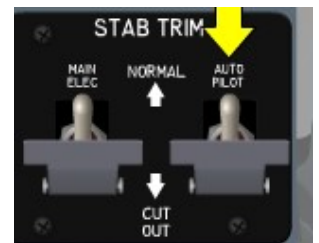


A/P engagement

Each autopilot can be engaged by pushing a separate CMD (commanded) or CWS (control wheel steering) switch.

A/P engagement in CMD or CWS is possible when:

- No force is being applied to the control wheel, and
- The STAB TRIM AUTOPILOT CUTOUT switch is at NORMAL



Only one A/P can be engaged at a time, unless the APP (approach) mode is engaged, which allows dual A/P approach operation.

Dual A/P operation provide control through landing flare and touchdown or automatic go-around.

Single A/P operation cannot provide full automatic flare, touchdown and go-around.



A/P disengagement

The A/P automatically disengages when either of the following occurs:

- A/P disengage switch is pushed
- Pushing an illuminated A/P ENGAGE switch
- Pushing A/P DISENGAGE bar down
- Pushing either TO/GA (takeoff/go-around) switch with a single A/P engaged in CMD or CWS:
 - Above 2000 ft RA with flaps not UP or G/S (glideslope) engaged, or
 - Below 2000 ft RA, or
 - Flaps not UP, or
 - G/S engaged
- Pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD
- Activating either pilot's control wheel trim switch
- Moving the STAB TRIM AUTOPILOT CUTOUT switch to CUTOUT
- Column or wheel force override (with a single A/P engaged CMD, AFDS system will maintain F/D bars)
- Either IRS (L or R) system fails or "FAULT" light illuminated
- Loss of electrical power or a sensor inputs prevent proper A/P operation
Re-engagement is possible after power is restored, for dual A/P operation both GEN must power the busses
- Loss of respective hydraulic system pressure
(loss of ENG 1 pump, and heavy demand on system A, may cause A/P to disengage)
- 2 radio altimeter provide independent RA to respective FCC, failure of a radio altimeter will disconnect A/P 2 seconds after LOC and G/S capture.

Flight director

Turning a F/D switch ON displays command bars on the respective pilot PFD if command pitch and roll modes are engaged. F/D can be operated with or without A/P or A/T engaged. F/D can be used with CWS engaged.

FD operates in the same command modes as A/P, except:

- Takeoff mode is a F/D only mode
- Dual F/D is available for single engine operation
- F/D has **no landing flare capability (F/D command bars disappear at 50 ft RA on an ILS approach)**

Normally FCC-A drives captain command bars and FCC-B commands first officer bars.



With both F/D ON, the logic for both pilot's F/D modes is controlled by the master FCC and both FMA (flight mode annunciator) show the same status.

Master FCC is indicated by illumination of the respective "MA" F/D light. Master FCC is determined according to:

- If no A/P in CMD: master FCC is the for the first F/D turned ON
- One or both A/P in CMD: master FCC is for the first A/P turned to CMD (regardless of F/D)

F/D modes are controlled directly from the respective FCC (**independent operation**) when neither A/P in CMD, both F/D are ON and:

- APP mode engaged with LOC and G/S captured, or
- GA mode engaged and below 400 ft RA, or
- TO mode engaged and below 400 ft RA

• APP mode
• TO/GA < 400ft

Independent F/D operation is indicated by both "MA" illuminated, when independent operation terminates, "MA" is extinguished on the slaved side.

If a generator is lost during F/D TO or GA, or during dual F/D approach and below 800 ft RA, the FCC on the unaffected side positions command bars on both attitude indicator, affected side "MA" is extinguished.



AFDS status annunciation

AFDS status is displayed between attitude indicator and FMA. Annunciation are:

- "CMD": one or both A/P is engaged in CMD
- "FD": F/D is ON and A/P is either OFF or in CWS
- "CWS P": pitch CWS engaged
- "CWS R": roll CWS engaged
- "SINGLE CH": displayed:
 - i. for single A/P ILS approaches, appear after LOC capture and remains for entire approach
 - ii. for dual A/P ILS approach, annunciates after LOC capture and extinguish after pitch monitor confidence test is successfully completed



CWS (control wheel steering)

Engaging CWS modes engages A/P pitch and roll axes in CWS mode. In CWS, the A/P takes as target parameters the existing attitude by the time control pressure is released from wheel/column.

If aileron pressure is released with 6° or less bank, CWS rolls wing level and hold present heading. This heading hold feature is inhibited:

- Below 1500 ft RA with landing gear down
- After F/D VOR capture with TAS 250 Kts or less
- After F/D LOC capture in APP mode



CWS P engaged with CMD

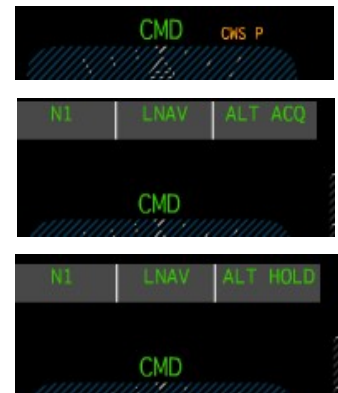
Pitch axis engage in CWS with roll axis in CMD when:

- A CMD pitch mode has not been selected or was deselected, or
 - A/P pitch has been manually overridden with column force
- *NOTE: manual pitch override is inhibited in approach with both A/P engaged

When approaching a selected altitude in CWS P with a CMD engaged, CWS P changes to ALT ACQ (altitude acquisition) and when at selected altitude ALT HOLD engages.

If pitch is overridden while in ALT HOLD, ALT HOLD changes to CWS P. if control force is released:

- Within 250 ft: CWS P changes to ALT ACQ, aircraft return to selected altitude
- More than 250 ft: CWS P remains engaged



CWS R engaged with CMD

Roll axis engages in CWS with pitch axis in CMD when:

- A CMD roll mode has not been selected or was deselected, or
- A/P roll has been manually overridden*

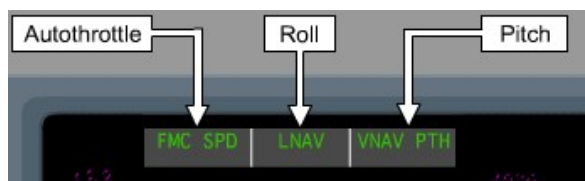
CWS R with a CMD engaged can be used to capture a selected radio course while VOR/LOC or APP is armed. Upon intercepting the radial or localiser, CWS R change to VOR/LOC engaged and A/P tracks selected course.



	CWS P / CMD	CWS R / CMD
Engages	- No CMD pitch - Manual override	- No CMD roll - Manual override
Approaching target	CWS P → ALT ACQ → ALT HOLD	CWS R / VOR/LOC or APP → VOR/LOC

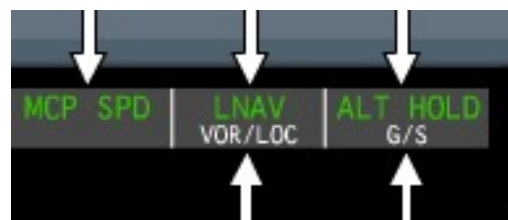
AFDS annunciation

FMA are displayed on PFD, from left to right the modes are: A/T modes, roll modes, pitch modes



Engaged mode are shown at the top in large GREEN letters

Armed mode are shown at the bottom in smaller WHITE letters



A/T modes

N1 = A/T is maintaining thrust at selected N1 limit displayed on thrust mode display, including full go-around limit

GA = A/T is maintaining thrust at reduced go-around setting

RETARD = A/T is moving thrust levers at aft stop (followed by ARM mode)

FMC SPD = A/T is maintaining FMC commanded speed (limited to N1 shown on thrust display)

MCP SPD = A/T is maintaining MCP speed set in IAS/MACH (limited to N1 shown on thrust display)

THR HLD = thrust lever servos are inhibited, pilot can move thrust levers manually

ARM = no A/T mode engaged, A/T switch ARM position:

- Thrust lever servos are inhibited, pilot can set thrust manually
- Minimum speed protection is provided

Pitch modes

TO/GA =

- For takeoff engages:
 - With both F/D ON prior starting takeoff: pressing either TO/GA button
 - With either F/D OFF:
 - Pressing either TO/GA button after 80 Kts IAS
 - Below 2000 ft RA
 - Prior to 150 seconds after lift-off
 - Then AFDS pitch commands:
 - 10° nose down until 60 Kts IAS
 - 15° nose down after 60 Kts until a sufficient ROC is acquired
 - MCP speed + 20 Kts then

- For go-around engages pushing either TO/GA button when:

- In-flight below 2000 ft RA
- In-flight above 2000 ft RA with flaps not UP or G/S captured
- Not in takeoff mode
- Either F/D ON or OFF

or below 2000 ft RA

NOTE: TO/GA engages in pitch mode only with dual A/P (see A/P disengagement)

- When engaged, F/D commands:
 - Roll to hold ground track and pitch to 15° nose up
 - After reaching a programmed ROC, pitch commands target airspeed for each flap setting, based on MTOW calculation

VNAV = VNAV is armed prior to takeoff

VNAV = VNAV is engaged by:

- pushing VNAV on MCP
- at 400 ft RA if armed prior to takeoff

With **VNAV** engaged, the FMC commands AFDS pitch and A/T to fly the vertical profile

VNAV SPD = AFDS maintain FMC speed displayed on: airspeed indicator and/or CDU

VNAV PTH = AFDS maintain FMC altitude or descent with pitch commands

V/S = armed by pushing V/S

V/S = engages moving the thumbwheel, AFDS commands pitch to hold selected V/S

ALT ACQ = indicates a transition manoeuvre entered automatically from V/S, LCL CHG or VNAV to MCP selected altitude. During VNAV transition, ALT ACQ engages but does not annunciate

ALT HOLD = AFDS commands pitch to hold MCP selected altitude or altitude at which ALT HOLD was pushed

MCP SPD = pitch commands to maintain the MCP speed shown in IAS/MACH

G/S = AFDS is armed for G/S capture

G/S = AFDS follows the ILS glideslope

FLARE = during dual A/P ILS approach, FLARE is armed and displayed after LOC and G/S capture below 1500 ft RA, the second A/P couples with flight controls and A/P go-around modes arms

FLARE = during dual A/P ILS approach, engages at 50 ft RA and accomplish autoland flare manoeuvre

Roll modes

LNAV = the AFDS is armed (prior to takeoff) to engage LNAV at 50 ft RA

LNAV = the AFDS intercept and tracks active FMC route:

- on any heading when within 3 NM of active route segment, or
- if outside:
 - aircraft is on an intercepting course of 90° or less, and
 - aircraft will intercept the route before the active waypoint

HDG SEL = aircraft is turning to or is on the MCP selected heading

VOR/LOC = AFDS is armed to capture VOR or LOC course

VOR/LOC = AFDS tracks the VOR course or LOC in-bound course

LVL CHG

During level change:

- climb: A/T hold limit thrust (**N1**) and AFDS hold selected airspeed (**MCP SPD**)
- descent: A/T hold idle thrust (**RETARD then ARM**) and AFDS hold selected airspeed (**MCP SPD**)

LVL CHG is inhibited after G/S capture

Autothrottle system

The A/T moves the thrust levers with separate servo motors, except while in the THR HLD and ARM modes.

The A/T operates properly with EECs ON or ALTN, in either case A/T uses the FMC N1 limit. During A/T operation, it is recommended to have both EECs ON or ALTN, as this produces minimum thrust lever separation



A/T engagement

The A/T ARM switch is located on the MCP:

- ARM (magnetically held): A/T is armed for engagement. A/T automatically engages when AFDS pitch modes engage, A/T engage in **N1** or **SPD** modes:
 - i. **LVL CHG** or **VNAV**:
 - a. in climb, A/T engages in **N1**
 - b. in descent, A/T engages in **RETARD** then **ARM** (when thrust at idle)
 - ii. **ALT ACQ** or **ALT HOLD**:
 - a. Not in VNAV, A/T engages in **MCP SPD**
 - b. In **VNAV**, A/T remains in **FMC SPD**
 - iii. Engagement of **G/S**, A/T engages in **MCP SPD**
 - iv. Alpha floor automatically engages the A/T when armed
- OFF: disengages A/T and prevent A/T engagement

A/T disengagement

Pushing either A/T disengage switches, disengage A/T, "**A/T**" flashes and A/T ARM switch trips OFF.

A/T disengages when:

- A/T ARM switch moved OFF
- Pushing either A/T disengage switches
- A/T system fault is detected
- 2 seconds have elapsed from touchdown ("A/T" do not flashes)

A/T disengage when operating in:

- SPD mode, or
- RETARD for descent mode, or
- N1 mode other than GA mode

AND

- Thrust levers become separated more than 10°, or
- Significant thrust difference along with control wheel roll input greater than 10°

AUTOMATIC FLIGHT – NORMAL OPERATION

MCP mode selection



Pushing a mode switch, engages the mode and illuminates the “GREEN” light. Pushing an engage mode switch, disengage the mode and extinguish the light.

When de-selection of an active mode is inhibited, the “GREEN” light is extinguished.

when engagement of a mode would conflict with current AFS operation, pushing the mode selector switch has no effect.

All AFDS can be disengaged by:

- Selecting another command mode
- Disengaging the A/P and both F/Ds OFF



Automatic flight takeoff and climb

Normal operation

Automatic flight takeoff is a F/D only function of TO/GA mode. A/P may be engaged after takeoff.

During automatic flight takeoff:

- A/T maintains takeoff N1 limit from FMC
- F/D commands bars are displayed
- Prior to takeoff:
 - Both F/D must be ON (FD on A/P status indication)
 - A/T must be ARM (ARM shows on A/T FMA)
- To engage takeoff mode:
 - Either TO/GA button must be pushed
- During takeoff:
- Below 60 Kts:
 - A/T is in N1, roll is engaged in HDG SEL, pitch command 10° nose down
 - Thrust levers advance until engines reach takeoff thrust
 - indication on FMA are: N1 / HDG SEL / TO/GA
- at 60 Kts: pitch commands 15° nose up
- at 84 Kts: A/T annunciates THR HLD
- at lift-off: pitch command 15° nose up, bank is limited to 8° below 400 ft RA and 10°-30° above 400 ft RA
- sufficient ROC is acquired: pitch commands MCP speed + 20 Kts
- at 800 ft RA: A/T FMA changes from THR HLD to ARM

- thrust reduction:
 - reduction to climb thrust can be made pushing N1 when **ARM** annunciates
 - automatically at thrust reduction altitude (set on CDU)
 - automatically when aircraft levels off in **ALT HOLD** or **VNAV PTH**

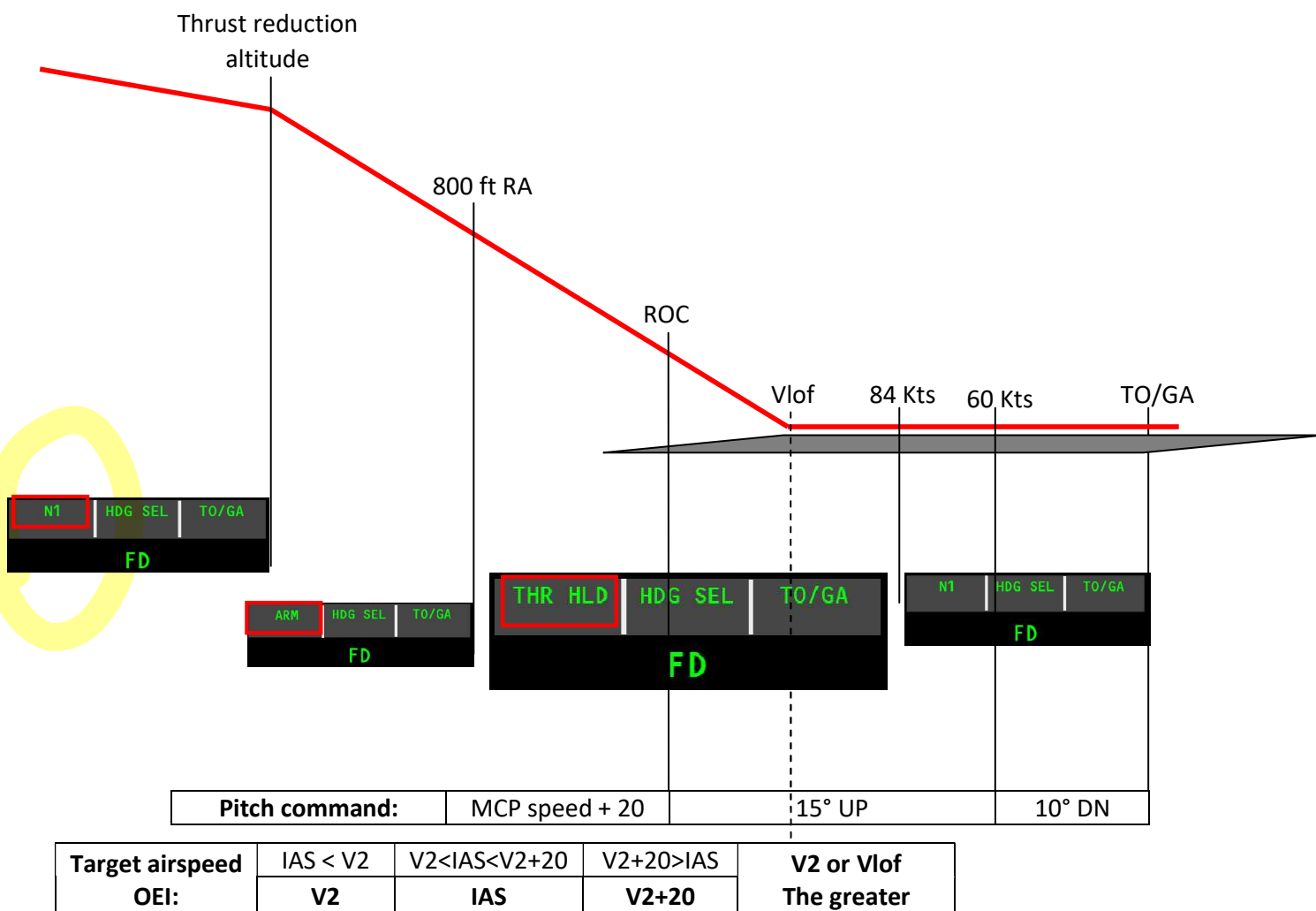
NOTE: a second press on TO/GA button during takeoff mode will adjust thrust limit and N1 bug to full GA thrust, but:

- below 800 ft RA: manual motion of thrust lever is required (THR HLD still engaged)
- above 800 ft RA: thrust levers advance to full GA thrust
- takeoff mode termination:
 - below 400 ft RA: turning both F/D OFF terminate takeoff mode
 - above 400 ft RA: selecting another pitch mode or engaging an A/P:
 - CMD replaces FD in the A/P status display
 - Pitch engages in LVL CHG (MCP SPD on FMA) unless another pitch mode is selected
 - MCP IAS/MACH and airspeed cursor change to $V_2 + 20$ Kts
 - Roll modes engages in HDG SEL, unless another mode is selected

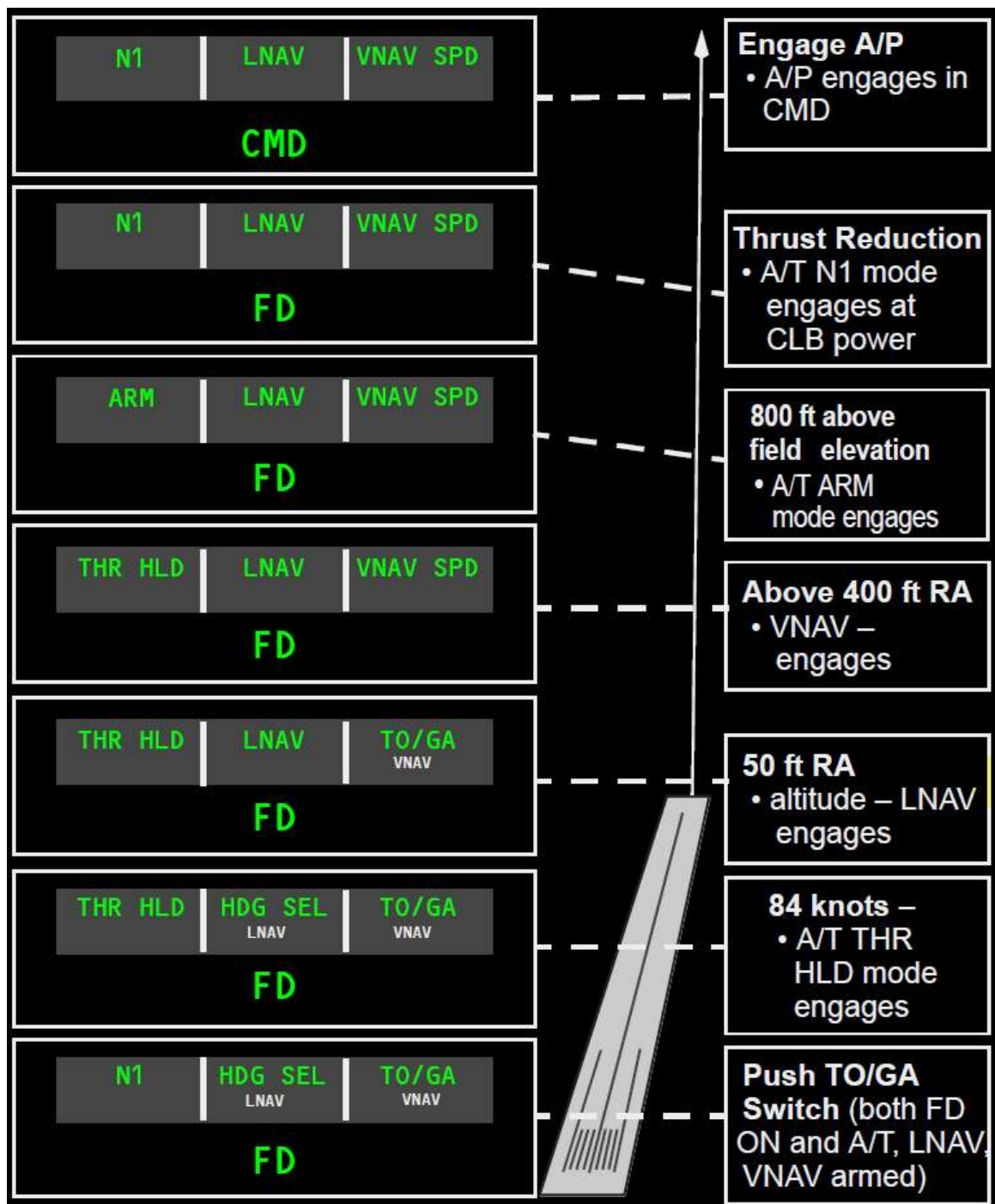


Engine failure during takeoff (KEEP-GOING decision)

- At lift-off: the pitch command target airspeed is V_2 or airspeed at lift off, whichever is greater
- During takeoff climb: the pitch target airspeed is:
 - V_2 , if actual airspeed is below V_2
 - If actual speed is between V_2 and V_2+20 , actual speed is target airspeed
 - If actual speed is above V_2+20 , V_2+20 is target airspeed



Automatic takeoff with VNAV and LNAV armed



Automatic flight en-route

A/P and F/D can be used after takeoff to fly a lateral and vertical navigation using LNAV and VNAV provided by FMC, other modes available are:

- For lateral navigation (roll modes): **VOR/LOC** and **HDG SEL**
- For vertical navigation (pitch modes): **ALT HOLD**, **LVL CHG (MCP SPD)** and **V/S**

Automatic flight approach and landing

The AFDS provides guidance for:

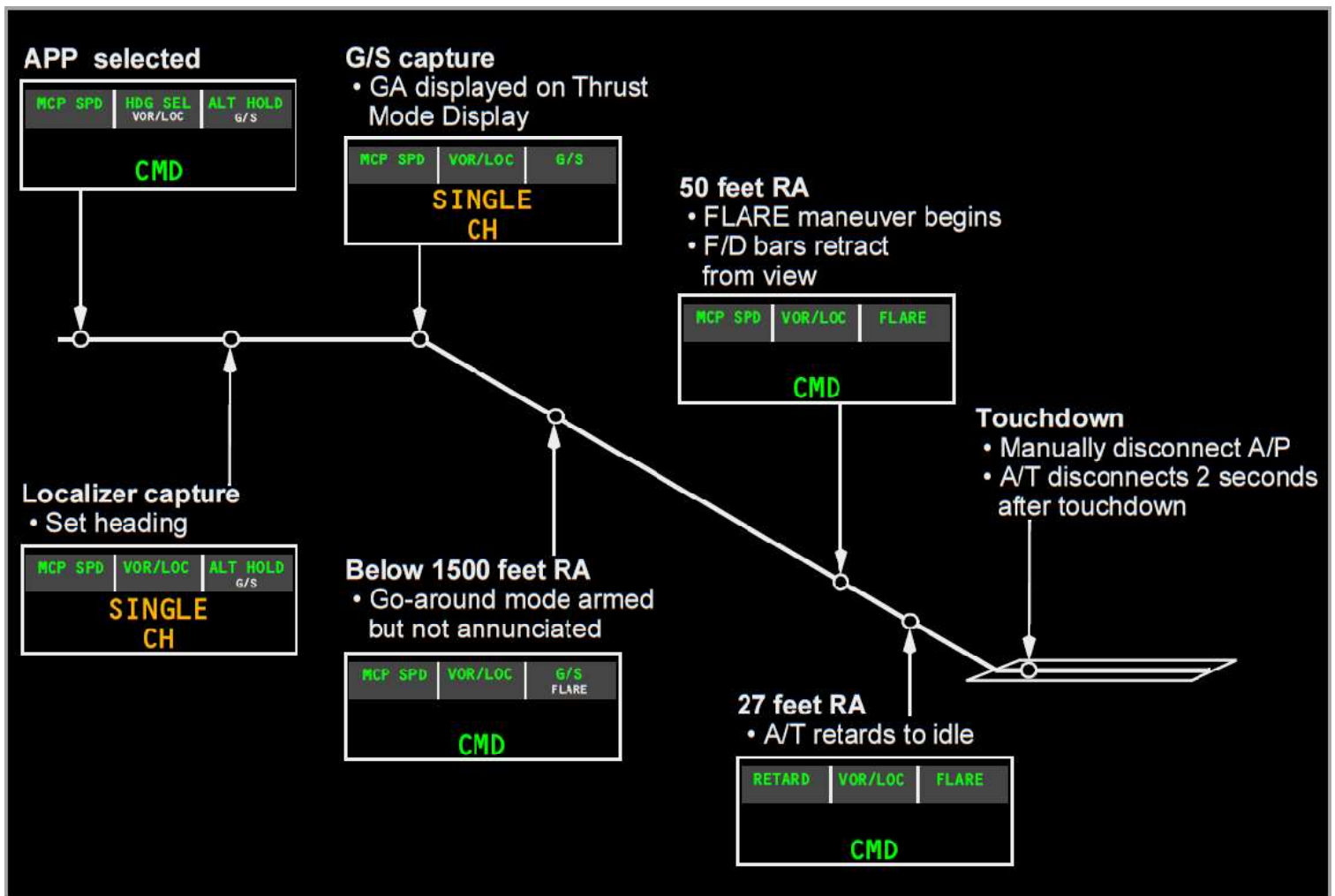
- Single A/P non precision approaches:
 - i. Pitch mode available: VNAV, LVL CHG or V/S
 - ii. Roll mode available: VOR/LOC, LNAV or HDG SEL
- Single and dual A/P precision approaches:
 - i. APP arms AFDS for LOC and G/S capture and tracking

Dual A/P approach

Dual A/P is available only in APP mode, providing a fail passive system through flare and touchdown or automatic go-around. During fail-passive operation, if a failure occurs in one autopilot, both A/P are disconnected with minima airplane manoeuvring. Aural and visual warning are given to pilots.

One VHF NAV receiver must be tuned to an ILS frequency before the approach mode can be selected. The second VHF NAV receiver must be tuned to the ILS frequency and corresponding CMD engaged before 800 ft RA, otherwise second CMD engagement is inhibited.

- Before approach:
 - After setting ILS frequency, pushing APP arms **VOR/LOC** and **G/S**
 - APP permits engagement of both CMD*
- Localiser capture:
 - Localiser can be intercepted using **HDG SEL**, **CWS R** or **LNAV**
 - Capture occurs no later than ½ dot
 - Upon capture **VOR/LOC** engages and track localiser, **SINGLE CH** annunciates
 - *NOTE: the second A/P engages below 1500 RA with LOC and G/S captured, when engaged **SINGLE CH** extinguish
- Glideslope capture:
 - Glideslope capture is inhibited before localiser capture
 - Glide slope can be captured from above or below, capture occur at 2/5 dot and:
 - i. **G/S** engages and track glideslope
 - ii. APP light extinguish (provided localiser also is captured)
 - iii. **G/A** is displayed on thrust mode display
- Establish on ILS below 1500 dt:
 - the second A/P is engaged and couples with flight control **SINGLE CH** extinguish
 - a test of ILS deviation monitor system is performed, LOC and G/S deviation scales turn **AMBER** and flash momentarily
 - **FLARE** is armed (by now manual override will disconnect A/P)
 - A/P go around mode is armed but not annunciated
 - NOTE: If an invalid ILS signal is detected, A/P disengage and F/D command bars disappear
- At 400 ft RA:
 - **Stabiliser trim is automatically trimmed an additional amount UP** (forward control column effort is required in case of A/P disengagement)
- At 350 ft RA:
 - **If FLARE is not armed, both A/P disconnect**
- FLARE:
 - At 50 ft RA: **FLARE** engages, F/D bars disappear
 - at 27 ft RA: A/T begin retarding thrust to be idle at touchdown, FMA annunciates **RETARD**
- after touchdown:
 - 2 seconds after touchdown: A/T is automatically disengaged
 - A/P must be disengaged manually, landing roll must be executed manually



single A/P approach

a single A/P approach can be executed by engaging only one CMD. Single A/P approach operation is same as the dual, with the following exception:

- Full automatic FLARE and touchdown is not available, FLARE is not annunciated
- Stabiliser trim bias (up trim at 400 ft RA) is not applied
- A/P go-around is not available
- **SINGLE CH** is annunciated for the entire approach
- if the pilot is flying manually but not following F/D command bars and then select CMD, the autopilot reverts to CWS for the pitch and/or roll mode, the approach mode will then re-arm

Automatic flight go-around

Go-around mode is engaged by pushing either TO/GA button.

A/P go-around requires dual A/P operation, GA is armed when FLARE is armed.

For single A/P operation, manual F/D go-around is available only, GA is armed when:

- A/T switch in ARM
- Descending below 2000 ft RA
- above 2000 ft RA with flaps not UP or G/S captured or below 2000 ft
- with or without AFDS engaged

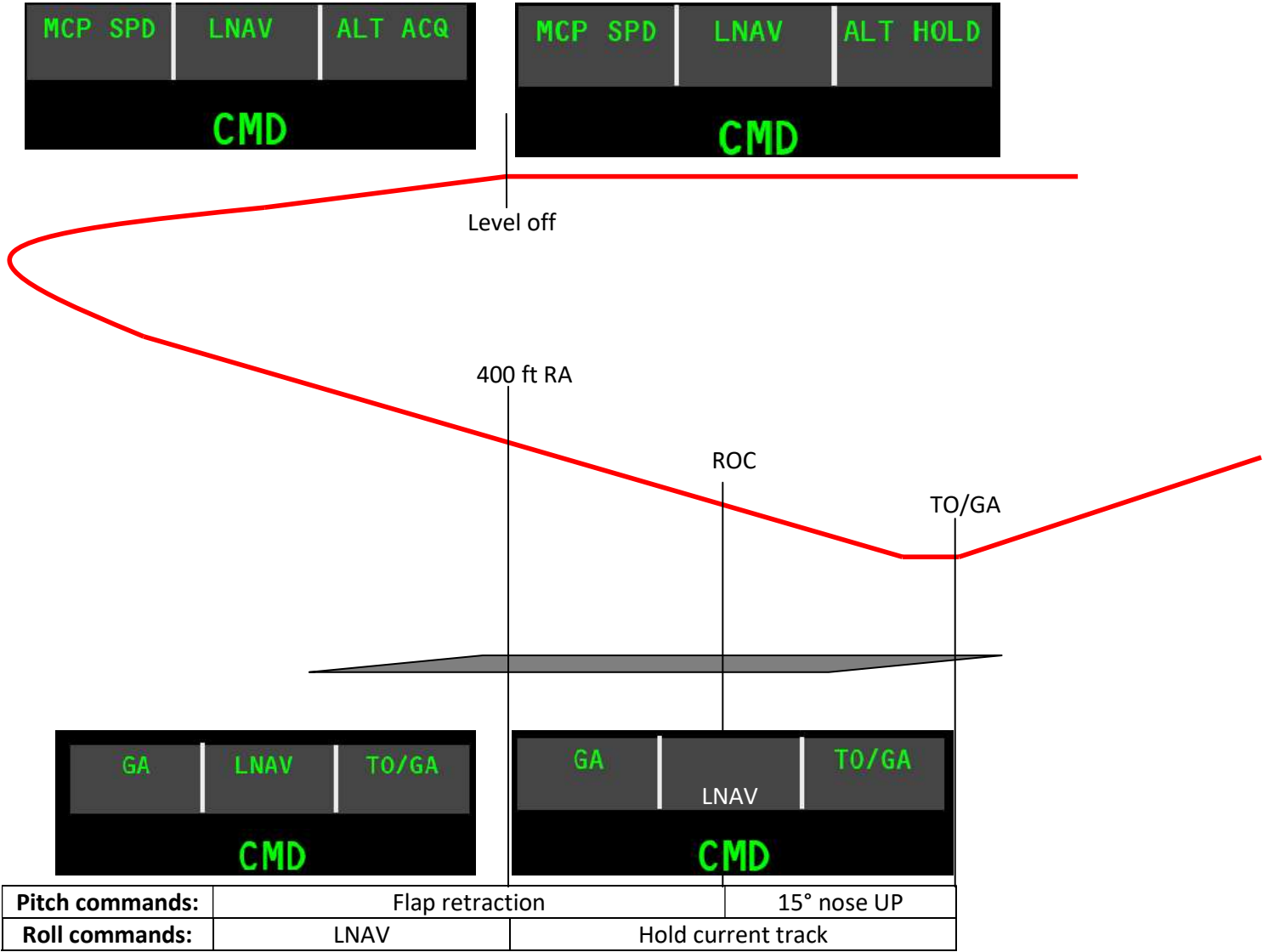
A/P go-around

The A/P go-around requires dual operating A/P after FLARE is annunciated and prior to touchdown.

- Go-around initiation:
 - Go-around initiate when either TO/GA button is pushed
 - A/T engages in GA mode
 - Thrust levers advance towards reduced FMC go-around N1 to produce 1000 to 2000 ft/min ROC.
 - Pitch mode engages in TO/GA
 - F/D pitch command 15° nose up
- Go-around roll commands:
 - Below 400 ft RA: hold current track, FMA engage roll mode blanks, LNAV is armed
 - Above 400 ft RA: LNAV engage
- Reaching a programmed ROC:
 - F/D pitch command target airspeed for each flap settings, based on MTOW calculation
 - MCP IAS/MACH display blanks, command airspeed cursor automatically move to target airspeed for the existing flap position, based on MTOW calculation

NOTE: with the second push of TO/GA button A/T advances to full go-around N1 limit

- TO/GA mode termination:
 - Below 400 ft RA: AFDS remains in go-around mode unless both A/P and F/D are disengaged
 - Above 400 ft RA: select a different pitch or roll mode:
 - i. If roll mode is changed first:
 - a. Selected mode engages in single A/P roll, commanded by the A/P who was first in CMD
 - b. Pitch remain in dual A/P control in TO/GA mode
 - ii. If pitch mode is changed first:
 - a. Selected mode engages in single A/P pitch, command by the A/P who was first in CMD
 - b. Second A/P disengages
 - c. Roll mode engages in CWS R
 - iii. A/T go-around mode is terminated when:
 - a. Another pitch mode is selected
 - b. ALT ACQ engages
- Level off:
 - ALT ACQ engages when approaching the selected altitude if the stabiliser position is satisfactory for single A/P operation (pitch mode cannot be changed from TO/GA unless sufficient nose-down trim input to compensate stabiliser bias. Normally nose down trimming is performed automatically by A/P)
 - If stabiliser position is not satisfactory:
 - i. ALT ACQ is inhibited, pitch remains in TO/GA
 - ii. "A/P" disengage light illuminate steady (disengage A/P or select higher MCP ALT to extinguish)



F/D go-around

If both A/P are not engaged, a manual F/D only go-around is available:

- In-flight below 2000 ft RA
- In-flight above 2000 ft RA with flaps not UP or G/S captured
- Not in takeoff mode
- If the TO/GA switches are activated after touchdown (wheel spin-up)

F/D go-around is basically the same as A/P go-around with the following exception:

- (EI-FTF through YW135) F/D roll command hold current track below 50 ft AGL, above 50 ft AGL LNAV will engage.
- TO/GA mode termination:
 - Below 400 ft RA: both F/D switches must be turned OFF
 - Above 400 ft RA: select a different pitch or roll mode:
 - i. If the roll mode is changed first:
 - a. F/D roll engages in the selected mode
 - b. F/D pitch mode remains in TO/GA
 - ii. If the pitch mode is changed first:
 - a. F/D pitch engages in the selected mode
 - b. F/D roll modes automatically changes to HDG SEL
- Engaging an A/P in CMD automatically engages the A/P and F/Ds in LVL CHG for pitch

Single engine F/D go-around

- Go-around initiate with push of either TO/GA button:
 - (EI-FTF through YW135) F/D roll command hold current track below 50 ft AGL, above 50 ft AGL LNAV will engage.
 - Pitch mode engages in TO/GA
 - F/D target speed is displayed on MCP IAS/MACH display and airspeed cursor
 - F/D pitch commands 13° nose up
 - as ROC increases, F/D pitch commands maintain a target speed:
 - if engine failure occurs prior to go-around engagement: target speed is selected MCP speed
 - if engine failure occurs after go-around engagement and:
 - i. prior to 10 seconds from go-around engagement: target speed is selected MCP approach speed
 - ii. after 10 seconds from go-around engagement and airspeed at engine failure:
 - a. is within 5 Kts of the V_{GAE} : V_{GAE} becomes target speed
 - b. more than 5 Kts above V_{GAE} : current airspeed becomes target speed
- NOTE: target speed is never less than V_2 speed based on flap position, unless in windshear
- acceleration: F/D commanded acceleration cannot occur until a higher speed is selected on the MCP

Engine failure occur:			
Before go-around engagement	After go-around engagement		
Selected MCP speed	Within 10 seconds	More than 10 seconds	
	MCP approach speed	Within 5 Kts V_{GAE}	More than 5 Kts V_{GAE}
		V_{GAE}	Current airspeed

AUTOMATIC FLIGHT – NON-NORMAL PROCEDURE

AFS operation in windshear

A/P and F/D provide positive correction to counteract most windshear. A/T aid to recover by providing quick response to any increase or decrease in speed.

Takeoff and go-around windshear

If windshear is encountered during a F/D or A/P takeoff or go-around:

- Pitch commands to maintain target airspeed until vertical speed decreases to + 600 ft/min
- Then pitch commands 15° nose up
- If vertical speed continues to decrease, pitch continue to command 15° nose up until a speed of approximately stick shaker, which result in intermittent stick shaker activation
- As the airplane transit windshear, climb rate increases above + 600 ft/min, then pitch command acceleration back to target airspeed

Approach and landing windshear

If windshear is encountered during approach or landing F/D and A/P attempt to hold the airplane on altitude or on G/S if after G/S capture. They will do that without regards to angle of attack or stick shaker limitation. A stall can occur if the pilot does not intervene by:

- Pushing TO/GA, or
- Disconnecting the A/P and flying manually

Warning

Severe windshear may exceed the performance capability of the system and/or airplane. The flight crew must be prepared to disconnect the A/T, advance thrust lever at forward stop, disconnect A/P and manually fly the aircraft.

Command speed limiting and reversion modes

AFS command speed limiting and reversion are independent of stall and Mach warning.

Command speed limiting

AFS provide speed, pitch and thrust to avoid exceeding:

- VMO/MMO
- Flaps and landing gear placard speeds
- Minimum speed (based on 1.3 Vs for current flap configuration)

Command speed can be equal, but will never exceeds these limits.

Speed greater than VMO/MMO cannot be selected in MCP IAS/MACH.

Speeds greater than flaps/landing gear placard and less than minimum speed can be selected.

When commanded speed is outside limit an over-speed/under-speed symbol appear on IAS/MACH display, the AFS allows acceleration/deceleration to slightly short of the limit, then command the limit speed.

Flashing "A": under-speed, a speed 15 Kts greater than minimum speed must be selected to remove the symbol

Flashing "8": over-speed



Reversion modes

During some flight situation, speed control by AFDS or A/T alone could be insufficient to prevent exceeding a limit speed, if this occur, AFDS and A/T automatically revert to a more effective combination. Reversion mode are:

- Placard limit reversion
- Minimum airspeed reversion

Mode reversion occur slightly before reaching the limit speed.

Placard limit reversion

When one of the placard limit reversion is reached (gear, flap, VMO/MMO):

- Over-speed limiting symbol appear
- If AFDS or A/T is in SPD control, speed is maintained slightly below limit
- If the AFDS is engaged but not in SPD or CWS mode, and the A/T is ARM but not in a SPD mode, A/T revert to SPD and control speed to slightly below limit

EI-DAC through EI-FEI and [EI-FIA through YW135]

- For VMO/MMO only, if the A/T is engaged in a SPD mode and thrust lever are at idle, the AFDS, if in a V/S mode [EI-FIA through YW135: or CWS P] will automatically engage in LVL CHG mode

EI-FIA through YW135

- If the A/T is not available, no reversion response to gear and flap placard speeds is available. The AFDS reverts to speed control for VMO/MMO speed limiting

Minimum speed reversion

EI-DAC through EI-FEI and [EI-FIA through YW135]

The AFDS and A/T do not control to a speed less than minimum speed for the current flap configuration (1.3 Vs). Minimum speed, FMC speed or selected speed, whichever is higher, becomes target speed.

If actual speed becomes equal or slightly below minimum speed:

- Under-speed symbol appear
- If operating in V/S [EI-FIA through YW135: or CWS P], the AFDS revert to LVL CHG
- If operating in VNAV PTH, AFDS reverts to LVL CHG except if flying a level segment
- No reversion provided from V/S to LVL CHG when flaps are greater than 12.5°

EI-FIA through YW135

AFS commands a speed 5 Kts greater than minimum speed, reaching this speed, normal MCP speed selection re-activates and under-speed symbol disappear.

If in LVL CHG climb with a commanded speed equal or less than minimum speed and a minimum ROC cannot be maintained without deceleration, A/P disengages and F/D bars disappear.

A/P disengage (QRH 4.1)

AUTOPILOT DISENGAGE

A/P
P/RST

Condition: All autopilots are disengaged. The red light flashes and the aural tone sounds.

- 1 Fly the airplane manually or re-engage an autopilot.



A/T disengage (QRH 4.1)

AUTOTHROTTLE DISENGAGE

A/T
P/RST

Condition: The autothrottle is disengaged. The red light flashes.

- 1 Control thrust manually or re-engage the autothrottle.



FLIGHT MANAGEMENT – SYSTEM DESCRIPTION

Overview

Navigation systems include:

- FMS
- 2 GPS receivers
- ADIRS (2 IRS)
- Radio navigation system
- Transponder
- AWR (airborne weather radar)

GPS (global positioning system)

2 independent GPS receivers (L and R) receive GPS signals, each one is capable of providing an accurate aircraft position to FMC and other aircraft systems. GPSs position are shown on POS REF page 2/3.

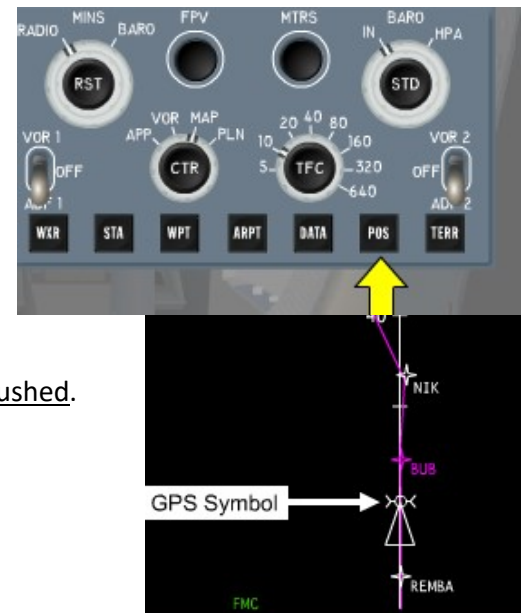
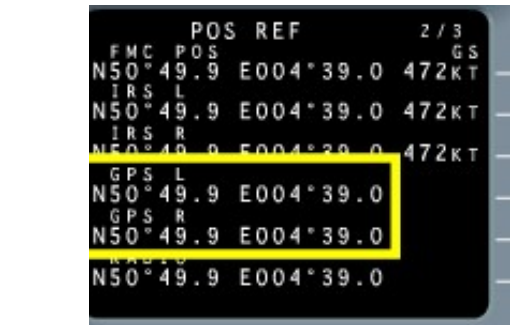
GPS position relative to FMC position is shown on POS SHIFT page 3/3.

GPS currently in use by FMC is shown on NAV STATUS page 1/2.

When POS on EFIS control panel is pushed, ND display L and R GPS position symbol, GPS are identical and show a single symbol when calculating the same position.

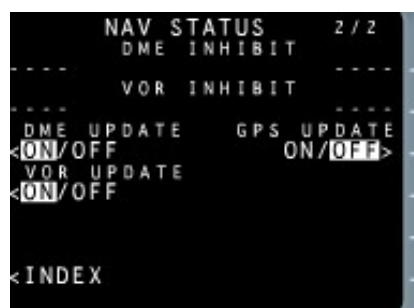
“GPS” illuminate on IRS control panel:

- when both GPS sensors have failed.
- If a single GPS has failed, illuminate when either annunciator panel is pushed.



The FMC logic selects the position from one GPS unit as primary position information source.

GPS information can be deselected on NAV STATUS page 2/2, no other GPS control is available, since GPS is completely automatic.



Inertial system

ADIRUs provide inertial position to FMC. Inertial system computes: airplane position, ground speed and attitude for DUs, FMS, auto-flight and other.

Main component of the inertial reference system are:

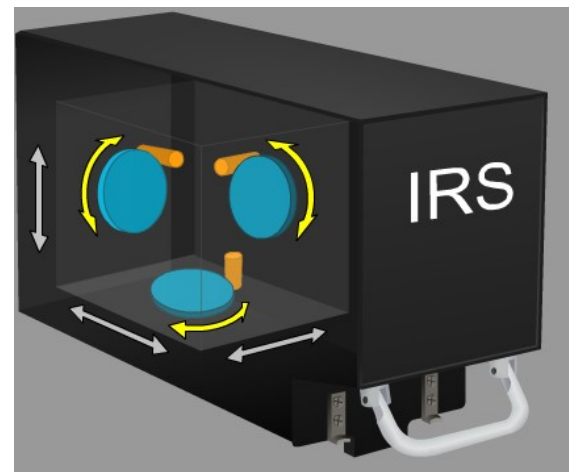
- ADIRU
- ISDU (inertial system display unit)
- IRS MSU (inertial reference system – mode selector panel)
- IRS transfer switch



2 independent IRS are installed. Each IRS has 3 sets of laser gyro and accelerometers. The IRS are the sole source of attitude and heading (except STBY attitude and compass).

In normal navigation, IRS provides:

- Attitude
- True and magnetic heading
- Acceleration
- Vertical speed
- Ground speed
- Track
- Present position
- Wind



IRS alignment

An IRS must be aligned before entering NAV mode, present position is normally entered through FMC's CDUs POS INIT page, otherwise can be entered through the ISDU.

Normal alignment begins by moving the IRS selector to NAV, the:

- IRS performs a short power test, "ON DC" illuminate
- When "ON DC" extinguish and "ALIGN" illuminate, alignment process begins
- Then present position can be entered

Total alignment time varies from 5 to 17 minutes depending on airplane latitude.



If position entered:

- Is not within 4 NM of the origin airport, VERIFY POSITION appear on CDU's scratchpad
- Does not pass the IRS internal comparison test, ENTER IRS POSTION appear on CDU's scratchpad

In both cases "ALIGN" flashes to indicate that one of the 2 internal test has not been passed

If the same position is re-entered, IRS will accept this position and continue the alignment process.

A second internal test compares entered and IRS computed latitude:

- If this second test fails, "ALIGN" flashes and "FAULT" illuminate
- If this second test is passed, IRS will complete alignment and enter NAV mode

During transit, or short ground time, a 30 seconds realignment may be performed selecting ALIGN. Present position should be entered in POS INIT page before switching to NAV.

Loss of alignment

If the aircraft is moved during alignment or fast alignment, the IRS automatically begins the full alignment process.

A new full alignment process will begin also if:

- IRS loses both AC and DC power
- If MSU switch is moved out of NAV position

If alignment is lost in-flight, NAV function is unavailable for the remainder of the flight, moving the MSU on ATT will restore attitude reference. ATT mode requires 30 seconds of straight and level un-accelerated flight.

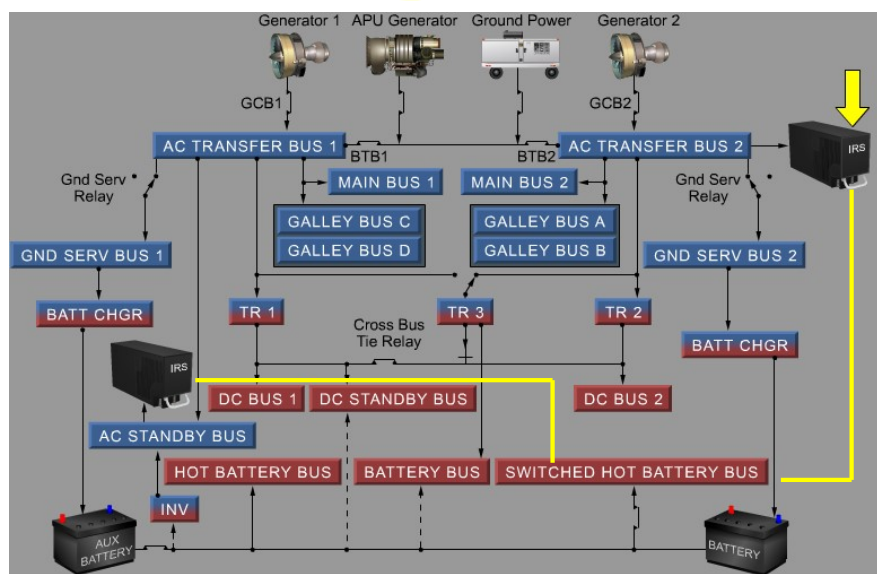
ATT mode can provide also magnetic heading, but manually entered initial MAG HDG on POS INIT page is required. Drift up to 15° may occur, thus requires a periodical check with an operating compass system.

IRS magnetic heading

Magnetic heading is calculates from true heading by application of zone variation. Variation values are stored in each IRS memory, data with present position are combined to obtain magnetic heading.

IRS power

IRS can be operated by both AC and DC power, normally IRS L is powered by AC STANDBY BUS and IRS R from AC TRANSFER BUS 2. If AC power is lost, both IRS automatically switch to SWITCHED HOT BATTERY BUS. IRS R becomes unpowered if AC is not restored in 5 minutes.



Initial power up requires battery power, the system then connects to AC power, if AC is removed, SWITCHED HOT BATTERY BUS continue to supply IRS with DC power. both “ON DC” lights illuminate and ground “horn” sounds to alert ground crew that the IRSs are on battery power. When IRS selector is moved OFF, the IRS remains powered for approximately 30 seconds, “ALIGN” remains illuminated until complete IRS shut down.

ISDU, MSU and IRS transfer switch

ISDU display data according to the selectors position, a keyboard allows entry to the IRS system.

MSU is used to select IRS operating mode, indication light indicates IRS status, IRS transfer switch is used to transfer all system inputs from the functioning IRS (should one IRS fail or data being inaccurate)



Radio navigation system

ADF (automatic direction finding)

Only one ADF receiver is installed (RYR). If heading or track information are lost or invalid, ADF pointers on the DUs are removed, ADF pointers on the STBY RMI will not display correct bearings.

ADF pointers are displayed on DUs when VOR/ADF switch is on ADF.

DME (distance measuring equipment)

2 DME frequency scanning are installed. The FMC auto-tunes DME receivers as necessary for position updating. Tuned DME are shown on NAV STATUS page 1/2, DME updating can be inhibited on NAV STATUS page 2/2. Obtained position is displayed on POS REF page 2/3.

Flight crew must manually select DME on VHF NAV receiver, and relative VOR/ADF switch on EFIS control panel must be on VOR, for DME to be displayed on ND DUs. DME is shown also on PFDs when an ILS frequency is tuned.



ILS/VOR (instrument landing system/VHF omnidirectional radio-range)

LOC updating on FMC occurs only when al ILS is manually tuned on VHF NAV receiver.

VOR must be manually tuned on VHF NAV receiver to be displayed on ND DUs and STBY RMI.

VOR-DME radio updating is available if a valid in-range station is tuned. VOR1 and VOR2 bearings are displayed on DUs when VOR/ADF switch is on VOR. Should either VOR receiver fail, the VHF NAV transfer switch enables selection of the opposite VHF NAV receiver for display.



Morse IDENT

Morse IDENT is converted in alpha characters and then shown on DUs.

NOTE: the identifier name is not compared with FMC database, the decode feature may incorrectly convert the identifier.



Transponder and AWR

Transponder

2 ATC transponder are installed and controlled by a single panel. Transmission are automatically enabled, when air/ground sensing indicates air mode. TCAS is controlled by transponder panel as well.

If installed, the automatic dependent surveillance – broadcast (ADS-B) data is down-linked to ATC and may be used for airplane tracking.



ARW (airborne weather radar)

AWR antenna scan a forward arc of 180°, level of rainfall are indicated with a coloured scale.

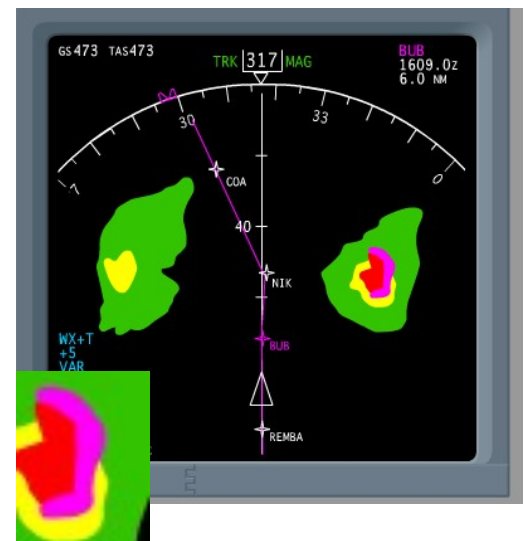
Ground mapping mode

Ground mapping mode is available on MAP mode, the radar displays surfaces with the same coloured scale, according to the reflective capability. The display enables identification of coast lines, hilly or mountainous regions, cities or large structure and lakes (no reflectivity)

Turbulence mode

Turbulence mode displays normal precipitation and precipitation associated with turbulence. When radar detects an horizontal precipitation movement speed greater than 5 m/s, that target displays becomes magenta.

This magenta area indicates heavy turbulence and is normally limited to 40 NM range, regardless of selected range.



EI-DAC through EI-EXF: Predictive windshear (PWS)

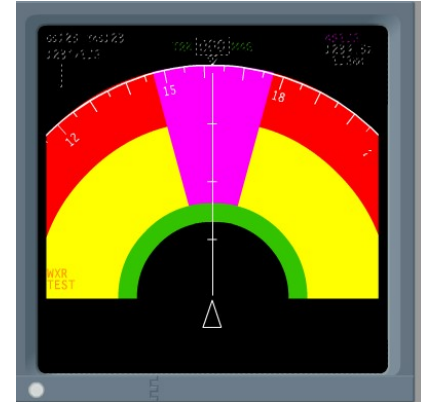
PWS alerting is provided below 1200 ft RA, AWR antenna scan sweep with PWS enabled is:

- On ground and in-flight below 2300 ft: 120°
- Above 2300 ft RA: 180°



AWR controls (mode selector panel and EFIS control panel)

- WXR (EFIS control panel): energises AWR antenna and shows returns on MAP, MAP CTR and expanded VOR and APP modes. AWR range is limited to 320 NM regardless of EFIS range selection.
- TEST: test AWR operation, it shows a test pattern on NDs if WXR is selected
- WX: shows AWR returns at preselected GAIN level
- WX/TURB: shows AWR return with turbulence detection within 40 NM
NOTE: turbulence detection requires presence of detectable precipitation, CAT (clear air turbulence) cannot be detected
- MAP: show ground return
- GAIN: set receiver sensitivity to enhance ground mapping:
 - AUTO: automatically adjust gain
 - MAX: maximum reduction of ground return



NOTE: GAIN knob works only in MAP mode, GAIN is automatically set for other modes.

- TILT: sets antenna tilt up or down

RDR-4000 multi-scan radar (EI-FEE through YW135)

These are just basic information regarding RDR-4000, for further specification see RDR-4000 manual

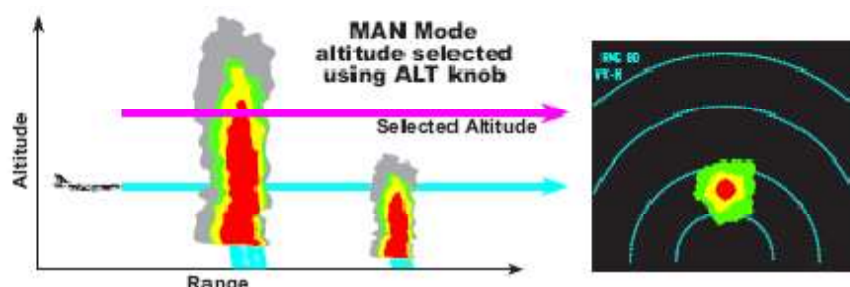
Multi-scan weather radar collect data from different scans and merge the information into a total 3D weather picture. Special software eliminates ground clutter.

When operating in the automatic mode, multiple radar scans at pre-selected tilt angles detect short, mid and long range weather. Tilt and gain inputs are not required. This results in weather detection at all ranges and in all phases of flight. Additional processing ensures data from thunderstorm tops within 5000 ft of the airplane remain on the radar display until it no longer poses a danger.

- MAP: the purpose of MAP is to aid in identify prominent terrain features. Data from terrain database is not used, the ground map is generated automatically and simultaneously with weather.
- MAN: manual weather mode provide a means to assess storm cell height and development by providing a selectable altitude “slices”. Upon initial selection the ALT knob is used to select the desired “slice” from MSL to 60000 ft in 1000 ft increment. Turbulence and secondary weather information are removed in MAN mode.



(manual selection is obtained by displaying a selected altitude of the 3D picture instead of changing antenna tilt)

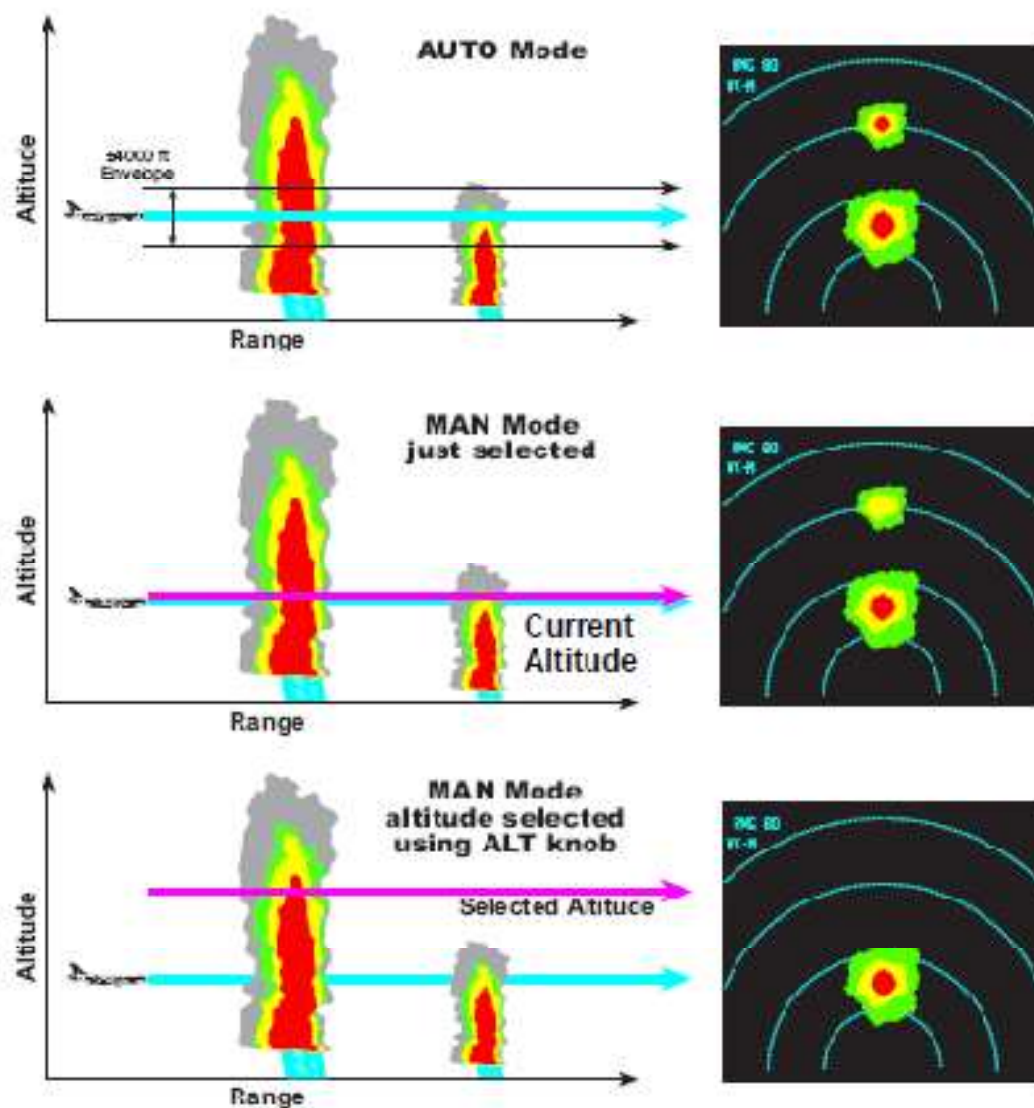
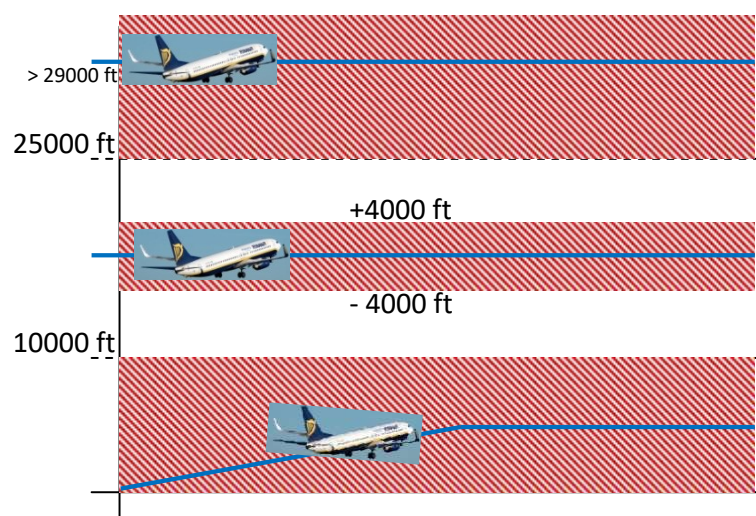


- AUTO: provide automatic weather, turbulence and PWS detection. The flight path weather that fills in the 3D memory is the detected weather in front of the aircraft out to 320 NM, and from ground level up to 60000 ft MSL. The radar designate weather along flight path as “flight path” weather. All other weather is designated as “secondary” weather, and is displayed with black striped through it.

EI-FEE through EI-FRT and [EI-FRV through EI-FRT]

“flight path” weather:

- ± 4000 ft to expected flight path
- At cruise altitude [above 29000 ft] the floor of the envelope is fixed at 25000 ft
- On ground and during dep. and app. procedure, the ceiling of the envelope is fixed at 10000 ft



Flight management system (FMS) overview

Flight Management System (FMS) aids:

- Managing automatic navigation
- In-flight performance optimization
- Fuel monitoring
- Flight deck displays

Flight Management System (FMS) comprised of:

FMCS	Flight Management Computer System
AFDS	Autopilot / Flight Director System
A/T	Autothrottle
IRS	Inertial Reference System
GPS	Global Positioning System

automatic flight function manage airplane LNAV and VNAV.

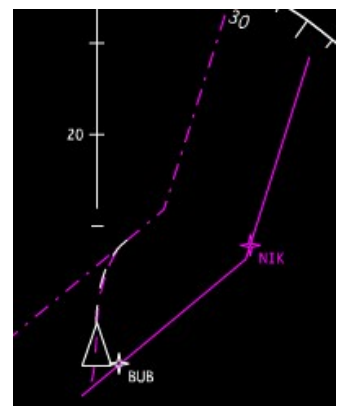
The crew manually enter the route on the CDU, FMS then uses its navigation database, airplane position and supporting system data to calculate flight path.

The FMS can automatically tune the navigation radios and determine LNAV courses.

Navigation database

The FMS navigation database provides the necessary data to fly routes, SIDs, STARs, holding and procedure turns.

Lateral offset from programmed route can be calculated and commanded.



VNAV calculation

For VNAV, computation include:

- Fuel burn data
- Optimum speed and recommended altitude
- Operating in RTA (required time of arrival):
 - i. Required speed
 - ii. Takeoff time
 - iii. En-route progress information

Flight management computer

A dual FMC installation is provided and certified as a “sole source”.

The second FMC serves as a backup, providing complete navigational function if other FMC fails. One FMC is always designated as primary, this is controlled by the FMC source select switch.

BOTH ON L / BOTH ON R: isolates FMC operation

NORMAL: the **L FMC is primary by default**

Primary FMC is responsible for:

- Nav aids tuning and updating between FMCs
- Synchronise FMCs and CDUs
- Provide input to A/P and A/T



IRS position

When external updating is not available, FMC uses IRS position. If IRS position is the only position source, FMC applies correction factors to IRS position, based on IRS monitoring during normal operation, comparing IRS position with other source, thus determine typical IRS errors

FMC database

The FMC has 2 database, navigation and performance database:

- Performance database: contains all aircraft related performance
- Navigation database: contains information regarding:
 - i. VHF navigation aids
 - ii. Waypoints
 - iii. Airports
 - iv. Runways
 - v. Operator information (SIDs, STARs.... And company routes)

A/T system

FMC commands A/T automatically when in VNAV mode. N1 limit thrust can be entered in CDUs, according to this, the A/T provides thrust levers position and thrust equalisation commands through the EECs.

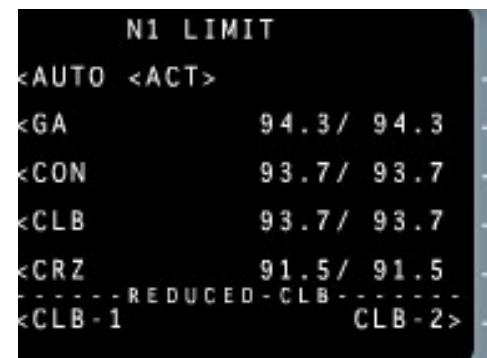
FMC provides also reference thrusts, reference thrusts can be selected through CDU N1 LIMIT page.

Takeoff thrust

Thrust reduction height for takeoff can be selected in the TAKEOFF REF page 2/2. A default value is established by the airline, however allowable entry for flight crew are from 800 ft to 9999 ft.

Reduced thrust takeoff can be used by:

- Selecting a fixed de-rate on N1 LIMIT page
- Selecting an assumed temperature (SEL/OAT) on N1 LIMIT or TAKEOFF REF page
- Selecting a combination of the above



NOTE: maximum thrust reduction authorised is 25%. De-rate value is considered new N1 LIMIT, exceeding de-rate limit could cause loss of directional control on ground. Assumed temperature thrust is not considered a limit.

CLB thrust

2 fixed climb thrust can be selected on N1 LIMIT page:

- CLB1: reduces climb N1 limit by 3% (10% of thrust approximately)
- CLB2: reduces climb N1 limit by 6% (20% of thrust approximately)

Climb setting gradually increases to full rated climb thrust by 15000 ft.

NOTE: CLB1 and CLB2 are dependent on takeoff setting, in order to avoid exceeding N1 limit. Reduced climb thrust improve engine life but increases trip fuel.



CRZ thrust

In cruise phase, thrust reference automatically change to CRZ, CRZ can be manually selected on N1 LIMIT page.

Fuel monitoring

If fuel quantity is invalid, scratchpad indicate VERIFY GW AND FUEL, PERF INIT page fuel line changes to dashes.

The FMC uses the last valid fuel quantity for performance prediction and VNAV. The crew must manually enter estimated fuel weight periodically to keep FMC gross weight current. VERIFY GW AND FUEL shows every 30 minutes if periodical entry are not performed. Is inhibited during descent with V_{REF} selected.

```

PERF INIT 1/2
GW/CRZ CG TRIP/CRZ ALT
160.0/ 8.0% FL330/FL330
PLAN/FUEL CRZ WIND
- - - - - 060°/ 10
ZFW ISA DEV
130.0 -3°F -2°C
RESERVES T/C OAT
5.0 -61°F -52°C
COST INDEX TRANS ALT
144 5000
-----
<INDEX N1 LIMIT>
VERIFY GW AND FUEL
  
```

CHECK FMC FUEL QUANTITY message indicate that FMC has detected an unexpected fuel quantity drop.

FMC calculates predicted fuel at destination, if:

- Less than reserve value entered: USING RSV FUEL message annunciate
- Less than 2000 lbs (900 Kg): INSUFFICIENT FUEL message annunciate

CDU (control display unit)

There are 2 CDU available, used to input data in the FMC. Data can be entered using either CDU, although simultaneous entry should be avoided. Same FMC data and computations are available on both CDU, however each pilot has control over what is displayed on his CDU.

Components

Pushing a line select key:

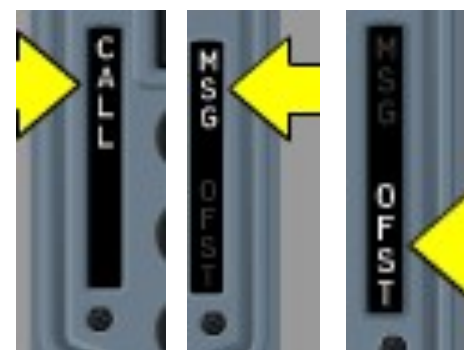
- Moves data from scratchpad to the selected line and vice-versa
- Selects page, procedure, performance etc...
- Delete data from selected line when "DELETE" is in scratchpad



"MSG": a scratchpad message is shown

"OFST": LNAV gives guidance for lateral route offset

"CALL": a subsystem (other than FMC) is requesting control of the CDU



Function keys:



EXEC light: active data is modified but not executed

EXEC button: execute data modification active, light extinguish

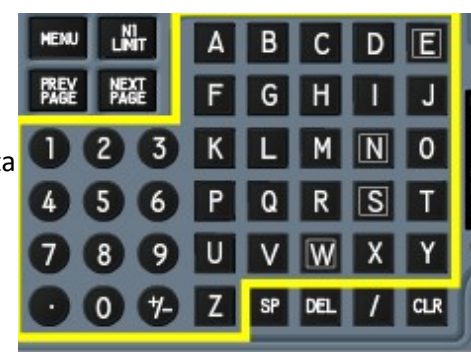
Alphanumeric keys: puts selected key in the scratchpad

DEL: put "DELETE" in the scratchpad

CLR: push = clear last scratchpad character/ push and hold = clear all scratchpad data

SP: enter a space in the scratchpad

/ : enter a / in the scratchpad

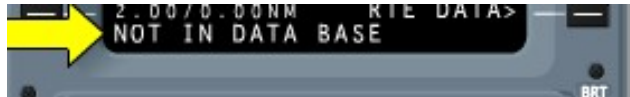


Display components

- Page title:
 - ACT: active data
 - MOD: modified data
- line title: title of line below



- scratchpad area



- page number area: page number/total number of pages
- □□□□ = data input is mandatory
- - - - - = data input is optional



- Prompt: shows pages, select mode, control display



FLIGHT MANAGEMENT – NORMAL OPERATION

Navigation system

ADF panel

Frequency selector knob:

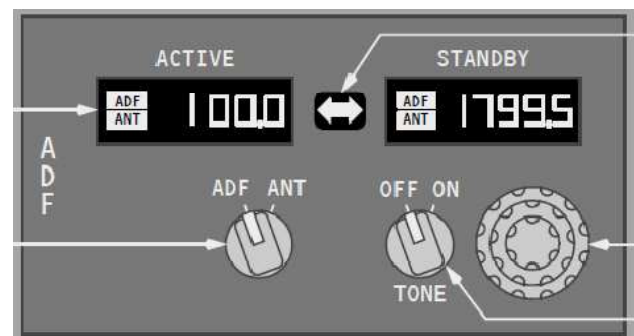
- Outer knob: sets hundreds
- Middle knob: sets tens
- Inner knob: sets tenth and ones

Mode selector:

- ADF: audio reception is possible and bearing information are sent to DUs and STBY RMI
- ANT: audio reception is optimised, bearing info are not sent to DUs

Tone switch:

- ON: tone is added to associated ADF receiver audio
- OFF: removes the tone



VHF navigation panel (EI-DAC through EI-FRZ)

Frequency selector knob:

- Outer knob: set digit left of decimal point
- Inner knob: set digit right of decimal point

TEST:

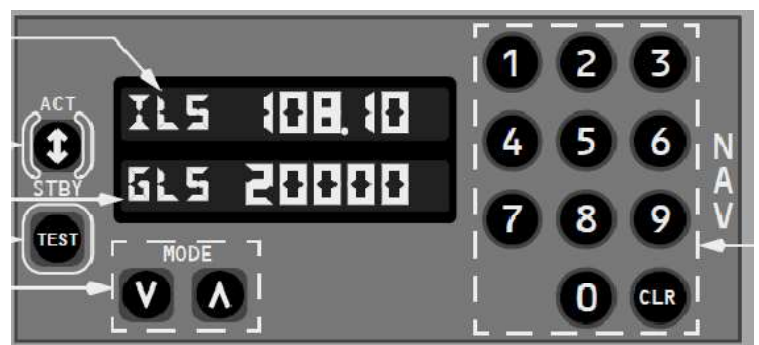
- With a VOR frequency tuned and 000° course selected:
 - Shows VOR flags
 - Deviation bars disappear and then return to centre position
 - Bearing pointer slews to 180°
 - DME displays: DME fail flag, dashes and normal DME distances
- With an ILS frequency tuned and a course within 90° of airplane heading:
 - Pointers disappear and LOC and G/S flags appear momentarily
 - Pointers appear and display 1 dot up and left, then 1 dot low and right, then return normal display
 - DME displays: DME fail flag, dashes and normal DME distances



Multi-mode navigation control (EI-FTA through YW135)

Actual (ACT) and standby (STBY) frequency and mode is indicated in each display

- TEST: as for normal panel except that testing GLS DME is not tested
- MODE switches: manually insert ILS, VOR or GLS



ATC transponder panel

- ATC switch: select active transponder for transmission
- Code selector knob: set transponder code
- IDENT: sent identification signal
- ALT switch: selected altitude reporting source from ADIRU 1 or 2
- ATC FAIL light: indicate transponder malfunction (AMBER)
- Mode selector knob:
 - TEST: perform a test of transponder and TCAS
 - STBY: transponder is powered but does not reply from ATC or other TCAS signals
 - ALT OFF: enables mode A and S without ALT reporting
 - ALT ON: enables mode A, C (ALT rep.) and S
 - TA (only): enables transponder and TCAS TA (only). only TA will be displayed. TA (only) selection is normally made in cases where degraded aircraft performance is a factor (ie. Engine failure)
 - TA/RA: enables transponder and TCAS TA and RA, with:
 - TFC ON: TA, RA and "proximate intruders" will be displayed
 - TFC OFF: TA, RA will be displayed automatically



FMS (flight management system)

FMS phases of flight are:

- Pre-flight
- Takeoff
- Climb
- Cruise
- Descent
- Approach
- Flight complete

Pre-flight phase

During pre-flight phase OFP information are entered in FMC to initialise LNAV and VNAV

Required pre-flight data are: initial position, route, performance and takeoff data

Optional pre-flight data are: SIDs and STARs, RTA, winds and reduced takeoff and climb thrust limit

	Begins	ends
Takeoff phase	TO/GA selection	Thrust reduction altitude
Climb phase	Thrust reduction altitude	Top of climb (T/C)
Cruise phase	Top of climb (T/C)	Top of descent (T/D)
Descent phase	Top of descent (T/D)	*2 NM from first WPT of a published approach/transition selected from ARRIVAL page
Approach phase	*	N/A

Flight complete phase

After landing, the flight complete phase clears all the active flight plan and load data. Some pre-flight data initialise to default values for the next flight.

Definitions

- Active: means current information being used for LNAV and VNAV calculation
- Inactive: refers to route information not currently being used for LNAV and VNAV calculation
- Initialise: means entering data to make the system operational
- ECON: is a speed schedule based on cost index, calculated to minimise operating cost
NOTE: low cost index = low fixed cost/high fuel cost = lower speed
- ERASE: remove flight crew entered data, which has resulted in a modification
- Conditional waypoint: is not necessary associated with land reference, can be a time or altitude requirement

FMC position updating

In-flight: FMC determine present position using IRS, GPS and NAV radios

On ground: FMC determine present position using IRS or GPS:

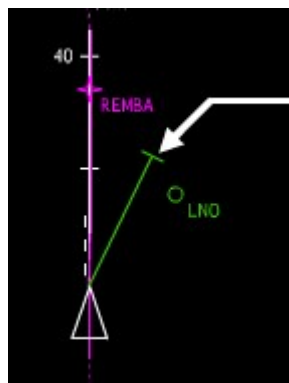
- if GPS is not available: FMC uses IRS
- if GPS UPDATE is OFF: FMC updates position to the takeoff runway threshold when TO/GA is pushed

FMC updates position from navigation sensors in the following priority order:

- GPS
- 2 or more DME
- 1 VOR/DME
- 1 LOC/DME
- 1 LOC

NOTE: if DME data are not available to FMC, IRS position only is considered.

If radio updating is not available, along/across errors may occur. Selecting POS on EFIS control panel ay show real bearing to flight plan entered station (if active).



Actual Radial and DME for LNO VOR

Required navigation performance (RNP)

Required navigation performance (RNP) and actual navigation performance (ANP) information are available on POS SHIFT page. RNP as published and stored in navigation database is displayed, otherwise a default apply:

- | | | |
|-------------------------|--------|---------------------------|
| - Oceanic default RNP: | 10 NM | time to alert: 60 seconds |
| - En-route default RNP: | 2 NM | time to alert: 30 seconds |
| - Terminal default RNP: | 1 NM | time to alert: 10 seconds |
| - Approach default RNP: | 0.3 NM | time to alert: 10 seconds |

If ANP exceeds the displayed RNP value, after the designated time to alert:

UNABLE REQD NAV PERF displays on CDU scratchpad

LNAV

LNAV provides steering commands to the next waypoint.

LNAV can be selected before takeoff:

- Below 50 ft RA: commands wing level
- At 50 ft RA: LNAV engages (if within engagement criteria)

LNAV engages if:

- Within 3 NM of active route, or
- With an intercepting track less than 90°, provided that the route will be intercepted prior to next active waypoint

If LNAV is selected but not within LNAV capture criteria: NOT ON INTERCEPT HDG appear on scratchpad

If a manual entered waypoint identifier is not database: NOT IN DATA BASE appear on scratchpad, however the waypoint can still be entered as coordinates or bearing/distance or bearing/bearing

Waypoint naming

Waypoint identifier can have maximum 5 characters.

if the name have more than 5 characters: the first and last letter are kept and the rest of name is abbreviated.

Unnamed turn points not coincidental with named waypoints	= ✦ _{IDE##}	→ Identifier code of NAVAID plus the distance from the NAVAID to the point
INW distance 18NM	= ✦ _{INW18}	→ If distance is 99NM or less, the NAVAID identifier comes first, then distance
CSN distance 106NM	= ✦ _{06CSN}	→ If distance is 100NM or more, the last two digits of the distance are used and come first, then the NAVAID identifier
Waypoint located at unnamed airspace type (ex. FIR)	= ✦ _{FRA01}	→ Identified by the 3 letter airspace type identification and a 2 digit sequence number
Unnamed oceanic control area reporting points	= ✦ _{5040N}	→ Report points in the northern hemisphere use "N" and "E", points in the southern hemisphere use "S" and "W"

N75°W170° = ✦_{75N70} → Latitude precedes longitude, use last 2 digits of the 3 digit value

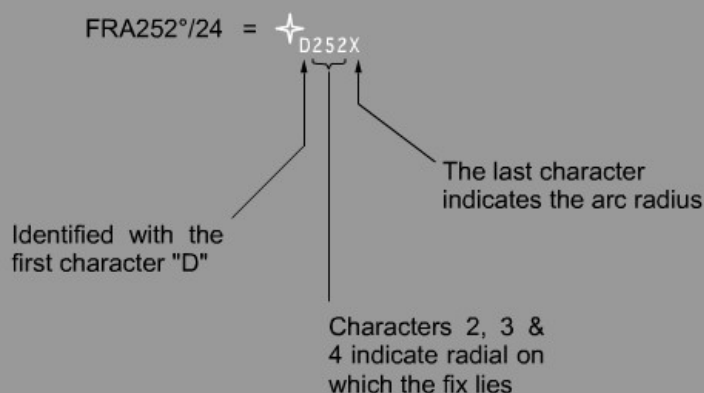
N50°W040° = ✦_{5040N} → Placement of designator in the 5 character set indicates whether the first longitude digit is 0 or 1

N50°W040° = ✦_{5040N} → Letter is the last character if the longitude is less than 100°

N75°W170° = ✦_{75N70} → Letter is the third character if the longitude is greater than 100°

N50°W040° = ✦ _{5040N}	S52°W075° = ✦ _{5275W}	} N = north latitude, west longitude E = north latitude, east longitude S = south latitude, east longitude W = south latitude, west longitude
N75°W170° = ✦ _{75N70}	S07°W120° = ✦ _{07W20}	
N50°E020° = ✦ _{5020E}	S50°E020° = ✦ _{5020S}	
N06°E110° = ✦ _{06E10}	S06°E110° = ✦ _{06S10}	

Unnamed terminal fix along a DME arc procedure:



- The radius is expressed by a letter (X) where A = 1 mile, B = 2 miles, C = 3 miles etc...

CPR338°/29 = ✧_{CPR29} → Unnamed waypoint along a DME arc with radius greater than 26 miles is identified by the station identifier and DME radius

CPR134°/29 = ✧_{CP29A}
CPR190°/29 = ✧_{CP29B} } Multiple unnamed waypoints along a DME arc with radius greater than 26 miles - station identifier reduced to 2 characters followed by the radius and a sequence character

DME step down fix = ✧_{138D}
DME step down fix = ✧_{106D}
DME step down fix = ✧_{56D}
DME step down fix = ✧_{3D} } Identified by the distance and the letter "D"

Outer Marker 13R = ✧_{OM13R}
Middle Marker 21 = ✧_{MM21} } Marker beacons identified by marker type followed by runway number

RX = Runway Extension Fix	IM = Inner Marker
FA = VFR Final Approach Fix	BM = Back Course Marker
CF = Final Approach Course Fix	MD = Minimum Descent Altitude
FF = Final Approach Fix	A = (+ an alpha) Step Down Fix
IF = Initial Approach Fix	RW = Runway Threshold
OM = Outer Marker	MA = Missed Approach Point other than RW
MM = Middle Marker	TD = Touchdown Point Inboard of RW

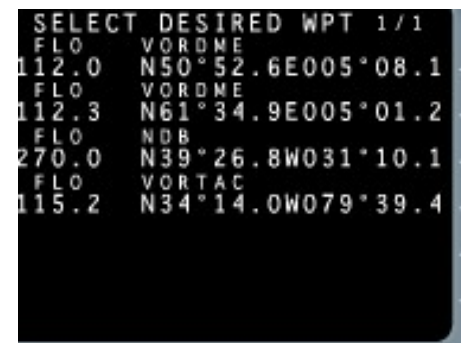
Examples ✧_{OM25L} ✧_{RW04}
✧_{MM09} ✧_{RW18L} } Runway-related fixes or waypoints located at unnamed runway-related fixes are identified by adding a 2-letter prefix to the runway number
✧_{IM23}

C() = Final Approach Course Fix	()B = Back Course ILS
F() = Final Approach Fix	()D = VOR / DME
P() = Missed Approach Point	()V = VOR only
I() = Initial Approach Point	()S = VOR with DME Points
D() = Minimum Descent Altitude	()N = NDB
T() = Touch Down Point	()Q = NDB with DME Points
R() = Runway Centerline Intercept	()M = MLS
()I = ILS	()T = Tacan
()L = Localizer only	()R = RNAV

Examples ✧_{CI32R}
✧_{PV15} } Airports with more than one approach to the same runway, 2 letter prefix may change to allow different identifiers for the same waypoint. The first letter identifies type of fix and the second letter identifies the type approach
✧_{FN24L}

Airport reference point (ARP): ICAO identifier is used

If more waypoint have the same name, SELECT DESIRED WPT page appear, where the correct waypoint can be chosen according to coordinate.



Manually entered data

N47°W008° = ✈️ N47W008 → Pilot defined waypoints entered as latitude and longitude display in 7 character format
entered as N47W008

N47°15.4' W008°3.4' = ✈️ N47W008 → Leading zeros must be entered. Digits and decimal points (to 1/10 minute) must be entered unless latitude or longitude are full degrees
entered as N4715.4W00803.4

SEA330/10 = ✈️ SEA01
 SEA330/OLM020 = ✈️ SEA02

Waypoints entered as a place bearing / distance or place bearing / place bearing are identified by first 3 characters of entry followed by 2-digit sequence number

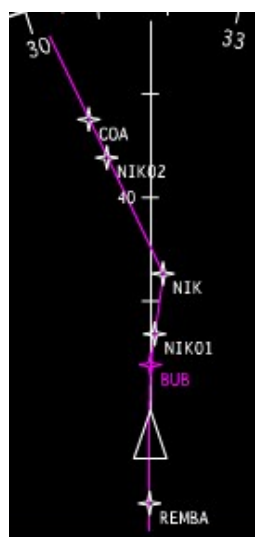
Along track waypoint are entered in CDU using the waypoint name followed by / and distance to waypoint, the entered distance is considered after the waypoint by default, if prior the waypoint is required, - must be entered before the distance. And they are named as waypoint name followed by serial number (ie. NIK01, NIK02....)

ie. NIK/25 : 25 NM after NIK

ie. NIK/-15 : 15 NM before NIK

NOTE: the entered distance must not exceed leg distance between active waypoint.

NOTE: modified waypoint appear in **WHITE**



MOD	RTE	LEGS	1/5
317°	UB	6.0NM	
321°		.789 / FL260	
321°	IK01	5.7NM	
		.789 / FL260	
291°	IK	15NM	
		.789 / FL260	
291°	IK02	25NM	
		.789 / FL260	
	OA	8.0NM	
		.789 / FL260	
ERASE		RTE DATA>	

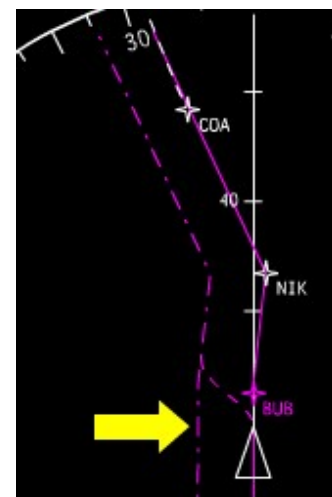
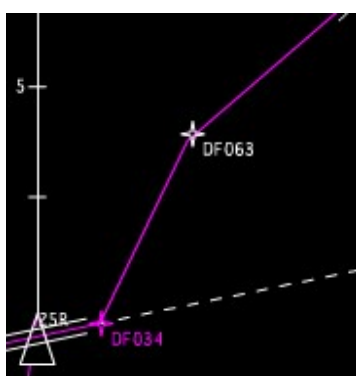
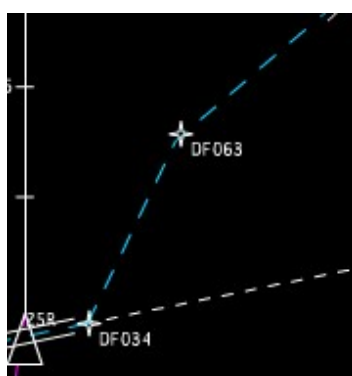
Route ND displays

Inactive and non-executed route displays dashed **CYAN**

Active and executed route displays in **MAGENTA**

Modification to an active route displays as dashed **WHITE**

Executed offset route are displayed as dot-dash **MAGENTA**



VNAV

Constrains

VNAV controls path and speed to comply with waypoint crossing constrains. Waypoint crossing constrains are entered on the right side of CDU LEGS page. Barometric constrains must be below cruise altitude to be valid.

- Manually entered or as part of a procedure constrains are displayed in large font
- FMC predicted value (do not act as restrictions) are displayed in small font

ACT	RTE	LEGS	1 / 4
250'		0.5NM	
DF134			
203'		5.4NM	
DF163		250 / FL100	
224'		17NM	
OLDAS		335 / FL116	
266'		13NM	
OLIVI		335 / FL137	
296'		19NM	
KIR		335 / FL164	
RNP / ACTUAL			
1.00 / 0.00NM			
		RTE DATA>	

EI-FTK through YW135

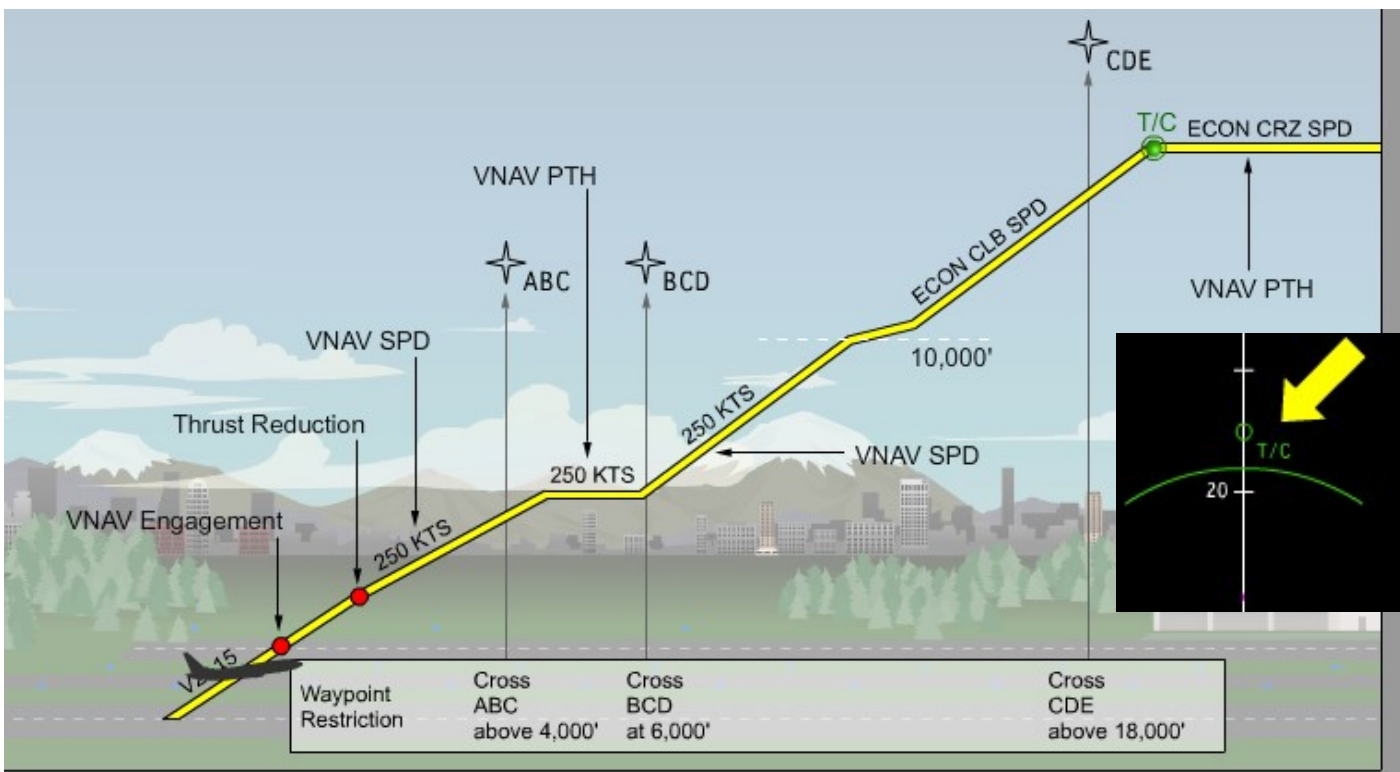
- Waypoint restriction is **MAGENTA** when it is active
- Modified waypoint restriction are shaded WHITE until they are executed

All speed restriction are considered by the FMC as "at or below" constrains.

Manually entered speed (enter / after digits) and altitude restriction require the same method to be entered:

- "at or above": entered with suffix A (250A/) (100A)
- "at or below": entered with suffix B (200B/) (150B)
- Mandatory restriction: entered without suffix
- Altitude restriction between 2 altitude: lower limit first (200A250B)

Takeoff and climb



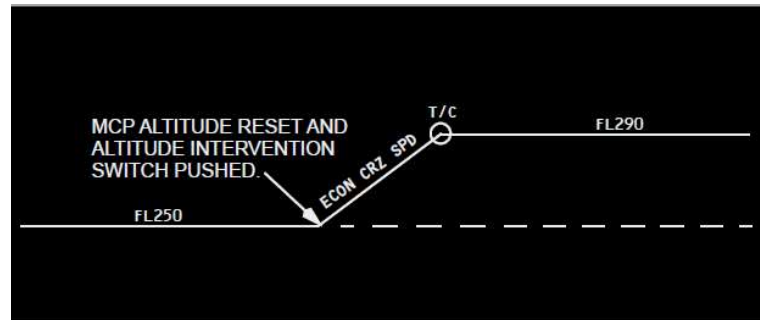
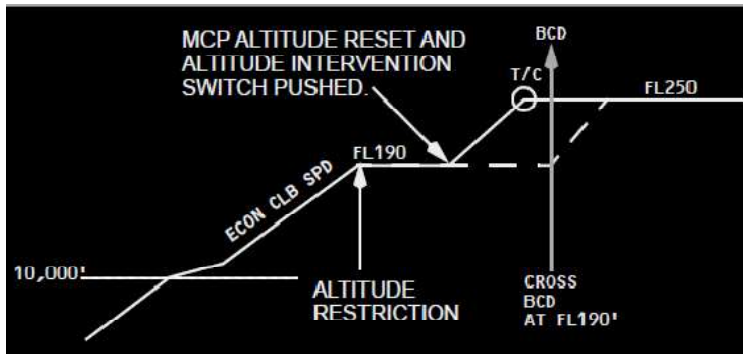
If armed for takeoff **VNAV** activates at 400 ft AGL:

- Climb thrust reduction is accomplished: manually pushing N1 or automatically at thrust reduction altitude
- VNAV climb profile uses VNAV SPD at the default climb speed or manually entered speed. A/T use selected climb thrust limit
- VNAV enter VNAV PTH to remain within departure altitude constrains, speed maintained during VNAV PTH is the procedure or waypoint constrain speed, default VNAV or entered speed
- When T/C is reached, CRZ phase begins (FMC displays T/C anytime a change from CLB to CRZ is computed)
- If the climb-speed profile cannot achieve an altitude restriction: UNABLE NEXT ALTITUDE appear

MCP altitude intervention (EI-FOC through YW135)

The altitude intervention will only apply to the active flight plan. The altitude intervention switch may be used during climb or descent to delete altitude restrictions between the current altitude and MCP altitude. If cleared to climb before restriction waypoint above altitude restriction, reset MCP altitude and push altitude intervention. If used during cruise, it increases the cruise altitude.

(basically altitude intervention allow to enter selected MCP altitude in the FMC and climb in VNAV)



EI-DAC through EI-FOB

Altitude intervention cannot be used to decrease cruise altitude, because FMC would enter an early descent.

EI-FOC through YW135

Altitude intervention enables both climb and descent to a new cruise altitude.

Descent will be allowed only if at a distance greater than 50 NM from T/D. if selected MCP altitude is below a descent constrain, the result of pressing altitude intervention will be an early descent to respect constrain, subsequent press may be used to delete this descent constrain.

MCP speed intervention

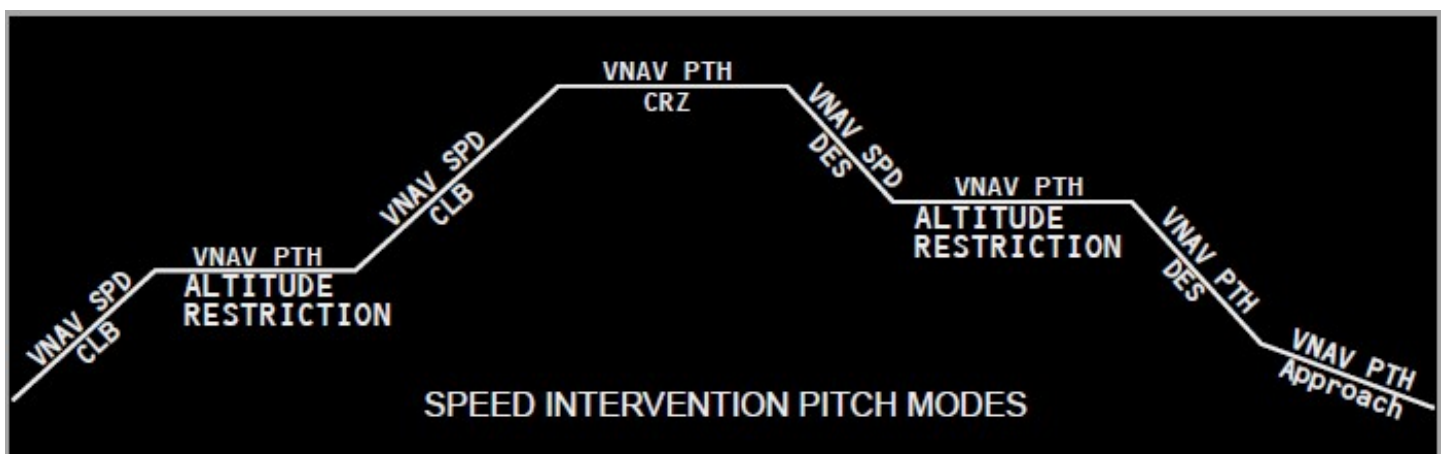
Speed intervention allows the flight crew to change airplane speed with IAS/MACH selector with VNAV engaged.

In a path descent using speed intervention, VNAV PTH changes to VNAV SPD:

- VNAV PTH: thrust control speed
- VNAV SPD: pitch control speed

EI-FOC through YW135

In approach phase, during speed intervention, the pitch mode remain in VNAV PTH. The FMC will remain in the current vertical mode regardless of IAS/MACH selector changes.



Cruise

At cruise altitude, FMC set cruise speed until reaching T/D, the A/T sets cruise thrust to maintain level flight at the target speed. Alternate cruise option are:

- LRC (long range cruise)
- MRC (maximum range cruise): if cost index is set to zero
- Flight crew entered speed

If a step-climb is entered, the FMC calculates step-point (where climb should begin) shown on NDs as S/C and on CRZ and PROGRESS pages.

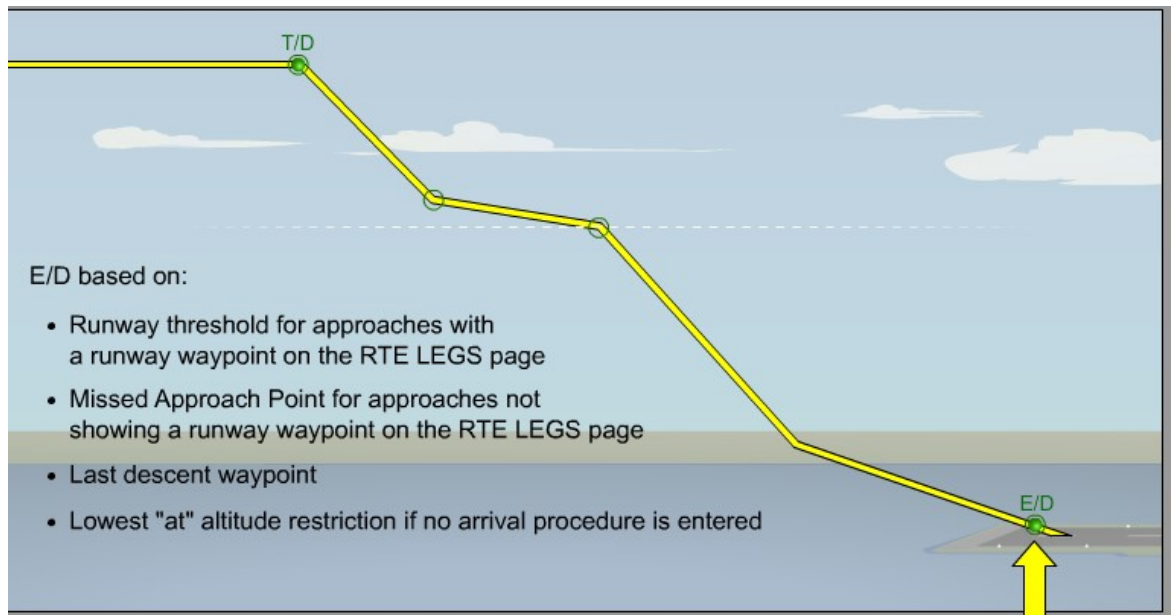


Descent

VNAV can perform a descent in either path or speed mode:

- Path descent:
 - FMC uses idle thrust and controls pitch to stay in the descent profile
 - Pilot must monitor and adjust speed
- Speed descent:
 - FMC uses idle thrust and controls pitch to stay at target airspeed
 - Pilot must monitor and adjust descent to stay on the profile

End of descent point (E/D) is calculated by the FMC as the last of:



Once the E/D is known, the FMC calculates T/D, where the FMC descent phase begins. The VNAV path is based on:

- Idle thrust
- Speedbrake retracted
- Decreasing wind-speed with decreasing altitude
- Applicable target speeds
- Constrains

Normally, the target speed is:

- ECON speed above the airspeed restriction altitude
- 240 Kts below the airspeed restriction altitude

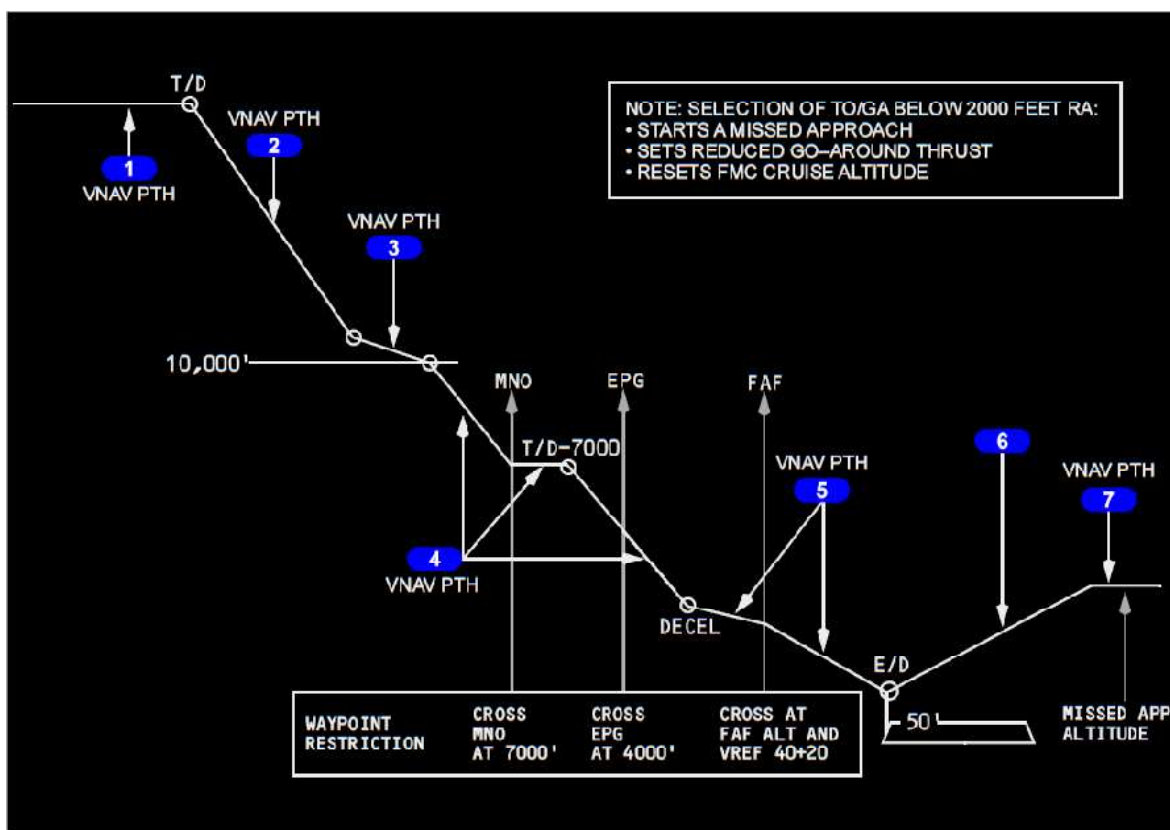
VNAV will not permit descent below airspeed restriction altitude until airspeed is below restricted value + 10. If a levelled deceleration segment is required, it is identified by two GREEN open circle.

Descent path assume deceleration (O DECEL) to reach FAF or G/S interception at $V_{ref_{flap40}} + 20$.

Target speeds are changed by entries on DESCENT page, these entries are "at or below". Wind and thrust assumption are changed in DES FORECAST page.

DRAG REQUIRED: appear in scratchpad when unexpected tailwind results in a significant increase in speed to maintain path

DES PATH UNACHIEVABLE: planned descent profile cannot be accomplished, VNAV disengages if a limit speed will be exceeded.

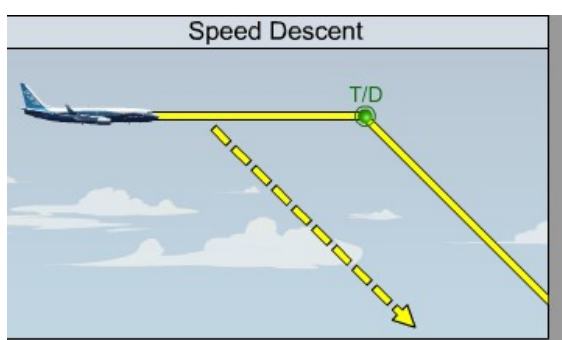
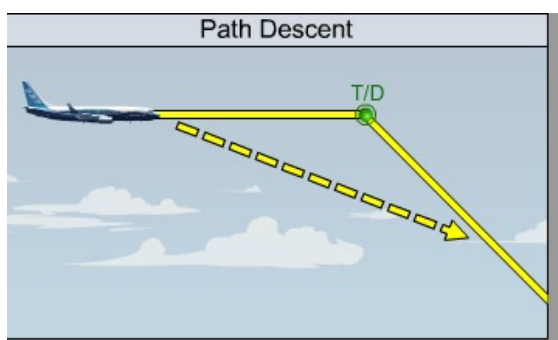


Early descent

If a VNAV descent is started before T/D:

- VNAV PTH is planned: VNAV commands 1000 ft/min until planned idle descent path is intercepted
- VNAV SPD is planned: VNAV commands an idle thrust descent

An early descent can be started by pushing: DES NOW prompt or ALT INTERV



Approach

The FMC approach mode begins when the aircraft is within:

- 2 NM of first approach waypoint (including transition), or
- 2000 ft of airport elevation

Whichever occurs first

When the FMC is “on approach”, the following features are available:

FMC "On Approach":

- UNABLE RNP alerting levels are higher
- When preparing for a missed approach and the MCP altitude is set at least 300 ft above the current airplane altitude
 - VNAV will continue to command a descent
- If the airplane is more than 200 ft below the vertical path
 - VNAV commands zero vertical speed until intercepting the path

FMC transitions out of "On Approach" when:

- 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

Go-around

Below 2000 ft RA, transition to go-around logic happens when:

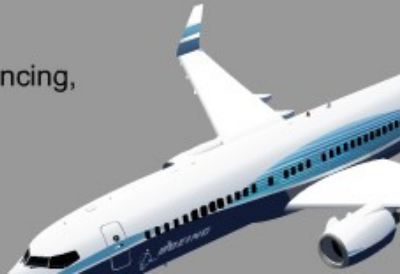
Transition to Go-Around logic:

- Pushing either TO/GA switch while in 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 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
- 

- 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 ft above airport elevation
 - The MCP altitude
-  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 ft above airport elevation



During go-around:

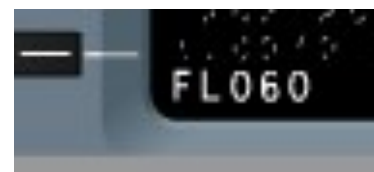
- LNAV may be engaged above 400 ft RA
- LNAV may be engaged after flap retraction

Data entry

Altitude entry

Altitude can be entered in the FMC as 3, 4 or 5 digit or as FL. The FMC automatically displays altitude or flight level according to transition altitude.

NOTE: maximum negative altitude allowed is – 1000 ft



Examples of 3 digit entries (transition altitude = 10,000 ft):

800 ft = 008 or FL008 → Entry (3 digit entries represent altitude in increments of 100 ft)
800 → Displayed as

1500 ft = 015 or FL015 → Entry
1500 → Displayed as

11,500 ft = 115 or FL115 → Entry
FL115 → Displayed as

25,000 ft = 250 or FL250 → Entry
FL250 → Displayed as

Examples of 4 digit entries (transition altitude = 18,000 ft):

50 ft = 0050 → Entry
50 → Displayed as

835 ft = 0835 → Entry
840 → Displayed as

1500 ft = 1500 → Entry
1500 → Displayed as

8500 ft = 8500 → Entry
8500 → Displayed as

9994 ft = 9994 → Entry
9990 → Displayed as

Examples of 5 digit entries (transition altitude = 4000 ft):

50 ft = 00050 → Entry 50 → Displayed as	9995 ft = 09995 → Entry FL100 → Displayed as
835 ft = 00835 → Entry 840 → Displayed as	11,500 ft = 11500 → Entry FL115 → Displayed as
1500 ft = 01500 → Entry 1500 → Displayed as	25,000 ft = 25000 → Entry FL250 → Displayed as
8500 ft = 08500 → Entry FL085 → Displayed as	

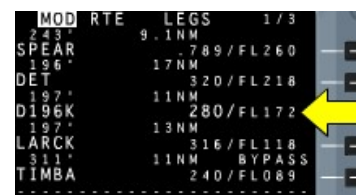
airspeed entry

airspeed can be entered as:

- calibrated airspeed: using 3 digits
- Mach number: using decimal point followed by 1, 2 or 3 digits

Data pairs

- To enter the outboard value: enter the value normally
- To enter the inboard value: enter the value followed by /
- To enter pairs: enter / between the values



Bearing

Bearing entries require 3 digits (if necessary enter leading 0), 360° is shown as 000.

Temperature

To enter a positive temperature: enter value normally

to enter a negative value: use leading -

FLIGHT MANAGEMENT – NON-NORMAL OPERATION

FMC requires continuous electric power to operate correctly, if power is interrupted and:

- Less than 10 seconds have elapsed: LNAV and VNAV disengage, FMC data are retained and FMC recover normal operation upon resuming power
- More than 10 seconds have elapsed:
 - i. On ground: all entries must be made again
 - ii. In-flight: LNAV and VNAV disengage, data are retained. Before LNAV and VNAV re-engagement it is necessary to instruct the FMC how to return on the active route

dual FMC failure (QRH 11.4)

FMC P/RST	FMC FAIL - Dual
(For ACFT dispatched under Dual FMC Ops)	
Condition:	Display of VTK followed by MAP failure flags on one or both navigation displays.
Objective:	To restore dual FMC operation, configure for single FMC operation or resume conventional navigation.

Note: LNAV/VNAV may disengage.

- 1 Check both navigation display MAP modes and FMC CDUs.
- 2 Choose one:
 - ◆ No FMC data on the captain's and first officer's navigation display MAP modes **and** no FMC data on both CDUs:
Both FMCs are failed.
▶▶ **Go to step 7**
 - ◆ No FMC data on the captain's navigation display MAP mode **and** no FMC data on both CDUs:
Left FMC is failed.
▶▶ **Go to step 3**
 - ◆ No FMC data on the first officer's navigation display MAP mode, MSG light is illuminated **and** SINGLE FMC OPERATION scratchpad message is shown:
Right FMC is failed.
▶▶ **Go to step 3**
- 3 FMC source
select switch BOTH ON L or BOTH ON R
Select the operating FMC.
- 4 **Wait** 1 minute.
- 5 Check for FMC-L and FMC-R bearing/distance information on POS SHIFT page 3/3.

- 6 Choose one:

◆ Bearing/distance information for **both** FMCs are displayed:

FMC source select switch NORMAL
■ ■ ■ ■

◆ Bearing/distance information for only a **single** FMC is displayed:

Continue with single FMC operation.
■ ■ ■ ■

- 7 Resume conventional navigation. Without an operating FMC, LNAV and VNAV are not available.
- 8 Verify position relative to terrain using conventional navigation.

Note: EGPWS may use inaccurate GPS position data or an inappropriate value of RNP. This could result in a VSD terrain display that is incorrectly positioned relative to the airplane track.

- 9 **When** preparing for the approach:

Use the SPD REF selector to set the current gross weight.

Use the SPD REF selector to set the reference airspeed bugs.

Use the N1 SET selector to set the N1 bugs.
■ ■ ■ ■

Single FMC failure (QRH 11.3)

FMC
P/RST

FMC FAIL - Single

(For ACFT dispatched under Single FMC Ops)

Condition: One or more of these occur:

- Loss of FMC data on a CDU
- Loss of FMC data on a navigation display map mode
- Illumination of the FMC alert light.

- 1 Resume conventional navigation. Without an operating FMC, LNAV and VNAV are not available.
- 2 Verify position relative to terrain using conventional navigation.

Note: EGPWS may use inaccurate GPS position data or an inappropriate value of RNP. This could result in a VSD terrain display that is incorrectly positioned relative to the airplane track.

- 3 **When** preparing for approach:

Use the SPD REF selector to set the current gross weight.

Use the SPD REF selector to set the reference airspeed bugs.

Use the N1 SET selector to set the N1 bugs.



COMMUNICATIONS – SYSTEM DESCRIPTION

Overview

A dedicated audio control panel (ACP) is provided for the captain, first officer and observer. Headsets or headphones jacks are available for each station, with speaker above the captain and first officer seats.

Microphone are either boom, hand-held or incorporated in the oxygen mask.

GPWS, altitude alerts, TCAS and windshear warning are heard through headsets and speakers at a fixed volume which cannot be changed or silenced.

The FLIGHT (FLT) interphone system provide private communication in the flight deck.

The SERVICE (SVC) interphone system provide communication between flight deck and cabin crew or ground personnel.

Passengers address (PA) is used to make passengers announcements.

A call system is provided to call cabin crew or ground personnel advising them that interphone communication is required.

VHF communication is available for short range communication ad HF is available for long range communication.

A SELCAL system is installed.

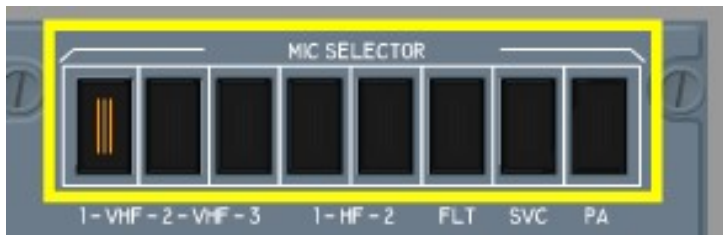
Cockpit voice recorder (CVR) records audio from flight deck area and store in memory the last 120 minutes.

Audio control panels (ACPs)

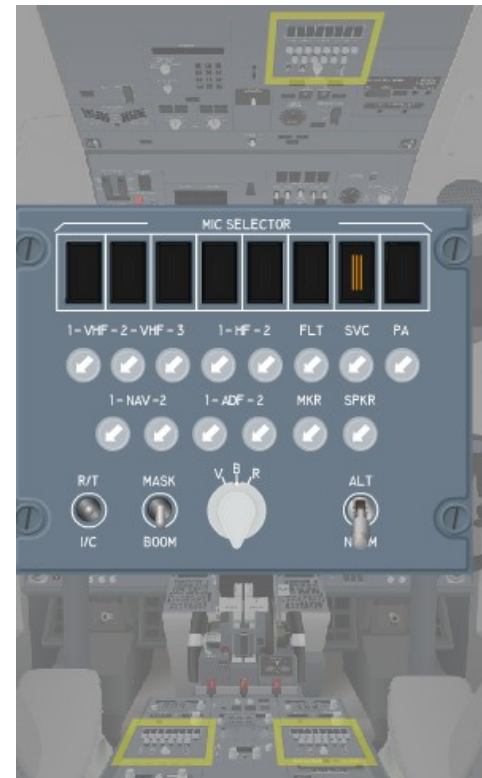
3 ACPs are available, 1 on the overhead and 2 on the centre console station. A remote electronic unit in the E & E bay contains audio system for ACPs.

Controls and indications

Transmitter selector (MIC SELECTOR) switches are illuminated when active, only one may be selected at a time.



Receiver switches are illuminated when active, more than one receiver may be selected at a time.



The push to talk (PTT) switch:

- R/T (radio/transmit): keys oxygen mask or boom microphone for transmission as selected by MIC SELECTOR
- I/C (inter/comm.): keys oxygen mask or boom microphone for direct transmission over FLIGHT interphone and bypasses transmitter selector

EI-DAC through EI-DLO: Spring loaded to neutral (NOTE **not** valid*)

EI-DLE through EI-DLO: spring loaded to neutral (*NOTE valid)

EI-FOB through YW135: spring loaded (R/T) / manually latch (I/C) to neutral position

EI-DLR through EI-FOA: R/T switch is spring loaded to neutral, switch latches in the I/C position.



*NOTE: the key-line timer limits VHF transmission to approximately 35 seconds. Approximately 25 to 30 seconds after any PTT is selected, the trans-receiver makes an aural tone which continues for 5 seconds. When the stops also the transmission stops and the radio is set to receiver mode automatically. The radio remains in receiver mode until the PTT is released and selected again.

MASK/BOOM switch allow selection between boom or oxygen mask microphone

The speaker (SPKR) is directly controlled by the switch/knob



ALT/NORM switch:

- NORM: related ACP operates normally
- ALT: relative ACP operates in degraded mode



Filter switch:

- V (voice): allow reception of NAV and ADF voice audio
- B (both): allow reception of NAV and ADF voice and range audio
- R (range): allow reception of NAV and ADF range audio (station Morse identifier)



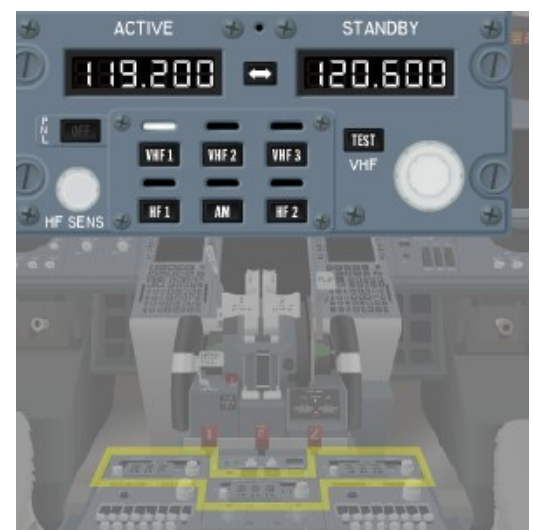
Radio tuning panel

VHF and HF communications are controlled through radio tuning panels.

Antennas locations are:

- HF: on the vertical stabiliser (fin)
- VHF 2 and VHF 3: on the lower fuselage
- VHF 1: on the upper fuselage

Pushing the radio tuning switch, tunes the associated radio and light illuminate.



The frequency selector knob allow STANDBY frequency setting:

- Outer knob: set second and third digit in 1 MHz increments
- Inner knob: set forth, fifth and sixth digit in 8.33 KHz increments



The radio tuning panel is disconnected from the radio when the radio tuning panel switch is **OFF** (light illuminated)



HF SENS knob set the on-side HF receiver sensitivity.

Off-side tunign light illuminate when:

- Radio normally associated with the associated panel is being used by another radio tuning panel
- Using the associated radio tuning panel to tune a radio not normally associated with it



VHF TEST switch removes the automatic squelch, background noise indicate that the receiver is operating, may also be used to receive weak signals.



The HF AM switch:

- Select amplitude modulation (AM) when light is on
- Select upper side band modulation (USB) when light is off

"INOP" ↔ "INOP" annunciation indicates that the radio is not available

"PANEL" ↔ "FAIL" annunciation indicates that the radio tuning panel has failed



Cockpit voice recorder (CVR)

CVR controls are located on the overhead panel.

Cockpit voice recorder switch:

- AUTO: the recorder operate from first engine start to 5 minutes after last engine shut down.
- ON: recording start immediately, when first engine start, switch trips to AUTO



CVR microphone operate according to cockpit voice recorder switch

ERASE button: all four recording channel data are erased after 2 seconds. It operates only on the ground with parking brake set

TEST button: in order to perform CVR test, CVR must be operating. If no fault are detected, the STATUS light illuminate momentarily and a tune may b heard though CVR HEADPHONE jack.

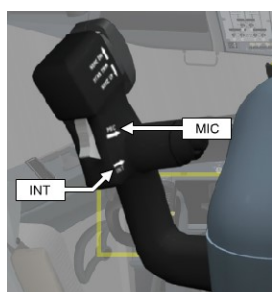
HEADPHONE jack is provided to monitor playback of voice recorder audio

STATUS light: illuminate momentarily if no fault are detected during CVR TEST

Interphone and PA

FLT interphone

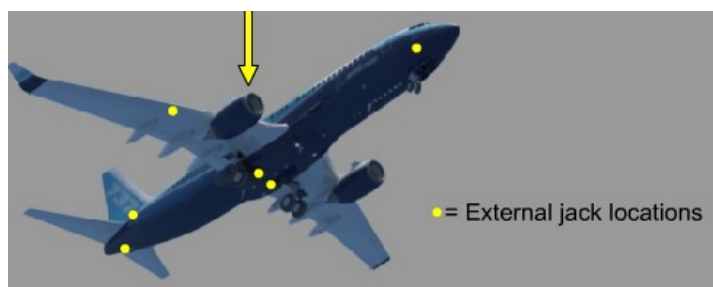
FLIGHT interphone system is independent from other communication networks. It provides private communication between the flight deck crew member without intrusion from the service interphone system. The ground crew may also use the FLIGHT interphone through a jack at the external power receptacle.



SVC interphone

SERVICE interphone may be used by cabin crew or ground crew to communicate with flight deck.

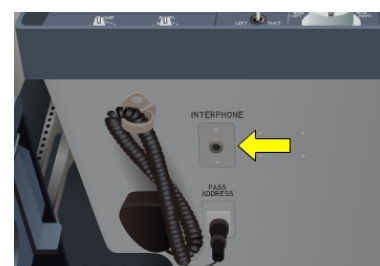
SERVICE interphone is selected either by pushing the control wheel PTT INT position or by selecting SVC transmitter selector.



SERVICE interphone switch:

OFF: external jacks are disconnected
ON: external jacks are connected to the system

A SERVICE interphone jack located on the central console, if used, bypasses ACP and with SVC ON, it can be used for ground communication.



Public address (PA)

From the flight, PA announcements are made by using a PA handset or by selecting PA on ACP transmitter.

PA are prioritised in this order:

1. Flight crew PA
2. Flight attendant PA
3. Passengers calls
4. Music

A PA hand microphone located on the control stand, bypasses ACPs and can be used for PA announcements.



Call system

A call may be initiated from: flight deck, flight attendant seats or external power receptacle.

Ground and cabin crew can call the flight deck. Only flight deck can call ground crew.

GRD CALL button: sounds an “horn” in the nose wheel well until button is released

ATTEND: sounds a two-tone chime in the cabin, **PINK** light illuminate

“**CALL**” illuminates when either ground or cabin crew are calling the flight deck

When ground call flight deck, PILOT CALL switch is used and a single-tone chime sounds

When cabin call flight deck, cabin handset button “2” is used, a single-tone chime sounds



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	None	Horn in NW Well
Attendant Station	Flight Deck	Blue Flight Deck Call Light	Single high-tone chime
Ext Power Panel	Flight Deck	Blue Flight Deck Call Light	Single high-tone chime
Flight Deck	Cabin	NO SMOKING or FASTEN BELT signs ON or OFF	Single high-tone chime

Call to flight attendant are identified by lights in the cabin.

Master Call Lights

- Pink - flight deck or other flight attendant station is calling
- Blue - a passenger seat call switch is activated
- Amber - a lavatory call switch is activated



COMMUNICATIONS – NORMAL PROCEDURE

Audio control panels (ACPs)

ACP function independently and each have a separate CB.

MIC SELECTOR

MIC SELECTOR can select one radio at a time, when selected, any microphone connected to the ACP may be keyed to transmit. When a transmitter is selected, associated receiver is automatically activated.

Any receiver can be used together, receiver switch:

- When pushed: select/deselect associated receiver unit and light illuminate/extinguishes
- When rotated: adjust associated receiver volume

SPKR switch function as receiver switch.

MASK/BOOM switch: change from boom and mask microphone, this does not affect operation of hand microphone.

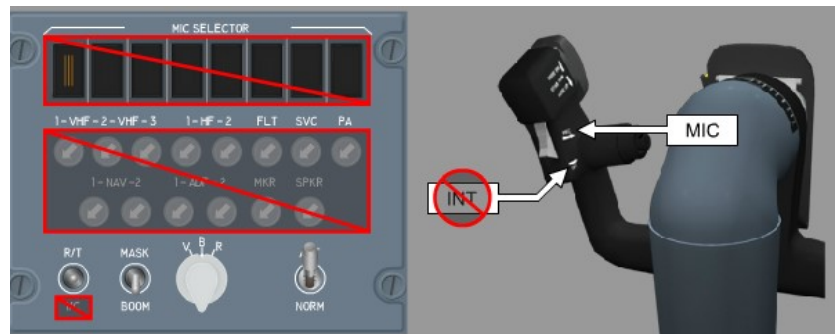
Degraded mode operation

The ACP cannot control remote electronic unit if either the ACP or the electronic unit has a malfunction. Degraded mode is activated by moving the NORM/ALT switch on ALT, when ALT is selected:

- Transmitter selectors (MIC SELECTOR) are not functional, only usable radio transmitter illuminate
- Receivers, SPKR, interphones and PA cannot be used
- Only usable radio is heard at a preset unchangeable volume through the headset
- Warning are not heard on degraded ACP
- Intercom switches are inoperative (I/C and INT on control wheel)
- MASK/BOOM switch work normally

During degraded mode:

- Captain and observer radio: uses VHF 1
- First officer radio: uses VHF 2



Radio communication system

During ground operation, primary communication means should be VHF 1 since the antenna is on the upper fuselage.

Selecting an HF communication will power the HF antenna, a tune is heard, lasting up to 7 seconds. If HF fails to tune, the tone last more than 7 seconds up to 15 seconds.

Interphone and PA systems

SERVICE interphone MIC SELECTOR (SVC) is used to communicate through service interphone.

PA can be selected on MIC SELECTOR (PA) or using PA handset.



Call system

SELCAL (selective call)

SELCAL may be used on VHF or HF. The ground station use SELCAL to transmits a unique four letter code. When called, the relative radio's light illuminate and a two-tone chime sounds.

Pressing the relative radio button, extinguish the light



COMMUNICATIONS – NON-NORMAL OPERATION

Stuck microphone (QRH 5.1)

Radio Transmit Continuous (Stuck Microphone Switch)

Condition: A radio transmits continuously without crew input.

- 1 MIC SELECTOR switches
(all audio selector panels)FLT INT

This deselects radios and stops radio transmissions.

Note: The microphone/interphone with the stuck switch continuously transmits on flight interphone.

- 2 The associated audio selector panel should stay on flight interphone. All other audio selector panels may be used normally.

