Bombardier CRJ700
REFERENCE INFORMATION

For detailed instructions on how to fly this aircraft, see the **Aircraft Information** articles in the **Learning Center.** For standard procedures, see the Checklists tab.

Total Flight Simulator aircraft weight with full fuel	**75,250 lbs**

NOTE: To adjust fuel load, on the **Aircraft** menu, click **Fuel and Load**.

V_{MO} - Maximum Operating Speed	**335 KIAS**
M_{MO} - Maximum Operating Speed Mach	**.85 Mach**
Turbulent Air Penetration Speed	**280 KIAS/.85 Mach**
V_{LO} - Maximum Gear Operating Speed	**220 KIAS/.41 Mach**
V_{LE} - Maximum Landing Gear Extension Speed	**220 KIAS/.41 Mach**

Maximum Flap Placard Speeds

Flaps degrees	KIAS
1	**230**
8	**230**
20	**230**
30	**185**
45	**170**

V_1 - Takeoff Decision Speed dry runway

Standard temperature, sea level pressure altitude

40,000 lbs (flaps 8)	**124 KIAS**
40,000 lbs (flaps 20)	**115 KIAS**

Standard temperature, 5,000' pressure altitude

50,000 lbs (flaps 08)	**144 KIAS**
50,000 lbs (flaps 20)	**134 KIAS**

V_R - Rotation Speed dry runway

Standard temperature, sea level pressure altitude

40,000 lbs (flaps 8)	**124 KIAS**
40,000 lbs (flaps 20)	**117 KIAS**

Standard temperature, 5,000' pressure altitude

50,000 lbs (flaps 8)	**144 KIAS**
50,000 lbs (flaps 20)	**135 KIAS**

V_2 - Minimum Climb Speed dry runway

Standard temperature, sea level pressure altitude

40,000 lbs (flaps 8)	**138 KIAS**
40,000 lbs (flaps 20)	**127 KIAS**

Standard temperature, 5,000' pressure altitude

50,000 lbs (flaps 8)	**154 KIAS**
50,000 lbs (flaps 20)	**143 KIAS**

V_{REF} - Landing Approach Speed gear down

59,000 lbs (flaps 45)	**125 KIAS**
61,000 lbs (flaps 45)	**128 KIAS**
73,000 lbs (flaps 45)	**141 KIAS**
77,000 lbs (flaps 45)	**145 KIAS**

NOTE: For explanations of speeds used on this tab, see "V-speeds" in the **Learning Center Glossary**.

BOMBARDIER CRJ700 PROCEDURES

For detailed instructions on how to fly this aircraft, see the BOMBARDIER CRJ700 Aircraft Information articles in the Learning Center. For suggested speeds, see the **Reference** page of the Kneeboard. Note that most actions can also be performed using the mouse.

To...	**Press...**
Display/hide main panel	**SHIFT+1**
Display/hide radios	**SHIFT+2**
Display/hide GPS	**SHIFT+3**
Display/hide engine controls	**SHIFT+4**
Display/hide overhead panel	**SHIFT+5**
Display/hide backup PFD	**SHIFT+6**
Display/hide PFD	**SHIFT+7**
Display/hide MFD	**SHIFT+8**
Display/hide EFIS	**SHIFT+9**

[ ] Thrust

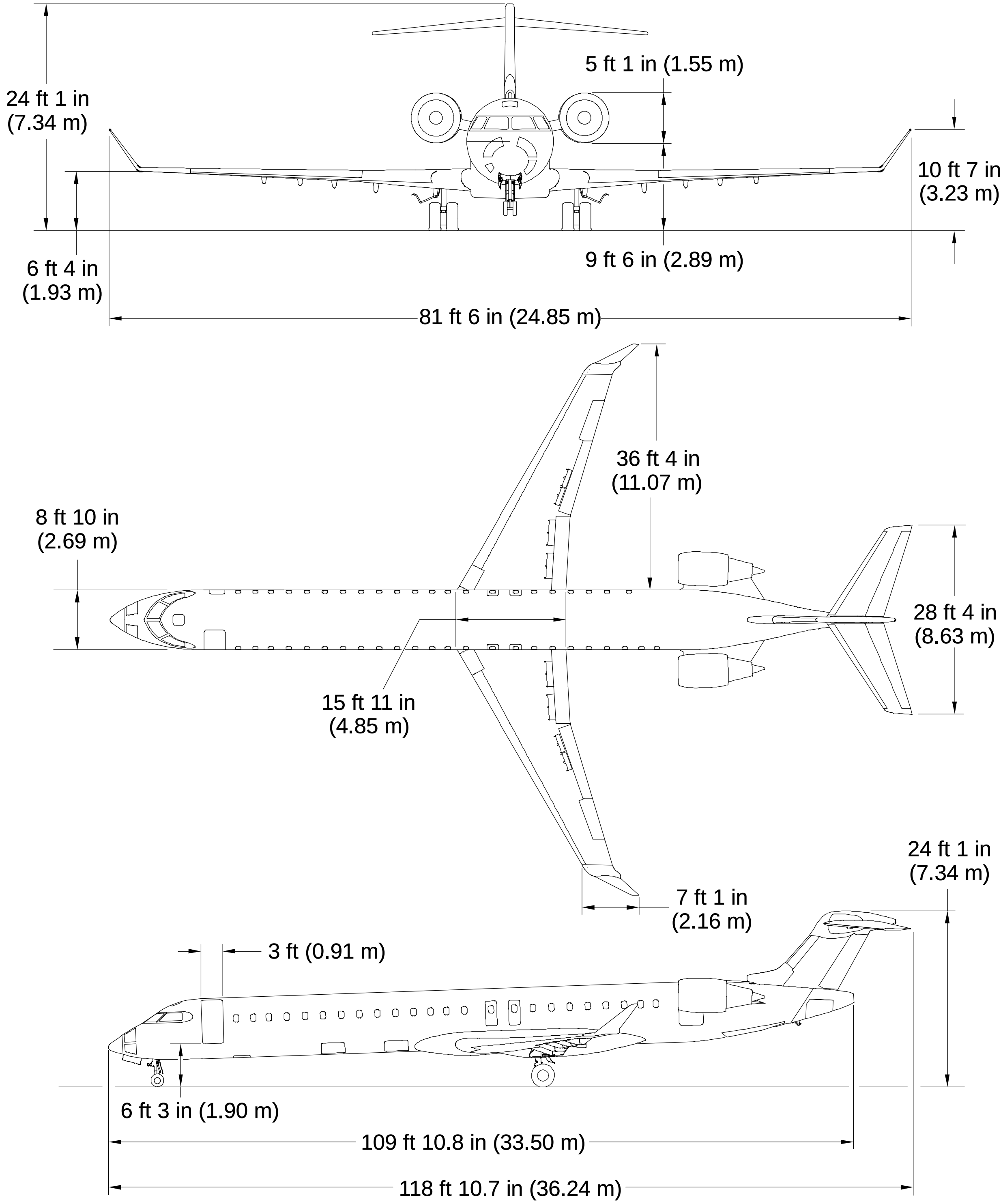
PUSHBACK (if parked at a gate)	
[ ] Pushback	**REQUEST** (press **SHIFT+P**, then **1** for tail-left or **2** for tail-right, then press **SHIFT+P** to stop)
BEFORE START	
[ ] Parking Brake	**SET** (press **CTRL+PERIOD** key)
ENGINE START	
Press **CTRL+E** to initiate engine autostart sequence.	
AFTER START	
[ ] De-ice	**AS REQUIRED**
[ ] Flight Controls	**CHECK**
[ ] Autopilot	**SET AND OFF**
[ ] Instruments	**CHECKED**
[ ] Avionics Switch	**ON**
[ ] Avionics	**SET** (press **SHIFT+2** to display radio stack)
[ ] Trim	**SET**
[ ] Beacon Light Switch	**ON**
BEFORE TAKEOFF	
[ ] Flaps	**SET FOR TAKEOFF** (press **F7** as necessary)
[ ] Bleeds	**Set**
TAKEOFF	

[ ] Brakes	**RELEASE** (press **PERIOD** key)
[ ] Strobe Lights	**ON**
[ ] Transponder	**ALT** (press **SHIFT+2** to display radio stack)
[ ] Thrust Levers	**VERIFY CORRECT FOR TAKEOFF**
[ ] Airspeed 80 KIAS	**CALLOUT "80 KNOTS"**
[ ] Airspeed V1	**CALLOUT "V1"**
[ ] Airspeed VR	**CALLOUT "ROTATE"**
--ROTATE TO APPROX. 10 DEGREES PITCH UP--	
[ ] Airspeed V2	**CALLOUT "V2"**
[ ] Landing Gear	**UP (WHEN POSITIVE CLIMB ESTABLISHED)** (press **G**)
[ ] Autopilot Heading Select switch	**ON IF DESIRED**
[ ] Airspeed	**MAINTAIN V2+15 KIAS**
[ ] Autopilot	**ENGAGE**
[ ] Flaps	**START RETRACT ON SCHEDULE AT 1,000' AGL** (press **F6** as necessary)
[ ] Bleeds	**AS REQUIRED** (press **F6** as necessary)
CLIMB	
[ ] Landing Lights	**OFF ABOVE 10,000' MSL**
[ ] Altimeter	**SET TO 29.92 CROSSING 18,000' MSL**
CRUISE	
[ ] Thrust Levers	**AS DESIRED** (press **F2** or **F3** as necessary)
[ ] Trim	**AS NECESSARY** (press **Num Pad 6** or **Num Pad 7** as necessary)
DESCENT	
[ ] Airspeeds (VREF, VAPP)	**COMPUTED AND SET** (see the Reference page of the Kneeboard)
[ ] Autobrake	**AS DESIRED**
[ ] De-ice	**AS REQUIRED**
[ ] Autopilot	**AS DESIRED**
[ ] Thrust Levers	**AS DESIRED** (press **F2** or **F3** as necessary)
[ ] Altimeter	**SET TO LOCAL SETTING CROSSING 18,000' MSL**
[ ] Avionics	**SET** (press **SHIFT+2** to display radio stack)
[ ] Airspeed	**<250 KIAS BELOW 10,000' MSL**

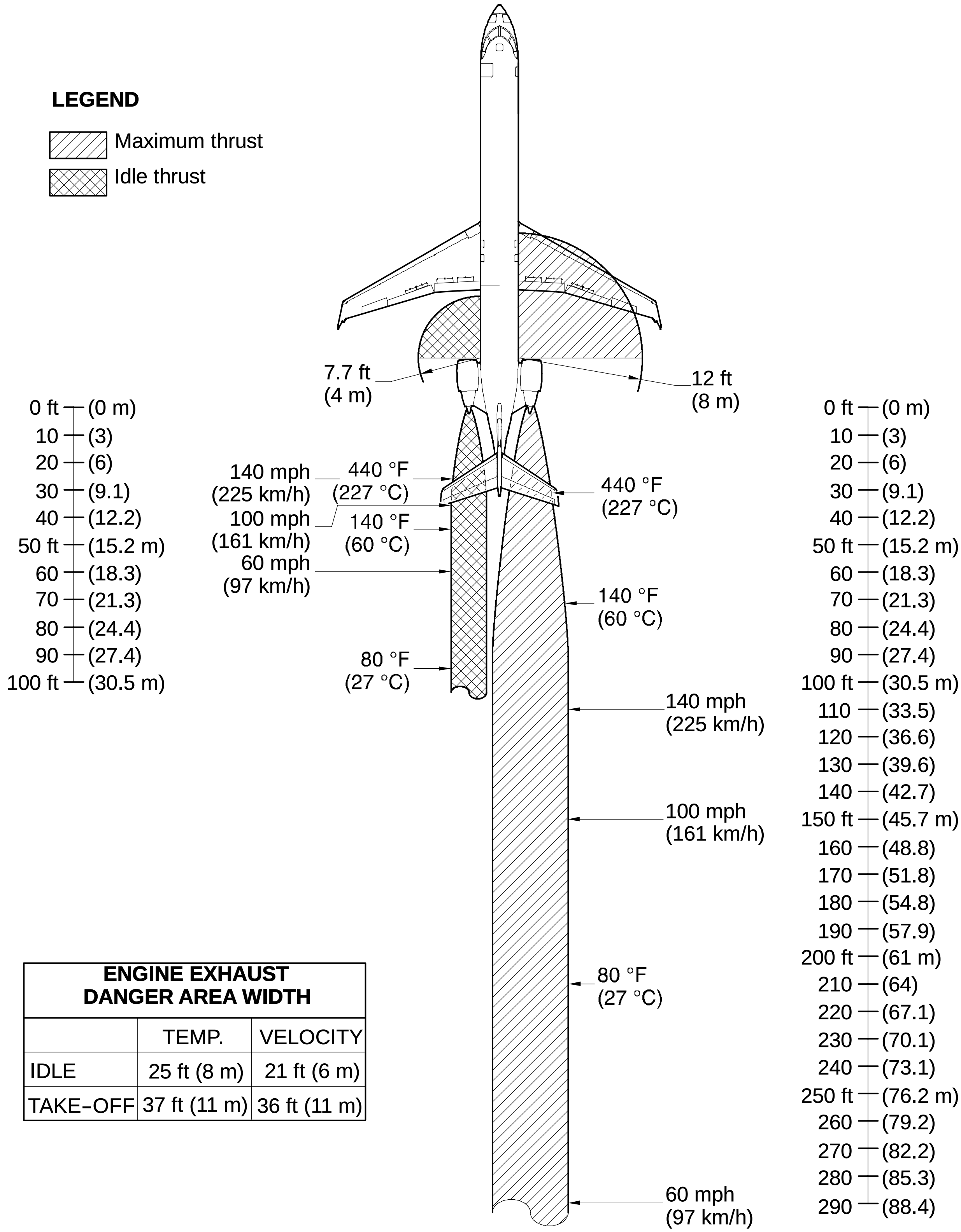
[ ] Landing Lights	**ON BELOW 10,000' MSL**
[ ] Approach Procedure	**REVIEW**
APPROACH	
[ ] Airspeed	**AS DESIRED**
[ ] Thrust Levers	**AS DESIRED** (press **F2** or **F3** as necessary)
[ ] Flaps	**AS DESIRED** (press **F7** as necessary)
[ ] Autopilot	**AS DESIRED**
LANDING	
[ ] Airspeed	**AS DESIRED**
[ ] Thrust Levers	**AS DESIRED** (press **F2** or **F3** as necessary)
[ ] Landing Gear	**DOWN and CONFIRMED** (press **G**)
[ ] Flaps	**AS DESIRED** (press **F7** as necessary)
[ ] Autopilot	**AS DESIRED**
LANDING ROLL	
[ ] Thrust Levers	**CLOSED** (press **F2** or **F3** as necessary)
[ ] Autothrottle	**CHECK OFF**
[ ] Speedbrake Lever	**CHECK FULL UP** (press **SHIFT+**/ [**FORWARD SLASH** key] if necessary)
[ ] Thrust Levers	**REVERSE** (press **F2** until Reverse)
[ ] Thrust Levers	**IDLE AT 60 KIAS** (press **F3** until Idle)
[ ] Autobrake	**OFF**
[ ] Brake	**AS NECESSARY** (press **PERIOD** key)
[ ] Autopilot	**CHECK DISENGAGED**
TAXI-IN	
[ ] Speedbrake Lever	**DOWN** (press **/** [**FORWARD SLASH** key])
[ ] Lights	**AS DESIRED**
[ ] Flap Lever	**UP** (press **F6** until Up)
[ ] Transponder	**STBY**
PARKING	
[ ] Parking Brake	**SET** (press **CTRL+PERIOD KEY**)
[ ] Fuel Control Switches	**CUTOFF** (press **CTRL+SHIFT+F1**)
[ ] De-ice	**OFF**
[ ] Lights	**AS REQUIRED**

[ ] Flight Director	**OFF**

NOTE: This aircraft's real-world checklists have been modified for use with Flight Simulator.



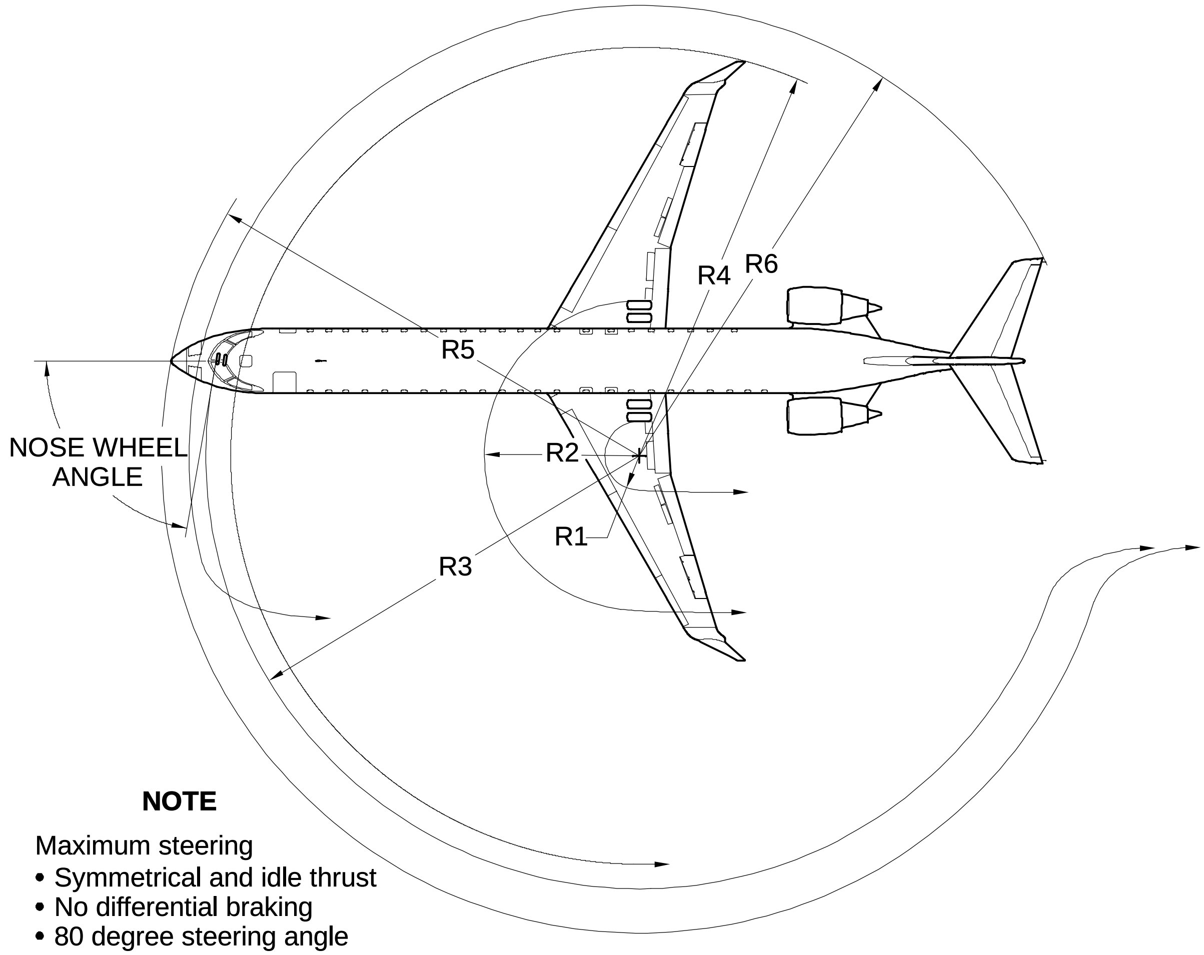
External Aircraft Dimensions <2224>
Figure 01–20–1



ENGINE EXHAUST DANGER AREA WIDTH

	TEMP.	VELOCITY
IDLE	25 ft (8 m)	21 ft (6 m)
TAKE–OFF	37 ft (11 m)	36 ft (11 m)

Engine Hazard Areas <2224>
Figure 01–20–2

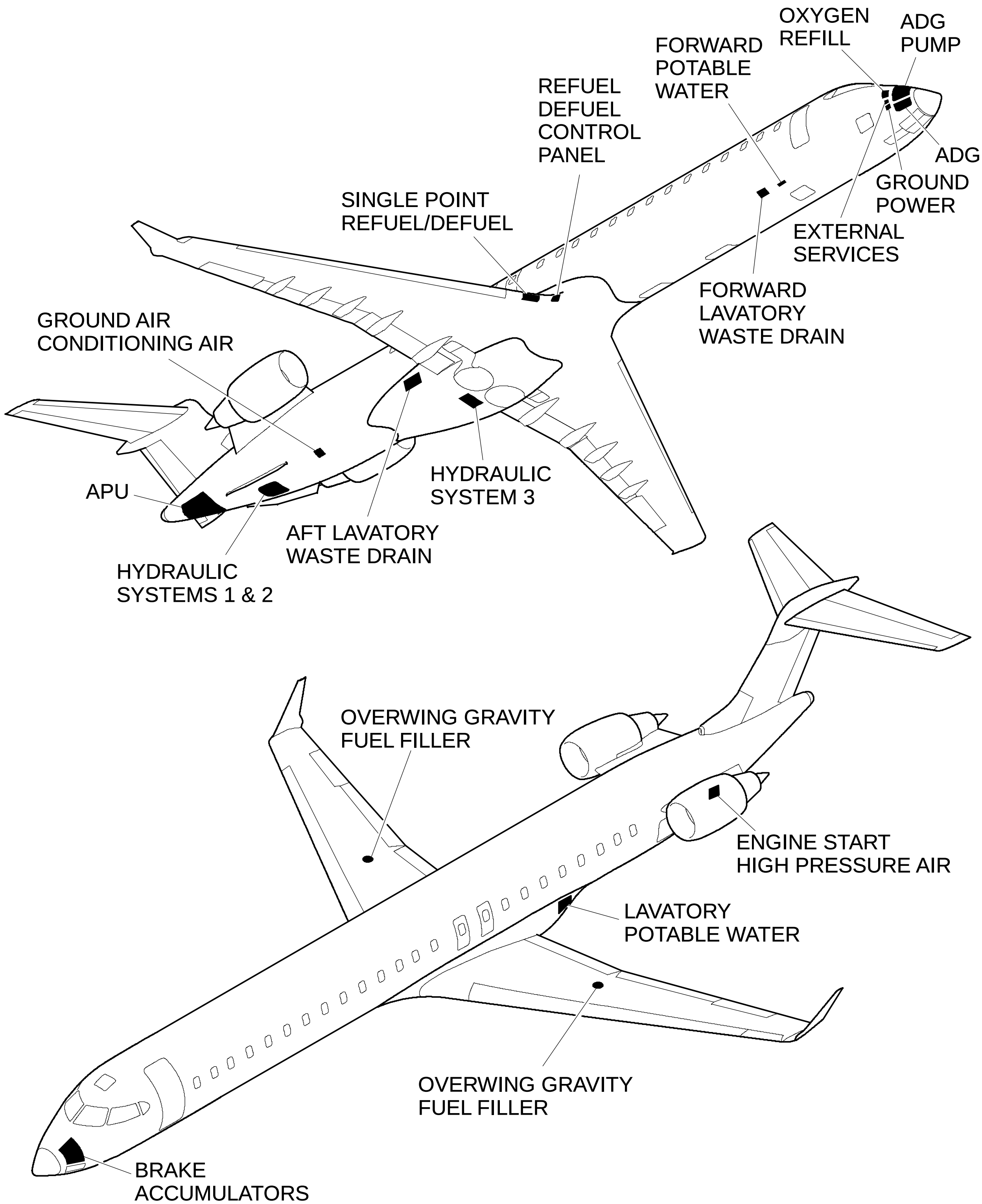


NOTE

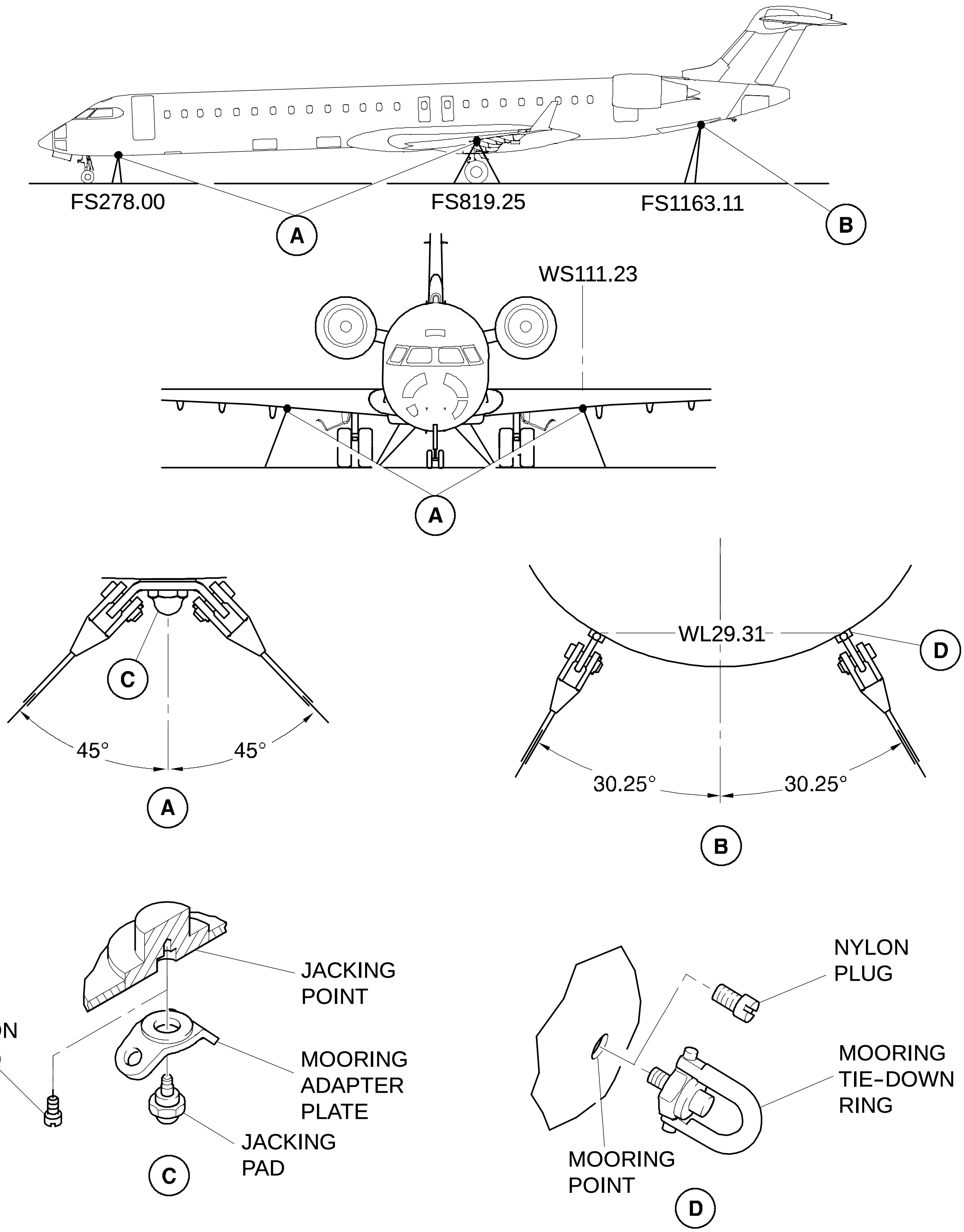
Maximum steering
- Symmetrical and idle thrust
- No differential braking
- 80 degree steering angle
- Slip of 3 degrees
- Dry runway
- Slow continuous turn
- Maximum airplane weight
- Aft center of gravity

TURNING RADII FOR VARIOUS NOSE WHEEL ANGLES												
ANGLE	R1		R2		R3		R4		R5		R6	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
20°	147.13	44.85	163.55	49.85	166.24	50.67	197.18	60.10	167.93	51.19	177.70	54.16
30°	89.70	27.34	106.10	32.34	114.01	34.75	139.76	42.59	116.85	35.62	124.41	37.92
40°	59.11	18.02	75.53	23.02	88.91	27.10	109.30	33.31	92.75	28.27	97.98	29.86
50°	39.15	11.93	55.57	16.94	74.77	22.79	89.49	27.27	79.45	24.22	82.29	25.08
60°	24.32	7.41	40.74	12.42	66.27	20.20	74.85	22.81	71.61	21.83	72.02	21.95
70°	12.24	3.73	28.65	8.73	61.17	18.64	63.00	19.20	66.99	20.42	64.96	19.80
80°	4.69	1.43	21.10	6.43	59.05	18.00	54.84	16.71	65.08	19.84	61.35	18.70

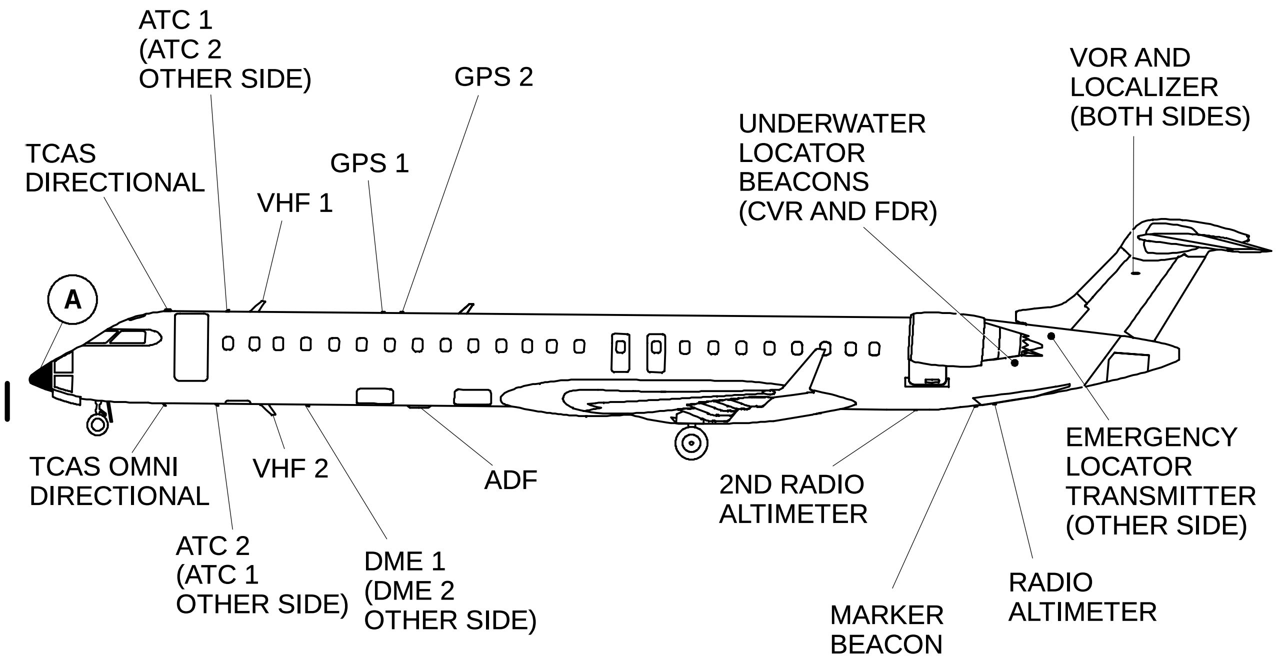
Taxiing and Turning Radii
Figure 01–20–3

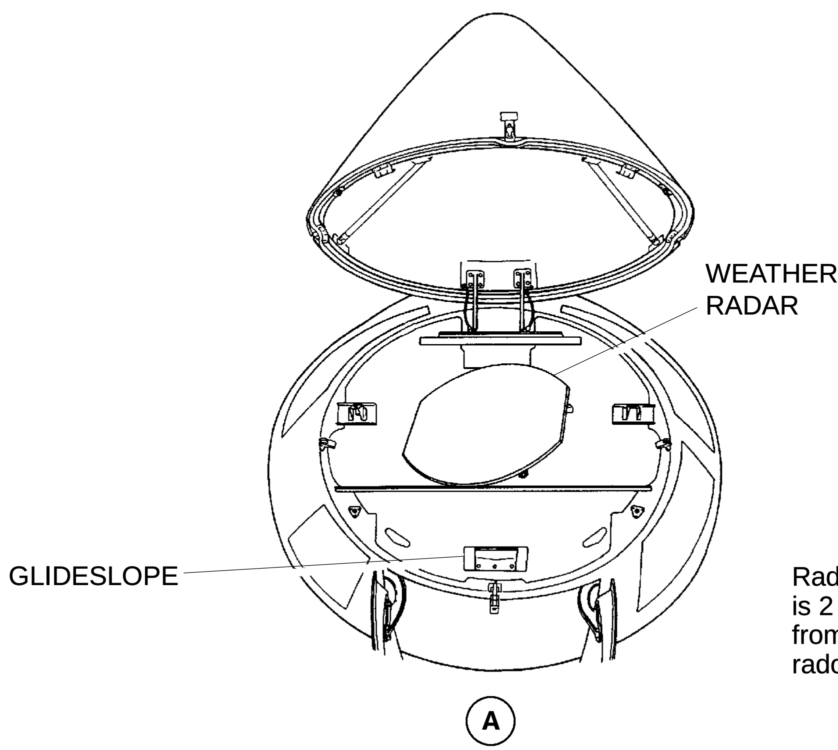


Airplane Service Points <2224>
Figure 01−20−4



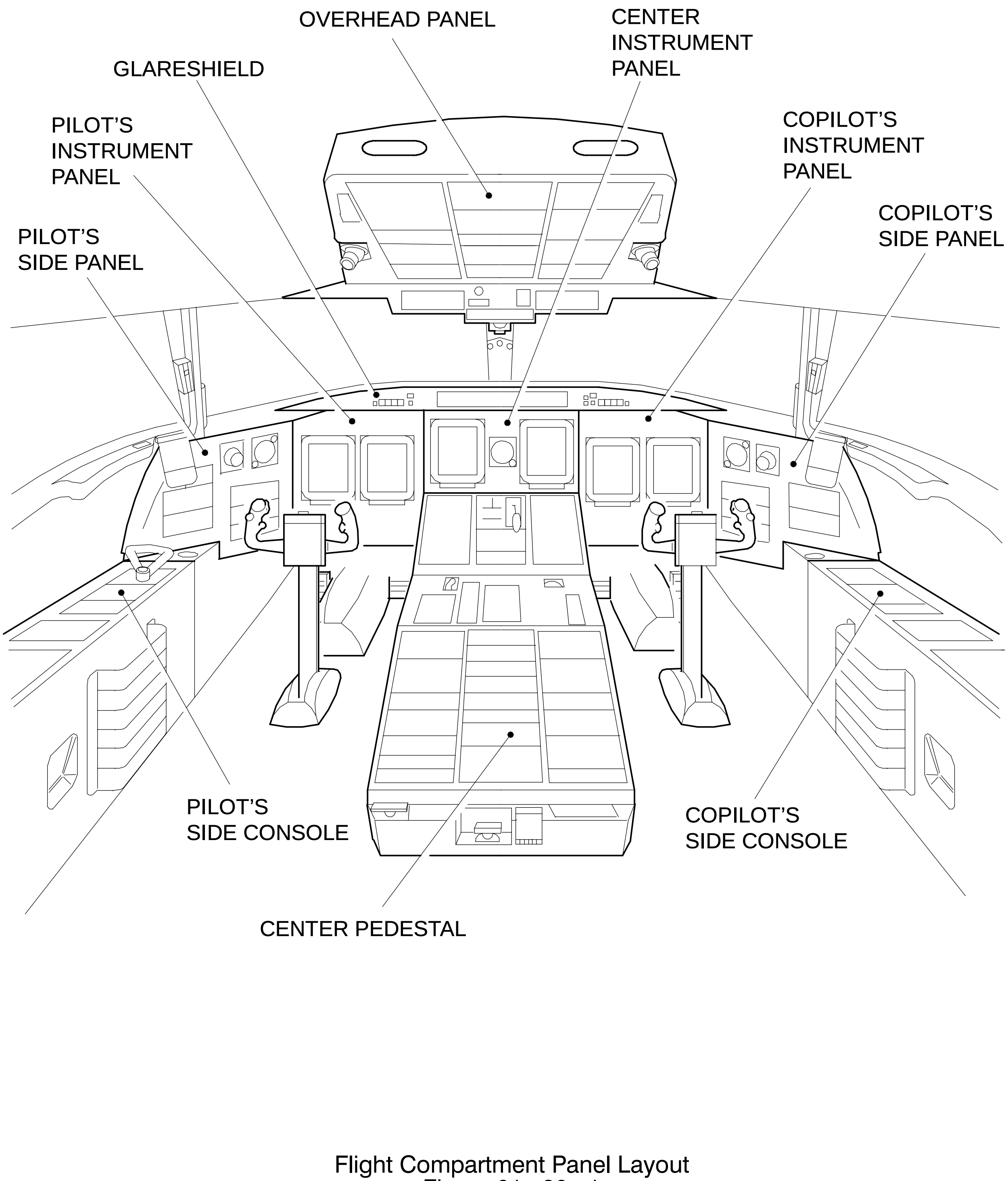
Airplane Mooring Points
Figure 01–20–5



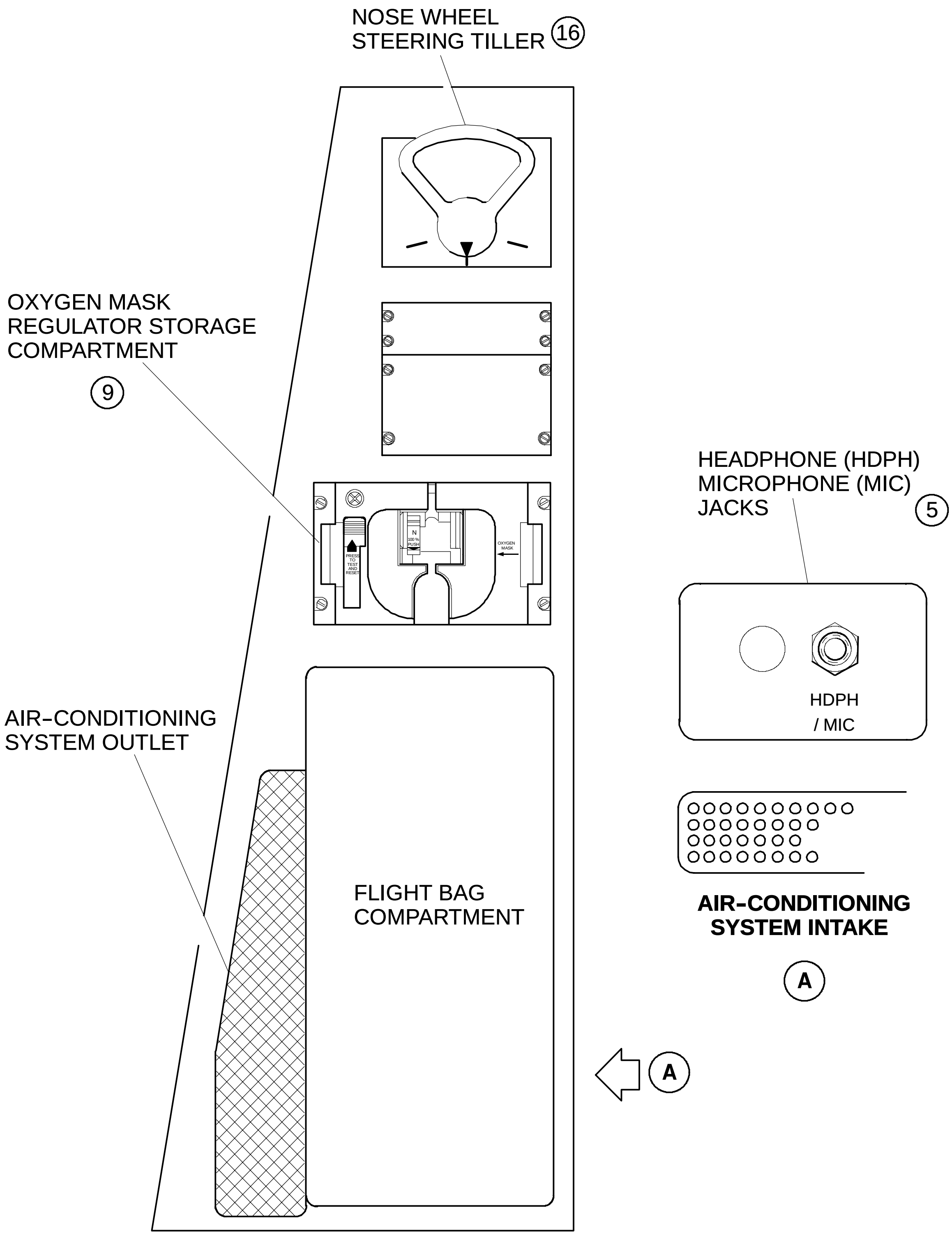


NOTE
Radar hazard area is 2 ft (0.6 m) from antenna with radome closed.

Airplane Antenna Locations <1045, 1027,1212>
Figure 01–20–6

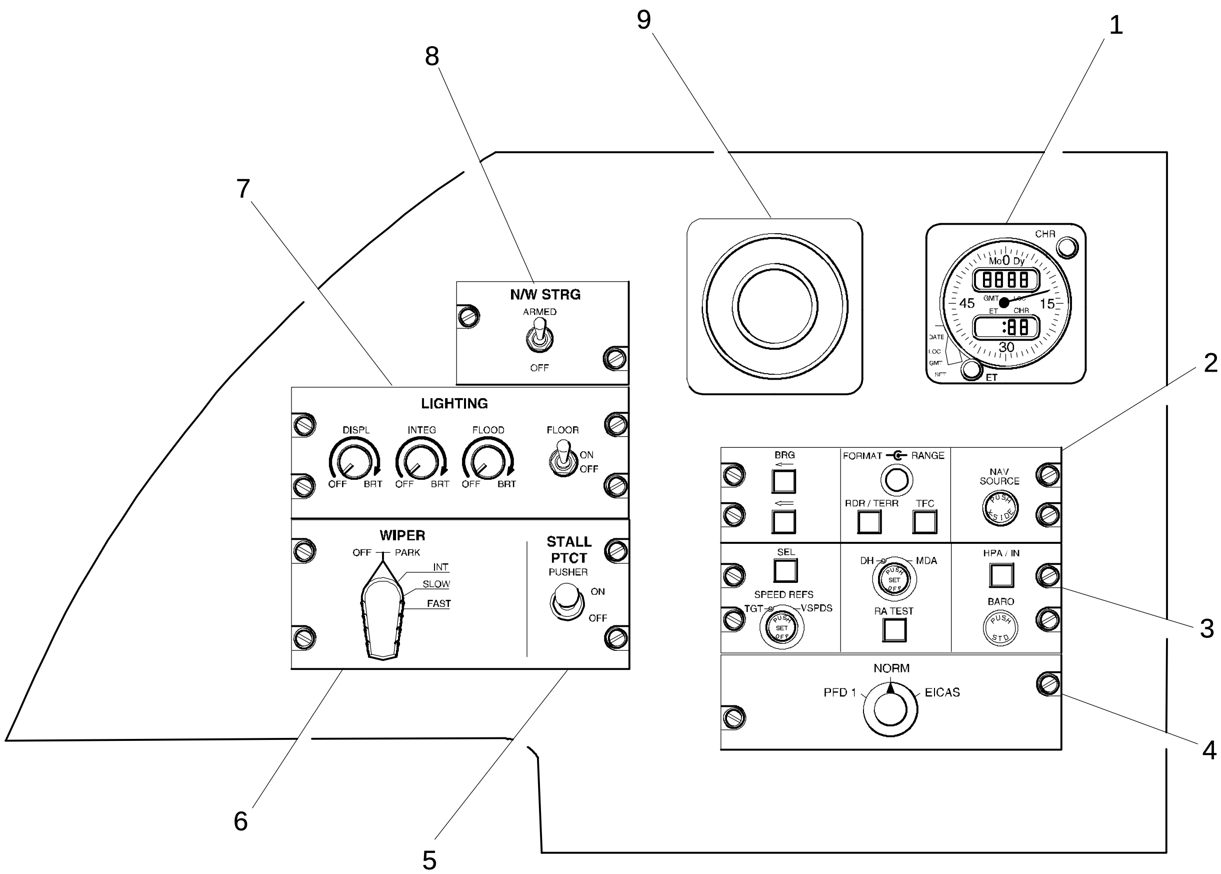


Flight Compartment Panel Layout
Figure 01-30-1



Indicates Chapter in which information on item may be found.

Pilot's Side Console <1205>
Figure 01–30–2

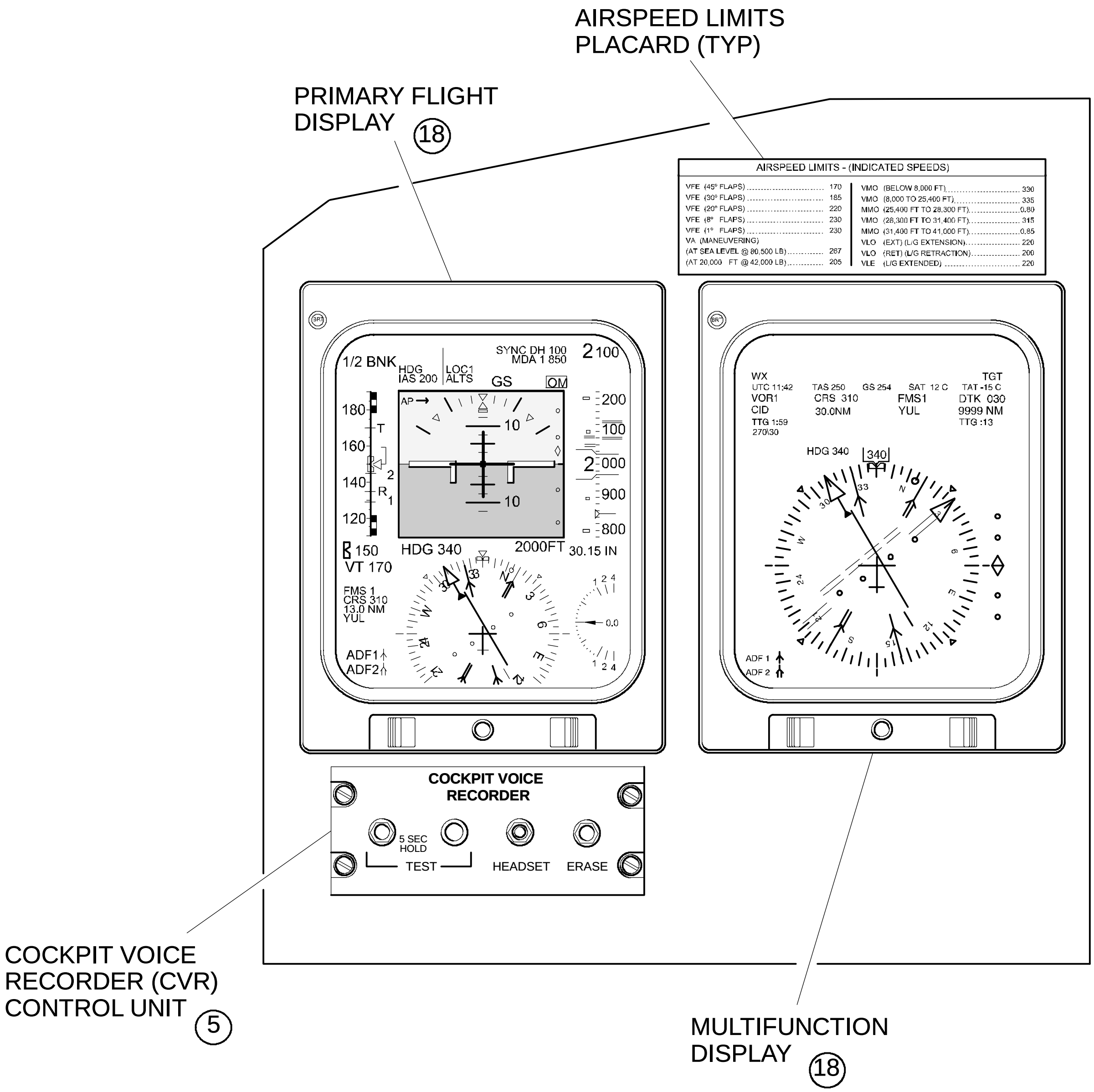


LEGEND

1. Clock. 12
2. Display control panel. 12 18
3. Air data reference panel. 12 18
4. Display reversionary panel. 2
5. Stall protection panel. 11
6. Windshield wiper control panel. 15
7. Lighting panel. 17
8. Nose wheel steering subpanel. 16
9. Air conditioning system gasper. 8

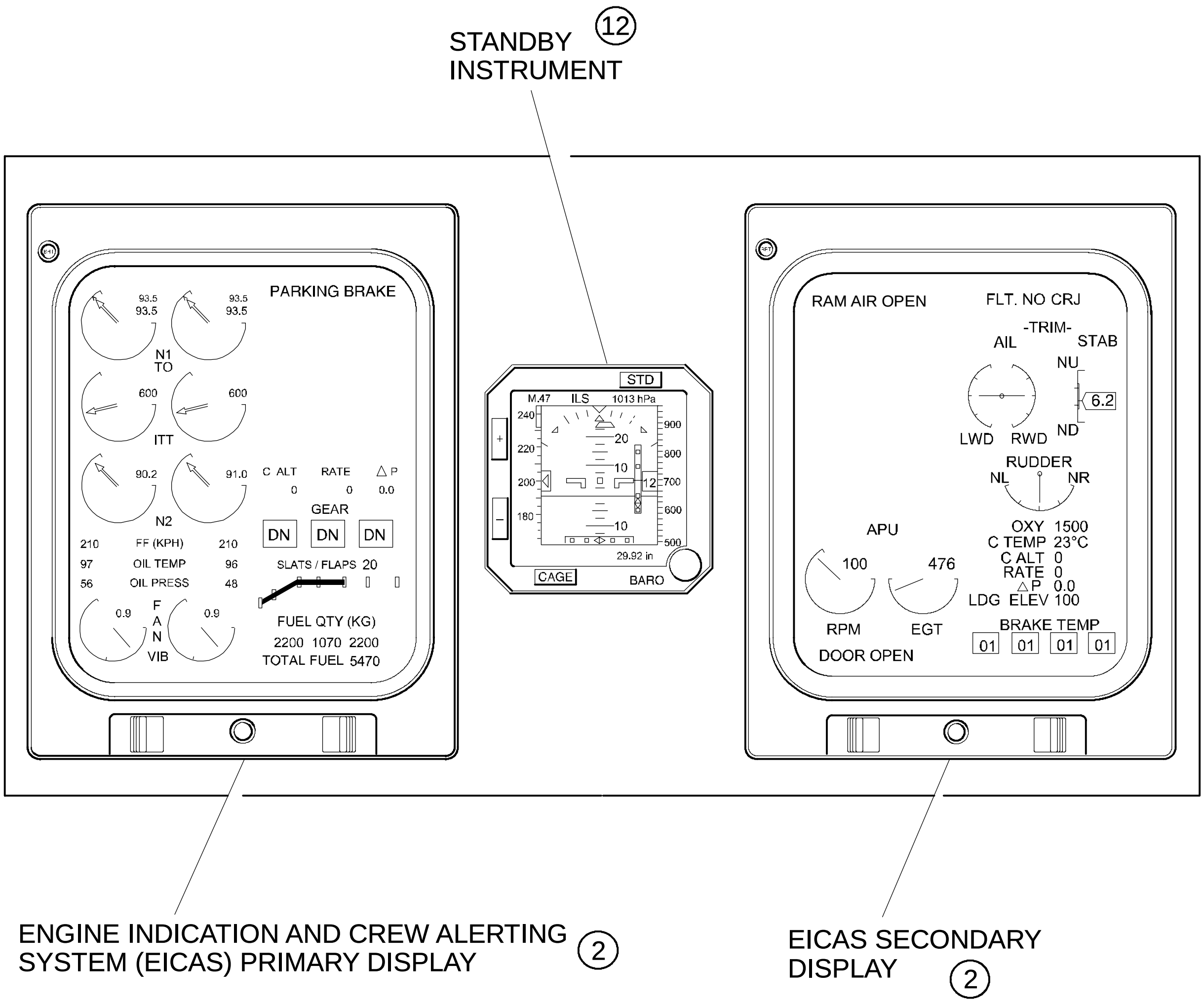
◯ Indicates Chapter in which information on item may be found.

Pilot's Side Panel <2040>
Figure 01–30–3



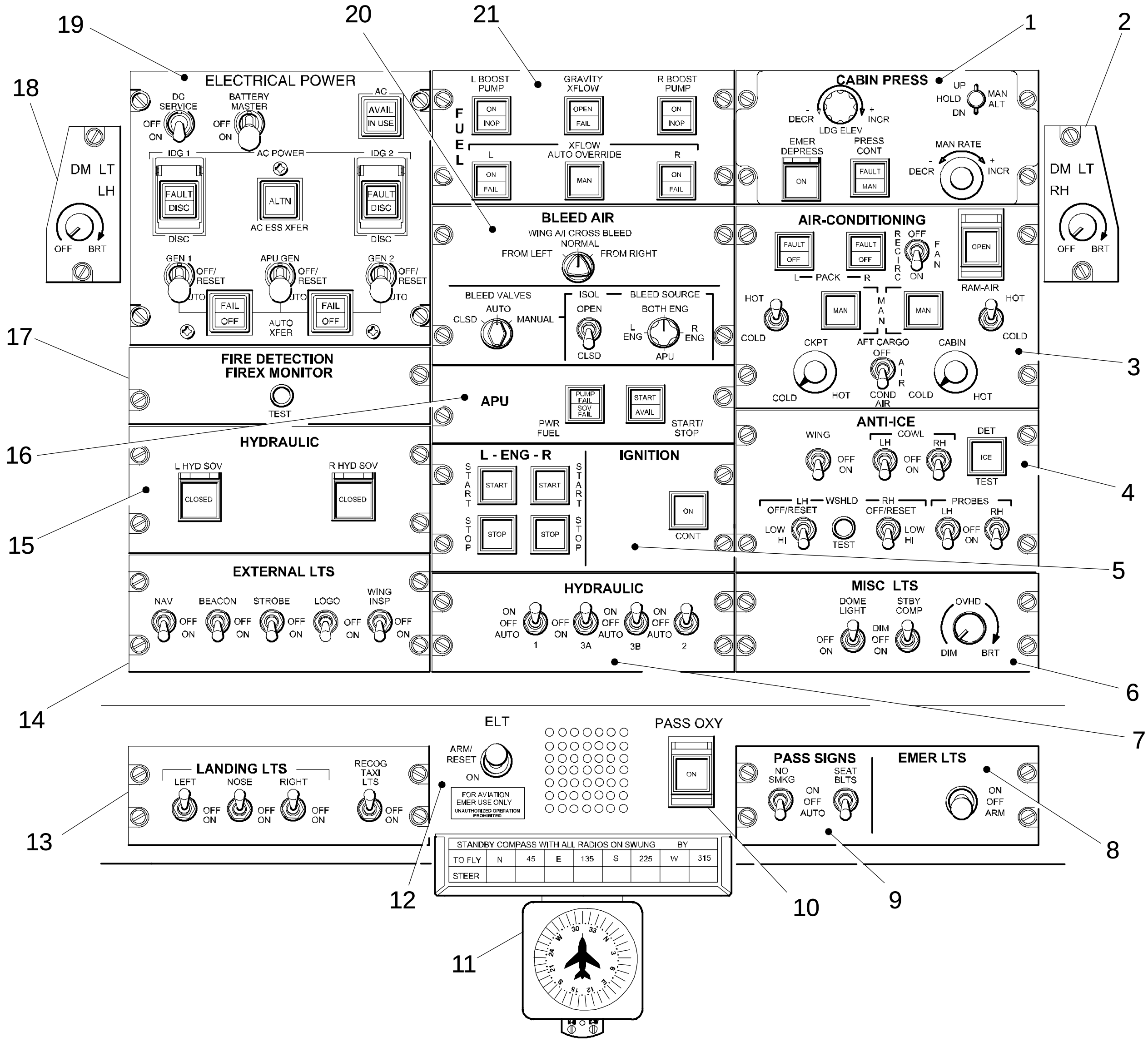
◯ Indicates chapter in which information on item may be found.

Pilot’s Instrument Panel <1015, 2217>
Figure 01–30–4



Indicates Chapter in which information on item may be found.

Centre Instrument Panel <1001>
Figure 01–30–5

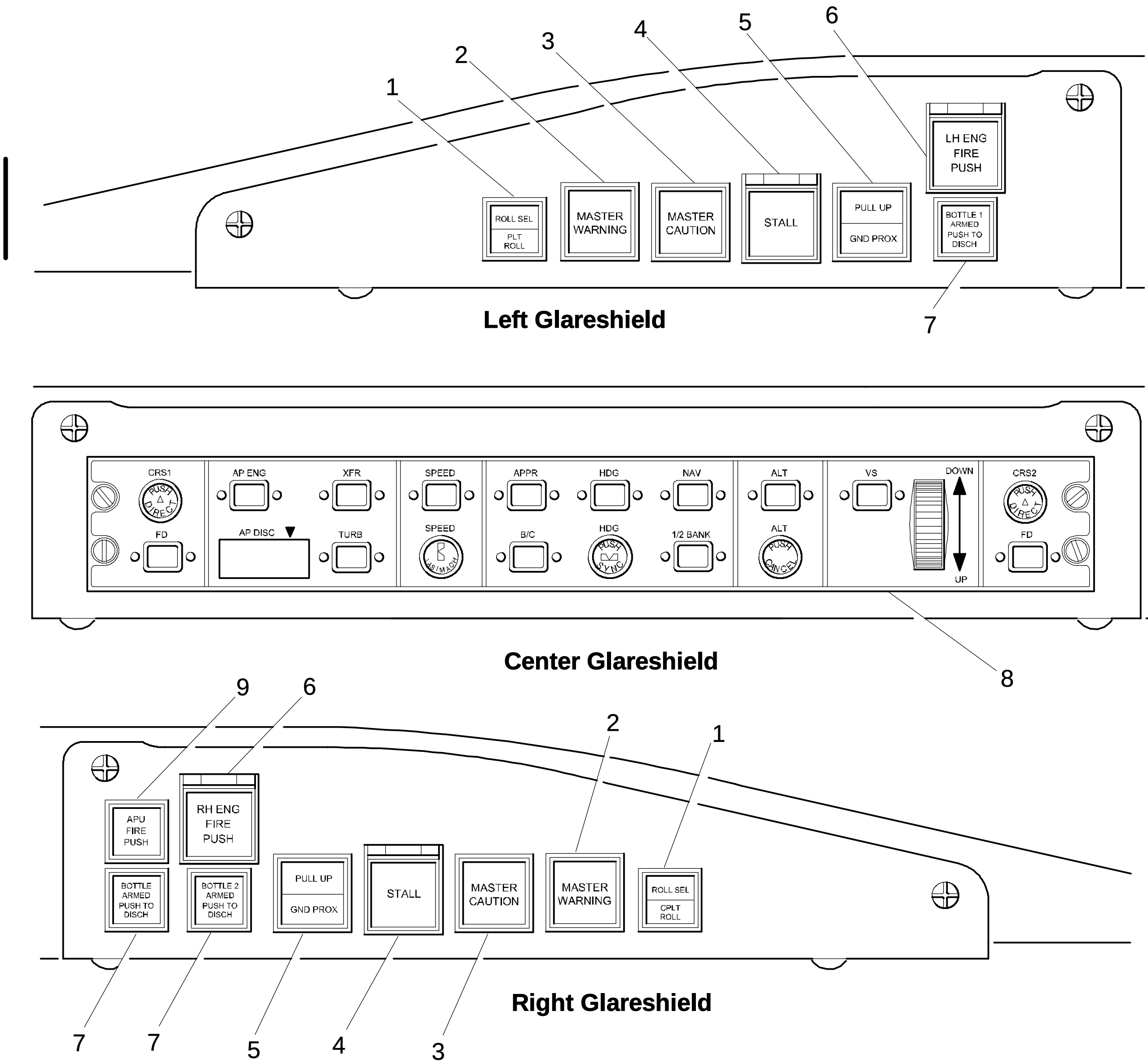


LEGEND

1. Cabin pressurization panel. 8
2. Copilot's dome light control. 17
3. Air–conditioning panel. 8
4. Anti–ice panel. 15
5. Engine / ignition panel. 20
6. Miscellaneous lights panel. 17
7. Hydraulic pump panel. 14
8. Emergency lights panel. 17
9. Passenger signs panel. 1
10. Passenger oxygen control. 9
11. Standby compass. 12
12. Emergency locator transmitter control. 9
13. Landing lights panel. 17
14. External lights panel. 17
15. Hydraulic shutoff panel. 14
16. APU panel. 4
17. Fire detection / FIREX monitor panel. 10
18. Pilot's dome light control. 17
19. Electrical panel. 7
20. Bleed air panel. 19
21. Fuel panel. 13

◯ Indicates Chapter in which information on item may be found.

Overhead Panel <1020><1201>
Figure 01–30–6

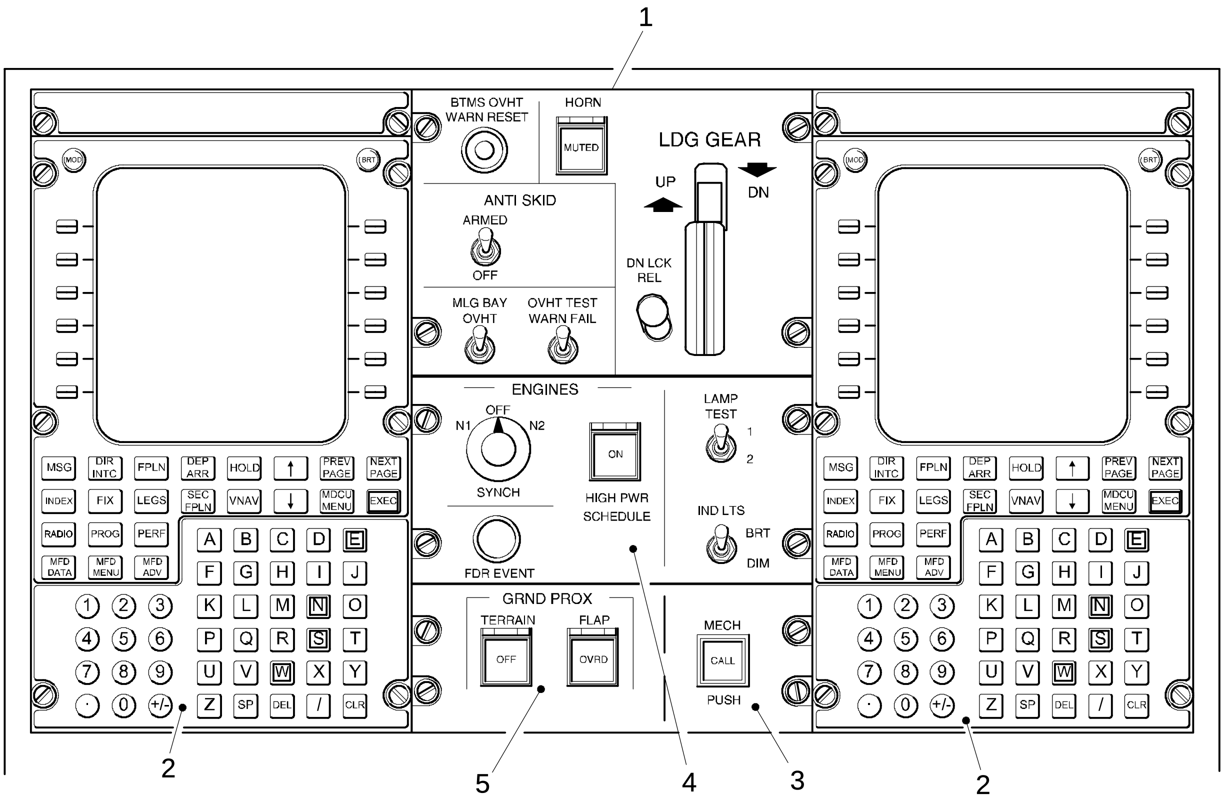


LEGEND

1. Roll select. (11)
2. Master warning. (2)
3. Master caution. (2)
4. Stall warning. (11)
5. GPWS and glideslope warning. (18)
6. Engine fire warning. (10)
7. Firex bottle discharge. (10)
8. Flight control panel. (3)
9. APU fire warning. (10)

◯ Indicates chapter in which information on item may be found.

Glareshield <2040>
Figure 01–30–7

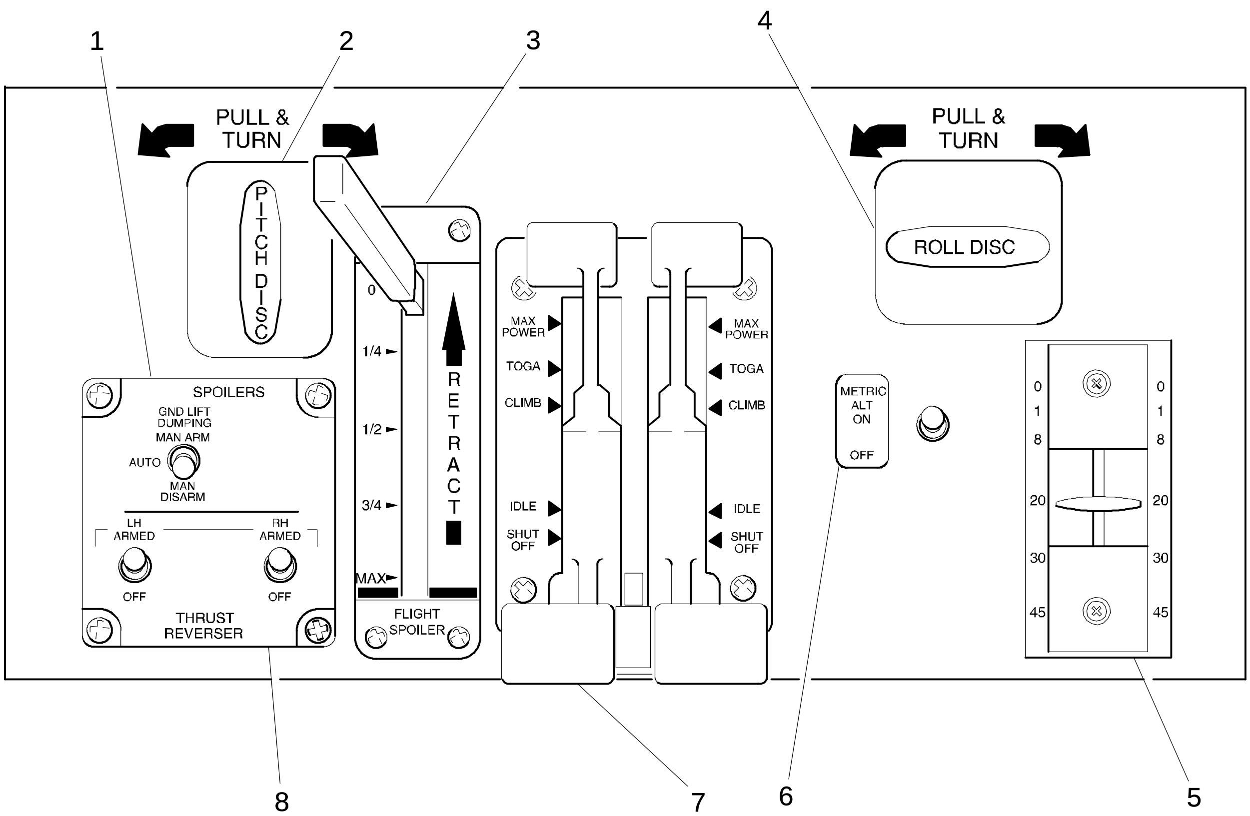


LEGEND

1. Landing gear control panel. (16)
2. Flight management system control display unit. (18)
3. Interphone panel. (5)
4. Engine / miscellaneous test panel. (20) (2) (17)
5. Ground proximity warning panel. (18)

◯ Indicates Chapter in which information on item may be found.

Centre Pedestal (Upper) <2040, 1214>
Figure 01–30–8

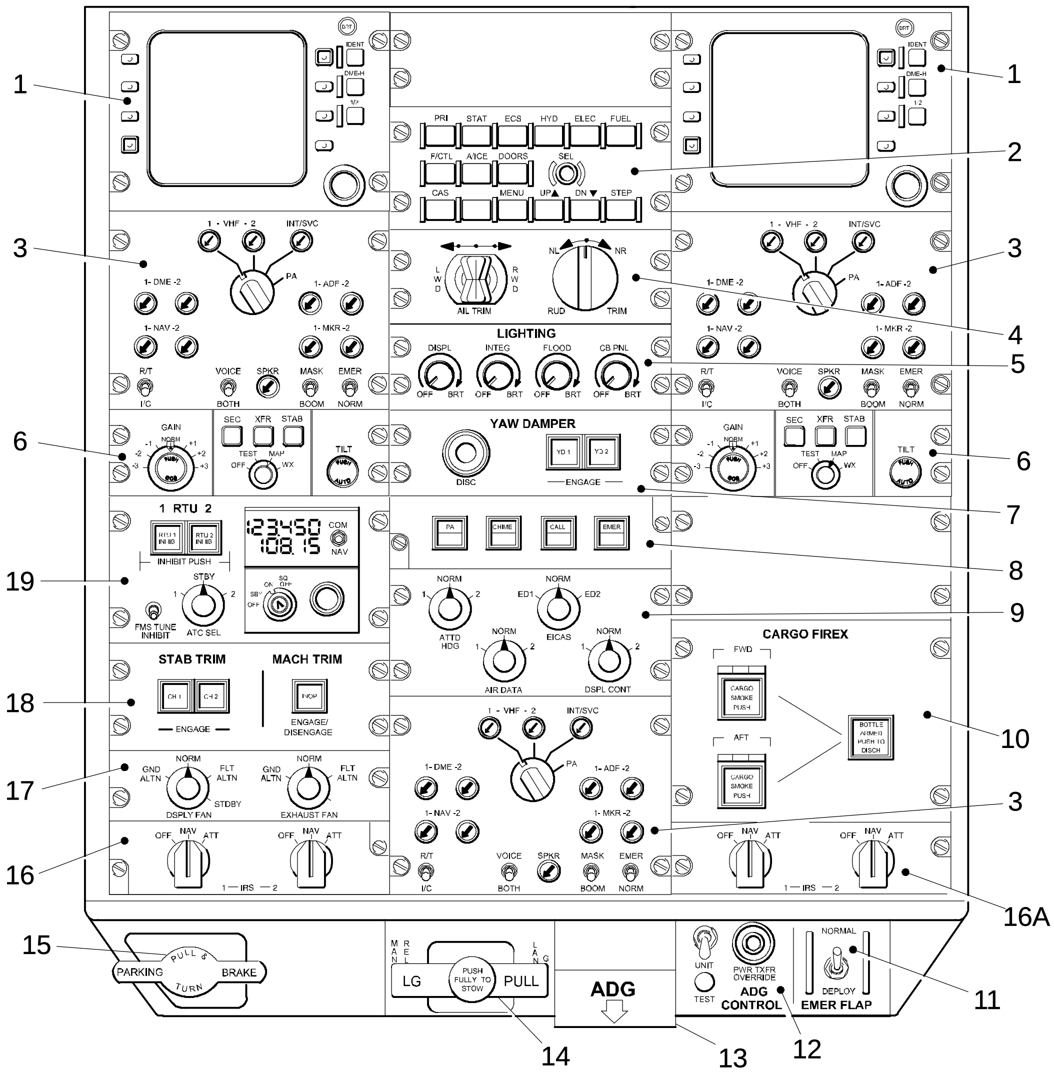


LEGEND

1. Spoilers system control subpanel. 11
2. Pitch disconnect control. 11
3. Flight spoiler lever. 11
4. Roll disconnect control. 11
5. Slat/ flap lever 11
6. Metric altimeter subpanel. 12
7. Thrust lever quadrant. 20
8. Thrust reverser subpanel. 20

◯ Indicates Chapter in which information on item may be found.

Center Pedestal – Thrust Lever and Flight Controls <1029, 2040>
Figure 01–30–9

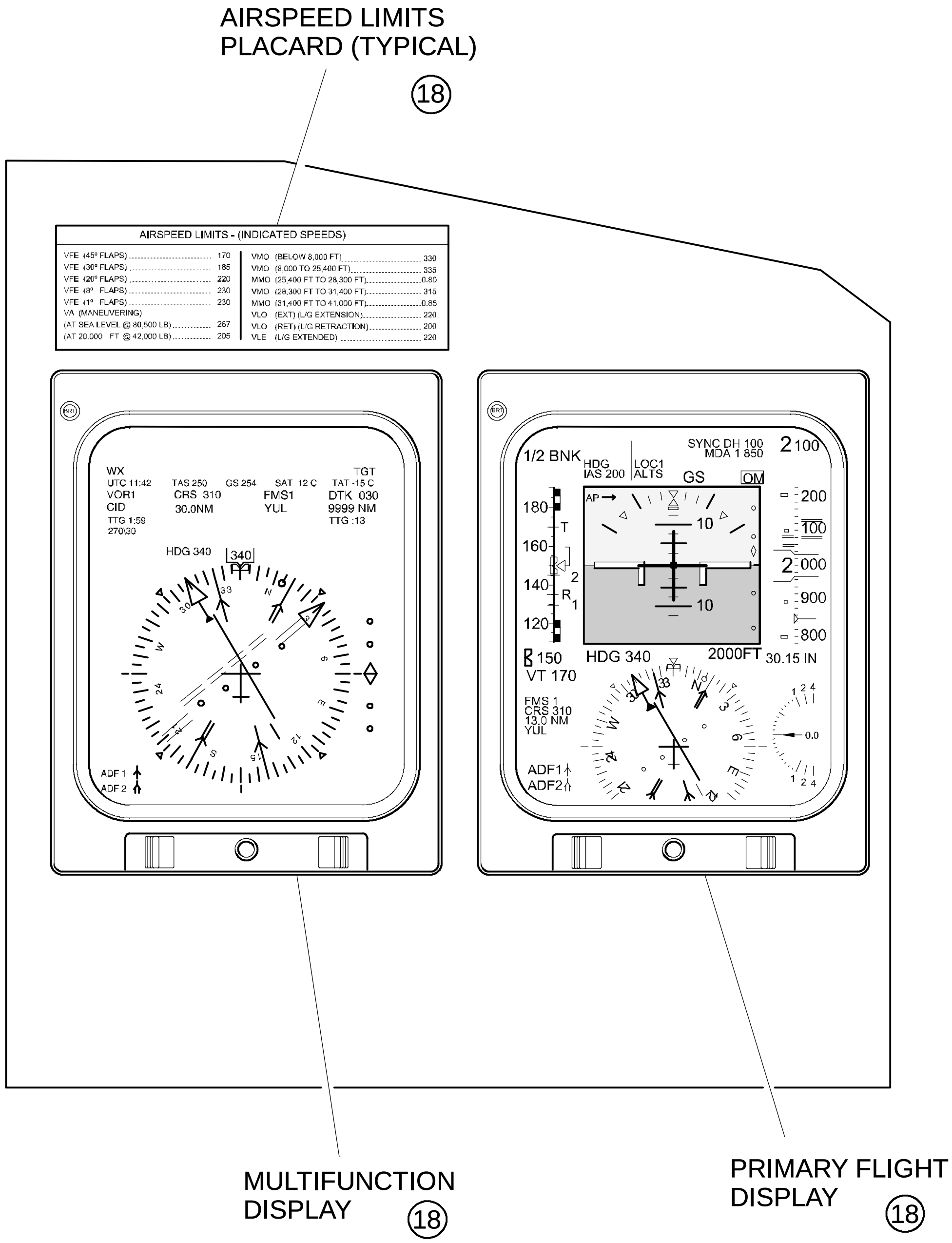


LEGEND

1. Radio tuning unit. 5 18
2. EICAS control panel. 2
3. Audio control panel. 5 18
4. Aileron/rudder trim panel. 11
5. Lighting panel. 17
6. Weather radar control panel. 18
7. Yaw damper panel. 11
8. Interphone control panel. 5
9. Source selector panel. 2 12
10. Cargo firex panel. 10
11. Emergency flap deploy control. 11
12. Air driven generator − auto−deploy panel. 7
13. Air driven generator − manual deploy handle. 7
14. Landing gear − manual release handle. 16
15. Parking brake handle. 16
16. Compass control panel (on both sides). 12
16A. <1025> IRS mode select unit. 12
17. Avionics cooling control panel. 8
18. Stabilizer/Mach trim panel. 11
19. Backup tuning unit. 5

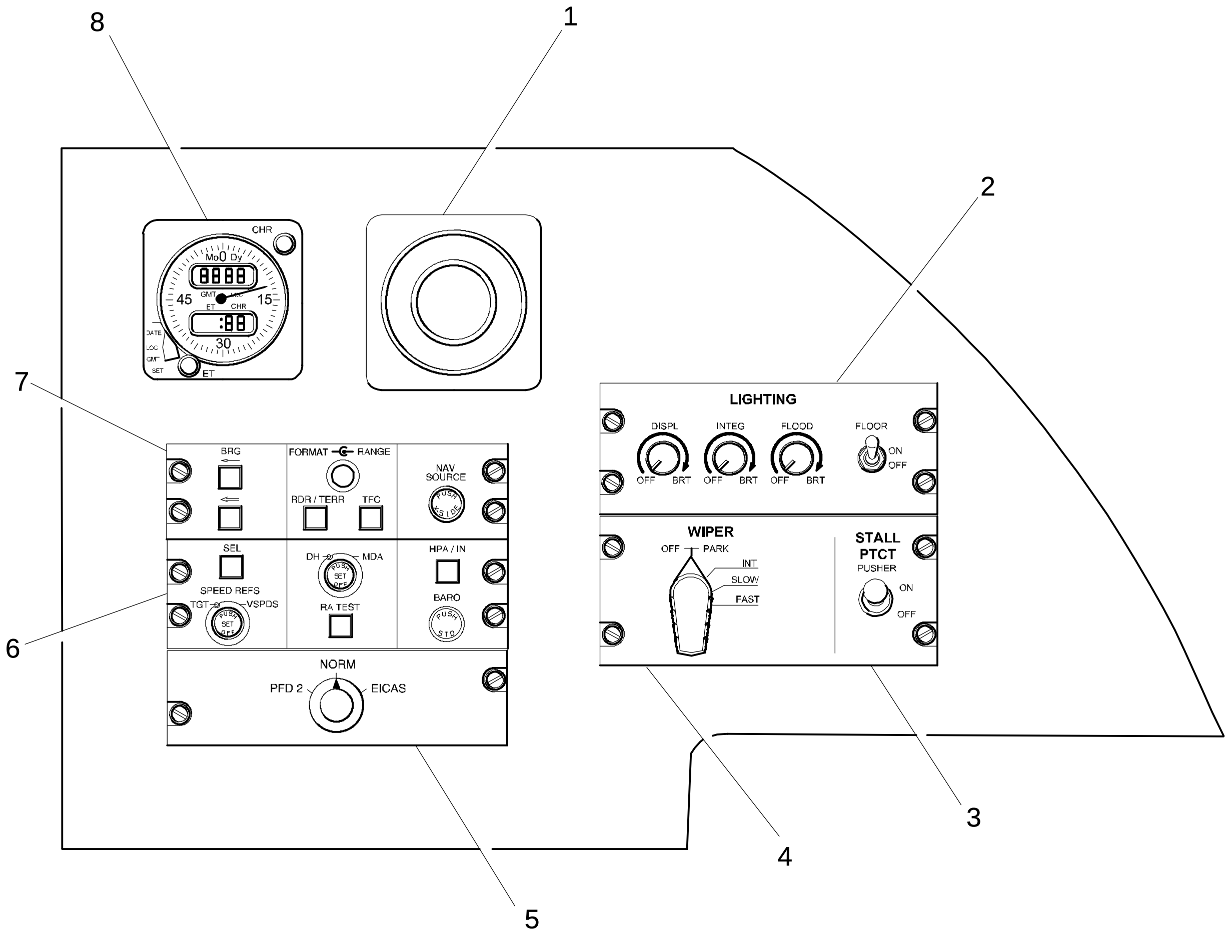
◯ Indicates Chapter in which information on item may be found.

Centre Pedestal (Lower) <1012, 1025,>
Figure 01−30−10



◯ Indicates Chapter in which information on item may be found.

Copilot’s Instrument Panel <1015, 2217>
Figure 01–30–11

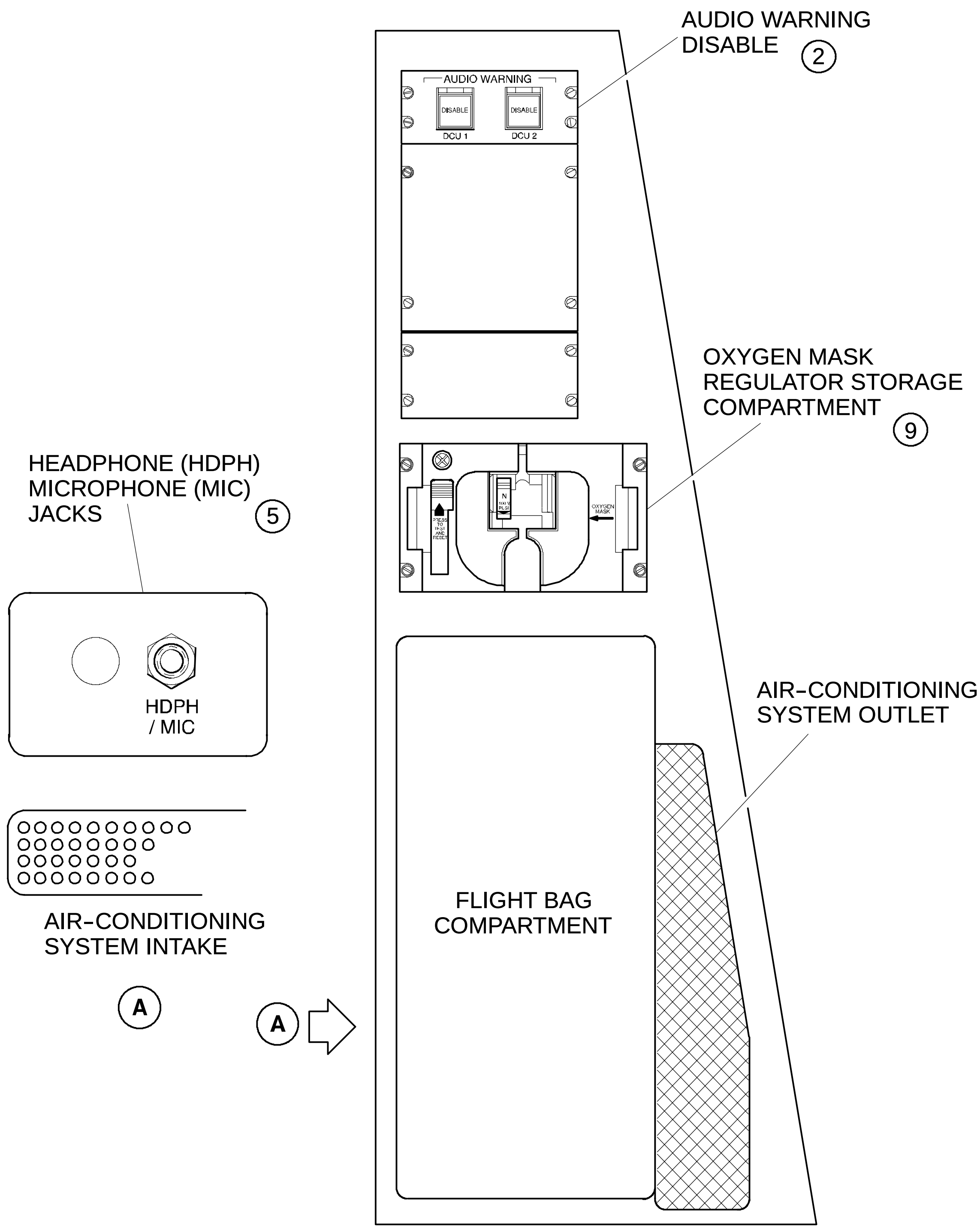


LEGEND

1. Air conditioning system gasper. (8)
2. Lighting panel. (17)
3. Stall protection panel. (11)
4. Windshield wiper control panel. (15)
5. Display reversionary panel. (2)
6. Air data reference panel. (12)(18)
7. Display control panel. (12)(18)
8. Clock. (12)

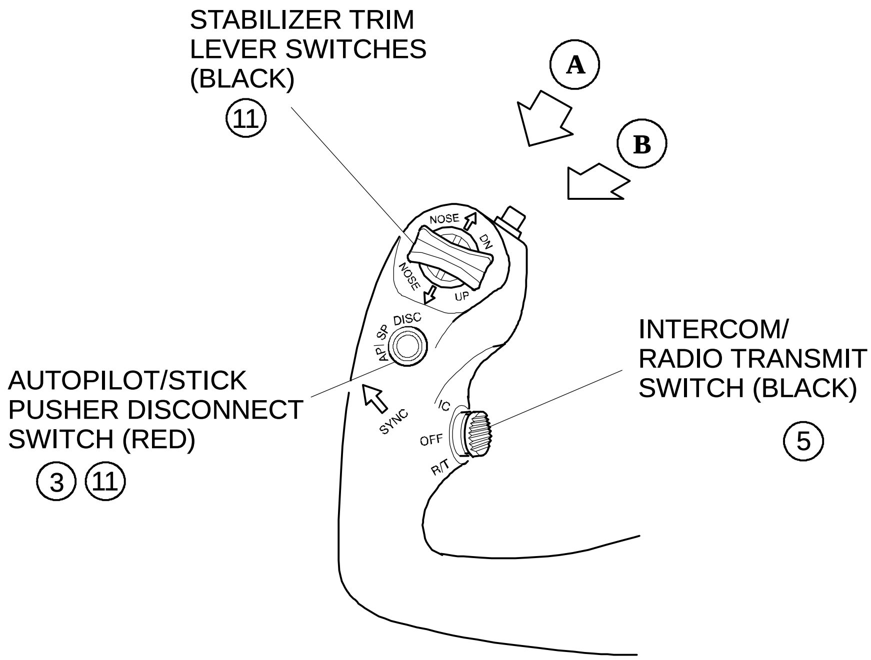
( ) Indicates Chapter in which information on item may be found.

Copilot’s Side Panel <2040>
Figure 01–30–12

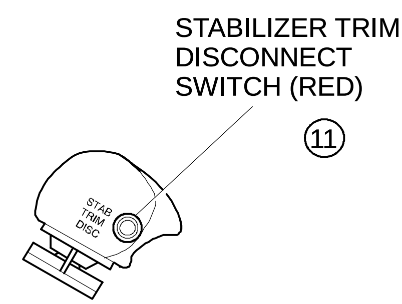


◯ Indicates Chapter in which information on item may be found.

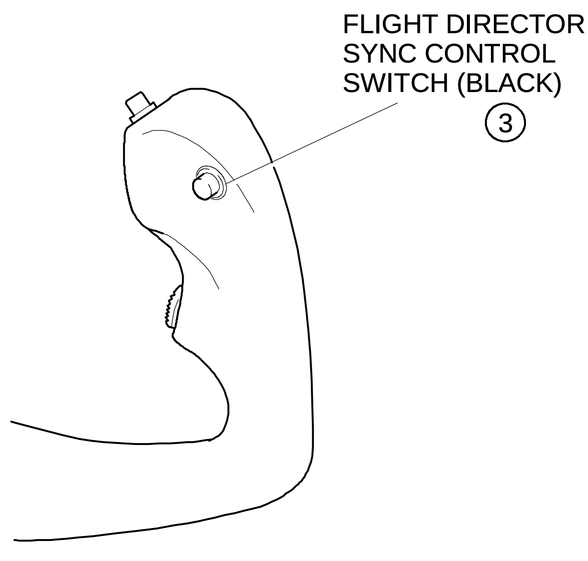
Copilot’s Side Console <1205>
Figure 01−30−13



Pilot's Control Wheel
(Copilot's Opposite)



A TOP VIEW



B REAR VIEW

◯ Indicates Chapter in which information on item may be found.

Control Wheels
Figure 01–30–14

1. REINFORCED FLIGHT COMPARTMENT DOOR <1226>

A. General

The reinforced flight compartment door is installed to enhance aircraft security. The door is used to protect the flight crew from ballistic threat and to prevent unauthorized access to the flight compartment. The door is made from Nomex core panels sandwiched in the middle with a bullet proof insert.

The door consists of:

(1) Slide latch

(2) Deadbolt assembly with key lock

(3) Two quick–release hinge pins

(4) Two decompression panels release latches

(5) Cabin viewer

(6) Strap handles

B. Operation

The slide latch is used to latch and unlatch the door

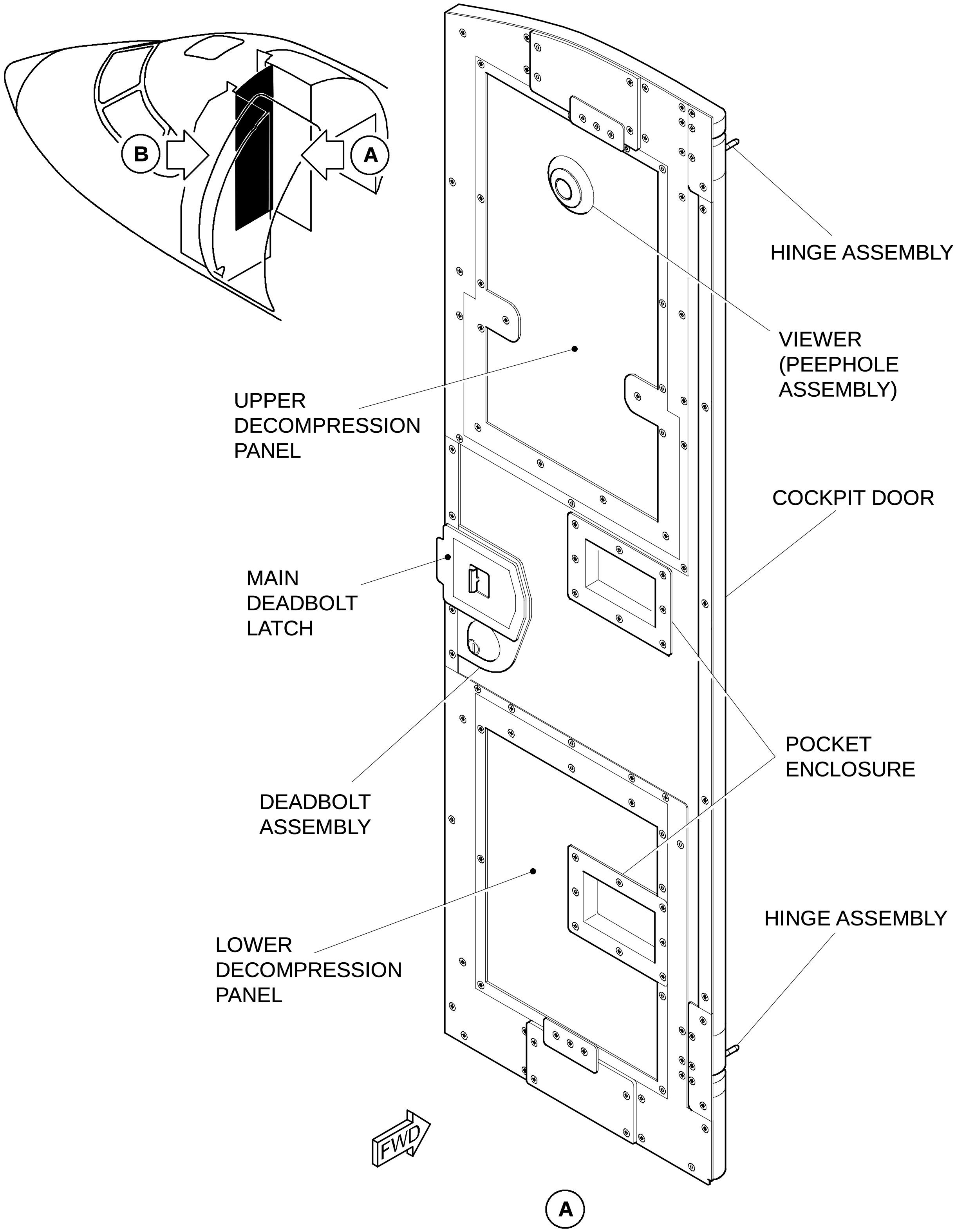
The deadbolt assembly is used securely lock the door. To lock or unlock the door from inside the flight compartment, the deadbolt knob is manually rotated to engage the deadbolt pin into the flight compartment bulkhead. A key is required to lock or unlock the door from the passenger compartment.

The door is hinged to the galley bulkhead. The door opens towards the passenger compartment and can be held open with a door retainer on the galley wall. The two quick–release pins are used to remove the door from inside the flight compartment and the strap handles are used to lift the door out of the way.

The bullet proof viewer has two lenses to increase the magnification for field of view.

The decompression panels are hinged on the door and held closed by the pressure release latches. When the pressure differential between the passenger compartment and the flight compartment exceeds a preset limit, the latches release to allow both panels to open. This is done to equalize the pressure between the two compartment.

At any time during the flight, if one of the required flight crew leaves the flight compartment, another crew member must replace him/her in the flight compartment to ensure that the required crew member is not locked out of the flight compartment.



Reinforced Flight Compartment Door
Figure 01–30–15

C. Evacuation

If the latch has failed or if the door has jammed, the following steps are used to remove the door in an emergency

WARNING

The lower door hinge pin must be released before the upper hinge pin. Failure to do so could result in the door suddenly coming disengaged from the hinges causing injury to persons.

From inside the flight compartment:

(1) Unlock and lift lower hinge pin.

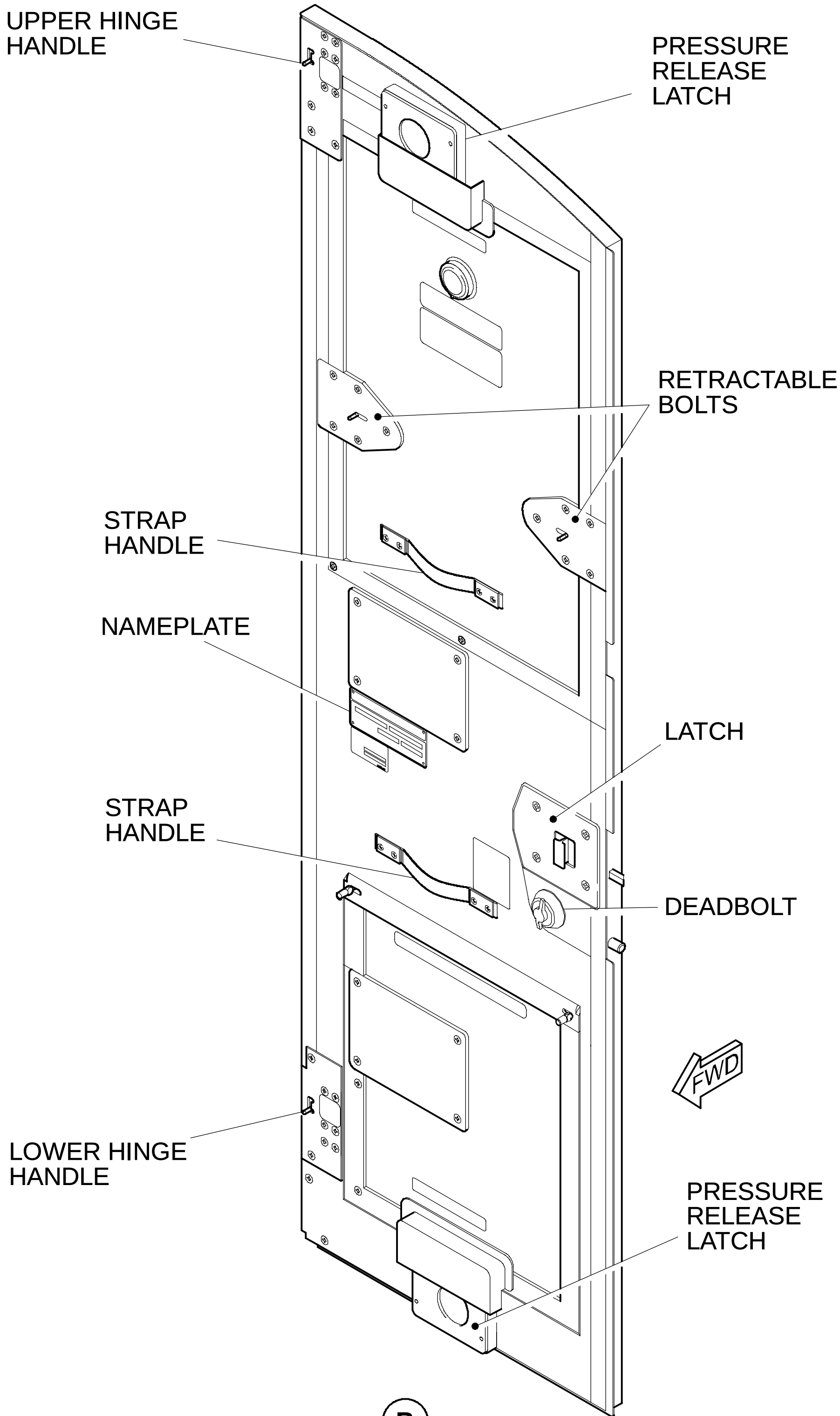
(2) Unlock and pull down upper hinge pin.

(3) Remove the door by forcibly pushing it out at the hinge side.

(4) Rotate door clockwise and stow against the galley.

From the passenger compartment:

In the event that the flight crew becomes trapped in the flight compartment or becomes incapacitated, it has been demonstrated that rescue personnel can remove the door using normally available, non-powered, hand carried, rescue tools (e. g. , crowbar, axe, etc.).



Reinforced Flight Compartment Door – Placards
Figure 01–30–16

CHAPTER 4 – AUXILIARY POWER UNIT

Page

LIST OF ILLUSTRATIONS

CONTROL

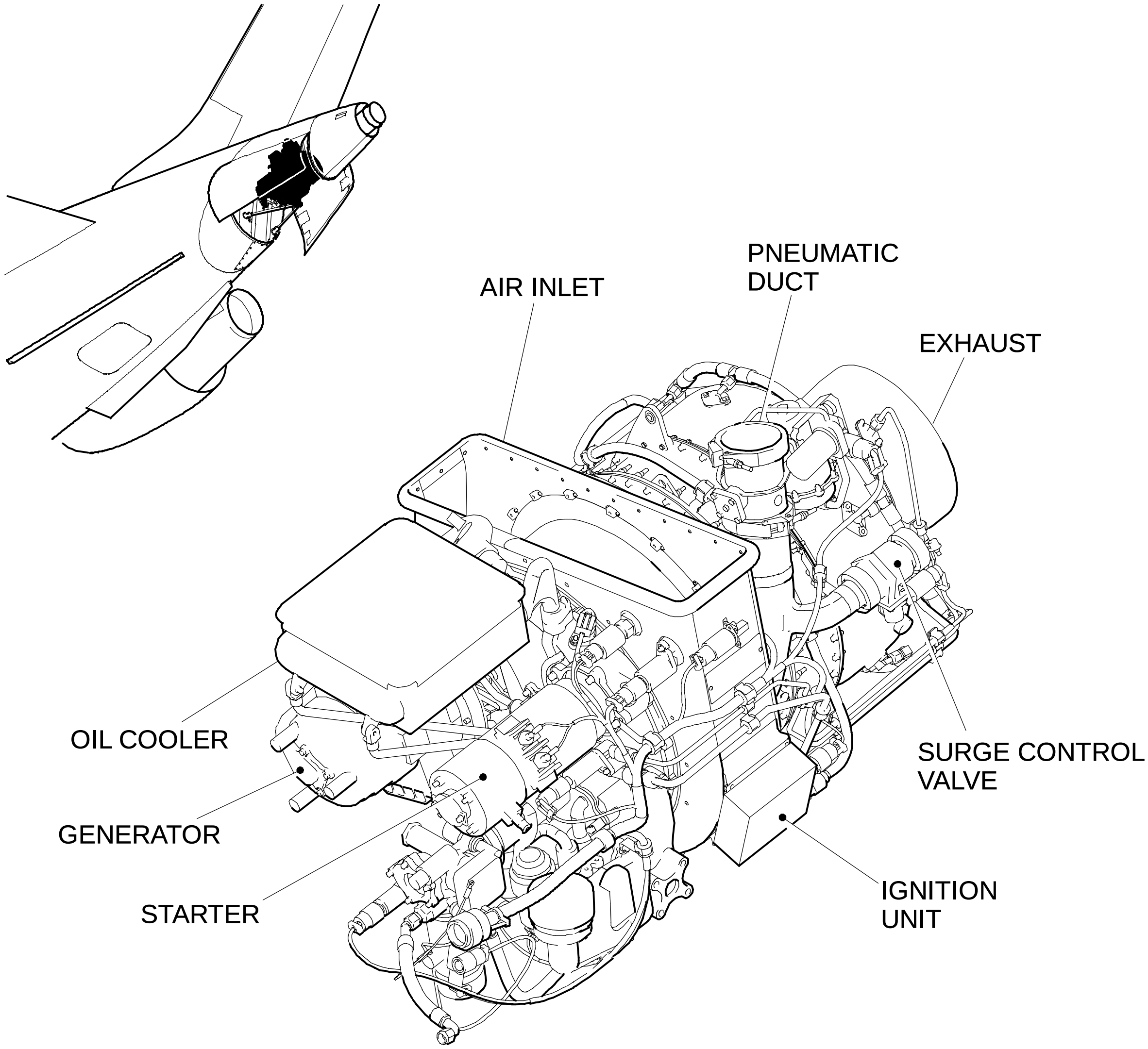
1. INTRODUCTION

The auxiliary power unit (APU) is a gas turbine power plant which drives an electrical generator. The generator is rated at 40 kVA and produces 115 VAC electrical power for backup to the main engine generators (refer to Chapter 7). The APU also supplies compressed air to the pneumatic system for main engine starting and environmental control (refer to Chapter 19). To prevent compressor surge, some compressor air is vented overboard by a surge control valve.

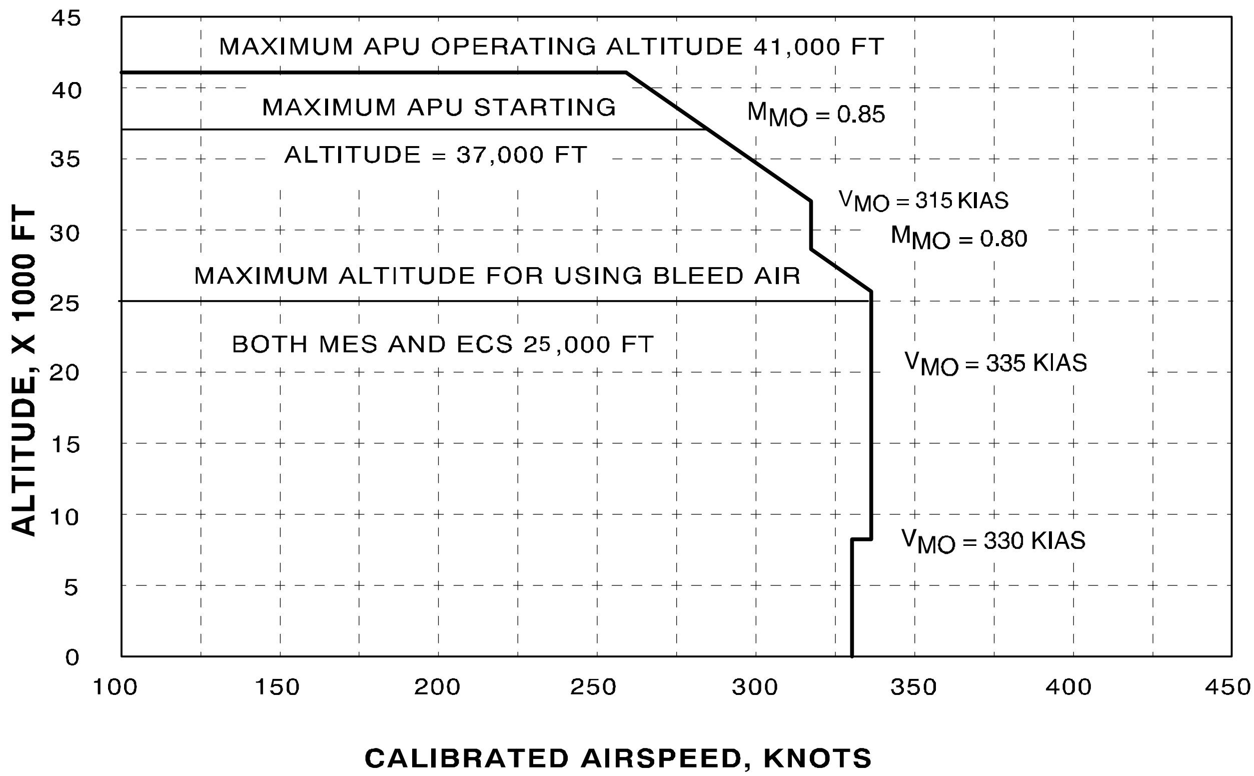
The APU is enclosed within a fireproof tailcone assembly. The APU compartment is composed of an upper section and forward and aft bulkheads made of titanium. Two clamshell doors made of fireproof composite material enclose the sides and bottom of the compartment.

An Electronic Control Unit (ECU), located in the aft equipment bay, controls the APU through all phases of operation. The ECU monitors all sensors and switches, sets up the appropriate fuel acceleration schedules and relays specific operating data to the engine indication and crew alerting system (EICAS). The ECU is powered through selection of a PWR/FUEL switchlight on the APU control panel in the flight compartment.

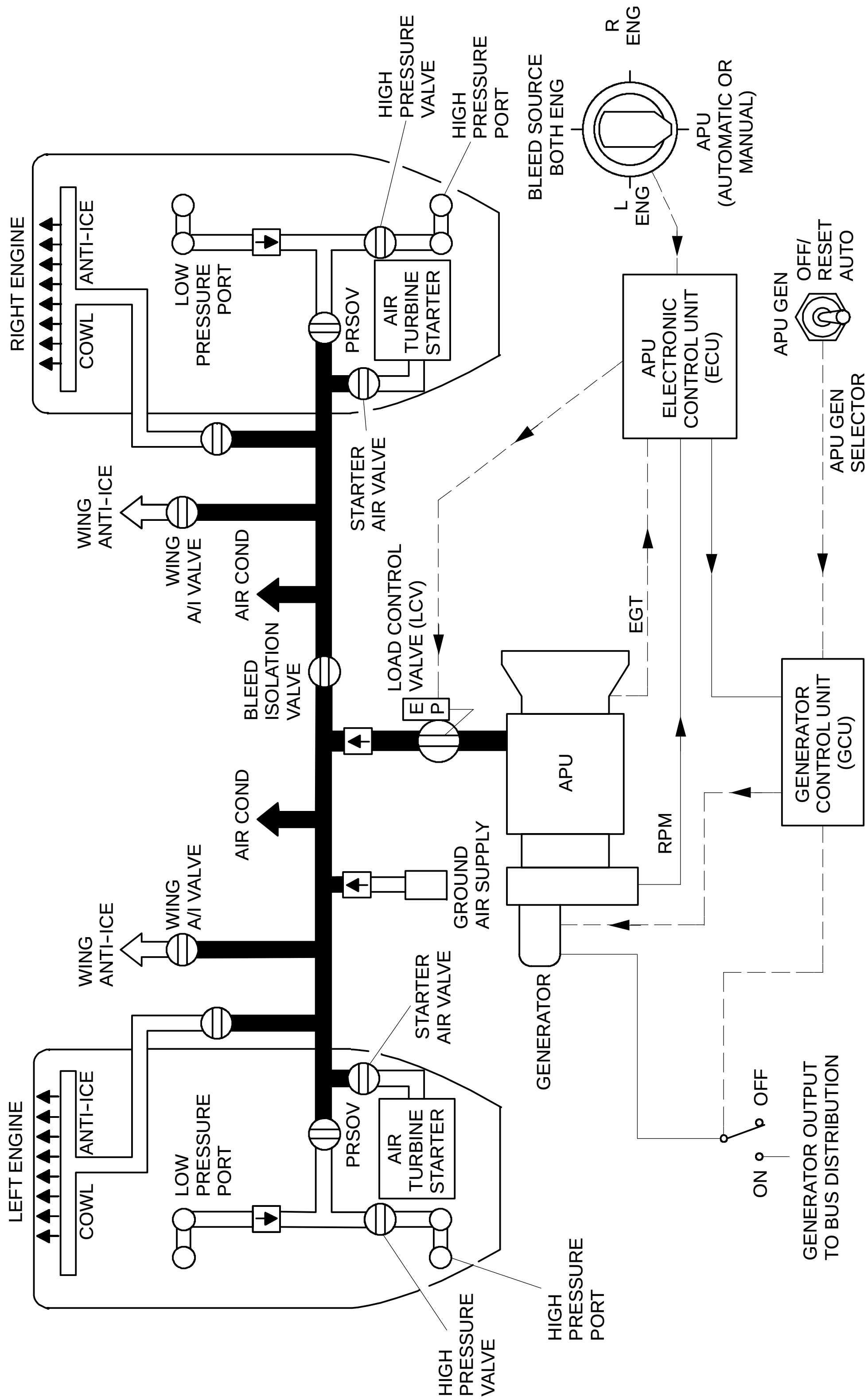
The APU intake door position is continuously shown on the EICAS status page. The APU RPM and exhaust gas temperature (EGT) are shown on the EICAS status page, only when the APU PWR/FUEL switchlight on the APU control panel is selected.



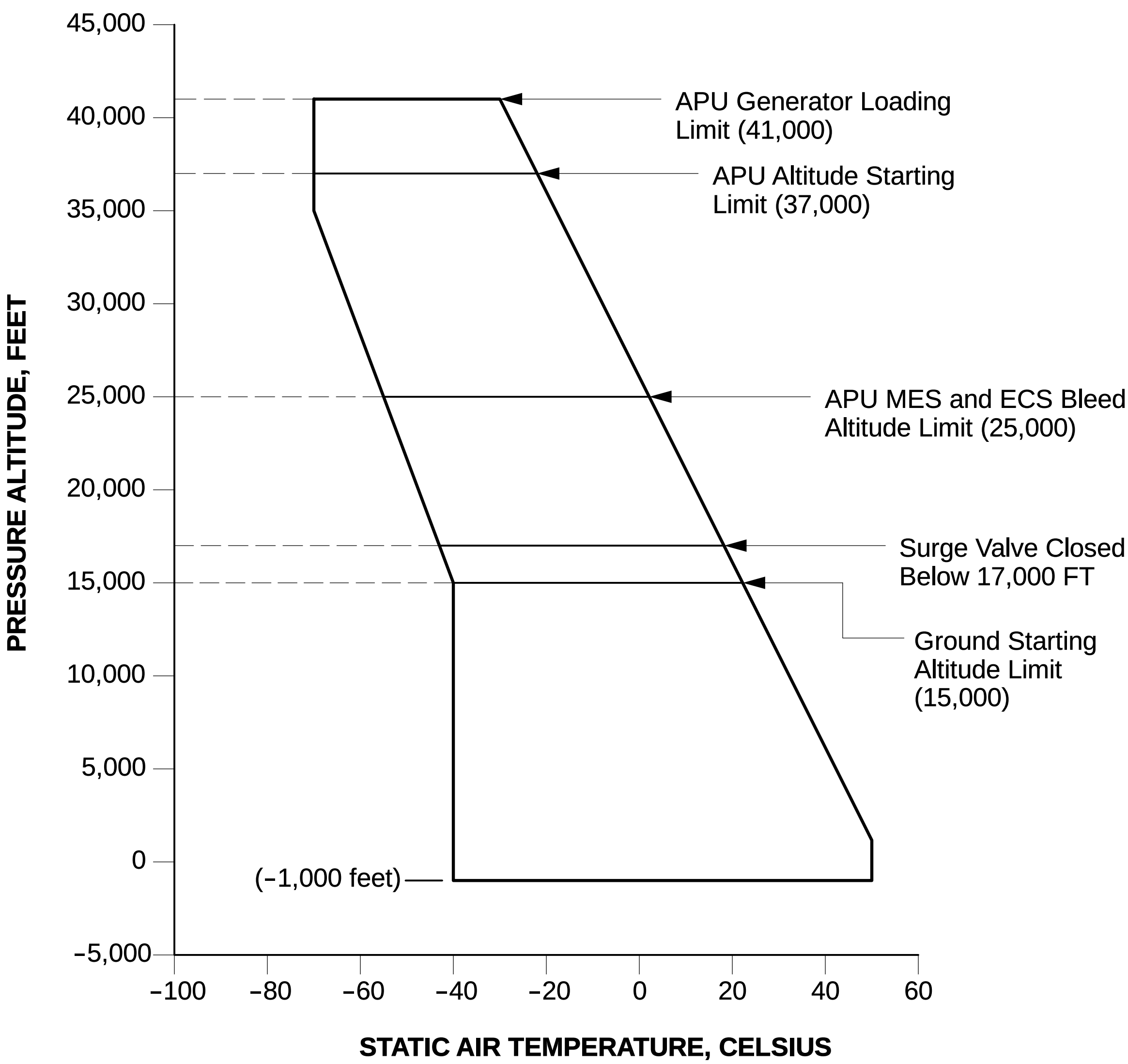
Auxiliary Power Unit − Introduction
Figure 04−10−1



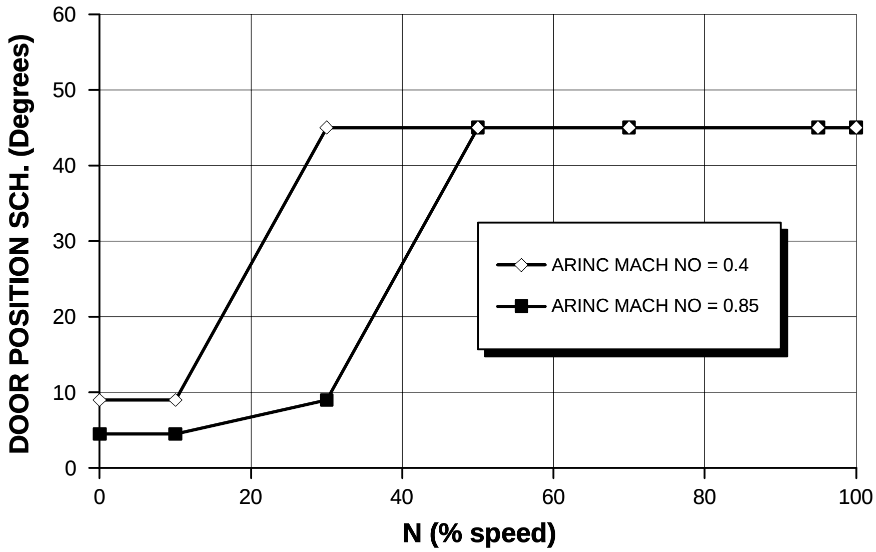
APU Altitude and Airspeed Envelope
Figure 04−10−2



Pneumatic Flow
Figure 04–10–3



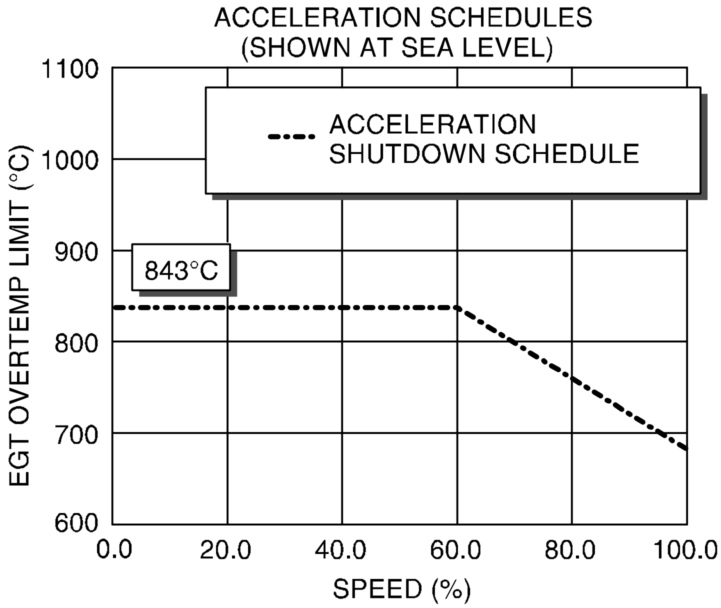
APU Start and Operating Limits
Figure 04–10–4



N (% speed)	ARINC MACH NO = 0.4 DOOR POSITION SCH. (Degrees)	ARINC MACH NO = 0.85 DOOR POSITION SCH (Degrees)
0	9.0	4.5
10	9.0	4.5
30	45.0	9.0
50	45.0	45.0
70	45.0	45.0
95	45.0	45.0
100	45.0	45.0

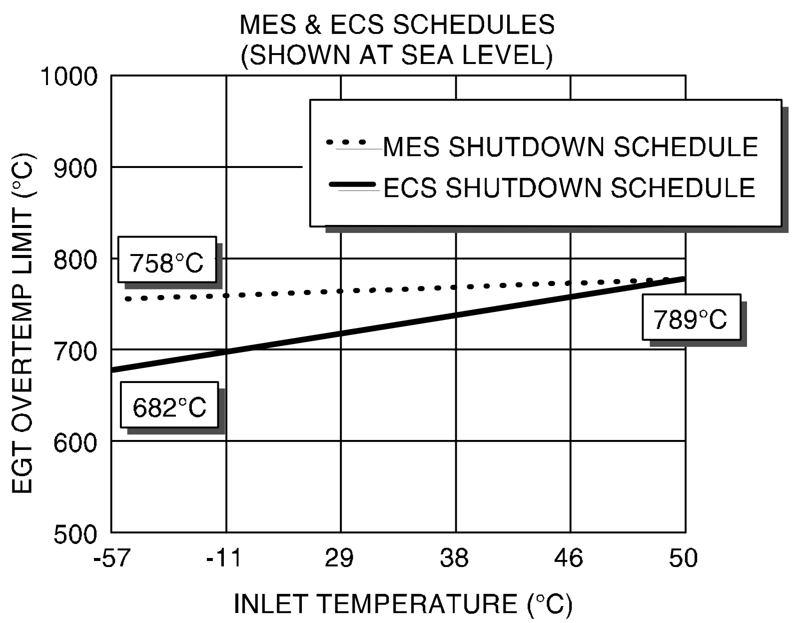
APU DOOR POSITION SCHEDULE

APU Door Position
Figure 04–10–5



NOTE

EGT acceleration shutdown limit increases with higher altitudes.



NOTE

EGT ECS & MES shutdown limits increase with higher inlet temperatures and higher altitudes.

EGT Shutdown Schedule
Figure 04−10−6

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1. APU POWER PLANT

The APU power plant consists of a gas turbine engine and gearbox.

A. Engine

The engine is a single-shaft, constant speed design, consisting of a compressor, a combustor and a two-stage turbine. The compressor draws large volumes of air through the inlet ducting and delivers it under pressure to the combustor. Fuel from the left collector tank is added to the high pressure air and ignited, increasing the energy of the airflow. The high velocity, high temperature gasses are delivered to the turbine section. The turbine converts the high velocity gasses into mechanical energy to drive the compressor and gearbox.

B. Gearbox

The gearbox reduces the turbine shaft rpm to a speed suitable to operate the gearbox mounted accessories. Accessories include the lubrication module, fuel control unit, electric starter and generator. The gearbox has an integral oil sump. The oil level can be checked using a sight glass on the oil filler assembly.

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1. SYSTEMS

The APU consists of a lubrication system, fuel system, ignition and starting systems, and an air intake and exhaust.

A. Lubrication

The lubricating system consists of a mechanically driven lubrication module, oil filter, oil cooler, low oil pressure switch, oil temperature sensor and a deprime solenoid. The lube module provides pressurized oil to the power plant, gearbox and generator for lubrication and heat removal. To ease starting under cold conditions, a de-prime solenoid allows vent air to enter the lube pump to reduce starter motor drag.

B. Fuel

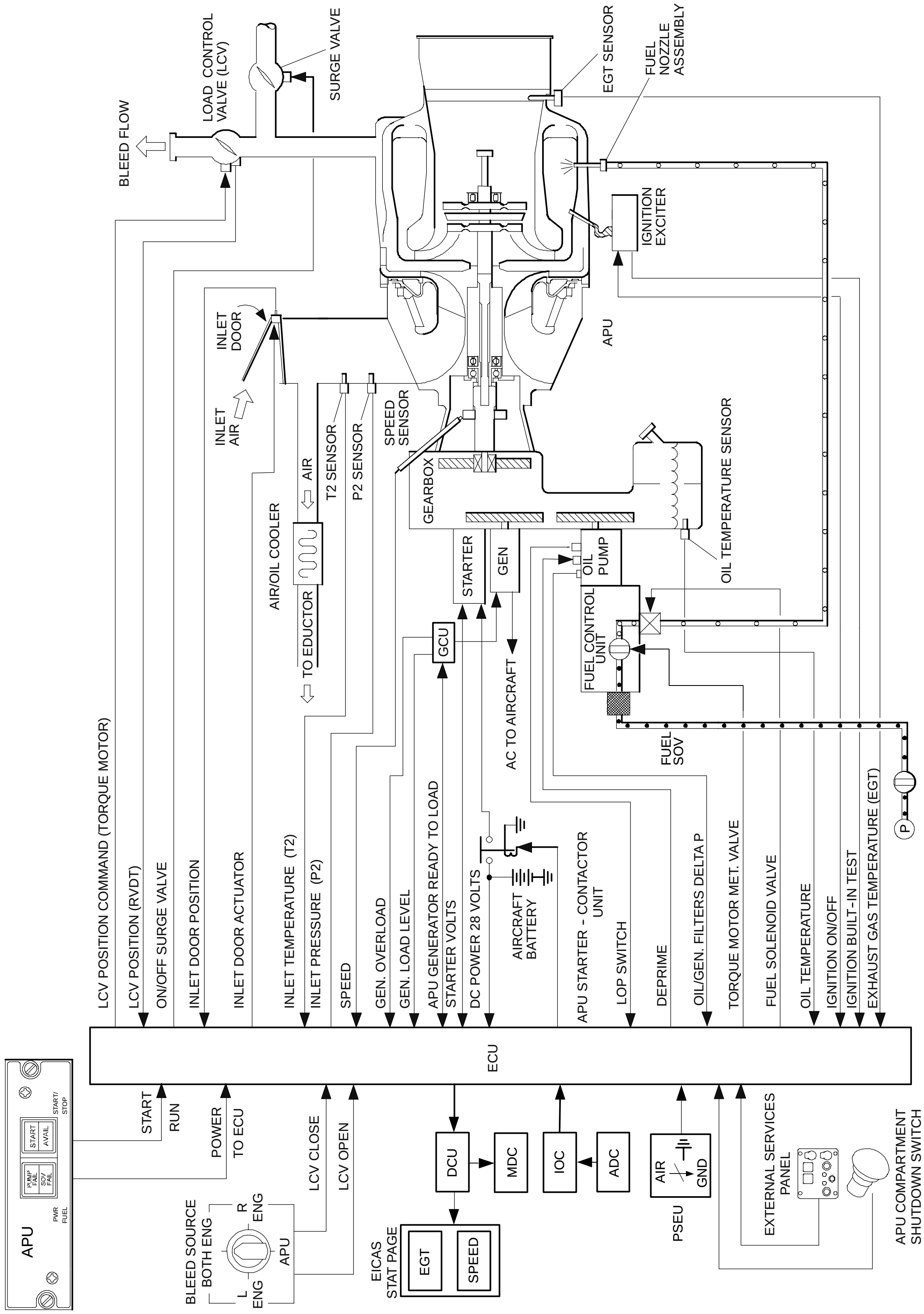
Fuel is supplied to a fuel control unit from the left collector tank by a dedicated APU fuel pump (refer to Chapter 13). The fuel control unit starts, stops and modulates the flow of fuel to the APU in response to commands from the ECU.

C. Ignition and Starting

The ignition and starter systems are controlled by the ECU. The ECU commands the DC starter motor to rotate the power plant. The starter accelerates the power plant to a specific speed where the ECU introduces fuel to the combustor. The ignition system is used to ignite the fuel/air mixture in the combustor which further accelerates the power plant. As the APU accelerates toward the onspeed condition, the starter is disengaged. When the APU reaches normal operating speed, the ignition is turned off. At this point the engine becomes self sustaining.

D. Air Intake and Exhaust

The air inlet door is located in the upper right side of the rear fuselage and is controlled by the ECU. When open, the door provides ram air for APU operation and oil cooling. On the ground, the air inlet door has only two positions, closed or open (0 and 45 degrees). In flight, during APU start, the ECU limits the door position in response to APU engine rpm and aircraft speed. This prevents excessive amounts of ram air which could cause the APU to flameout. When the APU is not operating, the door remains closed to prevent windmilling of the compressor. The inlet door also serves as a barrier in the event of fire. The exhaust duct is composed of stainless steel and is centered in the tailcone.



APU Controls and ECU Interface
Figure 04−30−1

1. CONTROL

The APU electronic control unit (ECU) provides full automatic control of APU starting, stopping, and protects the APU during all modes of operation. The control system ensures that priority is given to electrical loads by reducing bleed airflow.

A. Starting

When the PWR FUEL switchlight, on the APU panel, is selected:

- The ECU is powered
- The air inlet door opens (position is displayed on the EICAS status page)
- The APU RPM and EGT gauges are displayed on the EICAS status page
- The fuel pump comes on

When the START/STOP switchlight, on the APU control panel, is selected:

- The ignition is activated
- The starter motor is energized
- The fuel shutoff valve opens
- The START legend on the APU panel comes on
- The APU START status message is displayed

The starter motor is deactivated at 46% rpm on the ground or at 60% rpm if in flight and the START legend goes out. When the APU reaches 95% rpm, ignition is turned off. Two seconds after the APU reaches 99% rpm, the AVAIL legend, in the START/STOP switchlight, illuminates to notify the crew that the APU is ready for loading.

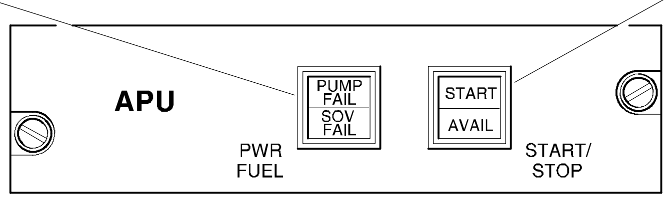
B. Stopping

To shutdown the APU, the crew pushes the START/STOP switchlight on the APU panel. The APU will automatically shed its loading and shutdown. The PWR/FUEL switch is deselected to close the fuel shutoff valve and to remove primary electrical power to the ECU.

In the event of an emergency, the flight crew can press the APU FIRE PUSH switchlight on the glareshield. On the ground, the APU can be shut down by pushing an APU emergency stop button located in the APU compartment or by selecting an APU shut–off switch on the external services panel on the RH forward fuselage. Either selection sends a signal to the ECU to carry out an immediate shutdown.

PWR FUEL
When pressed, APU fuel pump is energized and APU fuel shut–off valve opens, APU EICAS gauges and APU IN BITE message are displayed. On the ground, air inlet door is scheduled to open.
- PUMP FAIL (amber) light comes on to indicate that APU fuel pump has failed.
- SOV FAIL (amber) light comes on to indicate that the APU fuel shut–off valve has failed.

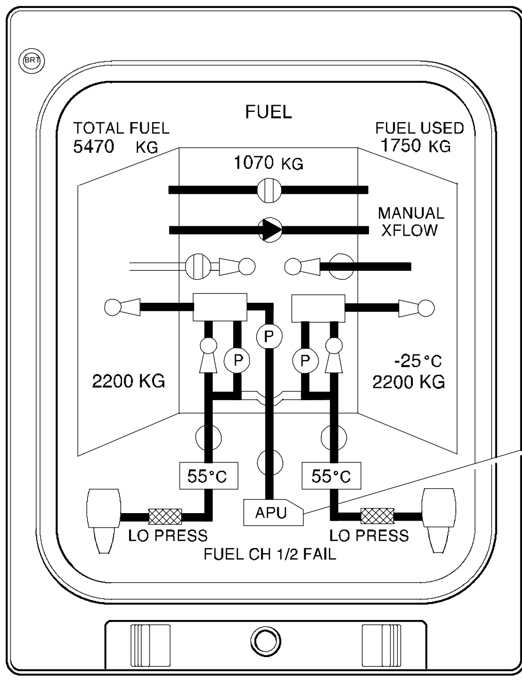
When pressed again, APU fuel pump is de–energized.



APU Control Panel
Overhead Panel

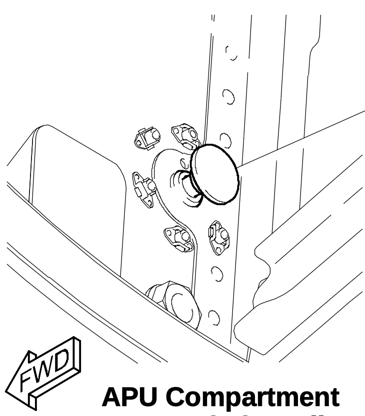
START/STOP
When pressed in:
- Start motor on
- START light (white) comes on
- At 60% rpm, START light goes out
- AVAIL light (green) comes on 2 seconds after APU reaches 99% rpm.

When pressed out:
- Fuel shut–off valve closes
- APU shuts down
- AVAIL light goes out
- Air inlet door closes



Fuel Page

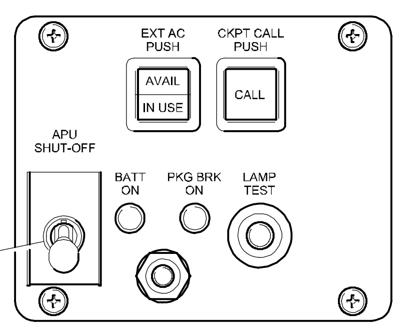
APU Symbol
- White – APU not running
- Half–Intensity Cyan – APU ready to load
- Half–Intensity Magenta – Invalid data



APU Compartment
Forward Firewall

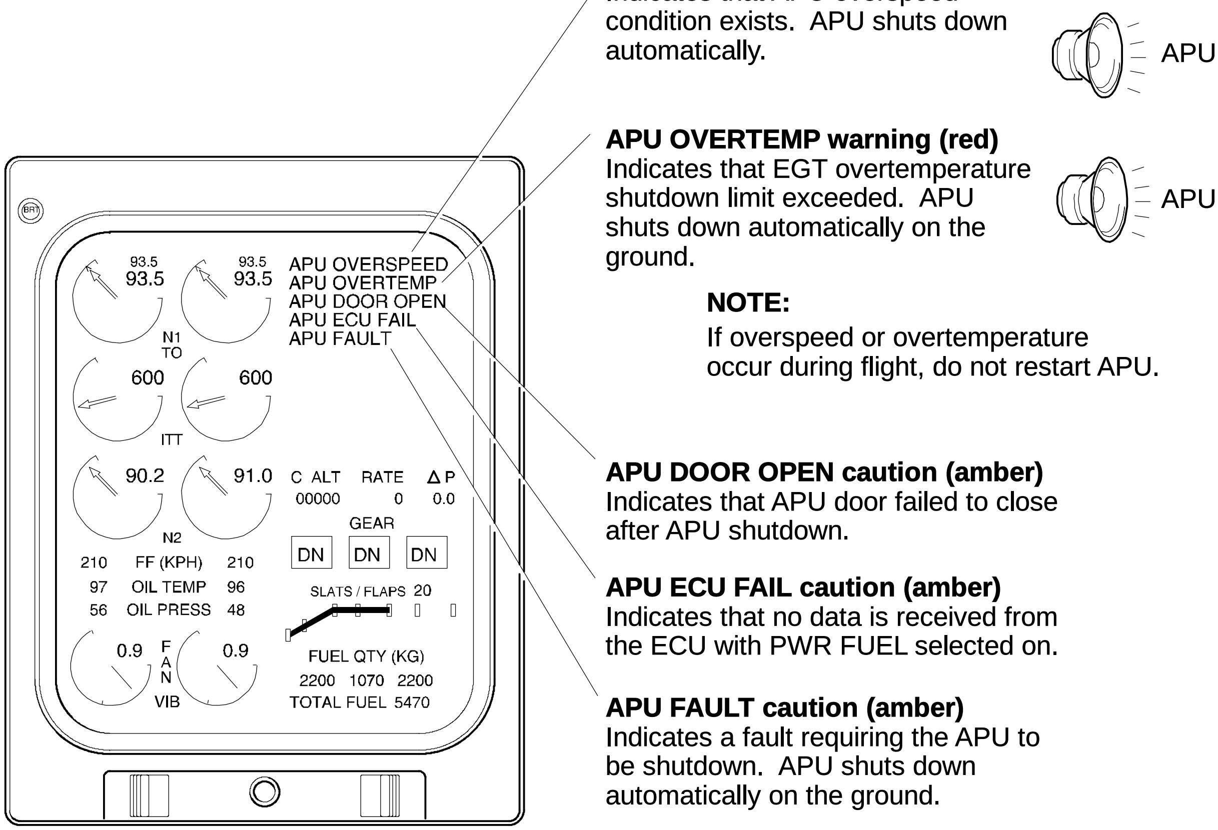
APU Emergency Stop
Used by maintenance personnel to shut down the APU.

APU SHUT–OFF (Guarded)
Used by maintenance personnel to shut down the APU.



External Service Panel
Right Forward Fuselage

Auxiliary Power Unit – Control <1001, 1205>
Figure 04–40–1



APU OVERSPEED warning (red)
Indicates that APU overspeed condition exists. APU shuts down automatically.

APU OVERTEMP warning (red)
Indicates that EGT overtemperature shutdown limit exceeded. APU shuts down automatically on the ground.

NOTE:
If overspeed or overtemperature occur during flight, do not restart APU.

APU DOOR OPEN caution (amber)
Indicates that APU door failed to close after APU shutdown.

APU ECU FAIL caution (amber)
Indicates that no data is received from the ECU with PWR FUEL selected on.

APU FAULT caution (amber)
Indicates a fault requiring the APU to be shutdown. APU shuts down automatically on the ground.

Primary Display

NOTE:
For pneumatic messages refer to Chapter 19.

EICAS Auxiliary Power Unit Indications – Primary Page <1001>
Figure 04–40–2

APU ALT LIMIT status (white)
Indicates that surge control valve has failed.

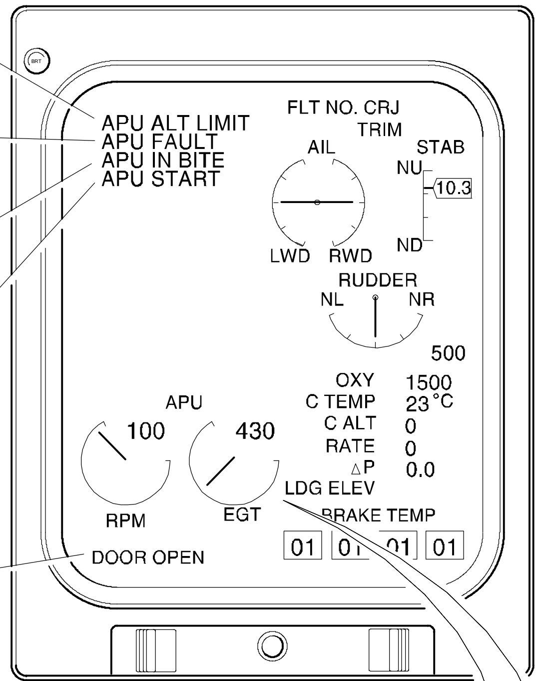
APU FAULT status (white)
Indicates loss of redundancy in sensors, impending filter bypass or fuel valve has failed open.

APU IN BITE status (white)
Indicates air inlet door not in position with PWR FUEL selected on.

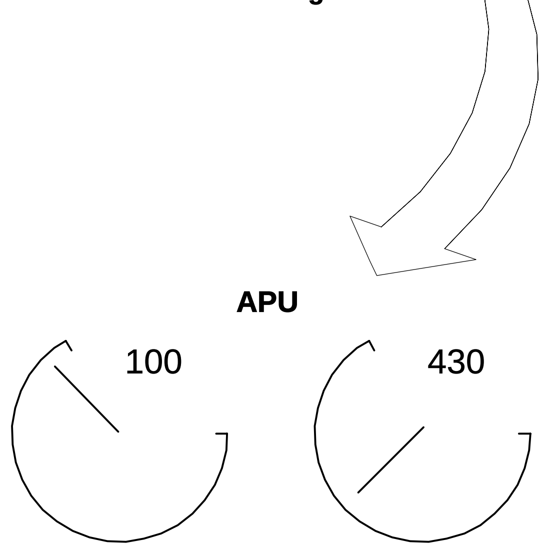
APU START status (white)
Indicates that starter motor is engaged.

APU Inlet Door Status Indicator (white)
Indicates air inlet door position:
- DOOR CLSD
- DOOR OPEN
- DOOR INHIB/CLSD
- DOOR INHIB/OPEN
- DOOR – – – (amber dashes)

NOTE:
Amber dashes indicates position unknown. Amber DOOR OPEN indicates door has failed to close after APU shutdown.



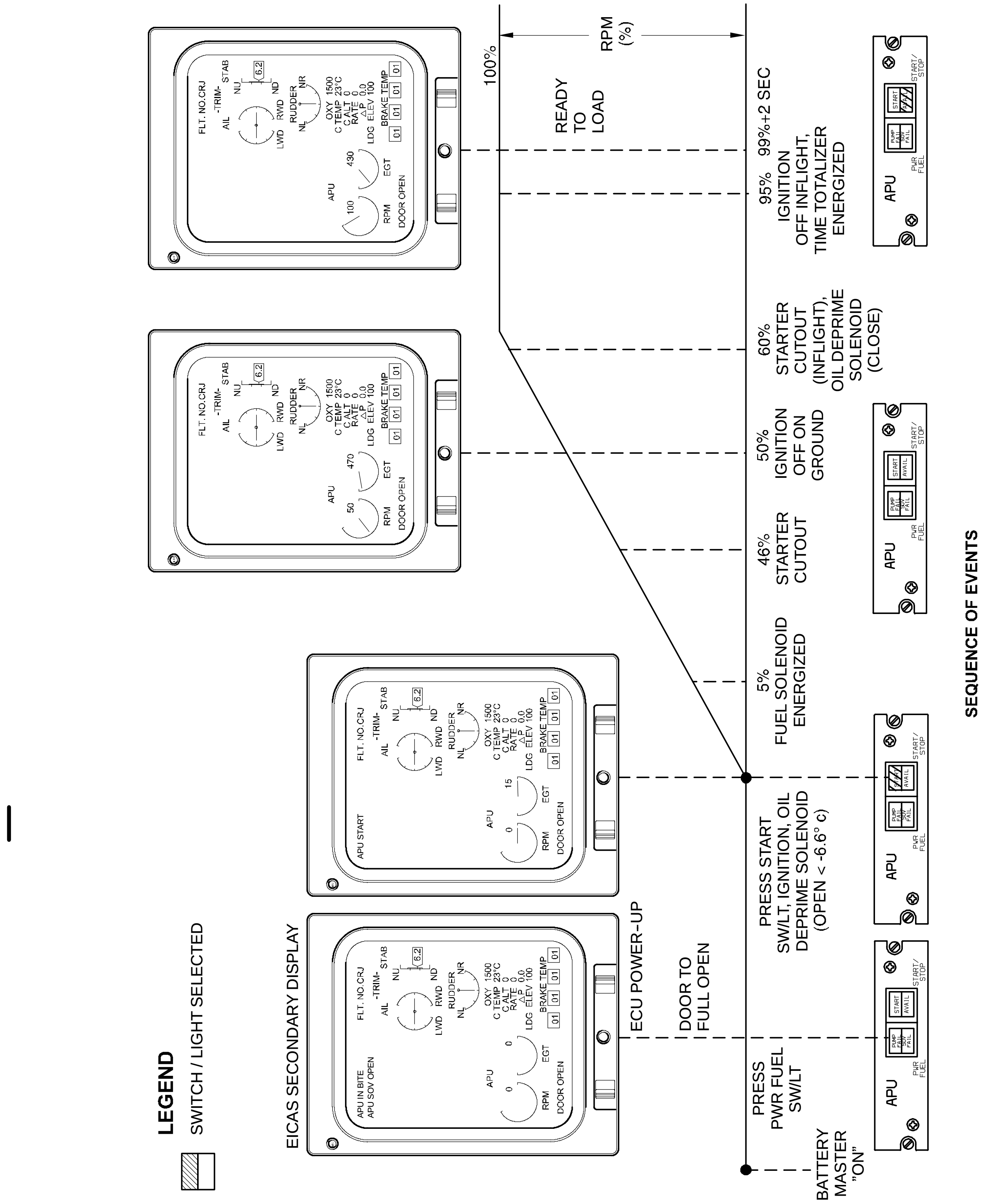
Status Page



APU RPM Readout, scale and pointer (green)
Indicates percent of APU rpm. Readout and pointer turn red during overspeed condition.

APU EGT Readout, scale and pointer (green)
Indicates exhaust gas temperature in degrees Centigrade. Readout and pointer turn red during overtemperature condition.

Auxiliary Power Unit and Indications – Status
Figure 04–40–3



Auxiliary Power Unit Start Sequence
Figure 04–40–4

C. Protective Shutdown

The ECU will shut down the APU (on ground or in flight) if any of the following faults occur:

- Overspeed – APU speed exceeded 106 percent.
- Loss of overspeed protection – A combination of speed sensors or overspeed circuits fail.
- Loss of speed sensor signals – Both speed sensor channels failed.
- APU door failed to open within 30 seconds of command.
- APU door was open then closed without command, while the APU was operating.
- ECU internal failure.
- No APU rotation – During start, speed did not reach 5% within specified time requirement (12 seconds for warm oil; 50 seconds for cold oil).
- No APU light-off – Light-off was not detected within specified time requirement.
- Slow start – Starting time period exceeded.
- No acceleration – Acceleration during start was less than 0.05% per second for 15 seconds.
- Speed fallback – The APU speed drops below 50% after starter cutout.
- Loss of DC power – Battery power lost for more than 200 milliseconds.
- APU fire/emergency – APU FIRE PUSH switch or one of the emergency shutdown switches was selected.
- Loss of air inlet door position sensor signal – Failure of air inlet door position sensor.

The ECU will shut down the APU (on ground) if any of the following faults occur:

- Overtemperature – APU EGT exceeded schedule limits.
- Low oil pressure (LOP) – Low oil pressure exists for 15 seconds with the APU operating.
- Oil pressure switch failed – Cannot detect a low oil pressure condition.
- High oil temperature – Oil temperature exceeded 300°F with the APU operating.
- Reverse flow – APU inlet temperature exceeded 350°F for 5 seconds with with the APU operating and LCV open.

- Underspeed – APU was operating and speed dropped below 80% for 5 seconds.
- Loss of EGT sensors – Both EGT sensor channels failed.
- APU oil filter in an impending bypass condition.

D. System Circuit Breakers

<table>
<tr><th>SYSTEM</th><th>SUB-SYSTEM</th><th>CB NAME</th><th>BUS BAR</th><th>CB PANEL</th><th>CB LOCATION</th><th>NOTES</th></tr>
<tr><td rowspan="4">Auxiliary Power Unit</td><td rowspan="4">Control</td><td>APU CONT</td><td rowspan="2">BATTERY BUS</td><td rowspan="2">1</td><td>N7</td><td></td></tr>
<tr><td>APU ECU PRIM</td><td>N11</td><td></td></tr>
<tr><td>APU ECU SEC</td><td rowspan="2">APU BATT DIRECT BUS</td><td rowspan="2">5</td><td>A6</td><td></td></tr>
<tr><td>APU DOOR ACT</td><td>B1</td><td></td></tr>
</table>

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CHAPTER 2 – AURAL/VISUAL INDICATING AND RECORDING

Page

LIST OF ILLUSTRATIONS

ENGINE INDICATING AND CREW ALERTING SYSTEM

RECORDING

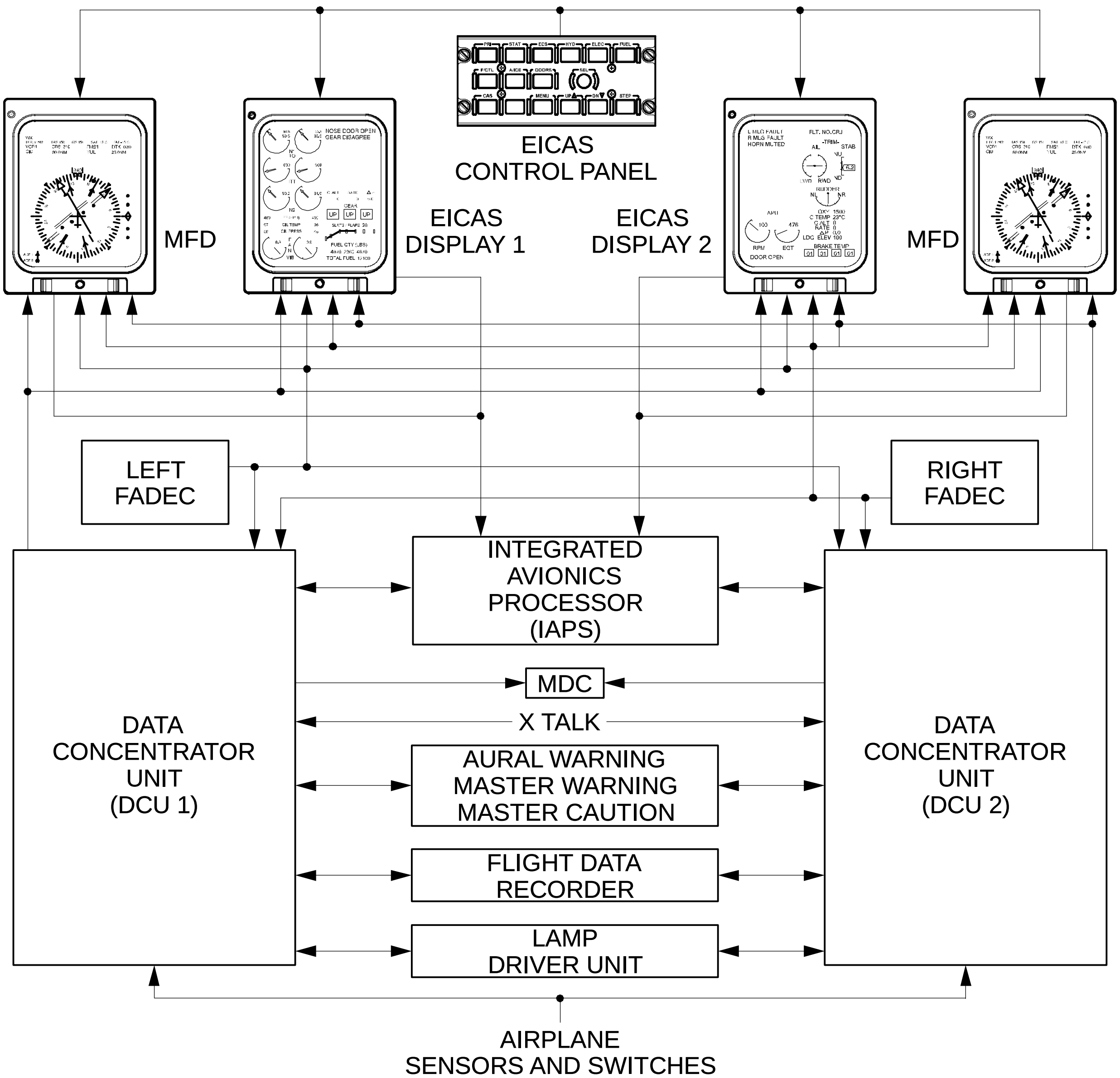
MAINTENANCE DATA COMPUTER

1. INTRODUCTION

The indicating and recording systems consist of components that provide visual indications of system operation and to record aircraft information.

Data from the aircraft systems and the full authority digital engine control (FADEC) on each engine is received and processed by two data concentrator units (DCU) located in the avionics compartment. The DCUs provide information to the engine indication and crew alerting system (EICAS). Master warning and caution lights on the glareshield enhance the indication system. Audio signals are generated within the DCUs and are heard through the flight deck speakers.

The DCUs also provide interface with the flight data recorder system (FDR), the lamp driver unit (LDU) and the maintenance data computer (MDC) via the integrated avionic processor (IAPS).



Aural/Visual Indicating and Recording Schematic
Figure 02–10–1

1. ENGINE INDICATING AND CREW ALERTING SYSTEM

The engine indicating and crew alerting system (EICAS) provides the crew with two electronic displays to monitor engines, control surfaces and all major aircraft systems. The EICAS system also provides the crew with alerting system messages that are posted on the EICAS displays in the form of warning, caution, advisory and status messages. All warning and caution messages will also illuminate the MASTER WARNING or MASTER CAUTION lights on the glareshield. Some crew alerts are also accompanied by aural tones and voice advisories. The EICAS system can also illuminate switchlights on specific system control panels to provide component/system status or to prompt corrective crew action.

The EICAS system consists of the following:

- Two EICAS displays on the center instrument panel – Used to display system information and status.

NOTE

The EICAS displays are referred to as EICAS Display 1 (ED1) and EICAS Display 2 (ED2). ED1 is on the left and ED2 is on the right. The information that is shown on each display is referred to as a page. In normal configuration, the Primary page is shown on ED1 and the Status page is shown on ED2.

- EICAS control panel on the center pedestal – Used to select which EICAS page, (primary page,status page, synoptic pages or menu page) is to be shown on ED2. The panel is also used to display additional caution and status messages on ED1 and ED2.

- Engine/Miscellaneous test panel on the center pedestal – Used to perform tests of the annunciator lights, set annunciator light levels, record specific flight data events and synchronize the engines N1 or N2.

- Display reversion control panels on the pilot's and copilot's side panel – PFD position – puts the primary flight display (PFD) information on the pilot's or copilot's multifunctional display (MFD). EICAS position – makes all EICAS information available on the pilot's or copilot's MFD.

- EICAS selector on the center pedestal SOURCE SELECTOR PANEL – Used to select where the EICAS information will be displayed. The information can be displayed on ED1 and ED2, or all the EICAS information can be displayed on either ED1 or ED2.

- MASTER WARNING and MASTER CAUTION switchlights on the glareshield. – Illuminate when a warning or caution is detected by the data concentrator units (DCUs).

- Lamp driver unit, located in the avionics compartment – Used to control and test flight compartment annunciator lights.

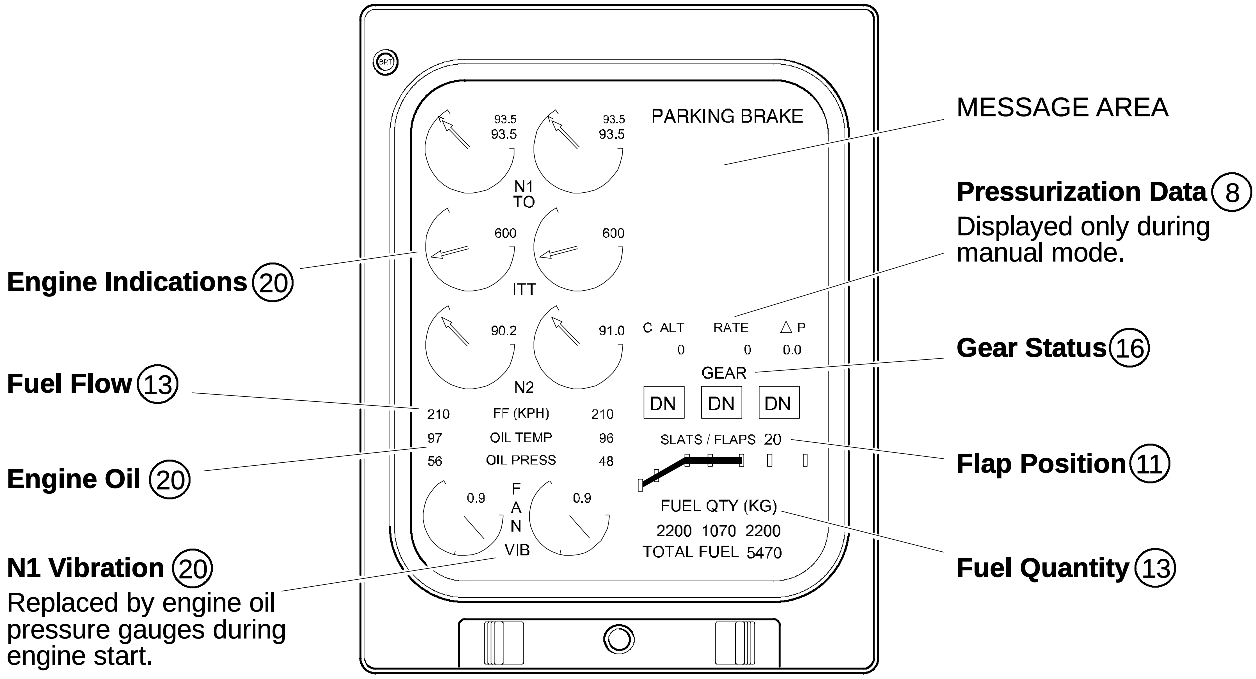
- Data concentrator units located in the avionics compartment – Used to process data and transmit the applicable data to the EICAS displays, flight data recorder and lamp driver units. The DCUs are also used to control the aural warning system.

The EICAS primary page displays the following information:

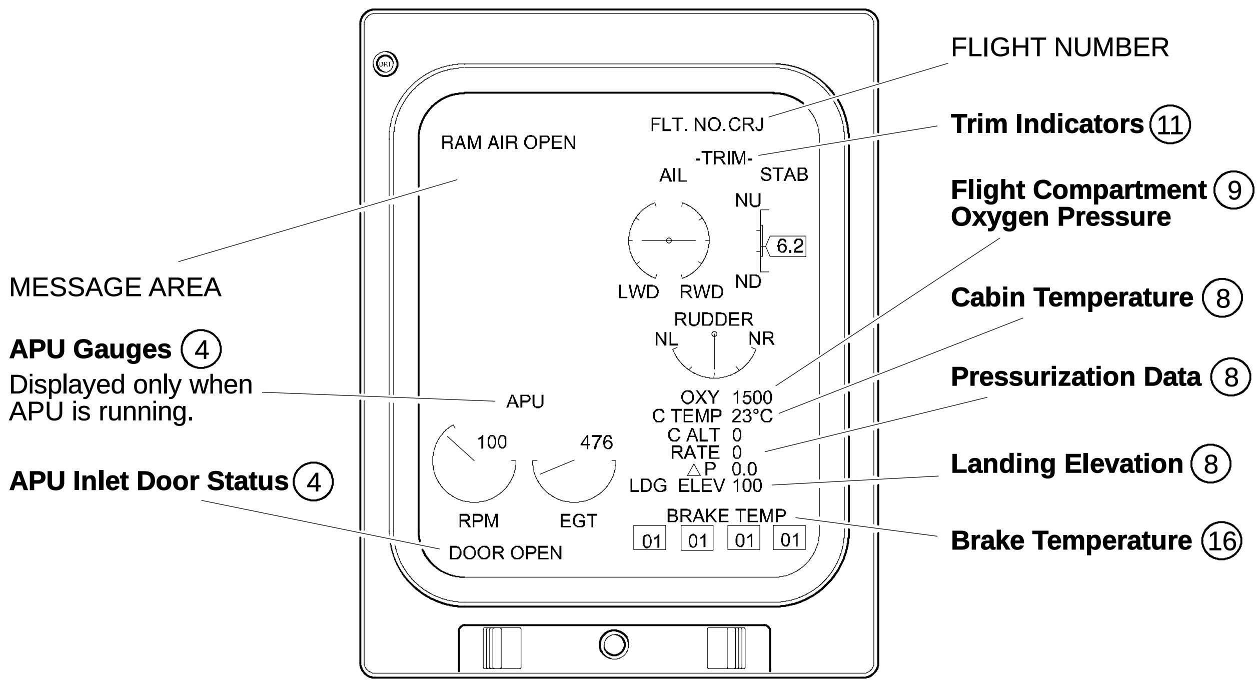
- Engine compressor and turbine speeds (N_1 and N_2 rpm)
- Engine temperature (ITT)
- Fuel flow (FF)
- Oil pressure and temperature
- Engine vibration data
- Pressurization data
- Landing gear position
- Slat/flap position
- Fuel tank quantities and total fuel
- Crew alerting system (CAS) messages in the form of red warning and amber caution messages

The EICAS status page displays the following information:

- Flight control trim indications
- Auxiliary power unit (APU) indications such as APU RPM, exhaust gas temperature (EGT) and APU inlet door status
- Pressurization data such as cabin altitude, cabin rate of change, cabin pressure differental, and landing field elevation
- Oxygen system pressure
- Brake system temperature readouts
- Aircraft systems synoptic pages (via the EICAS control panel)
- MENU page (via the EICAS control panel) allows reset of the fuel used indicator and displays the engine oil quantity
- Crew alerting system (CAS) messages in the form of green advisory and white status messages



Primary Page



Status Page

◯ Indicates Chapter in which information on item may be found.

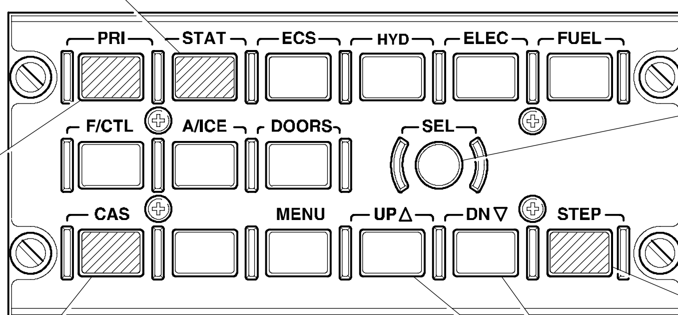
Engine Indicating and Crew Alerting System – General <1001>
Figure 02–20–1

Status Page (STAT)
Used to display the status page on the secondary display. A second push will remove status messages from view or will display additional status messages if more messages exist.

Synoptic Pages (ECS, HYD, ELEC, FUEL, F/CTL, A/ICE, DOORS, MENU)
Used to display system synoptic pages. A second push of the ELEC button will replace the AC electrical synoptic page with the DC electrical synoptic page.

Select (SEL)
Used to activate a selected item. Cursor symbol, letter or number will change color to acknowledge selection.

Primary Page (PRI)
Used to displays the primary page on the secondary display.

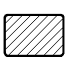


STEP
Used to step through pages on secondary display.

Crew Alerting System (CAS)
Used when primary page is displayed to remove caution messages from view or display additional caution messages if more messages exist.

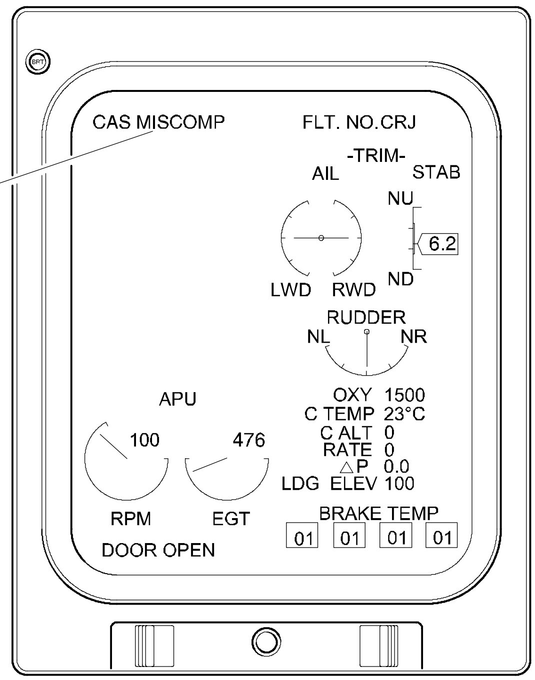
EICAS Control Panel
Center Pedestal

UP and DN
Used to control operation of cursor on menu page. These buttons slew the value of selected items.

 Indicates controls operable during a panel failure.

EICAS Control Panel
Figure 02–20–2

CAS MISCOMP status (white)
Indicates that a miscomparison of detected warning, caution or aural alerts exists between DCUs.

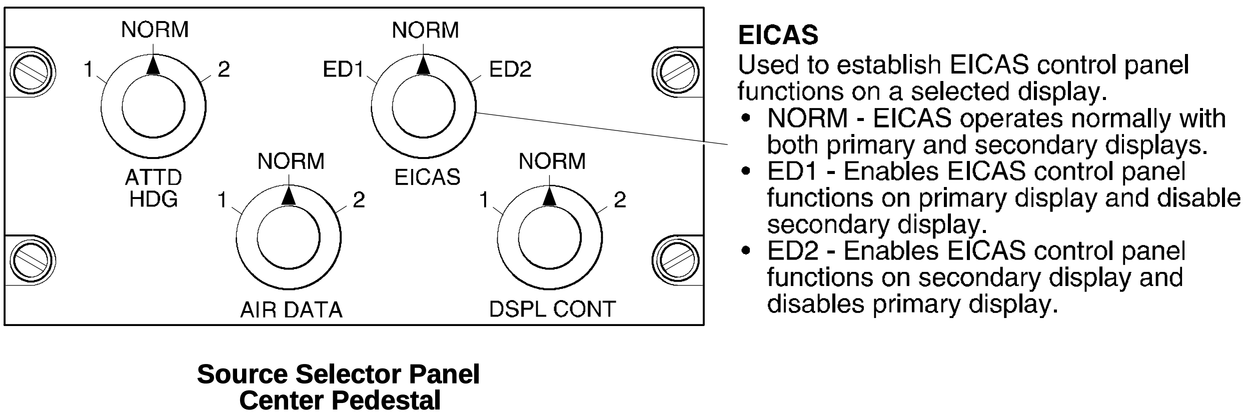


Status Page

EICAS Miscomparison Indication
Figure 02–20–3

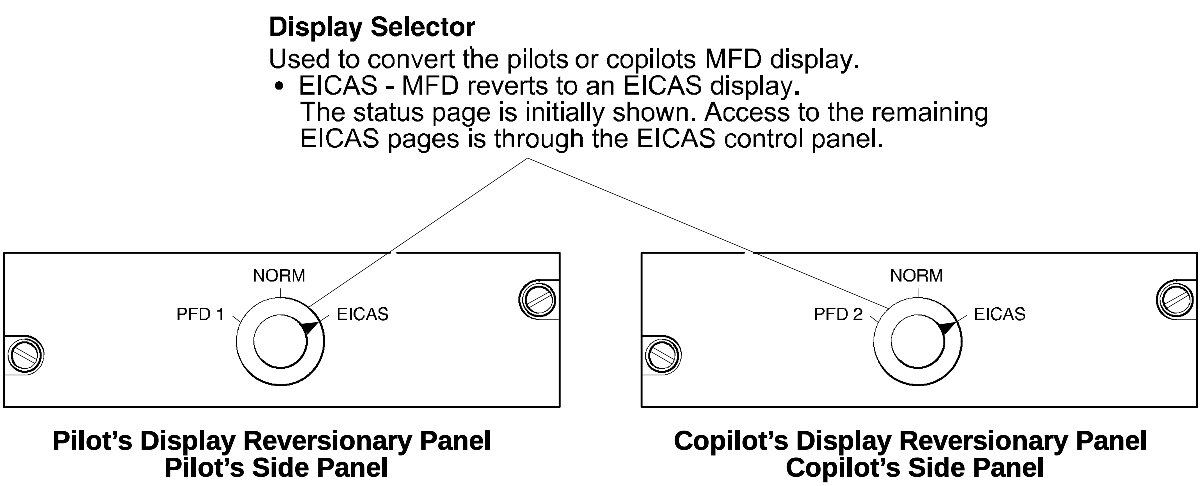
A. Display Reversion

If EICAS display 1 (ED1) fails, the primary page will be automatically displayed on ED2. If ED2 fails, there is no automatic transfer to ED1. With either display failure, the EICAS control panel is rendered inoperative. To regain control, the EICAS selector on the SOURCE SELECTOR PANEL must be set to the operable display (ED1 or ED2) to re-establish the EICAS control panel functions. The selector also makes available all EICAS information on the selected display.



Display Reversion
Figure 02–20–4

To ensure timely access to essential EICAS data, all EICAS pages can be made available on either MFD by selecting the EICAS position on the respective Display Reversionary Panel.



Display Selector
Figure 02–20–5

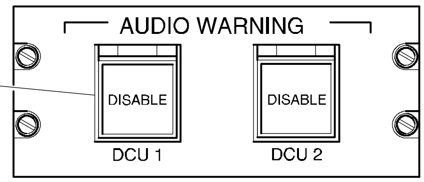
B. Aural Warning

Various tones call attention to warnings. There are ten types of aural alerts:

Sound	Indication	Chapter Reference
Warbler	Stall	Chapter 11, Flight Controls
Siren	Windshear	Chapter 18, Navigation
Whoop – Whoop	GPWS mode 1 or 2 (excessive descent rate or excessive closure rate)	Chapter 18, Navigation
Fire Bell	Fire warnings	Chapter 10, Fire Protection
Clacker	1. Excessive stabilizer trim movement 2. V_{MO}/M_{MO} exceedance 3. Airspeed too high for current flap setting	Chapter 11, Flight Controls Chapter 12, Flight Instruments
Cavalry Charge	Autopilot disconnect	Chapter 3, Automatic Flight Control System
Horn	Gear not down	Chapter 16, Landing Gear
Triple chime	Warning tone that precedes an aircraft system voice advisory	Chapters 2 through 20
C-chord	Altitude alert	Chapter 12, Flight Instruments
Single chime	Caution tone that precedes an aircraft system voice advisory	Chapters 2 through 20

DCU 1 and DCU 2 (Guarded)
Used to disable and silence the aural warnings of a faulty DCU.

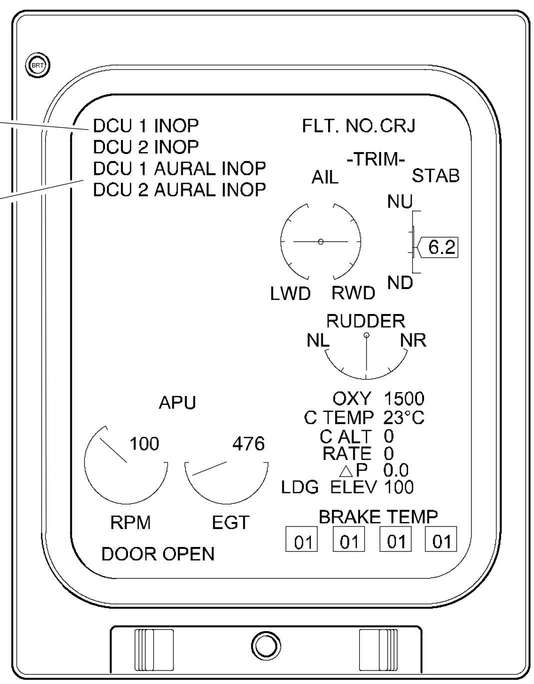
- DISABLE (white) light indicates respective DCU aural output is disabled.



Audio Warning Panel
Copilot's Side Console

DCU 1 or 2 INOP status (white)
Indicates internal fault or crosstalk fault in respective data concentrator unit.

DCU 1 or 2 AURAL INOP status (white)
Indicates internal aural fault in respective data concentrator unit or indicates respective DCU aural output has been disabled.



Status Page

DCU Controls and Indications
Figure 02–20–6

C. Master Warning / Master Caution Lights

Two MASTER WARNING lights come on flashing when any warning occurs. The lights remain on as long as the warning exists. Pushing either MASTER WARNING extinguishes both MASTER WARNING lights for the duration of that warning and resets the lights for future warnings.

Pushing the MASTER WARNING also silences the aural warnings except for the following cases:

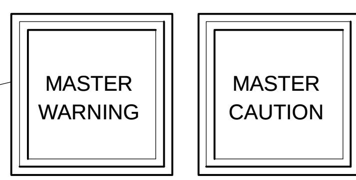
- Stall warbler
- GPWS/TCAS (voices and aural)
- Overspeed clacker
- Flap clacker
- Stabilizer trim clacker
- AP Disconnect cavalry charge
- Configuration warnings
- Gear Horn

Two MASTER CAUTION lights come on flashing when any caution occurs. Pushing either MASTER CAUTION extinguishes both MASTER CAUTION lights for the duration of that caution and resets the lights for future cautions.

Pushing the MASTER CAUTION will not silence the following:

- GPWS and TCAS voice alerts
- Altitude alert (C-chord) aural

MASTER WARNING
Both lights come on (red) in conjunction with warning lights and EICAS messages. Pushing either switch will turn both lights out and reset warning system for subsequent indications. Lights cannot be dimmed.



Left and Right Glareshield

MASTER CAUTION
Both lights come on (amber) in conjunction with caution lights and EICAS messages. Pushing either switch will turn both lights out and reset caution system for subsequent indications. Lights cannot be dimmed.

Master Warning / Master Caution Lights
Figure 02–20–7

D. Crew Alerting System Messages

Crew alerting system messages appear in the message area on both EICAS displays (ED1 and ED2). The messages are arranged by their urgency and order of occurrence. All crew alerting system messages are divided into one of four categories: warnings, cautions, advisories, or status.

- Warnings messages, are the most urgent type of crew alerts and indicate operational or aircraft system conditions that require immediate corrective action. All warning messages are preceded by a triple chime and appear in red at the top of the message area on ED1. For all warnings, the red MASTER WARNING lights will flash. Some warnings also have an aural alert consisting of a unique tone and a voice advisory. Warning messages cannot be removed from view, unless the applicable failure has been rectified.

- Cautions messages, are less urgent than warnings and indicate operational or aircraft system conditions that require prompt corrective action. All caution messages are preceded by a single chime and appear in amber immediately below the warnings in the message area on ED1. For all cautions, the amber MASTER CAUTION lights will flash. Caution messages can be removed from view by using the CAS button on the EICAS control panel.

- Advisories messages are used to show that a safe condition exists. They appear in green at the top of the message area on ED2. Advisory messages cannot be removed from view, unless the applicable system or switch has been deactivated or deselected.

- Status messages indicate that an abnormal condition exists or that a low-priority failure has occurred. They appear in white in the message area below the advisories. Status messages can be removed from view by using the STAT button on the EICAS control panel.

The most recent message appears at the top of its respective group of messages. A message is automatically removed from EICAS when the associated condition no longer exists. In this case, messages which appeared below the deleted message, each move up one line. When a new fault occurs, the new message will move older messages down one line.

If the number of warnings exceeds the message area (number of lines), then only the most recent warning messages are displayed and a red PAGE 1/2 appears at the bottom of the message area.

When more caution messages exist than can fit in the message area, a second page of cautions will be created and a page 1 of 2 will be indicated in the top RH corner of primary page. The CAS button on the EICAS control panel is then used to the next page of caution messages.

- Caution messages can be removed from view by pressing the CAS button, providing that both main generators are operating and on-line. A MSGS icon will appear, advising the crew that the caution messages are out of view.

NOTE

If a new abnormal situation occurs, the corresponding caution message will appear. To view all of the caution messages, re-select the CAS button.

Advisory messages cannot be removed from view, unless the appropriate system/switch, has been deactivated. If the number of advisories exceeds the message area, a green PAGE 1/2 appears at the bottom of the message area.

When more status messages exist than can fit in the message area, a second page of status messages will be created and a page 1 of 2 will be indicated in the top LH corner of the status page. The STAT button on the EICAS control panel is then used to select the next page of status messages.

- Status messages can be removed from view, anytime the EICAS system is powered, by pressing the STAT button on the EICAS control panel. A MSGS icon will appear, advising the crew that status messages are out of view.

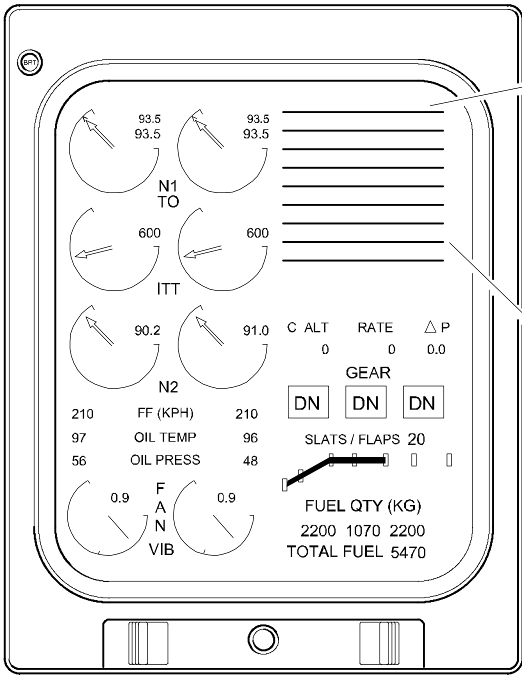
E. Synoptic Pages

Aircraft system information is presented in the form of synoptic pages. Synoptic pages are simplified top-level schematic diagrams used for pilot and maintenance information. The synoptic pages are dynamic displays of the aircraft systems status and operation which includes all major components and parameter values. When a malfunction occurs, the affected component and/or parameter value will change color. System flow lines are green to indicate flow and white to indicate no flow. Status and malfunction messages are also included on the synoptic pages.

The synoptic pages are selected by dedicated keys on the EICAS control panel (ECP) or by using the STEP key to sequence through the pages (refer to figure 2). In normal operation, the selected synoptic page will be displayed on EICAS display 2 (ED2). Pressing the STAT key will return the status page to ED2.

NOTE

A description of each synoptic page is included in its related chapter.



Primary Page

Warning Messages (red)
Conditions that require immediate corrective action.

Warning messages cannot be paged.

If the number of warning messages exceeds the available message area, only the most recent will be displayed.

Warning messages cannot be removed from view, without rectifying the failure.

Caution Messages (amber)
Conditions that require prompt corrective action.

Caution messages can be paged.

Caution messages can be removed from view, providing both main generators are operating and on–line.

Advisory Messages (green)
System response or acknowledgement messages (new condition).

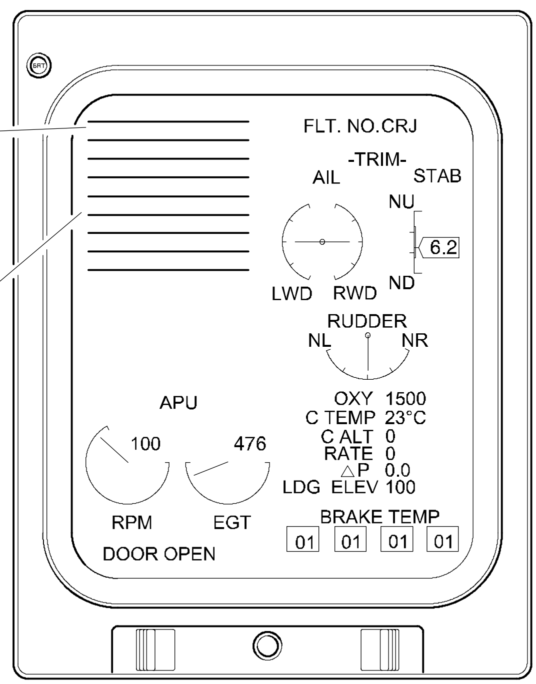
Advisory messages cannot be paged.

Advisory messages cannot be removed from view, without de–selecting the appropriate system.

Status Messages (white)
Conditions that require time available corrective action.

Status messages can be paged.

Status messages can be removed from view anytime.



Status Page

EICAS Display Message Fields <1001>
Figure 02–20–8

F. EICAS Warning Messages (Red) and Aurals

Message	Aural	Chapter
AFCS MSG FAIL		3
ANTI-ICE DUCT	Anti-Ice Duct	19
APU FIRE	☆	10
APU OVERSPEED	APU	4
APU OVERTEMP	APU	4
BRAKE OVHT	Brakes	16
CABIN ALT	Cabin Pressure	8
CONFIG AILERON	Config Trim	2
CONFIG AP	Config Autopilot	2
CONFIG FLAPS	Config Flaps	2
CONFIG RUDDER	Config Trim	2
CONFIG SPLRS	Config Spoilers	2
CONFIG STAB	Config Trim	2
DIFF PRESS	Cabin Pressure	8
EMER PWR ONLY		7
ENGINE OVERSPD		20
GEAR DISAGREE	Gear Disagree	16
L BLEED DUCT	Bleed Air Duct	19
L COWL A/I DUCT	Anti-Ice Duct	19
L ENG FIRE	☆	10
L ENG OIL PRESS	Engine Oil	20
L REV DEPLOYED		20
MLG BAY OVHT	Gear Bay Overheat	10
NOSE DOOR OPEN	Nose Door	16
PARKING BRAKE	Config Brakes	16
PASSENGER DOOR	Door	6
R BLEED DUCT	Bleed Air Duct	19
R COWL A/I DUCT	Anti-Ice Duct	19
R ENG FIRE	☆	10
R ENG OIL PRESS	Engine Oil	20
R REV DEPLOYED		20
SMOKE AFT CARGO	Smoke	10
SMOKE AFT LAV		10
SMOKE FWD CARGO	Smoke	10
SMOKE FWD LAV		10
WING OVHT	Wing Overheat	15

NOTE

☆ Firebell aural tone.

G. EICAS Caution Messages (Amber)

Message	Ch.	Message	Ch.	Message	Ch.	Message	Ch.
AC 1 AUTOXFER	7	ELT ON	9	L ENG SOV FAIL	13	R ENG DEGRADED	20
AC 2 AUTOXFER	7	EMER DEPRESS	8	L ENG SOV OPEN	13	R ENG FLAMEOUT	20
AC BUS 1	7	EMER LTS OFF	17	L ENG SQB	10	R ENG SOV CLSD	13
AC BUS 2	7	ENG BTL 1 LO	10	L ENG SRG CLSD	20	R ENG SOV FAIL	13
AC ESS BUS	7	ENG BTL 2 LO	10	L ENG SRG OPEN	20	R ENG SOV OPEN	13
AC SERV BUS	7	FIRE SYS FAULT	10	L ENG TAT HEAT	15	R ENG SQB	10
AFT CARGO DET	10	FLAPS FAIL	11	L FADEC	20	R ENG SRG CLSD	20
AFT CARGO DOOR	6	FLT SPLR DEPLOY	11	L FADEC OVHT	20	R ENG SRG OPEN	20
AFT CARGO OVERHEAT	8	FUEL CH 1/2 FAIL	13	L FIRE FAIL	10	R ENG TAT HEAT	15
AFT CARGO SQB 1	10	FUEL IMBALANCE	13	L FUEL FILTER	13	R FADEC	20
AFT CARGO SQB 2	10	FWD CARGO DET	10	L FUEL LO PRESS	13	R FADEC OVHT	20
AFT SERVICE DOOR	6	FWD CARGO DOOR	6	L FUEL LO TEMP	13	R FIRE FAIL	10
ALT LIMITER	8	FWD CARGO SQB 1	10	L FUEL PUMP	13	R FUEL FILTER	13
ANTI-ICE DUCT	19	FWD CARGO SQB 2	10	L MAIN EJECTOR	13	R FUEL LO PRESS	13
ANTI-ICE LOOP	19	FWD SERVICE DOOR	6	L PACK	8	R FUEL LO TEMP	13
AP PITCH TRIM	3	GEN 1 OFF	7	L PACK AUTOFAIL	8	R FUEL PUMP	13
APR CMD SET	20	GEN 2 OFF	7	L PACK TEMP	8	R FWD EMER DOOR	6
AP TRIM IS LWD	3	GEN 1 OVLD	7	L PITOT HEAT	15	R MAIN EJECTOR	13
AP TRIM IS ND	3	GEN 2 OVLD	7	L REV INOP	20	R PACK	8
AP TRIM IS NU	3	GLD NOT ARMED	11	L REV UNLOCKED	20	R PACK AUTOFAIL	8
AP TRIM IS RWD	3	GLD UNSAFE	11	L REV UNSAFE	20	R PACK TEMP	8
APU BATT OFF	7	GND SPLR DEPLOY	11	L SCAV EJECTOR	13	R PITOT HEAT	15
APU BLEED ON	19	HYD EDP 1A	14	L START ABORT	20	R REV INOP	20
APU BTL LO	10	HYD EDP 2A	14	L START VALVE	20	R REV UNLOCKED	20
APU DOOR OPEN	4	HYD 1 HI TEMP	14	L STATIC HEAT	15	R REV UNSAFE	20
APU ECU FAIL	4	HYD 2 HI TEMP	14	L THROTTLE	20	R SCAV EJECTOR	13
APU FAULT	4	HYD 3 HI TEMP	14	L WINDOW HEAT	15	R START ABORT	20
APU FIRE FAIL	10	HYD 1 LO PRESS	14	L WING A/I	15	R START VALVE	20
APU GEN OFF	7	HYD 2 LO PRESS	14	L WSHLD HEAT	15	R STATIC HEAT	15
APU GEN OVLD	7	HYD 3 LO PRESS	14	L XFER SOV	13	R THROTTLE	20
APU LCV CLSD	19	HYD PUMP 1B	14	LOW FUEL	13	RUD LIMITER	11
APU LCV OPEN	19	HYD PUMP 2B	14	MACH TRIM	11	R WINDOW HEAT	15
APU PUMP	13	HYD PUMP 3A	14	MAIN BATT OFF	7	R WING A/I	15
APU SOV FAIL	13	HYD PUMP 3B	14	MLG OVHT FAIL	16	R WSHLD HEAT	15
APU SOV OPEN	13	HYD SOV 1 OPEN	14	NO STRTR CUTOUT	20	R XFER SOV	13
APU SQB	10	HYD SOV 2 OPEN	14	OB BRAKE PRESS	16	SLATS FAIL	11
A/SKID INBD	16	IB BRAKE PRESS	16	OB FLT SPLRS	11	SPOILERONS ROLL	11
A/SKID OUTBD	16	IB FLT SPLRS	11	OB GND SPLRS	11	STAB TRIM	11
AUTO PRESS	8	IB GND SPLRS	11	OB SPOILERONS	11	STAB TRIM LIMIT	11
AV BAY DOOR	6	IB SPOILERONS	11	OVBD COOL	8	STALL FAIL	11
AVIONICS FAN	8	ICE	15	OXY LO PRESS	9	STBY PITOT HEAT	15
BATTERY BUS	7	ICE DET FAIL	15	PARK BRAKE SOV	16	STEERING INOP	16

Message	Ch.	Message	Ch.	Message	Ch.	Message	Ch.
BLEED MISCONFIG	19	IDG 1	7	PASS OXY ON	9	TAT PROBE HEAT	15
BULK FUEL TEMP	13	IDG 2	7	PAX DR LATCH	6	WING A/I SNSR	15
CABIN ALT	8	ISOL FAIL	19	PAX DR OUT HNDL	6	WING XBLEED	15
CARGO BTL LO	10	L AFT EMER DOOR	6	PITCH FEEL	11	WOW INPUT	16
CTR CARGO DOOR	6	L AOA HEAT	15	PROX SYS CHAN	16	WOW OUTPUT	16
DC BUS 1	7	L BLEED DUCT	19	PROX SYSTEM	16	XFLOW PUMP	13
DC BUS 2	7	L BLEED LOOP	19	R AFT EMER DOOR	6	YAW DAMPER	11
DC EMER BUS	7	L COWL A/I	15	R AOA HEAT	15		
DC ESS BUS	7	L COWL A/I OPEN	15	R BLEED DUCT	19		
DC SERV BUS	7	L COWL LOOP	19	R BLEED LOOP	19		
DISPLAY COOL	8	L ENG BLEED	19	R COWL A/I	15		
EFIS COMP INOP	12	L ENG DEGRADED	20	R COWL A/I OPEN	15		
EFIS COMP MON	12	L ENG FLAMEOUT	20	R COWL LOOP	19		
ELEVATOR SPLIT	11	L ENG SOV CLSD	13	R ENG BLEED	19		

H. EICAS Advisory Messages (Green)

Message	Chapter
ADS HEAT TEST OK	15
APU SOV CLSD	13
COWL A/I ON	15
CPLT ROLL CMD	11
ENGS HI PWR SCHED	20
FDR EVENT	2
FIRE SYS OK	10
FLAPS EMER	11
FLT SPLR DEPLOY	11
GLD MAN ARM	11
GND SPLR DEPLOY	11
GRAV XFLOW OPEN	13
HYD SOV 1 CLOSED	14
HYD SOV 2 CLOSED	14
ICE	15
L AUTO IGNITION	20
L COWL A/I ON	15
L ENG SOV CLSD	13
L FUEL PUMP ON	13
L REV ARMED	20
PARKING BRAKE ON	16
PLT ROLL CMD	11
R AUTO IGNITION	20
R COWL A/I ON	15
R ENG SOV CLSD	13
R FUEL PUMP ON	13
R REV ARMED	20
SPLR/STAB IN TEST	11
T/O CONFIG OK	2
WING A/I ON	15
WING/COWL A/I ON	15

I. EICAS Status Messages (White)

Message	Ch.	Message	Ch.	Message	Ch.
AC 1 AUTOXFER OFF	7	GLD MAN DISARM	11	PITCH FEEL FAULT	11
AC 2 AUTOXFER OFF	7	GPWS FAIL	18	PROX SYS FAULT 1	16
AC ESS ALTN	7	GRAV XFLOW FAIL	13	PROX SYS FAULT 2	16
ACARS CALL	<1214 >5	GS CANCEL	18	RAM AIR OPEN	8
ACARS MESSAGE	<1214 >5	HGS FAIL	18	R AUTO XFLOW ON	13
ACARS NOCOMM	<1214>5	HORN MUTED	16	R COWL A/I DUCT	15
ADG AUTO FAIL	7	IAPS DEGRADED	3	RECIRC FAN FAULT	8
ADG FAIL	7	IAPS OVERTEMP	3	RECIRC FAN OFF	8
AFT CARGO SOV	8	IB FLT SPLR FAULT	11	R ENG BLEED CLSD	19
APU ALT LIMIT	4	IB GND SPLR FAULT	11	R ENG BLEED SNSR	19
APU BATT CHGR	7	IB SPLRONS FAULT	11	R ENGINE START	20
APU FAULT	4	ICE DET 1 FAIL	15	R ENG SHUTDOWN	20
APU IN BITE	4	ICE DET 2 FAIL	15	R ENG SQB	10
APU LCV OPEN	19	IDG 1 DISC	7	R FADEC FAULT 1	20
APU SOV OPEN	13	IDG 2 DISC	7	R FADEC FAULT 2	20
APU START	4	IRS 1 IN ATT	12 <1025>	R IGN A FAULT	20
A/SKID FAULT	16	IRS 2 IN ATT	12 <1025>	R IGN B FAULT	20
AUTO PRESS 1 FAIL	8	IRS 1 OVERTEMP	12 <1025>	R ITT EXCEEDED B	20
AUTO PRESS 2 FAIL	8			R ITT EXCEEDED B1	20
AUTO PRS 1/2 FAIL	8	ISOL CLOSED	19	R ITT EXCEEDED C	20
AUTO XFLOW INHIB	13	ISOL OPEN	19	R MLG FAULT	16
BLEED CLOSED	19	L AUTO XFLOW ON	13	R OIL LEVEL LO	20
BLEED MANUAL	19	L COWL A/I DUCT	15	R PACK FAULT	8
CABIN ALT WARN HI	8	L ENG BLEED CLSD	19	R PACK OFF	8
CABIN PRESS MAN	8	L ENG BLEED SNSR	19	R RARV FAULT	8
CABIN TEMP MAN	8	L ENGINE START	20	R REV FAULT	20
CAS MISCOMP	2	L ENG SHUTDOWN	20	R THROTTLE FAULT	20
CKPT TEMP MAN	8	L ENG SQB	10	RUD LIMIT FAULT	11
CONT IGNITION	20	L FADEC FAULT 1	20	R VIB FAULT	20
CPAM FAIL	8	L FADEC FAULT 2	20	R XFLOW ON	13
DC CROSS TIE CLSD	7	L IGN A FAULT	20	SEAT BELTS	17
DC ESS TIE CLSD	7	L IGN B FAULT	20		
DC MAIN TIE CLSD	7	L ITT EXCEED B	20	SLAT FAULT	11
DCU 1 AURAL INOP	2	L ITT EXCEED B1	20	SLATS HALFSPEED	11

Message	Ch.	Message	Ch.	Message	Ch.
DCU 2 AURAL INOP	2	L ITT EXCEED C	20	SPEED REFS INDEP	3
DCU 1 INOP	2	L MLG FAULT	16	SPLR/STAB FAULT	11
DCU 2 INOP	2	L OIL LEVEL LO	20	SSCU 1 FAULT	11
DUCT MON FAULT	19	L PACK FAULT	8	SSCU 2 FAULT	11
EMER LTS ON	17	L PACK OFF	8	STAB CH 1 INOP	11
ENG SYNC OFF	20	L RARV FAULT	8	STAB CH 2 INOP	11
ESS TRU 1 FAIL	7	L REV FAULT	20	STAB FAULT	11
ESS TRU 2 FAIL	7	L THROTTLE FAULT	20	STEERING DEGRADED	16
ESS TRU 2 XFER	7	L VIB FAULT	20	TERRAIN FAIL	18
FD 1 FAIL	3	L XFLOW ON	13	TERRAIN NOT AVAIL	18
FD 2 FAIL	3	MAIN BATT CHGR	7	TERRAIN OFF	18
FDR ACCEL FAIL	2	MAN XFLOW	13	TRU 1 FAIL	7
FDR FAIL	2	MDC FAULT	2	TRU 2 FAIL	7
FIRE SYS FAULT	10	MLG FAULT	16	TRU FAN FAIL	7
FLAP FAULT	11	NO SMOKING	17	VHF 3 VOICE	5
FLAPS HALFSPEED	11	OB FLT SPLR FAULT	11	WINDSHEAR FAIL	18
FLUTTER DAMPER	11	OB GND SPLR FAULT	11	WING A/I FAULT	15
FUEL CH 1 FAIL	13	OB SPLRONS FAULT	11	WING XBLEED OPEN	15
FUEL CH 2 FAIL	13	OUTFLOW VLV OPEN	8	YD 1 INOP	11
FUEL QTY DEGRADED	13	OVBD COOL FAIL	8	YD 2 INOP	11

J. Inhibits

During the initial take-off, final take-off and landing phases, the DCUs will process inhibit logic to minimize intermittent or distracting warning or caution messages.

(1) Initial Take-off Phase

The initial take-off inhibits are enabled when:

- Left and right engine N_1 is greater than 79%,
- weight-on-wheels, and airspeed is less than 100 knots.

The initial take-off inhibit is removed when:

- Left and right engine N_1 is less than 67.6%, or
- Airplane is in the final take-off phase.

(2) **Final Take-off Phase**

The final take-off inhibits are enabled when:

- Left and right engine N_1 is greater than 79%, and
- airspeed transitions to greater than 100 knots.

The final take-off inhibit is removed when:

- Left and right engine N_1 is less than 67.6%, or
- Radio altitude is greater than 400 ft AGL, or
- 30 seconds after ground to air transition.

(3) **Landing Phase**

Landing phase inhibits are enabled when:

- Radio altitude transitions to less than 400 ft AGL, and
- landing gear down and locked.

The landing phase inhibit is removed when:

- 30 seconds after air to ground transition or
- Radio altitude transitions from less than 400 ft to greater than 400 ft.

K. Warning Inhibits

The following warning messages, their corresponding lights and aurals are inhibited during initial take-off:

Airplane System	Warning Message (Inhibited during take-off)	Aural (Inhibited during take-off)
Environmental Control System	CABIN ALT	Cabin Pressure
Flight Controls		Overspeed Clacker
Landing Gear	GEAR DISAGREE NOSE DOOR OPEN	Gear Disagree Nose Door

The following warning messages, their corresponding lights and aurals are inhibited during approach:

Airplane System	Warning Message (Inhibited during approach)	Aural (Inhibited during approach)
Auxiliary Power Unit	APU OVERTEMP	APU
Doors	PASSENGER DOOR	Door
Environmental Control System	CABIN ALT DIFF PRESS	Cabin Pressure Cabin Pressure
Ice and Rain Protection	ANTI-ICE DUCT L COWL A/I DUCT R COWL A/I DUCT WING OVHT	Anti-Ice Duct Anti-Ice Duct Anti-Ice Duct Wing Overheat
Landing Gear	NOSE DOOR OPEN	Nose Door
Power Plant	L ENG OIL PRESS R ENG OIL PRESS	Engine Oil Engine Oil

L. Caution Inhibits

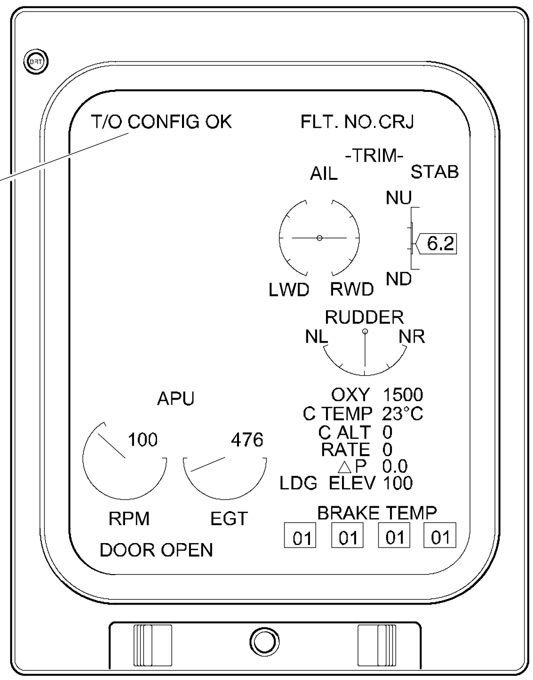
All caution messages and their corresponding lights (if applicable) are inhibited during take-off and/or landing except the following:

Airplane System	Caution Message (Not Inhibited)	
Automatic Flight Control System	YAW DAMPER	
Auxiliary Power Unit	APU LCV CLSD	
Fire Protection	FIRE SYS FAULT	
Flight Controls	GLD NOT ARMED GLD UNSAFE GND SPLR DEPLOY IB (OB) FLT SPLRS IB (OB) GND SPLRS IB (OB) SPOILERONS	PITCH FEEL RUD LIMITER SLATS FAIL SPOILERONS ROLL STAB TRIM STAB TRIM LIMIT STALL FAIL
Flight Instruments	EFIS COMP MON	
Hydraulic Power	HYD 1 (2) (3) LO PRESS	
Ice and Rain Protection	ICE ICE DET FAIL	L (R) COWL A/I OPEN L (R) WING A/I
Landing Gear	A/SKID INBD (OUTBD) IB (OB) BRAKE PRESS	PROX SYSTEM WOW INPUT (OUTPUT)
Pneumatic	ANTI-ICE DUCT L (R) BLEED DUCT	L (R) COWL LOOP
Power Plant	L (R) ENG FLAMEOUT L (R) ENG SRG CLSD L (R) FADEC L (R) FADEC OVHT	L (R) REV INOP L (R) REV UNLOCKED L (R) REV UNSAFE

M. Take–Off Configuration Warning

Take-off configuration warnings are armed when the airplane is on the ground and both engines are accelerated towards take-off thrust (N_1 greater than 70%).

T/O CONFIG OK advisory (green)
Indicates that the airplane is in a proper take–off configuration. Message goes out upon airplane rotation.



Status Page

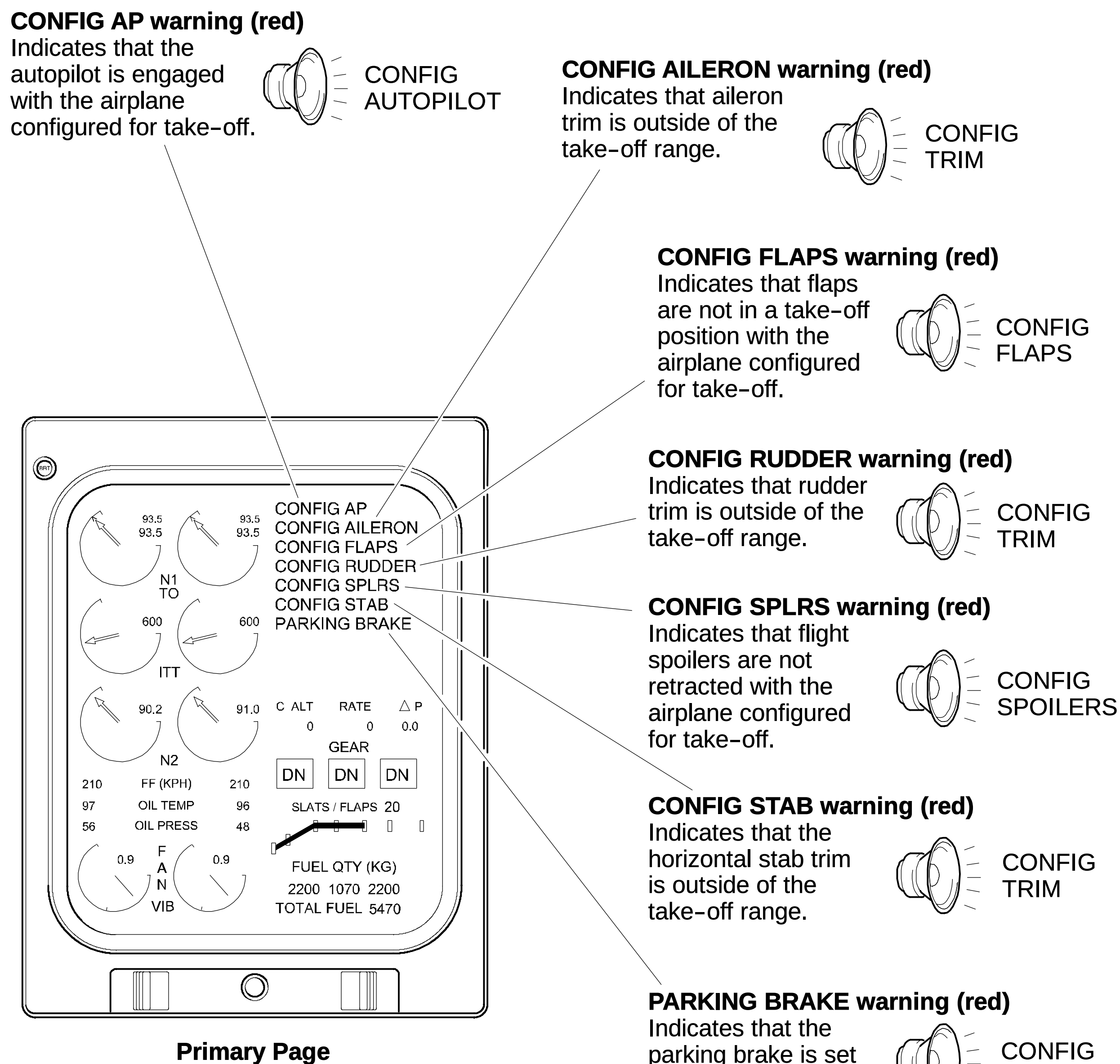
Take–Off Configuration Advisory
Figure 02–20–9

The following systems / conditions are checked:

Condition	**Voice Message**	**EICAS Message**
Autopilot engaged	Config Autopilot	CONFIG AP
Flaps not in take-off position	Config Flaps	CONFIG FLAPS
All spoilers not in take-off position (down)	Config Spoilers	CONFIG SPLRS
Horizontal stabilizer outside of take-off range (“green band”)	Config Trim	CONFIG STAB
Parking brake set (brake valve closed)	Config Brakes	PARKING BRAKE
Rudder trim outside of take-off range (trim > ±1 degree)	Config Trim	CONFIG RUDDER
Aileron trim outside of take-off range (trim > ±1 degree)	Config Trim	CONFIG AILERON

If the airplane is in an unsafe take-off configuration, configuration aural and warning messages, and both MASTER WARNING lights come on.

All configuration warning indications are cancelled when the configuration error is corrected.



Take–Off Configuration Warning <1001>
Figure 02–20–10

N. Landing Configuration Warning

The landing gear horn will sound 2 minutes after ground to air transition with any landing gear not down and locked, if one of the follow conditions exists:

- Radio altitude is less than 500 ft AGL with both throttles at less than maximum landing setting or with flaps greater than 30 degrees

or

- Both throttles are at less than maximum landing setting or any one throttle is at IDLE with the landing gear warning horn muted

and

- Airspeed is less than 170 knots with flaps greater than 30 degrees or airspeed is less than 190 knots with flaps and slats at 0

and

- Radio altimeter or throttle is not valid

or

- Radio altitude is less than 1000 ft AGL with a vertical speed less than -400 ft/min

and

- No windshear warning or a windshear warning with a windshear monitor failure

or

- Radio altitude is less than 1000 ft AGL with vertical speed or GPWS not valid

NOTE

The landing gear horn may be muted with one thrust lever at IDLE and the landing gear not in the down and locked position. Refer to Chapter 16, Landing Gear.

The “Too low gear” aural warning is heard if any landing gear is not down and locked with the radio altitude less than 500 ft AGL and the indicated airspeed at less than 190 knots.

O. MENU Page

The MENU page is divided into three sections: menu section, confirmation section and parameter readout. A cursor on the left side of the screen is controlled by the UP/DN buttons on the EICAS control panel (ECP). The SELECT button on the ECP is used to select an line item.

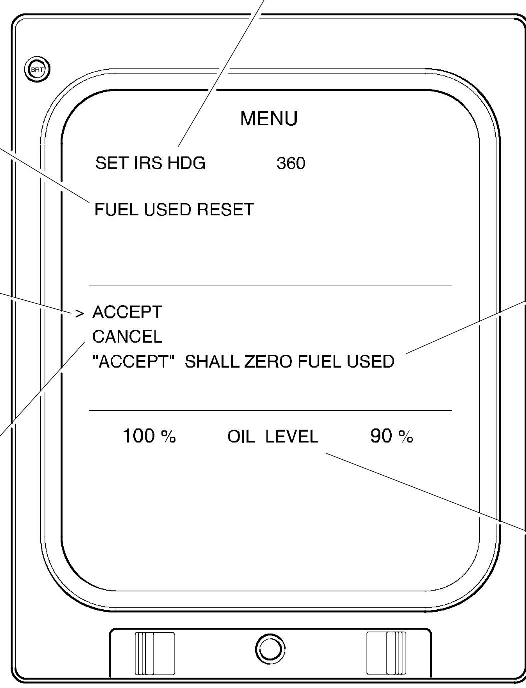
The menu list contains a single FUEL USED RESET line. When the line is selected, the ACCEPT/CANCEL selections in the confirmation section are used to accept or cancel the request to reset to zero the “Fuel Used” indication, on the FUEL synoptic page.

The parameter readouts section contains the engine OIL LEVEL indications.

SET IRS HDG and SET POS
Used to set IRS initial position or heading when FMS control display units are inoperative. SET POS appears after IRS heading has been set.

FUEL USED RESET 13
Fuel System.

Cursor Symbols (caret and underscore)
Indicates editable item. Positioned by UP or DN buttons on EICAS control panel. Cursored item changes colour from white to cyan.



Data Entry Messages
Messages come on (white) when cursor is positioned to ACCEPT alteration.

ACCEPT and CANCEL
Used to accept or cancel alterations. Works in conjunction with the SEL button on the EICAS control panel.

OIL LEVEL 20
Oil System.

MENU Page
EICAS Secondary Display
Center Instrument Panel

◯ Indicates Chapter in which information on item may be found.

Menu Page <1025>
Figure 02–20–11

P. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
EICAS	Primary Display	EICAS PRIM DISPL	DC BUS 1	1	H3	
			BATTERY BUS	2	Q5	
	Secondary Display	EICAS SEC DISPL	DC BUS 1	1	H4	
			BATTERY BUS	2	Q6	
	Control Panel	EICAS CONT PNL	BATTERY BUS	2	Q7	
	Lamp Driver Unit	EICAS LDU L	DC BUS 1	1	H5	
		EICAS LDU R	BATTERY BUS	2	Q8	
	Bright / Dim Power Supply	EICAS BRT / DIM PWR SUP 1	DC BUS 1	1	H6	
			BATTERY BUS	2	Q10	
		EICAS BRT / DIM PWR SUP 2	DC BUS 1	1	H7	
			BATTERY BUS	2	Q11	
	DCU 1	EICAS DCU 1	DC ESSENTIAL		U8	
			BATTERY BUS		Q1	
	DCU 2	EICAS DCU 2			Q2	

1. RECORDING

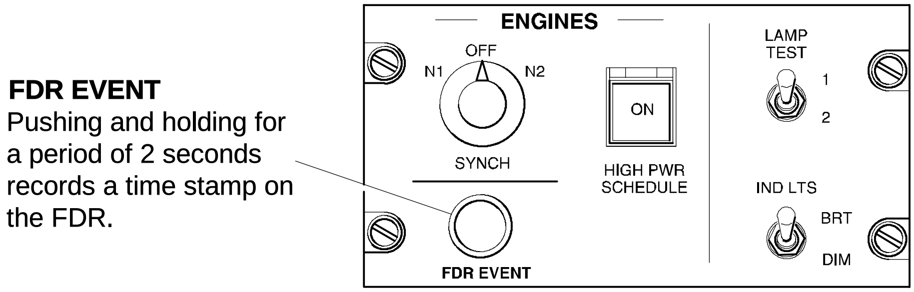
A flight data recorder (FDR) records aircraft systems data (including altitude, airspeed, position, heading, acceleration and radio communications events). The FDR provides a digital record of aircraft data for the last 25 hours of aircraft operation. The FDR normally receives data from data concentrator unit No.1 (DCU 1), records the information and sends it back to the DCU1 for comparison. If DCU 1 fails, DCU 2 will supply the data to the FDR.

The FDR will operate when the STROBE lights switch or BEACON lights switch is selected on, or if the aircraft is in a weight off wheels condition. The FDR has an internal clock which is used as the time reference from which events are recorded. An event can be marked by the pilot by operation of a FDR EVENT button on the Engine/Miscellaneous test panel.

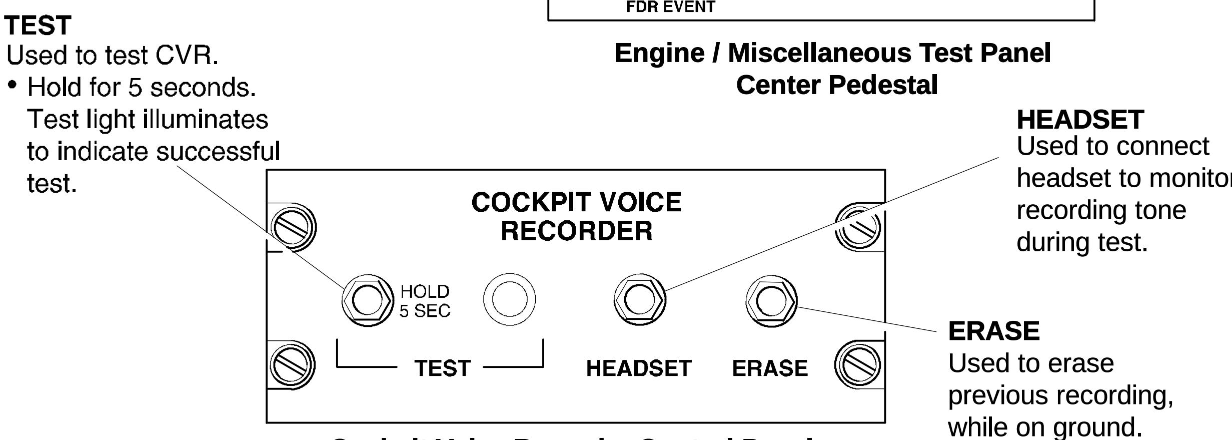
A cockpit voice recorder (CVR) starts recording as soon as power is applied to the aircraft. It has a solid state non-volatile memory with the capacity to record the last 120 minutes of cockpit and mixed PA audio. The deceleration of impact removes the power to prevent erasure of the data. <1065>

The FDR and CVR each includes an underwater locater device (ULD). The ULD is a battery operated, underwater, pulsed acoustic beacon which has an internal switch that is activated by water. When activated, the unit sends out a 36.5 to 38.5 kilohertz signal.

A quick access recorder (QAR), located in the underfloor avionics bay, operates under the same conditions as the FDR. The QAR receives flight data from the data concentrator unit (DCU) that is not supplying data to the FDR. The data is stored in files on a removable disk. <1204>



Engine / Miscellaneous Test Panel
Center Pedestal



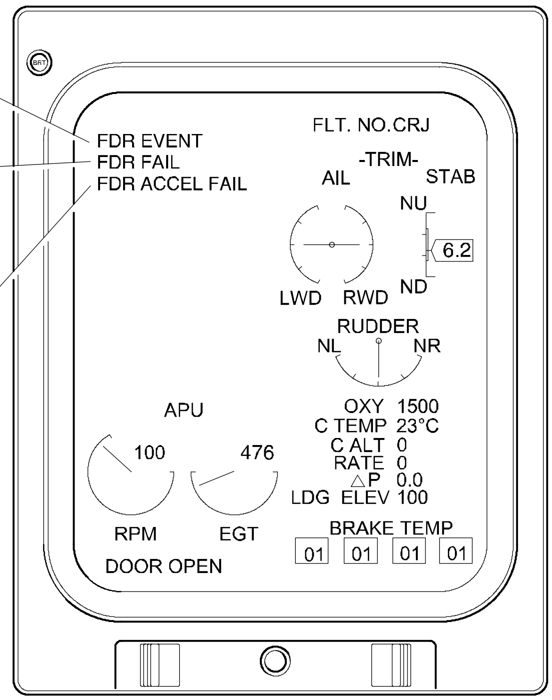
Cockpit Voice Recorder Control Panel
Pilot's Instrument Panel

Recording
Figure 02–30–1

FDR EVENT advisory (green)
Indicates that a FDR EVENT was selected.

FDR FAIL status (white)
Indicates a difference between the recorded data and the data supplied by the DCU.

FDR ACCEL FAIL status (white)
Indicates a FDR accelerometer failure.



Status Page

Recording – EICAS Indications
Figure 02–30–2

A. System Circuit Breakers

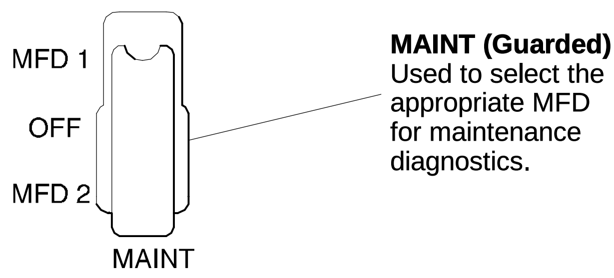
SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Recording	Flight Data Recorder	FLIGHT REC PWR	AC BUS 1	1	C9	
		FLIGHT REC CONT	DC BUS 1		E14	
	Cockpit Voice Recorder	CKPT VOICE REC	DC ESSENTIAL	2	V7	
	Quick Access Recorder <1204>	QAR	AC BUS 2		C13	

1. MAINTENANCE DIAGNOSTIC SYSTEM

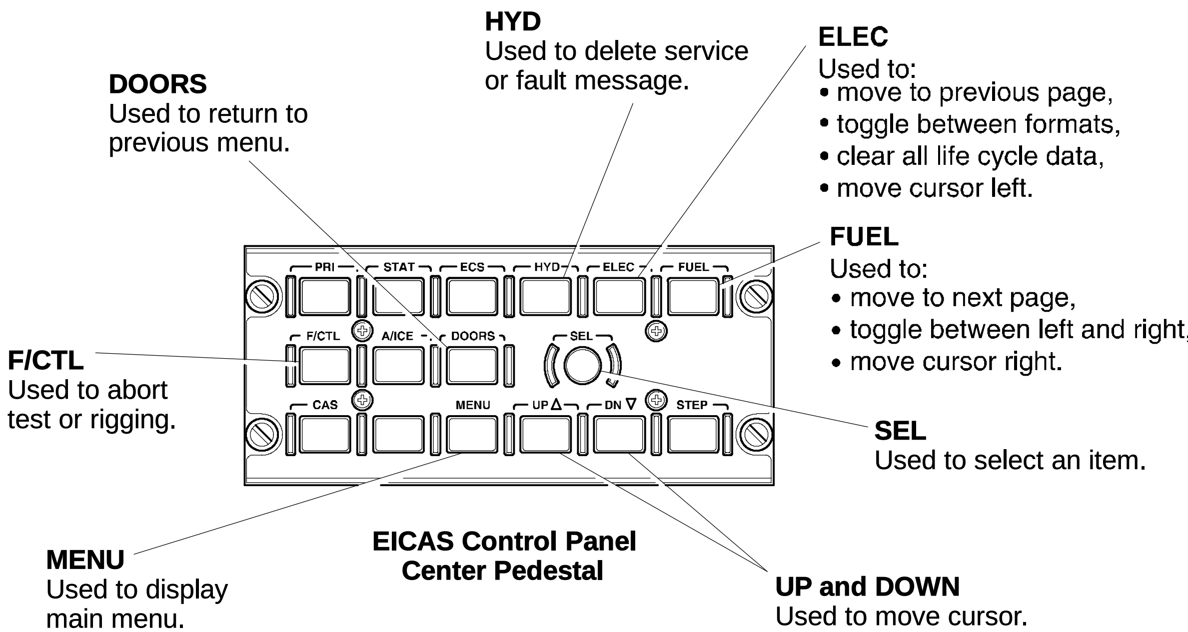
The maintenance diagnostic system is used by maintenance personnel to view current and historical information relating to specific aircraft systems health and operation.

The system uses a maintenance diagnostic computer (MDC) to process and record avionics and aircraft systems data for future retrieval. A maintenance switch, located behind the pilot's seat, is used to enter the maintenance diagnostics mode. The multifunctional displays (MFD) are used to display the maintenance data and the EICAS control panel is used to control and select information on the MFD display. A data loader unit is used to upload or download data to or from a floppy disk.

When the maintenance switch is set to MFD1 or MFD2, the applicable MFD is configured to display maintenance related display pages and the EICAS control panel is configured as a maintenance page control panel.



Maintenance Switch
Behind Pilot's Seat

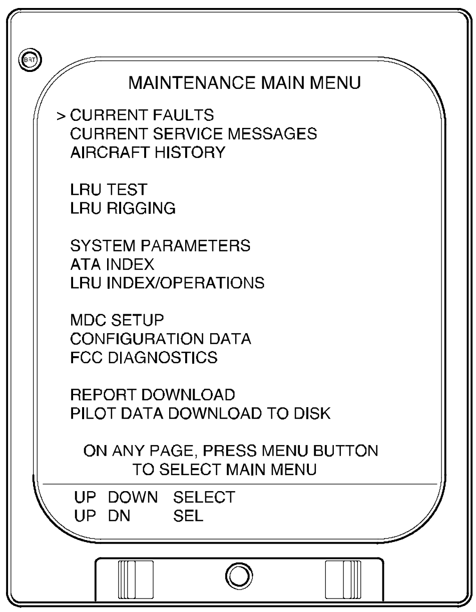


EICAS Control Panel
Center Pedestal

Maintenance Data Computer – Controls
Figure 02–40–1

A. Maintenance Main Menu Overview

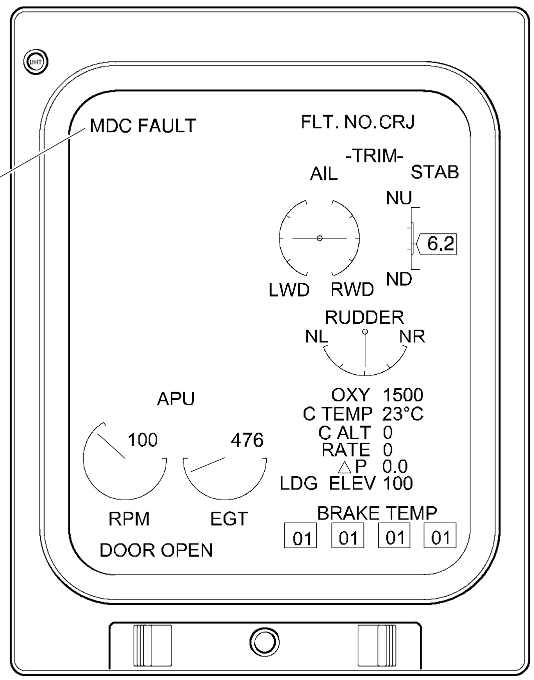
- Current Faults – Displays fault(s) currently detected by the MDC and failure messages reported by the DCU.
- Current Service Messages – Displays maintenance messages received from the DCU.
- Aircraft History – Provides access to history displays for faults, service messages, engine excellence and engine trends. Also used to access life cycle data and flight leg summary.
- LRU Testing – Used to initiate an line replaceable unit (LRU) test and display test results.
- LRU Rigging – Used to initiate the LRU programing procedure.
- System Parameters – Displays airplane system parameters.
- ATA Index – Displays list of ATA chapter numbers for all aircraft and avionics systems.
- LRU Index/Operations – Displays a list of LRUs and is used to select any associated test or rigging procedure.
- MDC Setup – Used to set aircraft identification and clock. Also used to load files.
- Configuration Data – Used to access the configuration of the integrated avionics processor system (IAPS) computers and to check the MDC version information.
- FCC Diagnostic – Displays instructions to put flight control system into diagnostic mode.



Maintenance Main Menu Page
Multifunction Display

Maintenance Main Menu EICAS Page
Figure 02–40–2

MDC FAULT status (white)
Indicates that a fault has been detected in the MDC.

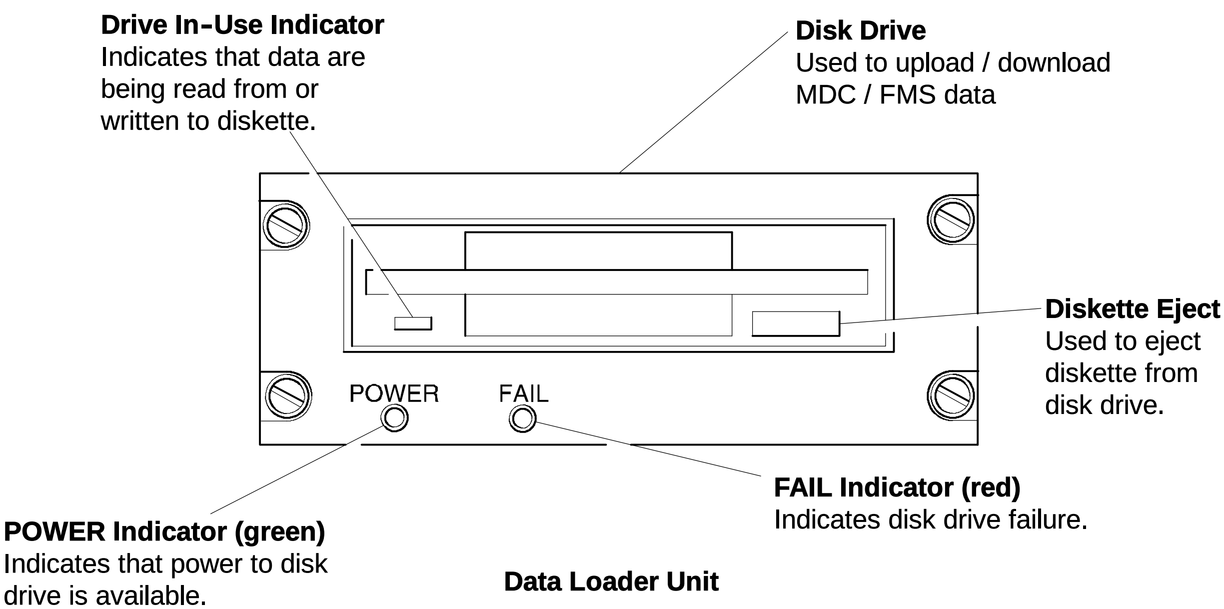


Status Page

MDC Fault Indication
Figure 02–40–3

B. Data Loader Unit

The data loader unit is located in the top of the forward entrance compartment. Through the download function from the MENU page, the unit enables the transfer of data files, between DOS-compatible diskettes and applicable aircraft systems. The data loader unit provides the capability to format disks, read directories and read/write files. <1018>



NOTE
Indicators are not dimmable.

Data Loader Unit <1018>
Figure 02–40–4

C. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Maintenance Data Computer	Data Loader	DATA LOAD	DC BUS 1	1	H10	
	MDC	IAPS L AFCS / MDC	BATTERY BUS	2	P6	

CHAPTER 2 – AURAL/VISUAL INDICATING AND RECORDING

LIST OF ILLUSTRATIONS

ENGINE INDICATING AND CREW ALERTING SYSTEM

RECORDING

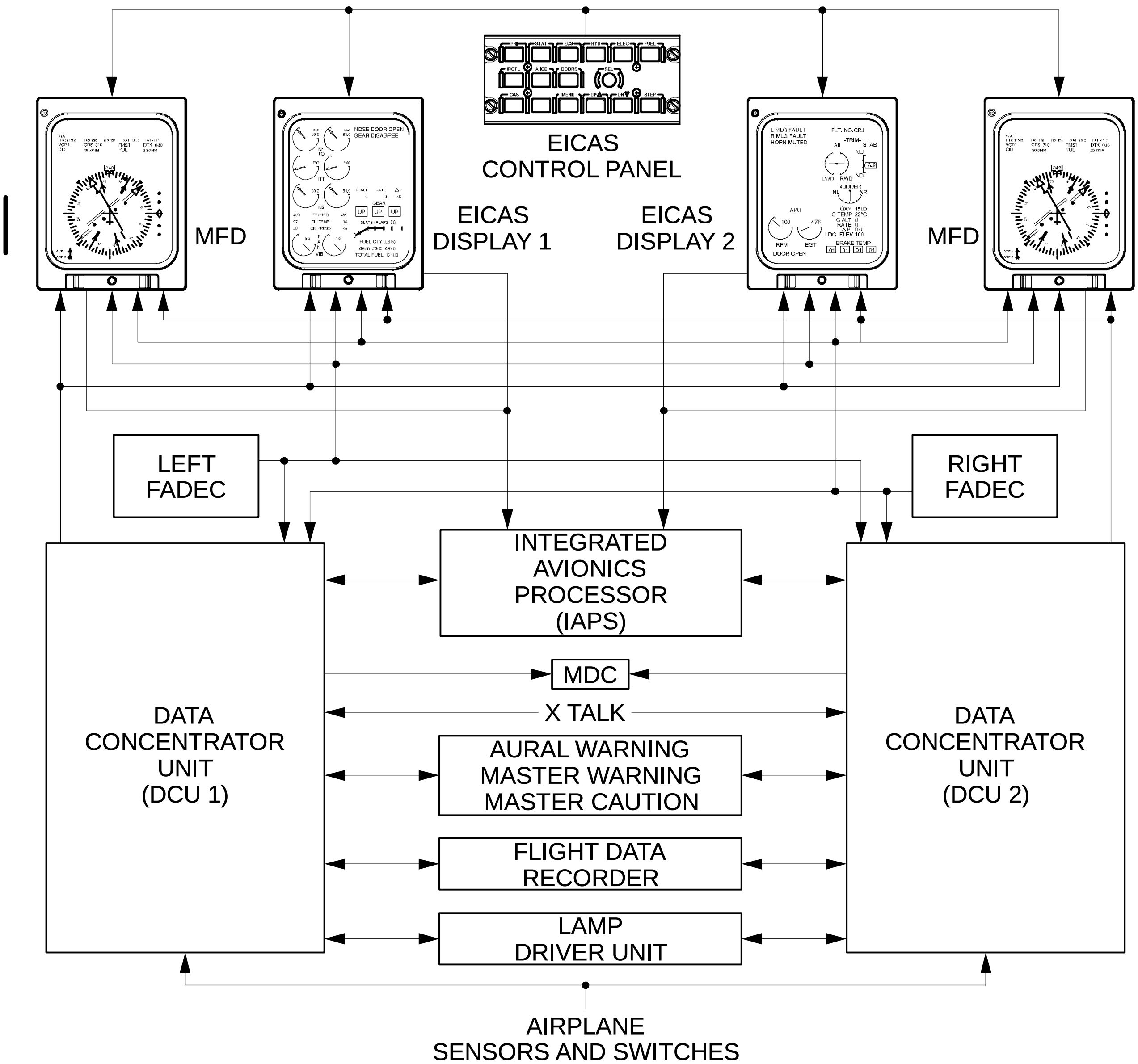
MAINTENANCE DATA COMPUTER

1. INTRODUCTION

The indicating and recording systems consist of components that provide visual indications of system operation and to record aircraft information.

Data from the aircraft systems and the full authority digital engine control (FADEC) on each engine is received and processed by two data concentrator units (DCU) located in the avionics compartment. The DCUs provide information to the engine indication and crew alerting system (EICAS). Master warning and caution lights on the glareshield enhance the indication system. Audio signals are generated within the DCUs and are heard through the flight deck speakers.

The DCUs also provide interface with the flight data recorder system (FDR), the lamp driver unit (LDU) and the maintenance data computer (MDC) via the integrated avionic processor (IAPS).



Aural/Visual Indicating and Recording Schematic
Figure 02–10–1

1. ENGINE INDICATING AND CREW ALERTING SYSTEM

The engine indicating and crew alerting system (EICAS) provides the crew with two electronic displays to monitor engines, control surfaces and all major aircraft systems. The EICAS system also provides the crew with alerting system messages that are posted on the EICAS displays in the form of warning, caution, advisory and status messages. All warning and caution messages will also illuminate the MASTER WARNING or MASTER CAUTION lights on the glareshield. Some crew alerts are also accompanied by aural tones and voice advisories. The EICAS system can also illuminate switchlights on specific system control panels to provide component/system status or to prompt corrective crew action.

The EICAS system consists of the following:

- Two EICAS displays on the center instrument panel – Used to display system information and status.

NOTE

The EICAS displays are referred to as EICAS Display 1 (ED1) and EICAS Display 2 (ED2). ED1 is on the left and ED2 is on the right. The information that is shown on each display is referred to as a page. In normal configuration, the Primary page is shown on ED1 and the Status page is shown on ED2.

- EICAS control panel on the center pedestal – Used to select which EICAS page, (primary page,status page, synoptic pages or menu page) is to be shown on ED2. The panel is also used to display additional caution and status messages on ED1 and ED2.

- Engine/Miscellaneous test panel on the center pedestal – Used to perform tests of the annunciator lights, set annunciator light levels, record specific flight data events and synchronize the engines N1 or N2.

- Display reversion control panels on the pilot's and copilot's side panel – PFD position – puts the primary flight display (PFD) information on the pilot's or copilot's multifunctional display (MFD). EICAS position – makes all EICAS information available on the pilot's or copilot's MFD.

- EICAS selector on the center pedestal SOURCE SELECTOR PANEL – Used to select where the EICAS information will be displayed. The information can be displayed on ED1 and ED2, or all the EICAS information can be displayed on either ED1 or ED2.

- MASTER WARNING and MASTER CAUTION switchlights on the glareshield. – Illuminate when a warning or caution is detected by the data concentrator units (DCUs).

- Lamp driver unit, located in the avionics compartment – Used to control and test flight compartment annunciator lights.

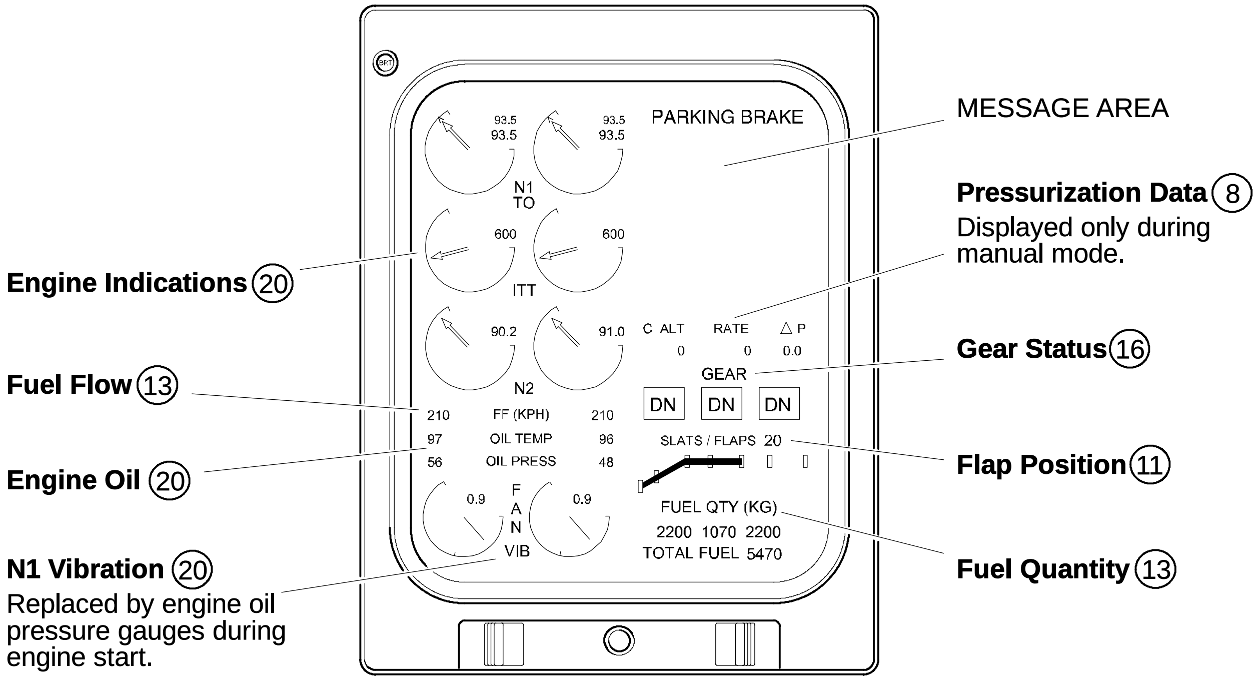
- Data concentrator units located in the avionics compartment – Used to process data and transmit the applicable data to the EICAS displays, flight data recorder and lamp driver units. The DCUs are also used to control the aural warning system.

The EICAS primary page displays the following information:

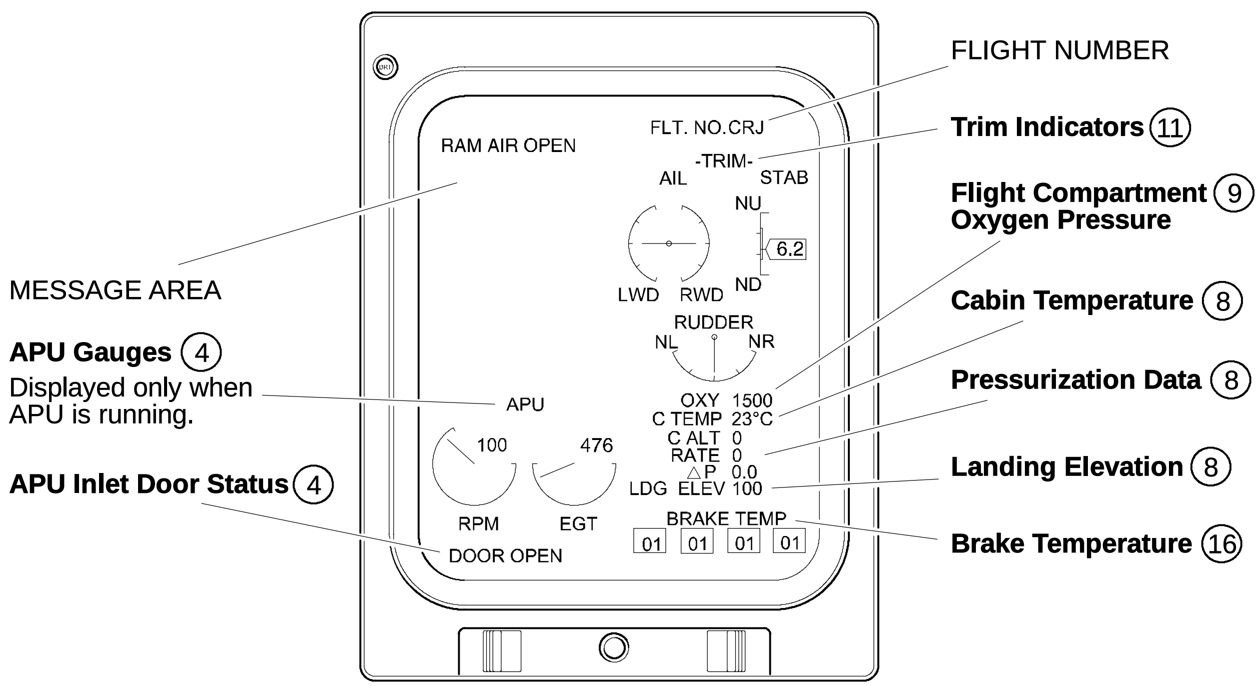
- Engine compressor and turbine speeds (N_1 and N_2 rpm)
- Engine temperature (ITT)
- Fuel flow (FF)
- Oil pressure and temperature
- Engine vibration data
- Pressurization data
- Landing gear position
- Slat/flap position
- Fuel tank quantities and total fuel
- Crew alerting system (CAS) messages in the form of red warning and amber caution messages

The EICAS status page displays the following information:

- Flight control trim indications
- Auxiliary power unit (APU) indications such as APU RPM, exhaust gas temperature (EGT) and APU inlet door status
- Pressurization data such as cabin altitude, cabin rate of change, cabin pressure differental, and landing field elevation
- Oxygen system pressure
- Brake system temperature readouts
- Aircraft systems synoptic pages (via the EICAS control panel)
- MENU page (via the EICAS control panel) allows reset of the fuel used indicator and displays the engine oil quantity
- Crew alerting system (CAS) messages in the form of green advisory and white status messages



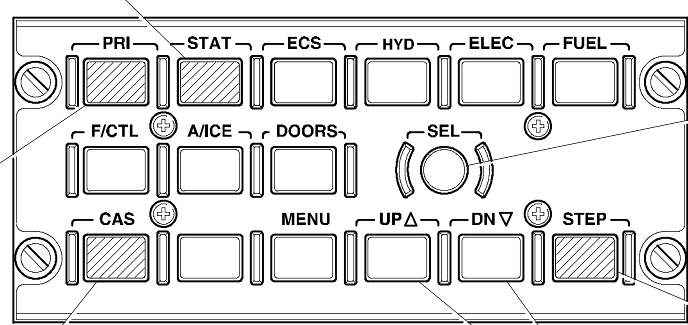
Primary Page



Status Page

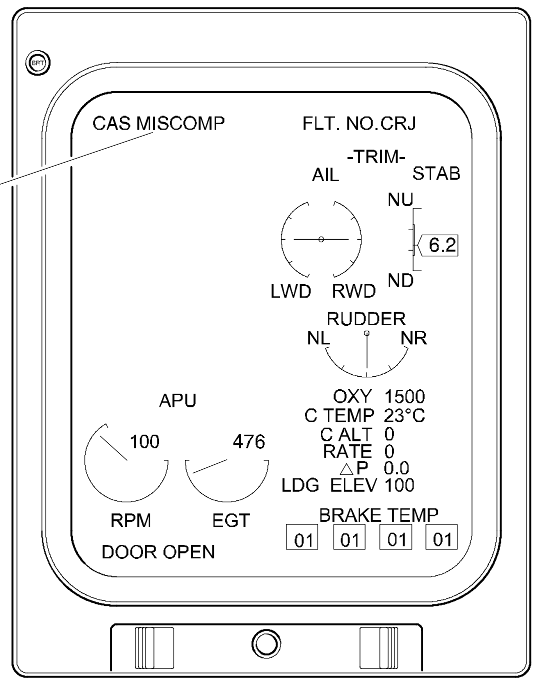
◯ Indicates Chapter in which information on item may be found.

Engine Indicating and Crew Alerting System – General <1001>
Figure 02–20–1



EICAS Control Panel
Figure 02–20–2

CAS MISCOMP status (white)
Indicates that a miscomparison of detected warning, caution or aural alerts exists between DCUs.

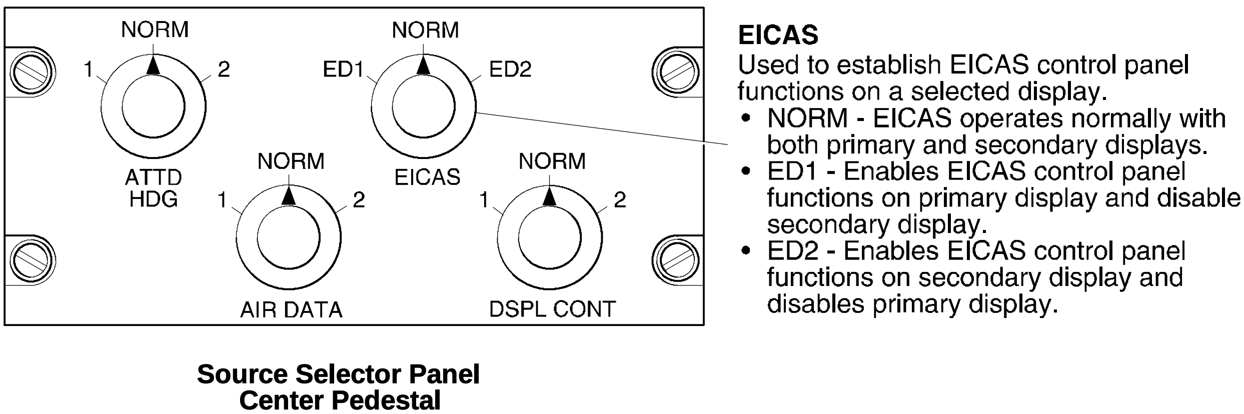


Status Page

EICAS Miscomparison Indication
Figure 02–20–3

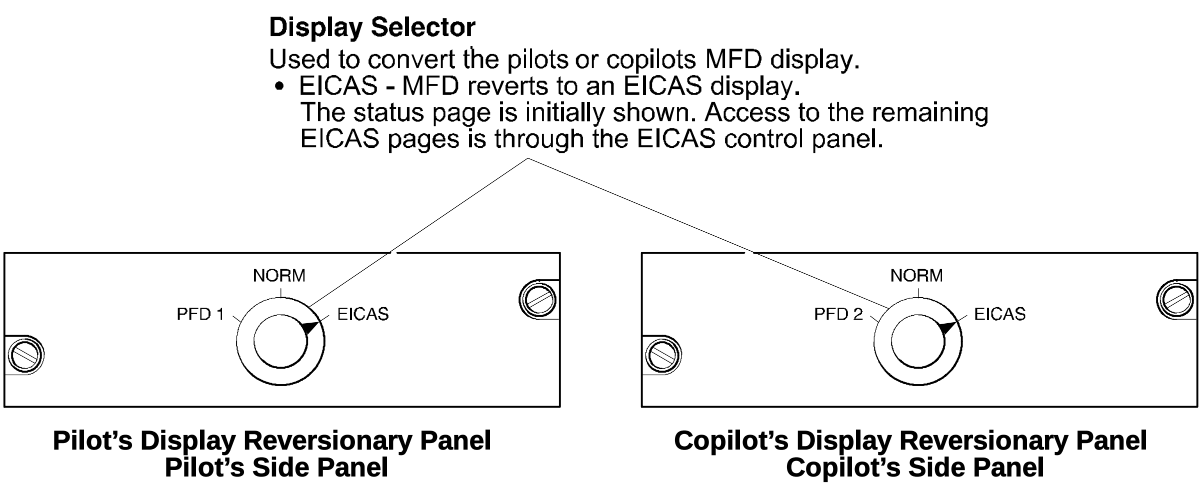
A. Display Reversion

If EICAS display 1 (ED1) fails, the primary page will be automatically displayed on ED2. If ED2 fails, there is no automatic transfer to ED1. With either display failure, the EICAS control panel is rendered inoperative. To regain control, the EICAS selector on the SOURCE SELECTOR PANEL must be set to the operable display (ED1 or ED2) to re-establish the EICAS control panel functions. The selector also makes available all EICAS information on the selected display.



Display Reversion
Figure 02–20–4

To ensure timely access to essential EICAS data, all EICAS pages can be made available on either MFD by selecting the EICAS position on the respective Display Reversionary Panel.



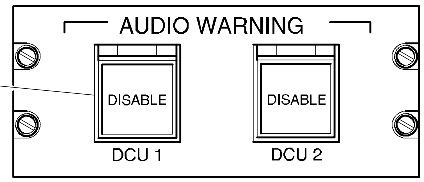
Display Selector
Figure 02–20–5

B. Aural Warning

Various tones call attention to warnings. There are ten types of aural alerts:

Sound	Indication	Chapter Reference
Warbler	Stall	Chapter 11, Flight Controls
Siren	Windshear	Chapter 18, Navigation
Whoop – Whoop	GPWS mode 1 or 2 (excessive descent rate or excessive closure rate)	Chapter 18, Navigation
Fire Bell	Fire warnings	Chapter 10, Fire Protection
Clacker	1. Excessive stabilizer trim movement 2. V_{MO}/M_{MO} exceedance 3. Airspeed too high for current flap setting	Chapter 11, Flight Controls Chapter 12, Flight Instruments
Cavalry Charge	Autopilot disconnect	Chapter 3, Automatic Flight Control System
Horn	Gear not down	Chapter 16, Landing Gear
Triple chime	Warning tone that precedes an aircraft system voice advisory	Chapters 2 through 20
C-chord	Altitude alert	Chapter 12, Flight Instruments
Single chime	Caution tone that precedes an aircraft system voice advisory	Chapters 2 through 20

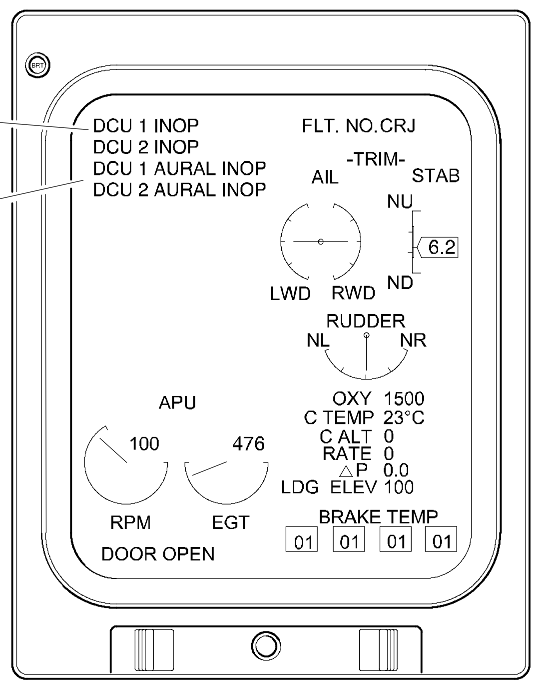
DCU 1 and DCU 2 (Guarded)
Used to disable and silence the aural warnings of a faulty DCU.
- DISABLE (white) light indicates respective DCU aural output is disabled.



Audio Warning Panel
Copilot's Side Console

DCU 1 or 2 INOP status (white)
Indicates internal fault or crosstalk fault in respective data concentrator unit.

DCU 1 or 2 AURAL INOP status (white)
Indicates internal aural fault in respective data concentrator unit or indicates respective DCU aural output has been disabled.



Status Page

DCU Controls and Indications
Figure 02–20–6

C. Master Warning / Master Caution Lights

Two MASTER WARNING lights come on flashing when any warning occurs. The lights remain on as long as the warning exists. Pushing either MASTER WARNING extinguishes both MASTER WARNING lights for the duration of that warning and resets the lights for future warnings.

Pushing the MASTER WARNING also silences the aural warnings except for the following cases:

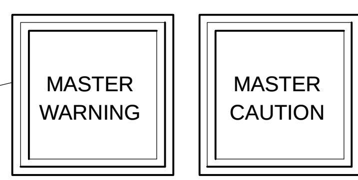
- Stall warbler
- GPWS/TCAS (voices and aural)
- Overspeed clacker
- Flap clacker
- Stabilizer trim clacker
- AP Disconnect cavalry charge
- Configuration warnings
- Gear Horn

Two MASTER CAUTION lights come on flashing when any caution occurs. Pushing either MASTER CAUTION extinguishes both MASTER CAUTION lights for the duration of that caution and resets the lights for future cautions.

Pushing the MASTER CAUTION will not silence the following:

- GPWS and TCAS voice alerts
- Altitude alert (C-chord) aural

MASTER WARNING
Both lights come on (red) in conjunction with warning lights and EICAS messages. Pushing either switch will turn both lights out and reset warning system for subsequent indications. Lights cannot be dimmed.



Left and Right Glareshield

MASTER CAUTION
Both lights come on (amber) in conjunction with caution lights and EICAS messages. Pushing either switch will turn both lights out and reset caution system for subsequent indications. Lights cannot be dimmed.

Master Warning / Master Caution Lights
Figure 02–20–7

D. Crew Alerting System Messages

Crew alerting system messages appear in the message area on both EICAS displays (ED1 and ED2). The messages are arranged by their urgency and order of occurrence. All crew alerting system messages are divided into one of four categories: warnings, cautions, advisories, or status.

- Warnings messages, are the most urgent type of crew alerts and indicate operational or aircraft system conditions that require immediate corrective action. All warning messages are preceded by a triple chime and appear in red at the top of the message area on ED1. For all warnings, the red MASTER WARNING lights will flash. Some warnings also have an aural alert consisting of a unique tone and a voice advisory. Warning messages cannot be removed from view, unless the applicable failure has been rectified.

- Cautions messages, are less urgent than warnings and indicate operational or aircraft system conditions that require prompt corrective action. All caution messages are preceded by a single chime and appear in amber immediately below the warnings in the message area on ED1. For all cautions, the amber MASTER CAUTION lights will flash. Caution messages can be removed from view by using the CAS button on the EICAS control panel.

- Advisories messages are used to show that a safe condition exists. They appear in green at the top of the message area on ED2. Advisory messages cannot be removed from view, unless the applicable system or switch has been deactivated or deselected.

- Status messages indicate that an abnormal condition exists or that a low-priority failure has occurred. They appear in white in the message area below the advisories. Status messages can be removed from view by using the STAT button on the EICAS control panel.

The most recent message appears at the top of its respective group of messages. A message is automatically removed from EICAS when the associated condition no longer exists. In this case, messages which appeared below the deleted message, each move up one line. When a new fault occurs, the new message will move older messages down one line.

If the number of warnings exceeds the message area (number of lines), then only the most recent warning messages are displayed and a red PAGE 1/2 appears at the bottom of the message area.

When more caution messages exist than can fit in the message area, a second page of cautions will be created and a page 1 of 2 will be indicated in the top RH corner of primary page. The CAS button on the EICAS control panel is then used to the next page of caution messages.

- Caution messages can be removed from view by pressing the CAS button, providing that both main generators are operating and on-line. A MSGS icon will appear, advising the crew that the caution messages are out of view.

NOTE

If a new abnormal situation occurs, the corresponding caution message will appear. To view all of the caution messages, re-select the CAS button.

Advisory messages cannot be removed from view, unless the appropriate system/switch, has been deactivated. If the number of advisories exceeds the message area, a green PAGE 1/2 appears at the bottom of the message area.

When more status messages exist than can fit in the message area, a second page of status messages will be created and a page 1 of 2 will be indicated in the top LH corner of the status page. The STAT button on the EICAS control panel is then used to select the next page of status messages.

- Status messages can be removed from view, anytime the EICAS system is powered, by pressing the STAT button on the EICAS control panel. A MSGS icon will appear, advising the crew that status messages are out of view.

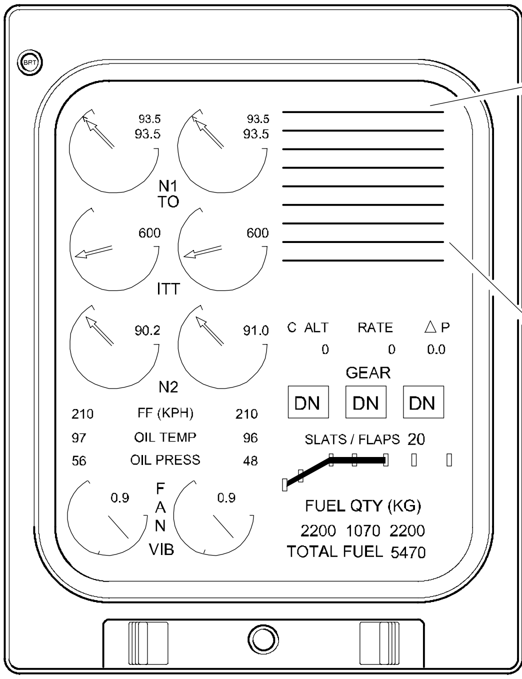
E. Synoptic Pages

Aircraft system information is presented in the form of synoptic pages. Synoptic pages are simplified top-level schematic diagrams used for pilot and maintenance information. The synoptic pages are dynamic displays of the aircraft systems status and operation which includes all major components and parameter values. When a malfunction occurs, the affected component and/or parameter value will change color. System flow lines are green to indicate flow and white to indicate no flow. Status and malfunction messages are also included on the synoptic pages.

The synoptic pages are selected by dedicated keys on the EICAS control panel (ECP) or by using the STEP key to sequence through the pages (refer to figure 2). In normal operation, the selected synoptic page will be displayed on EICAS display 2 (ED2). Pressing the STAT key will return the status page to ED2.

NOTE

A description of each synoptic page is included in its related chapter.



Primary Page

Warning Messages (red)
Conditions that require immediate corrective action.

Warning messages cannot be paged.

If the number of warning messages exceeds the available message area, only the most recent will be displayed.

Warning messages cannot be removed from view, without rectifying the failure.

Caution Messages (amber)
Conditions that require prompt corrective action.

Caution messages can be paged.

Caution messages can be removed from view, providing both main generators are operating and on–line.

Advisory Messages (green)
System response or acknowledgement messages (new condition).

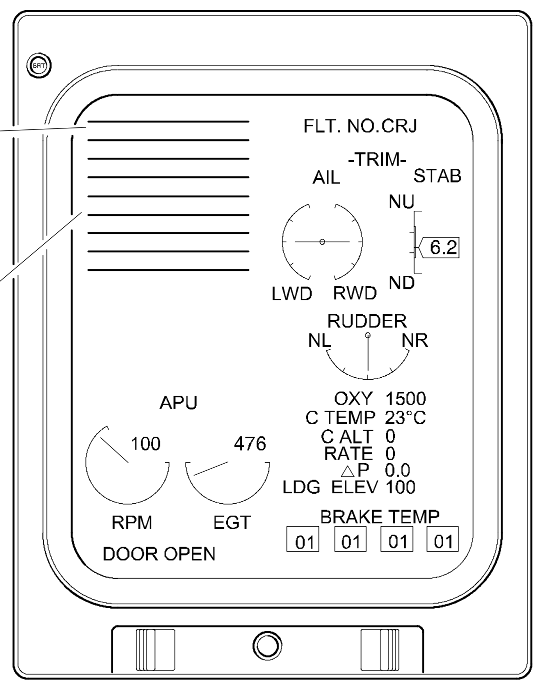
Advisory messages cannot be paged.

Advisory messages cannot be removed from view, without de–selecting the appropriate system.

Status Messages (white)
Conditions that require time available corrective action.

Status messages can be paged.

Status messages can be removed from view anytime.



Status Page

EICAS Display Message Fields <1001>
Figure 02–20–8

F. EICAS Warning Messages (Red) and Aurals

Message	Aural	Chapter
AFCS MSG FAIL		3
ANTI-ICE DUCT	Anti-Ice Duct	19
APU FIRE	☆	10
APU OVERSPEED	APU	4
APU OVERTEMP	APU	4
BRAKE OVHT	Brakes	16
CABIN ALT	Cabin Pressure	8
CONFIG AILERON	Config Trim	2
CONFIG AP	Config Autopilot	2
CONFIG FLAPS	Config Flaps	2
CONFIG RUDDER	Config Trim	2
CONFIG SPLRS	Config Spoilers	2
CONFIG STAB	Config Trim	2
DIFF PRESS	Cabin Pressure	8
EMER PWR ONLY		7
ENGINE OVERSPD		20
GEAR DISAGREE	Gear Disagree	16
L BLEED DUCT	Bleed Air Duct	19
L COWL A/I DUCT	Anti-Ice Duct	19
L ENG FIRE	☆	10
L ENG OIL PRESS	Engine Oil	20
L REV DEPLOYED		20
MLG BAY OVHT	Gear Bay Overheat	10
NOSE DOOR OPEN	Nose Door	16
PARKING BRAKE	Config Brakes	16
PASSENGER DOOR	Door	6
R BLEED DUCT	Bleed Air Duct	19
R COWL A/I DUCT	Anti-Ice Duct	19
R ENG FIRE	☆	10
R ENG OIL PRESS	Engine Oil	20
R REV DEPLOYED		20
SMOKE AFT CARGO	Smoke	10
SMOKE AFT LAV		10
SMOKE FWD CARGO	Smoke	10
SMOKE FWD LAV		10
WING OVHT	Wing Overheat	15

NOTE

☆ Firebell aural tone.

G. EICAS Caution Messages (Amber)

Message	Ch.	Message	Ch.	Message	Ch.	Message	Ch.
AC 1 AUTOXFER	7	ELT ON	9	L ENG SOV FAIL	13	R ENG DEGRADED	20
AC 2 AUTOXFER	7	EMER DEPRESS	8	L ENG SOV OPEN	13	R ENG FLAMEOUT	20
AC BUS 1	7	EMER LTS OFF	17	L ENG SQB	10	R ENG SOV CLSD	13
AC BUS 2	7	ENG BTL 1 LO	10	L ENG SRG CLSD	20	R ENG SOV FAIL	13
AC ESS BUS	7	ENG BTL 2 LO	10	L ENG SRG OPEN	20	R ENG SOV OPEN	13
AC SERV BUS	7	FIRE SYS FAULT	10	L ENG TAT HEAT	15	R ENG SQB	10
AFT CARGO DET	10	FLAPS FAIL	11	L FADEC	20	R ENG SRG CLSD	20
AFT CARGO DOOR	6	FLT SPLR DEPLOY	11	L FADEC OVHT	20	R ENG SRG OPEN	20
AFT CARGO OVERHEAT	8	FUEL CH 1/2 FAIL	13	L FIRE FAIL	10	R ENG TAT HEAT	15
AFT CARGO SQB 1	10	FUEL IMBALANCE	13	L FUEL FILTER	13	R FADEC	20
AFT CARGO SQB 2	10	FWD CARGO DET	10	L FUEL LO PRESS	13	R FADEC OVHT	20
AFT SERVICE DOOR	6	FWD CARGO DOOR	6	L FUEL LO TEMP	13	R FIRE FAIL	10
ALT LIMITER	8	FWD CARGO SQB 1	10	L FUEL PUMP	13	R FUEL FILTER	13
ANTI-ICE DUCT	19	FWD CARGO SQB 2	10	L MAIN EJECTOR	13	R FUEL LO PRESS	13
ANTI-ICE LOOP	19	FWD SERVICE DOOR	6	L PACK	8	R FUEL LO TEMP	13
AP PITCH TRIM	3	GEN 1 OFF	7	L PACK AUTOFAIL	8	R FUEL PUMP	13
APR CMD SET	20	GEN 2 OFF	7	L PACK TEMP	8	R FWD EMER DOOR	6
AP TRIM IS LWD	3	GEN 1 OVLD	7	L PITOT HEAT	15	R MAIN EJECTOR	13
AP TRIM IS ND	3	GEN 2 OVLD	7	L REV INOP	20	R PACK	8
AP TRIM IS NU	3	GLD NOT ARMED	11	L REV UNLOCKED	20	R PACK AUTOFAIL	8
AP TRIM IS RWD	3	GLD UNSAFE	11	L REV UNSAFE	20	R PACK TEMP	8
APU BATT OFF	7	GND SPLR DEPLOY	11	L SCAV EJECTOR	13	R PITOT HEAT	15
APU BLEED ON	19	HYD EDP 1A	14	L START ABORT	20	R REV INOP	20
APU BTL LO	10	HYD EDP 2A	14	L START VALVE	20	R REV UNLOCKED	20
APU DOOR OPEN	4	HYD 1 HI TEMP	14	L STATIC HEAT	15	R REV UNSAFE	20
APU ECU FAIL	4	HYD 2 HI TEMP	14	L THROTTLE	20	R SCAV EJECTOR	13
APU FAULT	4	HYD 3 HI TEMP	14	L WINDOW HEAT	15	R START ABORT	20
APU FIRE FAIL	10	HYD 1 LO PRESS	14	L WING A/I	15	R START VALVE	20
APU GEN OFF	7	HYD 2 LO PRESS	14	L WSHLD HEAT	15	R STATIC HEAT	15
APU GEN OVLD	7	HYD 3 LO PRESS	14	L XFER SOV	13	R THROTTLE	20
APU LCV CLSD	19	HYD PUMP 1B	14	LOW FUEL	13	RUD LIMITER	11
APU LCV OPEN	19	HYD PUMP 2B	14	MACH TRIM	11	R WINDOW HEAT	15
APU PUMP	13	HYD PUMP 3A	14	MAIN BATT OFF	7	R WING A/I	15
APU SOV FAIL	13	HYD PUMP 3B	14	MLG OVHT FAIL	16	R WSHLD HEAT	15
APU SOV OPEN	13	HYD SOV 1 OPEN	14	NO STRTR CUTOUT	20	R XFER SOV	13
APU SQB	10	HYD SOV 2 OPEN	14	OB BRAKE PRESS	16	SLATS FAIL	11
A/SKID INBD	16	IB BRAKE PRESS	16	OB FLT SPLRS	11	SPOILERONS ROLL	11
A/SKID OUTBD	16	IB FLT SPLRS	11	OB GND SPLRS	11	STAB TRIM	11
AUTO PRESS	8	IB GND SPLRS	11	OB SPOILERONS	11	STAB TRIM LIMIT	11
AV BAY DOOR	6	IB SPOILERONS	11	OVBD COOL	8	STALL FAIL	11
AVIONICS FAN	8	ICE	15	OXY LO PRESS	9	STBY PITOT HEAT	15
BATTERY BUS	7	ICE DET FAIL	15	PARK BRAKE SOV	16	STEERING INOP	16

Message	Ch.	Message	Ch.	Message	Ch.	Message	Ch.
BLEED MISCONFIG	19	IDG 1	7	PASS OXY ON	9	TAT PROBE HEAT	15
BULK FUEL TEMP	13	IDG 2	7	PAX DR LATCH	6	WING A/I SNSR	15
CABIN ALT	8	ISOL FAIL	19	PAX DR OUT HNDL	6	WING XBLEED	15
CARGO BTL LO	10	L AFT EMER DOOR	6	PITCH FEEL	11	WOW INPUT	16
CTR CARGO DOOR	6	L AOA HEAT	15	PROX SYS CHAN	16	WOW OUTPUT	16
DC BUS 1	7	L BLEED DUCT	19	PROX SYSTEM	16	XFLOW PUMP	13
DC BUS 2	7	L BLEED LOOP	19	R AFT EMER DOOR	6	YAW DAMPER	11
DC EMER BUS	7	L COWL A/I	15	R AOA HEAT	15		
DC ESS BUS	7	L COWL A/I OPEN	15	R BLEED DUCT	19		
DC SERV BUS	7	L COWL LOOP	19	R BLEED LOOP	19		
DISPLAY COOL	8	L ENG BLEED	19	R COWL A/I	15		
EFIS COMP INOP	12	L ENG DEGRADED	20	R COWL A/I OPEN	15		
EFIS COMP MON	12	L ENG FLAMEOUT	20	R COWL LOOP	19		
ELEVATOR SPLIT	11	L ENG SOV CLSD	13	R ENG BLEED	19		

H. EICAS Advisory Messages (Green)

Message	Chapter
ADS HEAT TEST OK	15
APU SOV CLSD	13
COWL A/I ON	15
CPLT ROLL CMD	11
ENGS HI PWR SCHED	20
FDR EVENT	2
FIRE SYS OK	10
FLAPS EMER	11
FLT SPLR DEPLOY	11
GLD MAN ARM	11
GND SPLR DEPLOY	11
GRAV XFLOW OPEN	13
HYD SOV 1 CLOSED	14
HYD SOV 2 CLOSED	14
ICE	15
L AUTO IGNITION	20
L COWL A/I ON	15
L ENG SOV CLSD	13
L FUEL PUMP ON	13
L REV ARMED	20
PARKING BRAKE ON	16
PLT ROLL CMD	11
R AUTO IGNITION	20
R COWL A/I ON	15
R ENG SOV CLSD	13
R FUEL PUMP ON	13
R REV ARMED	20
SPLR/STAB IN TEST	11
T/O CONFIG OK	2
WING A/I ON	15
WING/COWL A/I ON	15

I. EICAS Status Messages (White)

Message	Ch.	Message	Ch.	Message	Ch.
AC 1 AUTOXFER OFF	7	GLD MAN DISARM	11	PITCH FEEL FAULT	11
AC 2 AUTOXFER OFF	7	GPWS FAIL	18	PROX SYS FAULT 1	16
AC ESS ALTN	7	GRAV XFLOW FAIL	13	PROX SYS FAULT 2	16
ACARS CALL	<1214 >5	GS CANCEL	18	RAM AIR OPEN	8
ACARS MESSAGE	<1214 >5	HGS FAIL	18	R AUTO XFLOW ON	13
ACARS NOCOMM	<1214>5	HORN MUTED	16	R COWL A/I DUCT	15
ADG AUTO FAIL	7	IAPS DEGRADED	3	RECIRC FAN FAULT	8
ADG FAIL	7	IAPS OVERTEMP	3	RECIRC FAN OFF	8
AFT CARGO SOV	8	IB FLT SPLR FAULT	11	R ENG BLEED CLSD	19
APU ALT LIMIT	4	IB GND SPLR FAULT	11	R ENG BLEED SNSR	19
APU BATT CHGR	7	IB SPLRONS FAULT	11	R ENGINE START	20
APU FAULT	4	ICE DET 1 FAIL	15	R ENG SHUTDOWN	20
APU IN BITE	4	ICE DET 2 FAIL	15	R ENG SQB	10
APU LCV OPEN	19	IDG 1 DISC	7	R FADEC FAULT 1	20
APU SOV OPEN	13	IDG 2 DISC	7	R FADEC FAULT 2	20
APU START	4	IRS 1 IN ATT	12 <1025>	R IGN A FAULT	20
A/SKID FAULT	16	IRS 2 IN ATT	12 <1025>	R IGN B FAULT	20
AUTO PRESS 1 FAIL	8	IRS 1 OVERTEMP	12 <1025>	R ITT EXCEEDED B	20
AUTO PRESS 2 FAIL	8			R ITT EXCEEDED B1	20
AUTO PRS 1/2 FAIL	8	ISOL CLOSED	19	R ITT EXCEEDED C	20
AUTO XFLOW INHIB	13	ISOL OPEN	19	R MLG FAULT	16
BLEED CLOSED	19	L AUTO XFLOW ON	13	R OIL LEVEL LO	20
BLEED MANUAL	19	L COWL A/I DUCT	15	R PACK FAULT	8
CABIN ALT WARN HI	8	L ENG BLEED CLSD	19	R PACK OFF	8
CABIN PRESS MAN	8	L ENG BLEED SNSR	19	R RARV FAULT	8
CABIN TEMP MAN	8	L ENGINE START	20	R REV FAULT	20
CAS MISCOMP	2	L ENG SHUTDOWN	20	R THROTTLE FAULT	20
CKPT TEMP MAN	8	L ENG SQB	10	RUD LIMIT FAULT	11
CONT IGNITION	20	L FADEC FAULT 1	20	R VIB FAULT	20
CPAM FAIL	8	L FADEC FAULT 2	20	R XFLOW ON	13
DC CROSS TIE CLSD	7	L IGN A FAULT	20	SEAT BELTS	17
DC ESS TIE CLSD	7	L IGN B FAULT	20		
DC MAIN TIE CLSD	7	L ITT EXCEED B	20	SLAT FAULT	11
DCU 1 AURAL INOP	2	L ITT EXCEED B1	20	SLATS HALFSPEED	11

Message	Ch.	Message	Ch.	Message	Ch.
DCU 2 AURAL INOP	2	L ITT EXCEED C	20	SPEED REFS INDEP	3
DCU 1 INOP	2	L MLG FAULT	16	SPLR/STAB FAULT	11
DCU 2 INOP	2	L OIL LEVEL LO	20	SSCU 1 FAULT	11
DUCT MON FAULT	19	L PACK FAULT	8	SSCU 2 FAULT	11
EMER LTS ON	17	L PACK OFF	8	STAB CH 1 INOP	11
ENG SYNC OFF	20	L RARV FAULT	8	STAB CH 2 INOP	11
ESS TRU 1 FAIL	7	L REV FAULT	20	STAB FAULT	11
ESS TRU 2 FAIL	7	L THROTTLE FAULT	20	STEERING DEGRADED	16
ESS TRU 2 XFER	7	L VIB FAULT	20	TERRAIN FAIL	18
FD 1 FAIL	3	L XFLOW ON	13	TERRAIN NOT AVAIL	18
FD 2 FAIL	3	MAIN BATT CHGR	7	TERRAIN OFF	18
FDR ACCEL FAIL	2	MAN XFLOW	13	TRU 1 FAIL	7
FDR FAIL	2	MDC FAULT	2	TRU 2 FAIL	7
FIRE SYS FAULT	10	MLG FAULT	16	TRU FAN FAIL	7
FLAP FAULT	11	NO SMOKING	17	VHF 3 VOICE	5
FLAPS HALFSPEED	11	OB FLT SPLR FAULT	11	WINDSHEAR FAIL	18
FLUTTER DAMPER	11	OB GND SPLR FAULT	11	WING A/I FAULT	15
FUEL CH 1 FAIL	13	OB SPLRONS FAULT	11	WING XBLEED OPEN	15
FUEL CH 2 FAIL	13	OUTFLOW VLV OPEN	8	YD 1 INOP	11
FUEL QTY DEGRADED	13	OVBD COOL FAIL	8	YD 2 INOP	11

J. Inhibits

During the initial take-off, final take-off and landing phases, the DCUs will process inhibit logic to minimize intermittent or distracting warning or caution messages.

(1) Initial Take-off Phase

The initial take-off inhibits are enabled when:

- Left and right engine N_1 is greater than 79%,
- weight-on-wheels, and airspeed is less than 100 knots.

The initial take-off inhibit is removed when:

- Left and right engine N_1 is less than 67.6%, or
- Airplane is in the final take-off phase.

(2) **Final Take-off Phase**

The final take-off inhibits are enabled when:

- Left and right engine N_1 is greater than 79%, and
- airspeed transitions to greater than 100 knots.

The final take-off inhibit is removed when:

- Left and right engine N_1 is less than 67.6%, or
- Radio altitude is greater than 400 ft AGL, or
- 30 seconds after ground to air transition.

(3) **Landing Phase**

Landing phase inhibits are enabled when:

- Radio altitude transitions to less than 400 ft AGL, and
- landing gear down and locked.

The landing phase inhibit is removed when:

- 30 seconds after air to ground transition or
- Radio altitude transitions from less than 400 ft to greater than 400 ft.

K. Warning Inhibits

The following warning messages, their corresponding lights and aurals are inhibited during initial take-off:

Airplane System	Warning Message (Inhibited during take-off)	Aural (Inhibited during take-off)
Environmental Control System	CABIN ALT	Cabin Pressure
Flight Controls		Overspeed Clacker
Landing Gear	GEAR DISAGREE NOSE DOOR OPEN	Gear Disagree Nose Door

The following warning messages, their corresponding lights and aurals are inhibited during approach:

Airplane System	Warning Message (Inhibited during approach)	Aural (Inhibited during approach)
Auxiliary Power Unit	APU OVERTEMP	APU
Doors	PASSENGER DOOR	Door
Environmental Control System	CABIN ALT DIFF PRESS	Cabin Pressure Cabin Pressure
Ice and Rain Protection	ANTI-ICE DUCT L COWL A/I DUCT R COWL A/I DUCT WING OVHT	Anti-Ice Duct Anti-Ice Duct Anti-Ice Duct Wing Overheat
Landing Gear	NOSE DOOR OPEN	Nose Door
Power Plant	L ENG OIL PRESS R ENG OIL PRESS	Engine Oil Engine Oil

L. Caution Inhibits

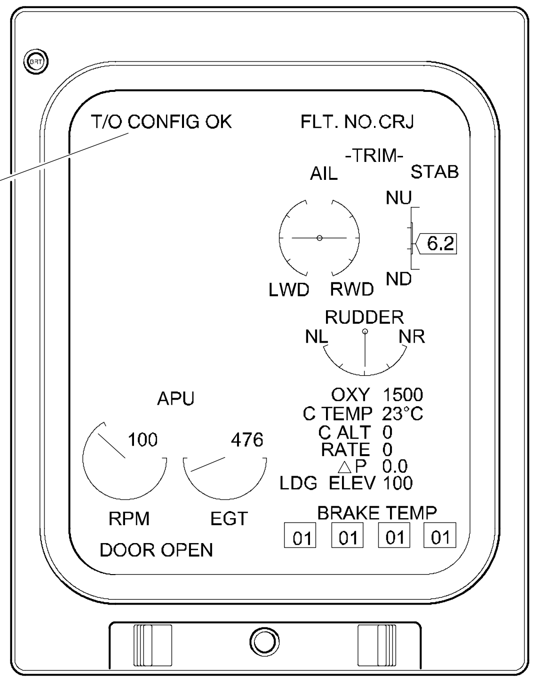
All caution messages and their corresponding lights (if applicable) are inhibited during take-off and/or landing <u>except</u> the following:

Airplane System	Caution Message (Not Inhibited)	
Automatic Flight Control System	YAW DAMPER	
Auxiliary Power Unit	APU LCV CLSD	
Fire Protection	FIRE SYS FAULT	
Flight Controls	GLD NOT ARMED GLD UNSAFE GND SPLR DEPLOY IB (OB) FLT SPLRS IB (OB) GND SPLRS IB (OB) SPOILERONS	PITCH FEEL RUD LIMITER SLATS FAIL SPOILERONS ROLL STAB TRIM STAB TRIM LIMIT STALL FAIL
Flight Instruments	EFIS COMP MON	
Hydraulic Power	HYD 1 (2) (3) LO PRESS	
Ice and Rain Protection	ICE ICE DET FAIL	L (R) COWL A/I OPEN L (R) WING A/I
Landing Gear	A/SKID INBD (OUTBD) IB (OB) BRAKE PRESS	PROX SYSTEM WOW INPUT (OUTPUT)
Pneumatic	ANTI-ICE DUCT L (R) BLEED DUCT	L (R) COWL LOOP
Power Plant	L (R) ENG FLAMEOUT L (R) ENG SRG CLSD L (R) FADEC L (R) FADEC OVHT	L (R) REV INOP L (R) REV UNLOCKED L (R) REV UNSAFE

M. Take-Off Configuration Warning

Take-off configuration warnings are armed when the airplane is on the ground and both engines are accelerated towards take-off thrust (N_1 greater than 70%).

T/O CONFIG OK advisory (green)
Indicates that the airplane is in a proper take–off configuration. Message goes out upon airplane rotation.



Status Page

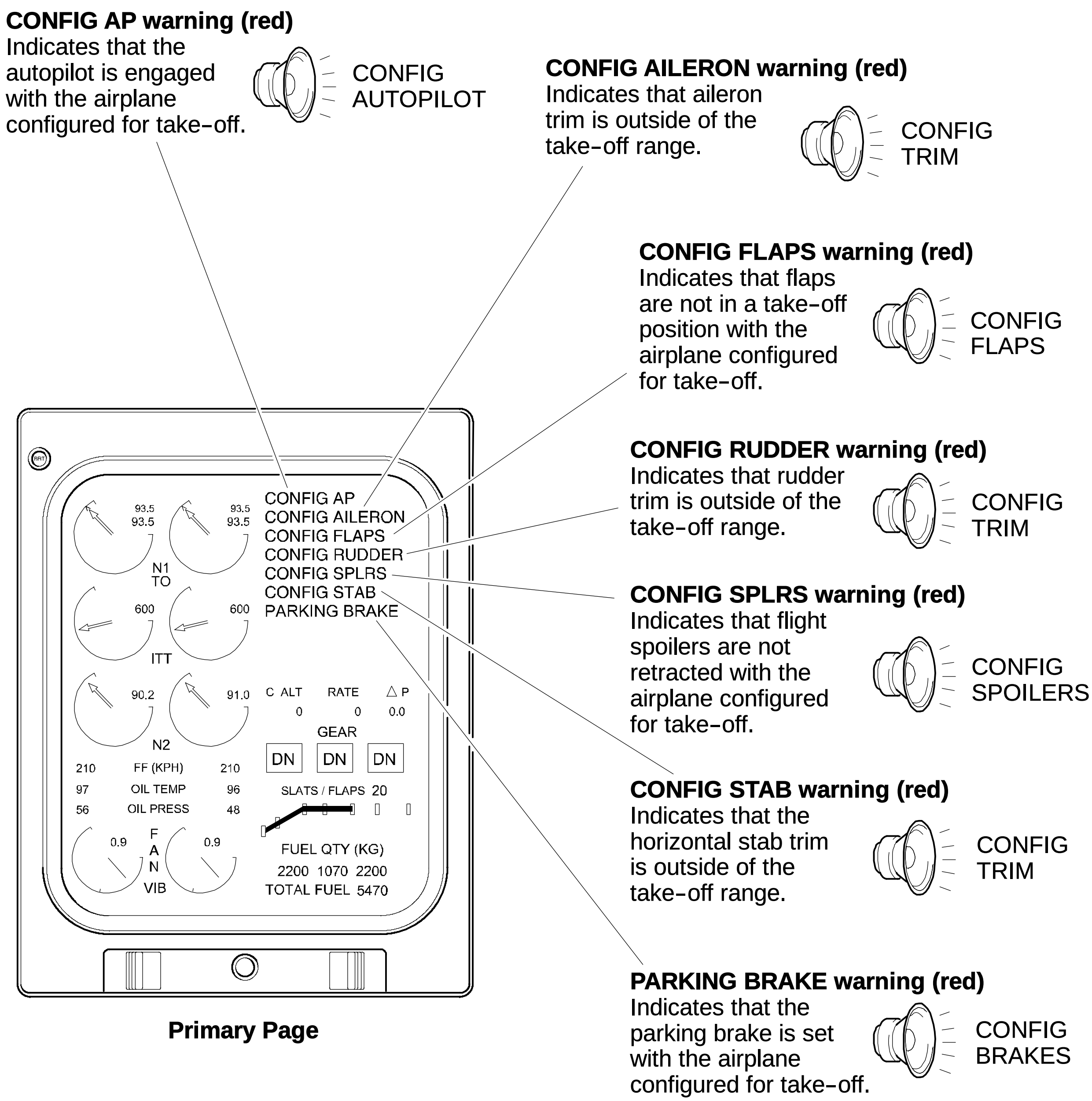
Take–Off Configuration Advisory
Figure 02–20–9

The following systems / conditions are checked:

Condition	Voice Message	EICAS Message
Autopilot engaged	Config Autopilot	CONFIG AP
Flaps not in take-off position	Config Flaps	CONFIG FLAPS
All spoilers not in take-off position (down)	Config Spoilers	CONFIG SPLRS
Horizontal stabilizer outside of take-off range (“green band”)	Config Trim	CONFIG STAB
Parking brake set (brake valve closed)	Config Brakes	PARKING BRAKE
Rudder trim outside of take-off range (trim > ±1 degree)	Config Trim	CONFIG RUDDER
Aileron trim outside of take-off range (trim > ±1 degree)	Config Trim	CONFIG AILERON

If the airplane is in an unsafe take-off configuration, configuration aural and warning messages, and both MASTER WARNING lights come on.

All configuration warning indications are cancelled when the configuration error is corrected.



Take–Off Configuration Warning <1001>
Figure 02–20–10

N. Landing Configuration Warning

The landing gear horn will sound 2 minutes after ground to air transition with any landing gear not down and locked, if one of the follow conditions exists:

- Radio altitude is less than 500 ft AGL with both throttles at less than maximum landing setting or with flaps greater than 30 degrees

or

- Both throttles are at less than maximum landing setting or any one throttle is at IDLE with the landing gear warning horn muted

and

- Airspeed is less than 170 knots with flaps greater than 30 degrees or airspeed is less than 190 knots with flaps and slats at 0

and

- Radio altimeter or throttle is not valid

or

- Radio altitude is less than 1000 ft AGL with a vertical speed less than -400 ft/min

and

- No windshear warning or a windshear warning with a windshear monitor failure

or

- Radio altitude is less than 1000 ft AGL with vertical speed or GPWS not valid

NOTE

The landing gear horn may be muted with one thrust lever at IDLE and the landing gear not in the down and locked position. Refer to Chapter 16, Landing Gear.

The “Too low gear” aural warning is heard if any landing gear is not down and locked with the radio altitude less than 500 ft AGL and the indicated airspeed at less than 190 knots.

O. MENU Page

The MENU page is divided into three sections: menu section, confirmation section and parameter readout. A cursor on the left side of the screen is controlled by the UP/DN buttons on the EICAS control panel (ECP). The SELECT button on the ECP is used to select an line item.

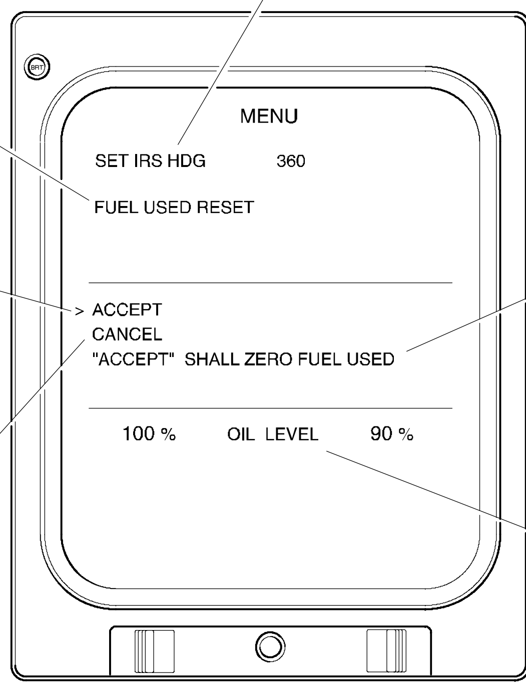
The menu list contains a single FUEL USED RESET line. When the line is selected, the ACCEPT/CANCEL selections in the confirmation section are used to accept or cancel the request to reset to zero the “Fuel Used” indication, on the FUEL synoptic page.

The parameter readouts section contains the engine OIL LEVEL indications.

SET IRS HDG and SET POS
Used to set IRS initial position or heading when FMS control display units are inoperative. SET POS appears after IRS heading has been set.

FUEL USED RESET (13)
Fuel System.

Cursor Symbols (caret and underscore)
Indicates editable item. Positioned by UP or DN buttons on EICAS control panel. Cursored item changes colour from white to cyan.



Data Entry Messages
Messages come on (white) when cursor is positioned to ACCEPT alteration.

ACCEPT and CANCEL
Used to accept or cancel alterations. Works in conjunction with the SEL button on the EICAS control panel.

OIL LEVEL (20)
Oil System.

MENU Page
EICAS Secondary Display
Center Instrument Panel

○ Indicates Chapter in which information on item may be found.

Menu Page <1025>
Figure 02–20–11

P. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
EICAS	Primary Display	EICAS PRIM DISPL	DC BUS 1	1	H3	
			BATTERY BUS	2	Q5	
	Secondary Display	EICAS SEC DISPL	DC BUS 1	1	H4	
			BATTERY BUS	2	Q6	
	Control Panel	EICAS CONT PNL	BATTERY BUS	2	Q7	
	Lamp Driver Unit	EICAS LDU L	DC BUS 1	1	H5	
		EICAS LDU R	BATTERY BUS	2	Q8	
	Bright / Dim Power Supply	EICAS BRT / DIM PWR SUP 1	DC BUS 1	1	H6	
			BATTERY BUS	2	Q10	
		EICAS BRT / DIM PWR SUP 2	DC BUS 1	1	H7	
			BATTERY BUS	2	Q11	
	DCU 1	EICAS DCU 1	DC ESSENTIAL		U8	
			BATTERY BUS		Q1	
	DCU 2	EICAS DCU 2			Q2	

1. RECORDING

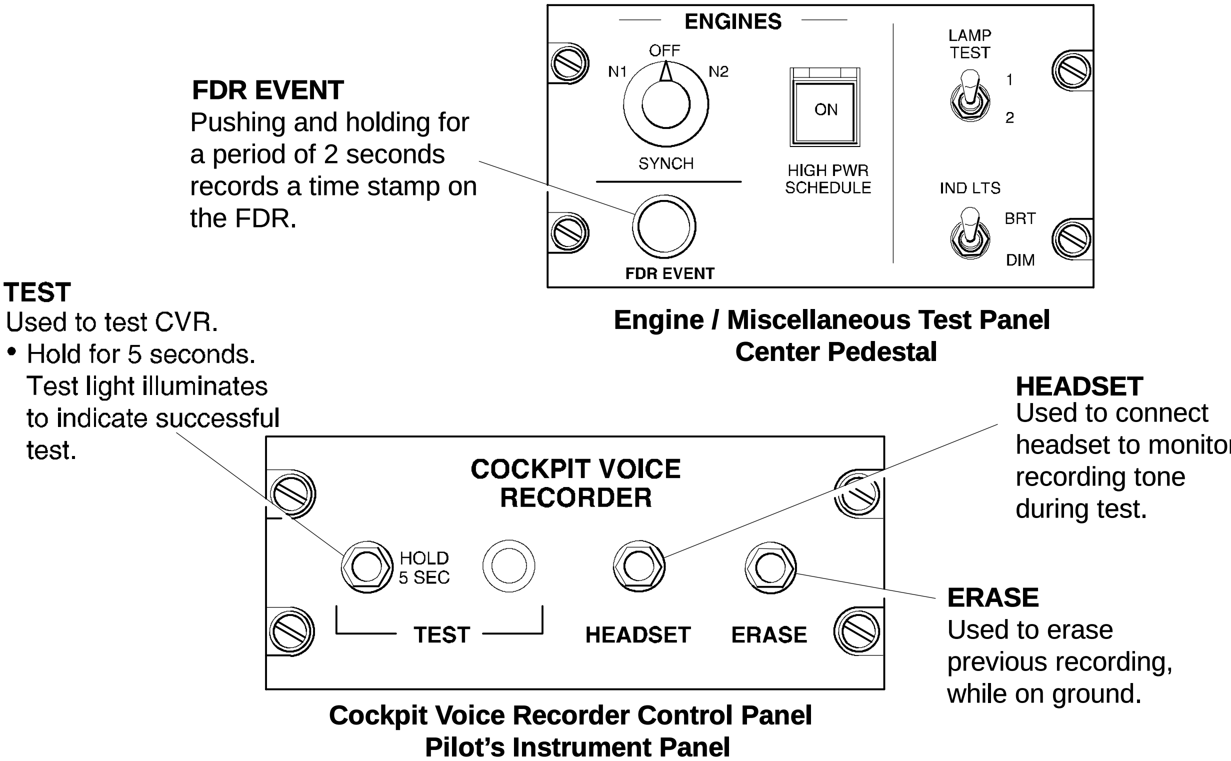
A flight data recorder (FDR) records aircraft systems data (including altitude, airspeed, position, heading, acceleration and radio communications events). The FDR provides a digital record of aircraft data for the last 25 hours of aircraft operation. The FDR normally receives data from data concentrator unit No.1 (DCU 1), records the information and sends it back to the DCU1 for comparison. If DCU 1 fails, DCU 2 will supply the data to the FDR.

The FDR will operate when the STROBE lights switch or BEACON lights switch is selected on, or if the aircraft is in a weight off wheels condition. The FDR has an internal clock which is used as the time reference from which events are recorded. An event can be marked by the pilot by operation of a FDR EVENT button on the Engine/Miscellaneous test panel.

A cockpit voice recorder (CVR) starts recording as soon as power is applied to the aircraft. It has a solid state non-volatile memory with the capacity to record the last 120 minutes of cockpit and mixed PA audio. The deceleration of impact removes the power to prevent erasure of the data. <1065>

The FDR and CVR each includes an underwater locater device (ULD). The ULD is a battery operated, underwater, pulsed acoustic beacon which has an internal switch that is activated by water. When activated, the unit sends out a 36.5 to 38.5 kilohertz signal.

A quick access recorder (QAR), located in the underfloor avionics bay, operates under the same conditions as the FDR. The QAR receives flight data from the data concentrator unit (DCU) that is not supplying data to the FDR. The data is stored in files on a removable disk. <1204>

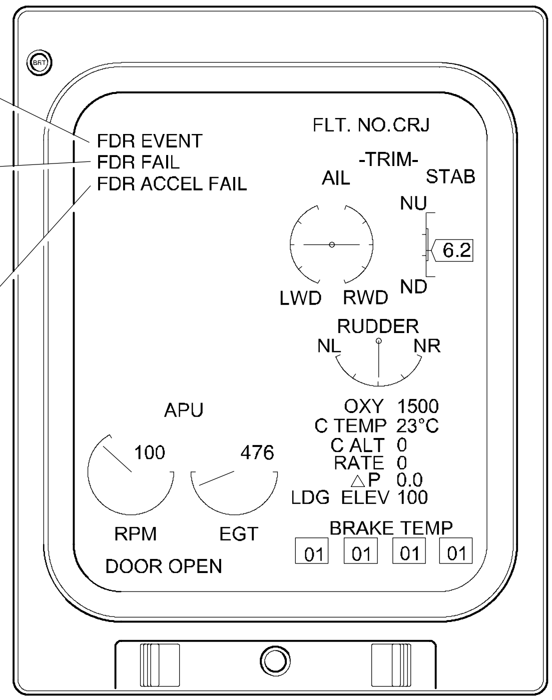


Recording
Figure 02–30–1

FDR EVENT advisory (green)
Indicates that a FDR EVENT was selected.

FDR FAIL status (white)
Indicates a difference between the recorded data and the data supplied by the DCU.

FDR ACCEL FAIL status (white)
Indicates a FDR accelerometer failure.



Status Page

Recording – EICAS Indications
Figure 02–30–2

A. System Circuit Breakers

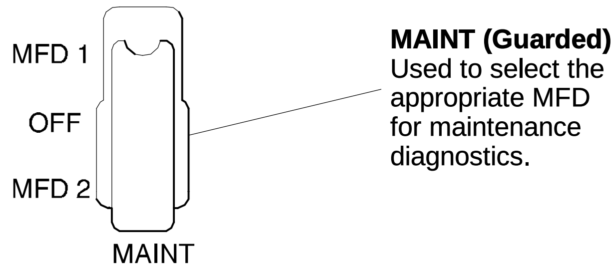
SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Recording	Flight Data Recorder	FLIGHT REC PWR	AC BUS 1	1	C9	
		FLIGHT REC CONT	DC BUS 1		E14	
	Cockpit Voice Recorder	CKPT VOICE REC	DC ESSENTIAL	2	V7	
	Quick Access Recorder <1204>	QAR	AC BUS 2		C13	

1. MAINTENANCE DIAGNOSTIC SYSTEM

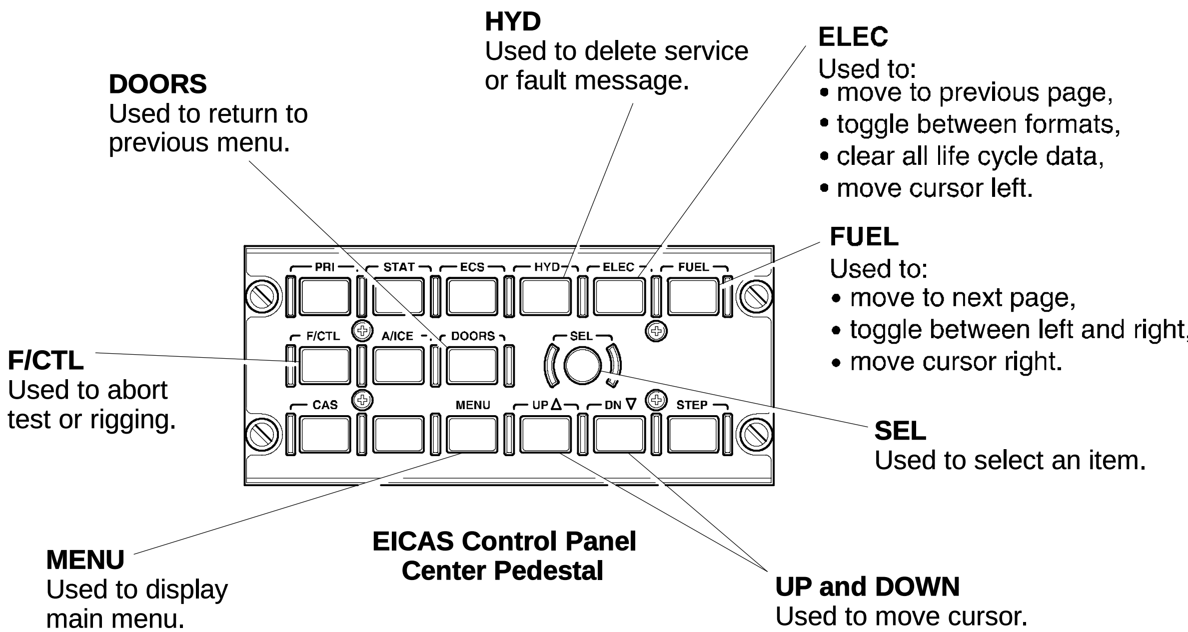
The maintenance diagnostic system is used by maintenance personnel to view current and historical information relating to specific aircraft systems health and operation.

The system uses a maintenance diagnostic computer (MDC) to process and record avionics and aircraft systems data for future retrieval. A maintenance switch, located behind the pilot's seat, is used to enter the maintenance diagnostics mode. The multifunctional displays (MFD) are used to display the maintenance data and the EICAS control panel is used to control and select information on the MFD display. A data loader unit is used to upload or download data to or from a floppy disk.

When the maintenance switch is set to MFD1 or MFD2, the applicable MFD is configured to display maintenance related display pages and the EICAS control panel is configured as a maintenance page control panel.



Maintenance Switch
Behind Pilot's Seat

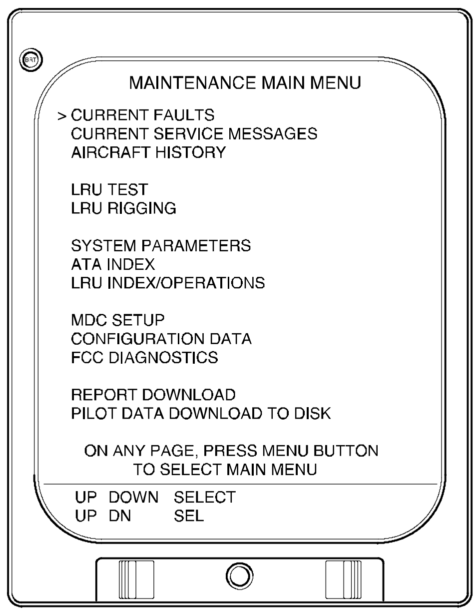


EICAS Control Panel
Center Pedestal

Maintenance Data Computer – Controls
Figure 02–40–1

A. Maintenance Main Menu Overview

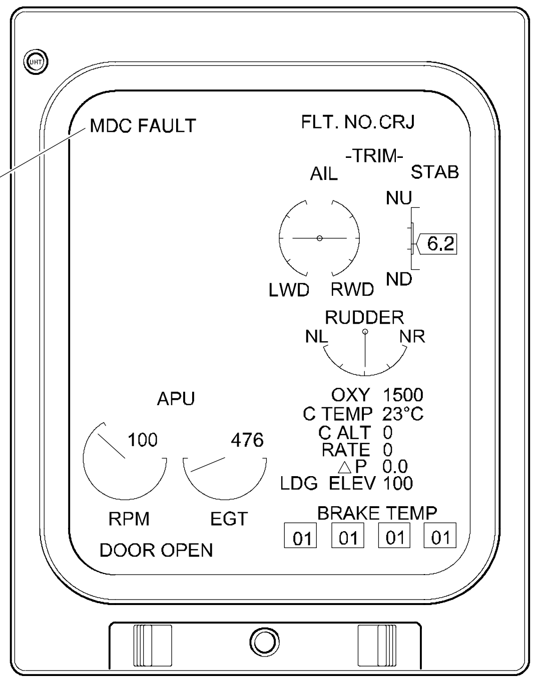
- Current Faults – Displays fault(s) currently detected by the MDC and failure messages reported by the DCU.
- Current Service Messages – Displays maintenance messages received from the DCU.
- Aircraft History – Provides access to history displays for faults, service messages, engine excellence and engine trends. Also used to access life cycle data and flight leg summary.
- LRU Testing – Used to initiate an line replaceable unit (LRU) test and display test results.
- LRU Rigging – Used to initiate the LRU programing procedure.
- System Parameters – Displays airplane system parameters.
- ATA Index – Displays list of ATA chapter numbers for all aircraft and avionics systems.
- LRU Index/Operations – Displays a list of LRUs and is used to select any associated test or rigging procedure.
- MDC Setup – Used to set aircraft identification and clock. Also used to load files.
- Configuration Data – Used to access the configuration of the integrated avionics processor system (IAPS) computers and to check the MDC version information.
- FCC Diagnostic – Displays instructions to put flight control system into diagnostic mode.



Maintenance Main Menu Page
Multifunction Display

Maintenance Main Menu EICAS Page
Figure 02–40–2

MDC FAULT status (white)
Indicates that a fault has been detected in the MDC.

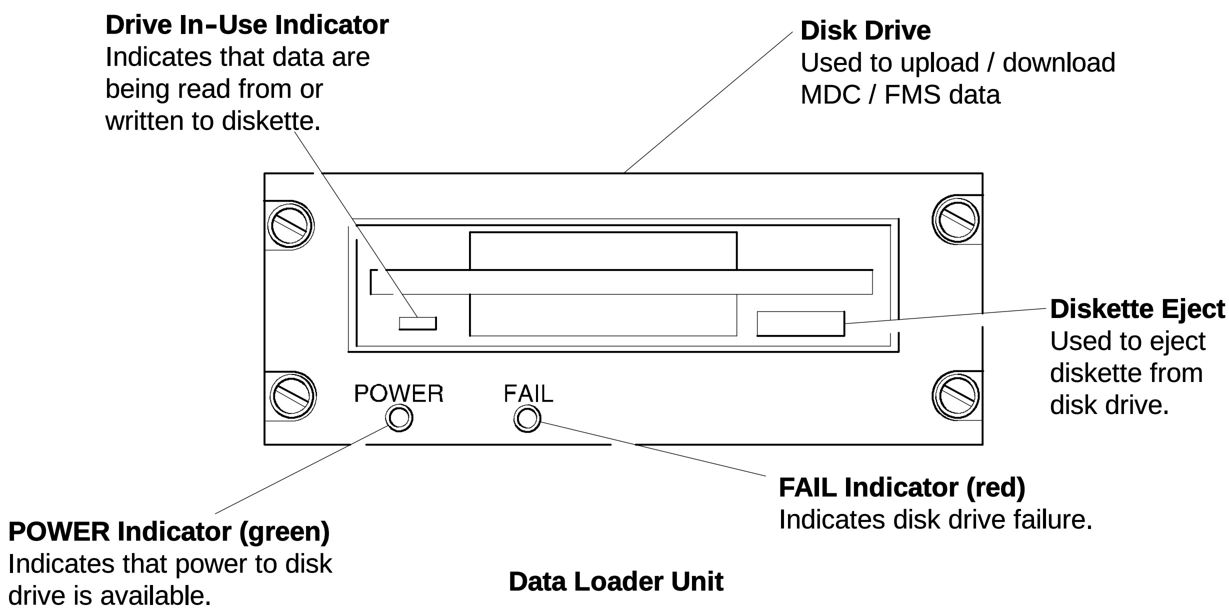


Status Page

MDC Fault Indication
Figure 02–40–3

B. Data Loader Unit

The data loader unit is located in the top of the forward entrance compartment. Through the download function from the MENU page, the unit enables the transfer of data files, between DOS-compatible diskettes and applicable aircraft systems. The data loader unit provides the capability to format disks, read directories and read/write files. <1018>



Data Loader Unit

NOTE
Indicators are not dimmable.

Data Loader Unit <1018>
Figure 02–40–4

C. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Maintenance Data Computer	Data Loader	DATA LOAD	DC BUS 1	1	H10	
	MDC	IAPS L AFCS / MDC	BATTERY BUS	2	P6	

CHAPTER 3 – AUTOMATIC FLIGHT CONTROL SYSTEM

LIST OF ILLUSTRATIONS

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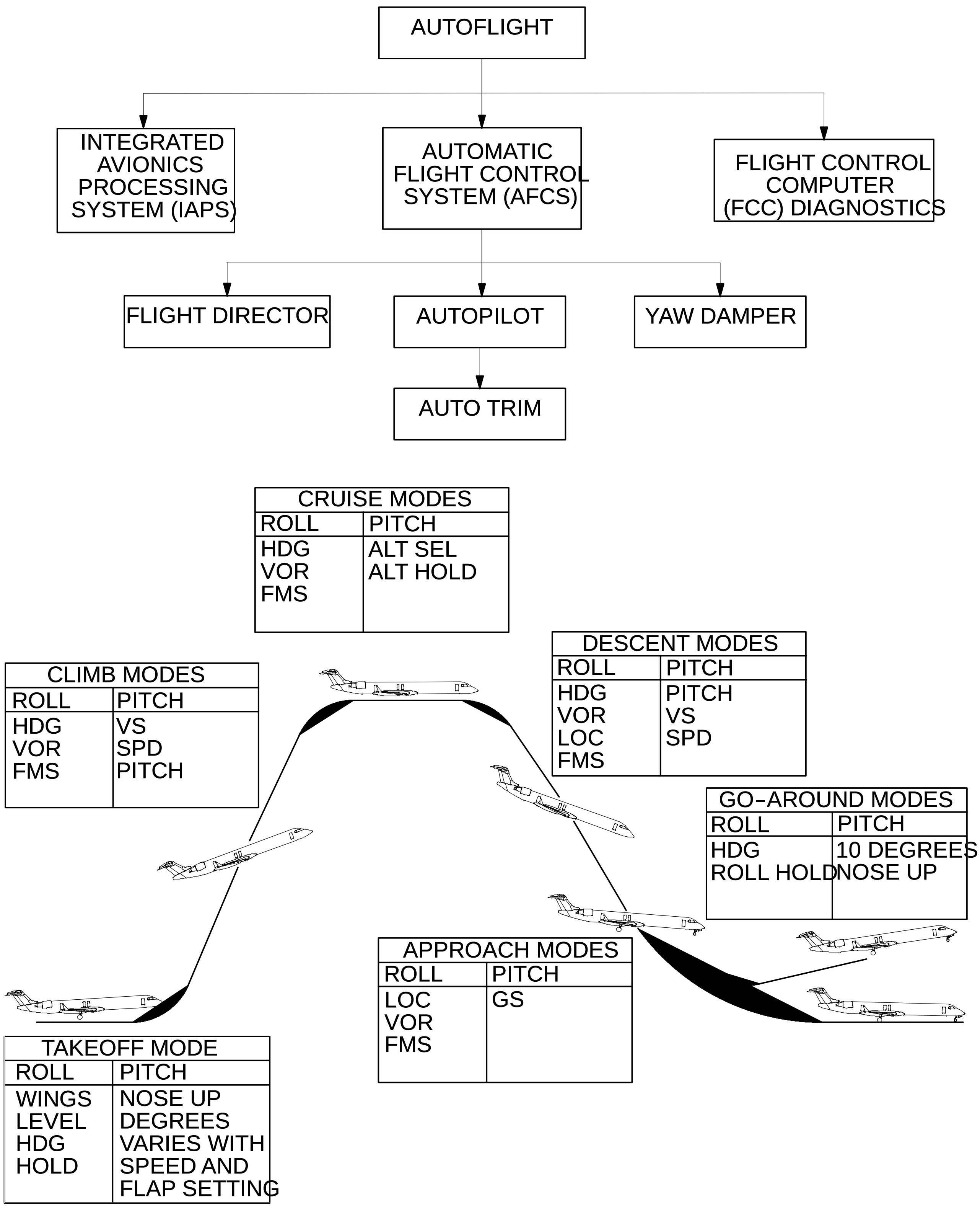
1. INTRODUCTION

The automatic flight control system (AFCS) provides integration of the autopilot and flight director systems. The system consists of two interlinked flight control computers, an autopilot, two yaw dampers, automatic elevator trim control and assorted servos and actuators.

The flight control computer receives mode selections from the flight control panel and sensor information from the air data system, navigation systems, inertial reference system, radio altimeter and surface position sensors. The flight control computer provides flight guidance commands to the autopilot. The autopilot provides the control signals to drive the aileron and elevator servos as well as the horizontal stabilizer trim. The flight director provides visual guidance using a command bar on the attitude director indicator portion of the primary flight displays. <1025>

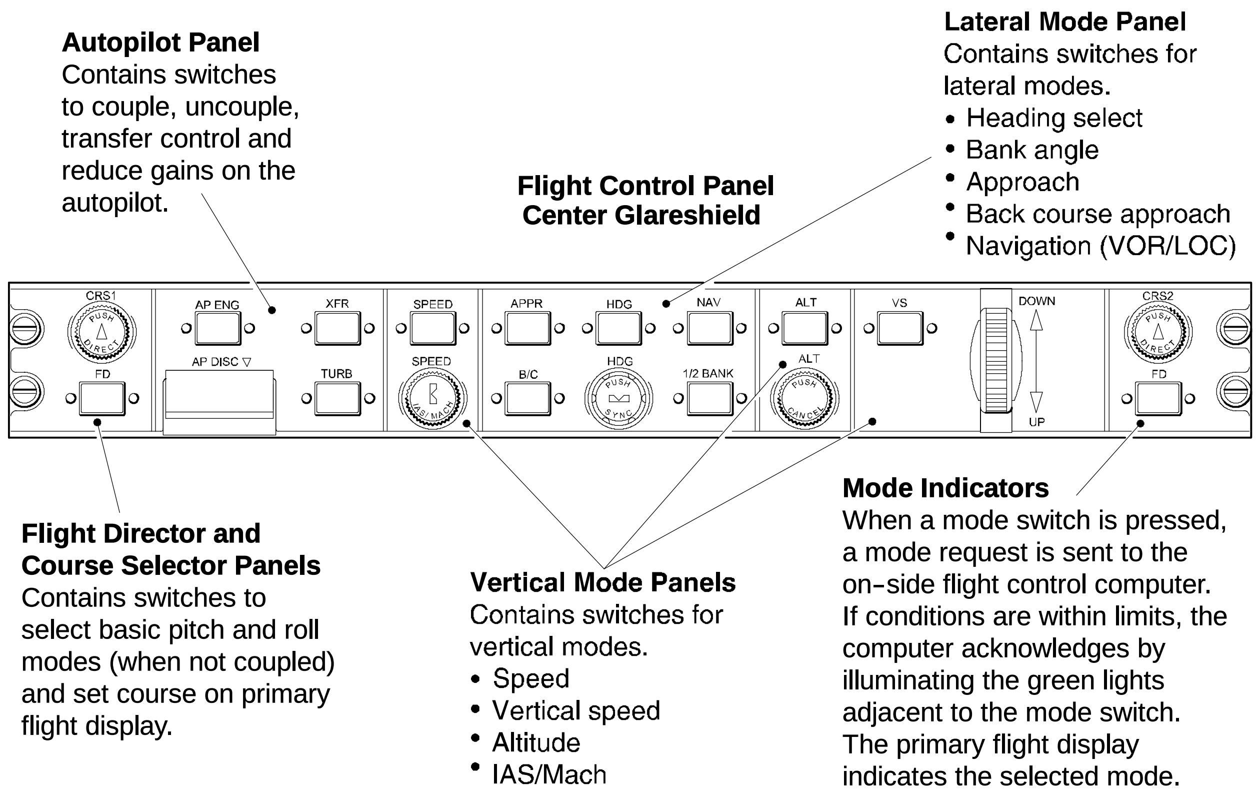


Auto Flight Systems and Modes – General
Figure 03–10–1

1. FLIGHT CONTROL AND GUIDANCE

Integration among the various avionics systems is provided by the integrated avionics processing system (IAPS) which is located in the avionics compartment. Two flight control computers (FCCs), mounted inside the IAPS, are the main computers for the automatic flight control system (AFCS). Control logic for the dual flight directors, the two axes autopilot with automatic pitch trim and the dual yaw dampers is contained in the two FCCs. The FCCs use the inertial reference system (IRS) and air data computer (ADC) system information to calculate flight path and control parameters for the AFCS. Other inputs to the flight control computers include selections made on the flight control panel, flight management computer outputs and radio system outputs. <1025>

The flight control panel is the mode selection panel for selecting and controlling the flight director and autopilot functions.



Flight Control Panel – Layout
Figure 03–20–1

Using the flight control panel, the crew can select the following functions:

- Remove flight director cues from the primary flight display and revert to basic pitch and roll displays
- Set course and fly to the active navigation source
- Engage, disengage and transfer control of the autopilot

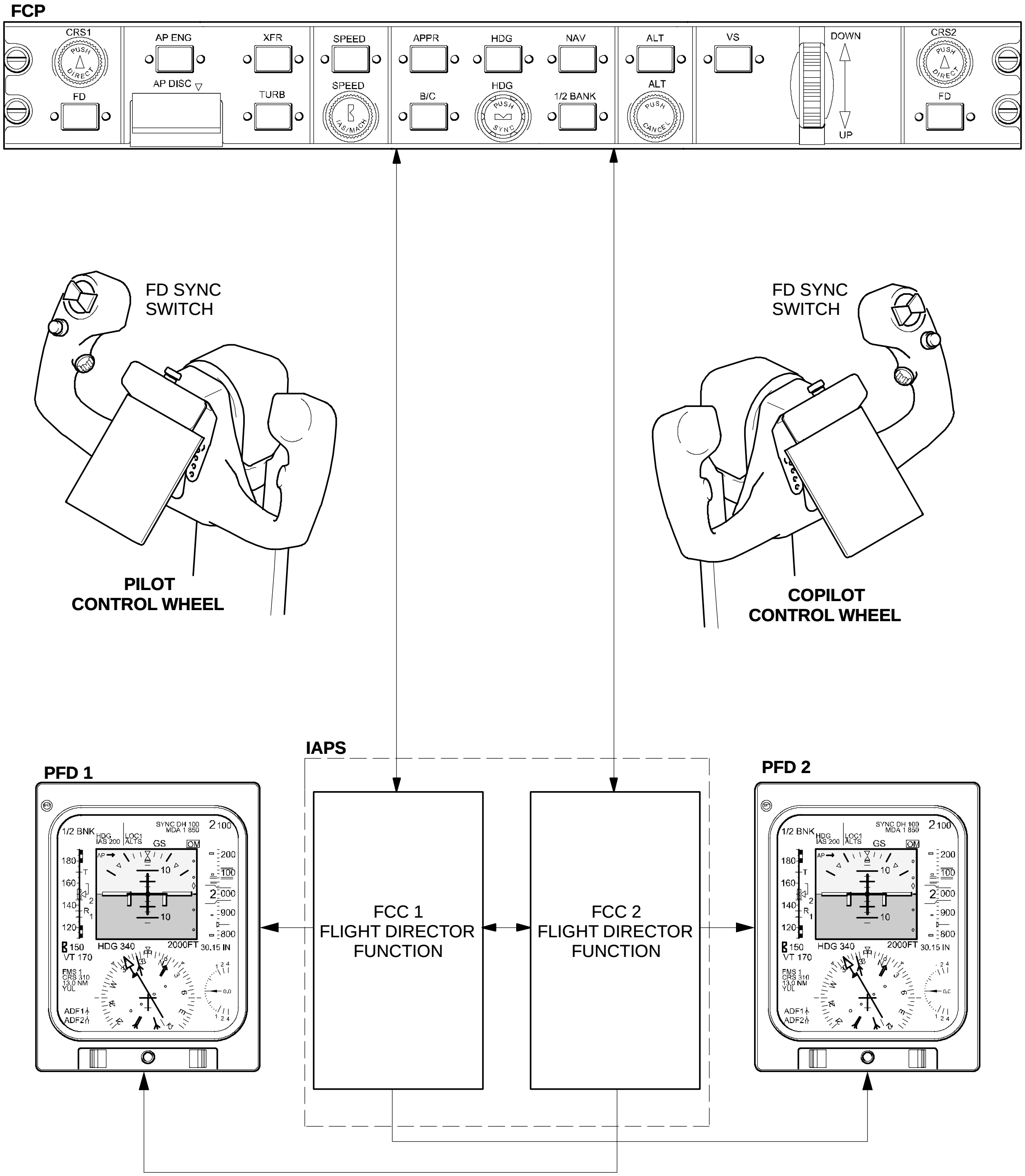
- Reduce autopilot gains
- Set and maintain airspeed, vertical speed, and altitude
- Set navigation, heading selection and approach modes

A. Flight Director

The flight director provides visual guidance, by means of command bars on the attitude director indicator, to fly the airplane manually or to visually monitor autopilot response to the guidance commands. The visual guidance commands (pitch and roll control) are integrated with the AFCS modes, selected on the flight control panel, for autopilot operation. AFCS operating modes can be selected to the flight directors with the autopilot disengaged. Pitch (including speed control) and roll guidance cues from the AFCS are displayed on the attitude director indicator portion of the primary flight displays.

The flight director system provides commands to perform the following:

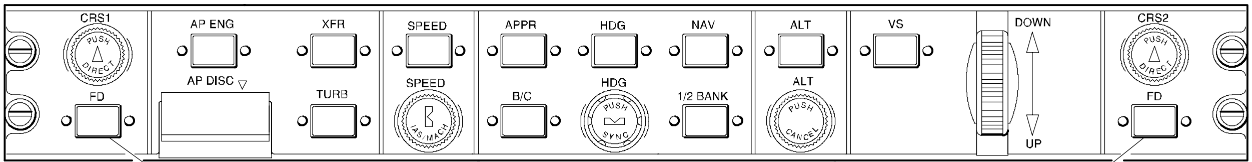
- Hold a desired attitude
- Maintain a pressure altitude
- Hold a vertical speed
- Hold a Mach number or indicated airspeed
- Capture and maintain a preselected barometric-corrected altitude
- Capture and track a preselected heading
- Capture and track a selected navigation source (VOR, LOC, G/S or FMS)
- Capture and track a localizer and glideslope
- Maintain a wings-level, fixed pitch-up attitude for takeoff or go-around
- Provide windshear escape guidance



Flight Director – Schematic <1015>
Figure 03–20–2

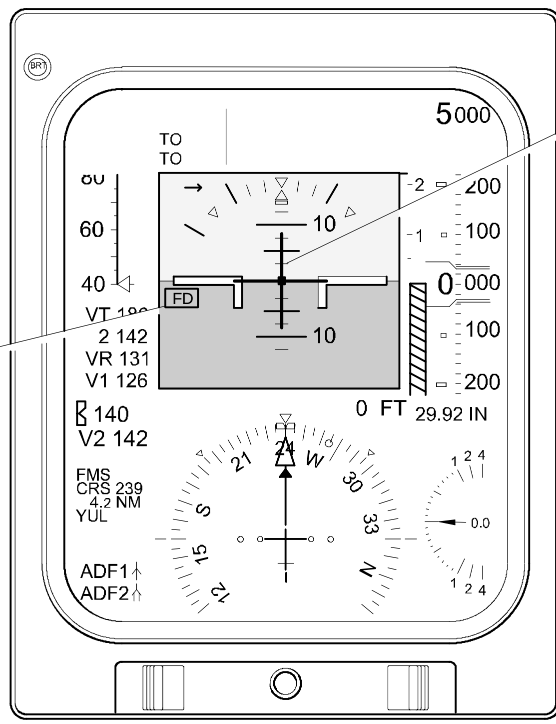
Flight directors are simultaneously turned on by either selecting a vertical mode, selecting a lateral mode, or by engaging the autopilot. Flight director selection activates all flight control mode annunciations and presents steering commands for the selected mode(s). When both flight directors are turned on, by engaging the autopilot, basic modes (pitch and roll) are automatically selected. When both flight directors are turned on, by selecting a vertical or lateral mode, basic modes are automatically selected for the other axis.

Transfer mode controls the routing of flight guidance commands to the autopilot and flight directors. When transfer mode is selected, the copilot's flight guidance command drives both flight directors. When not transferred, the pilot's flight guidance command drives both flight directors.



Flight Control Panel
Center Glareshield

FD
Used to select flight director off, when autopilot is not coupled.
- When pushed, removes steering and mode information from respective primary flight display.



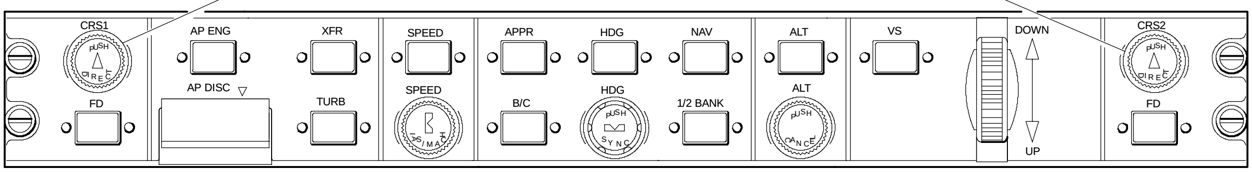
Flight Director (magenta)

FD Flag (red)
Indicates that either the pitch or roll data is invalid.

Primary Flight Display
Pilot's and Copilot's Instrument Panels

Flight Director – Controls and Indications <1015>
Figure 03–20–3

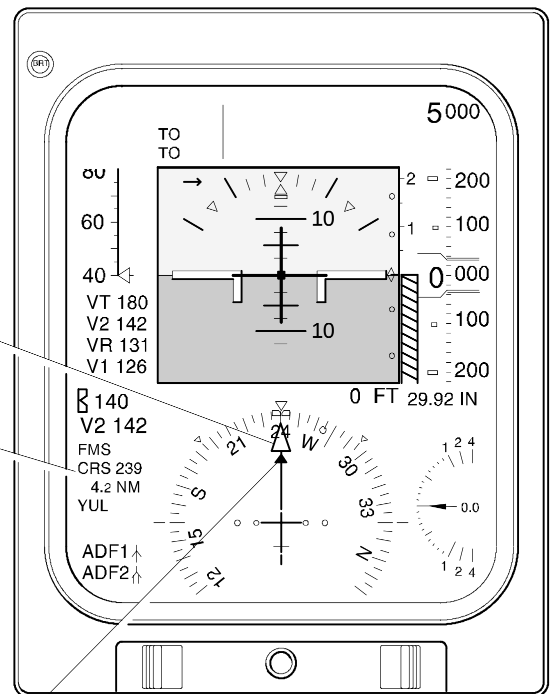
CRS 1 or 2
Used to set course pointer.
- When pressed, causes the course pointer to indicate the zero deviation course to the tuned VOR station.



Flight Control Panel
Center Glareshield

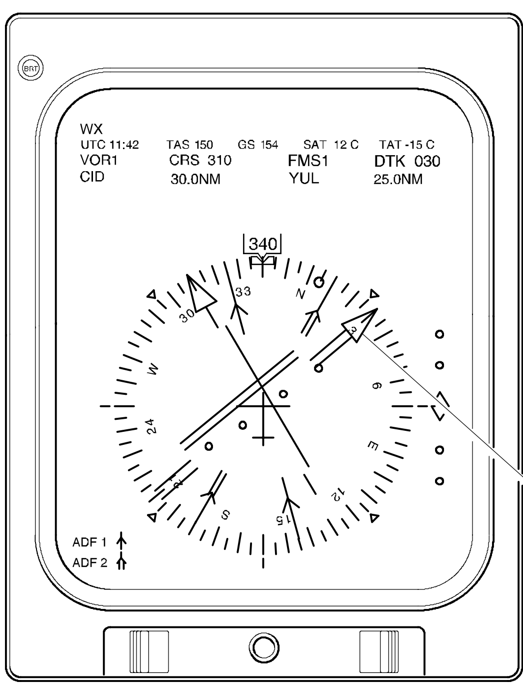
Course Pointer
Indicates position on compass rose that corresponds to selected course. Color matches navigation source.

Selected Course Readout
Indicates selected course as set using course knob on flight control panel. Color matches navigation source.



Primary Flight Display
Pilot's and Copilot's Instrument Panels

To / From Indicator
Indicates direction to or from the tuned station or waypoint. Color matches navigation source.



Multifunction Display – HSI Mode
Pilot's and Copilot's Instrument Panels

Cross-Side Course Pointer (cyan)
Indicates position on compass rose that corresponds to cross-side selected course. Displayed when activated by navigation source knob on display control panel.

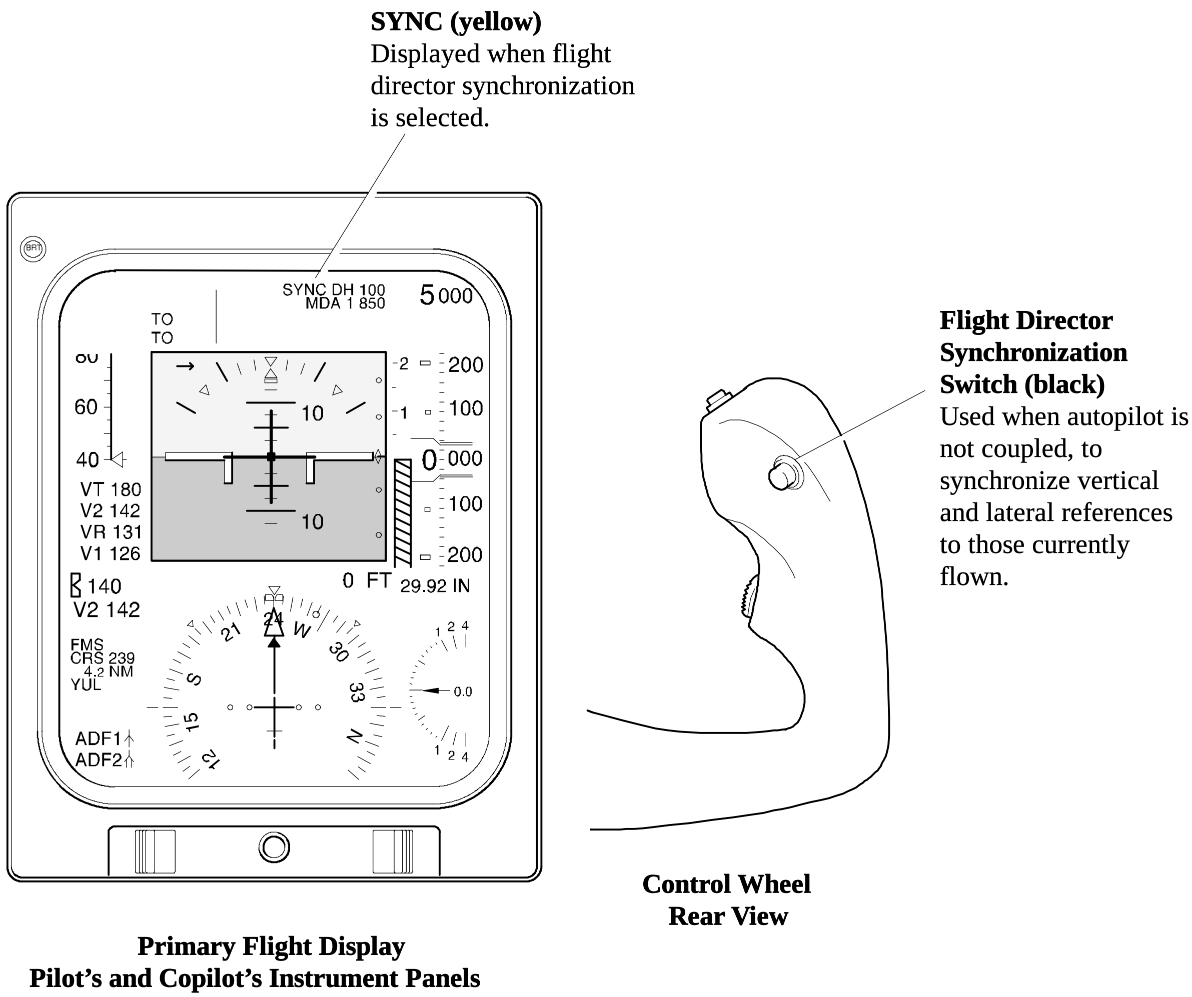
Course Pointer Control and Indication <1015>
Figure 03–20–4

B. Synchronization

Flight director synchronization is used to set the vertical and/or lateral reference to the current flight value. Selecting synchronization has no effect if the autopilot is engaged.

The vertical reference being synchronized is IAS (if in IAS mode), MACH (if in MACH mode), VS (if in VS mode), altitude hold memory (if in altitude hold, CLB or DES mode), or pitch angle memory (if in pitch mode). Overspeed and vertical capture modes are not affected by synchronization operation. The only lateral references that can be synchronized are the bank and heading memories of roll mode.

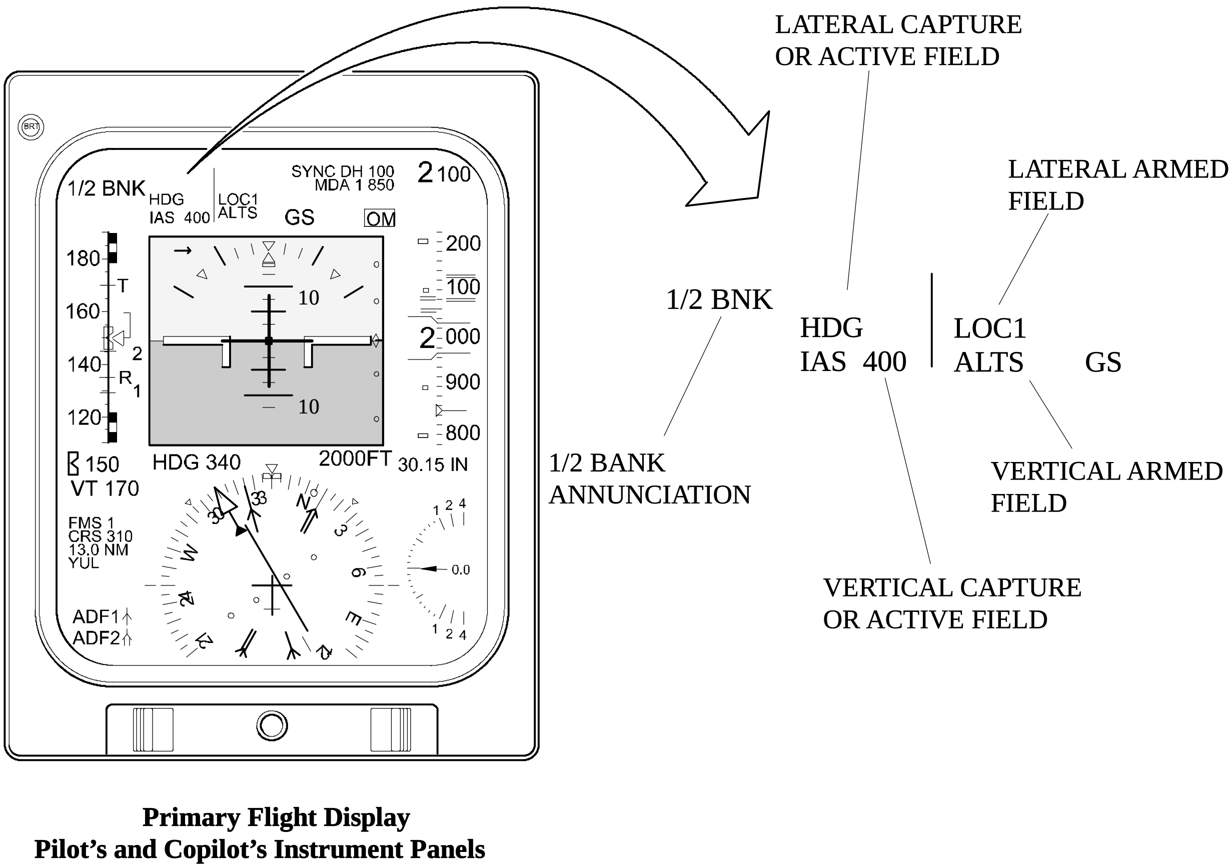
Synchronization is annunciated with a yellow SYNC on the primary flight display. The message will remain for 3 seconds, or until the sync switch is released, whichever is longer.



FD Synchronization <1015>
Figure 03–20–5

C. Flight Mode Annunciator

Flight mode annunciation is located above the blue (sky) portion of the attitude director Indicator. The flight mode annunciator presents flight mode information in two fields separated by a vertical cyan line. To the left of the line is the active or captured field (green) and to the right of the line is the armed field (white). The bottom line in each of the two fields contains vertical mode information and the upper lines contain lateral information.



Flight Mode Annunciator <1015>
Figure 03–20–6

D. Lateral Modes of Operation

(1) Lateral Take-Off Mode

Lateral take-off mode generates a wings level command while on the ground. After take-off, it generates a heading hold command, with a 5-degree bank limit, using the heading which existed at take-off. Selecting a lateral take-off mode turns on both flight directors, disengages the autopilot and clears all other lateral modes.

Lateral take-off mode is selected by pushing one of the thrust lever-mounted TOGA switches while on the ground. Lateral take-off mode is cleared by the selection of flight director synchronization or another lateral mode.

Lateral take-off mode is annunciated with a green TO message in the lateral capture field on the primary flight display.

(2) Navigation Mode

Navigation mode generates commands to capture and track a selected navigation source displayed on the primary flight display. Navigation mode is armed when selected, but cannot capture if the flight control computer is not receiving valid navigation data.

The capture point is a function of closure rate, with the capture point moving away from the radial/beam for high closure rates.

Navigation capture clears the heading selected. A localizer capture clears half bank and turbulence modes.

Dead reckoning is provided during VOR station passage. When DME data is available, dead reckoning region is approximately where the horizontal distance to the station is less than the altitude to the station. Without DME data, dead reckoning is based on a high rate of VOR deviation.

Navigation mode is selected by pushing the NAV switch on the flight control panel. Navigation mode is cleared by pushing the NAV switch again, by selecting another lateral mode or by changing the source of the on-side navigation signal.

Navigation mode arming is annunciated with two messages on the primary flight display, a green HDG message in the lateral capture field, and a white navigation source identifier (VOR1/2, LOC1/2 or FMS1/2) in the lateral arm field.

Navigation mode capture/tracking is annunciated with a green message in the lateral capture field on the primary flight display which identifies the navigation source (VOR1/2, LOC1/2 or FMS1/2). Dead reckoning operation is annunciated with a white DR message on the primary flight display.

(3) Heading Select Mode

Heading select mode generates commands to capture and maintain the selected digital heading readout and heading bug on the primary flight display. The selected heading can be changed by rotating the HDG knob (up to 360 degrees) on the flight control panel. Pushing the HDG knob will set the selected heading to the current heading.

Heading select mode is selected by pushing the HDG switch on the flight control panel. Heading select mode is cleared by pushing HDG switch or by selecting another lateral mode.

Heading select mode is annunciated with a green HDG message in the lateral capture field.

(4) Back Course Mode

Back course mode generates commands to capture and track the selected back course displayed on the primary flight display. Back course is armed when selected, but cannot capture if the flight control computer is not receiving valid localizer data.

The capture point is a function of closure rate, with the capture point moving away from the radial/beam for high closure rates. Back course capture clears turbulence, half bank and heading modes.

Back course mode is selected by pushing the B/C switch on the flight control panel. Back course mode is cleared by pushing the B/C switch again, by selecting another lateral mode, or by changing the source of the navigation signal to something other than a localizer.

Back course mode arming is annunciated with two messages on the primary flight display, a green HDG message in the lateral capture field, and a white navigation source identifier (B/C 1/2) in the lateral arm field. Back course mode capture/tracking is annunciated with a green message in the lateral capture field on the primary flight display which identifies the navigation source (B/C 1/2).

Back course steering information is invalidated when the navigation source is not a localizer.

(5) Roll Mode

Roll mode generates commands to hold the heading that exists when the mode is initiated, unless the roll angle upon initiation is over 5 degrees (commands are then generated to hold the roll angle). The roll mode reference is reset to the current heading, or current roll angle, upon autopilot engagement or synchronization.

Roll mode is automatically selected, when no other lateral mode is active, and the flight director is on. Roll mode is cleared by the selection of another lateral mode.

Roll mode is annunciated with a green ROLL message in the lateral capture field on the primary flight display.

(6) Half Bank Mode

Half bank mode reduces the maximum commanded bank angle to 15 degrees.

Half bank mode is selected by pushing the 1/2 BANK switch on the flight control panel. Half bank mode is automatically selected when climbing through 31,600 feet (pressure altitude) or if the airplane is above the half bank transition altitude when the flight director is turned on. Selection is inhibited when in the take-off mode, go-around mode, on-side approach mode capture, or any on-side localizer capture.

Half bank mode is manually cleared by pushing the 1/2 BANK switch again, and is automatically cleared when descending through the half bank transition altitude.

Half bank is annunciated with a white 1/2 BNK message on the primary flight display.

(7) Lateral Go-Around Mode

Lateral go-around mode generates a heading hold command, with a 5 degree bank limit. Selection of lateral go-around mode turns on both flight directors, disengages the autopilot, and clears all other lateral modes. Lateral and vertical go-around mode selections are coincident. When lateral go-around causes an autopilot disengage, the resultant autopilot disengage warning may be cancelled by another push of a TOGA switch, or by pushing the AP disconnect switch.

Lateral go-around mode is selected by pushing one of the thrust lever-mounted TOGA switches while airborne. Lateral go-around mode is cleared by selection of synchronization or another lateral mode.

Lateral go-around is annunciated with a green GA message in the lateral capture field on the primary flight display.

(8) Approach Mode

Approach mode generates commands to capture and track the selected navigation source displayed on the primary flight display. Tracking performance is higher, than in navigation mode. Approach mode is armed when selected, but cannot capture if the flight control computer is not receiving valid navigation data.

The capture point is a function of closure rate, with the capture point moving away from the radial/beam for high closure rates.

If the other side does not concurrently capture, it will continue to operate in heading select, until it independently captures.

Approach mode may automatically select glideslope mode. An on-side localizer capture clears turbulence mode on both sides.

Dead reckoning is provided during VOR station passage. When DME data is available, dead reckoning region is where DME distance to the station is less than 0.6 nautical mile (DME). Without DME data, dead reckoning is based on a high rate of VOR deviation.

Approach mode is selected by pushing the APPR switch on the flight control panel. Approach mode is cleared by pushing the APPR switch again, by selecting another lateral mode, or by changing the source of the on-side navigation signal.

Approach mode arming is annunciated with two messages on the primary flight display, a green HDG message in the lateral capture field, and a white navigation source identifier (VOR1/2, LOC1/2 or FMS1/2) in the lateral arm field. Approach mode capture/tracking is annunciated with a green message in the lateral capture field on the primary flight display which identifies the navigation source (VOR1/2, LOC1/2 or FMS1/2). Dead reckoning operation is annunciated with a white DR message on the primary flight display.

E. Vertical Mode of Operation

(1) Vertical Take-Off Mode

Vertical take-off mode generates a variable fixed pitch-up command dependant on flap setting for takeoff and the spread between V2 and Vr. Loss of an engine reduces the pitch-up command.

Selecting vertical mode turns on both flight directors, disengages the autopilot, clears all other vertical modes and switches the flight guidance commands to a dual independent configuration. Lateral and vertical take-off mode selections are coincident.

When take-off causes an autopilot disengagement, the resultant warning may be cancelled by another push of a TOGA switch, or by pushing the autopilot disconnect switch.

Vertical take-off mode is selected by pushing one of the thrust lever-mounted TOGA switches while on the ground. Vertical take-off mode is cleared by engaging the autopilot, by selecting synchronization, or by the selection or capture of another active mode.

Vertical take-off mode is annunciated with a green TO message in the vertical capture field on the primary flight display.

(2) Pitch Mode

When pitch mode is selected, the pitch reference (pitch command on the primary flight display) is set to the current pitch angle. Pitch mode generates commands to maintain the pitch reference value.

The pitch reference value can be changed using the VS pitch wheel. Rotation of the VS pitch wheel will change the pitch reference by 1/2 degree per click. The pitch reference is reset to the current pitch attitude upon either autopilot engagement, transferring to pitch mode, or synchronization.

When the preselected altitude is captured, rotating the VS pitch wheel also rearms the altitude preselect mode.

When capturing or tracking a preselected altitude, a new preselected altitude must be chosen prior to the selection of pitch mode, to avoid an immediate recapture of the existing preselected altitude.

Pitch mode is automatically selected when no other vertical mode is active, and the flight director is on. Rotating the VS pitch wheel on the flight control panel will manually select pitch mode when the flight director is on, unless in glideslope capture or VS mode. Pitch mode is cleared by the selection of a vertical hold mode, or by a vertical mode capture.

Pitch mode is annunciated with a green PTCH message in the vertical capture field on the primary flight display.

(3) Altitude Hold Mode

Altitude hold mode generates commands to capture and maintain the altitude reference. When altitude hold mode is selected, the altitude reference is set to the current pressure altitude.

The altitude reference is reset to current pressure altitude by selection of synchronization. There is no display of altitude reference value.

Altitude hold mode is selected by pushing the ALT switch on the flight control panel, or by changing the altitude preselect setting while in altitude preselected track. Selection is inhibited when in glideslope capture or overspeed.

Altitude hold mode is cleared by pushing the ALT switch again, by selection of a vertical hold mode, or by vertical mode capture.

Altitude hold mode is annunciated with a green ALT message in the vertical capture field on the primary flight display.

(4) Altitude Preselect Mode

Altitude preselect mode generates commands to capture and track preselected altitudes. The barometric preselected altitude is displayed on the primary flight display, and controlled via the ALT knob on the flight control panel.

Altitude preselect mode is armed upon selection. The capture point is a function of closure rate, with the capture point moving away from the preselected altitude for high closure rates.

During altitude capture (within 200 ft of the preselect altitude), if the preselected altitude is changed or if the VS pitch wheel is rotated, the autopilot or flight director will continue to capture the original preselected altitude.

If a new preselect altitude is not set, then selection of IAS, MACH, PTCH or VS mode, will result in the current altitude being captured.

After capturing preselected altitude (altitude track), if preselect altitude is changed, altitude hold is automatically selected and altitude preselect rearmed.

Pushing in the ALT knob will cancel aural and visual alerts associated with the preselected altitude.

Altitude preselect mode is automatically selected upon selection of any vertical mode, except glideslope capture or overspeed. Altitude preselect mode is cleared by glideslope capture or overspeed.

Altitude preselect is annunciated on the primary flight display with a white ALTS message in the vertical arm field for arm; a green ALTS CAP message in the vertical capture field for capture, and a green ALTS message in the vertical capture field for track. Altitude captures, which are cleared without a subsequent selection of altitude track or arm, are annunciated with a yellow ALTS message on the primary flight display, which will remain for 10 seconds, or until altitude preselect is rearmed, whichever is shorter.

(5) Speed Mode (CLB, DES, IAS)

Speed mode generates commands to maintain the airspeed reference value. When speed mode is selected, the IAS reference (primary flight display) is set to the current airspeed.

The airspeed reference can be manually set, using the speed knob. The airspeed reference is reset to current airspeed by the selection of autopilot engagement or synchronization.

Upon altitude capture, (selected altitude), speed mode is disabled.

Speed mode is displayed in either IAS CLB or DES. Selection of the speed readout is accomplished by pushing the SPEED knob on the flight control panel.

In DES mode, if a large reduction in target airspeed is commanded with simultaneous spoiler deployment, the autopilot may enter a Pitch Hold sub–mode (no annuciation of Pitch Hold sub–mode is provided). Pitch Hold sub–mode was designed to maintain a constant pitch attitude as a means of decelerating to the new target airspeed without sacrificing rate of decent or passenger comfort. The only indication that the autopilot has entered Pitch Hold sub–mode is that the airspeed is not decreasing and stays well above the target airspeed. In DES mode, if the airspeed is not decreasing, the Pilot can either disconnect the autopilot and assume manual control, or select another vertical mode such as VS or PTCH and adjust the vertical speed or pitch as required to resume deceleration to the target airspeed.

(6) Vertical Speed Mode

Vertical speed mode generates commands to maintain the VS reference value. When vertical speed mode is selected, the VS reference (primary flight display) is set to the current vertical speed.

The VS reference value can be changed, throughout a ±12,000 feet/minute range, using the VS pitch wheel on the flight control panel. The VS reference is reset to the current vertical speed by the selection of autopilot engagement or synchronization.

When capturing or tracking a preselected altitude, a new preselected altitude must be chosen prior to selection of vertical speed mode, to avoid an immediate recapture of existing preselected altitude.

Vertical speed mode is manually selected by pushing the VS switch on the flight control panel. Selection is inhibited when in glideslope capture or overspeed. Vertical speed mode is cleared by pushing the VS switch again, by selecting a vertical hold mode, or by a vertical mode capture.

Vertical speed mode is annunciated with a green VS #.# ↑ or VS #.# ↓ in the vertical capture field on the primary flight display. The #.# is the VS reference value, in thousands of feet/minute (values over 10,000 feet/minute are displayed without a decimal point). The up arrow displays a positive reference and the down arrow displays a negative reference.

The flight control computer operates in the active mode. Capture will not occur if the localizer is not captured, or if the flight control computer is not receiving valid glideslope data. Upon glideslope capture, other vertical modes are automatically cleared on the captured side. If the other side does not concurrently capture the glideslope, it will continue to operate in the current active vertical mode, or ensuing vertical mode, until it independently captures glideslope.

Climb or descent rate is achieved by moving the rotary switch on the flight control panel.

(7) Glideslope Mode

Glideslope mode will generate commands to capture and track the glideslope. Captures can be performed from above or below the beam.

The capture point is a function of closure rate, with the capture point moving away from the beam for high closure rates.

Glideslope mode is automatically selected when in an approach mode, inbound, with a valid localizer as the lateral navigation source. Glideslope mode is automatically cleared by the loss of approach mode. When armed, glideslope mode is also cleared by turning outbound, or by the loss of a valid localizer as the lateral navigation source. When captured, glideslope mode is cleared by changing the source of the lateral navigation signal to an invalid localizer.

Glideslope arming is annunciated with a white GS message in the vertical arm field on the primary flight display. Glideslope capture is annunciated with a green GS message in the vertical capture field on the primary flight display.

(8) Vertical Go-Around Mode

Go-around mode generates a fixed pitch-up command, the value depending on whether both engines are operating or if one engine is inoperative (OEI).

Selection of vertical go-around mode turns on both flight directors, disengages the autopilot, clears all other vertical modes and switches the flight guidance commands to a dual-independent configuration. Vertical and lateral modes coincide.

When a go-around causes the autopilot to disengage, the autopilot warning can be cancelled by another push to the TOGA switch, or by pushing the autopilot disconnect switch.

Vertical go-around mode is selected by pushing either one of the thrust lever-mounted TOGA switches while airborne. Go-around mode is cleared by engaging the autopilot, by selecting synchronization or by the selection or capture of another active mode. Go-around mode is annunciated with a green GA message in the vertical capture field on the primary flight display.

F. Altitude Alert System

The primary flight displays alert the pilots that the aircraft is approaching the preselected altitude, or that the aircraft is deviating from a previously selected and acquired altitude. Altitude advisories are indicated on the primary flight displays in the following locations: on the altimeter portion, at the preselect altitude digital readout (above the barometric tape), and at the preselect bugs,including the double bars (across the fine and coarse tapes).

The altitude alert system processes data from the air data computers and is independent of the autopilot or flight director mode. The ALT knob on the flight control panel is used to set the desired altitude.

The preselect digital readout and bugs change state and colour as follows:

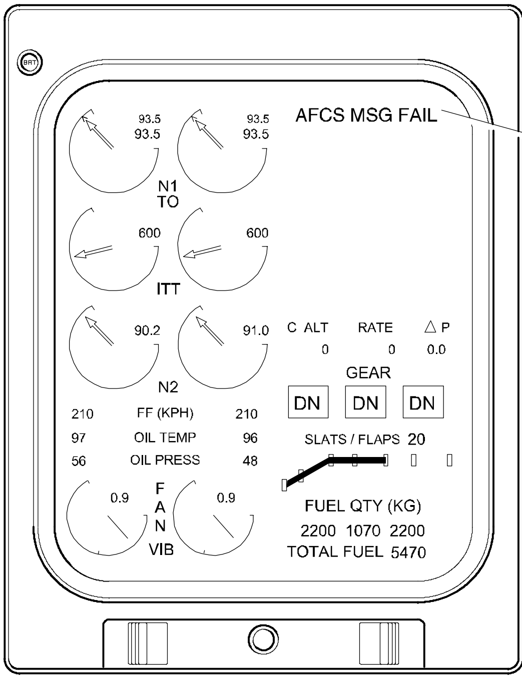
- At the altitude alert threshold, the readout and bugs flash magenta for approximately four seconds, and a one-second aural tone sounds. The threshold is approximately 1,000 feet from the selected altitude.

- When within 200 feet from the selected altitude, the readout and bugs come on steady to indicate altitude capture.

- If the airplane subsequently deviates more than 200 feet from the selected altitude, the readout and altitude bugs (double bars) will flash amber and a 1 second tone will be heard. The readout and altitude bugs will continue to flash amber as long as the aircraft is deviated more than 200 feet or cancelled.

- When the aircraft is –200 feet below the selected altitude the flashing magenta bugs and readout will cancel.
- If the aircraft subsequently continues to deviate ($\pm$1000 feet) from the selected altitude, a 1 second tone will be heard.
- When the aircraft is again within 200 feet of the selected altitude, the readout and bugs will turn magenta and stop flashing.

Altitude alerts can be cancelled by pushing the ALT switch or selecting a different altitude. Altitude alerts are inhibited if the glideslope is captured.



Primary Page

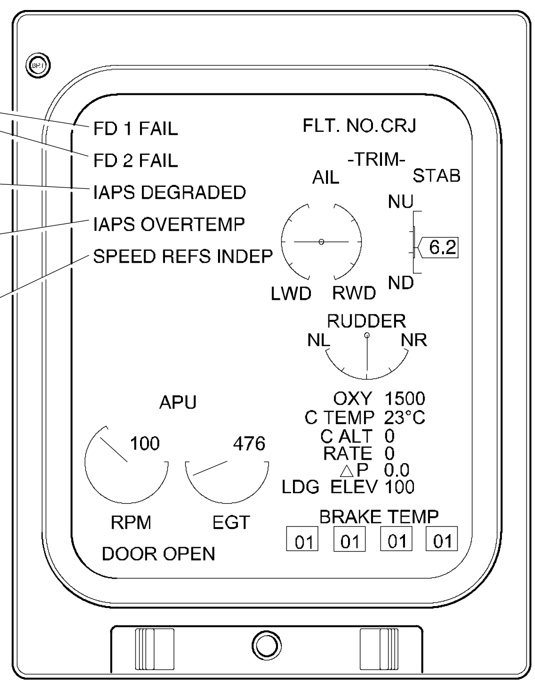
AFCS MSG FAIL warning (red)
Indicates all AFCS (IAPS) data busses are invalid.

FD 1 or 2 FAIL status (white)
Indicates that the respective flight director has failed.

IAPS DEGRADED status (white)
Indicates that an IAPS bus has failed.

IAPS OVERTEMP status (white)
Indicates that an IAPS overtemperature condition has been detected.

SPEED REFS INDEP status (white)
Indicates that pilot and copilot vertical–speed selection is not synchronized or air data computer cross–talk has failed.



Status Page

AFCS EICAS Indications <1001>
Figure 03–20–7

G. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Automatic Flight Control System	IAPS	IAPS L	DC BUS 1	1	H1	
		IAPS R	DC BUS 2	2	H1	
		IAPS L FAN	BATTERY BUS		P7	
		IAPS R FAN	DC BUS 2		H3	
		IAPS L AFCS / MDC	BATTERY BUS		P6	
		IAPS R AFCS	DC BUS 2		H2	

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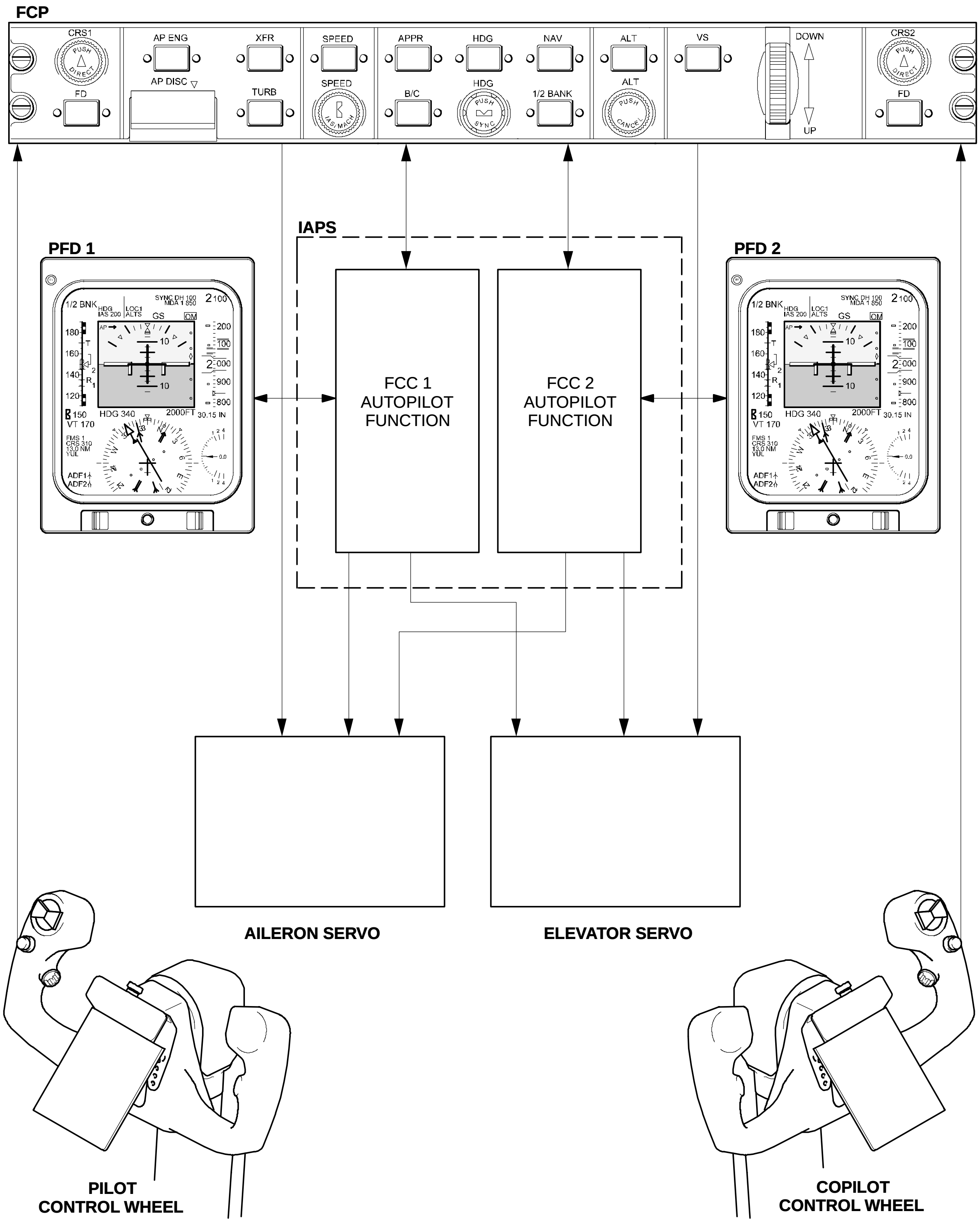
1. AUTOPILOT

The automatic flight control system (AFCS) provides a two axes, digital, fail-passive autopilot. The fail-passive autopilot system is protected against internal single hardware faults and limits any malfunctioning commands to a response that is easily controlled by the pilot. Command inputs to the ailerons and elevators are provided by servos controlled by the flight control computers (FCCs). The FCCs input the yaw damper system to control the rudder. The autopilot controls the aircraft in response to flight director commands by actuating the appropriate control surfaces.

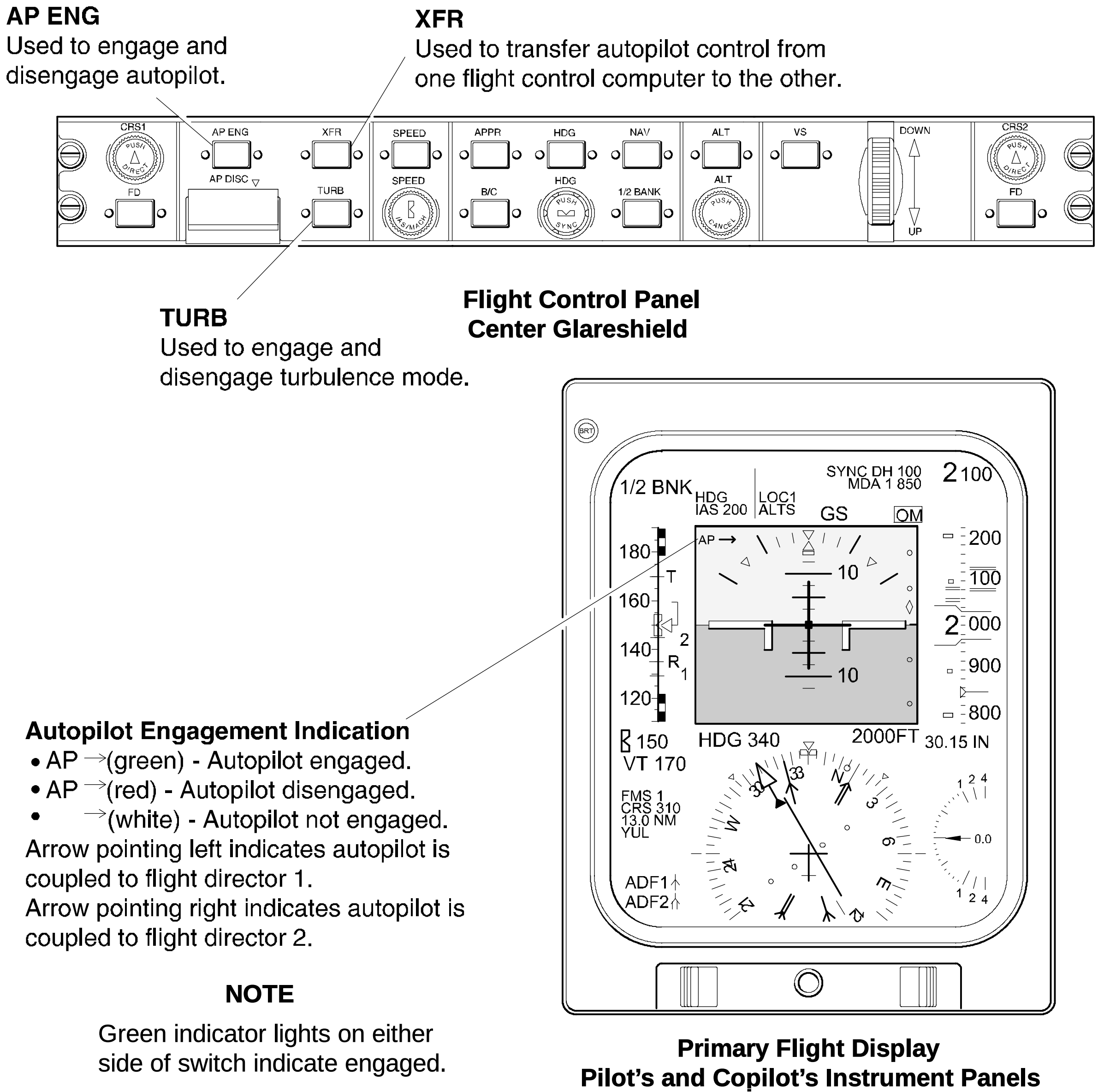
To engage the autopilot, the following is required.

- Both flight control computers must be operative
- At least one channel of the horizontal stabilizer trim is operative
- At least one yaw damper is engaged
- At least one IRS system is operable <1025>
- At least one air data computer (ADC) is operative
- There is no significant instability of the aircraft

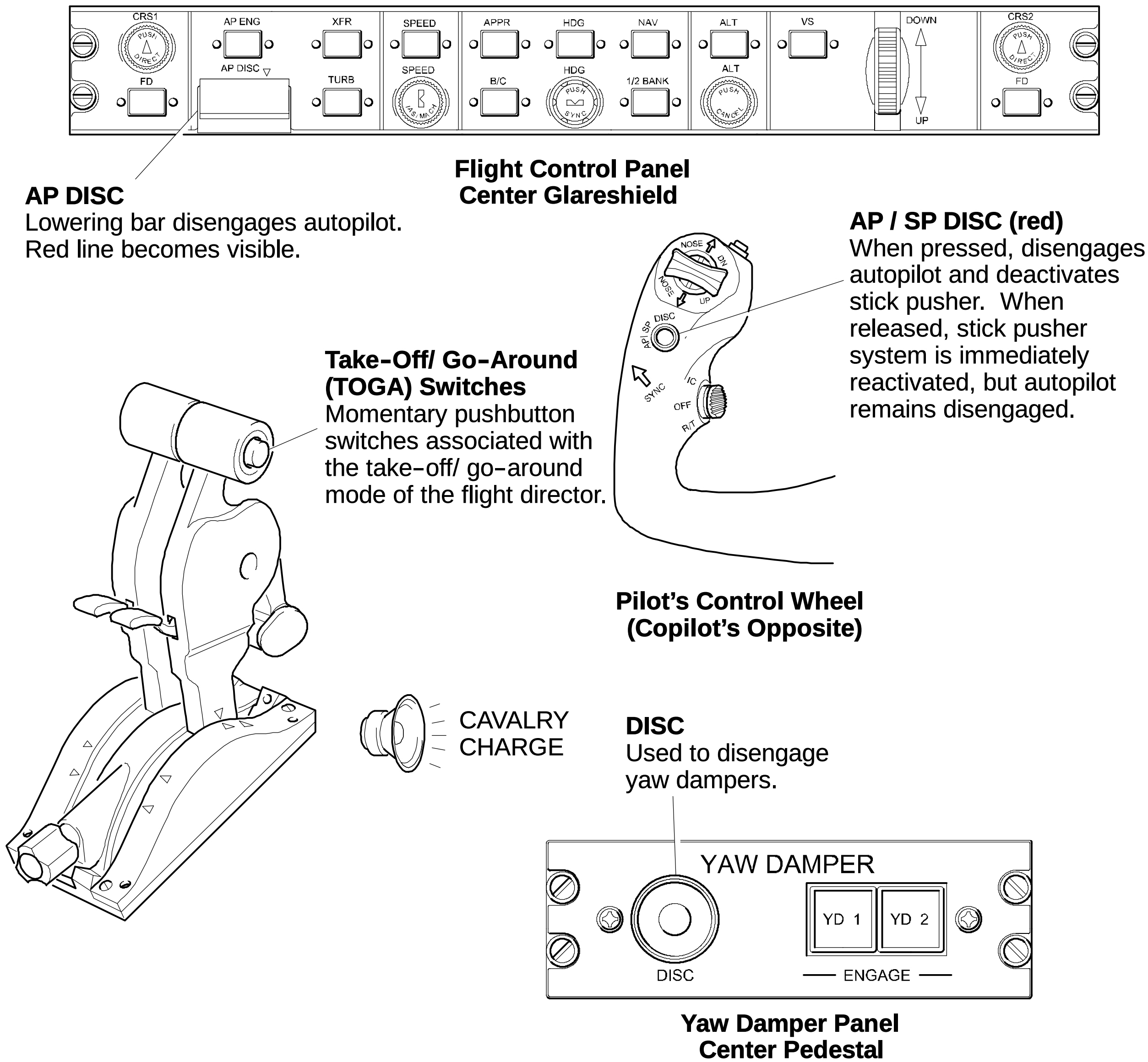
Turbulence mode reduces autopilot gain so that flight control computer response to turbulent flight conditions is slowed and aircraft motion is smoother. On approach, an on-side localizer capture automatically clears the autopilot turbulence mode.



Autopilot Schematic <1015>
Figure 03–30–1



Autopilot – General <1015>
Figure 03–30–2



Autopilot – Controls
Figure 03–30–3

The autopilot can be disengaged manually by any of the following:

- Pushing either AP/SP DISC switch on the control wheels
- Pushing the AP ENG switch on the flight control panel
- Lowering the AP DISC switch-bar on the flight control panel (a red line becomes visible)
- Operating either stabilizer trim switch on the control wheels
- Pressing either TOGA switch on the thrust levers
- Pressing the yaw damper DISC pushbutton on the yaw damper panel

Disengagement of the autopilot causes a cavalry charge aural alert and the AP indication on the primary flight display (PFD) to turn red. The autopilot disengage warning will automatically cancel, after approximately two repetitions of the cavalry charge, when a disengagement is mutually induced.

Automatic disengagement of the autopilot occurs:

- If both yaw dampers are disengaged or fail
- If a failure condition is detected by the FCC monitoring circuits
- If a stall warning occurs
- During windshear avoidance procedures

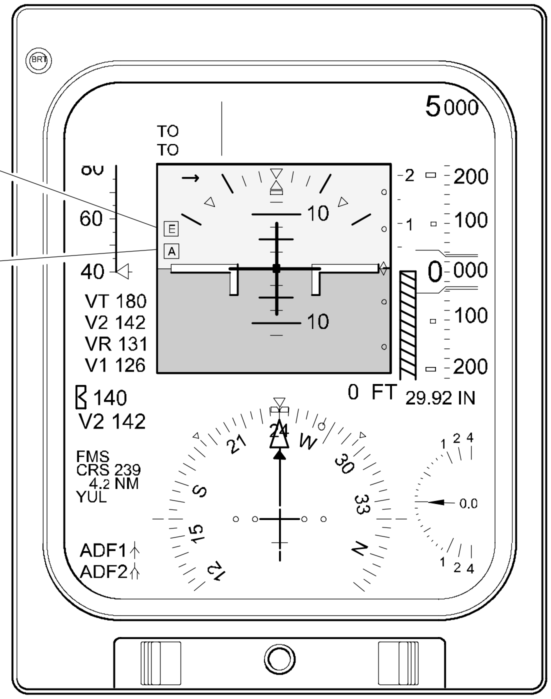
The autopilot is automatically disengaged two seconds after a windshear warning (if the autopilot has not already been disengaged). During those two seconds, the autopilot will follow the windshear commands.

In the event that the autopilot is disengaged due to a system fault, pressing the AP/SP DISC switch or either TOGA switch will cancel the red flashing AP indication on the PFD and silence the aural warning.

The automatic flight control system monitors both axes of the autopilot when engaged. If a control surface is detected to be significantly out of trim, an indication will appear on the PFD and a caution message will be displayed on the EICAS primary page to indicate in which direction that the control surface is out of trim.

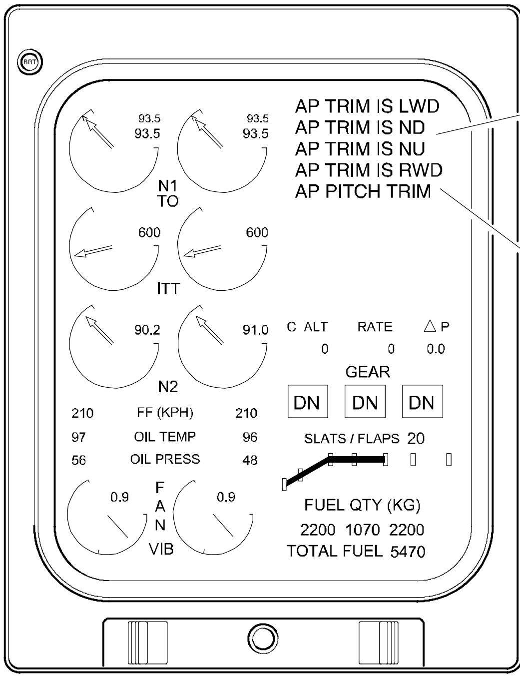
Elevator Mistrim Indicator (yellow)
Indicates that the horizontal stabilizer is in a mistrim condition, when the autopilot is engaged.

Aileron Mistrim Indicator (yellow)
Iindicates that the ailerons are in a mistrim condition, when the autopilot is engaged.



Primary Flight Display
Pilot’s and Copilot’s Instrument Panels

Autopilot – PFD Flags <1015>
Figure 03–30–4



AP TRIM IS LWD, ND, NU or RWD caution (amber)
Indicates that a significant mistrim has been detected.
- LWD - Left wing down
- ND - Nose down
- NU - Nose up
- RWD - Right wing down

AP PITCH TRIM caution (amber)
Indicates that autopilot pitch trim has failed.

Primary Page

Autopilot – EICAS Messages <1001>
Figure 03–30–5

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CHAPTER 5 – COMMUNICATIONS

LIST OF ILLUSTRATIONS

RADIO COMMUNICATION SYSTEM

1. INTRODUCTION

The communications system consists of the following:

- Audio Integrating System
- Announcement and Boarding Music System <1035>
- Radio Communication System

Two radio tuning units are used to frequency tune the radios. A back-up standby tuning unit is provided in the event of a failure of one of the radio tuning units. The audio integrating system receives inputs from the radios and the intercom/interphone systems. The system then provides audio output to the flight crew speakers, headsets, passenger address system, communication radios and recorders. All incoming, outgoing and internal communications are recorded on the cockpit voice recorder.

The flight crew intercom system permits communications between stations within the aircraft, selection and monitoring of audio on the communications and navigation receivers, and selection for transmission on the communications transceivers. The flight crew can select and monitor the audio output of one or more communications transceivers and navigation receivers.

Individual speakers, installed above the pilot and copilot, are used to monitor audio selected at the audio control panels. Hand microphone jacks are installed at the rear of each control column. Headset jacks are installed below the pilot's and copilot's side consoles and the right side of the observer's station.

The service interphone system provides intercommunication between various service and maintenance areas and the flight compartment. The service interphone and passenger address systems are interconnected. The flight attendants use their telephone-type handsets for both systems. One handset is located on each attendant's panel. Switches located on the interphone control panel in the flight compartment centre pedestal, access the external maintenance interphone stations and flight attendant's handsets.

The passenger address system enables the pilots and flight attendants to address passengers through speakers located throughout the cabin and in the lavatory.

The announcement and boarding music system provides voice messages and music through the passenger address system. <1035>

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1. AUDIO INTEGRATING SYSTEM

The audio integrating system provides display, switching and control of all incoming and outgoing audio signals from the aircraft navigation and communication systems. The audio integrating system receives inputs from various radio sources and from internally generated audio systems. The system provides audio output to the flight crew speakers, headsets, passenger address system, communication radios and to the cockpit voice recorder.

A. Audio Control Panels

Three audio control panels, located in the centre pedestal, provide the primary interface between flight crew and audio system. Each audio control panel provides a rotary transmit switch for selection of communication transceivers, interphone/service and passenger address systems.

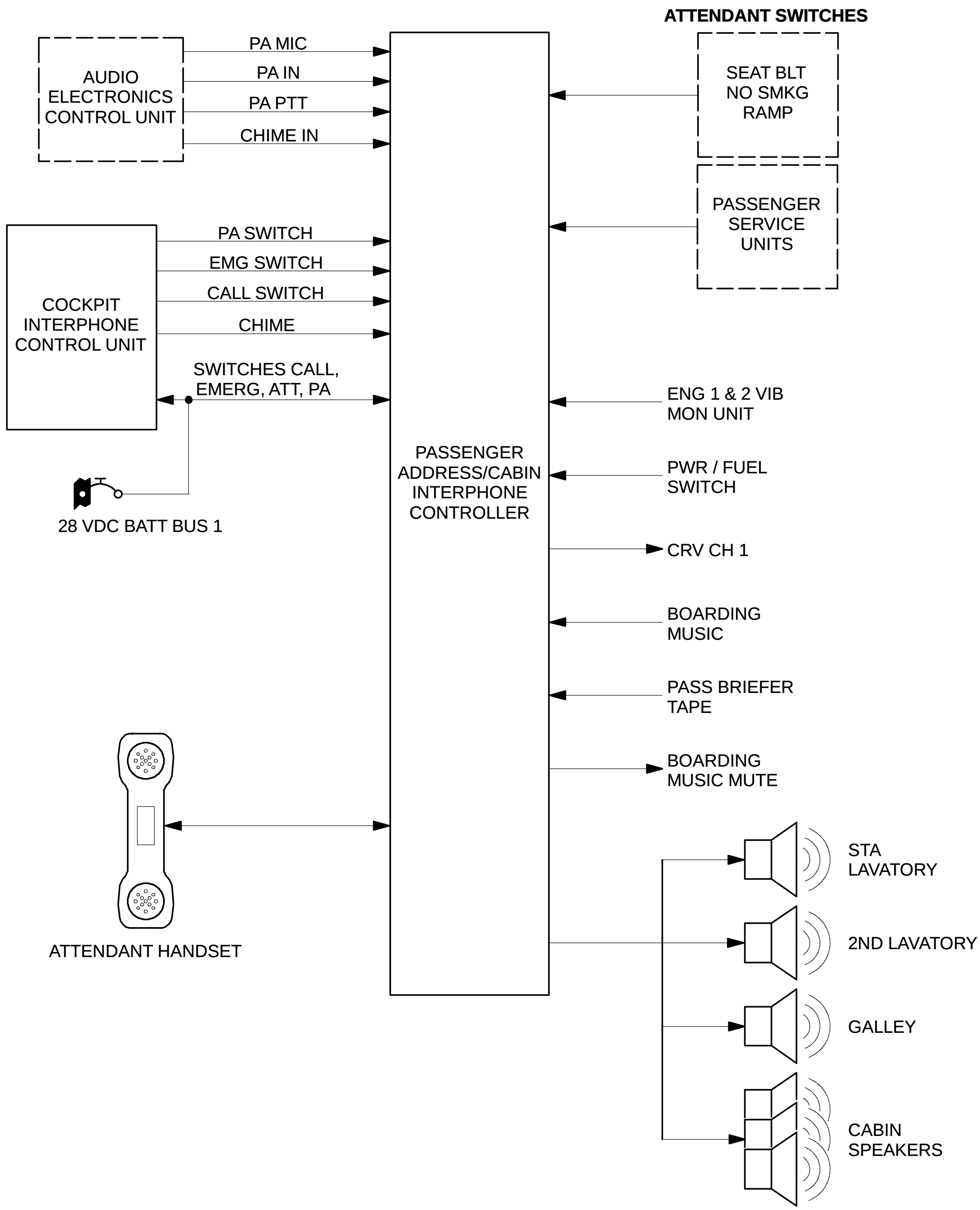
Audio from the selected system is enabled by pressing the corresponding pushbutton and adjusting the desired volume. A switch and a potentiometer are combined in each pushbutton. Audio sources selected on the audio control panel can be routed to the flight compartment speakers by pressing in the speaker switch. Speaker volume is controlled by rotating the speaker control.

A radio transmit (R/T) and intercom (I/C) switch is used to transmit on the radios or passenger address system. The R/T position, when pressed, allows the pilot to transmit. When released, it returns to the OFF position, to receive. Continuous (“hot mike”) conversation is provided in the I/C position for the intercom systems. A radio transmit (R/T) and intercom (I/C) switch is also provided on each pilot control wheel.

Selecting VOICE on the VOICE/BOTH switch eliminates the station Morse code identifier from VOR, ILS and ADF received signals. The MASK/BOOM switch gives the flight crew a choice between headset with boom mike (or hand mike) with BOOM selected, or the oxygen mask microphone, when MASK is selected.

During normal operation, the latching EMER/NORM switch is in the NORM position. The EMER position is used only when the audio integrating system fails. The EMER/NORM switch is disabled at the observer’s station.

When the pilot’s audio control panel EMER/NORM switch is set to EMER, the pilot’s headset is connected directly to NAV 1 navigation radio and VHF 1 communication radio. Most of the system is bypassed making most audio control panel functions inoperative. Cockpit speakers are disabled and all warnings and tones are heard through the headsets. The observers station, passenger address and interphones are disabled in emergency mode.

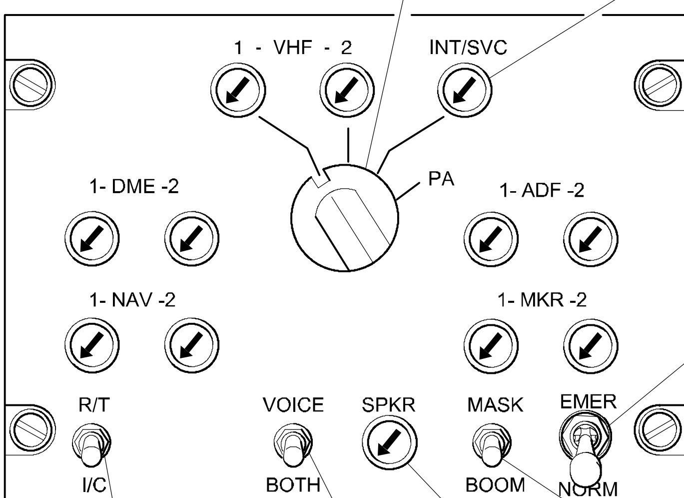


Passenger Address System Interface Diagram
Figure 05–20–1

Transmit Selector
Selects desired communications system and energizes channel. Only one channel at a time may be selected.

Receive Pushbuttons
Press to monitor respective navigation or communication system. Press again to deselect. Switches are lit when pressed. Any number of audio sources can be monitored at the same time. Rotate clockwise to increase volume.

Audio Control Panel
Center Pedestal



EMER / NORM (Lever–locked)
- NORM – Normal functions.
- EMER – Bypasses audio electronics control unit.
  Pilot has two–way communication on VHF 1, audio on NAV 1 and aural warnings.
  Copilot has two–way communication on VHF 2, audio on NAV 2 and aural warnings.
  Observer has aural warnings only.

NOTE

Inoperative at observer's audio control panel.

MASK/BOOM
- MASK – Oxygen mask microphone of respective station is active.
- BOOM – Boom microphone of respective station is active.

Radio Transmit (RT)
Intercom (IC)
Used to transmit on radios or passenger address system.
- RT – When held, permits communication using headset or oxygen mask microphones.
- IC – Provides hot mic talk through interphone system.

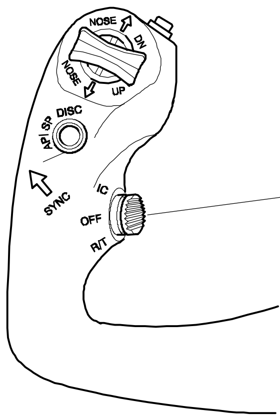
VOICE/BOTH
- VOICE – Station identification is filtered out allowing only voice signals to be audible.
- BOTH – Station identification and voice signals are audible.

SPKR
Press to select and deselect audio on the flight compartment speakers. Rotate to adjust volume.

NOTE

Inoperative at observer's audio control panel.

Audio Control Panel
Figure 05–20–2



Radio Transmit (RT)
Intercom (IC)
Used to transmit on radios or passenger address system.

- RT – When held, permits communication using headset or oxygen mask microphones.
- IC – Provides hot mic talk through interphone system.

Pilot's Control Wheel (Copilot's Opposite)

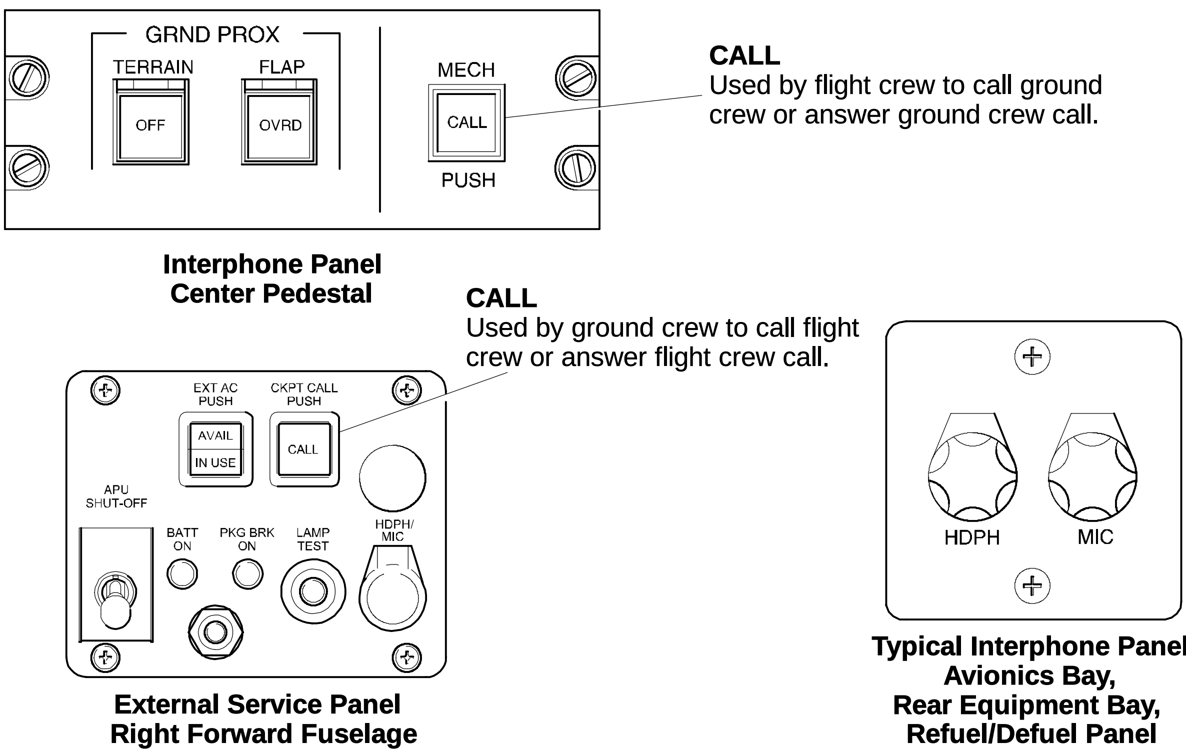
Pilot's Control Wheel (Copilot's opposite)
Figure 05–20–3

B. Ground Crew Interphone

There are four external interphone stations in the aircraft in the following locations:

- External service panel
- Refuel/defuel panel
- Avionics bay
- Aft equipment bay

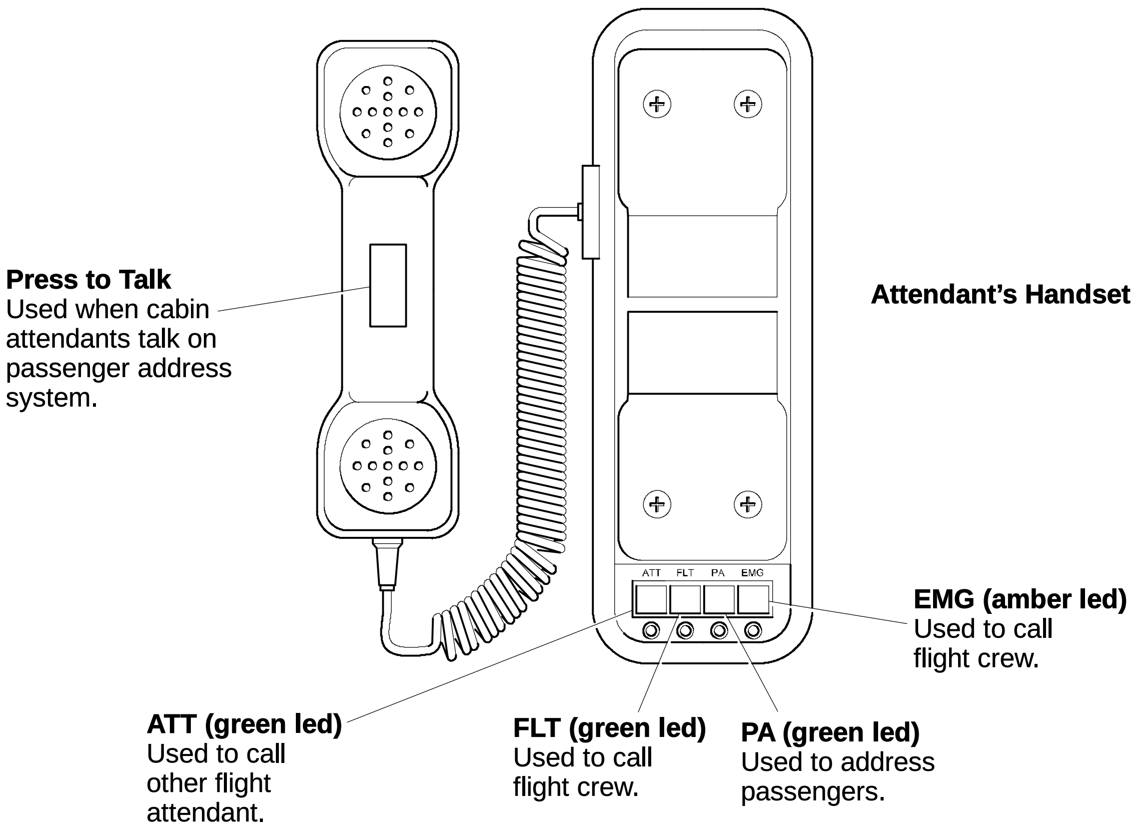
When pressed, the CALL switch on the interphone or external service panels allows either position to call the other. When either switch is pressed and released, both lights are illuminated for 30 seconds and a two tone chime sounds in the aircraft.



GND Crew Interphone <2040,1205>
Figure 05–20–4

C. Attendant’s Handset

Switches on the attendant’s handset cradle and on the intercom control panel, in the flight compartment, are used for routing communications to the crew and passengers. On the handset cradle, the ATT button signals both attendant stations by illuminating the ATT indicators green. To call the flight crew, the attendant removes the handset from the hook and presses the FLT or the EMG button. This will illuminate the CALL or EMER light on the intercom control panel and sound a high-low chime on the flight compartment speakers. When PA is selected on the intercom control panel, and the RT/IC switch, on the control wheel, is set to IC, two-way conversation is established. The galley speaker is muted when a flight attendant’s handset is activated.



Attendant's Handset
Figure 05−20−5

D. Passenger Address System

The passenger address system allows both pilots and flight attendants to make announcements to the passengers.

Cabin speakers are installed in the passenger service unit above each passenger seat. Additional speakers are installed in the lavatories and the galley(s). Volume of the cabin speakers is automatically adjusted for engine background noise.

Pressing in the PA button on the handset cradle and pressing the PTT switch in the handset allows either flight attendant to make an announcement on the PA system. The announcement will interrupt any entertainment system that may be operating. To ensure priority access to the system, all other PA transmissions are overridden when the pilot pushes the PA switch on the intercom control panel.

E. Intercom Control Panel

The intercom control panel is located on the centre pedestal and is used to select one of four communication modes. When a button is pressed the labeled mode is activated and any previous mode is deactivated.

To make an announcement from the flight compartment:

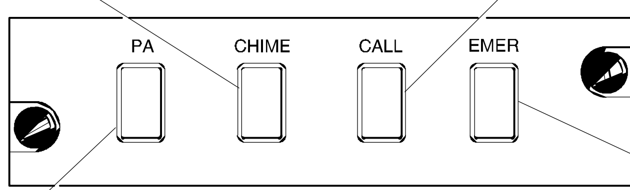
- Set the audio control panel rotary transmit selector to PA
- Press the PA pushbutton on the intercom control panel
- Use any press to talk switch to transmit

The PA indicator light on both flight attendant handset cradles will illuminate (green) and the PA pushbutton on the intercom control panel will illuminate (green).

Pressing the CHIME pushbutton, only sounds a high-low chime in the passenger compartment (there are no indicator lights for this action).

When the CALL is pressed, it illuminates green and sounds a high-low chime in the passenger compartment. The green FLT indicator light on both flight attendant's handset cradles illuminate and a red light comes on in the mid-cabin overhead exit sign.

The EMER button is used to notify the flight attendants of an in–flight emergency. When activated, the EMER indicator light, on the intercom panel, flashes (amber) and a high-low chime sounds. In the passenger compartment, The amber EMG light, at both flight attendant stations, flashes on the handset cradles and a red light flashes on the mid-cabin overhead exit sign.



CKPT Intercom Control Panel
Figure 05–20–6

F. Passenger Service Units

An attendant call button is installed in each overhead passenger service unit. When a passenger activates the attendant call button:

- the cabin speakers sound a high tone chime
- an amber light on the passenger service unit illuminates
- a ceiling mounted call light comes on

When the NO SMKG or SEAT BLTS switch is turned on in the flight compartment, the passenger compartment speakers sound a low tone chime and the NO SMKG and SEAT BLTS lights are illuminated.

G. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Audio Integrating System	Audio	AUDIO PILOT	BATTERY BUS	1	Q6	
		AUDIO C/PLT			Q7	
		AUDIO OBS			Q8	
		AUDIO OBS	DC BUS 2	2	H4	
		AUDIO PILOT	DC ESSENTIAL		V2	
	Interphone	CABIN INPH	BATTERY BUS		Q3	
	Passenger Address	PASS ADDR			Q4	

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1. ANNOUNCEMENT AND BOARDING MUSIC SYSTEM <1035>

The announcement and boarding music system is a source of voice messages and music for the passenger address system. The digital boarding music unit is located in the top of the forward wardrobe. The unit is energized by pressing and releasing the momentary action ON. During power up, the system performs a self test that checks the system components and data file integrity.

System configuration, messages and music are contained in a memory card installed in the unit. The flight crew can not access the card.

Pressing the language/volume key, labeled L/V, activates the language selection mode. The up and down arrows and the SEL (select) key may then be used to select up to four languages. The order of selection is the order that the languages will play.

The liquid crystal display (LCD) lists the languages as they are selected. When in play mode, the active (cued) language will be highlighted. If the flight attendant activates a message, the SEL key is inhibited for the duration of the message.

After pressing the A (announcement) key, the up and down arrows and the PLAY key may be used to scroll up and down the list of available message and music files and select a particular group of messages to be played.

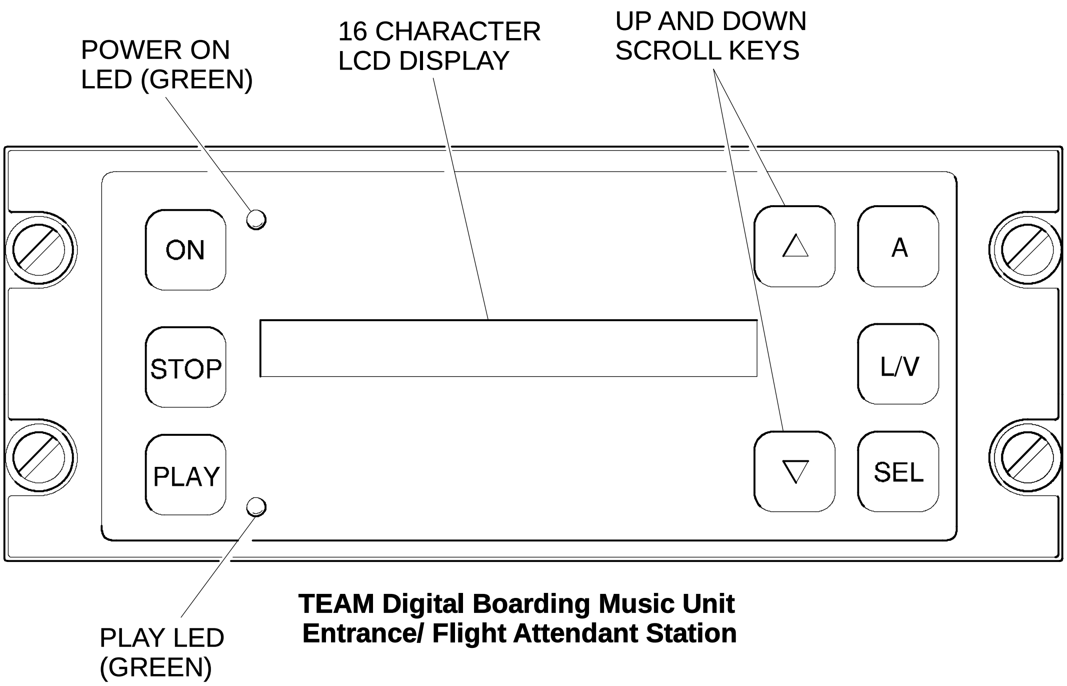
The selected message or music group name will appear on the LCD and the first cued up message will be highlighted. Music can be selected by scrolling through the displayed titles and pressing the SEL key. The PLAY key will cause the highlighted file, message or music, to be broadcasted. When no music is selected for three minutes, the system defaults to announcement mode.

In play mode, selecting the L/V key will allow the user to adjust the volume of the broadcast by pressing the up and down arrows. The broadcast can be interrupted by pressing STOP.

A signal from the PSEU (oxygen deployment at cabin altitude greater than 10,000 feet) keys up to three prepared messages. These messages supersede all other system outputs. The music system is, also, muted when a crew member makes an announcement using the passenger address system.

Control Panel Function Keys:

- ON – Turns the system ON and OFF
- STOP – Stops the broadcast
- PLAY – Plays the announcement or music
- A – Announcement, used to enter the Announcement Menu
- L/V – Language/volume used to select the Language Menu or adjust volume
- SEL – Selects the language or music



Announcement and Boarding Music System <1035>
Figure 05–25–1

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Boarding Music System	Boarding Music Unit	BOARD MUSIC	DC BUS 1	1	G3	

1. RADIO COMMUNICATION SYSTEM

Two VHF radio communication systems provide AM voice communication with ground stations and other aircraft. The radios work with the audio integrating system to provide full two way communication. The audio control panels provide selection and control of the audio outputs. <1012>

Transceiver tuning range is 118.000 to 136.975 MHz. Frequency tuning and mode selection is done by two primary radio tuning units (RTU). Frequency tuning can also be done by a backup standby tuning unit or the FMS control display unit.

A. Radio Tuning Unit

The radio tuning units and radio systems have an on-side relationship. RTU 1 monitors and controls COM 1 and RTU 2 monitors and controls COM 2. In the event of total AC power loss or failure of both radio tuning units, the backup tuning unit provides reversionary control of COM 1.

Radio information is presented on two levels of the radio tuning units. The top level page displays the overall status of all radios and allows the operator to make frequency changes. A COM main page provides the means to change frequencies, codes and operating modes.

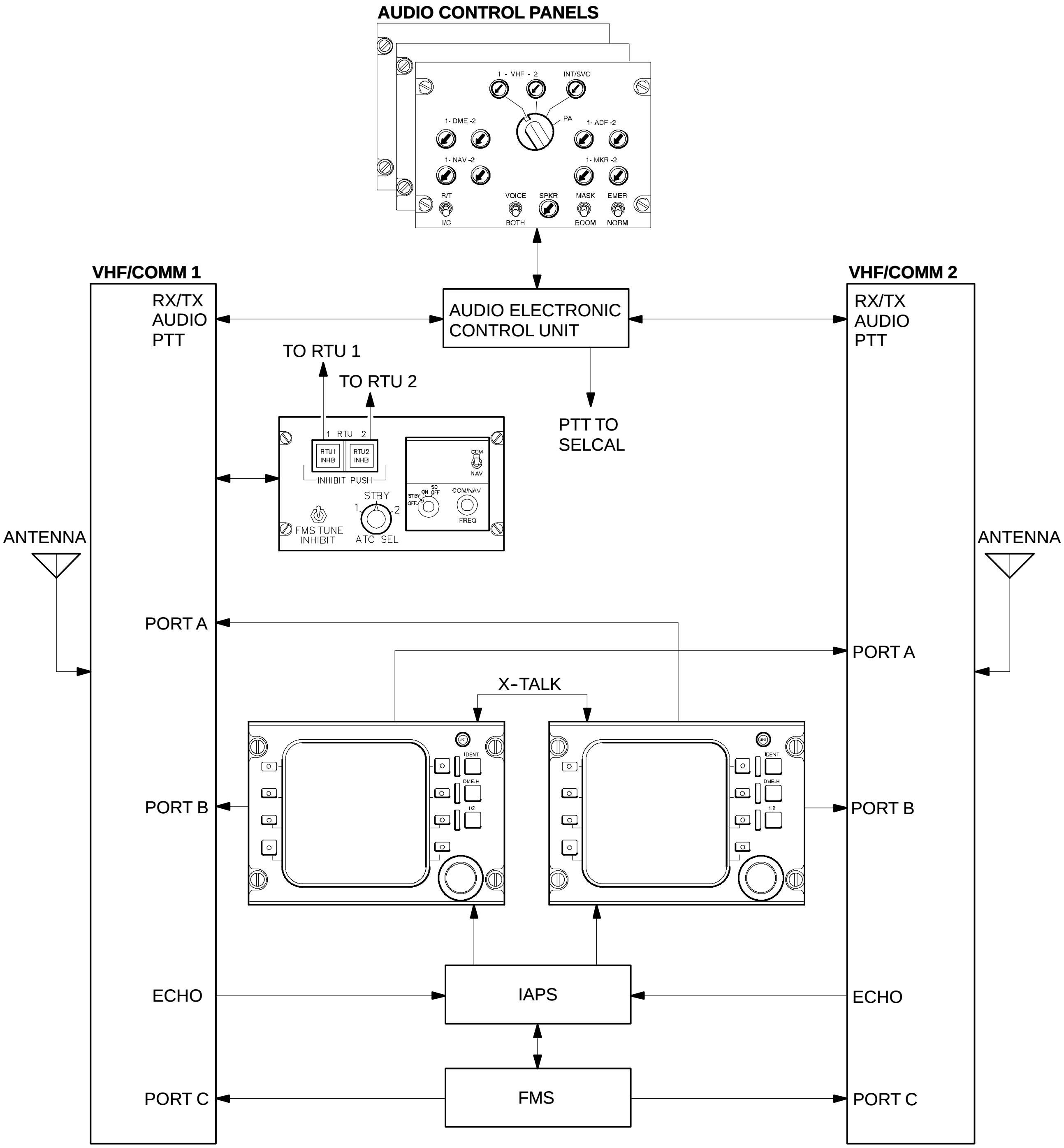
The active VHF COM frequency is shown on the top left hand side of the radio tuning unit top level page, while the preset frequency is displayed on the top right hand side. Pressing the line select key adjacent to any frequency brings the tuning window to that frequency. It is then possible to modify that frequency with the frequency select knobs. Pressing the line select key adjacent to the preset frequency twice, swaps the active frequency with the preset frequency. Pressing the line select key adjacent to the active frequency twice, brings up the COM main page.

On the main page, pressing the line select key adjacent to the SQUELCH field toggles the squelch ON or OFF. The selected state is displayed in large cyan letters. The inactive state is displayed in smaller white letters.

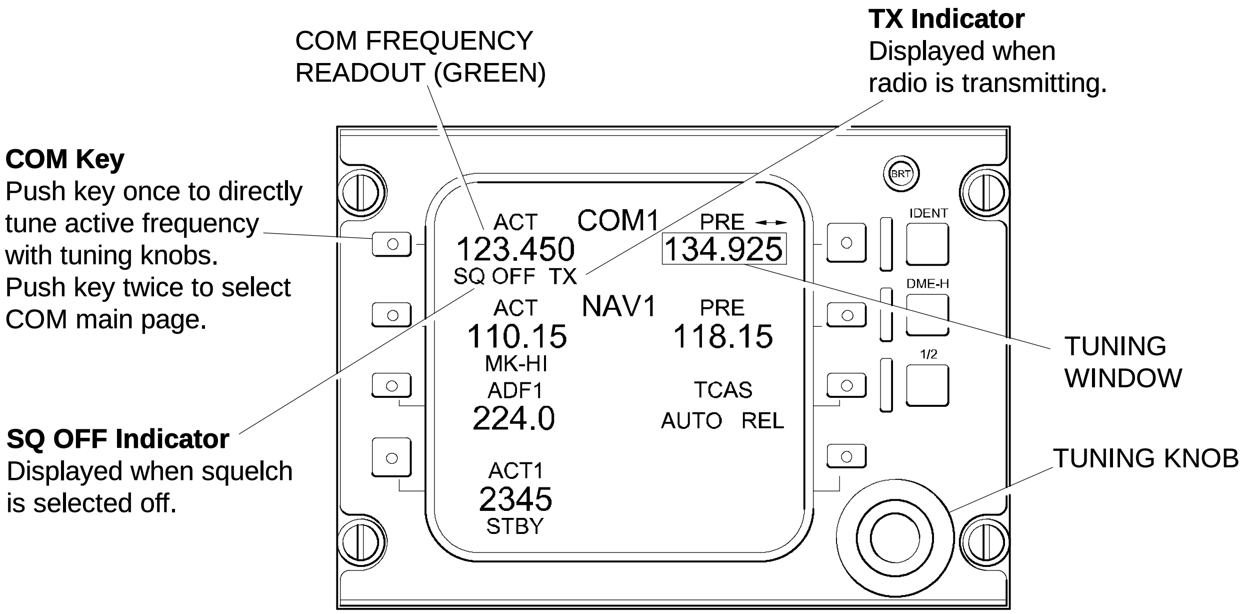
If no entry is made on the main page within 20 seconds, the radio tuning unit display will return to the default top level page. The operator can press the line select key next to the RETURN line to return to the top level page at any time.

If the squelch is selected OFF, a SQ OFF message is displayed on the top level page. Since Squelch ON is considered the normal operating mode it is not displayed on the top level page. When a COM transceiver is transmitting, a TX annunciation is displayed in cyan letters below and to the right of the active frequency field on the top level page.

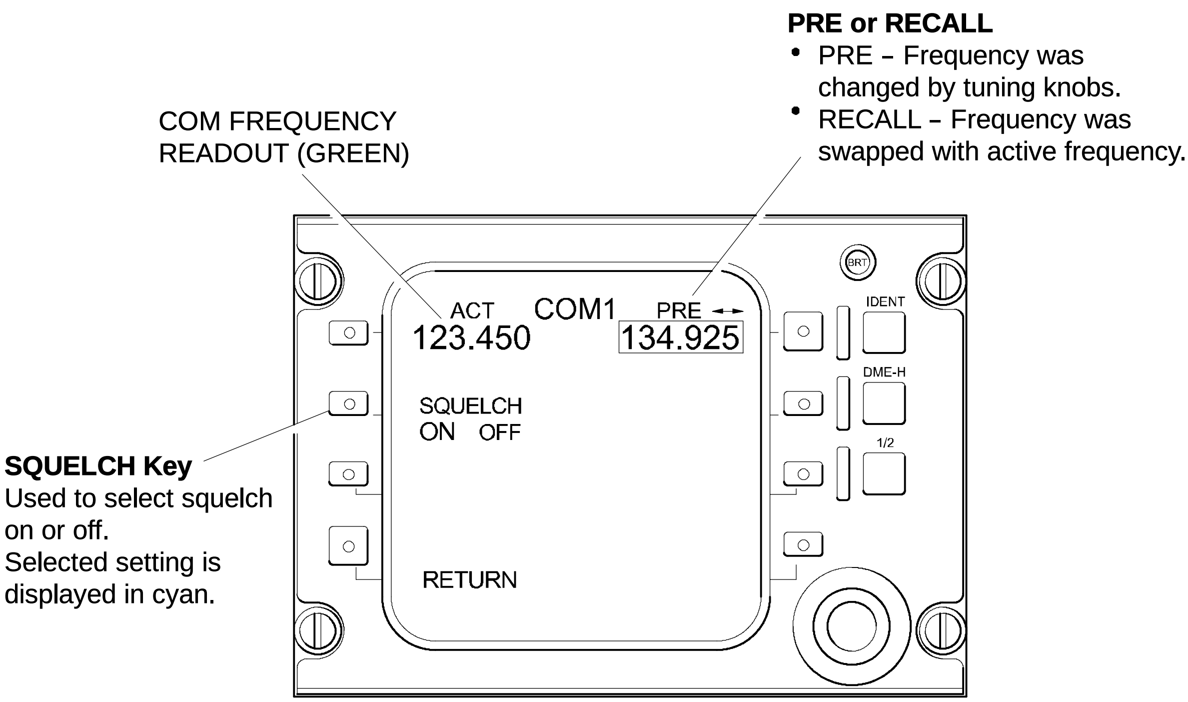
The radio tuning units continuously monitor the status of the VHF COM transceivers and if any discrepancy is detected between the commanded frequency and the actual tuned frequency, the frequency indication is replaced by white dashes to warn the pilot of the inconsistency.



VHF Communication Interface
Figure 05−30−1



Radio Tuning Unit – Top Level Page
Center Pedestal



Radio Tuning Unit – COM Main Page
Center Pedestal

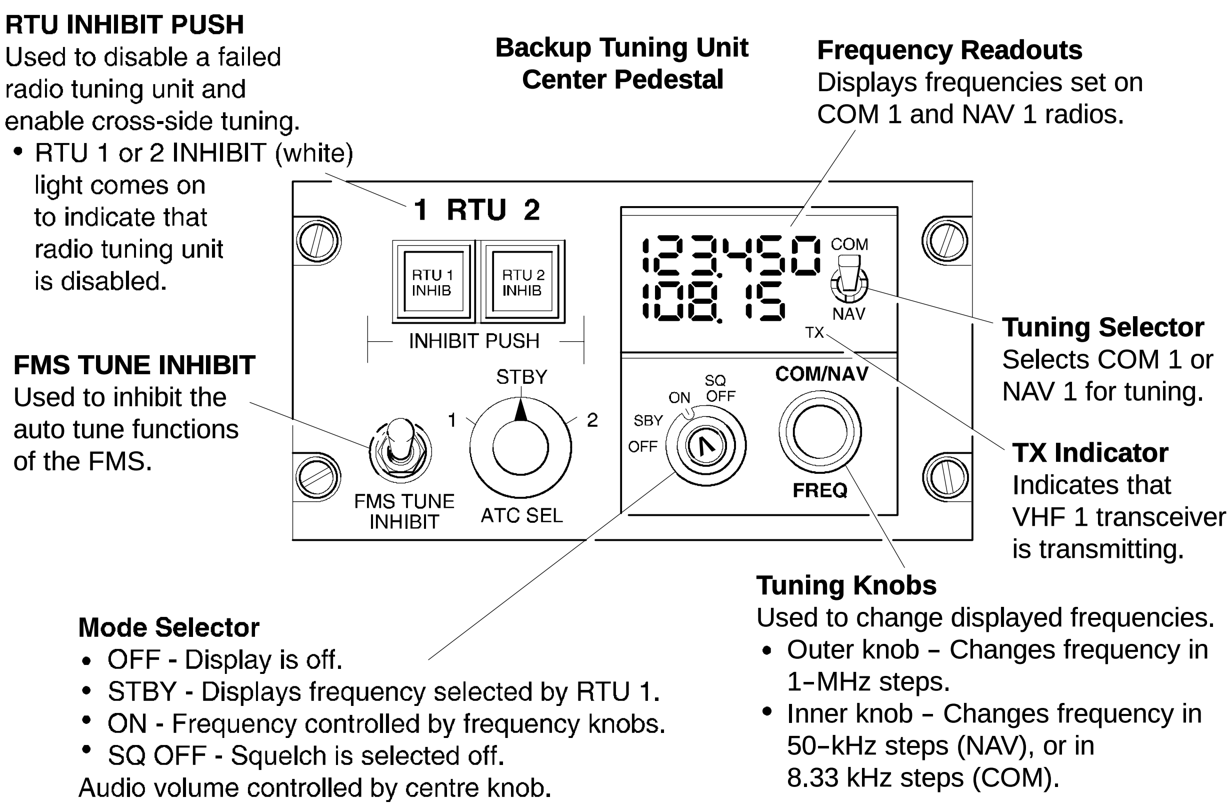
Radio Tuning Unit <1012>
Figure 05–30–2

B. Backup (Standby) Tuning Unit

Under normal conditions the backup tuning unit is in standby mode and acts as a system monitor displaying the echoed frequencies from the radios. The backup tuning unit provides radio control in the event of the loss of both radio tuning units and the flight management system. The active frequencies are stored in non-volatile memory and can be recalled after a power interruption.

When the backup tuning unit is switched on, it takes over control of the left side VHF COM 1 and NAV 1, and overrides all other controls.

Radio tuning unit inhibit switches, on the backup tuning unit, are used to disable a failed primary radio tuning unit. Cross-side tuning can then be accessed by using the 1/2 cross-side key on the serviceable radio tuning unit. Not all available radios can be displayed on the radio tuning unit at once. Switching back and forth with the 1/2 key is required to display all of the radios. When both radio tuning units fail, the displays go blank and cross-side tuning becomes inoperative.



Backup Tuning Unit <1012>
Figure 05–30–3

C. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Radio Communication System	Backup Tuning Unit	EMER TUNING	BATTERY BUS	1	Q4	
	Transceiver	VHF COM 1			Q3	
		VHF COM 2	DC BUS 2	2	H10	
	Radio Tuning Unit	RTU 1	DC ESSENTIAL		U9	
		RTU 2	DC BUS 2		K7	

CHAPTER 6 – DOORS

Page

LIST OF ILLUSTRATIONS

EMERGENCY EXITS

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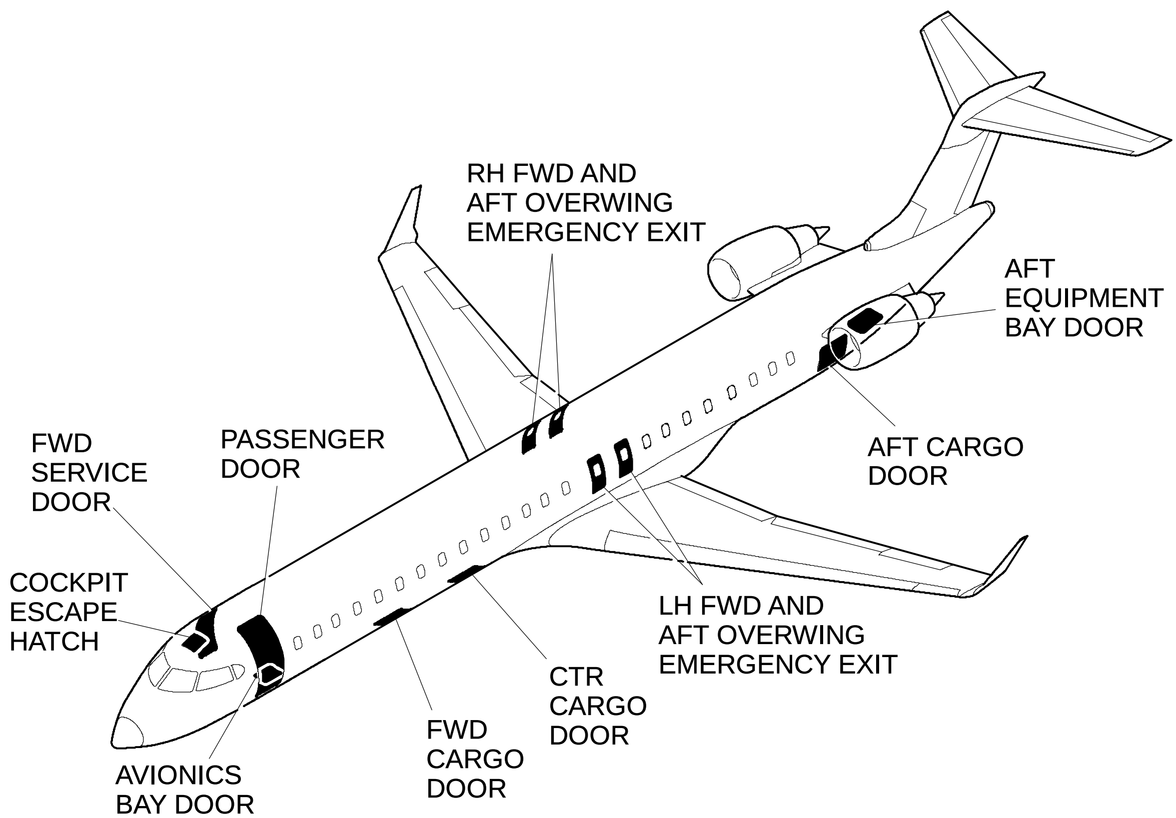
1. INTRODUCTION

The aircraft has 12 doors consisting of the passenger door, the galley service door, four overwing emergency exits, the cockpit overhead escape hatch, three cargo doors, the avionics compartment door and the aft equipment compartment door. The passenger and flight compartment doors can be operated from inside or outside of the aircraft and can also be used for emergency evacuation. The three cargo doors, the aft equipment compartment door and the avionics compartment door can only be operated from outside the aircraft. All doors, except the aft equipment compartment door and the cockpit overhead escape hatch are monitored by the proximity sensing electronic unit which provides the flight crew with door status information on the EICAS. <2224>



Doors – Introduction <2224>
Figure 06–10–1

The doors aural and visual indication system is triggered by signals received from position sensors and switches. Inputs from the position sensors and switches are processed by the proximity sensing electronic unit and transmitted to the EICAS. Door warning and caution messages are displayed on the EICAS primary page and the door status is displayed on the DOORS synoptic page.

A. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Doors	Indication	DOOR IND	DC ESSENTIAL	2	R8	

1. PASSENGER DOOR

The passenger door, located at the forward left-hand side of the fuselage, is the main entrance and exit to the cabin area.

The passenger door incorporates integral stairs with a retractable lower step and folding handrails. The door is hinged at the cabin floor level and opens outward. A counter–balance mechanism with gas springs is used to take the weight of the door and to dampen the door movement At the fully open position, the door rests on a support wheel.

Handrails are provided to assist passengers in boarding and disembarking. Mechanical linkages raise the handrails when the door is opened and collapse them when the door is closed. When jetways are in use, the handrails must be collapsed. Collapsing of the handrails is done by removing the forward and aft handrail quick–release pins (fig 06–20–4).

Closing the passenger door from inside the aircraft is normally accomplished using the power assist system which is controlled from a DOOR ASSIST switchlight on the forward fight attendants panel.

A. Opening the Door from Inside

(1) Lift the inner handle out of its cam recess.

- The outer handle ejects from its recess.
- The latch mechanism unlocks.
- The pressurization flap on the passenger door’s exterior surface opens.

(2) Continue the upward movement of the handle to the OPEN position.

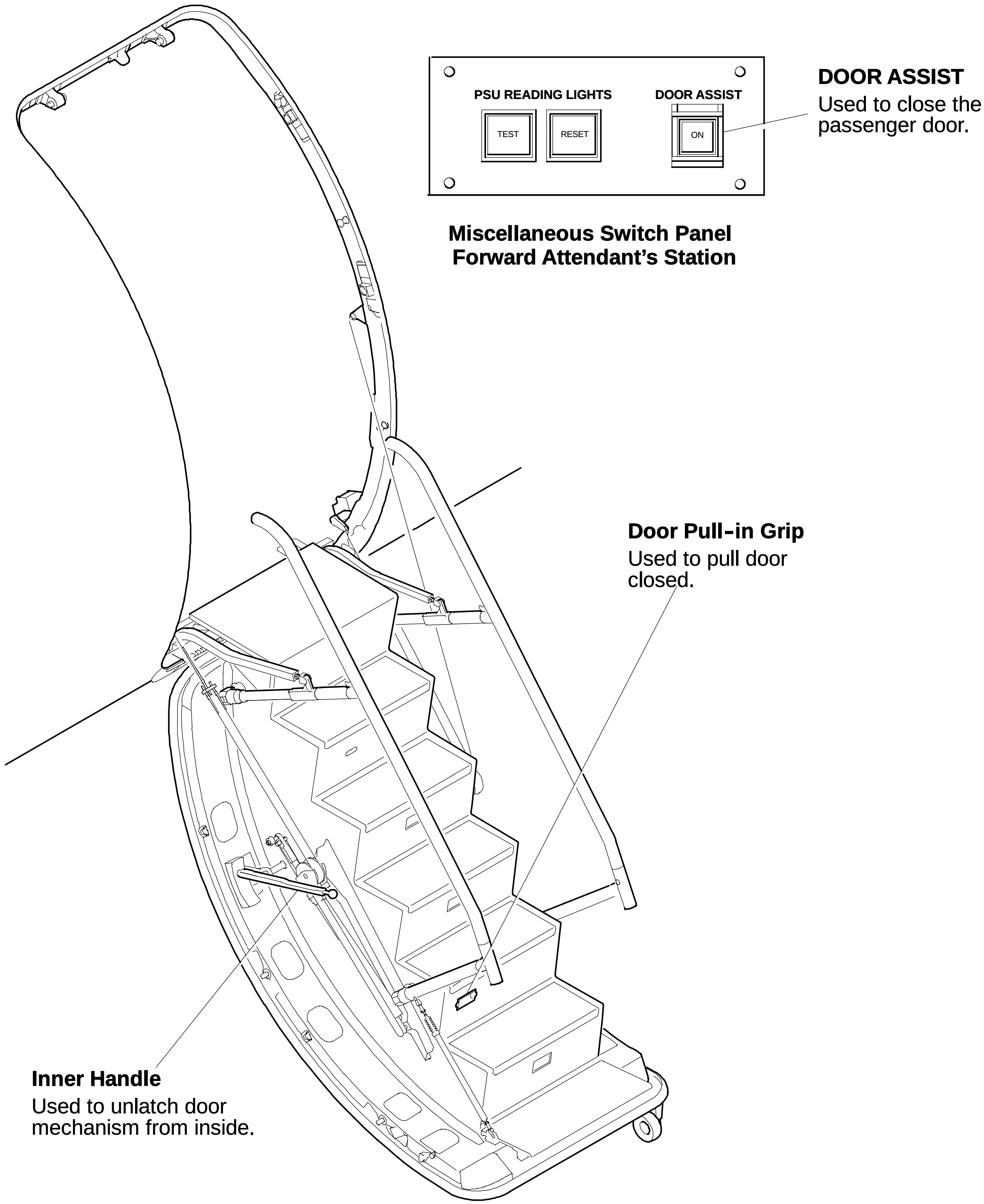
- The latch cams and latch pins disengage from the door frame fittings.
- Fwd and aft pull–out levers open the door to the near vertical (balanced) position.

(3) Firmly push the door outward.

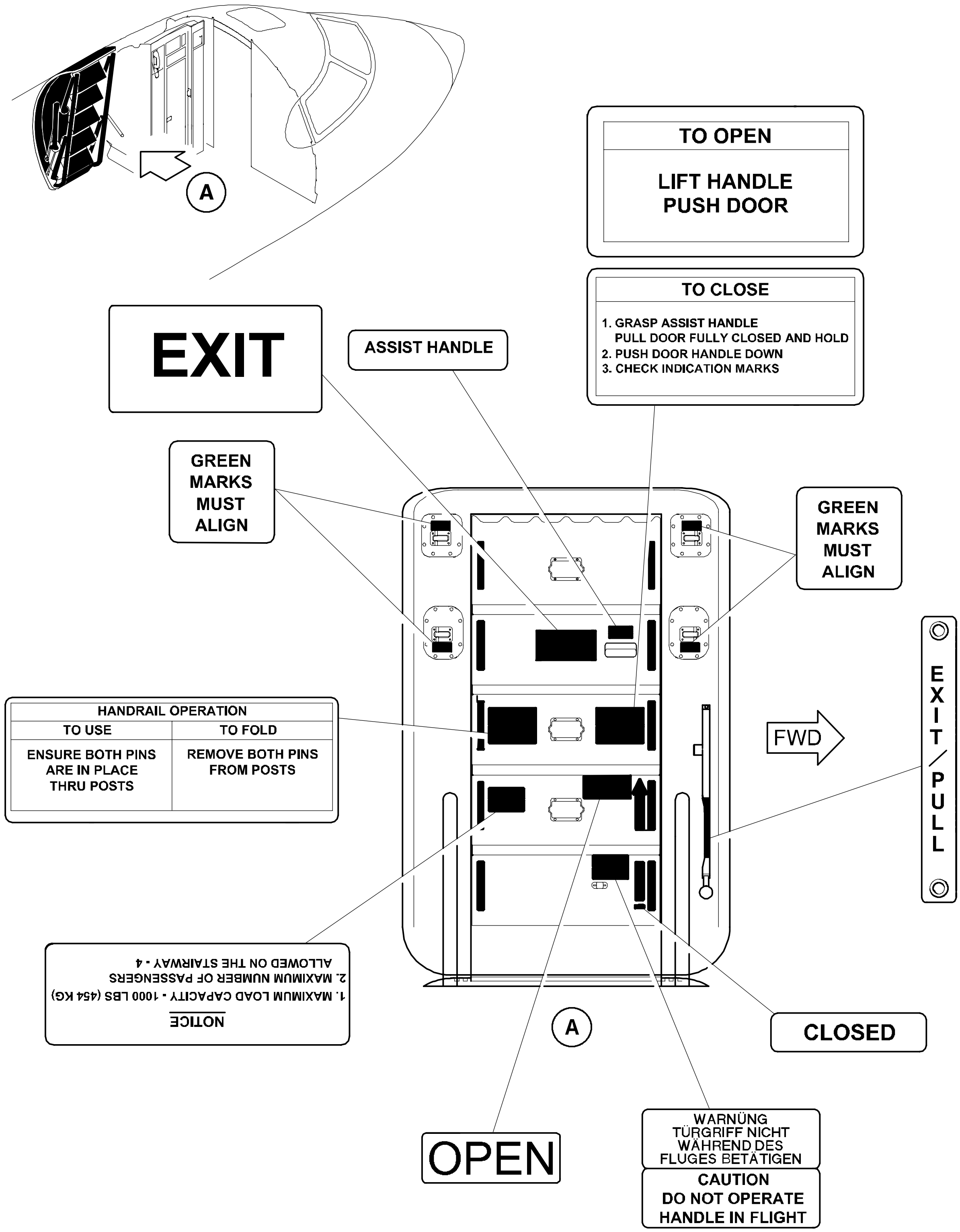
NOTE

Maximum load capacity of the door is 454 kgs (1000 lbs) or a maximum of four passengers on the stairs at any time.

- The door descends in a gradual downward movement (dampened by the counterbalance mechanism gas springs).
- The retractable lower step and folding handrails deploy.
- The door support wheel extends and locks in place before reaching the ground.



Passenger Door
Figure 06–20–1



Interior Passenger Door – Placards
Figure 06–20–2

B. Closing and Latching the Door from Inside

(1) Press and hold the DOOR ASSIST switch on the forward attendant's panel.

NOTE

Do not operate the electrical motor during power switching.

(2) The electrical motor pulls the door up and stops automatically when the door reaches the near vertical position.

NOTE

The cam mechanism under the lower step includes a handle interlock. The interlock is used to prevent the inner handle from moving to the closed position until the door is fully pulled into the fuselage structure.

(3) Grasp the handle in the second step riser and pull the door fully closed.

- The fwd and aft pull-in/push-out levers engage in respective cams to hold the door in this position.

(4) Push the inner handle down to the CLOSED position.

- The latch cams and latch pins engage in the door frame fittings.
- The inner handle, the outer handle and the door vent flap close simultaneously.

(5) Make sure the visual indications of door latches are as follows:

- Green marks on latch cams must align with green marks on door structure (2 locations),
- Green marks on latch pins must align with green marks on indicator windows (4 locations),
- The latch mechanism lower lock indicator flag changes from a red UNLOCKED to a green LOCKED indication.

C. Opening the Door From Outside

(1) Push-in the outer handle push plate, grab the handle grip and pull outward then downward.

- The door latch mechanism unlocks.
- The pressurization flap opens.

- The latch cams and latch pins disengage from the door frame fittings.
- The fwd and aft pull-in levers open the door to near vertical position.
- The door descends in a gradual downward movement (dampened by the counterbalance mechanism gas springs).
- The two folding handrails deploy.
- The support wheel extends and locks in place before reaching the ground.

D. Closing and Latching the Door from Outside

(1) Manually raise the door up and push it fully closed.

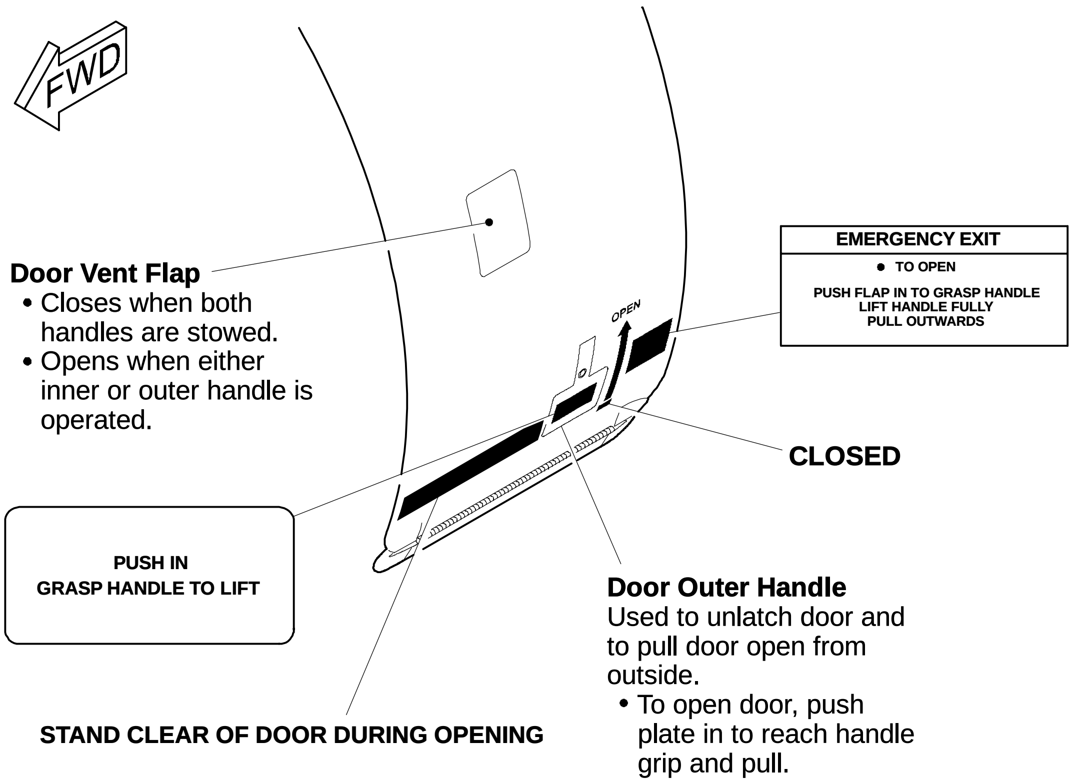
NOTE

The gas springs will assist in retracting the door up to near vertical position.

- The fwd and aft pull-in levers engage in respective cams to hold door in this position.

(2) Push outer handle down fully in its recess.

- The latch cams and latch pins engage in the door frame fittings.
- The inner handle, outer handle and door vent flap close simultaneously.



Exterior Passenger Door – Placards
Figure 06–20–3

E. Lowering the Stair Handrails

When the door is closed,

(1) Remove the two quick–release pins from the holes of the stair handrails.

(2) Stow the quick–release pins in the storage holes of the brackets.

(3) Open the passenger door.

When the door is open,

(4) Hold the stair handrails and remove the two quick release pins from the holes of the stair handrails.

(5) Stow the quick–release pins in the storage holes of the brackets.

CAUTION

Do not use force to lift/lower the stair handrails. Ensure that the bottom step is free to unfold/fold as the stair handrails are gradually lifted/lowered.

(6) Lower the stair handrails and ensure that the clips on the stair handrails attach to the quick release pins.

F. Lifting the Stair Handrails

When the door is open,

CAUTION

Do not close the door without the quick release pins in the storage holes of the brackets or in the holes of the stair handrails.

(1) Remove the quick release pins from the storage holes of the brackets.

(2) Lift the handrails into position.

WARNING

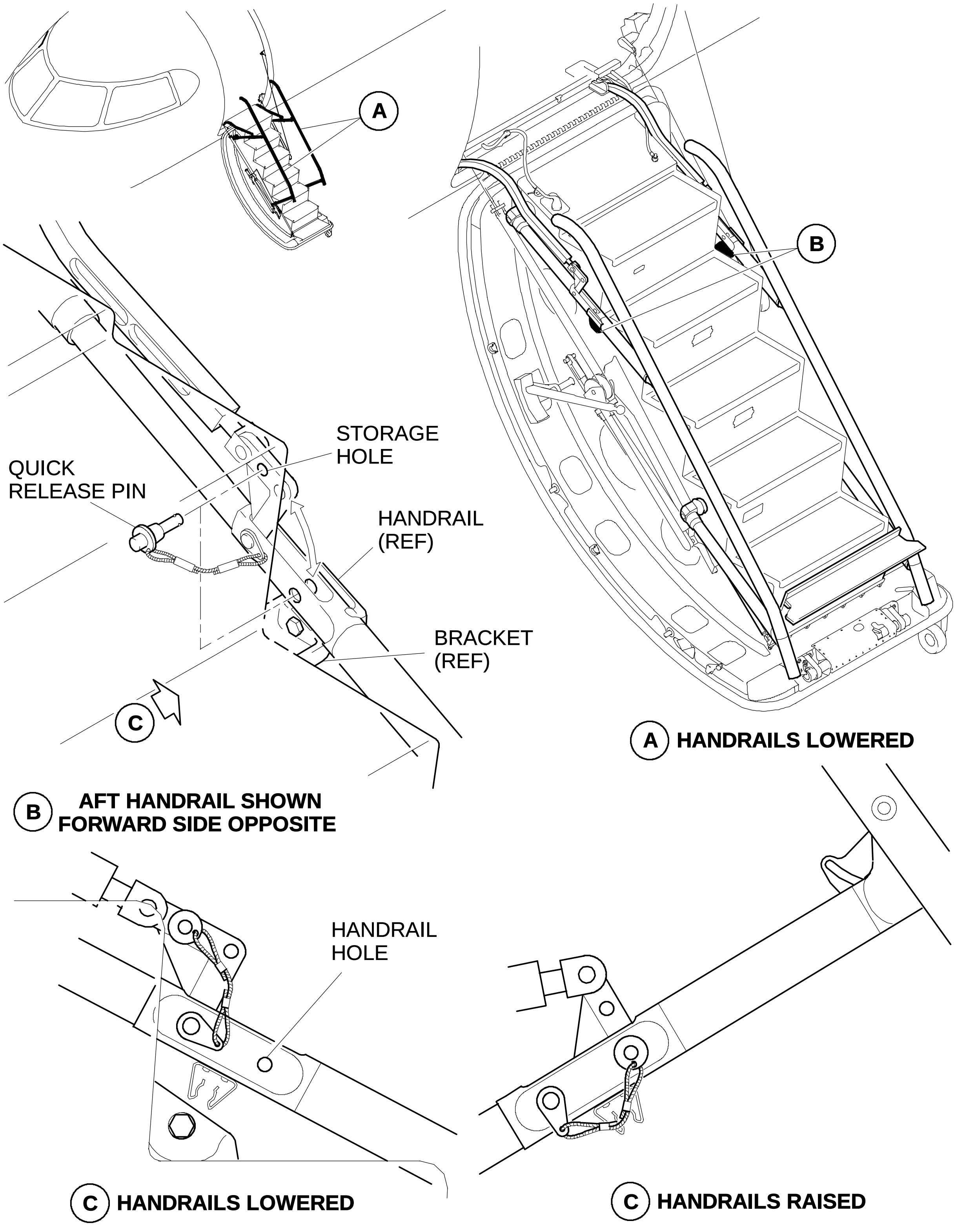
The quick-release pins must be installed in the holes of the stair handrails before you move the airplane. This is necessary so the stair handrail are in the upper position in case of an emergency evacuation.

(3) Install the two quick-release pins in the holes of the stair handrails.

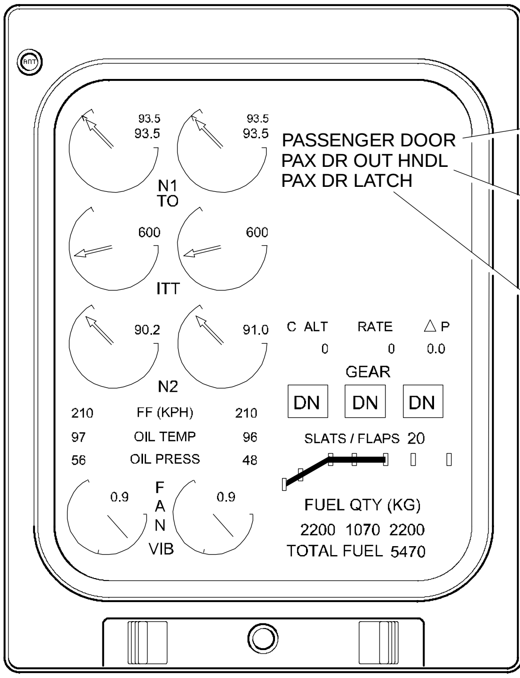
When the door is closed,

(4) Remove the two the quick-release pins from the storage holes of the brackets.

(5) Insert the quick-release pins into the holes of the stair handrails.



Passenger Door – Handrails
Figure 06–20–4



Primary page

PASSENGER DOOR warning (red)
Indicates that the passenger door is unsafe.

DOOR

(when engines are running)

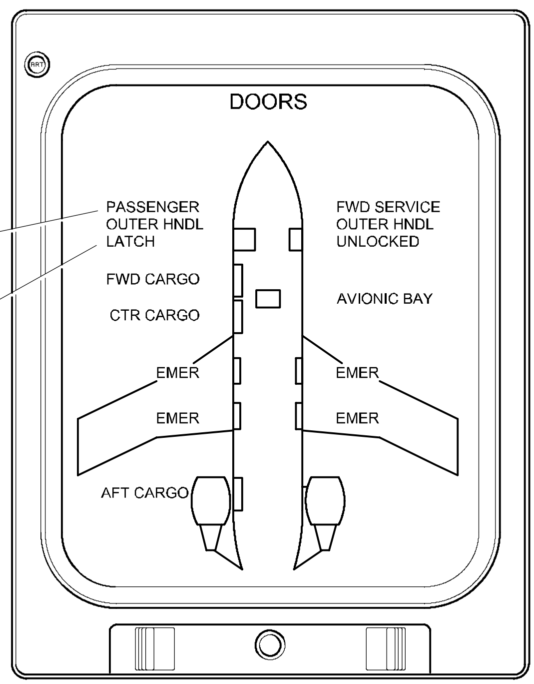
PAX DR OUT HNDL caution (amber)
Indicates that the passenger door outer handle is not stowed**.**

PAX DR LATCH caution (amber)
Indicates that the passenger door is not latched**.**

PASSENGER
Door outline color matches message.
Red – Indicates door is unsafe.
- Amber – Indicates door not latched
- or outer handle is not stowed.

Green – Indicates door is safe.
- Half intensity magenta – Indicates
- door status is unknown.

OUTER HNDL or LATCH (amber)
Displayed when passenger door is not latched or when outer handle is not stowed.



Doors Page

Door EICAS Messages <1001, 2224>
Figure 06–20–5

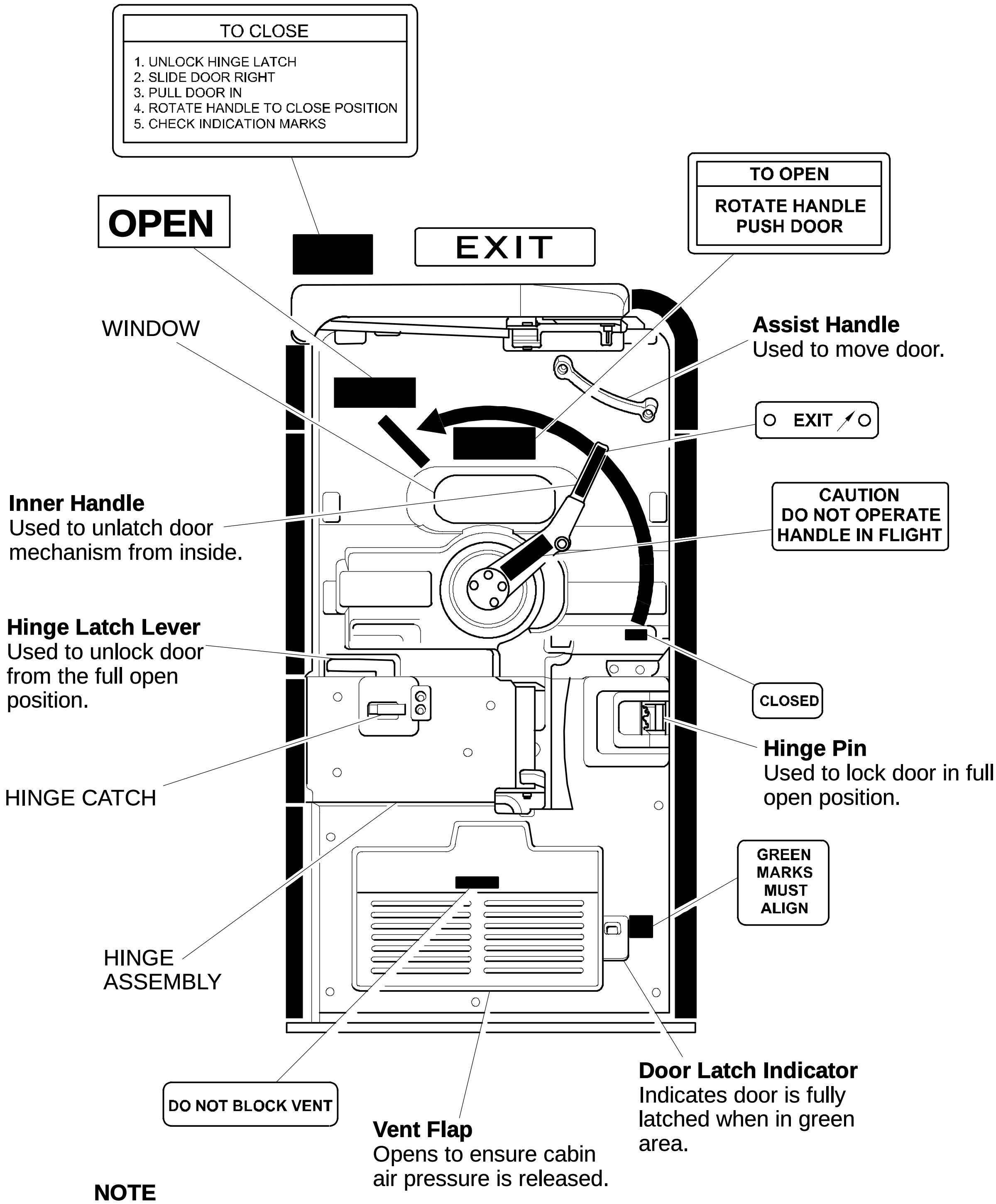
G. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Passenger Door	Actuator	PASS DOOR ACT	DC BUS 1	1	E1	

1. GALLEY/SERVICE DOOR

The galley service door is used for servicing the galley, and can also be used for emergency evacuation of the cabin area. It is located on the right forward fuselage. The outer structure of the door has a window, outer handle and a cabin pressure vent door. The door initially moves upward to clear stops on the fuselage structure, then swings outward and fully forward to the lock open position, parallel to the fuselage. <2224>

The inner door handle rotates counterclockwise to unlatch and clockwise to latch. The outer door handle rotates clockwise to unlatch and counter-clockwise to latch.

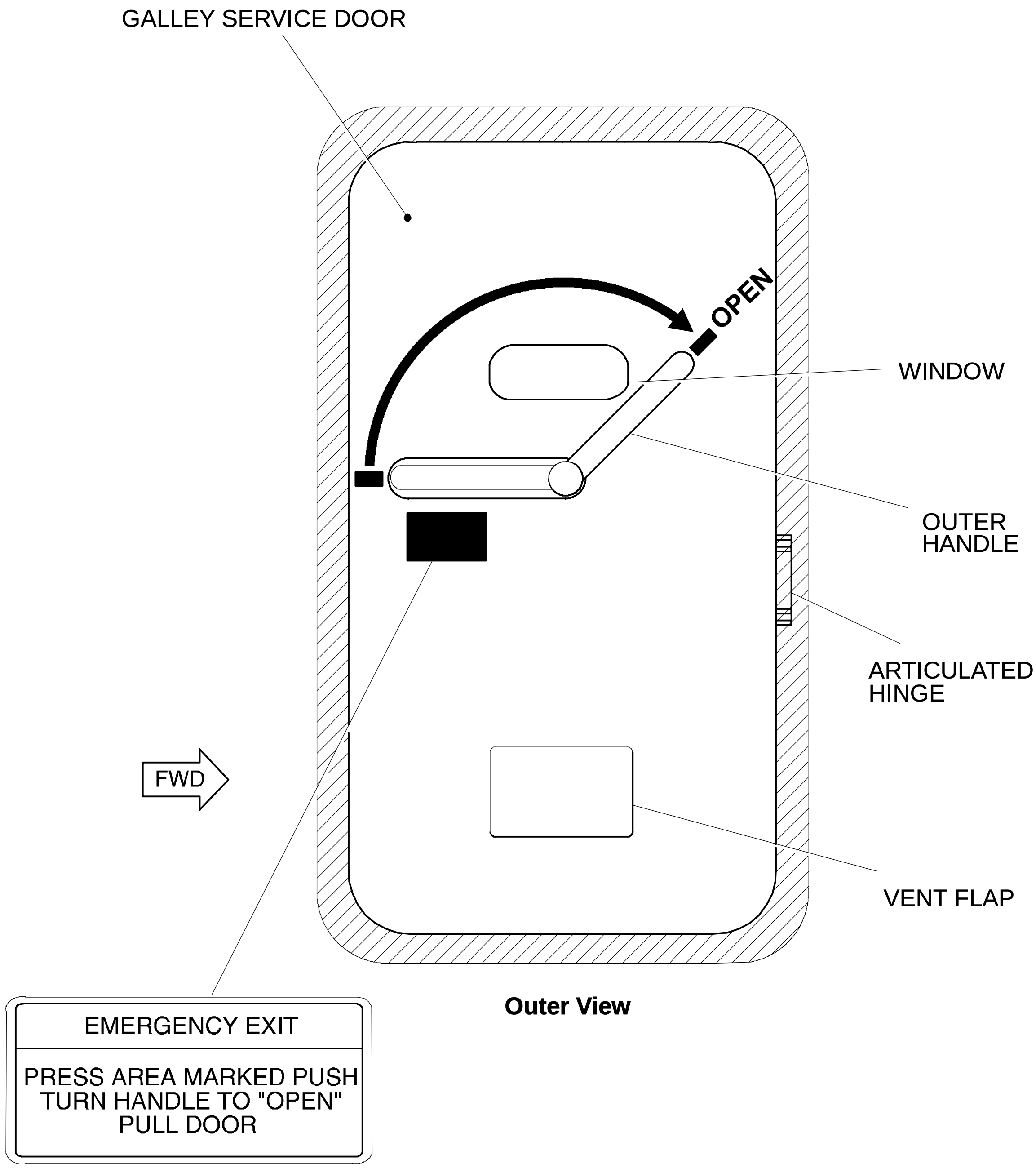


NOTE

Non–radioactive luminescent marker strip installed around door.

Interior Galley/Service Door Placards

Figure 06–30–1



Exterior Galley/Service Door

Figure 06–30–2

A. Opening the Galley Service Door from Inside

To open the galley service door from inside:

- Rotate the inner handle counter-clockwise to the OPEN position.
  - The door moves up, to clear the door stop fittings (guided by door rollers within track fittings).
  - The two lower latches disengage from the door lower frame latch fittings.
  - The vent flap opens.
- Push the door outward and forward until it locks in open position.

B. Closing and Latching the Galley Service Door from Inside

To close and latch the galley service door from inside:

- Pull the hinge latch lever, to release the door from the locked open position.
  - The door moves aft, in front of the door opening.
- Pull the door in to engage the rollers in the door track fittings, then rotate the inner handle to the CLOSED position (clockwise).
  - The door slides down, behind the door stop fittings (guided by door rollers within track fittings).
  - The two lower latch pins fully engage in the door frame latch fittings.
  - The vent flap closes.
- Verify the correct indication of door latch through the indicator window located at the lower aft corner of the door.
  - The green mark on the indicator sector aligns with the green mark on the indicator window.

C. Opening the Galley Service Door from Outside

To open the galley service door from outside:

- Release the outer handle from the door recess.
  - The door latch mechanism unlocks.
  - The vent flap opens.
- Rotate the outer handle fully clockwise to the OPEN position.

  - The door moves up, to clear the door stop fittings (guided by door rollers within track fittings).

  - The two lower latch pins disengage from the door frame latch fittings.

- Pull the door outward and move it forward until it locks in position.

D. Closing and Latching the Galley Service Door from Outside

To close and latch the galley service door from outside:

- Pull the latch lever, to release the door from the locked open position.

  - The door moves aft into the door opening.

- Push the door in to engage the door rollers in the track fittings, then rotate the outer handle counter-clockwise to the CLOSED position until it lines up with its recess.

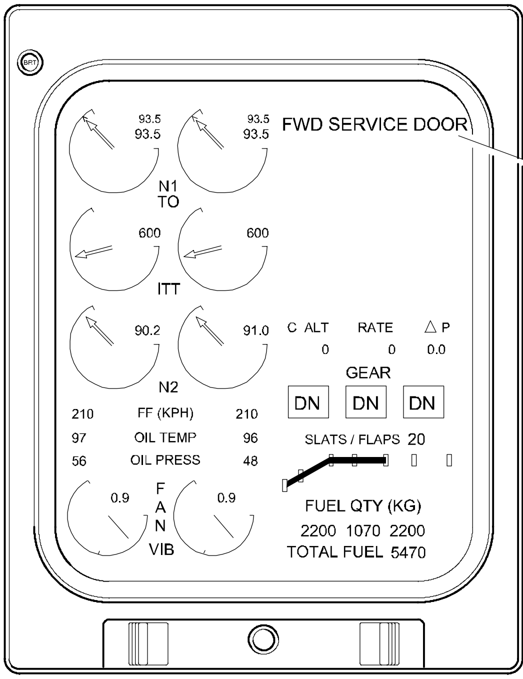
  - The door slides down, behind the door stop fittings (guided by door rollers within track fittings).

  - The two lower latch pins engage in the door frame latch fittings.

- Release the handle.

  - The outer handle springs into its recess.

  - The vent flap closes as the outer handle gets near the end of its travel.



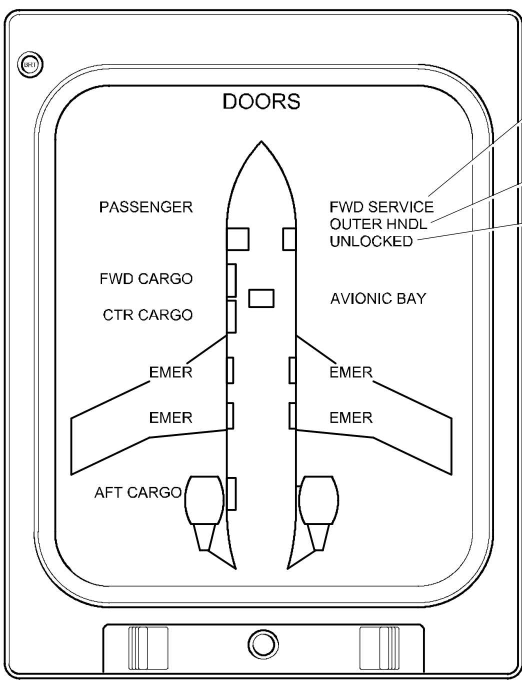
FWD SERVICE DOOR
Indicates that the forward service door is unlockedor outer handle is not stowed.

Primary Page

FWD SERVICE
Door outline color matches message.
- Amber - Indicates door not latched or outer handle is not stowed.
- Green - Indicates door is safe.
- Half intensity magenta - Indicates door status is unknown.

OUTER HNDL (amber)
Displayed when service door outer handle is not stowed.

UNLOCKED (amber)
Displayed when service door is unlocked.



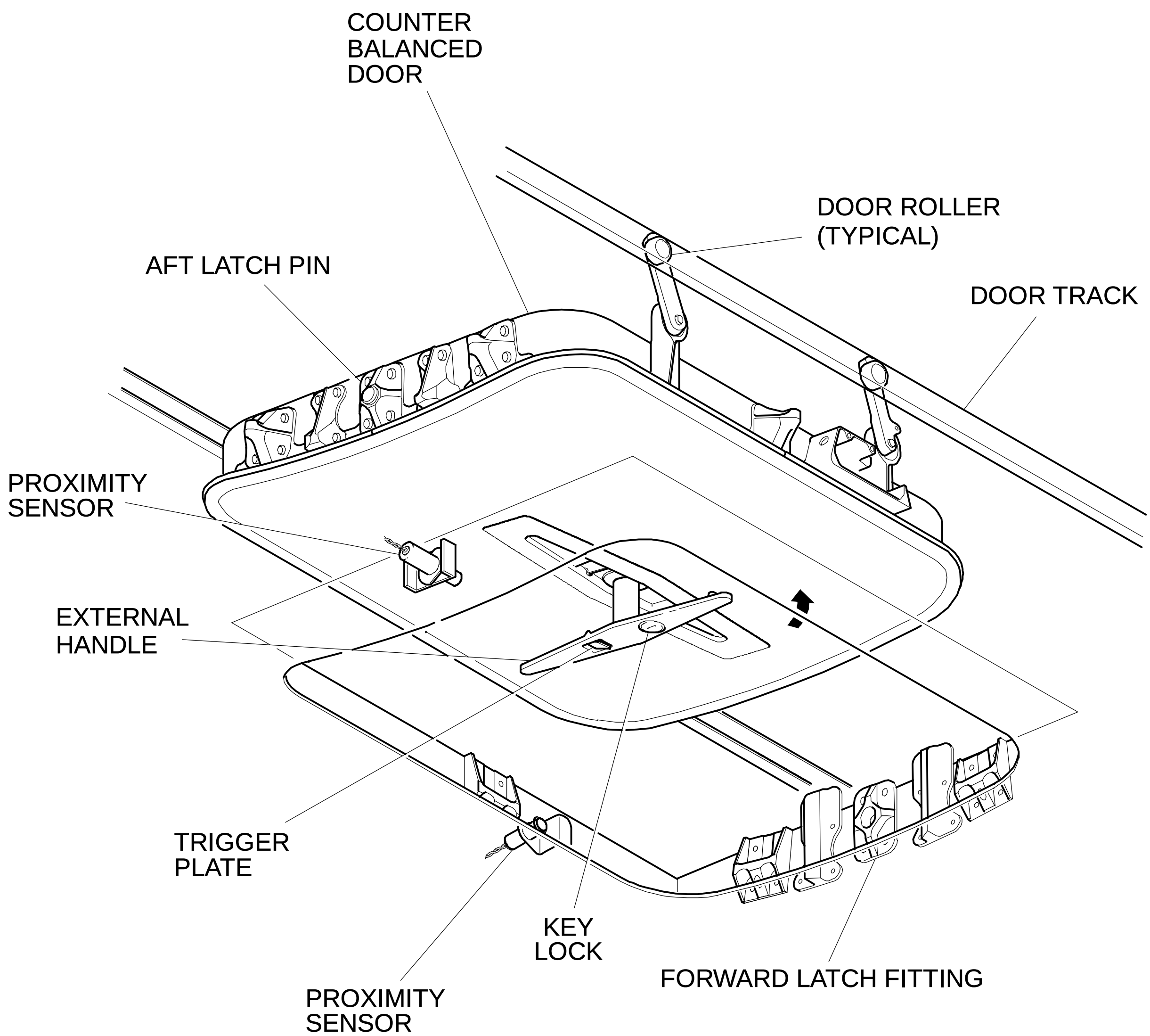
Doors Page

Service Door – EICAS Messages <1001, 2224>
Figure 06–30–3

1. AVIONICS BAY DOOR

The avionics compartment door is used to gain access to the equipment in the avionics compartment. It is located on the centerline of the lower forward fuselage. The door opens inward and moves up on four spring–loaded roller arms. The roller arms engage a set of tracks that allows the door to be moved forward or aft in the avionics compartment. The door does not open from the inside.

The door outer handle is rotated to the OPEN position to unlatch and to the CLOSED position to latch.



Avionic Bay Door
Figure 06–40–1

A. Opening the Avionics Bay Door

To open the avionics bay door:

- Press the outer handle trigger plate.

The handle ejects from the door recess.

- Rotate the handle 90 degrees counterclockwise to the OPEN position.

The fwd and aft latch pins disengage from the door frame latch fittings.

- Push the door up.

A latch on the roller arms locks the door in the up position.

- Rotate the the outer handle to the CLOSED position and push the handle into the door recess.
- Slide the door fwd or aft as required.

B. Closing the Avionics Bay Door

To close the avionics bay door:

- Slide the door above its opening.
- Press the handle trigger plate.

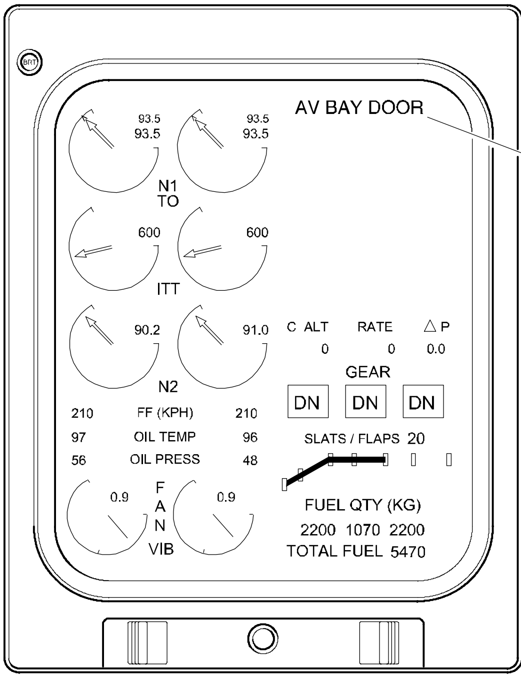
The handle ejects from the door recess.

- Rotate the handle to the OPEN position to release the hold–open latch.
- Pull the door fully down to compress the door seal, and rotate the handle to the CLOSED position.

The fwd and aft latch pins engage in the door frame latch fittings.

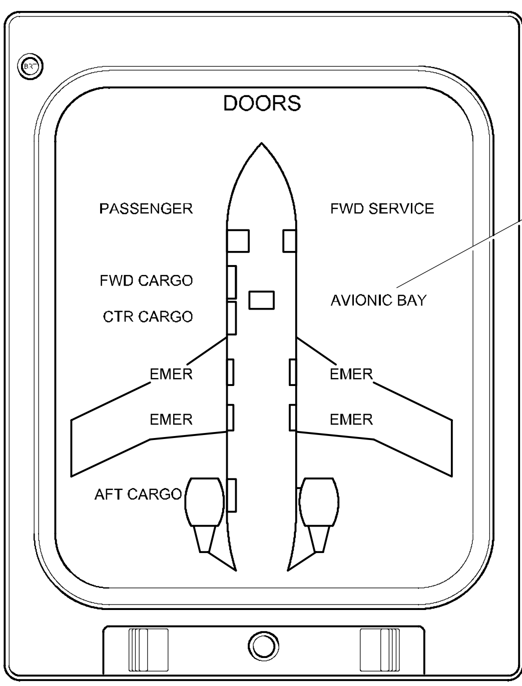
- Push the handle into the door recess.

The door handle locks in the stowed position.



Primary Page

AV BAY DOOR caution (amber)
Indicates that the avionic door is not closed or cam is not locked.



Doors Page

AVIONIC BAY
Door outline color matches message.
- Amber – Indicates door not latched or outer handle is not stowed.
- Green – Indicates door is safe.
- Half intensity magenta – Indicates door status is unknown.

AV Bay Door – EICAS messages <1001, 2224>
Figure 06–40–2

1. CARGO COMPARTMENT DOORS

The aircraft has two cargo compartments and three cargo doors. Access to both cargo compartments is located on the left side of the fuselage. The forward cargo compartment is located below the cabin area, forward of the wing, and has two doors. The aft cargo compartment is located aft of the cabin area. The cargo door handles are operated from the outside only.

A. Aft Cargo Compartment Door

The aft cargo door opens inward, and up inside the upper fuselage. The door movement is assisted by a balance spring and cable system.

The aft cargo door handle is rotated to the OPEN position to unlatch and to the CLOSED position to latch.

B. Opening the Aft Cargo Door

To open the aft cargo door:

- Press the control handle trigger plate.

The control handle ejects.

- Rotate the control handle to the OPEN position (counterclockwise).

The door mechanism unlatches.

The door moves inward, within guiding tracks.

- Manually move the door fully up.

The door moves up, guided by track rollers, and remains in full open position.

C. Closing and Latching the Aft Cargo Door

To close and latch the aft cargo door:

- Manually lower the door.

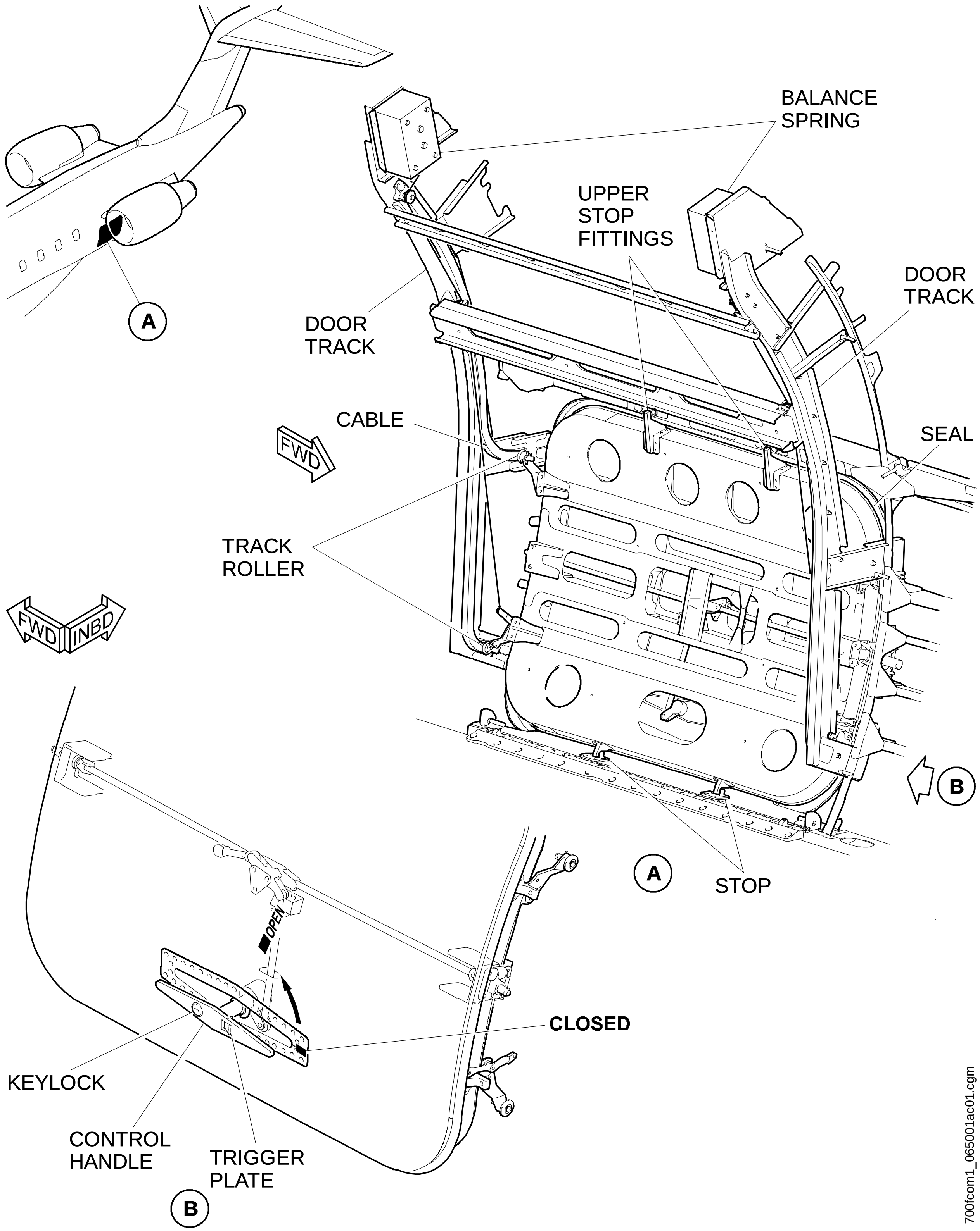
The door moves down, guided by track rollers.

- Pull the door outward against the stops, and rotate the control handle to the CLOSED position (clockwise).

The door mechanism latches as the control handle reaches the end of its rotation.

- Correctly align the control handle with the door recess and push it fully in.

The control handle locks in position.



Aft Cargo Bay Door
Figure 06–50–1

D. Forward Cargo Compartment Doors

NOTE

Although there is only one forward cargo compartment, there are two access doors. One door is refered to as the forward cargo compartment door and the other is refered to as the center cargo compartment door.

The forward and center cargo compartment doors are identical in construction and operation. Each door outer structure incorporates a two part control handle and a vent flap. The doors will initially move inward to clear the door stops, then swing down to the locked open position, parallel to the lower fuselage. Two sets of balance springs assist the door up and down movement.

E. Opening Either Forward Cargo Compartment Door

To open either forward cargo compartment door:

- Press the secondary handle trigger plate.

The pressurization flap opens.

The secondary control handle ejects.

The control handle and its access panel unlock.

- Pull the control handle.

The door mechanism unlatches, and locks in unlatched position.

The door moves in and up to clear the door stops.

- Using the control handle, manually move the door down around the lower fuselage until it latches in the full open position.

F. Closing and Latching Either Forward Cargo Compartment Door

To close and latch either forward cargo compartment door:

- Pull both door open latch levers simultaneously to unlatch the door from the full open position.

The door comes up to its balanced position.

- Using the control handle, manually raise the door upwards until the latch shafts contact their respective roller fittings.

The door mechanism unlocks (from the unlatched position).

- Position the door in front of the door stops, and push the control handle fully in.

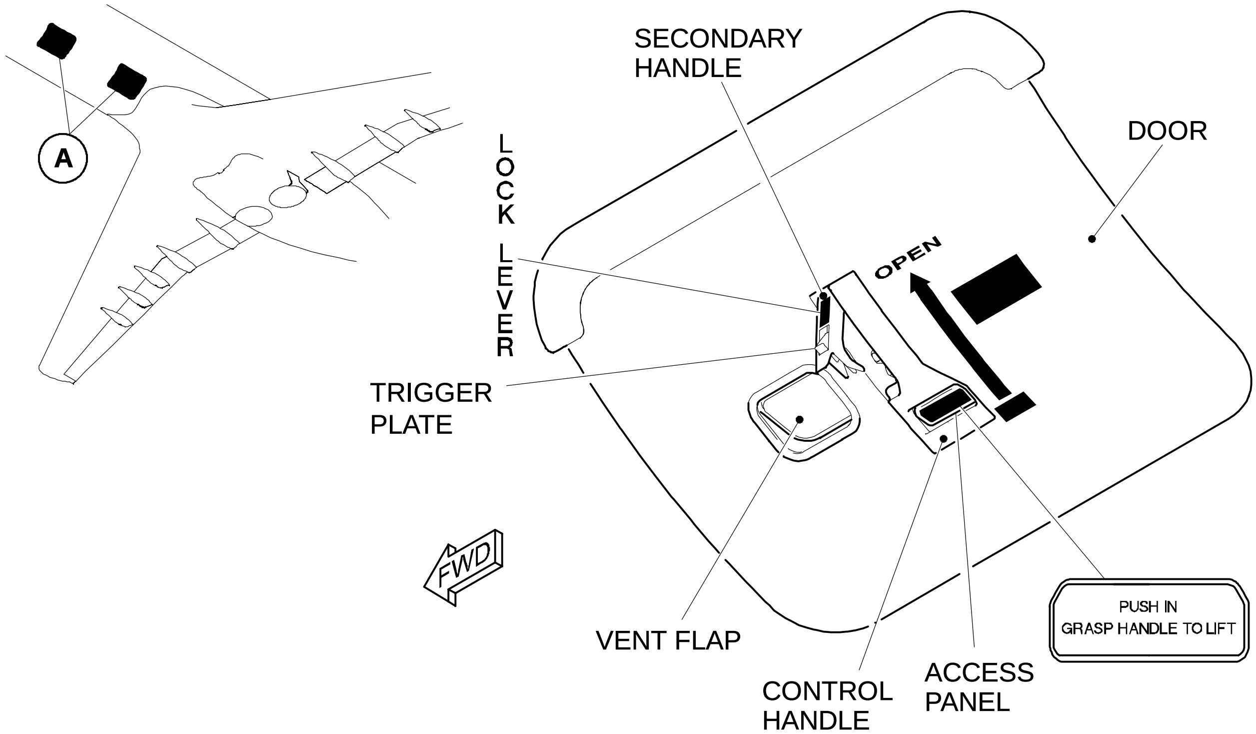
The door mechanism latches as the control handle reaches the end of its travel.

The control handle latches in stowed position, its access panel closes.

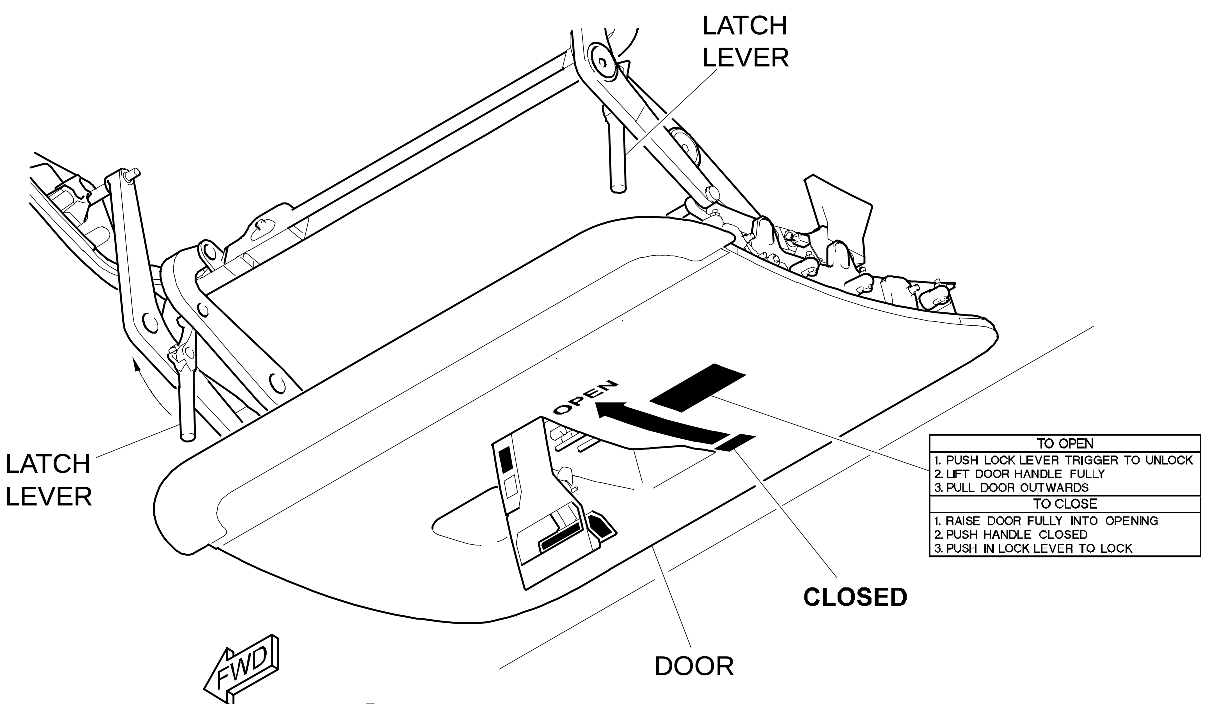
- Push the secondary handle fully in.

The control handle and its access panel are locked in position.

The vent flap closes.

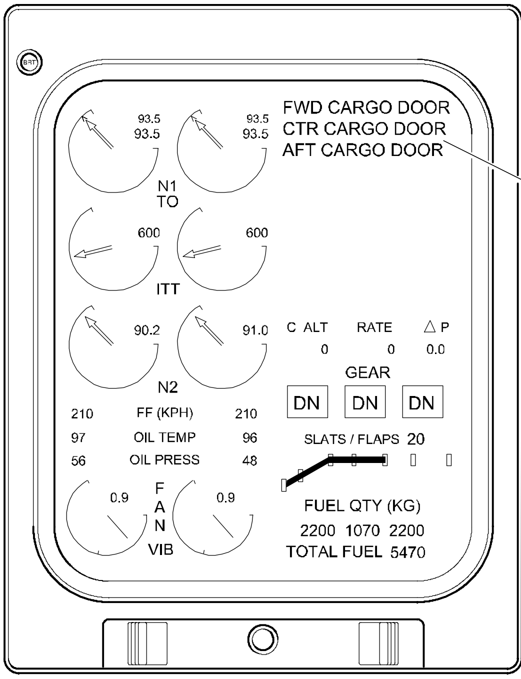


(A) CLOSED POSITION



(A) FULL OPEN POSITION

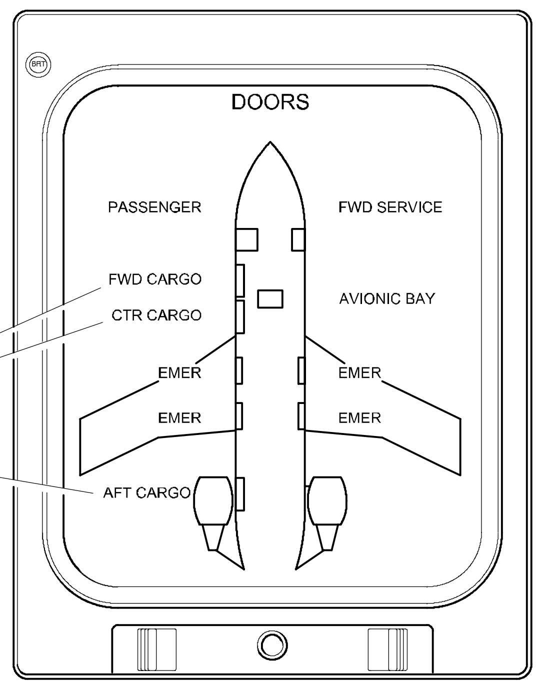
Forward Cargo Bay Doors
Figure 06–50–2



FWD, CTR or AFT CARGO DOOR caution (amber)
Indicates that the respective cargo door is unsafe.

Primary Page

FWD CARGO, CTR CARGO and AFT CARGO
Door outline color matches message.
- Amber – Indicates door is unsafe.
- Green – Indicates door is safe.
- Half intensity magenta – Indicates door status is unknown.



Doors Page

Cargo Bay Doors <1001, 2224>
Figure 06–50–3

1. AFT EQUIPMENT COMPARTMENT DOOR

The aft equipment compartment door is located on the lower aft fuselage. It provides access to the equipment located in the unpressurized aft equipment compartment. The aft equipment compartment door is hinged at the front and opens downwards. The door is also removeable through quick release hinge pins. The door handle is pulled out to unlatch and is pushed in to latch.

A. Opening the Door

To open the aft equipment compartment door:

- Press the control handle trigger plate. The control handle ejects.
- Rotate the control handle. The door mechanism unlatches.
- Manually move the door fully down.

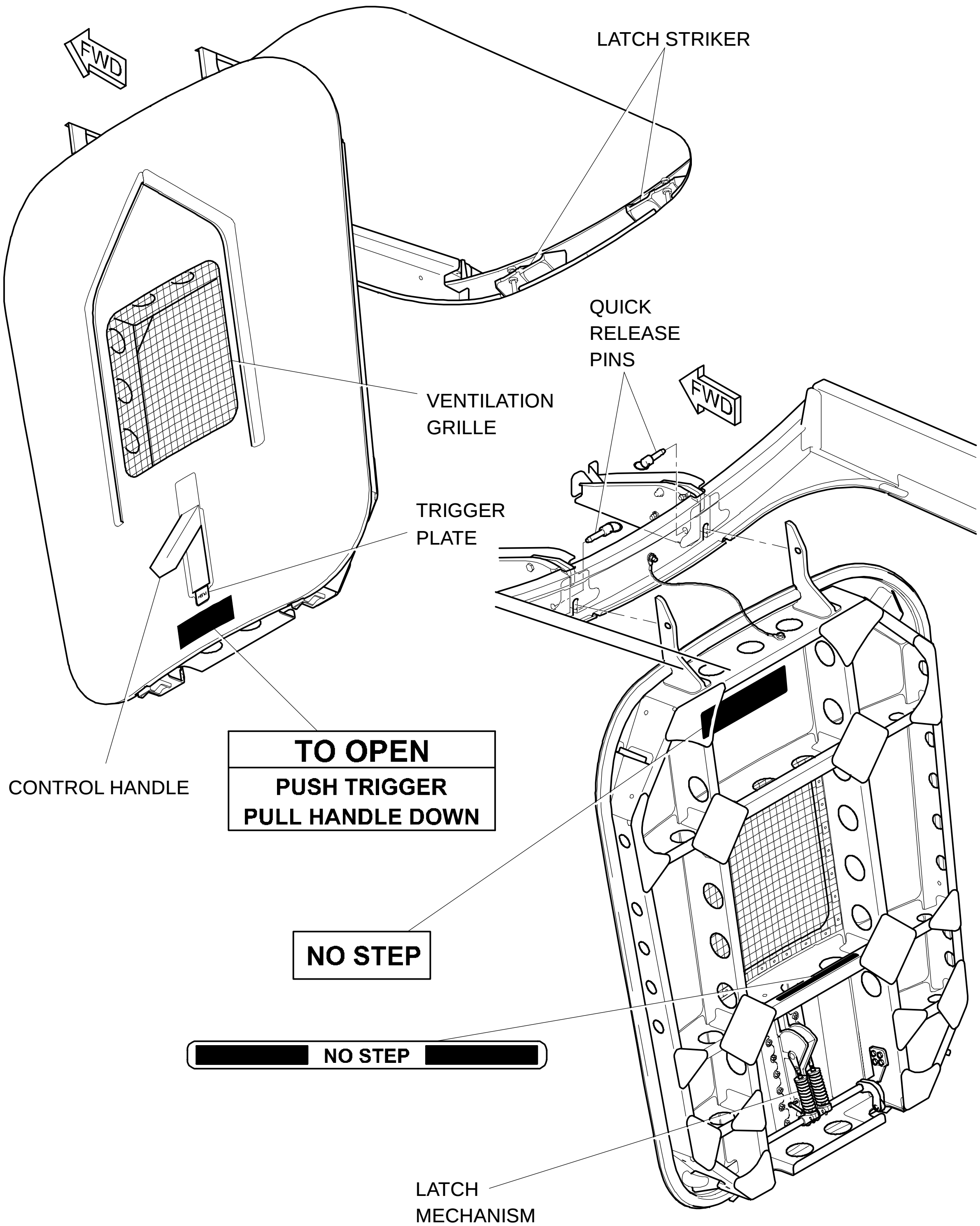
B. Closing and Latching the Door

To close the aft equipment compartment door:

- Manually move the door up in its opening.
- Rotate the control handle. The door mechanism latches as the control handle reaches the end of its travel.
- Push the control handle fully in. The control handle locks in position.

NOTE

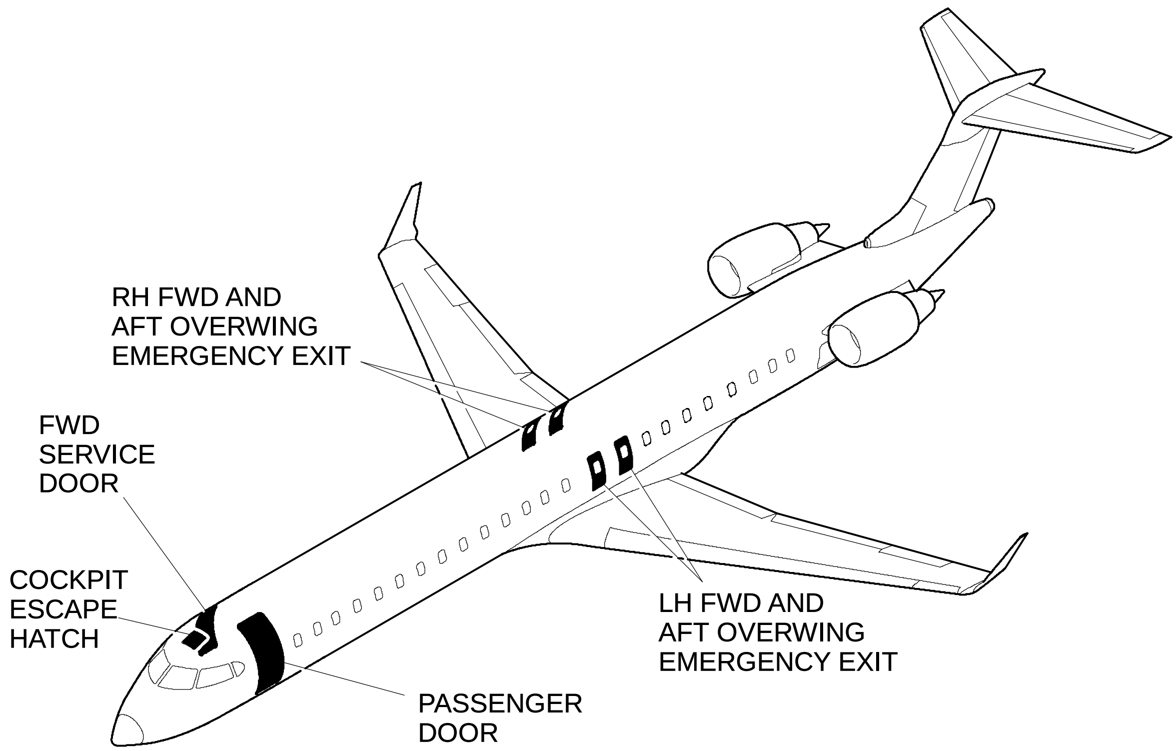
There is no cockpit indication for an unsafe aft equipment compartment door.



Aft Equipment Bay Door
Figure 06−60−1

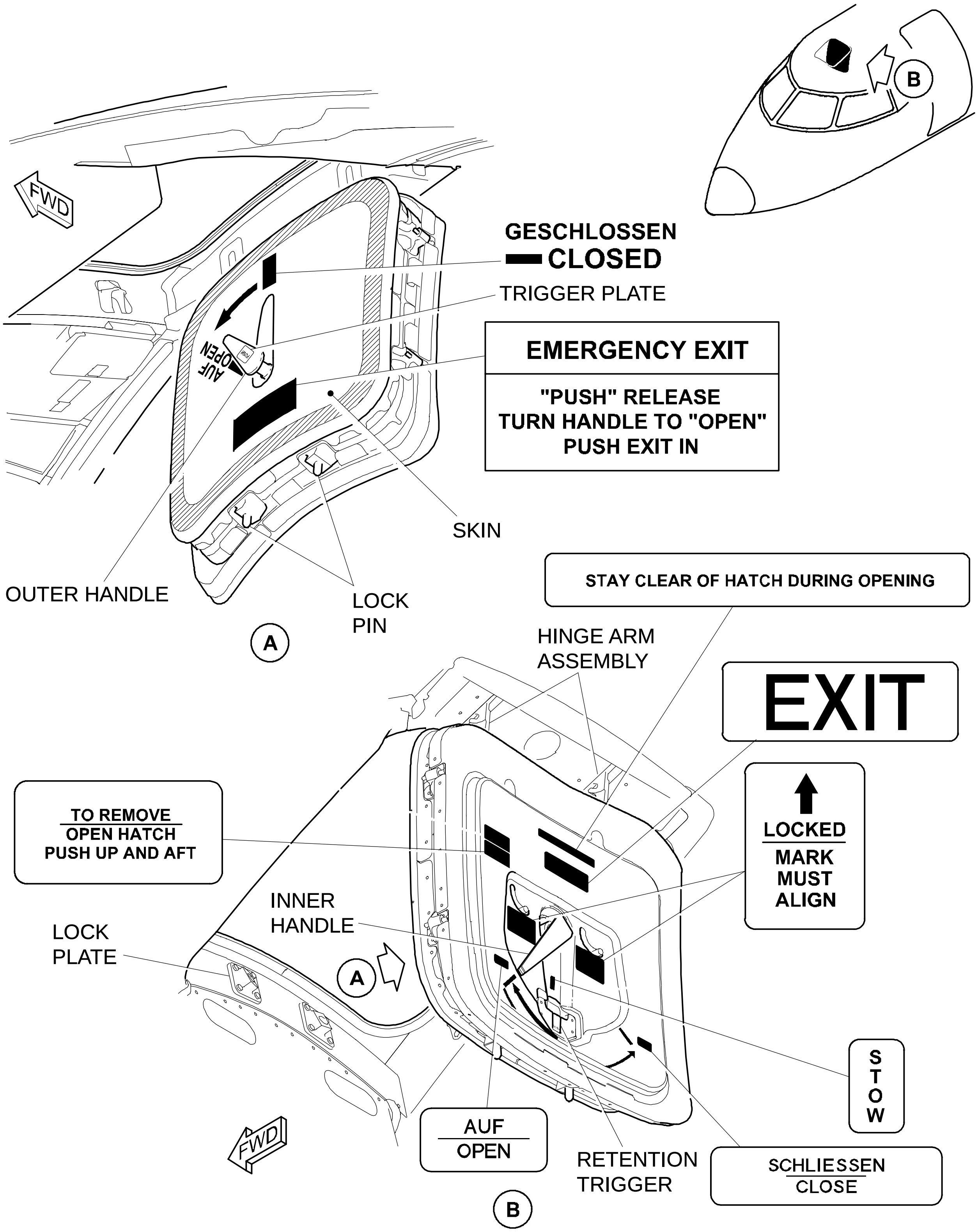
1. EMERGENCY EXITS

Emergency evacuation of the cabin area is accomplished through the passenger door, the galley service door, the four overwing emergency exits, and the cockpit overhead escape hatch. All emergency exits can be opened from the inside or outside of the aircraft.

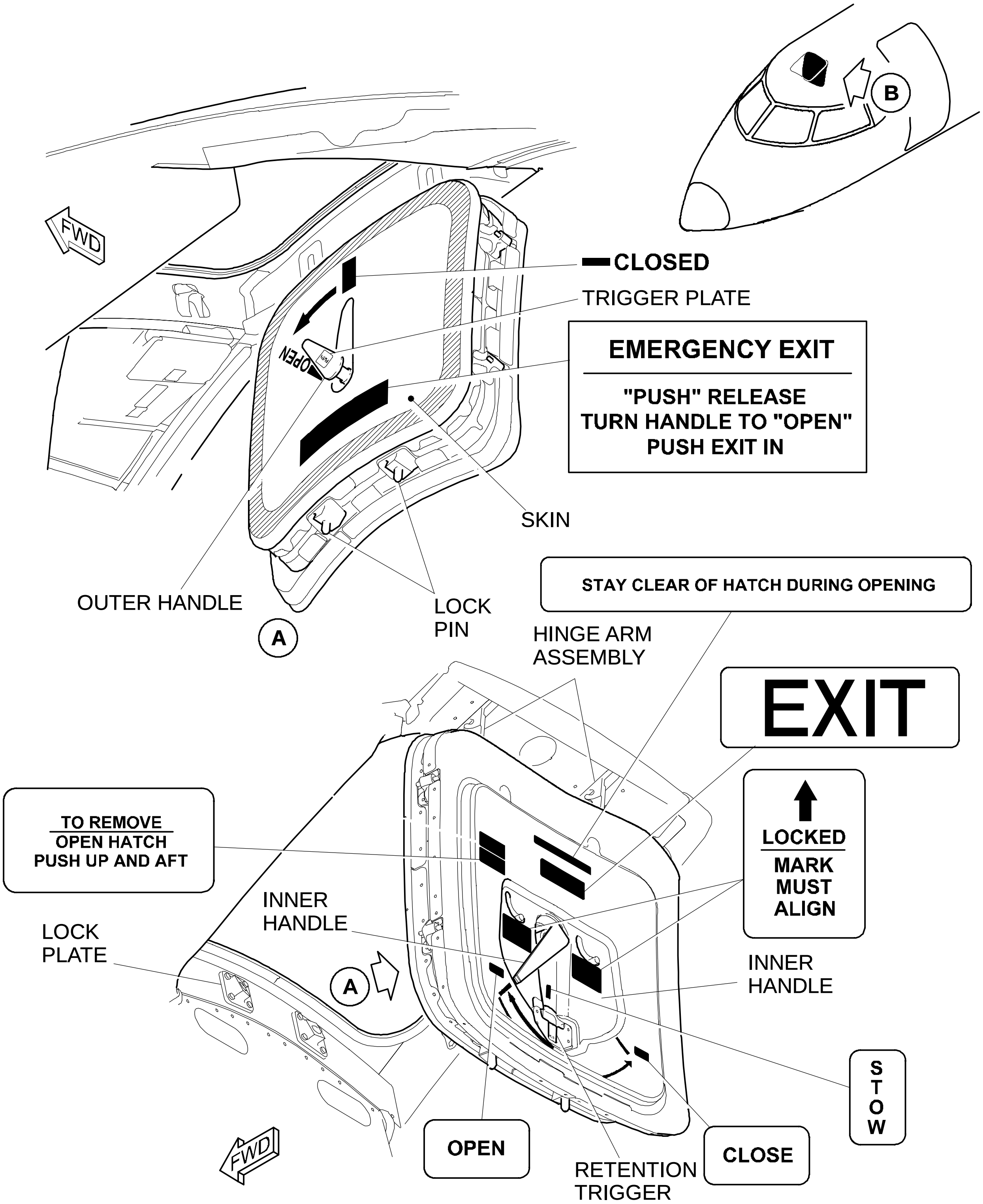


Emergency Doors – Introduction <2224>
Figure 06–70–1

PASSENGER DOOR	36 X 70 Inches	91 X 178 cm	Type I Exit
CREW ESCAPE HATCH	19 X 20 Inches	48 X 51 cm	
GALLEY SERVICE DOOR	24 X 48 Inches	61 X 122 cm	Type I Exit
OVERWING EMERGENCY EXIT	20 X 38 Inches	51 X 97 cm	Type III Exit



Cockpit Escape Hatch
Figure 06–70–2



Cockpit Escape Hatch
Figure 06–70–3

A. Cockpit Escape Hatch

The cockpit overhead escape hatch provides an emergency exit for the pilots in case of emergency evacuation. The hatch opens inwards and is removeable at the hinge supports.

The hatch inner and outer handles are rotated to the OPEN position to unlatch and rotated to the CLOSED position to latch.

NOTE

There is no cockpit indication for an unsafe crew escape hatch.

(1) Opening the Crew Escape Hatch from Inside

To open the crew escape hatch from inside:

- Press the hatch inner handle release button.

The inner handle ejects.

- Rotate the inner handle to the OPEN position (left).

The hatch mechanism unlatches.

- Manually move the hatch fully down.

(2) Closing the crew escape Hatch from Inside

To close the crew escape hatch from inside:

- Manually lift the hatch into its opening.
- Push the aft part of the hatch up to squeeze the seal, and rotate the inner handle to the CLOSED position (right).

The door mechanism latches as the inner handle reaches the end of its rotation.

- Correctly align the inner handle with the door recess and push it fully in.

The inner handle locks in stowed position.

(3) Opening the Crew Escape Hatch from Outside

To open the crew escape hatch from outside:

- Press the outer handle trigger plate.

The outer handle ejects.

- Rotate the outer handle to the OPEN position (right) and carefully lower the hatch fully down, (to avoid injuries to the crew).

To close the crew escape hatch from outside:

(4) **Closing the Crew Escape Hatch from Outside**

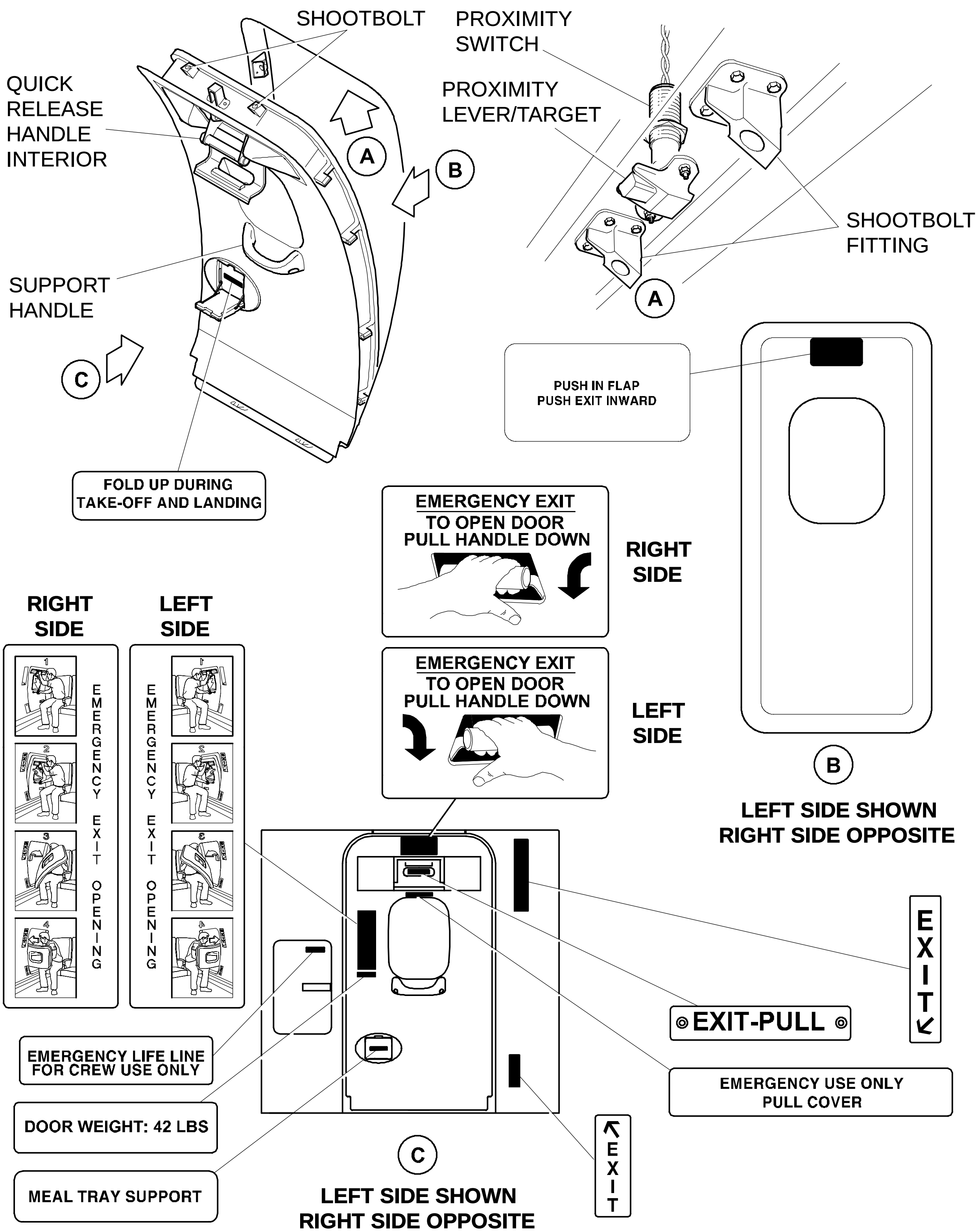
To close the crew escape hatch from outside:

- Using the door outer handle, manually lift the hatch in its opening.
- Pull the outer handle up to squeeze the seal and rotate it to the CLOSED position.

The door mechanism latches as the outer handle reaches the end of its rotation.

- Correctly align the outer handle with the door recess and push it fully in.

The outer handle locks in the stowed position.



Overwing Emergency Exits
Figure 06–70–4

B. Overwing Emergency Exits

Four overwing emergency exits are provided for the evacuation of the cabin area. The overwing exits are located on either side of the passenger compartment, above the wings. They exits open inward and are then are lifted free from the lower of hinge supports. The overwing emergency exits can also be opened from outside the aircraft.

The left and right overwing emergency exits can be easily opened using the single action inner or outer handles located on the upper part of the door. Once opened, the door can be moved away from the exit using the two inner handles.

(1) **Opening the Overwing Emergency Exits from Inside**

- Open the exit door inner handle cover.
- Grab the exit door inner handle and pull inward and down.

  The door shootbolts retract.

  NOTE

  The door shootbolts will be held in a retracted position by a latch lever under the inner handle.

  The exit door opens inward and is then free to be moved away.

- Grab the lower handle and move the exit door to a suitable location away from the emergency exit.

(2) **To open the overwing emergency exits from outside:**

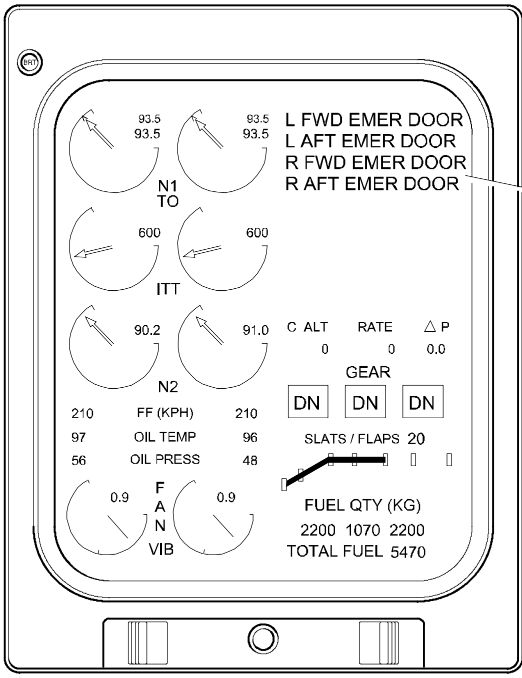
- Push-in the red outer handle push plate.

  The exit door opens inward and is free to be moved away.

- Grab the inner handles and move the exit door away from the exit.

(3) **Closing the Overwing Emergency Exits from Inside**

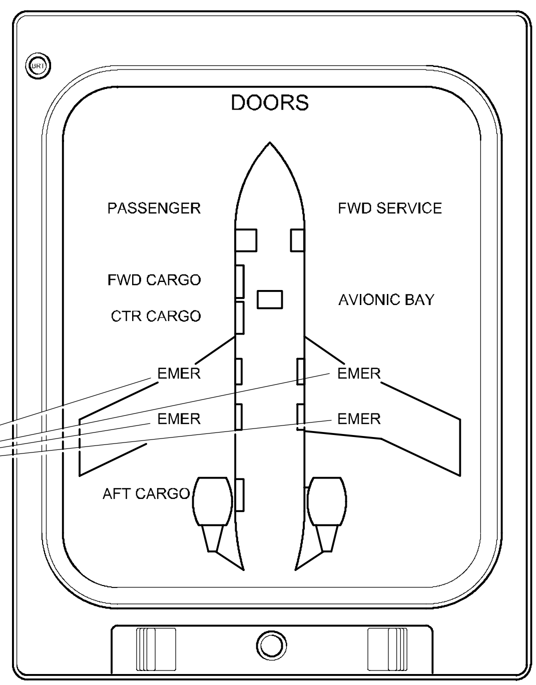
- Manually lift and place the overwing emergency exit door in front of its opening and set it on its hinge supports.
- Push the upper part of the hatch fully outward to squeeze the seal.
- Release the shootbolt latch lever under the handle
- Push the inner handle up and outward to fully engage the shootbolts.
- Close the inner handle cover



L (FWR or AFT) EMER DOOR or
R (FWR or AFT) EMER DOOR caution (amber)
Indicates that the respective overwing emergency exit is unsafe.

Primary Page

EMER
Door outline color matches message.
- Amber - Indicates exit is unsafe.
- Green - Indicates exit is safe.
- Half intensity magenta - Indicates exit status is unknown.



Doors Page

Emergency Doors EICAS Indications <1001, 2224>
Figure 06–70–5

CHAPTER 7 – ELECTRICAL

LIST OF ILLUSTRATIONS

DC ELECTRICAL SYSTEM

CIRCUIT BREAKER PANELS

1. INTRODUCTION

The aircraft AC electrical power is provided by two engine-driven generation systems. Each system includes an integrated drive generator (IDG) and a generator control unit (GCU). An auxiliary power unit (APU) generator is also available as a back AC power source to replace either or both IDGs.

In the event of total AC power loss, emergency AC power is available from an in-flight air-driven generator (ADG). The ADG assembly is stowed in a compartment on the right side of the nose section.

DC power is supplied by four transformer rectifier units (TRU) which rectifies AC input power into DC output power. An AC power center (ACPC) and two DC power centers (DCPCs) are used for connecting AC and DC power to the appropriate buses, depending on system configuration and health. The following is a list of all the aircraft electrical system buses:

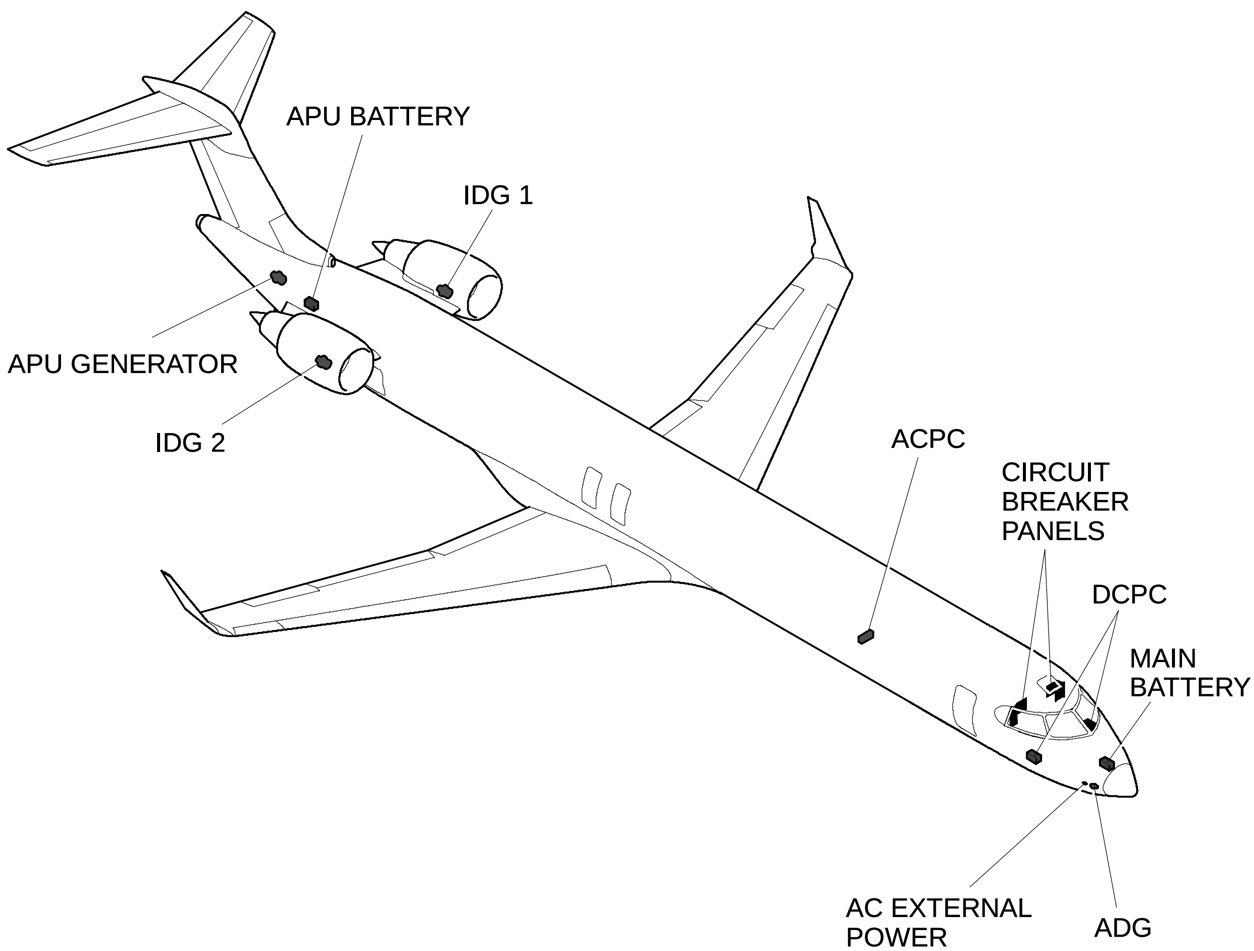
AC BUSSES	DC BUSSES
	DC BUS 1
	DC BUS 2
AC BUS 1	DC ESSENTIAL BUS
AC BUS 2	DC SERVICE BUS
AC ESSENTIAL BUS	DC BATTERY BUS
AC SERVICE BUS	DC EMERGENCY BUS
ADG BUS	DC UTILITY BUS
	MAIN BATTERY DIRECT BUS
	APU BATTERY DIRECT BUS

A main battery and an APU battery, with battery chargers, are installed in the aircraft electrical power system. Power for starting the APU is provided by the APU battery.

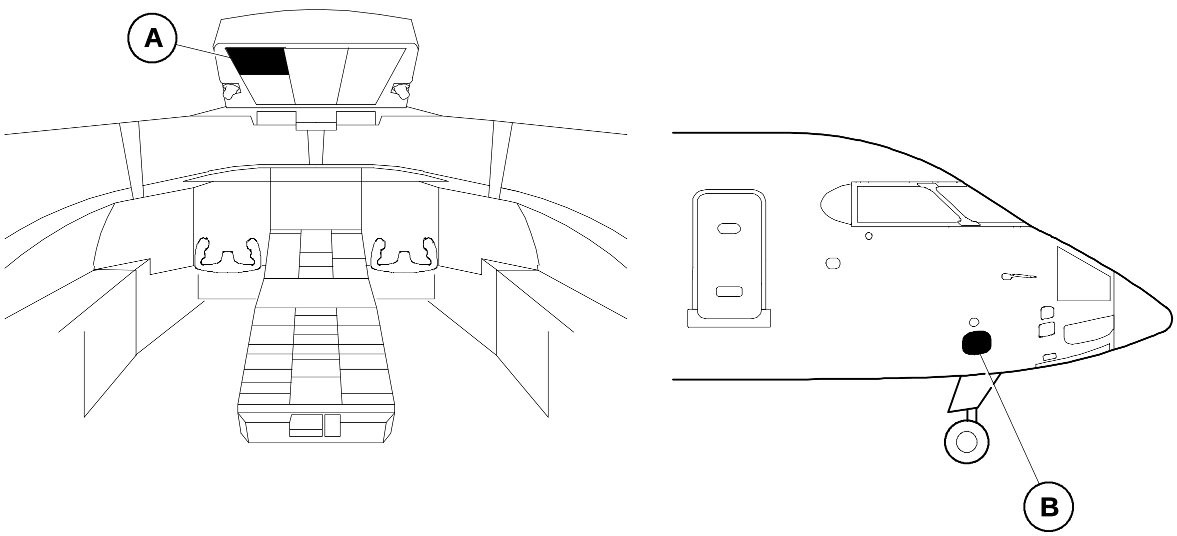
On the ground, the aircraft can receive external AC power through a receptacle located on the forward right side of the fuselage.

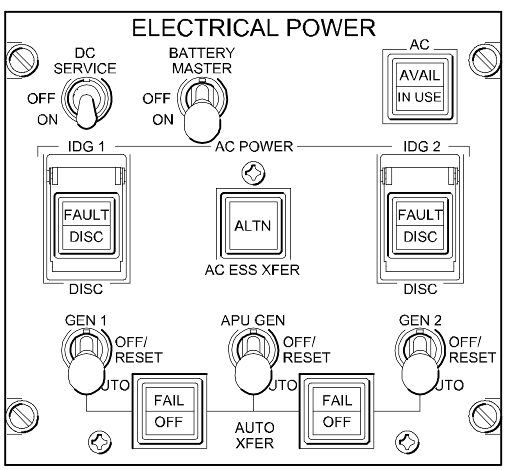
The electrical power panel in the flight compartment, and the external service panel on the right forward fuselage, contain the AC system control switches. The switches are used for manual and automatic control of the electrical power generating system and external power operation.

Electrical system warnings and cautions are displayed on the EICAS primary page. Status and advisory messages are displayed on the EICAS status page. General views of the electrical systems are displayed on the EICAS, AC and DC synoptic pages. Access to the AC and DC synoptic page is through the EICAS control panel (ECP). One push of the ELEC key on the ECP will display the AC synoptic page. Pushing the ELEC key a second time will display the DC synoptic page.

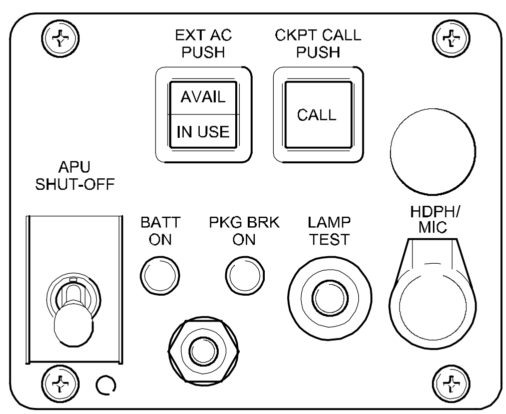


Electrical System − Introduction
Figure 07−10−1





A **Electrical Power Panel**
Overhead Panel



B **External Service Panel**
Right Forward Fuselage

Electrical System – Control Panels <1205>
Figure 07–10–2

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1. AC ELECTRICAL SYSTEM

AC power for the aircraft electrical systems is provided by two engine-driven, integrated drive generators (IDGs) which power all AC buses during normal operations. An APU generator provides a backup AC power source, in flight, if an IDG is inoperative or when the aircraft is on the ground with the engines off. If all AC power is lost in flight, emergency AC power is provided automatically by a deployable air-driven generator (ADG). The AC distribution system is controlled by the respective IDG and APU generator control units (GCUs). Each generator is monitored by the GCUs for voltage, frequency and kilovolt amps (kVA) for display on the EICAS and for system fault protective shutdowns.

A. Integrated Drive Generator (IDG)

Each IDG consists of a constant speed drive (CSD) and a generator. The CSD hydro-mechanically, converts the variable input speed from the engine accessory gearbox to a constant output speed to the generator to produce a constant frequency. An oil cooler cools the oil used by the IDG.

Each IDG has a disconnect switchlight (on the electrical panel) to manually decouple the IDG from the engine gearbox in the event of a CSD low oil pressure or high oil temperature. The IDG will automatically disconnect if a severe over temperature or overtorque condition occurs. Once disconnected, either manually or automatically, the IDG cannot be reconnected in flight. It can only be reset on the ground, with the engine shutdown.

Voltage and frequency regulation and fault protection is incorporated into each generator control unit (GCU). The GCU also protects the electrical system from overcurrent and differential current faults. In the event of a malfunction, the GCU will automatically disconnect the faulty generator from the respective AC buses. The generator may be reset when the malfunction is corrected or no longer exists, by selecting the generator switch to the OFF/RESET position then back to ON.

B. APU Generator

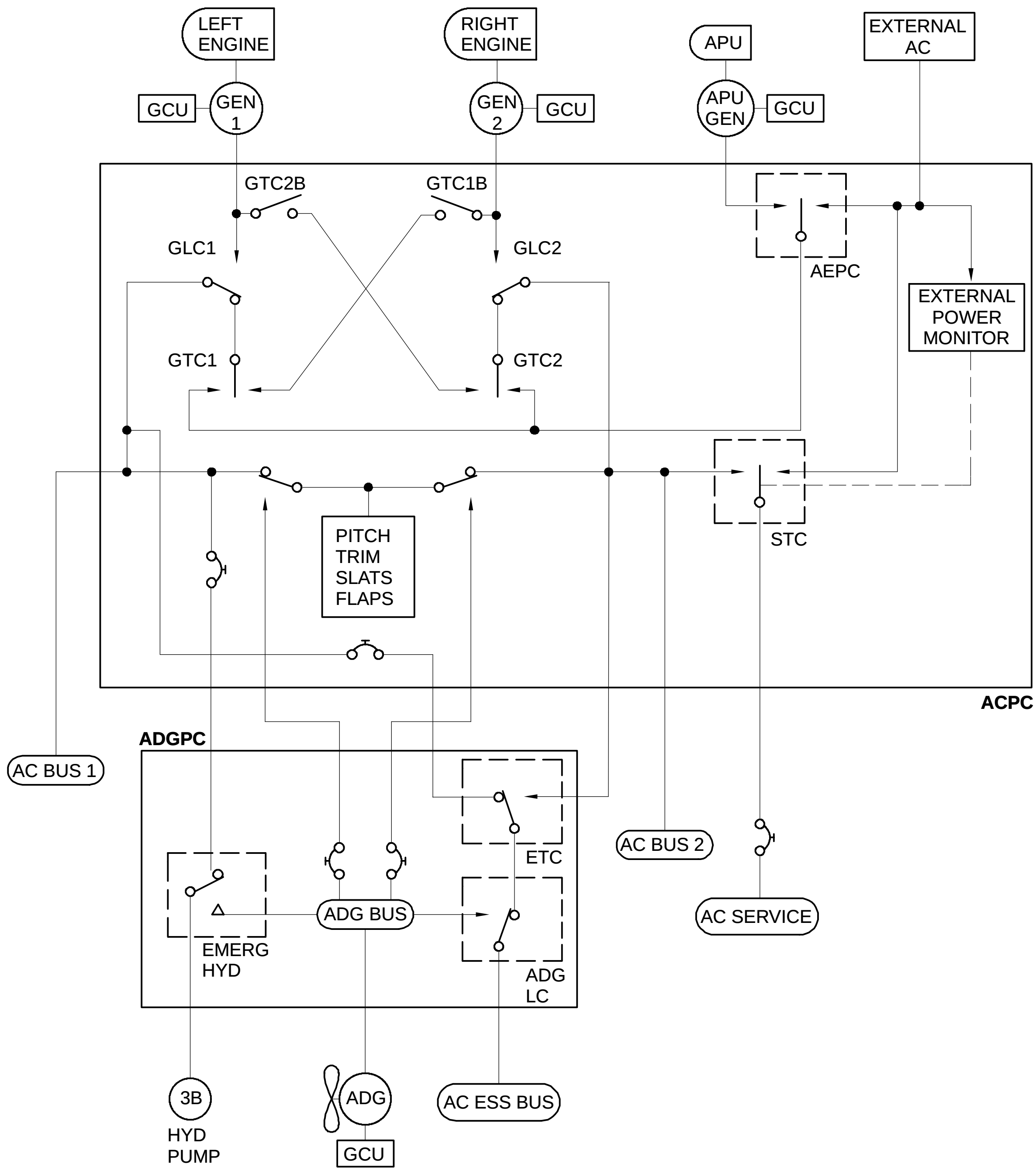
The APU generator is driven, directly by the APU gearbox, at a constant speed to maintain a constant frequency output. A GCU, identical to the IDG GCU, provides the same regulation and protection functions as the IDG GCUs.

C. AC Distribution

AC power from IDG 1 and IDG 2 is distributed to the AC buses via GCU controlled switches in the AC power center (ACPC). There is a priority control of AC power distribution. During normal operations, IDG 1 powers AC bus 1 and IDG 2 powers AC bus 2. Failure of an IDG generator, for any reason other than a fault on its associated bus, will automatically transfer the load from the failed IDG to the remaining operative IDG. The APU generator can then be used to replace the failed IDG to power the respective AC bus.

On the ground, if the aircraft is being powered with external AC power and either the APU or an IDG is brought on line, the external power will be automatically disconnected and the respective APU or IDG generator will power all the AC buses. When external power is not available, the APU generator provides electrical power to the AC buses and bleed air to start the aircraft engines. If an IDG is powering its respective AC bus and the APU generator is powering the other AC bus, when the remaining IDG is brought on line, the APU generator will be automatically taken off line.

IDG 1	APU GENERATOR	IDG 2
Failed	Not available	Both AC Bus 1 and AC Bus 2
Failed	AC Bus 1	AC Bus 2
Both AC Bus 1 and AC Bus 2	Not available	Failed
AC Bus 1	AC Bus 2	Failed
Failed	Both AC Bus 1 and AC Bus 2	Failed



AC System Distribution
Figure 07–20–1

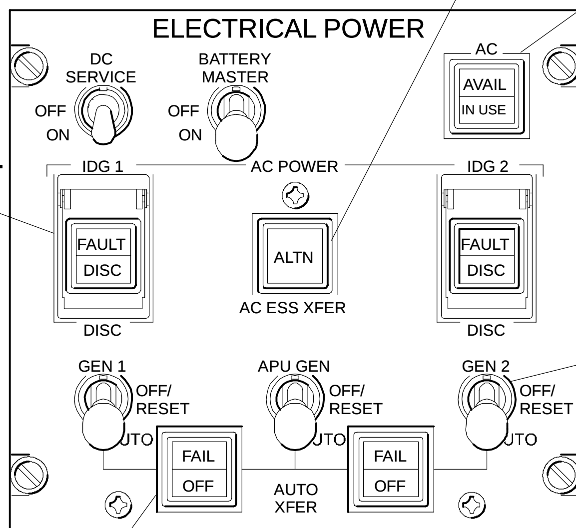
AC ESS XFER
Used to switch essential bus feed from AC bus 1 to AC bus 2.
- ALTN (white) light indicates essential bus is fed from AC bus 2.

Transfer is automatic during an AC bus 1 failure.

IDG 1 and 2 DISC (Guarded)
Used to disconnect IDG from engine.
- DISC (white) light indicates selected disconnect is successful.
- FAULT (amber) light indicates a fault within IDG (low oil pressure or high oil temperature).

IDG will automatically disconnect, when an overtemperature or overtorque condition occurs.

Once disconnected, the IDG cannot be reset with the engines running.



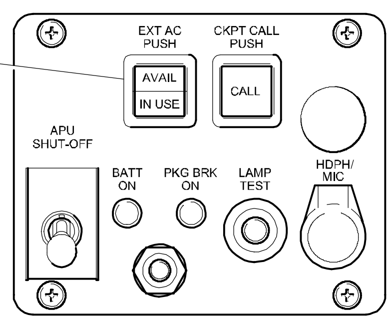
Electrical Power Panel
Overhead Panel

AC
Used to select external AC power.
- AVAIL (green) light indicates external power is connected and is ready to use.
- IN USE (white) light indicates that the external AC power unit is supplying the electrical system.

GEN 1, 2 and APU GEN
- AUTO – Connects generator to associated bus.
- OFF/ RESET – Disconnects generator from associated bus and/ or resets the generator control circuit.

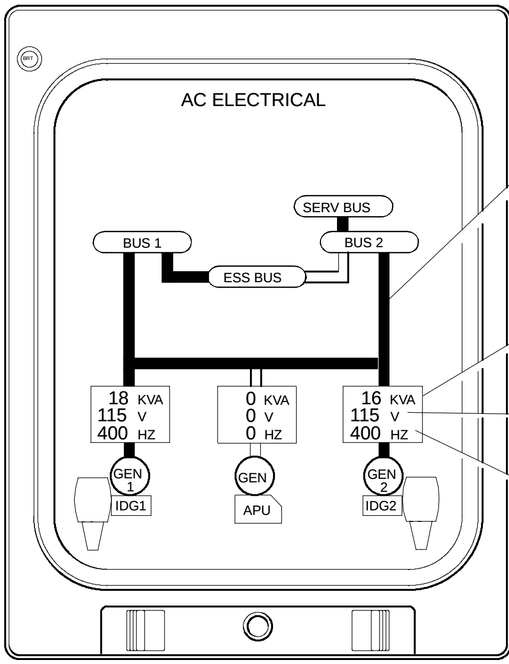
AUTO XFER
Used to disable automatic transfer of associated IDG.
- OFF (white) light indicates autotransfer is selected off.
- FAIL (amber) light indicates a fault preventing autotransfer.

EXT AC PUSH
Used to select external AC power.
- AVAIL (green) light indicates external power is connected and is ready to use.
- IN USE (white) light indicates that the external AC power unit is supplying the electrical system.



External Service Panel
Right Forward Fuselage

AC Electrical System
Figure 07–20–2



Flow Lines
- Green – Bus energized.
- Blank – Bus not energized.

Generator Load
Displays the load on the generator.

Generator Voltage
Displays the generator voltage level.

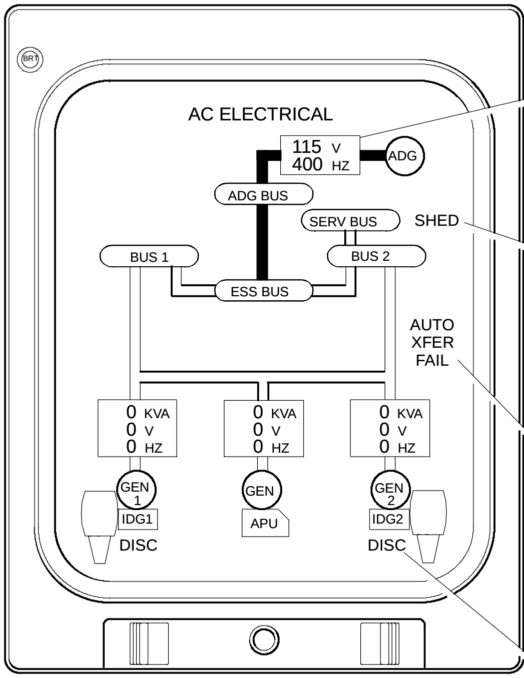
Generator Frequency
Displays the generator frequency level.

AC Electrical Page

EICAS DIGITAL READOUT	GREEN	AMBER	WHITE	HALF INTENSITY MAGENTA	AMBER DASHES
XX KVA	Generator loaded	Generator overload	Generator not loaded	Insufficient data	Invalid data
XXX V	Voltage in range	–	Voltage not in range	Insufficient data	Invalid data
XXX HZ	Frequency in range	–	Frequency not in range	Insufficient data	Invalid data

EICAS OUTLINE	GREEN	AMBER	WHITE	HALF INTENSITY MAGENTA	HALF INTENSITY CYAN
BUS	Bus powered	Bus not powered or voltage low	–	Invalid data	–
GEN	Generator on	Generator off with engine / APU running	Both generator and engine / APU are off	Invalid data	–
IDG	Constant speed drive on	Low oil pressure or high oil temperature	Engine is off or IDG has disconnected	Invalid data	–
APU	–	–	Engine / APU off	Invalid data	Engine / APU running and ready to load

AC Electrical System Synoptic Page
Figure 07–20–3 Sheet 1



AC Electrical Page

ADG Features
Displayed when ADG voltage is more than 10 volts and frequency is more than 300 Hz.

SHED (white)
Indicates that service bus is not powered.

AUTO XFER OFF (white)
Indicates that corresponding automatic transfer has been selected off.

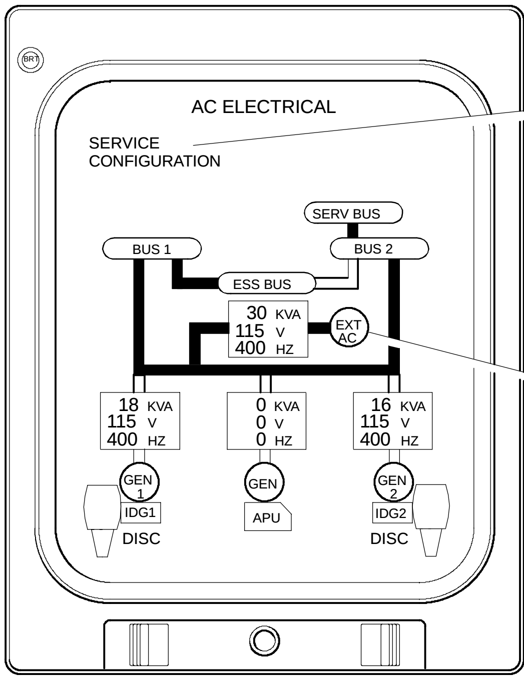
AUTO XFER FAIL (amber)
Indicates that corresponding automatic transfer has failed.

DISC (white)
Indicates that IDG has been disconnected.

EICAS DIGITAL READOUT	GREEN	WHITE	AMBER DASHES
XXX V	Between 108 and 130 volts	Less than 108 volts or more than 130 volts	Invalid data
XXX HZ	Between 360 and 440 Hz	Less than 360 Hz or more than 440 Hz	Invalid data

EICAS OUTLINE	GREEN	WHITE
ADG BUS	ADG outline green	ADG outline white
ADG	Voltage and frequency digital readouts green	Voltage or frequency digital readouts white

AC Electrical System Synoptic Page
Figure 07–20–3 Sheet 2



SERVICE CONFIGURATION (green)
Displayed when external AC power is available and the AVAIL switchlight on the external AC service panel has been selected. Only the AC service bus will be powered.

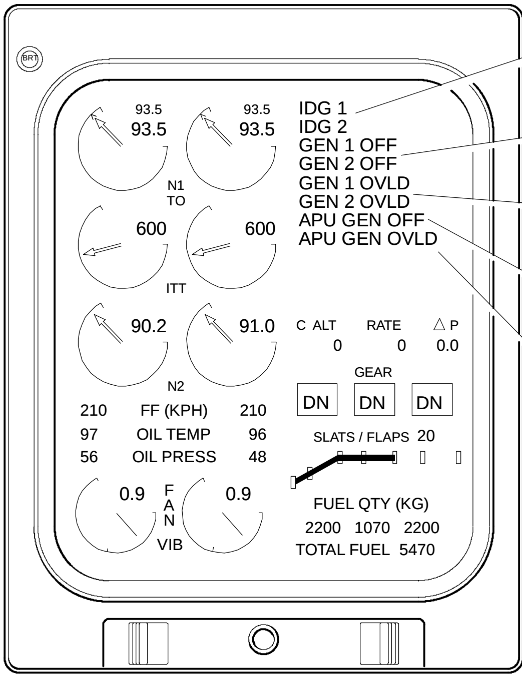
External AC Power Features
Displayed when external AC voltage is more than 10 volts and frequency is more than 50 Hz.

AC Electrical Page

EICAS DIGITAL READOUT	GREEN	AMBER	WHITE	HALF INTENSITY MAGENTA	AMBER DASHES
XX KVA	Loaded	Overload	Not loaded	Insufficient data	Invalid data
XXX V	Between 106 and 124 volts	–	Less than 106 volts or more than 124 volts	–	Invalid data
XXX HZ	Between 370 and 430 Hz	–	Less than 370 Hz or more than 430 Hz	–	Invalid data

EICAS OUTLINE	GREEN	WHITE	HALF INTENSITY MAGENTA
EXT AC	External AC available or in use	External AC not available and not in use	Invalid data

AC Electrical System Synoptic Page
Figure 07–20–3 Sheet 3



Primary Page

IDG 1 or 2 caution (amber)
Indicates that IDG has low oil pressure or high oil temperature.

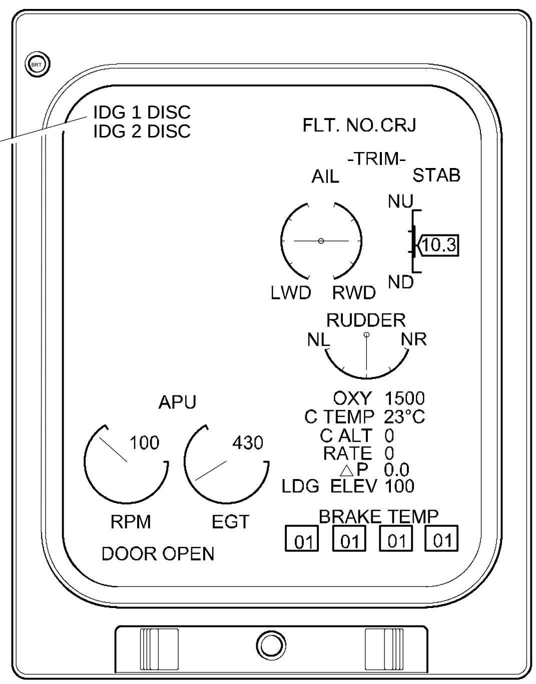
GEN 1 or 2 OFF caution (amber)
Indicates that generator is off.

GEN 1 or 2 OVLD caution (amber)
Indicates that generator control unit has detected a load of greater than 40 kVA.

APU GEN OFF caution (amber)
Indicates that APU generator is off and APU is ready to load.

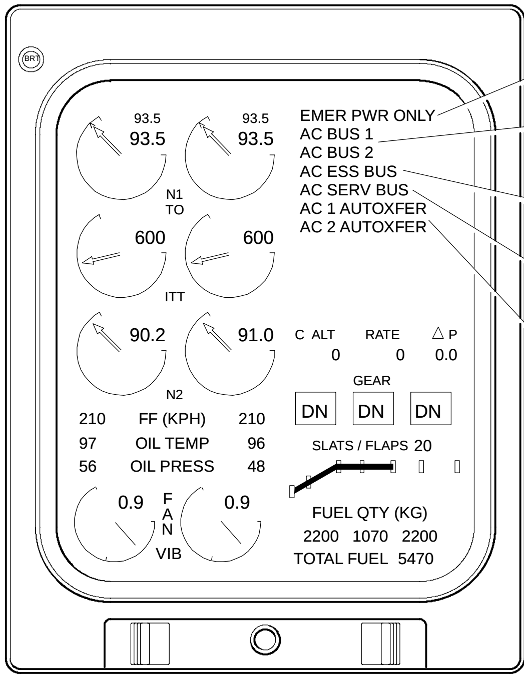
APU GEN OVLD caution (amber)
Indicates that generator control unit has detected a load of greater than 40 kVA.

IDG 1 or 2 DISC status (white)
Indicates that IDG has been disconnected, either automatically or manually.



Status Page

AC Electrical System – EICAS Indications (Generators) <1001>
Figure 07–20–4



EMER PWR ONLY warning (red)
Indicates that the ADG has deployed.

AC BUS 1 or 2 caution (amber)
Indicates that the associated bus is not powered.

AC ESS BUS caution (amber)
Indicates that AC essential bus is less than 90 Volts.

AC SERV BUS caution (amber)
Indicates that AC bus 2 is powered and AC service bus is less than 90 Volts.

AC 1 or 2 AUTOXFER caution (amber)
Indicates that the corresponding automatic bus transfer has failed.

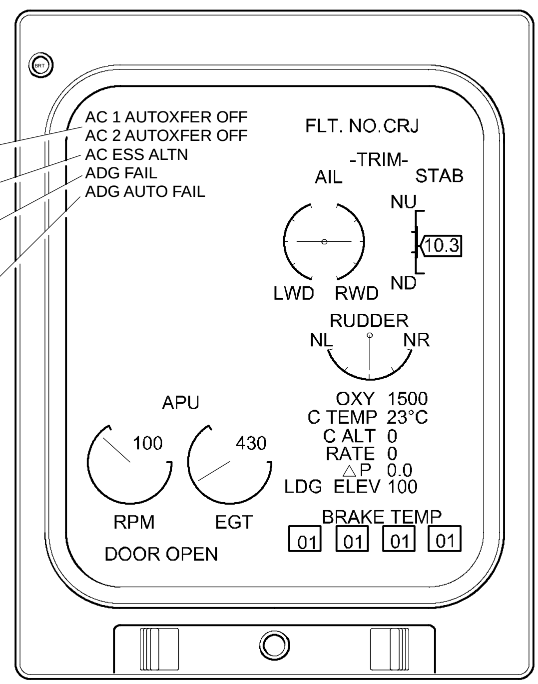
Primary Page

AC 1 or 2 AUTOXFER OFF status (white)
Indicates that the corresponding automatic bus transfer has been selected off.

AC ESS ALTN status (white)
Indicates that AC essential bus is being fed from AC bus 2.

ADG FAIL Status (white)
Indicates that generator control unit has failed.

ADG AUTO FAIL status (white)
Indicates a fault in the deploy control unit, unit is not powered or up-lock solenoid has failed.



Status Page

AC Electrical System – EICAS Indications (Busses)<1001>
Figure 07–20–5

The AC essential bus is normally powered by AC bus 1. If a fault exists on AC bus 1, the GCU will automatically transfer the power supplied to the AC essential bus, from AC bus 1 to AC bus 2. The crew can also manually transfer the AC essential bus supply power, from AC bus 1 to AC bus 2, using the AC ESS XFER switchlight on the electrical panel. In flight, the AC service bus is normally powered from AC bus 2. On the ground, it is powered from the APU or external AC.

D. AC Loads Distribution

AC BUS 1	AC BUS 2	AC ESSENTIAL
Flight Recorder Power	Quick Access Recorder (QAR) <1204>	Essential TRU 1
TRU 1	TRU 2	Display Cooling Fan 1
Main Battery Charger	Essential TRU 2	Avionics Cooling Fan 1
Recirculating Fan 1	Recirculating Fan 2	Crossflow Pump
Display Cooling Fan 2	Galley Exhaust Fan	Left Pitot Heater
Lavatory Exhaust Fan	Galley Heater	Standby Pitot Heater
Baggage Compartment Heater	Slats and Flaps Channel 2	Left AOA Heater
Slats and Flaps Channel 1	Pitch Trim Channel 2	Ice Detector 1
Pitch Trim Channel 1	Hydraulic Pumps 3A and 1B	Left Window Heater
Hydraulic Pumps 3B and 2B	Right Windshield Heaters	Cabin Ceiling Lighting
Hydraulic System Fan	Right Window Heater	CB Panel Integral Lights
Left Windshield Heater	Ice Detector 2	Pilot Panel Integral Lights
TAT Probe Heater	Copilot Panel Integral Lights	Overhead Panel Integral Lights
Right AOA Heater	Inertial Reference Unit Fan <1025>	Center Panel Integral Lights
Right Pitot Heater		Traffic Alert and Collision Avoidance System (TCAS)
Enhanced Ground Proximity Warning System (EGPWS)		Engine Ignition A
Engine Vibration Monitor		
Avionics Cooling Fan 2		
ADG Heater		

AC SERVICE BUS	ADG Bus
APU Charger	Hydraulic Pump 3B
Logo Lights <1020>	Pitch Trim #2
Cabin Sidewall Lighting	Slats and Flaps #1
Cabin Ceiling Lighting	Slats and Flaps #2
Toilet	
Water System	

E. Air Driven Generator (ADG)

In the event of a complete AC power failure in flight, the ADG will automatically deploy and supply emergency AC power to the ADG bus and to the AC essential bus. If the automatic deploy function fails, the ADG can be deployed manually by pulling the ADG manual release handle on the ADG CONTROL control panel at the rear of the center console.

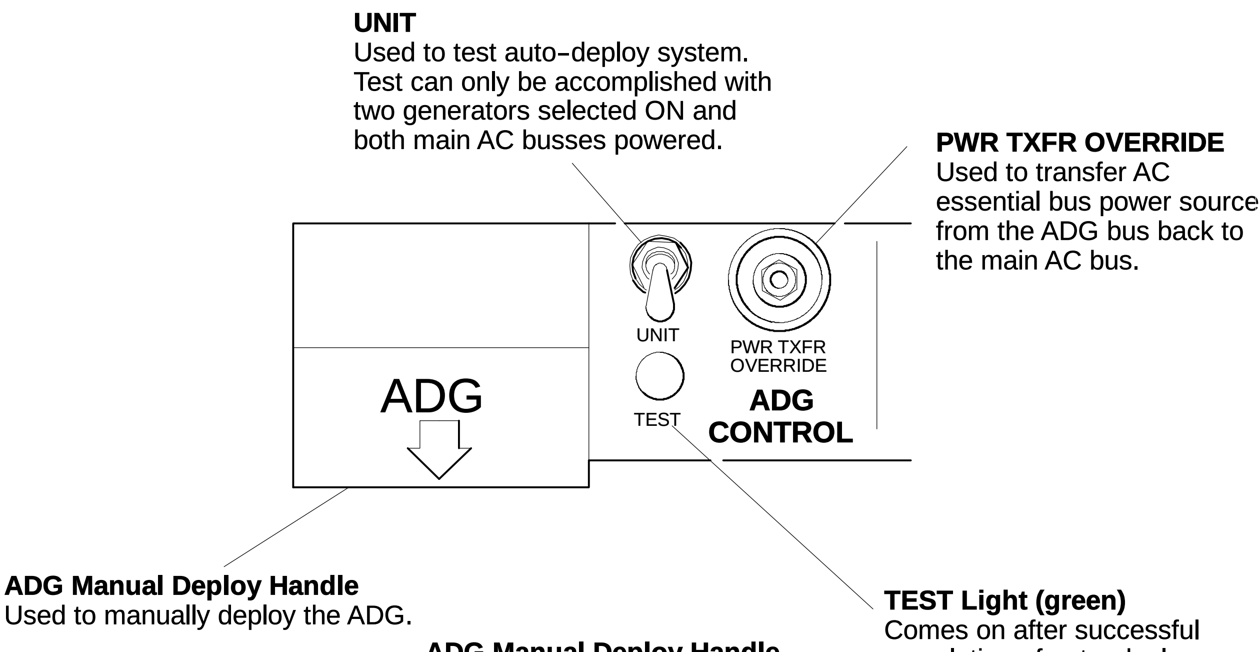
The ADG is heated in flight by an internal heater. The heater protects against frost or ice formation which could prevent the ADG from deploying in an emergency. The heater is continuously powered in flight from AC Bus 1 when the nose gear is up and locked. On landing, when the nose gear is extended, power is removed from the heater.

The ADG bus will supply power to the 3B hydraulic pump, flaps and slats and pitch trim channel 2. If either main generator is restored, the crew can override the ADG by pressing the PWR TXFR OVERRIDE button on the ADG control panel. This will reconnect the restored IDG to power AC bus 1 and 2. The ADG will continue to power the critical flight controls and the ADG bus. The flaps and slats will move at half speed when powered from the ADG bus.

The ADG generator, voltage, frequency and ADG bus indications on the EICAS, AC ELECTRICAL synoptic page are only displayed when the ADG bus is powered.

The ADG will continue to operate and supply power to the ADG bus until the airspeed decreases below 135 kts. At that point, if the APU generator or IDG has not been restore, the only power available will be from the batteries.

The ADG cannot be restowed in flight. It is restowed manually, on the ground, by maintenance personnel.



ADG Manual Deploy Handle and Auto–Deploy Panel Center Pedestal

Air Driven Generator (ADG)
Figure 07–20–6

F. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
AC Electrical Power	Generators	IDG 1 DISC	BATTERY BUS	1	P10	
AC Electrical Power	Generators	IDG 2 DISC	BATTERY BUS	1	P11	
AC Electrical Power	Generator Control	GCU 1	BATTERY BUS	1	Q9	
AC Electrical Power	Generator Control	GCU 2	BATTERY BUS	1	Q10	
AC Electrical Power	Generator Control	GCU 3	BATTERY BUS	1	Q11	
AC Electrical Power	AC Bus 1	PWR SENS	AC BUS 1	1	C14	
AC Electrical Power	ADG	ADG HEATER	AC BUS 1	1	C13	
AC Electrical Power	AC Bus 2	PWR SENS	AC BUS 2	2	C14	
AC Electrical Power	AC Essential Bus	AC ESS FEED	AC ESSENTIAL	1	S2	
AC Electrical Power	AC Essential Bus	PWR SENS	AC ESSENTIAL	1	S11	
AC Electrical Power	AC Service Bus	PWR SENS	AC SERVICE	2	D10	
AC Electrical Power	AC Service Bus	AC SERVICE FEED	AC SERVICE	2	E2	
AC Electrical Power	AC Power Center	ACPC CONT 1	DC BUS 1	1	D13	
AC Electrical Power	AC Power Center	ACPC CONT 2	DC BUS 2	2	L9	
AC Electrical Power	AC Power Center	ACPC CONT 3	BATTERY BUS	2	N1	
AC Electrical Power	ADG Deploy	ADG DEPLOY AUTO	BATTERY BUS	2	N6	
AC Electrical Power	ADG Deploy	ADG DEPLOY MAN	BATTERY BUS	2	N7	
AC Electrical Power	External AC Power	EXT AC PWR	APU BATT DIRECT BUS	5	A8	
AC Electrical Power	External AC Power	EXT AC PWR 1	MAIN BATTERY DIRECT BUS	6	A8	

1. DC ELECTRICAL SYSTEM

Four transformer rectifier units (TRU) and two batteries (Main and APU) provide the aircraft with DC electrical power.

A. Transformer Rectifier Units (TRU)

AC power from AC bus 1, AC bus 2 and from the AC essential bus is converted by four transformer rectifier units to 28VDC and supplied to DC bus 1, DC bus 2, DC essential bus, battery bus, DC service bus and the DC utility bus. Normal distribution of the TRU outputs is shown in the following table:

INPUT BUS	TRU	OUTPUT BUS
AC Bus 1	TRU 1	DC Bus 1
AC Bus 2	TRU 2	DC Bus 2 / DC Utility Bus
	Essential TRU 2	DC Battery Bus
AC Essential Bus	Essential TRU 1	DC Essential Bus

ESS TRU 2 is normally supplied AC power from AC BUS 2. If AC BUS 2 is not available, ESS TRU 2 will be automatically supplied from the AC ESS BUS, via the ESS TRU 2 XFR switch.

B. Batteries

There are two nickel-cadmium batteries installed in the aircraft, an APU battery and a main battery. The APU battery is located in the aft equipment compartment and provides DC power to the APU battery direct bus. The APU batery has a nominal output voltage of 24 Vdc with a capacity of 43 ampere-hours. The main battery is located in the nose avionics compartment and provides DC power to the main battery direct bus. The main batery has a nominal output voltage of 24 Vdc with a capacity of 17 ampere-hours.

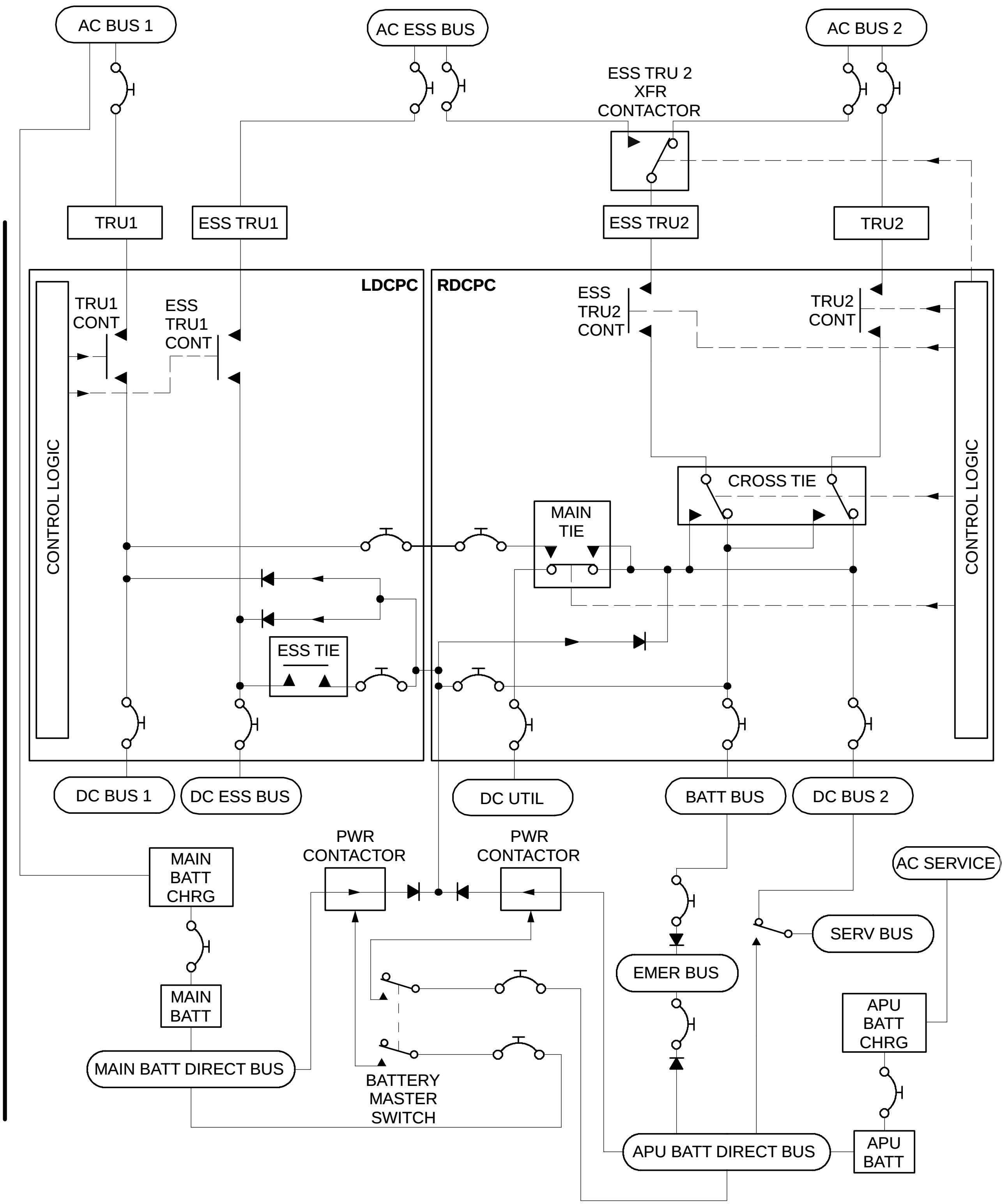
Each battery is maintained at full charge by its related battery charger. The main battery charger is powered from AC bus 1 and the APU battery charger is powered from the AC service bus. Battery charging is controlled automatically. Each charger monitors the battery voltage and temperature to control the charge rate and prevent overheating (thermal runaway).

C. DC Distribution

DC power is distributed through two DC power centers (DCPCs) located in the avionics compartment. DC bus 1 and DC bus 2 are powered from TRU 1 and TRU 2 respectively with connection controlled by the DCPC control logic. The DC essential, battery and DC emergency buses are normally powered from the essential TRUs. In the event that both essential TRUs fail, the DC essential, battery and emergency bus will be powered by TRU 2 via the automatic CROSS TIE.

The Main battery direct bus, APU battery direct bus, and the emergency bus are all hot buses (they are continuously powered at all times from the batteries). When the BATTERY MASTER switch is selected ON, an input signal is supplied to the two power controllers (PC) to connect their respective batteries to the DCPCs for power distribution. Each battery direct bus can power the DC battery bus. Both the battery bus and the APU battery direct bus feed the DC emergency bus. The DC service bus is normally powered from DC bus 2. If the DC SERVICE switch on the electrical power panel is selected ON, the DC service bus is powered from the APU battery direct bus.

If a complete loss of AC power occurs, the ESS TIE will close to connect the DC essential bus to the battery bus for emergency power. If TRU 1 or TRU 2 fails, the MAIN TIE will close to connect DC Bus 1 and DC Bus 2 to functioning TRU (1 or 2) When the MAIN TIE closes, the DC utility bus is shed to reduce load draw on the remaining TRUs. When both essential TRUs fail or when both TRU 1 and TRU 2 fail, the CROSS TIE closes. If AC bus 2 fails, essential TRU 2 will be powered from the AC essential bus.

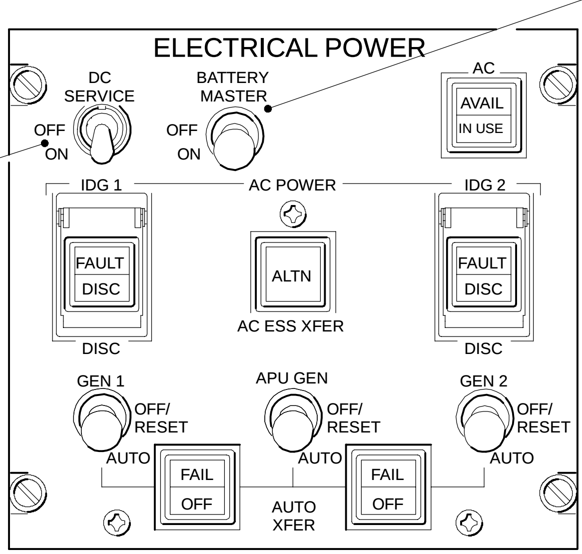


DC Electrical System – Schematic
Figure 07–30–1

BATTERY MASTER
Used to connect the APU and main battery direct busses to the battery bus.

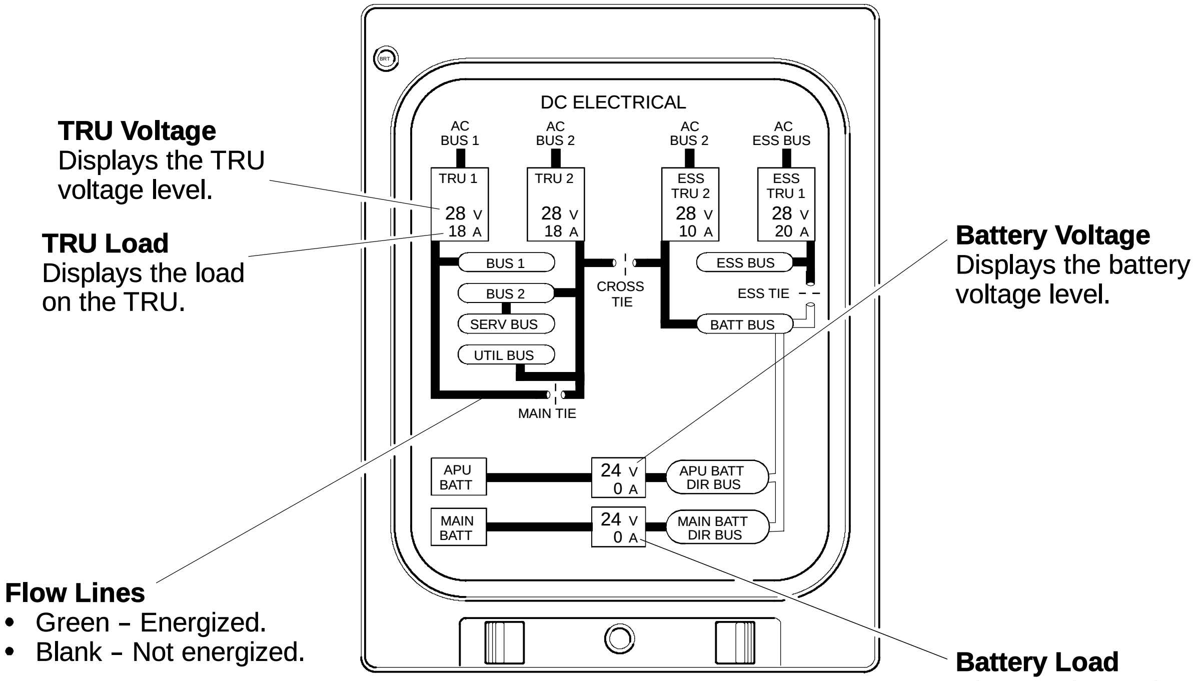
NOTE
Battery master should always be in the ON position in flight.

DC SERVICE
Used to connect the DC service bus to the APU battery direct bus.



Electrical Power Panel
Overhead Panel

Electrical Power Overhead Panel
Figure 07–30–2

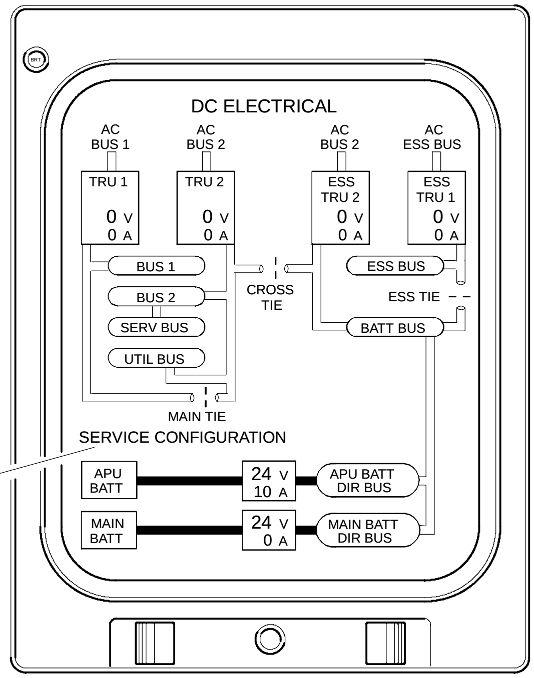


DC ELEC Page
EICAS Secondary Display
Center Instrument Panel

EICAS DIGITAL READOUT	GREEN	WHITE	AMBER DASHES
xx V (TRU)	Between 22 and 29 volts	Less than 22 volts or more than 29 volts	Invalid data
xx V (BATT)	Between 18 and 32 volts	Less than 18 volts or more than 32 volts	Invalid data
xx A (TRU)	Between 3.7 and 120.7 amps	Less than 3.7 amps or more than 120.7 amps	Invalid data
xx A (BATT)	Not less than 1.7 amps or not less than 12 volts	Less than 1.7 amps and less than 12 volts	Invalid data

EICAS OUTLINE	GREEN	AMBER	WHITE	HALF INTENSITY MAGENTA
BUS	Bus powered	Bus not powered	–	Invalid data
DIR BUS	Not less than 18 volts	Less than 18 volts	–	Invalid data
TRU	Not less than 3.7 amps and not less than 18 volts	–	Less than 3.7 amps and less than 18 volts	Invalid data
BATT	Not less than 18 volts	Less than 18 volts	–	Invalid data

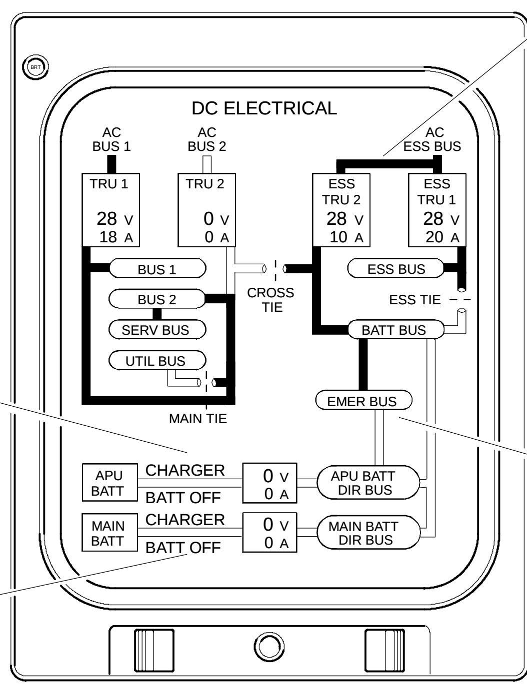
DC Electrical Page Tru Voltage
Figure 07–30–3



SERVICE CONFIGURATION (amber)
Indicates that the DC SERVICE has been selected on.

DC Electrical Page

Alternate AC Essential Flow Lines
Displayed only when AC bus 2 is not available.



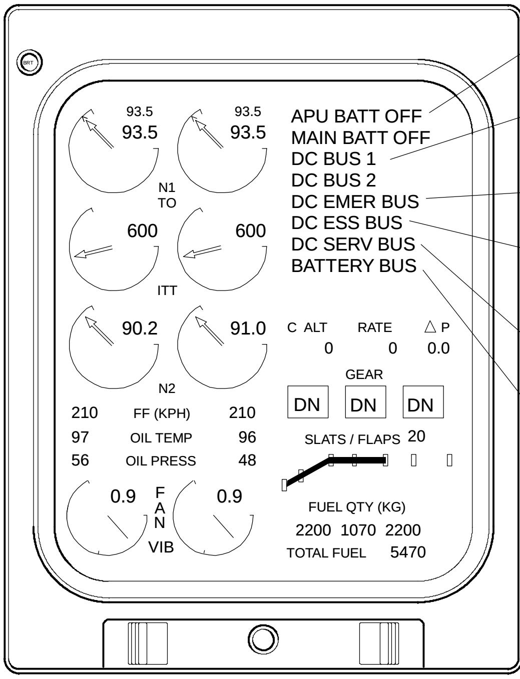
CHARGER (white)
Indicates that the corresponding charger is not charging.

BATT OFF (amber)
Indicates that the corresponding battery is not available.

DC Emergency Bus and Flow Lines
Displayed only when the emergency bus is not powered by both the battery bus and the APU battery direct bus.

DC Electrical Page

DC Electrical Page Service Configuration
Figure 07–30–4



APU or MAIN BATT OFF caution (amber)
Indicates that APU or main battery is not available.

DC BUS 1 or 2 caution (amber)
Indicates that the corresponding DC bus is not powered with either AC bus 1 or 2 on line.

DC EMER BUS caution (amber)
Indicates that emergency bus is not powered.

DC ESS BUS caution (amber)
Indicates that essential bus is not powered in flight or essential bus is not powered on the ground with either AC essential bus or APU generator on line.

DC SERV BUS caution (amber)
Indicates that service bus is not powered with either DC bus 2 powered or DC SERVICE selected on and APU voltage $\geq$18 volts.

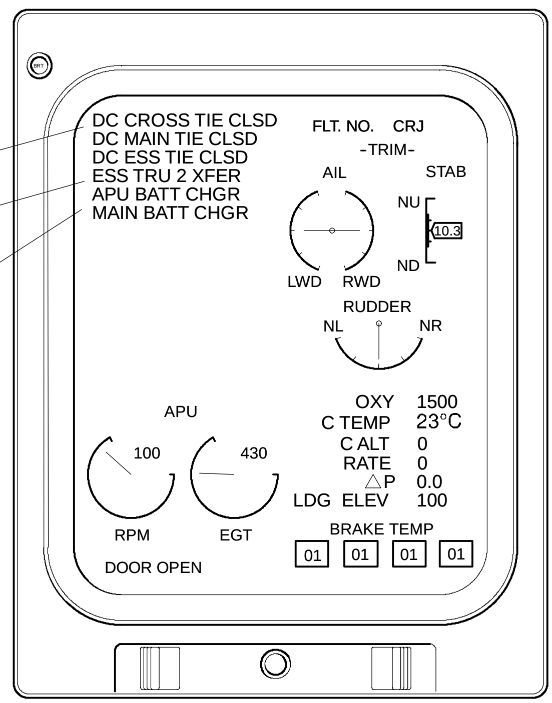
BATTERY BUS caution (amber)
Indicates that battery bus is not powered.

Primary Page

DC CROSS, MAIN or ESS TIE CLSD status (white)
Indicates that the corresponding bus tie is closed.

ESS TRU 2 XFER status (white)
Indicates that essential TRU 2 is powered by AC essential bus.

APU or MAIN BATT CHGR status (white)
Indicates that the corresponding battery is overheating or not charging.



Status Page

EICAS Primary Display Auxiliary Power Unit / Main Battery off <1001>
Figure 07–30–5

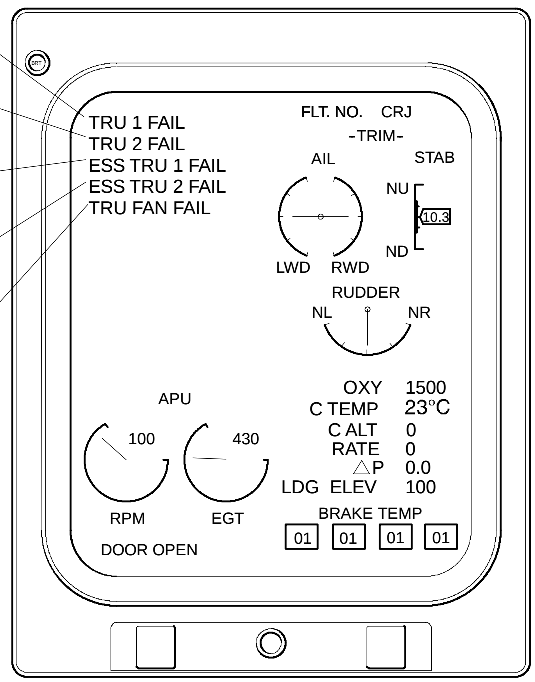
TRU 1 FAIL status (white)
Indicates that TRU 1 voltage is < 18 volts with AC bus 1 on line or main tie is closed with TRU 1 load < 3.7 amps.

TRU 2 FAIL status (white)
Indicates that TRU 2 voltage is < 18 volts with AC bus 2 on line or main tie is closed with TRU 2 load < 3.7 amps.

ESS TRU 1 FAIL status (white)
Indicates that essential TRU 1 voltage is < 18 volts with AC essential bus on line or essential tie is closed with essential TRU 1 load < 3.7 amps.

ESS TRU 2 FAIL status (white)
Indicates that essential TRU 2 voltage is < 18 volts with AC bus 2 on line or essential TRU 2 is powered by AC essential bus or essential tie is closed with essential TRU 2 load < 3.7 amps.

TRU FAN FAIL status (white)
Indicates that any of 4 TRU fans have failed.



Status Page

Transformer Rectifire Unit Fail – Status Page
Figure 07–30–6

D. DC Loads Distribution

DC BUS 1		
Flight Recorder Control	ACS Control 2 Channel A	Brake Pressure Application
EICAS Primary Display	Lavatory Smoke Detector	PSEU Channel A
EICAS Secondary Display	SSCU 1 Channel A	Nose Wheel Steering
Left Lamp Driver Unit	Pitch Feel 1	Anti-Skid
EICAS Dimming	Radio Altimeter 1	Left Cabin Reading Lights
Data Loader	Hydraulic Pump 2 and 3B Control	Cockpit Dome Light
Left IAPS	Hydraulic System Fan Control	Taxi Lights
Boarding Music	Hydraulic System 2 Indication	Nose Landing Lights
Passenger Door Actuator	Anti-Ice Control Channel A	Cockpit Floor Lights
ACPC Control 1	Left T2 Heater	Rear Anti-Collision Lights
Baggage Compartment Control	Pilot Windshield Wiper	Wing Inspection Lights
Fan Monitor	Left Windshield Heater Control	Maintenance Lights
Cabin Pressure Control 1	ADS Heater Control 2	GPS 1
Cockpit Temperature Sensors	Right Static Heaters	DME 1
Aft Cabin Temperature Sensors		Weather Radar

DC BUS 2		
Right IAPS	SSCU 1 Channel B	Right Window Heater Control
Right AFCS	Aileron and Rudder Trim	PSEU Channel B
Right IAPS Fan	Clock 2	Nose Wheel Steering
Observer Audio	Radio Altimeter 2 <1045>	Brake Pressure Indication
VHF Communication 2	Air Data Computer 2	Anti-Skid
RTU 2	Primary Flight Director 2	Chart Holder Lights
Service Bus Feed	Multifunctional Display 2	Copilot Map Light
ACPC Control 2	EFIS Control Panel 2	Wing Anti-Collision Lights
Left ACS Pressure Sensors	Attitude Heading 2	ADF 2
Cabin Pressure Control 2	Right Fuel Pump and Control	Transponder 2
Galley Heater Control	Hydraulic System 1 Indication	VHF Navigation 2
Fwd Cabin Temperature Sensors	Hydraulic Pump 1 and 3A Control	DME 2
ACS Control 1 Channel B	Right T2 Heater	AHRS Fan 2
Right ACS Manual	Copilot Windshield Wiper	GPS 2 <1027>
	Right Windshield Heater Control	
	Right EFIS CRT Dimming	

EMERGENCY BUS	SERVICE BUS	UTILITY BUS
APU Battery Direct Bus Feed	Service Lights	Right Cabin Reading Lights
FIREX	Boarding Lights	
Engine and APU Fuel SOVs	Navigation Lights	
Hydraulic SOVs	Toilet Lights	
	Galley Area Lights	
	Beacon Lights	
	Water System	

ESSENTIAL BUS		
EICAS DCU 1	Stall Protection Right Channel	Anti-Ice Control Channel B
RTU 1	Left EFIS CRT Dimming	Instrument Flood Lights
Pilot Audio	EFIS Control Panel 1	Emergency Lights
Cockpit Voice Recorder	Air Data Computer 1	ADF 1
Door Indication 1 and 2	Primary Flight Director 1	Transponder 1
ACS Control 2 Channel B	Multifunctional Display 1	VHF Navigation 1
Left ACS Manual	Crossflow Pump Control	Attitude Heading 1
Display Fan Control	Fuel System Control	AHRS Fan 1
Right ACS Pressure Sensors	Left Static Heater	Bleed Air SOVs
Flap and Slat Control Channel 1	ADS Heater Control 1	Thrust Reversers
SSCU 2	ADS Standby Heater Control	Right Engine Oil Pressure
Pitch Feel 2 Rudder Travel Limit	Left Window Heater Control	Left T2 Heater

BATTERY BUS		
EICAS DCU 1 and 2	ACPC Control 3	Gravity Fuel Crossflow
EICAS Primary Display	ADG Deployment	Fuel Transfer SOVs
EICAS Secondary Display	ACS Control 1 Channel A	APU Fuel Pump
EICAS Control Panel	Ram Air SOV	Hydraulic System 3 Indication
Right Lamp Driver Unit	Manual Cabin Pressure Control	Cowl Anti-Ice Valves
EICAS Dimming	Passenger Oxygen Deployment	Wing Anti-ice Isolation Valve
Left AFCS	Crew Oxygen Monitor	PSEU Channel A and B
MDC	Cargo Smoke Detection	Weight-On-Wheels
Left IAPS Fan	Fire Detection	Passenger Signs
APU Control	MLG Bay Overheat Detection	Wing Landing Lights
APU ECU Primary	Flap and Slat Control Channel 2	Map Lights
VHF Communication 1	Aileron and Rudder Trim Indication	Cabin Utility Lights
Emergency Tuning	Stall Protection Stick Pusher	Overhead Panel Lights
Pilot, Copilot and Observer Audio	Stall Protection Left Channel	EICAS and RTU Dimming
Cabin Interphone	Standby Instrument	Left Engine Oil Pressure
Passenger Address	Clock 1	Engine Starting
Emergency Bus Feed	Left Fuel Pump and Control	FADEC
IDG Disconnect	Fuel System Control	Engine Ignition B
Generator Control Units	Right T2 Heater	

MAIN BATTERY DIRECT BUS	APU BATTERY DIRECT BUS	
Main Battery Power Sensors	APU ECU Secondary	Service Bus Feed
Main Battery Control	APU Door Actuator	Emergency Bus Feed
External AC Power	APU Battery Power Sensors	Refuel/Defuel Control
DCPC 2	APU Battery Control	Emergency Refuel
Main Battery Charger Output	DCPC 1	Engine Oil Indication
Clocks	External AC Power	Engine Oil Replenishment <1213>
Cockpit Dome Lights		

E. System Circuit Breakers

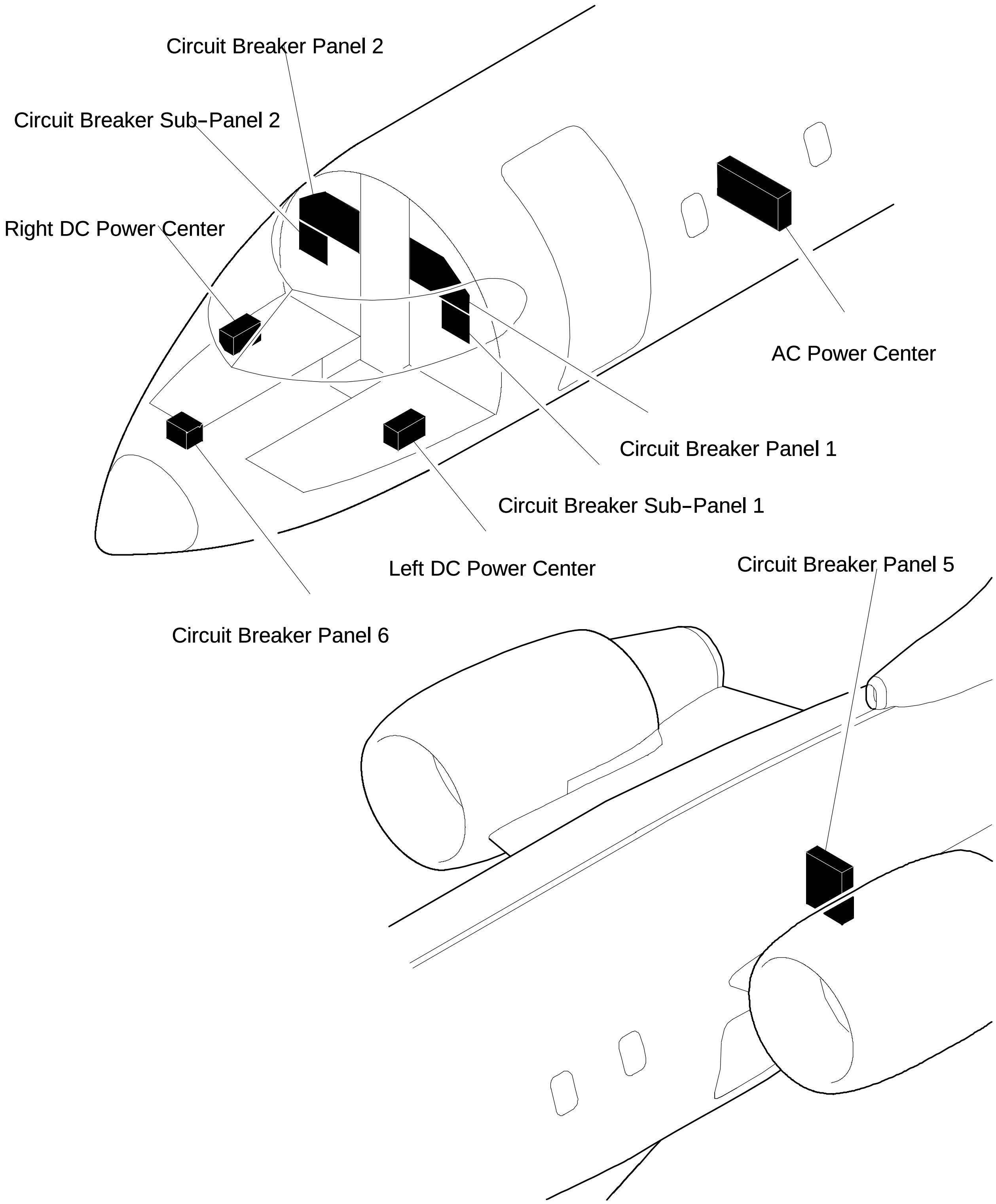
SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
DC Electrical Power	Transformer Rectifier Units	TRU 1	AC BUS 1	1	B5	
		ESS TRU 1	AC ESSENTIAL		T2	
		ESS TRU 2B			T5	
		TRU 2	AC BUS 2	2	B5	
		ESS TRU 2A			C5	
	DC Bus 1	DC 1 FEED	DC BUS 1	1	D6	
		PWR SENS			D14	
		RCCB DC 1			D3	
	DC Bus 2	DC 2 FEED	DC BUS 2	2	L8	
		PWR SENS			L10	
		RCCB DC 2		1	D4	
	DC Essential Bus	DC ESS FEED	DC ESSENTIAL	2	R6	
		PWR SENS			R11	
		RCCB DC ESS		1	D5	
	DC Emergency Bus	EMER BUS FEED	APU BATT DIRECT BUS	5	A10	
		EMER BUS FEED	BATTERY BUS	1	L10	
		PWR SENS	DC EMERGENCY		R11	
	DC Service Bus	SERV BUS FEED	APU BATT DIRECT BUS	5	A9	
		SERV BUS FEED	DC BUS 2	2	F5	
		PWR SENS	DC SERVICE		M11	
	DC Utility Bus	PWR SENS	DC UTILITY		L1	
		DC UTILITY FEED			L7	
	Battery Bus	BATT BUS FEED	BATTERY BUS		N2	
		PWR SENS		1	L3	
	DC Power Center	DCPC	APU BATT DIRECT BUS	5	A4	
		DCPC 2	MAIN BATTERY DIRECT BUS	6	B1	

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
DC Electrical Power	APU Battery	APU BATT DIR FEED	DC EMERGENCY	1	R1	
		APU BATT CONT	APU BATT DIRECT BUS	5	A3	
		APU BATT PWR SENS			A1	
		APU BATT PWR SENS REF			A2	
		RCCB APU BATT		1	D2	
	Main Battery	MAIN BATT CONT	MAIN BATTERY DIRECT BUS	6	A3	
		MAIN BATT PWR SENS			A1	
		MAIN BATT PWR SENS REF			A2	
		RCCB MAIN BATT		1	D1	
	Battery Charging	APU CHARGER	AC SERVICE	2	E5	
		MAIN BATTERY CHARGER	AC BUS 1	1	C5	
		MAIN BATT CHARGER OUTPUT	MAIN BATTERY DIRECT BUS	6	B6	

1. CIRCUIT BREAKER PANELS

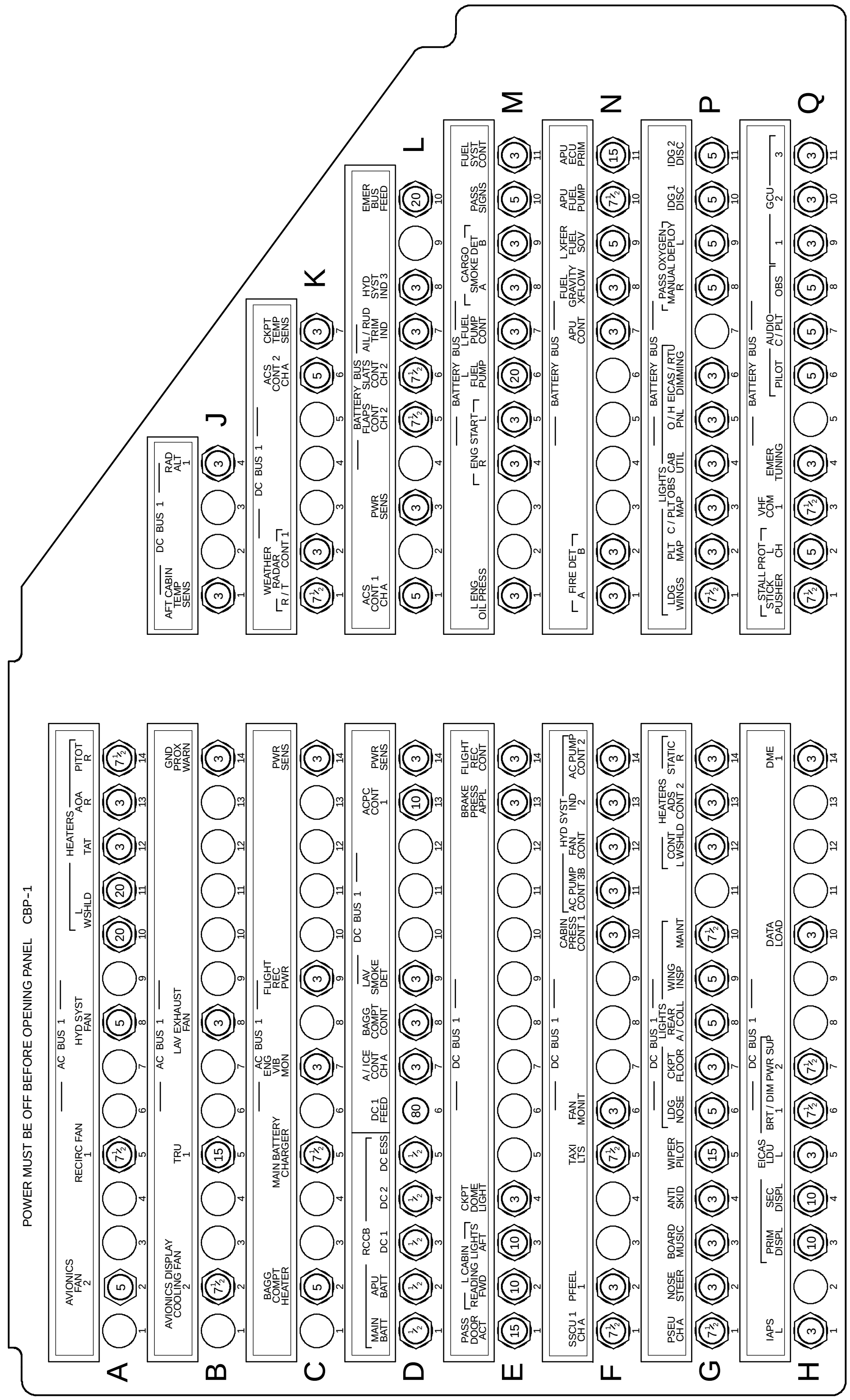
There are eight circuit breaker panels (CBP's) located in the aircraft (Refer to figure 1). There are two circuit breaker panels, identified as CBPs 1 and 2, located in the flight compartment. A circuit breaker panel, identified as CBP–5, is located in the aft equipment compartment. Another circuit breaker panel, identified as CBP–6, is located in the forward equipment compartment. Circuit breakers are also installed on the AC power center, the left and right DC power centers and on the galley control panel (not shown). Circuit breaker panels 1, 2 and the galley circuit breakers are crew accessable during flight. Circuit breaker panels 5, 6, and the circuit breakers on the AC and DC power centers are only accessable on the ground.

The circuit breakers are clearly identified. For circuit breaker referencing, each circuit breaker panel is laid out in an alphanumeric grid with letters running down the side of the panel and numbers running across each row (Refer to figure 2). For example, the location of a circuit breaker on circuit breaker panel 1, in the 4th row, column 2, would be identified as CBP1–D2. In this instance, D2 is the circuit breaker for the APU BATT.



Panel Overview
Figure 07–40–1

CIRCUIT BREAKER PANEL 1
(Behind Pilot's Seat)



Circuit Breaker Panel 1 (For Reference Only)
Figure 07−40−2

2. ATA NUMBERING AND CIRCUIT BREAKER LOCATION

The aircraft circuit breakers are listed in this chapter by ATA as follows:

SUBJECT	ATA	FCOM 1 CHAPT
AIR CONDITIONING	21	8
AUTO FLIGHT	22	3
COMMUNICATIONS	23	5
ELECTRICAL	24	7
EQUIPMENT	25	9 & 10
FIRE PROTECTION	26	10
FLIGHT CONTROLS	27	11
FUEL	28	13
HYDRAULICS	29	14
ICE & RAIN	30	15
INDICATING & RECORDING	31	2
LANDING GEAR	32	16
LIGHTING	33	17
NAVIGATION	34	12 & 18
OXYGEN	35	9
PNEUMATICS	36	19
WATER & WASTE	38	21
MDC (DIAGNOSTICS)	45	2
APU	49	4
DOORS	52	6
POWERPLANT	71 TO 80	20

The circuit breakers for each ATA are listed by sub-section and alphabetically as follows:

3. ATA 21 - AIR CONDITIONING

A. AVIONICS COOLING

CB IDENT	LOCATION
AVIONICS DISPLAY COOLING FAN 1	CBP1-U2
AVIONICS DISPLAY COOLING FAN 2	CBP1-B2 (3-PHASE)

AVIONICS COOLING FAN 1	CBP1–V2
AVIONICS COOLING FAN 2	CBP1–A2
DISPLAY FAN CONT	CBP2–T10
FAN MONIT	CBP1–F6

B. BAGGAGE COMPARTMENT

CB IDENT	LOCATION
BAGG COMPT CONT	CBP1–D8
BAGG COMPT HEATER <1201>	CBP1–C2 (3–PHASE)

C. GALLEY AND LAVATORY SYSTEM

CB IDENT	LOCATION
GALLEY EXHAUST FAN	CBP2–B8 (3–PHASE)
GALLEY HEATER	CBP2–B11 (3–PHASE)
GALLEY HEATER CONT	CBP2–F11
LAV EXHAUST FAN	CBP1–B8 (3–PHASE)

D. PRESSURIZATION

CB IDENT	LOCATION
CABIN PRESS CONT 1	CBP1–F10
CABIN PRESS CONT 2	CBP2–F10
CABIN PRESS MAN CONT	CBP2–P5

E. RAM AIR AND RECIRC SYSTEM

CB IDENT	LOCATION
RAM AIR SOV	CBP2–P4
RECIRC FAN 1	CBP1–A5
RECIRC FAN 2	CBP2–A5

F. TEMPERATURE CONTROL

CB IDENT	LOCATION
ACS CONT 1 CH A	CBP1−L1
ACS CONT 1 CH B	CBP2−J4
ACS CONT 2 CH A	CBP1−K6
ACS CONT 2 CH B	CBP2−K7
ACS L MAN	CBP2−T8
ACS R MAN	CBP2−K6
ACS L PRESS SENS	CBP2−F6
ACS R PRESS SENS	CBP2−T11
AFT CABIN TEMP SENS	CBP1−J1
CKPT TEMP SENS	CBP1−K7
FWD CABIN TEMP SENS	CBP2−J1

4. ATA 22 − AUTO FLIGHT

CB IDENT	LOCATION
IAPS L or (IAPS L FMS)	CBP1−H1
IAPS L AFCS/MDC	CBP2−P6
IAPS L FAN	CBP2−P7
IAPS R	CBP2−H1
IAPS R AFCS	CBP2−H2
IAPS R FAN	CBP2−H3

5. ATA 23 − COMMUNICATIONS

A. AUDIO INTEGRATING SYSTEM

CB IDENT	LOCATION
AUDIO − C/PLT	CBP1−Q7
AUDIO − PILOT	CBP1−Q6
AUDIO PILOT	CBP2−V2
AUDIO − OBS	CBP1−Q8 and CBP2−H4
CABIN INPH	CBP2−Q3
PASS ADDR	CBP2−Q4

B. ANNOUNCEMENT AND BOARDING MUSIC SYSTEM

CB IDENT	LOCATION
BOARD MUSIC	CBP1–G3

C. VHF

CB IDENT	LOCATION
EMER TUNING	CBP1–Q4
RTU 1	CBP2–U9
RTU 2	CBP2–K7
VHF COM 1	CBP1–Q3
VHF COM 2	CBP2–H10

6. ATA 24 – ELECTRICAL

A. AC SYSTEM

CB IDENT	LOCATION
AC ESS FEED	CBP1–S2
AC ESS FEED 1	AC PWR CTR
AC ESS FEED2	AC PWR CTR
ACPC CONT 1	CBP1–D13
ACPC CONT 2	CBP2–L9
ACPC CONT 3	CBP2–N1
AC SERVICE FEED	CBP2–E2
APU GEN POR	AC PWR CTR
CABIN FEED 1	AC PWR CTR
BATT BUS FEED	CBP2–N2
CABIN FEED 2	AC PWR CTR
CTRL PWR 1	AC PWR CTR
CTRL PWR 2	AC PWR CTR

CTRL PWR 3	AC PWR CTR
EXT AC POR	AC PWR CTR
EXT AC PWR 1	CBP6–A8
EXT AC PWR	CBP5–A8
EXT AC V/F SENSE	AC PWR CTR
GCU – 1	CBP1–Q9
GCU – 2	CBP1–Q10
GCU – 3	CBP1–Q11
GEN 1 POR	AC PWR CTR
GEN 2 POR	AC PWR CTR
IDG 1 DISC	CBP1–P10
IDG 2 DISC	CBP1–P11
PWR SENS	CBP1–S11 and C14
PWR SENS	CBP2–D10 and C14
SERVICE BUS FEED	AC PWR CTR
TRU EMP IN	AC PWR CTR
TRU EMP OUT	AC PWR CTR

B. ADG

CB IDENT	LOCATION
AC ESS FEED	ADG PWR CTR
ADG DEPLOY – AUTO	CBP2–N6
ADG DEPLOY – MAN	CBP2–N7
ADG HEATER	CBP1–C13
ADG LOADS 1	ADG PWR CTR
ADG LOADS 2	ADG PWR CTR
ADG V/F SENSE	ADG PWR CTR

C. DC SYSTEM

CB IDENT	LOCATION
APU BATT CONT	CBP5–A3
APU BATT DIR FEED	CBP1–R1

APU BATT PWR SENS	CBP5–A1
APU BATT PWR SENS REF	CBP5–A2
APU CHARGER	CBP2–E5
BATT/ESS XFEED	R DC PWR CTR
DC 1 FEED	CBP1–D6
DC1/2 XFEED	R DC PWR CTR
DC 2 FEED	CBP2–L8
DC ESS FEED	CBP2–R6 and DC PWR CTR
DC UTILITY FEED	CBP2–L7
DCPC 1	CBP5–A4
DCPC 2	CBP6–B1
EMER BUS FEED	CBP1–L10
EMER BUS FEED	CBP5–A10
ESS TRU 1	CBP1–T2
ESS TRU 1 – LOGIC PWR	L DC PWR CTR
ESS TRU 1 – SENSE HI	L DC PWR CTR
ESS TRU 1 – SENSE LO	L DC PWR CTR
ESS TRU 2A	CBP2–C5
ESS TRU 2B	CBP1–T5
ESS TRU 2 – LOGIC PWR	R DC PWR CTR
ESS TRU 2 – SENSE HI	R DC PWR CTR
ESS TRU 2 – SENSE LO	R DC PWR CTR
FEED – BATT BUS	R DC PWR CTR
FEED – DC 2	R DC PWR CTR
FEED – DC UTIL	R DC PWR CTR
MAIN BATT CHARGER OUTPUT	CBP6–B6
MAIN BATT CONT	CBP6–A3
MAIN BATT PWR SENS	CBP6–A1
MAIN BATT PWR SENS REF	CBP6–A2
MAIN BATTERY CHARGER	CBP1–C5
PWR SENS	CBP1–D14, L3, R11
PWR SENS	CBP2–L1, L10, M11, R11
RCCB – APU BATT	CBP1–D2
RCCB – DC 1	CBP1–D3
RCCB – DC 2	CBP1–D4
RCCB – DC ESS	CBP1–D5

RCCB – MAIN BATT	CBP1–D1
SERV BUS FEED	CBP2–F5 and CBP5–A9
TRU 1	CBP1–B5
TRU 1 – LOGIC POWER	L DC PWR CTR
TRU 1 – SENSE HI	L DC PWR CTR
TRU 1 – SENSE LO	L DC PWR CTR
TRU 2	CBP2–B5
TRU 2 – LOGIC POWER	R DC PWR CTR
TRU 2 – SENSE HI	R DC PWR CTR
TRU 2 – SENSE LO	R DC PWR CTR
XFEED – BATT/ESS	L DC PWR CTR
XFEED – DC 1/2	L DC PWR CTR

7. ATA 25 – EQUIPMENT AND FURNISHINGS

CB IDENT	LOCATION
COFFEE MAKER 1	GALLEY CONTROL PANEL
COFFEE MAKER 2	GALLEY CONTROL PANEL
OUTLET	GALLEY CONTROL PANEL
OVEN 1	GALLEY CONTROL PANEL
OVEN 2	GALLEY CONTROL PANEL

8. ATA 26 – FIRE PROTECTION

A. DETECTION

CB IDENT	LOCATION
CARGO – SMOKE DET A	CBP1– M8
CARGO – SMOKE DET B	CBP1–M9
FIRE DET – A	CBP1–N1
FIRE DET – B	CBP1–N2
LAV SMOKE DET	CBP1–D9
MLG BAY OVHT DET	CBP2–N9

B. EXTINGUISHING

CB IDENT	LOCATION
FIREX – A	CBP1–R2
FIREX – B	CBP1–R3

9. ATA 27 – FLIGHT CONTROLS

A. AILERONS

CB IDENT	LOCATION
AIL TRIM	CBP2– F3
AIL/RUD TRIM IND	CBP1–L7

B. ELEVATORS

CB IDENT	LOCATION
P FEEL 1 RTL 1	CBP1–F2
P FEEL 2 RTL 2	CBP2–R5

C. FLAPS

CB IDENT	LOCATION
FLAPS 1	AC PWR CTR
FLAPS 2	AC PWR CTR
FLAPS CONT CH 1	CBP2–R1
FLAPS CONT CH 2	CBP1–L5

D. HORIZONTAL STABILIZER

CB IDENT	LOCATION
P FEEL 1 RTL 1	CBP1–F2
P FEEL 2 RTL 2	CBP2–R5
PITCH TRIM 1	AC PWR CTR
PITCH TRIM 2	AC PWR CTR

SSCU 1 CH A	CBP1–F1
SSCU 1 CH B	CBP2–F1
SSCU 2 CH A	CBP2–R3
SSCU 2 CH B	CBP2–R4

E. RUDDER

CB IDENT	LOCATION
AIL/RUD TRIM IND	CBP1–L7
RUDDER TRIM	CBP2–F2

F. SLATS

CB IDENT	LOCATION
SLATS CONT CH 1	CBP2–R2
SLATS CONT CH 1	CBP1–L6
SLATS 1	AC PWR CTR
SLATS 2	AC PWR CTR

G. SPOILERS

CB IDENT	LOCATION
SSCU 1 CH A	CBP1–F1
SSCU 1 CH B	CBP2–F1
SSCU 2 CH A	CBP2–R3
SSCU 2 CH B	CBP2–R4

H. STALL PROTECTION

CB IDENT	LOCATION
STALL PROT – L CH	CBP1–Q2
STALL PROT – R CH	CBP2–U5
STALL PROT – STICK PUSHER	CBP1–Q1

10. ATA 28 – FUEL

A. DISTRIBUTION

CB IDENT	LOCATION
APU FUEL PUMP	CBP1–N10
FUEL SOV – L ENG	CBP1–R8
FUEL SOV – R ENG	CBP1–R7
FUEL SOV – APU	CBP1–R9
L FUEL PUMP	CBP1–M6
L FUEL PUMP CONT	CBP1–M7
R FUEL PUMP	CBP2–G9
R FUEL PUMP CONT	CBP2–G10

B. MANAGEMENT

CB IDENT	LOCATION
CROSSFLOW PUMP	CBP1–S5
CROSSFLOW PUMP CONT	CBP2–R7
FUEL GRAVITY XFLOW	CBP1–N8
L XFER FUEL SOV	CBP1–N9
R XFER FUEL SOV	CBP2–P8

C. REFUELING/DEFUELING

CB IDENT	LOCATION
EMER REFL	CBP5–B5
FUEL DEFL	CBP5–B4

D. INDICATION

CB IDENT	LOCATION
FUEL SYST CONT	CBP1–M11
FUEL SYS CONT	CBP2–U11

11. ATA 29 – HYDRAULICS

A. SYSTEMS 1 AND 2

CB IDENT	LOCATION
HYD SOV – L ENG	CBP1–R6
HYD SOV – R ENG	CBP1–R5
HYD SYST – AC PUMP CONT 1	CBP2–F13
HYD SYST – AC PUMP CONT 2	CBP1–F14
HYD SYST FAN	CBP1–A8
HYD SYST – FAN CONT	CBP1–F12
HYD SYST – IND 1	CBP2–F12
HYD SYST – IND 2	CBP1–F13

B. SYSTEM 3

CB IDENT	LOCATION
HYD SYST – AC PUMP CONT 3A	CBP2–F14
HYD SYST – AC PUMP CONT 3B	CBP1–F11
HYD SYST IND 3	CBP1–L8

12. ATA 30 – ICE & RAIN

A. AIR DATA ANTI–ICE

CB IDENT	LOCATION
HEATERS – ADS CONT 1	CBP2–S2
HEATERS – ADS CONT 2	CBP1–G13
HEATERS – ADS CONT STBY	CBP2–S3
HEATERS – AOA L	CBP1–T8
HEATERS – AOA R	CBP1–A13
HEATERS – PITOT L	CBP1–T7
HEATERS – PITOT R	CBP1–A14
HEATERS – PITOT STBY	CBP1–T9
HEATERS – STATIC L	CBP2–S1
HEATERS – STATIC R	CBP1–G14
HEATERS – TAT	CBP1–A12

B. COWL ANTI–ICE

CB IDENT	LOCATION
A/ICE – VALVE L ENG	CBP2–N3
A/ICE – VALVE R ENG	CBP2–N4

C. ICE DETECTION

CB IDENT	LOCATION
ICE DET 1	CBP1–T11
ICE DET 2	CBP2–A14

D. WING ANTI–ICE

CB IDENT	LOCATION
A/ICE CONT CH A	CBP1–D7
A/ICE CONT CH B	CBP2–T1
WING A/ICE ISOL	CBP2–N5

E. WINDSHIELD ANTI–ICE

CB IDENT	LOCATION
HEATERS – CONT L WIND	CBP2– S4
HEATERS – CONT L WSHLD	CBP1–G12
HEATERS – CONT R WIND	CBP2–G14
HEATERS – CONT R WSHLD	CBP2–G13
HEATER – L WIND	CBP1–U10
HEATERS – L WSHLD	CBP1–A10
HEATERS – L WSHLD	CBP1–A11
HEATER – R WIND	CBP2–C7
HEATERS – R WSHLD	CBP2–A10
HEATERS – R WSHLD	CBP2–A11

F. WINDSHIELD WIPERS

CB IDENT	LOCATION
WIPER C/PILOT	CBP2–G5
WIPER PILOT	CBP1–G5

13. ATA 31 – INDICATING & RECORDING

A. CLOCKS

CB IDENT	LOCATION
CLOCK 1	CBP2–N11 and CBP6–B7
CLOCK 2	CBP2–H5 and CBP6–B8

B. EICAS

CB IDENT	LOCATION
EICAS – CONT PNL	CBP2–Q7
EICAS – DCU 1	CBP2–Q1, U8
EICAS – DCU 2	CBP2–H13, Q2
EICAS – LDU L	CBP1–H5
EICAS – LDU R	CBP2–Q8
EICAS – PRIM DISPL	CBP1–H3 and CBP2–Q5
EICAS – SEC DISPL	CBP1–H4 and CBP2–Q6

C. RECORDERS

CB IDENT	LOCATION
	LOCATION
CKPT VOICE REC	CBP2–V7
CREW FORCE SYST <2222>	CBP1–E12
DATA LOAD <1018>	CBP1–H10
FLIGHT REC CONT	CBP1–E14

FLIGHT REC PWR	CBP1−C9
QAR <1204>	CBP2−C13

14. ATA 32 − LANDING GEAR

A. BRAKES

CB IDENT	LOCATION
ANTI−SKID	CBP1−G4 and CBP2−G4
BRAKE PRESS APPL	CBP1−E13
BRAKE PRESS IND	CBP2−G3

B. NOSE WHEEL STEERING

CB IDENT	LOCATION
NOSE STEER	CBP1−G2 and CBP2−G2

C. PROXIMITY SENSING

CB IDENT	LOCATION
PSEU CH A	CBP1−G1 and CBP2−P1
PSEU CH B	CBP2−G1 and CBP2−P2
WOW RELAY	CBP2−P3

15. ATA 33 − LIGHTING

A. EMERGENCY LIGHTING

CB IDENT	LOCATION
EMER LTS	CBP2− U3

B. EXTERNAL LIGHTING

CB IDENT	LOCATION
BEACON LIGHTS	CBP2−M8

LIGHTS – LDG NOSE	CBP1–G6
LIGHTS – LDG WINGS	CBP1–P1
LIGHTS – NAV	CBP2–M4
LIGHTS – REAR A/COLL	CBP1–G8
LIGHTS – WING A/COLL	CBP2–G8
LIGHTS – WING INSP	CBP1–G9
LOGO LIGHTS <1020>	CBP2–D11
TAXI LTS	CBP1–F5

C. FLIGHT COMPARTMENT LIGHTING

CB IDENT	LOCATION
CKPT DOME LIGHTS	CBP1–E4 and CBP6–B5
L EFIS CRT DIMMING	CBP2–U4
EICAS – BRT / DIM PWR SUP 1	CBP1–H6 and CBP2–Q10
EICAS – BRT / DIM PWR SUP 2	CBP1–H7 and CBP2–Q11
INST FLOOD LTS	CBP2–U2
INTEG LTS – C/PLT PNLS	CBP2–B14
INTEG LTS – CB PNLS	CBP1–V4
INTEG LTS – CTR PNLS	CBP1–V6
INTEG LTS – O/H PNLS	CBP1–V7
INTEG LTS – PLT PNLS	CBP1–V5
LIGHTS – CHART HOLDER	CBP2–G6
LIGHTS – CKPT FLOOR	CBP1–G7
LIGHTS – C/PLT MAP	CBP2–G7
LIGHTS – C/PLT OBS MAP	CBP1–P3
LIGHTS – EICAS/RTU DIMMING	CBP1–P6
LIGHTS – O/H PNL	CBP1–P5
LIGHTS – PLT MAP	CBP1–P2
R EFIS CRT DIMMING	CBP2–J3

D. PASSENGER COMPARTMENT LIGHTING

CB IDENT	LOCATION
CABIN LIGHTING CEILING	CBP1–T10

CABIN LIGHTING CEILING L	CBP2–D14
CABIN LIGHTING CEILING R	CBP2–D13
CABIN LIGHTING SIDEWALL L	CBP2–E14
CABIN LIGHTING SIDEWALL R	CBP2–D13
L CABIN – READING LIGHTS – AFT	CBP1–E8
L CABIN – READING LIGHTS – FWD	CBP1–E6
L CABIN – READING LIGHTS – MID	CBP1–E7
LIGHTS – BOARD	CBP2–M3
LIGHTS – CABIN UTIL	CBP1–P4
LIGHTS – GALLEY AREA	CBP2–M6
LIGHTS – TOILET	CBP2–M5
PASS SIGNS	CBP1–M10
R CABIN – READING LIGHTS AFT	CBP2–L4
R CABIN – READING LIGHTS FWD	CBP2–L3

E. SERVICE AND MAINTENANCE LIGHTING

CB IDENT	LOCATION
LIGHTS – AFT SERV	CBP2–M2
LIGHTS – FWD SERV	CBP2–M1
LIGHTS – MAINT	CBP1–G10
LIGHTS – SERV AREA	CBP2–M7

16. ATA 34 – NAVIGATION

A. AIR DATA SYSTEM

CB IDENT	LOCATION
ADC 1	CBP2–V3
ADC 2	CBP2–H6

B. AUTOMATIC DIRECTION FINDER (ADF)

CB IDENT	LOCATION
ADF 1	CBP2–V4
ADF 2	CBP2–H7

C. AIR TRAFFIC CONTROL TRANSPONDER SYSTEM (ATC)

CB IDENT	LOCATION
XPDR 1	CBP2–V5
XPDR 2	CBP2–H8

D. INERTIAL REFERENCE SYSTEM (IRS) <1025>

CB IDENT	LOCATION
AHRS FAN 1	CBP2–V9
AHRS FAN 2	CBP2–K5
ATT HDG 1	CBP2–V8
ATT HDG 2	CBP2–K4
IRU FAN <1025>	CBP2–C12

E. DISTANCE MEASURING EQUIPMENT (DME)

CB IDENT	LOCATION
DME 1	CBP1–H14
DME 2	CBP2–H14

F. ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS)

CB IDENT	LOCATION
EFIS CONT PNL 1	CBP2–U7
EFIS CONT PNL 2	CBP2–K3
EFIS CRT DIMMING	CBP2–U4
MFD 1	CBP2–V11

MFD 2	CBP2-K2
PFD 1	CBP2-V10
PFD 2	CBP2-K1

G. FLIGHT MANAGEMENT SYSTEM (FMS)

CB IDENT	LOCATION
CDU 1 < 1214>	CBP1-H9
CDU 2 < 1214>	CBP2-H9
FMS 1 <1214>	CBP1-H12
FMS 2 <1214>	CBP2-H12

H. GLOBAL POSITIONING SYSTEM (GPS)

CB IDENT	LOCATION
GPS 1	CBP1-G11
GPS 2 <1027>	CBP2-G11

I. GROUND PROXIMITY WARNING SYSTEM (GPWS)

CB IDENT	LOCATION
GND PROX WARN	CBP1-B14

J. RADIO ALTIMETER

CB IDENT	LOCATION
RAD ALT 1	CBP1-J4
RAD ALT 2 <1045>	CBP2-J2

K. STANDBY INSTRUMENTS

CB IDENT	LOCATION
INT STBY INST	CBP2-N10

L. TRAFFIC COLLISION AVOIDANCE SYSTEM (TCAS)

CB IDENT	LOCATION
TCAS	CBP1–V10

M. VHF NAVIGATION

CB IDENT	LOCATION
VHF NAV 1	CBP2–V6
VHF NAV 2	CBP2–H11

N. WEATHER RADAR

CB IDENT	LOCATION
WEATHER RADAR – CONT 1	CBP1– K2
WEATHER RADAR – R/T	CBP1–K1

17. ATA 35 – OXYGEN

CB IDENT	LOCATION
CREW OXYGEN MONITOR	CBP2–P11
PASS OXYGEN – AUTO DEPLOY L	CBP2–P10
PASS OXYGEN – AUTO DEPLOY R	CBP2–P9
PASS OXYGEN – MANUAL DEPLOY L	CBP1–P9
PASS OXYGEN – MANUAL DEPLOY R	CBP1–P8

18. ATA 36 – PNEUMATICS

CB IDENT	LOCATION
ACS – L PRESS SENSE	CBP2–F6
ACS R PRESS SENS	CBP2–T11
BLEED SOV L	CBP2–S10
BLEED SOV R	CBP2–S11

19. ATA 38 – WATER AND WASTE

CB IDENT	LOCATION
AC POWER	GALLEY CONTROL PANEL
AFT DRAIN MAST	GALLEY CONTROL PANEL
FWD DRAIN MAST	GALLEY CONTROL PANEL
TOILET	CBP2–D5
WASTE SYST	CBP2–M9
WATER CONT	CBP2–M10
WATER SYSTEM	CBP2–D8 (3 PHASE)

20. ATA 45 – MDC (DIAGNOSTICS)

CB IDENT	LOCATION
DATA LOAD <1018>	CBP1–H10
IAPS L AFCS / MDC	CBP2–P6

21. ATA 49 – APU

CB IDENT	LOCATION
APU CONT	CBP1–N7
APU DOOR ACT	CBP5–B1
APU ECU PRIM	CBP1–N11
APU ECU SEC	CBP5–A6
APU FUEL PUMP	CBP1–N10
FUEL SOV – APU	CBP1–R9

22. ATA 52 – DOORS

CB IDENT	LOCATION
DOOR IND 1	CBP2–R8
DOOR IND 2	CBP2–R9
PASS DOOR ACT	CBP1–E1

23. ATA 71 TO 80 – POWERPLANT

A. CONTROLS

CB IDENT	LOCATION
FADEC – L CH A	CBP5–B8
FADEC – L CH B	CBP5–B9
FADEC – R CH A	CBP5–B6
FADEC – R CH B	CBP5–B7
T2 HEATER L	CBP2–S8
T2 HEATER R	CBP2–N8

B. IGNITION AND STARTING

CB IDENT	LOCATION
ENG IGN A	CBP1–U7
ENG IGN B	CBP5–B10
ENG START – L	CBP1–M5
ENG START – R	CBP1–M4

C. INDICATING

CB IDENT	LOCATION
ENG VIB MON	CBP1–C7

D. OIL SYSTEM

CB IDENT	LOCATION
ENG OIL IND	CBP5–B2
ENG OIL REPL <1213>	CBP5–B3
L ENG OIL PRESS	CBP1–M1
R ENG OIL PRESS	CBP2–S7

E. THRUST REVERSER

CB IDENT	LOCATION
THRUST REV 1	CBP2–S5
THRUST REV 2	CBP2–S6

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CHAPTER 9 – EMERGENCY EQUIPMENT

LIST OF ILLUSTRATIONS

1. INTRODUCTION

This chapter describes the systems and equipment which are essential to the safety of the passengers and crew during a fire, rapid decompression, ditching and emergency evacuation. The aircraft emergency equipment includes the following:

–Oxygen equipment

–Evacuation devices (ELT)

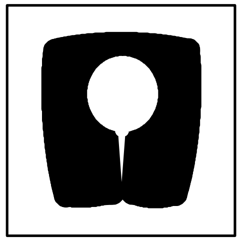
–Fire fighting equipment

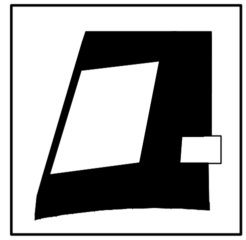
–Over water emergency equipment

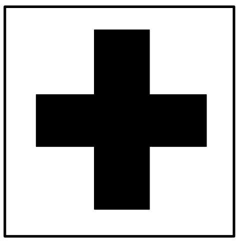
–First aid equipment.

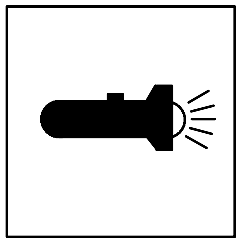
Placards containing symbols are used to indicate the location of the emergency equipment.

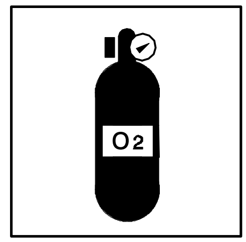

MEGAPHONE


LIFE VEST


SMOKE HOOD
(PROTECTIVE BREATHING
EQUIPMENT)


FIRST AID KIT


FLASHLIGHT



OXYGEN CYLINDER


HALON FIRE
EXTINGUISHER

Placard
Figure 09–10–1

1. OXYGEN

The oxygen systems supply oxygen to the flight crew and passengers in emergencies such as depressurization, decompression, smoke, fumes, first aid and during certain aircraft operations. The aircraft oxygen systems consists of two independent oxygen systems. One system supplies stored oxygen to the flight compartment crew and the other supplies generated oxygen to the passengers and flight attendants. In addition, portable oxygen bottles are provided in specific areas in the passenger compartment.

A. Crew Oxygen System

The crew oxygen system consists of an oxygen bottle, a ground servicing panel and three face masks.

B. Crew Oxygen Bottle

The crew oxygen bottle contains 50.0 cubic feet (1.419 liters) of oxygen and is located in an enclosure behind the entrance storage compartment. Normal bottle charge pressure is 1850 psi at 70°F (12.76 MPa at 21°C). The enclosure is well ventilated with a permanent flow of ECS air to the under floor avionics compartment. The air is then dumped overboard through the outflow valve.

The bottle assembly consists of a manual (lever type) shut-off valve, regulator, pressure gauge, pressure transducer, pressure switch, and a pressure relief valve.

The bottle outlet is monitored by a pressure transducer. If the outlet pressure decreases below 1410 psig (9.721 MPa), the EICAS will display an OXY LO PRESS caution message on the primary page.

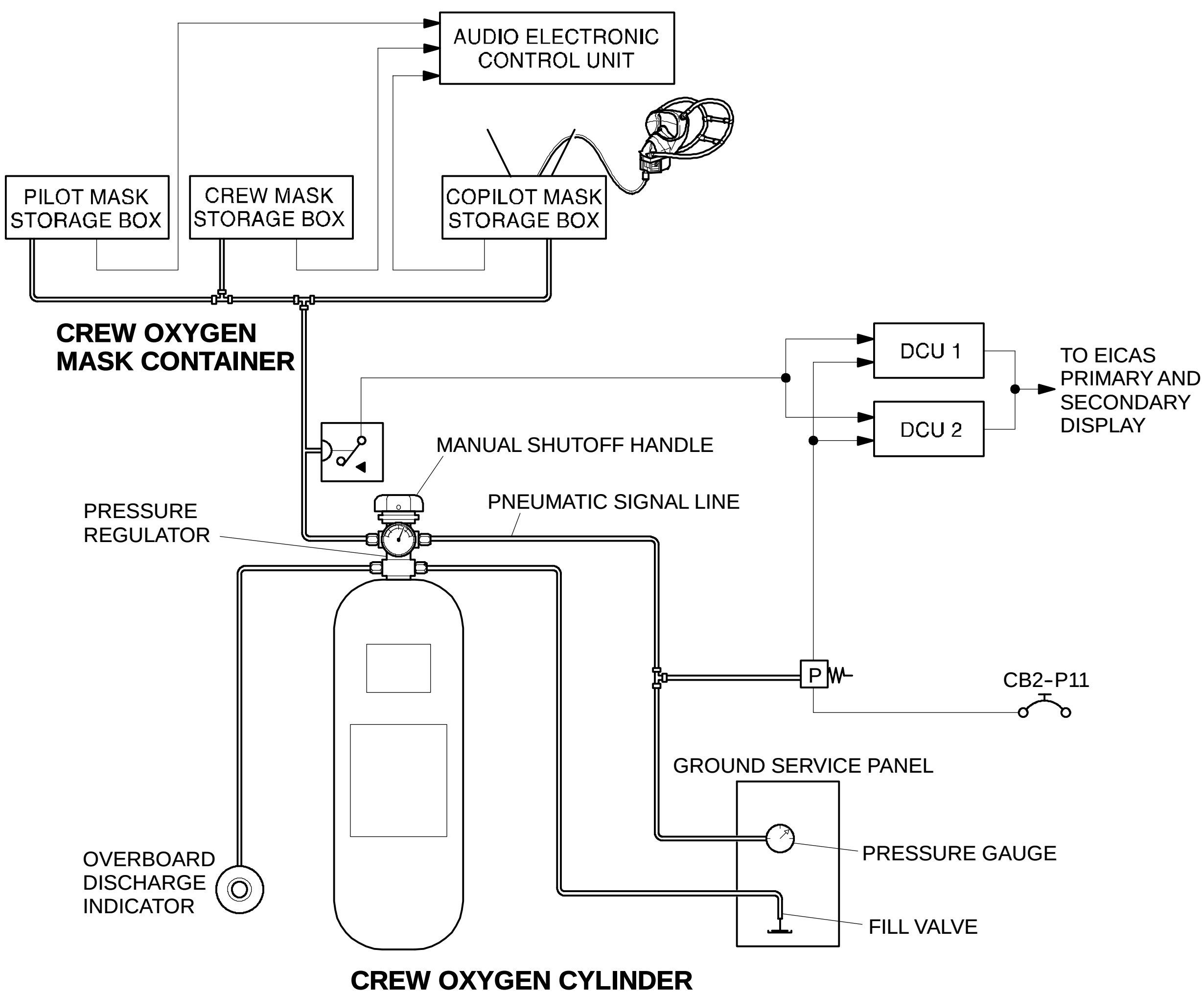
Output pressure is regulated to between 60 and 85 psig. If the output exceeds 94 psig, a low pressure relief valve opens venting the oxygen. The cylinder is protected from over pressure by a frangible high pressure relief valve. If the cylinder pressure reaches 2500 to 2775 psig, the valve ruptures and the oxygen is vented overboard through the high pressure discharge indicator on the left side of the forward fuselage.

The pressure switch monitors the outlet pressure from the regulator. If the pressure decreases below 45 psig, an OXY LO PRESS caution message will be displayed on the EICAS primary page.

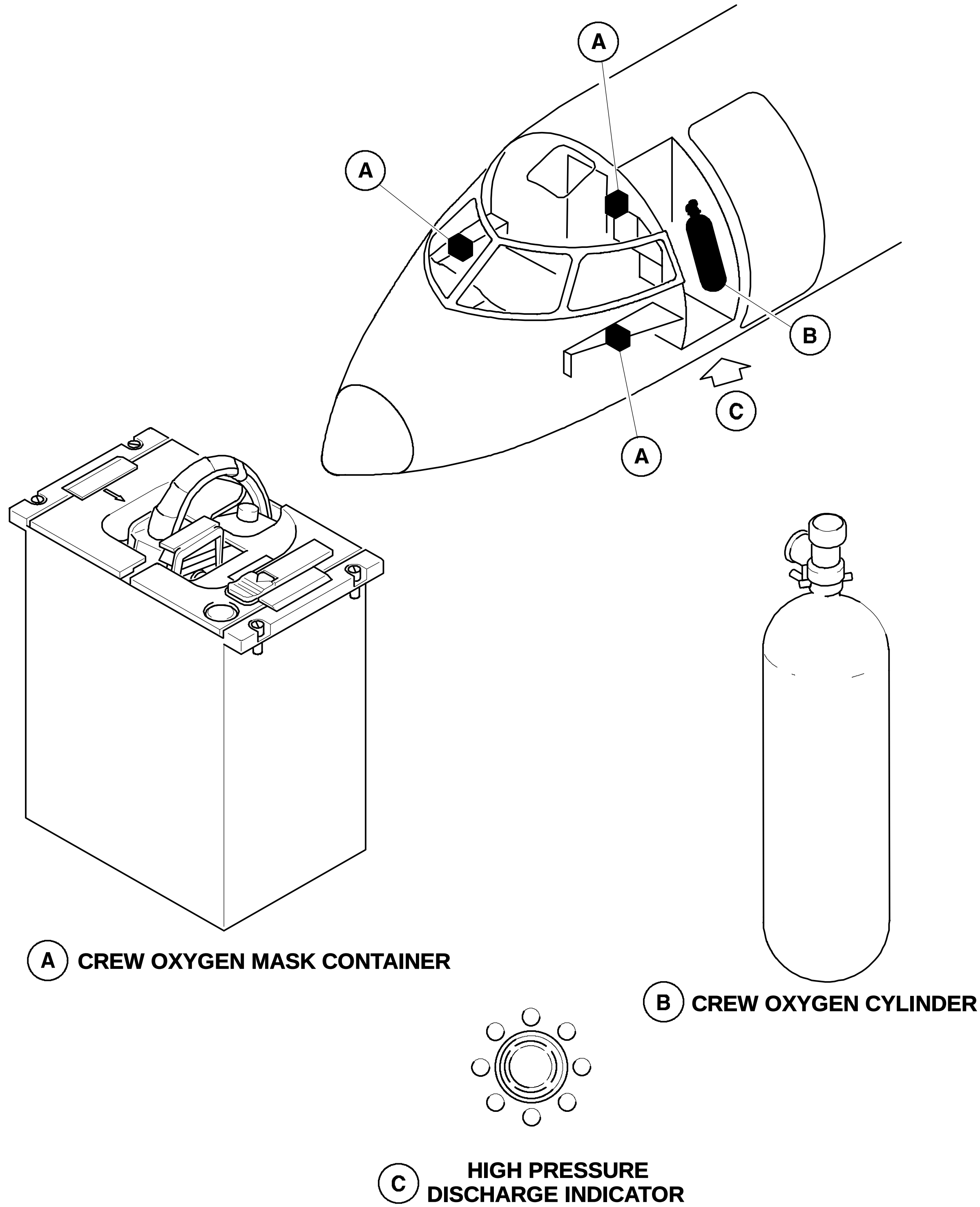
NOTE

If the OXY LO PRESS caution message is displayed, the crew should refer to the dispatch requirements charts.

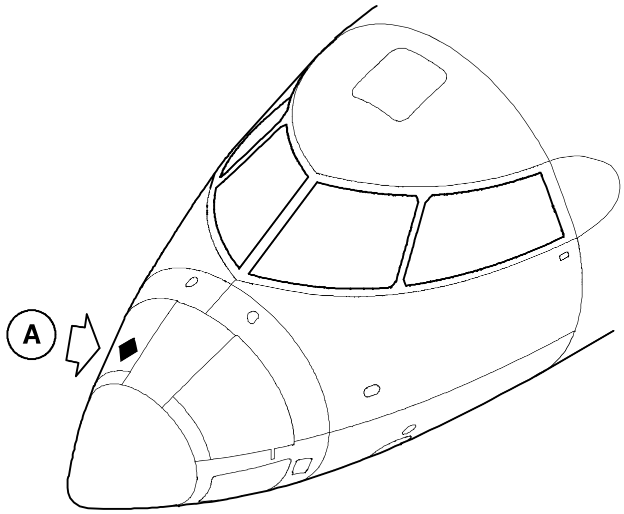
When the contents of the oxygen bottle is vented through the high pressure discharge indicator, a green snap disc dislodges, presenting a visual indication that the oxygen cylinder contents have been vented. The oxygen servicing panel is located on the right side of the forward fuselage. The service panel contains a fill port, a pressure servicing chart and a pressure gauge. Check valves in the fill and supply lines, prevent loss of oxygen when the bottle is removed or when the cylinder replenishment source is disconnected.



Crew Oxygen System – Schematic
Figure 09–20–1

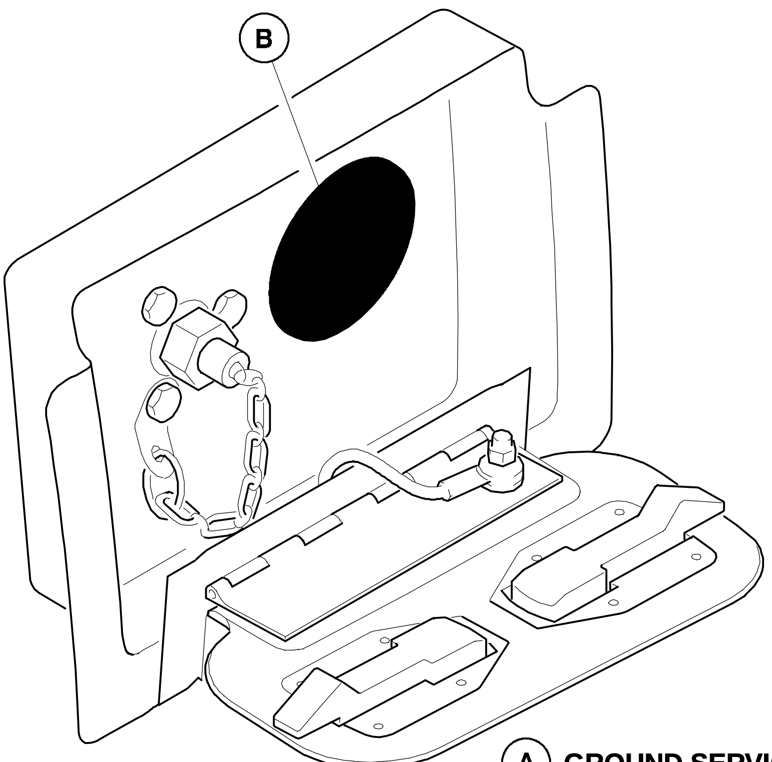


Crew Oxygen System Components
Figure 09–20–2

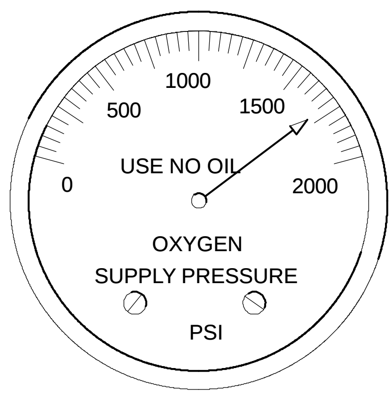


OXY. CYL. SERVICING CHARGE CYL. AT RATE NOT TO EXCEED 200 PSI/MIN TO "FULL" PRESSURE	
FULL PRESS. PSI	AMBIENT TEMP. °C
1990	38
1900	27
1805	16
1710	5
1620	−7
1530	−18
1435	−29
1340	−40

MAX. FILL PRESSURE VERSES TEMPERATURE CORRECTION CHART



A GROUND SERVICE PANEL



B GROUND SERVICE PANEL PRESSURE GAUGE

Ground Service Panel
Figure 09−20−3

C. Crew Oxygen Mask

The crew oxygen masks are located in stowage boxes. One for the pilot, one for the copilot and one for the 3rd flight crew position. The crew mask is a full face mask and includes an oxygen regulator, a pneumatically controlled inflatable harness, a flow-control knob, a mixture-control lever and a microphone. To release the mask from the stowage box, the operator squeezes the red release levers and holds them. This action opens the quick-release doors, frees the mask and inflates the harness. The operator then dons the mask. The red levers are then released, which deflates the harness, causing the mask to install correctly on the operator's head. <1033>

Oxygen is supplied to the mask regulator at about 78 psig (538 kPa). The regulator control (N/100% positions) allows the user to select a mixture of oxygen and air or pure oxygen.

- When the regulator control is set to the N position, a mixture of ambient air and pressurized oxygen is supplied to the mask on demand.
- With the control set to the 100% position, pure oxygen is supplied to the mask on demand.

The flow control knob is used to adjust the oxygen flow. If the knob is turned clockwise to the EMERGENCY position, the mask is supplied a constant flow of 100% oxygen at a positive pressure. To test the oxygen flow, press the flow control knob, which momentarily supplies oxygen to the mask.

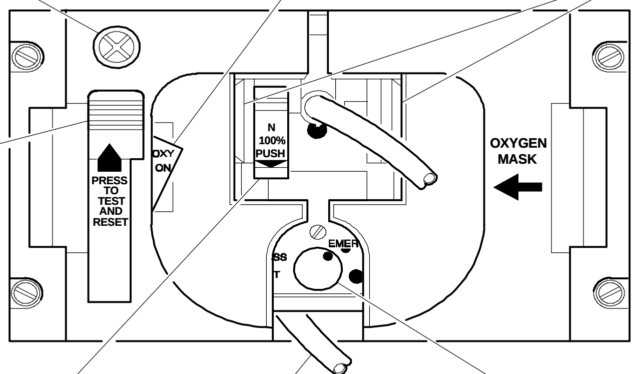
When cabin altitude is more than 30,000 feet (9,144 meters), the mask supplies pure oxygen regardless of the N/100% switch position.

To remove the mask, the red release levers on the mask are squeezed, which inflates the harness to allow the mask to be removed from the operators head.

Blinker
Shows yellow cross when oxygen is flowing or when harness is inflated. Black, indicates no oxygen flow.

Oxygen On Flag (white)
In view when mask is out to indicate that oxygen shut-off valve is open.

Release Levers (red)
Squeeze to unlock container doors, grasp levers and hose and pull to withdraw mask.



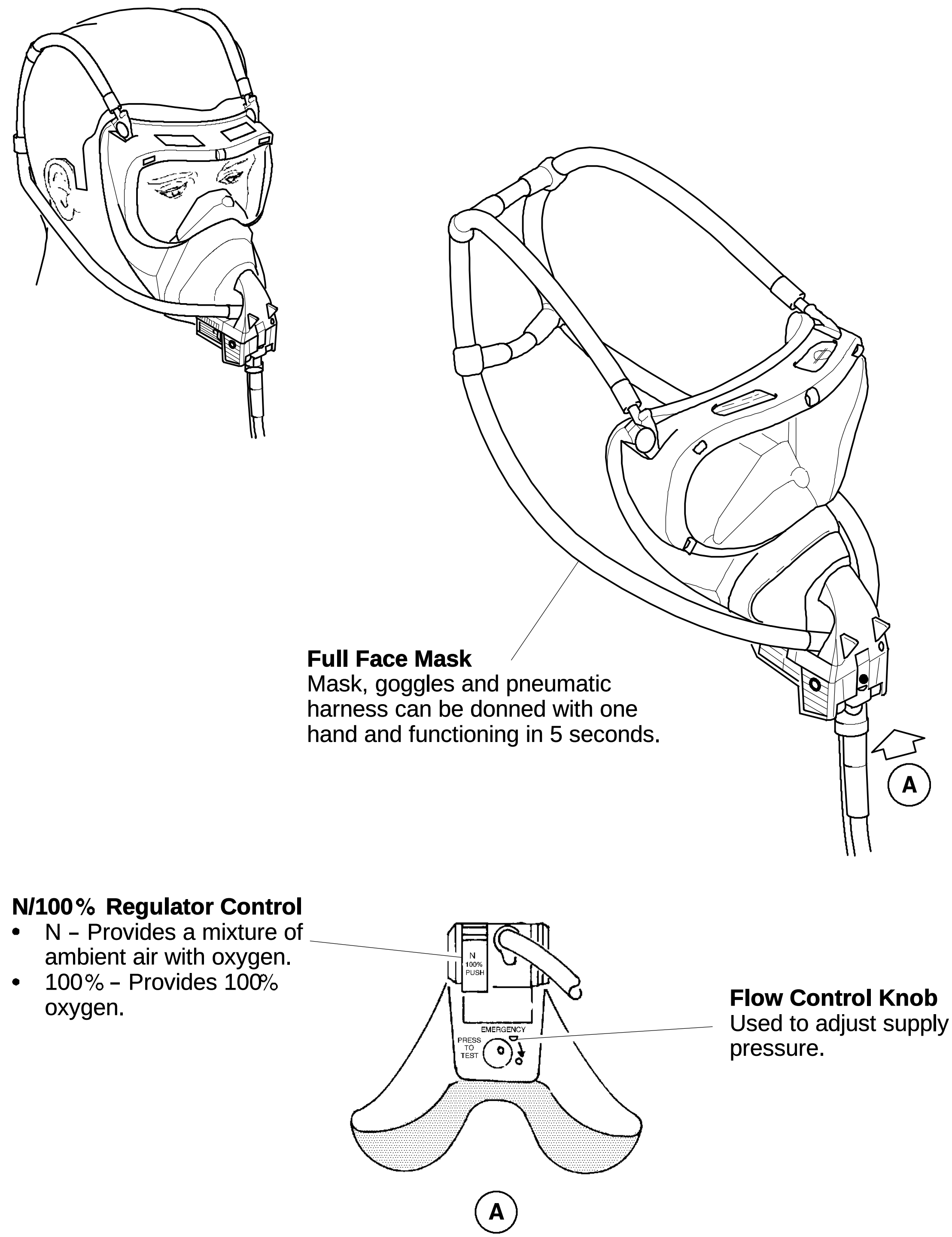
Test/Reset Lever
Press to test oxygen flow.

N/100% Regulator Control
- N – Provides a mixture of ambient air with oxygen.
- 100% – Provides 100% oxygen.

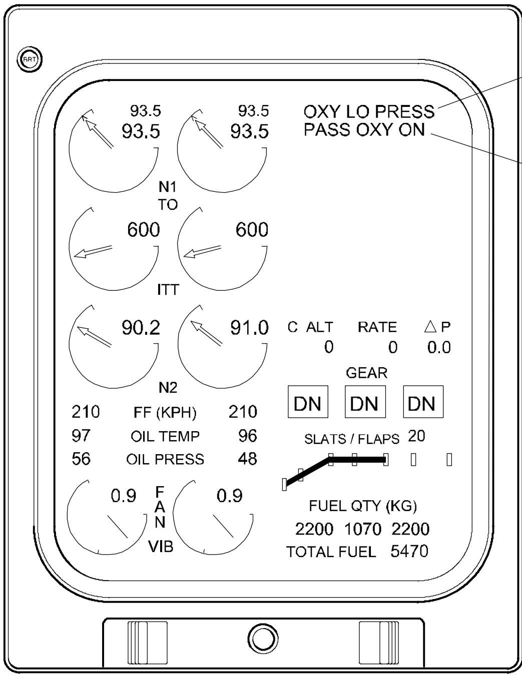
Oxygen Supply Hose

Flow Control Knob
Used to adjust the supply pressure.

Crew Oxygen Mask
Figure 09–20–4



Full Face Mask <1033>
Figure 09–20–5

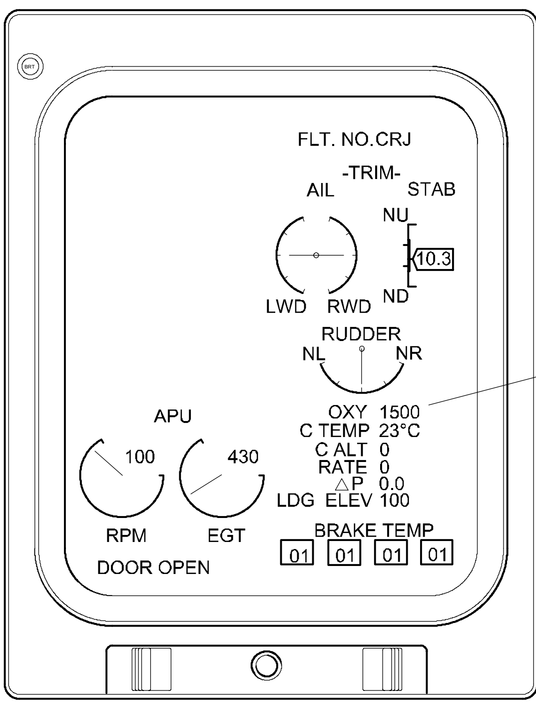


OXY LO PRESS caution (amber)
Indicates that the flight compartment oxygen bottle is low.

- Check dispatch requirements.

PASS OXY ON caution (amber)
Indicates that the passenger oxygen system has been activated.

Primary Page



Crew Oxygen System Pressure Readout
Indicates oxygen system pressure in increments of 10 psi.

- Amber < 1410 psi
- Green $\geq$ 1410 psi

Status Page

EICAS Oxygen Display <1001>
Figure 09–20–6

D. Minimum Flight Crew Oxygen Pressure

NOTE

The EICAS indication of the oxygen pressure is corrected for OAT.

Table 1 defines the oxygen system pressure as indicated on the EICAS which corresponds to the quantity of oxygen necessary to perform an emergency descent followed by a continuous cruise at 10,000 feet with normal (N) mask setting (FAR 121.333).

Table 2 defines the oxygen system pressure as indicated on the EICAS which corresponds to the quantity of oxygen necessary to perform an unpressurized continuous cruise at 10,000 feet for 15 minutes with normal (N) mask setting (JAR OPS 1.780).

Table 1 – 50 cu. ft. Oxygen Bottle		
Minimum Pressure (psi)	2 Crew	1175
	3 Crew	1629

Table 2 – 50 cu. ft. Oxygen Bottle (JAA)		
Minimum Pressure (psi)	2 Crew	378
	3 Crew	436

The utilization of the above table is as follows:

- If oxygen pressure is greater than that given in Table 1, then there is enough oxygen to perform an emergency descent from 41,000 feet to 10,000 feet in 10 minutes, followed by 110 minutes of cruise at 10,000 feet.

- If oxygen pressure is between the values given in Tables 1 and 2, then there is enough oxygen to cruise at 10,000 feet for 15 minutes in an unpressurized cabin. <JAA>

- If oxygen pressure is lower than that given in Table 2, the oxygen bottle has to be refilled. <JAA>

E. Crew Oxygen Consumption Data (As per FAR 121.333)

The following tables show the total time (in hours and minutes) that oxygen will be available at various mask settings, during various flight conditions, at initial bottle pressures of 1410 psi (pressure threshold that triggers OXY LOW PRESS message on the EICAS) and 1850 psi (max. crew oxygen bottle pressure). A margin of safety of 10% was subtracted from the full charge of 1850 psi in all cases.

LEVEL FLIGHT AT CABIN PRESSURE ALTITUDE OF 8,000 FEET <1033>				
Crew members	**2**		**3**	
Initial Bottle Pressure	**1400 psi**	**1850 psi**	**1400 psi**	**1850 psi**
Normal Mask Setting	2^h 48’	3^h 47’	1^h 52’	2^h 32’
100% Mask Setting	0^h 38’	0^h 51’	0^h 25’	0^h 34’
Emergency Mask Setting	0^h 35’	0^h 48’	0^h 24’	0^h 32’

DESCENT (10 Min.) FROM 41,000 feet TO LEVEL FLIGHT AT SAFE ALTITUDE <1033> (100% MASK SETTING FOR DESCENT AND NORMAL MASK SETTING FOR LEVEL FLIGHT)					
Crew members		**2**		**3**	
Initial Bottle Pressure		**1400 psi**	**1850 psi**	**1400 psi**	**1850 psi**
Cabin Pressure Altitude	**10,000 Feet**	3^h 13’	4^h 25’	2^h 04’	2^h 52’
	14,000 Feet	3^h 08’	4^h 16’	2^h 02’	2^h 48’
	18,000 Feet	2^h 43’	3^h 31’	1^h 47’	2^h 27’
	21,000 Feet	2^h 16’	2^h 59’	1^h 31’	2^h 03’

DESCENT (10 Min.) FROM 41,000 feet TO LEVEL FLIGHT AT SAFE ALTITUDE <1033> (100% MASK SETTING FOR BOTH DESCENT AND LEVEL FLIGHT)					
Crew members		**2**		**3**	
Initial Bottle Pressure		**1400 psi**	**1850 psi**	**1400 psi**	**1850 psi**
Cabin Pressure Altitude	**10,000 Feet**	0^h 47’	1^h 02’	0^h 33’	0^h 43’
	14,000 Feet	0^h 53’	1^h 11’	0^h 37’	0^h 49’
	18,000 Feet	1^h 03’	1^h 24’	0^h 43’	0^h 57’
	21,000 Feet	1^h 11’	1^h 35’	0^h 48’	1^h 05’

F. Passenger Oxygen System

The passenger oxygen system provides chemically generated oxygen for all cabin occupants in the event of cabin depressurization.

The oxygen generators and oxygen masks are installed as part of the passenger service unit panel and are available at all passenger seats, in the lavatories and at the flight attendant stations.

All oxygen compartment doors will open to present the oxygen masks automatically if cabin altitude reaches 14,500 ±500 feet.

If the automatic system fails to open the doors, or if it is necessary to override the automatic system, the flight crew can operate the (guarded) PASS OXY switchlight on the overhead panel to open the oxygen doors in the passenger service units. As a back-up to electrically opening the doors, each individual oxygen compartment door can be opened manually through a release hole in the door.

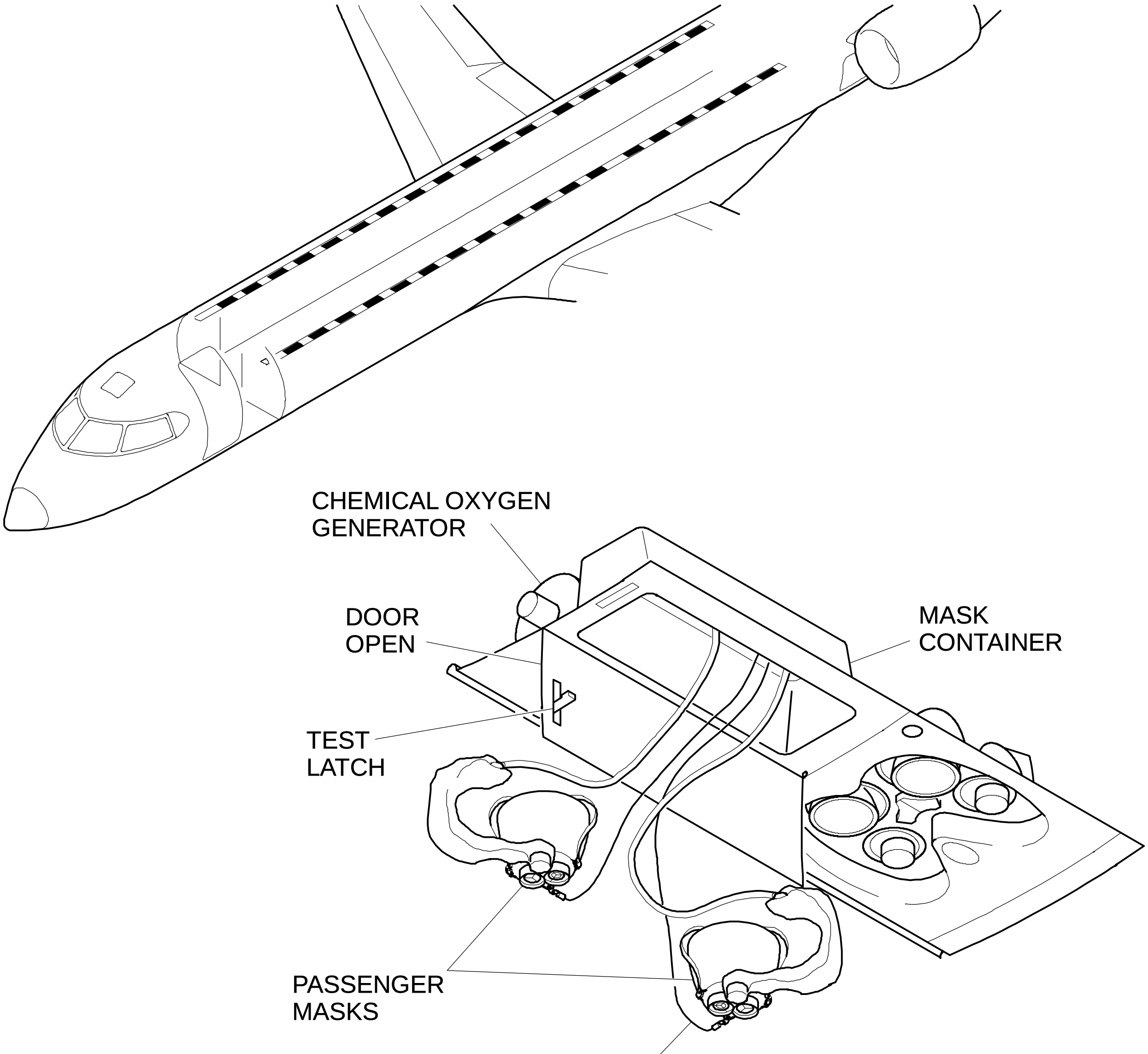
When the oxygen compartment doors are open, the passengers will pull the oxygen mask to their face, which pulls a lanyard connected to the firing pin of the chemical oxygen generator. This initiates the flow of oxygen to the passenger's oxygen mask. A flow indicator in the supply tube will show green when oxygen is flowing. The reservoir bags on the passenger oxygen masks begins to fill with oxygen. The chemical oxygen generator supplies approximately 22 minutes of oxygen to each mask.<1071>

WARNING

The oxygen generator surface temperature may reach 260 °C (500 °F) when generating oxygen. Do not touch or attempt to remove generator. Burn injury can result. If an active generator is inadvertently removed from the compartment, the generator must be placed in a metal container such as a lavatory or galley sink. The generator's heat will scorch other materials or fabrics.

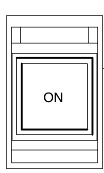
NOTE

Odor similar to scorched cloth may be created by activation of generator. The odor does not affect the purity of the oxygen supply and there is no fire hazard.



Passenger Service Unit

PASS OXY



Overhead Panel

PASS OXY (Guarded)
Used when passenger oxygen system auto-deployment has failed or to override the auto-deployment system.
- ON (white) light indicates that oxygen system has deployed.

Passenger Oxygen System
Figure 09–20–7

G. Portable Oxygen System

The portable oxygen system is available to supply oxygen to the crew or the passengers during an emergency.

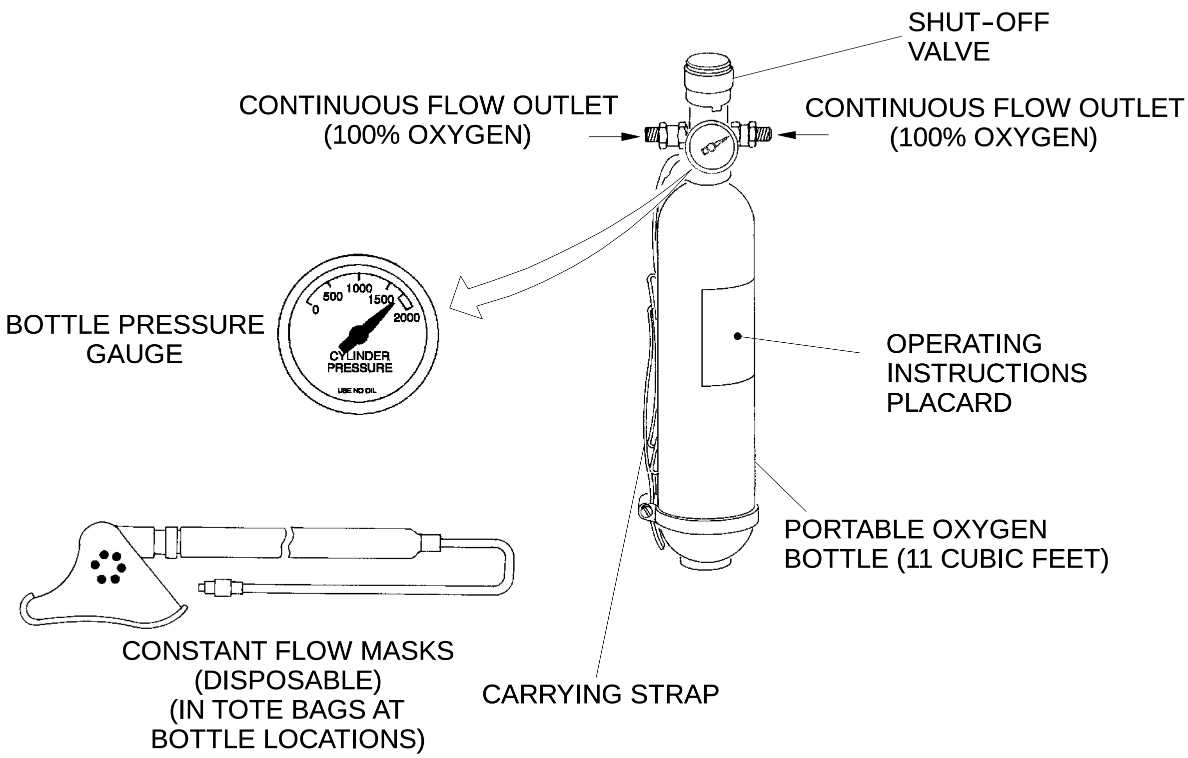
The portable oxygen bottles are provided, as protective breathing units, to be used for protection against smoke and harmful gases. In addition, the portable oxygen bottles can also be used for first aid purposes.

Portable oxygen bottles, with disposable masks, are located near each flight attendant station. The portable oxygen bottles allow the flight attendants to move about the passenger compartment during an emergency. The portable oxygen cylinders and masks can also supply therapeutic oxygen for first aid. Each cylinder has two regulator outlets which are color coded and pre-set to provide appropriate flow rates. An instruction decal located on the cylinder provides clear, easy to read operating instructions.

The contents gauge on each portable oxygen bottle indicates from 0 to 2000 psi with a red band between 1800 to 2000 psi. The bottle is fully charged when the gauge needle indicates in the red band.

WARNING

Take precautions to ensure that oxygen bottles do not come into contact with oil, grease, or other contaminants during handling. An explosion could result if this happens.



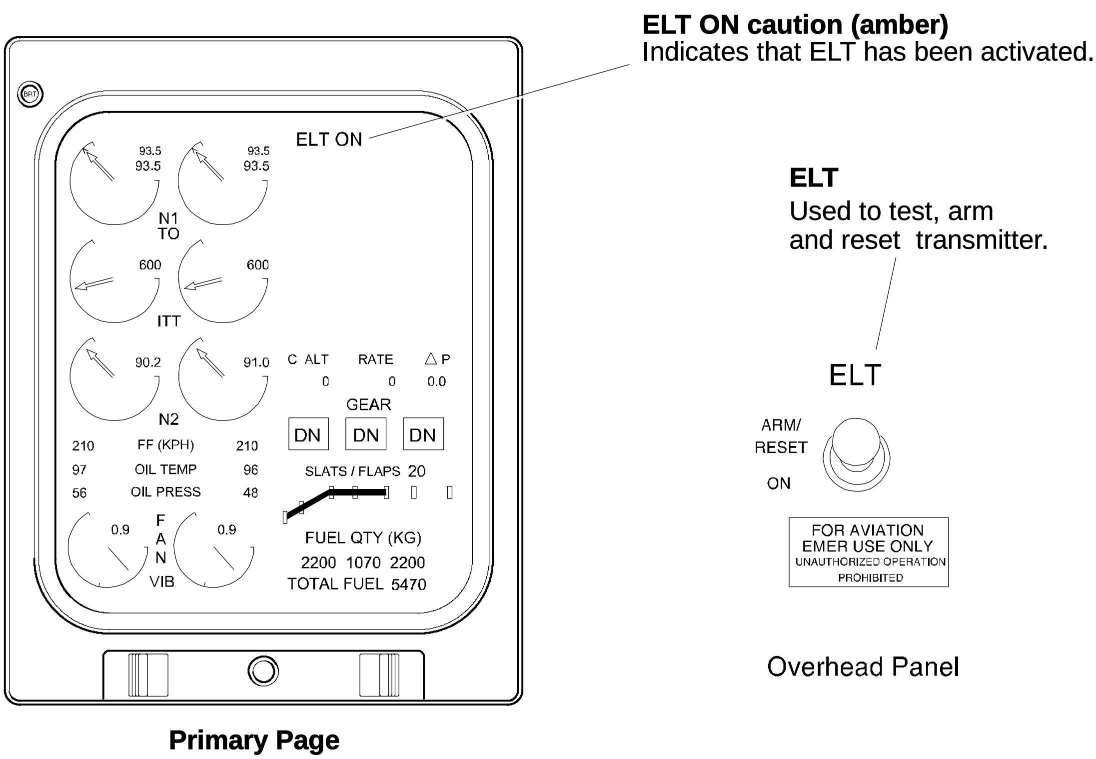
Portable Oxygen System
Figure 09–20–8

H. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Oxygen	Passenger Oxygen	PASS OXYGEN MANUAL DEPLOY R	BATTERY BUS	1	P8	
		PASS OXYGEN MANUAL DEPLOY L			P9	
		PASS OXYGEN AUTO DEPLOY R		2	P9	
		PASS OXYGEN AUTO DEPLOY L			P10	
	Crew Oxygen	CREW OXYGEN MONITOR			P11	

1. EMERGENCY LOCATOR TRANSMITTER

The satellite capable emergency locator transmitter (ELT) is located in the aft equipment compartment and is automatically activated during an aircraft crash. The ELT transmits a standard swept tone on 121.5, 243.0 and 406.0 MHz for satellites. The two position ELT switch is located in the flight compartment on the overhead panel and is labeled ARM/RESET and ON. The switch is used to test, arm and reset the unit. During normal flight operations, the ELT switch is in the ARM/RESET position. The ELT can be manually activated by selecting the ELT switch to ON. To reset the unit after it has been activated automatically, the switch is selected to the ON position, then back to the ARM/RESET position. <1092>



Emergency Locator Transmitter <1001>
Figure 09–30–1

1. FIRE FIGHTING EQUIPMENT

Portable fire extinguishers, fire protection gloves and protective breathing equipment are provided to fight a fire occurring inside the flight or passenger compartment.

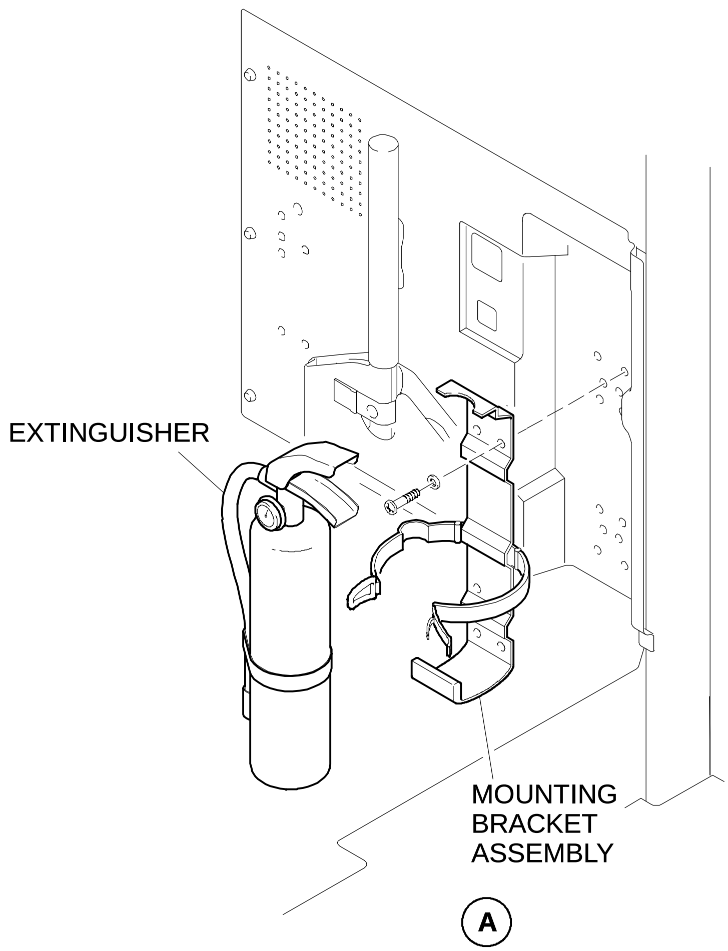
A. Portable Halon Fire Extinguishers

There are four hand-operated fire extinguishers containing Halon 1211 in the aircraft. One is located in the cockpit, one in the entrance storage compartment, one is on the right aft lower bulkhead and one is located in the left fwd overhead bin. Halon 1211 is effective on electrical, oil and fuel fires, and is suitable for use in cold weather.

Effective discharge time of a 3–1/2 pound bottle is 10 to 12 seconds. Ventilate the compartment promptly after successfully extinguishing the fire to reduce gasses produced by the fire and Halon.

WARNING

If a fire extinguisher is to be discharged in the flight compartment, all flight crew must wear oxygen masks with EMERGENCY selected (100% oxygen). Crew exposure to high levels of Halon vapors may result in dizziness, impaired coordination, and reduced mental sharpness.

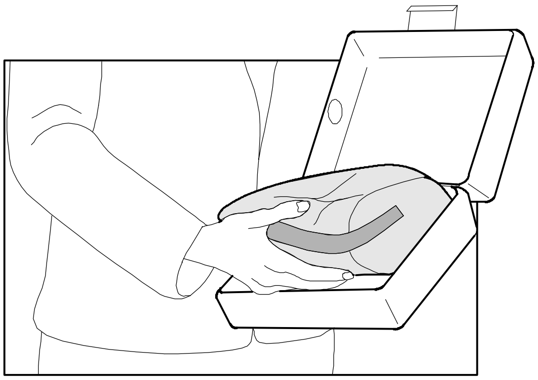


NOTE
Flight compartment extinguisher shown.

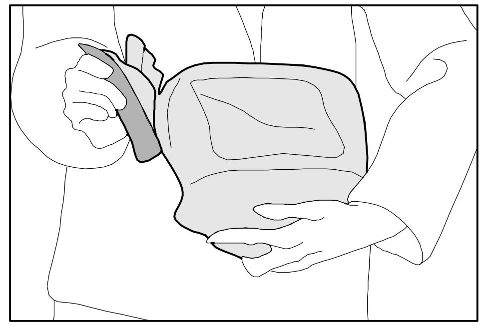
Portable Halon Fire Extinguisher – Typical
Figure 09–40–1

B. Protective Breathing Equipment

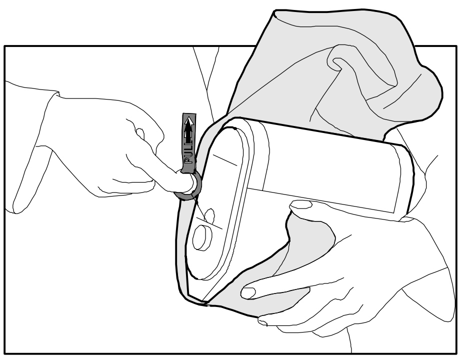
The protective breathing equipment consists of four protective breathing units (PBUs). The PBUs are self-contained smoke hoods with on-demand oxygen regeneration systems that prevent injury to crew members from smoke inhalation. Each PBU is in a vacuum-sealed bag, and is kept in a storage container with a tamper-proof seal. One PBU is installed in the flight compartment on the bulkhead behind the Copilots seat. Another is in the forward storage compartment. One is located on the bulkhead behind the last row of seats on the left side of the aircraft and one is located in the left forward overhead bin.



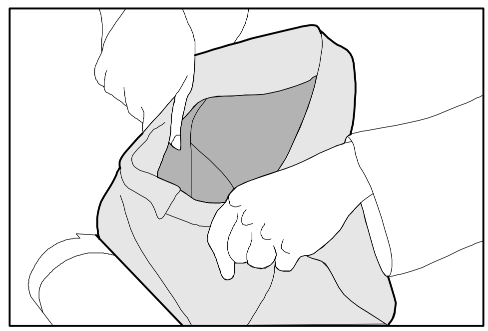
1. Remove device from storage case.



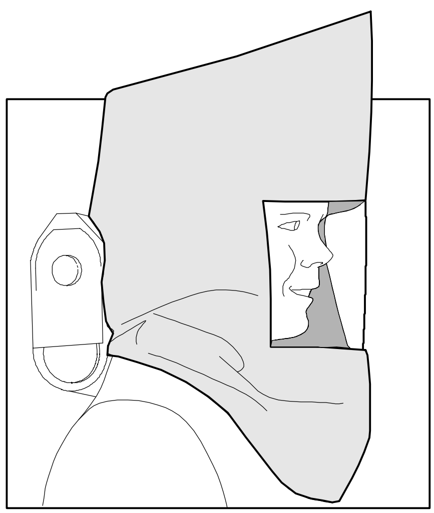
2. Tear off red pull strip and remove device from protective cover.



3. Pull activation ring, on the life support pack, in the direction indicated.



4. With the life support pack away from user, grasp hole in neck seal with thumbs, insert chin into hole and pull hood across face and over head.



5. Pull hood down until headband firmly engages forehead (approximately 15 minutes of respiration protection).

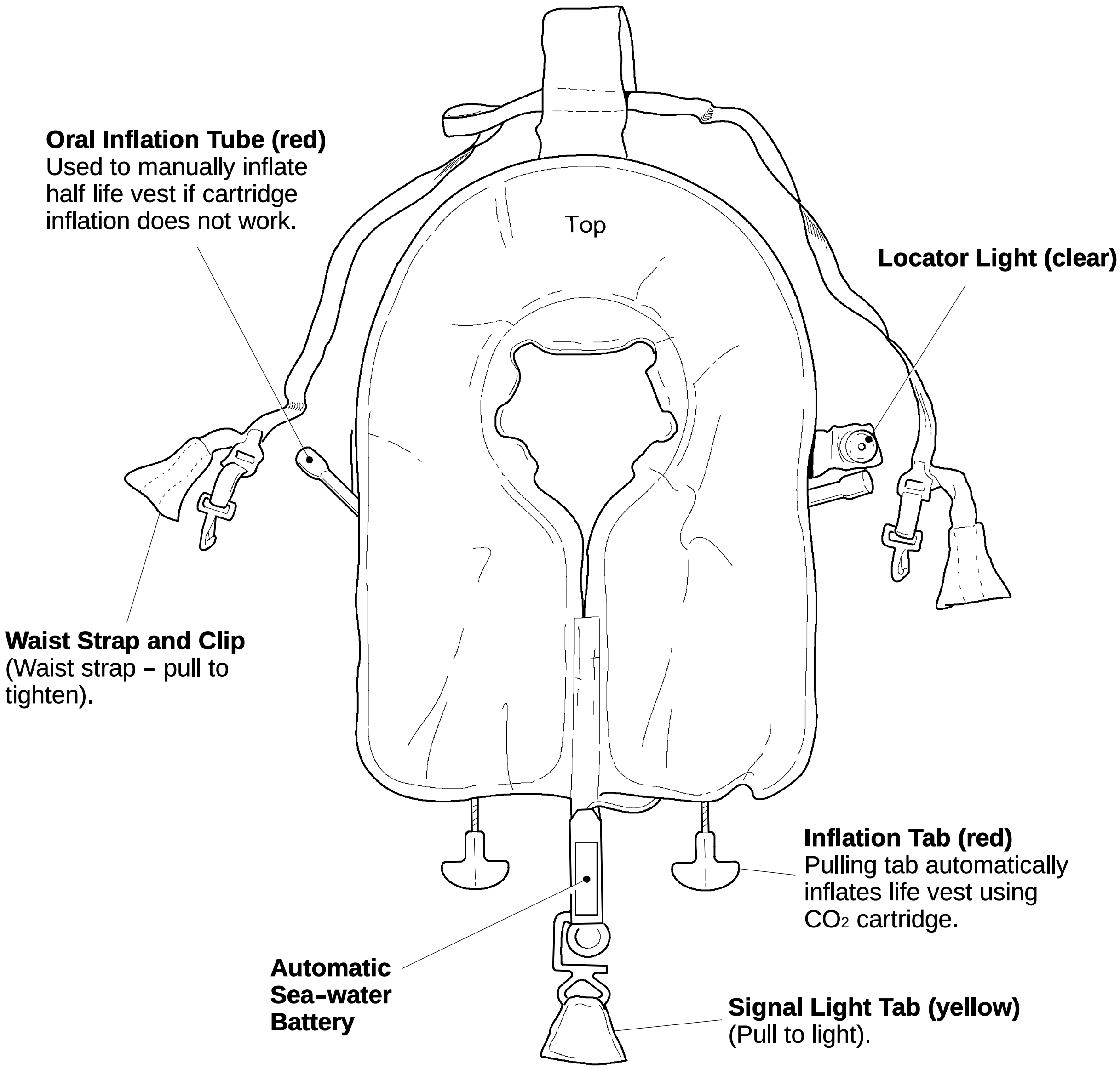
Protective Breathing Equipment
Figure 09–40–2

1. OVER WATER EMERGENCY EQUIPMENT

A life vest is provided for each member of the flight crew. One life vest is stowed under each pilot seat, one life vest is stowed adjacent to the 3rd crew seat and one is adjacent to each flight attendants seat.

Each life vest includes a manual and an oral inflation system, a locator light, and a system for automatic battery plug removal during life vest deployment.

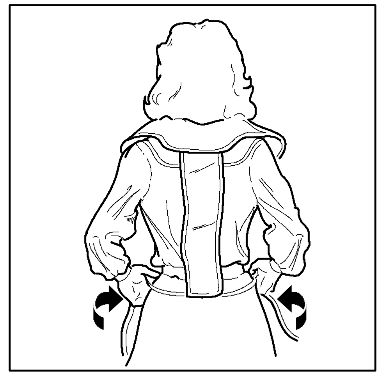
Each passenger seat cushion serves as a floatation device.



Life Vest
Figure 09–50–1

1. Locate and remove the life vest.

2. Put the life vest over head...



3. ...with the back piece behind.

4. Fasten rings to catch.

5. Pull straps tight.

6. Jerk down on red inflation tabs.

7. Should it become necessary, life vest can be orally inflated by blowing into red oral inflation tubes.

CAUTION

Inflate life vest just before leaving the airplane!
If using overwing emergency exit inflate life vest when on the wing.

Life Vest Operation
Figure 09–50–2

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1. FLIGHT COMPARTMENT EMERGENCY EQUIPMENT

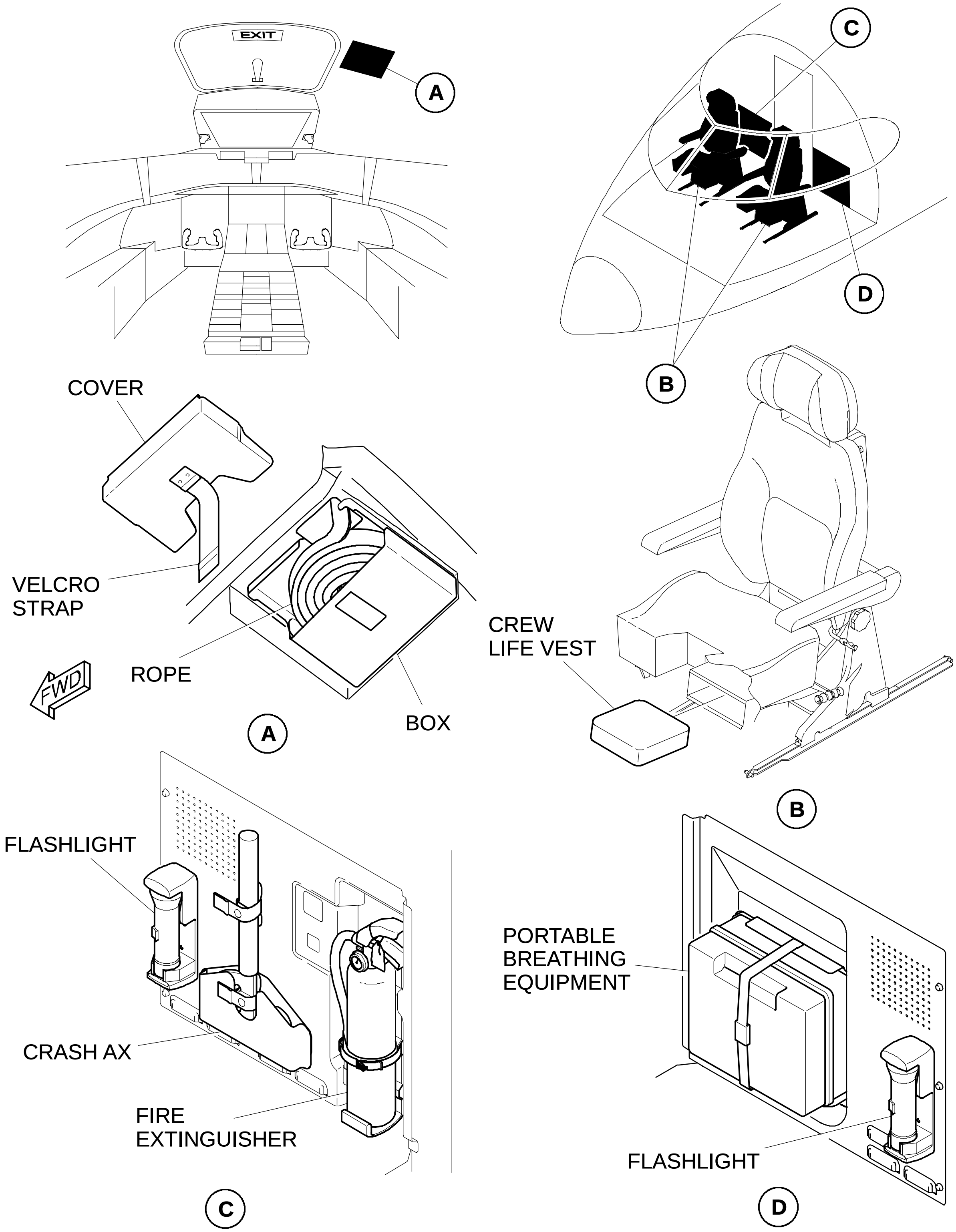
Emergency equipment that is located in the flight compartment includes:

- Crash axe
- Fire Extinguisher (Refer to 09–40–1)
- Portable Breathing Equipment (Refer to 09–40–5)
- Crew life vests (Refer to 09–50–1)
- Escape rope

The crash axe is mounted on the lower flight compartment bulkhead behind the copilot.

A flashlight is mounted on the lower flight compartment bulkhead behind each pilot. Each flashlight is powered using two, standard type, D–cell batteries.

The escape rope is installed in the upper right head–liner. It has a cover that is secured with a Velcro strap. The rope is used by the flight compartment crew in an emergency to exit the aircraft through the overhead escape hatch and lower themselves to the ground.



Flight Compartment Emergency Equipment
Figure 09−60−1

CHAPTER 8 – ENVIRONMENTAL CONTROL SYSTEM

LIST OF ILLUSTRATIONS

1. INTRODUCTION

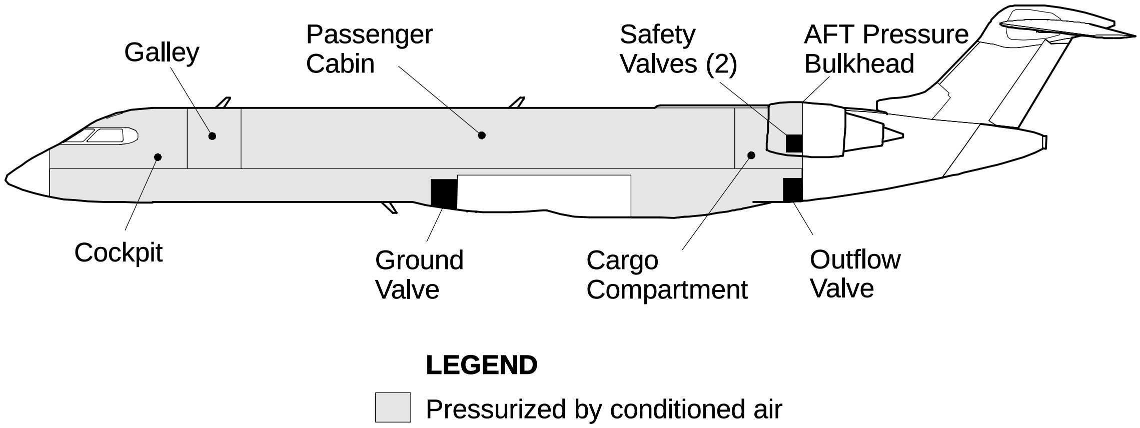
The environmental control system (ECS) provides temperature and pressure regulated air for heating, ventilating and for pressurizing the flight and passenger compartments. Exhaust air from each compartment is used to ventilate the avionics and cargo compartments, before being dumped overboard through an outflow valve and a ground valve.

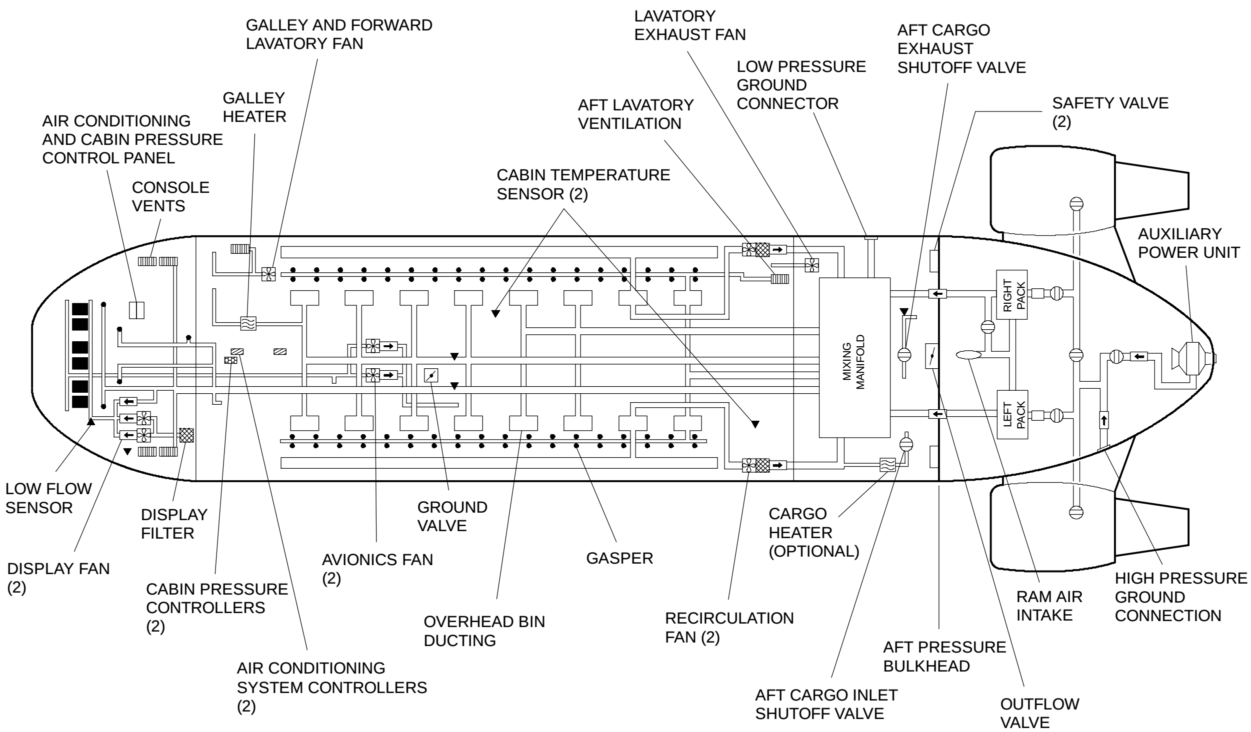
For ground operations, pneumatic air for operation the ECS can be obtained from any of the following:

- A ground air supply cart connected to the aircraft
- The auxiliary power unit (APU)
- Either or both engines.

During flight, the engines normally supply bleed air for operating the air-conditioning, pressurization, and avionics cooling systems.

ECS warnings and cautions are displayed on the engine indication and crew alerting system (EICAS) primary page. ECS advisory and status messages are displayed on the EICAS status page. Views of the aircraft ECS temperature, pressure, valve positions and system status indications are displayed on the EICAS ECS synoptic page.





Air Conditioning System
Figure 08−10−1

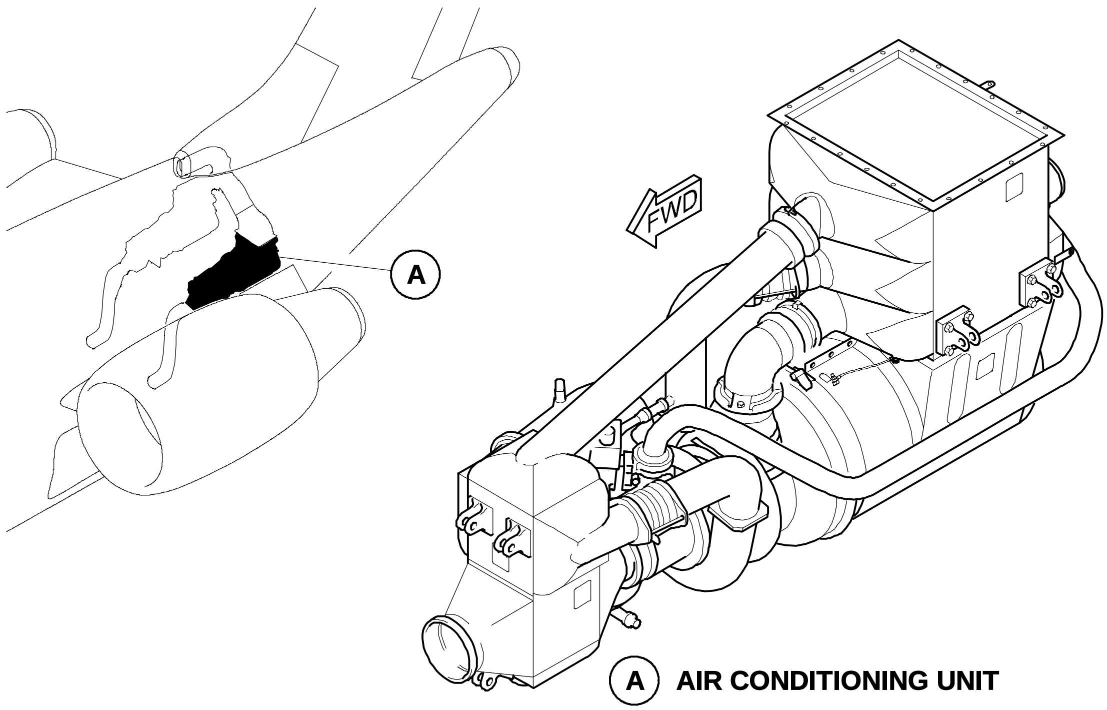
1. AIR-CONDITIONING SYSTEM

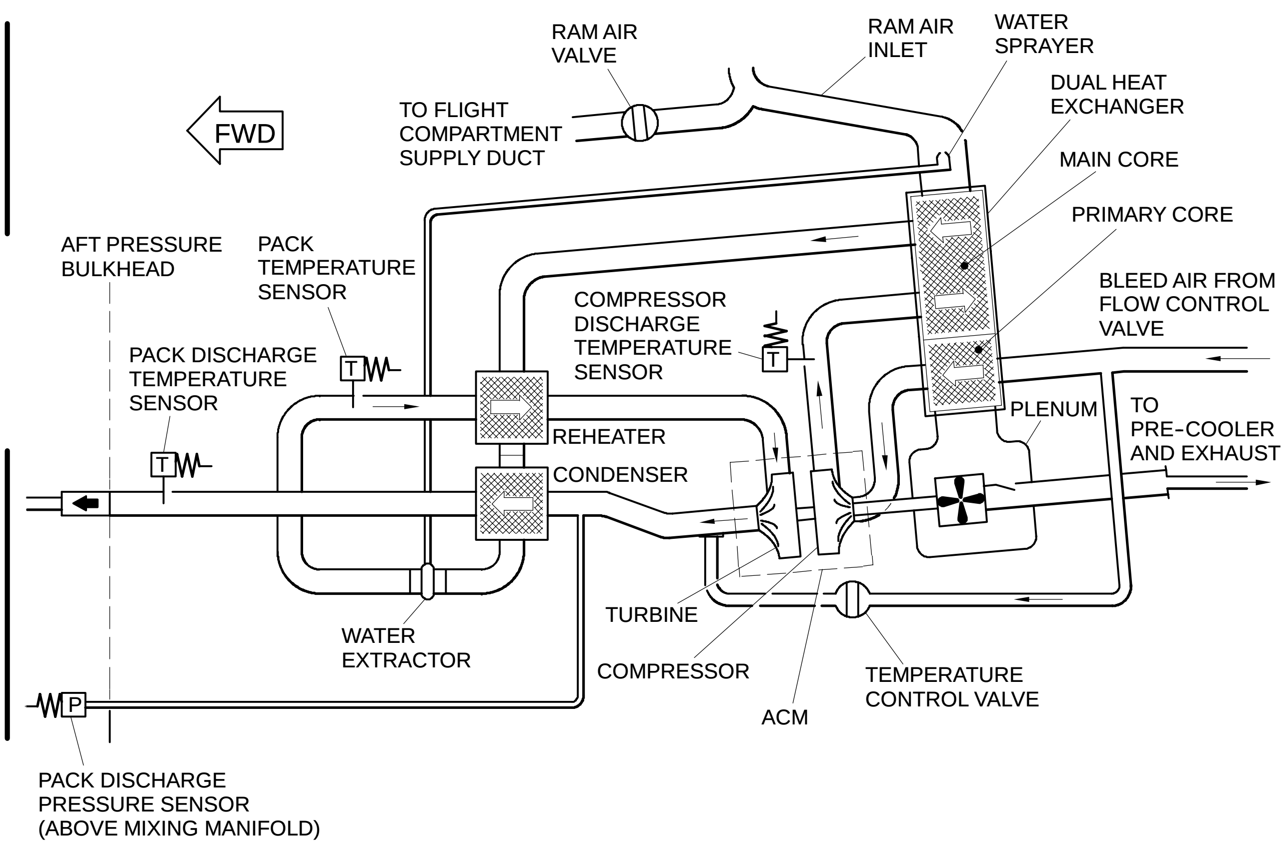
There are two air-conditioning systems packs which operate in parallel to supply conditioned air, through a common distribution system, to the flight and passenger compartments. Each system consists of an air-conditioning unit or package (PACK), an air-conditioning system controller (ACSC) and ducting. Ram air is provided for pack cooling and ventilation. The ACSC also controls the engine bleed air supply system (see Chapter 19).

A. Packs

The packs are located in the aft equipment compartment (Refer to figure 08-20-9) and provide cooling of the engine or APU bleed air supplies for distribution to the flight and passenger compartments. Each pack consists of an air cycle machine (ACM), dual heat exchange, reheater, and condenser which are used to decrease the temperature and water content of the bleed air used in the conditioning process. The pressurized conditioned air from both packs is supplied to a mixing manifold, under the aft cargo compartment floor, where the air is then distributed to the flight and passenger compartments.

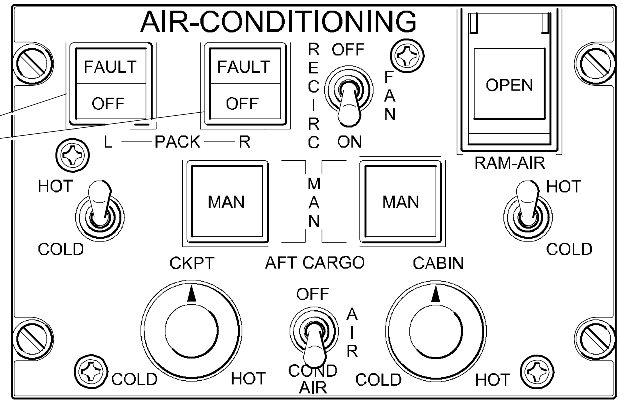
For normal operation, each pack receives hot bleed air from its related engine or from the APU where it is directed to the primary core of the heat exchanger via a precooler. The primary core uses ram air to initially cool the bleed air and then the air is directed to the ACM compressor where the air temperature and pressure is increased. The air is then directed back for a double pass through the main core of the heat exchanger. From the main core, the air is then directed to the reheater and condenser where water is extracted from the air and then fed to the ram air duct to be used as a cooling medium. Air from the condenser is then directed through the reheater and then to the ACM turbine where the heat energy is extracted by expanding the air. This causes a decreases in the air temperature which is then supplied to the mixing manifold of the distribution system. A ram air regulating valve RARV, which is controlled by the ACSCs, directs ram air from the the fan in the plenum to the cores of the precooler. This is done to regulate the temperature of the air from the engines to the heat exchanger. If the RARV fails, a L (R) RARV FAULT status message is displayed on the EICAS status page.



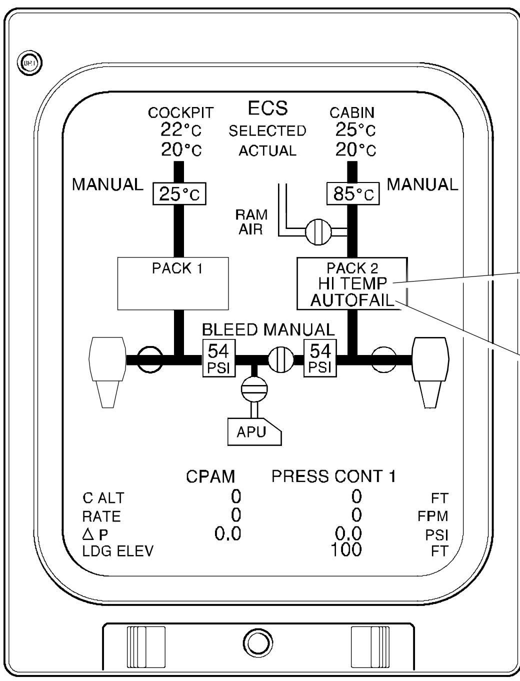


Air Conditioning Unit Schematic
Figure 08-20-1

Left (L) and Right (R) PACK
Used to control operation of air conditioning packs.
- OFF (white) light indicates pack is selected off.
- FAULT (amber) light indicates pack has failed in both automatic and manual modes.



Air-Conditioning Panel
Overhead Panel

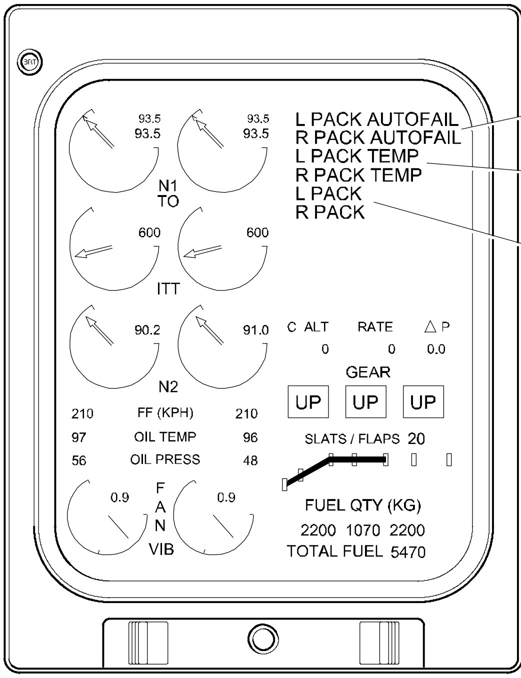


HI TEMP (amber)
Indicates high temperature sensed in respective pack outlet.

AUTOFAIL (amber)
Indicates failure of respective pack in automatic mode.

ECS Page

Packs Control <1201>
Figure 08–20–2



L or R PACK AUTOFAIL caution (amber)
Indicates failure of respective pack in automatic mode and system is not in manual mode.

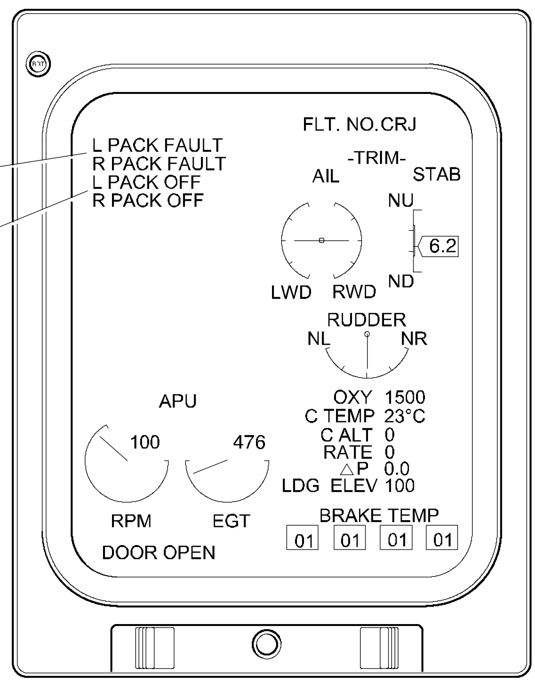
L or R PACK TEMP caution (amber)
Indicates a high (> 85º C) or low (< 5º C) temperature when in manual mode.

L or R PACK caution (amber)
Indicates failure of respective pack in automatic and manual modes.

Primary Page

L or R PACK FAULT status (white)
Indicates a fault in respective pack.

L or R PACK OFF status (white)
Indicates that respective pack has been selected off.



Status Page

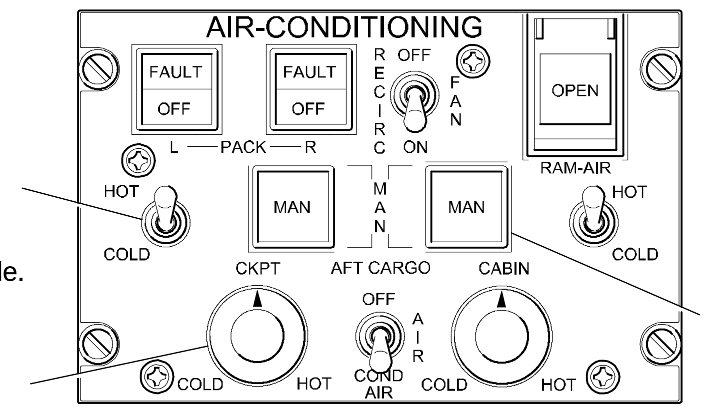
Packs EICAS Indications<1001>
Figure 08–20–3

B. Temperature Control

The flight compartment and the passenger compartments have identical but independently-operated temperature control systems. Each controller subsystem is dedicated to an air-conditioning pack. Temperature control, in automatic mode, is provided by CKPT and CABIN selector knobs on the air conditioning panel. Control in manual mode is provided by left and right pack MAN switchlights and HOT/COLD switches on the same panel. The individual packs can be manually turned OFF by selecting the respective L or R PACK switchlight on the air conditioning panel.

Manual Mode Temperature Control
Used to operate air conditioning temperature control valves in manual mode.

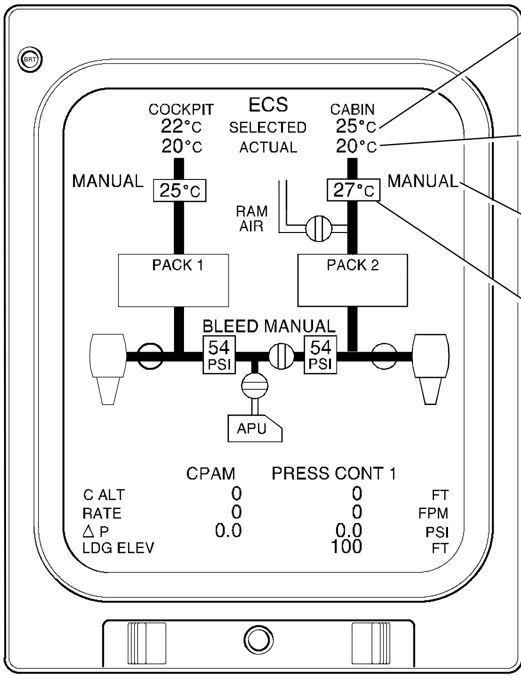
Automatic Mode Temperature Control
Used to provide automatic control of temperature in selected compartment.



MAN
Used to select manual mode temperature control.
- MAN (white) light indicates manual control is selected.

Air-Conditioning Panel
Overhead Panel

Temperature Controls <1201>
Figure 08–20–4



ECS Page

Selected Temperature (cyan)
Displays temperature selected by respective temperature control when in automatic mode only. Displays 24 (white) if data is not available.

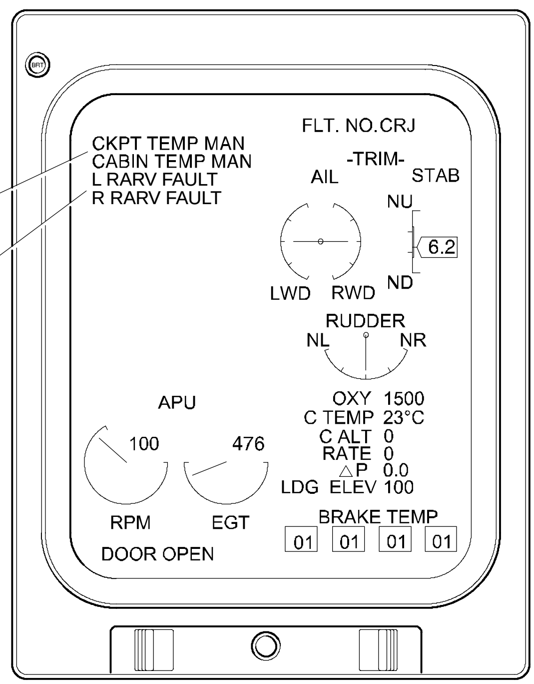
Actual Temperature (white)
Displays temperature sensed at associated temperature sensing fan. Invalid data is displayed as amber dashes.

MANUAL (white)
Indicates that respective MAN switch is selected.

Supply Duct Temperature (white)
Displays temperature sensed in respective air conditioning supply duct. Invalid data is displayed as amber dashes.

CKPT or CABIN TEMP MAN status (white)
Indicates that respective MAN switch is selected.

L or R RARV FAULT status (white)
Indicates that the L or R RARV has failed in the open or toward the CLSD position.



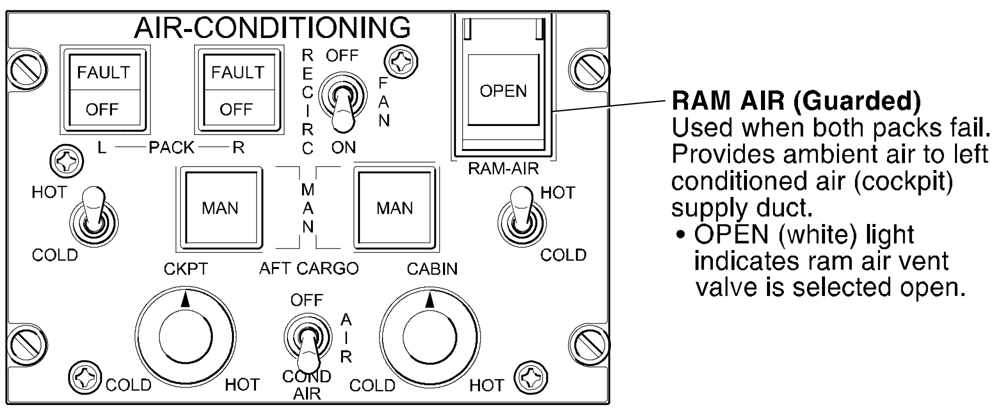
Status Page

Temperature Synoptic and EICAS Indications
Figure 08–20–5

C. Ram Air Ventilation

The cooling airflow for the left and right heat exchangers is supplied from a ram air intake scoop, located on the forward lower leading edge of the vertical stabilizer. During normal operations, the ram air passes over the heat exchangers and is then vented overboard through an exhaust duct in the lower aft fuselage. The ram air supply duct also provides cooling airflow to the hydraulic system heat exchanger for cooling No. 1 and No. 2 hydraulic systems fluid (Refer to Chapter 14).

Ram air ventilation is used only when the air conditioning packs fail (unpressurized). Operating the (guarded) RAM AIR switchlight, on the air-conditioning panel, opens the normally closed ram air valve. Ram air then enters the flight compartment air supply system. Ram air is also distributed to the passenger compartment from the mixing manifold.

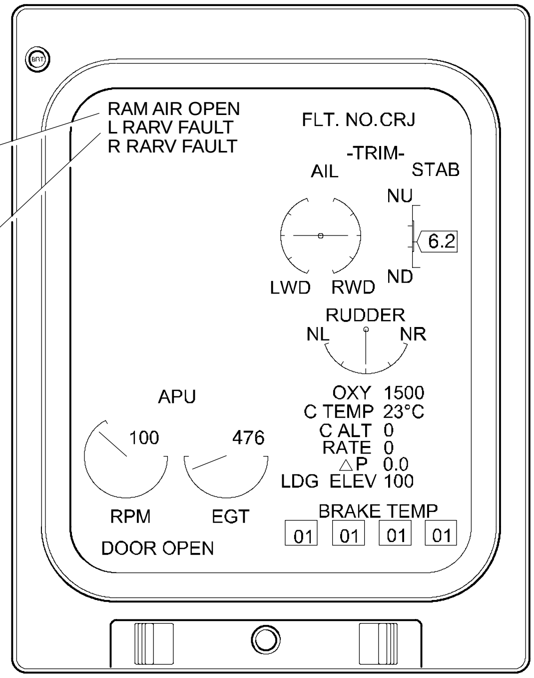


Air-Conditioning Panel
Overhead Panel

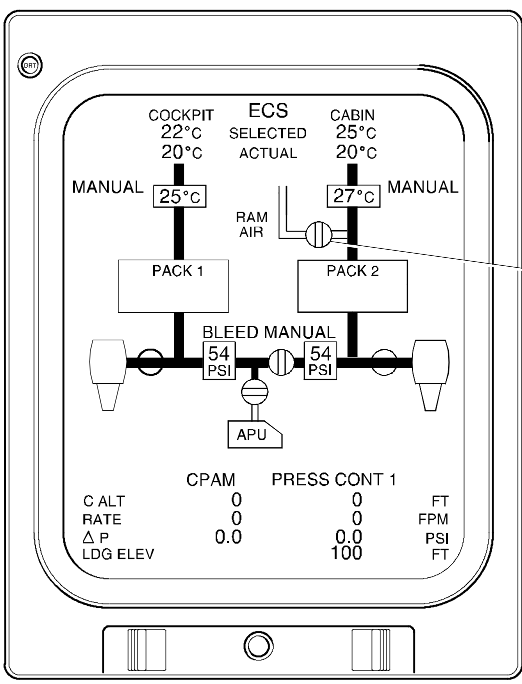
RAM Air Control <1201>
Figure 08-20-6

RAM AIR OPEN status (white)
Indicates that ram air valve has been selected open.

L (R) RARV FAULT status (white)
Indicates that ram air regulator valve has failed in open or close position.



Status Page



ECS Page

Ram Air Valve Position Indicator

open (white)

closed (white)

failed (half-intensity magenta)

Temperature Synoptic and EICAS Indications
Figure 08–20–7

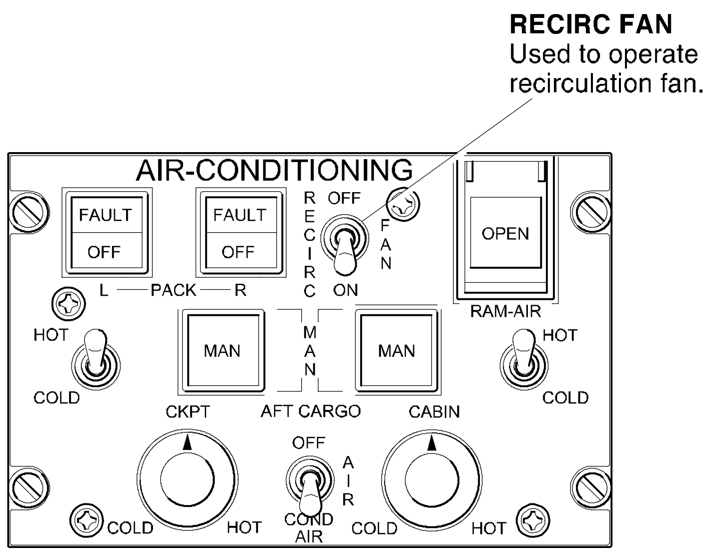
D. Conditioned Air Distribution

Conditioned air, from the left and right air-conditioning packs, is routed through separate ducting to a distribution mixing manifold. The mixing manifold mixes fresh air from the packs with recirculated air. The mixing manifold is designed so that the left pack primarily influences the flight compartment supply temperature. Like-wise,the right pack primarily influences the passenger compartment supply temperature If either pack fails, the mixing manifold will allow the remaining pack to supply the entire aircraft.

Conditioned air, to the passenger compartment, is distributed from ducts along each side of the aircraft. Passenger compartment exhaust air is routed underfloor to the outflow valves on the aft pressure bulkhead.

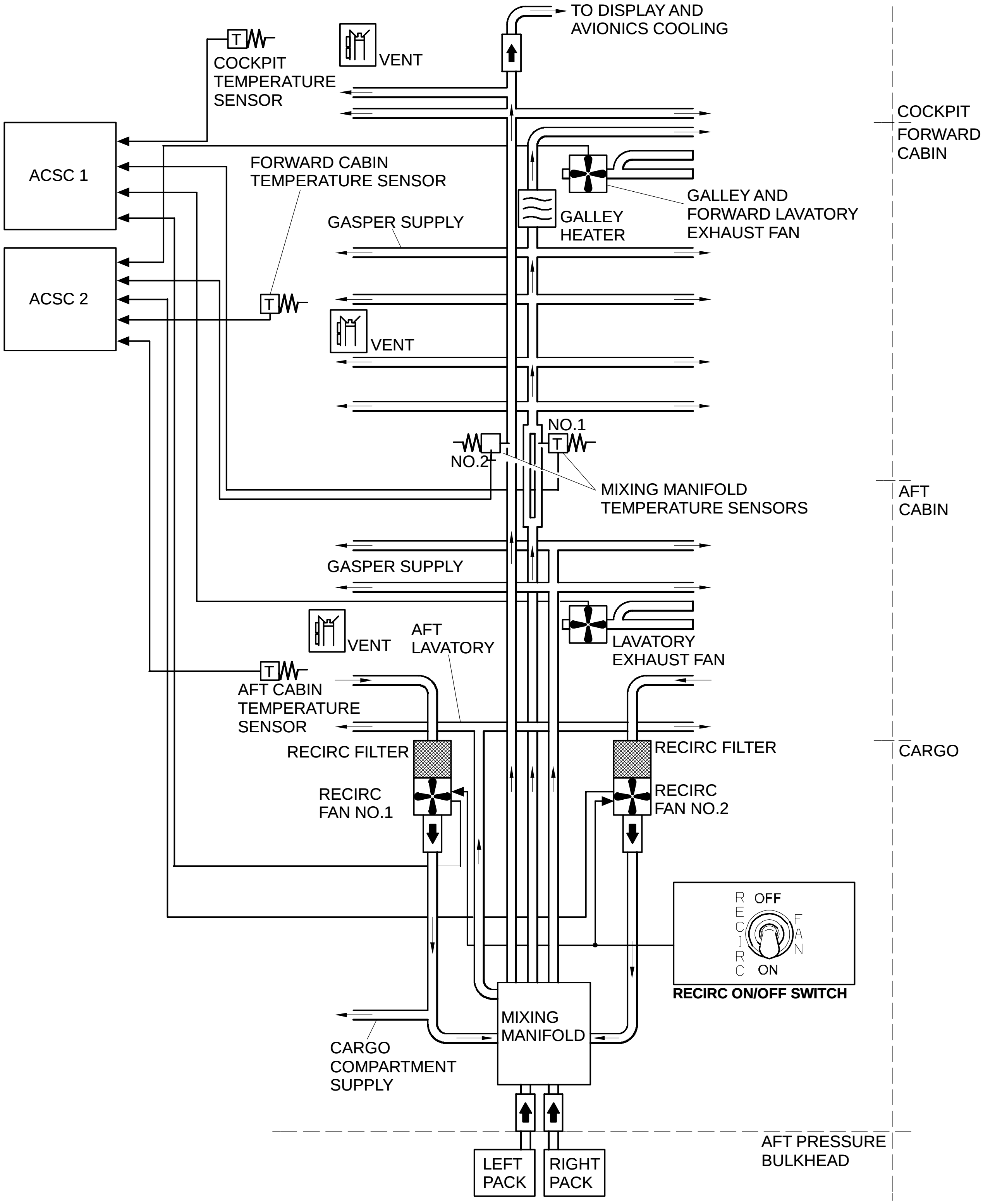
Conditioned air, to the flight compartment, is distributed to the side console panels, gaspers and vents, and avionics units within the instrument panel. Dedicated fans and ducts direct conditioned air over the flight compartment display units. Flight compartment exhaust air is routed underfloor through the avionics compartment to the outflow valve at the aft pressure bulkhead.

Recirculation of the air is provided by two recirculation fans connected to the distribution manifold. The fans are controlled by a single RECIRC switch on the air-conditioning panel.



Air-Conditioning Panel
Overhead Panel

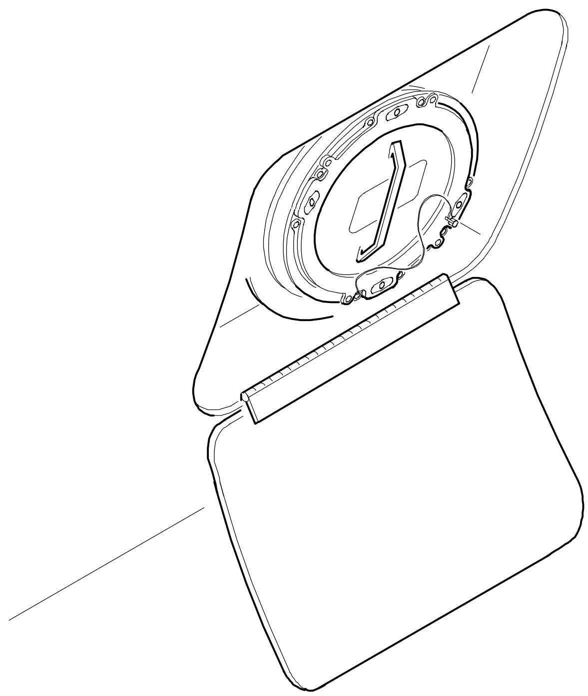
Recirculation Air Control <1201>
Figure 08-20-8



Air Distribution Schematic
Figure 08-20-9

E. Low Pressure Ground Air Connection <1007>

An external ground air connector, located on the right aft fuselage, is provided for ground air-conditioning. Low pressure compressed air from a ground air conditioning cart can be supplied directly into flight and passenger compartment distribution systems.



LOW PRESSURE GROUND AIR
CONNECTION PANEL

Low Pressure Ground Air Connection <1007>
Figure 08-20-10

F. System Circuit Breakers

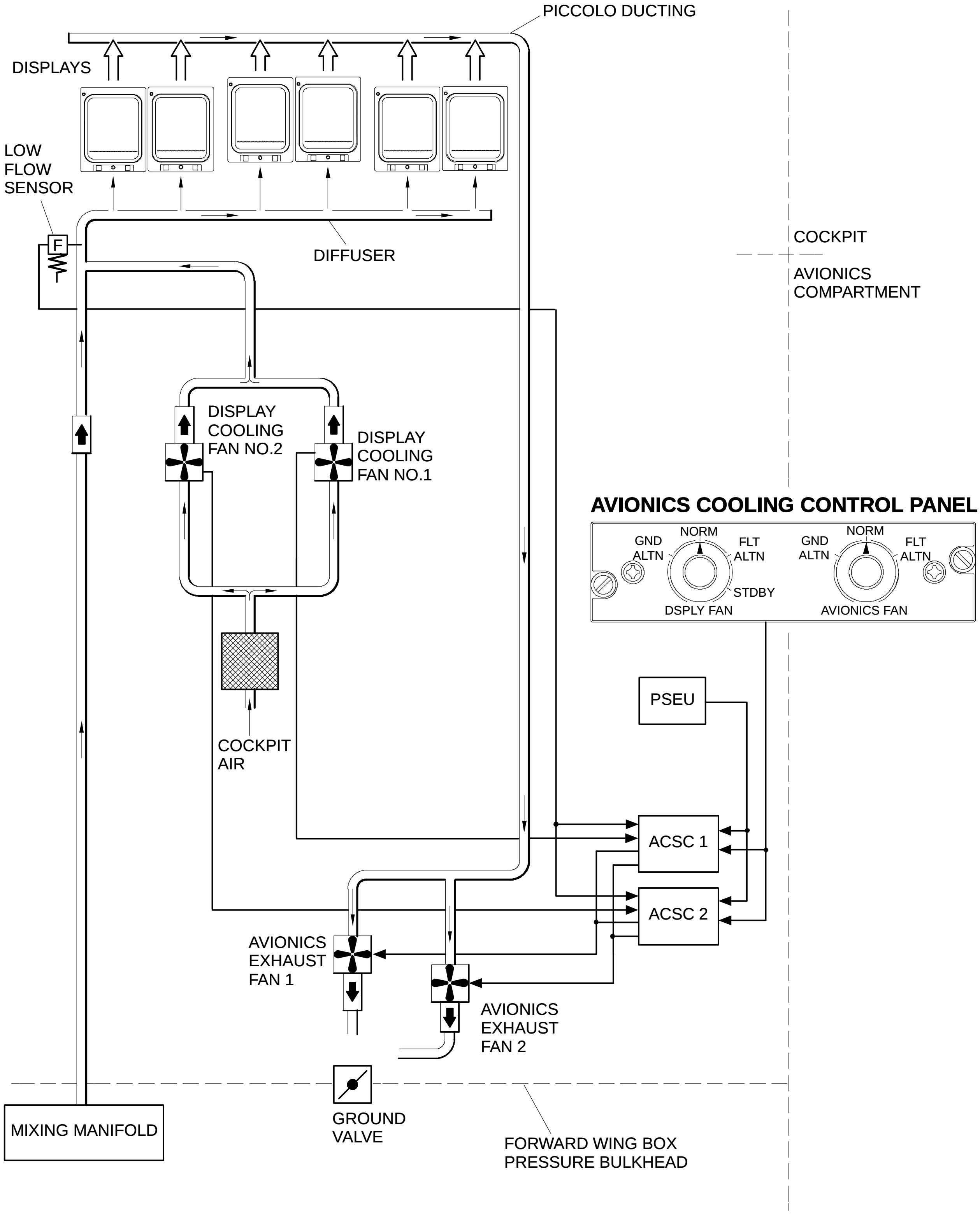
SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Air Conditioning	Control	ACS CONT 1 CH A	BATTERY BUS	1	L1	
		ACS CONT 1 CH B	DC BUS 2	2	J4	
		ACS CONT 2 CH A	DC BUS 1	1	K6	
		ACS CONT 2 CH B	DC ESSENTIAL	2	T7	
		ACS R MAN	DC BUS 2	2	K6	
		ACS L MAN	DC ESSENTIAL	2	T8	
	Pressure Sensors	ACS R PRESS SENS	DC ESSENTIAL	2	T11	
		ACS L PRESS SENS	DC BUS 2	2	F6	
	Temperature Sensors	CKPT TEMP SENS	DC BUS 1	1	K7	
		AFT CABIN TEMP SENS	DC BUS 1	1	J1	
		FWD CABIN TEMP SENS	DC BUS 2	2	J1	
	Ram Air	RAM AIR SOV	BATTERY BUS	2	P4	
	Recirculation Fan	RECIRC FAN 1	AC BUS 1	1	A5	
		RECIRC FAN 2	AC BUS 2	2	A5	
		FAN MONIT	DC BUS 1	1	F6	

1. AVIONICS COOLING SYSTEM

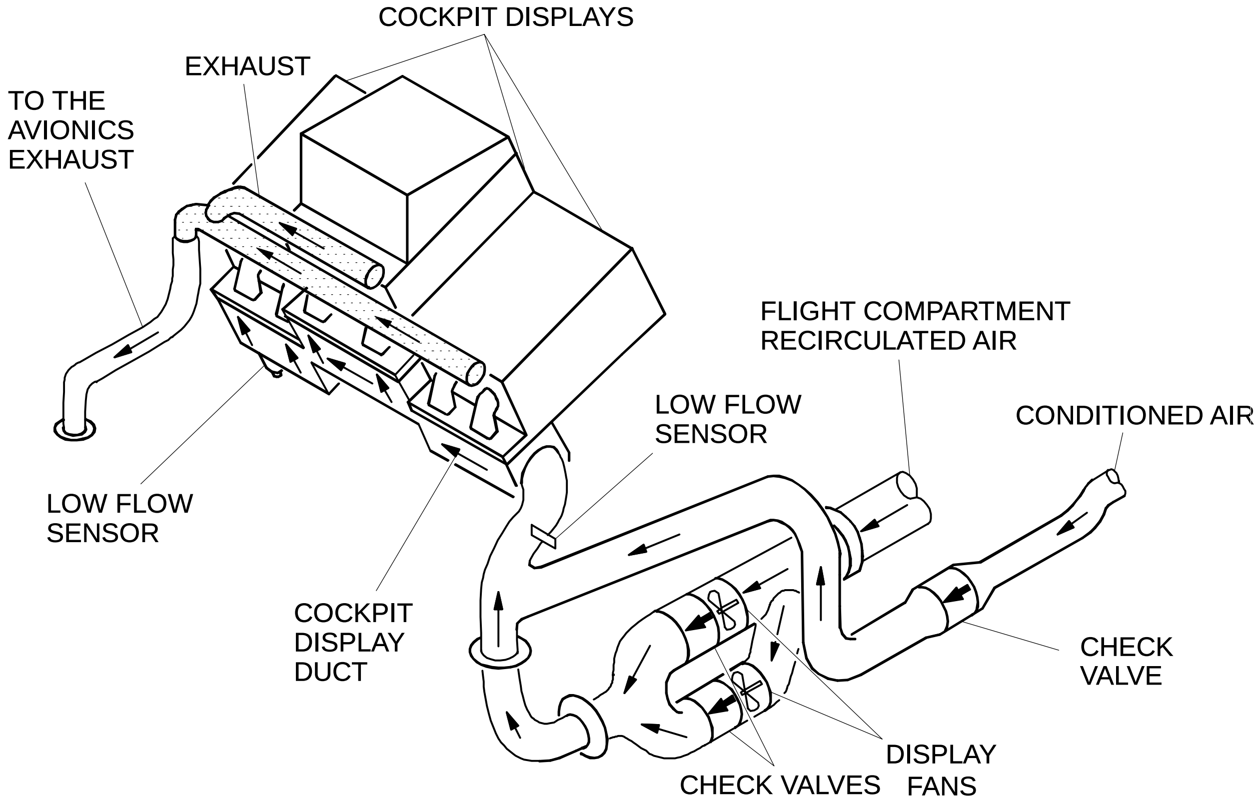
The electronic flight instruments in the flight compartment instrument panel, control panels and display units in the center pedestal, and electronic units in the left and right portions of the underfloor avionics bay are cooled during on-ground and flight operations.

The flight compartment displays are cooled with air from two display fans located under the flight compartment floor. Fan control is provided by a DSPLY FAN selector knob on the avionics cooling panel. Normally, only one fan operates at a time (operation is controlled by the PSEU). In flight, only fan 1 is powered and on the ground, only fan 2 is powered. When powered, the respective fan draws in air from the flight compartment and mixes it with conditioned air then supplies the air to the backs of each display. In the event of a fan failure, the alternate fan can be selected using the selector on the avionics cooling panel. If both fans fail, the selector is set to STDBY to permit conditioned air to ventilate the displays. A low flow sensor monitors air flow to ensure appropriate cooling. Check valves prevent loss of cooling air or reverse flow.

Two avionics exhaust fans are installed under the flight compartment floor. The fans are used to extract the heated air from behind the flight compartment displays and from the avionics equipment. Fan control is provided by a AVIONICS FAN selector knob on the avionics cooling panel. Normally, only one fan operates at a time (operation is controlled by the PSEU). In flight, only fan 1 is powered and on the ground, only fan 2 is powered. In the event of a fan failure, the alternate fan can be selected using the selector on the avionics cooling panel. On the ground, the heated air is dumped overboard through the ground outflow valve. In flight, the heated air is ducted to the pressurization outflow valve and dumped overboard.



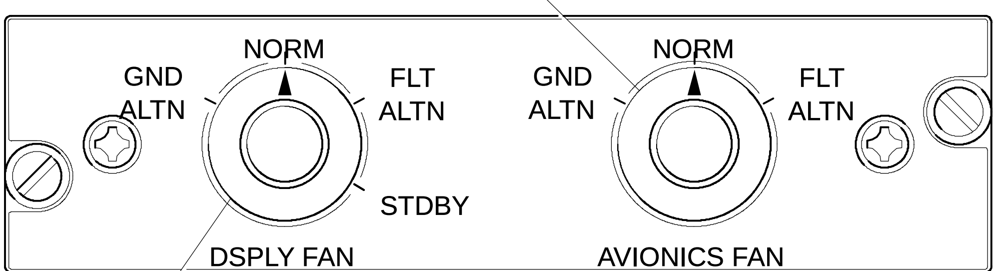
Cockpit Displays and Avionics Cooling System Schematic
Figure 08–30–1



Avionics Cooling System – General
Figure 08–30–2

AVIONICS FAN

- NORM – Fans in exhaust duct operate in automatic mode to exhaust hot air from the flight compartment displays and avionics compartment:
  Fan 1 during flight, and
  Fan 2 during ground operations.
- FLT ALTN – Selects fan 2 as the alternate fan in flight.
- GND ALTN – Selects fan 1 as the alternate fan on ground.

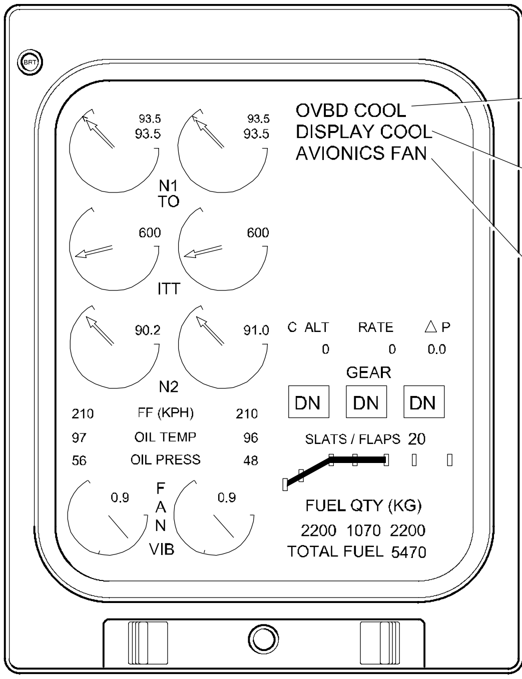


Avionics Cooling Fan Selector Panel
Center Pedestal

DSPLY FAN

- NORM – Fans in display duct operate in automatic mode providing airflow through flight compartment displays:
  Fan 1 during flight, and
  Fan 2 during ground operations.
- FLT ALTN – Selects fan 2 as the alternate fan in flight.
- GND ALTN – Selects fan 1 as the alternate fan on ground.
- STDBY – Selects conditioned air shut–off valve open.

Display Fan Controls
Figure 08–30–3



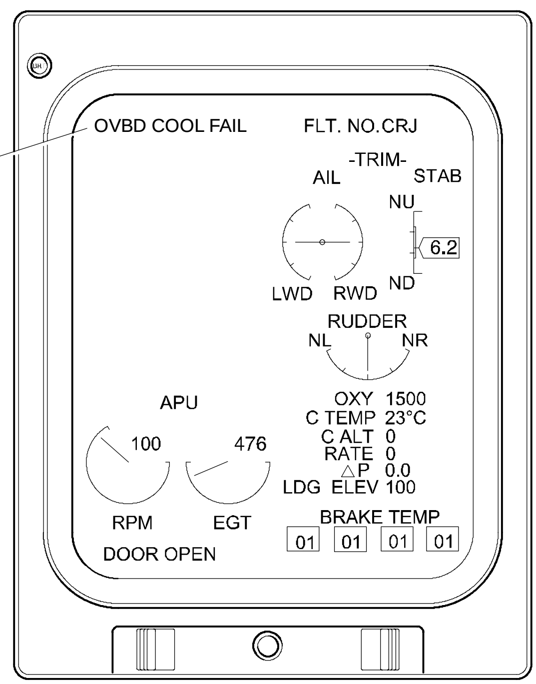
OVBD COOL caution (amber)
Indicates overboard exhaust shutoff valve not closed with passenger door and service door closed. The airplane will not pressurize to normal levels if valve has failed open.

DISPLAY COOL caution (amber)
Indicates low airflow in cockpit display cooling duct due to duct blockage or disconnection, or a fan has failed.

AVIONICS FAN caution (amber)
Indicates that avionics fan has failed or a low airflow exists in the exhaust duct.

Primary Page

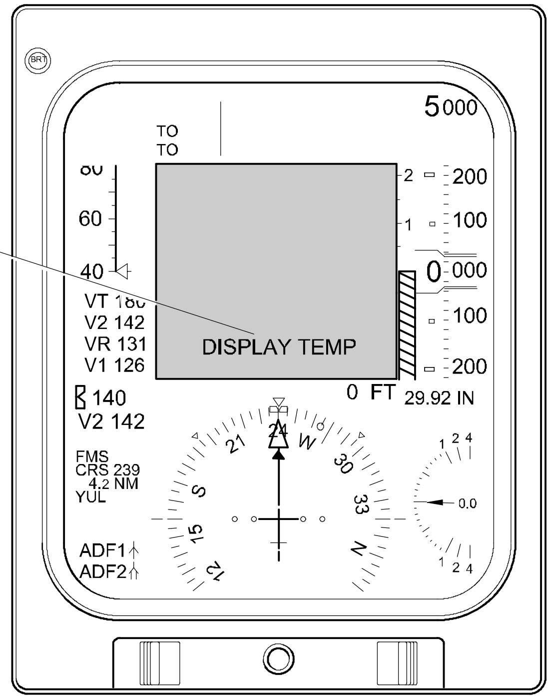
OVBD COOL FAIL status (white)
Indicates overboard exhaust shutoff valve has failed closed with the aircraft on the ground and the passenger door unlatched.



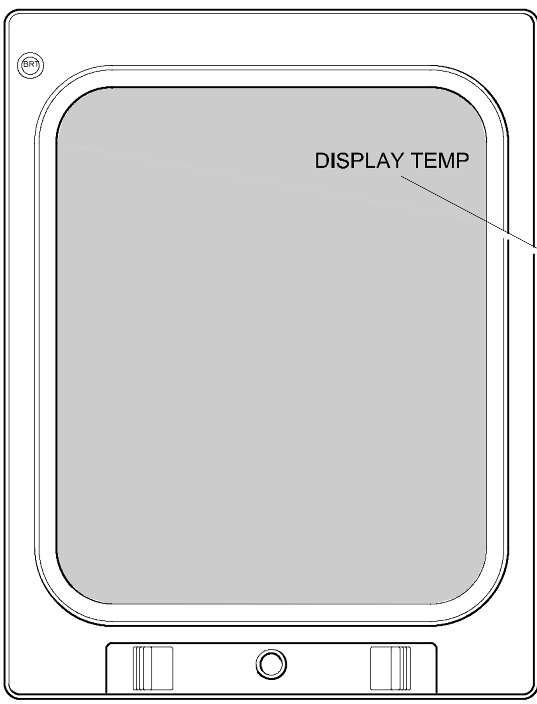
Status Page

Avionics Cooling EICAS Indications <1001>
Figure 08–30–4

Display Overtemperature warning (red)
Indicates an approaching thermal shutdown of PFD.
- Sky and ground raster is removed (to delay thermal shutdown).



Primary Flight Display
Pilot's and Copilot's Instrument Panels



Display Overtemperature warning (red)
Indicates an approaching thermal shutdown of MFD.

Multifunction Display
Pilot's and Copilot's Instrument Panels

Display Overtemperature Indications
Figure 08–30–5

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Avionics Cooling	Display Fans	AVIONICS DISPLAY COOLING FAN 1	AC ESSENTIAL	1	U2	
		AVIONICS DISPLAY COOLING FAN 2	AC BUS 1	1	B2	
		AVIONICS FAN 1	AC ESSENTIAL	1	V2	
Avionics Cooling	Display Fans	AVIONICS FAN 2	AC BUS 1	1	A2	Post SB670BA -21-004
Avionics Cooling	Display Fans	DISPLAY FAN CONT	DC ESSENTIAL	2	T10	

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1. AFT CARGO COMPARTMENT VENTILATION SYSTEM

The aft cargo compartment ventilation system allows the flight crew to control the air ventilation and temperature within the aft cargo compartment. <1201>

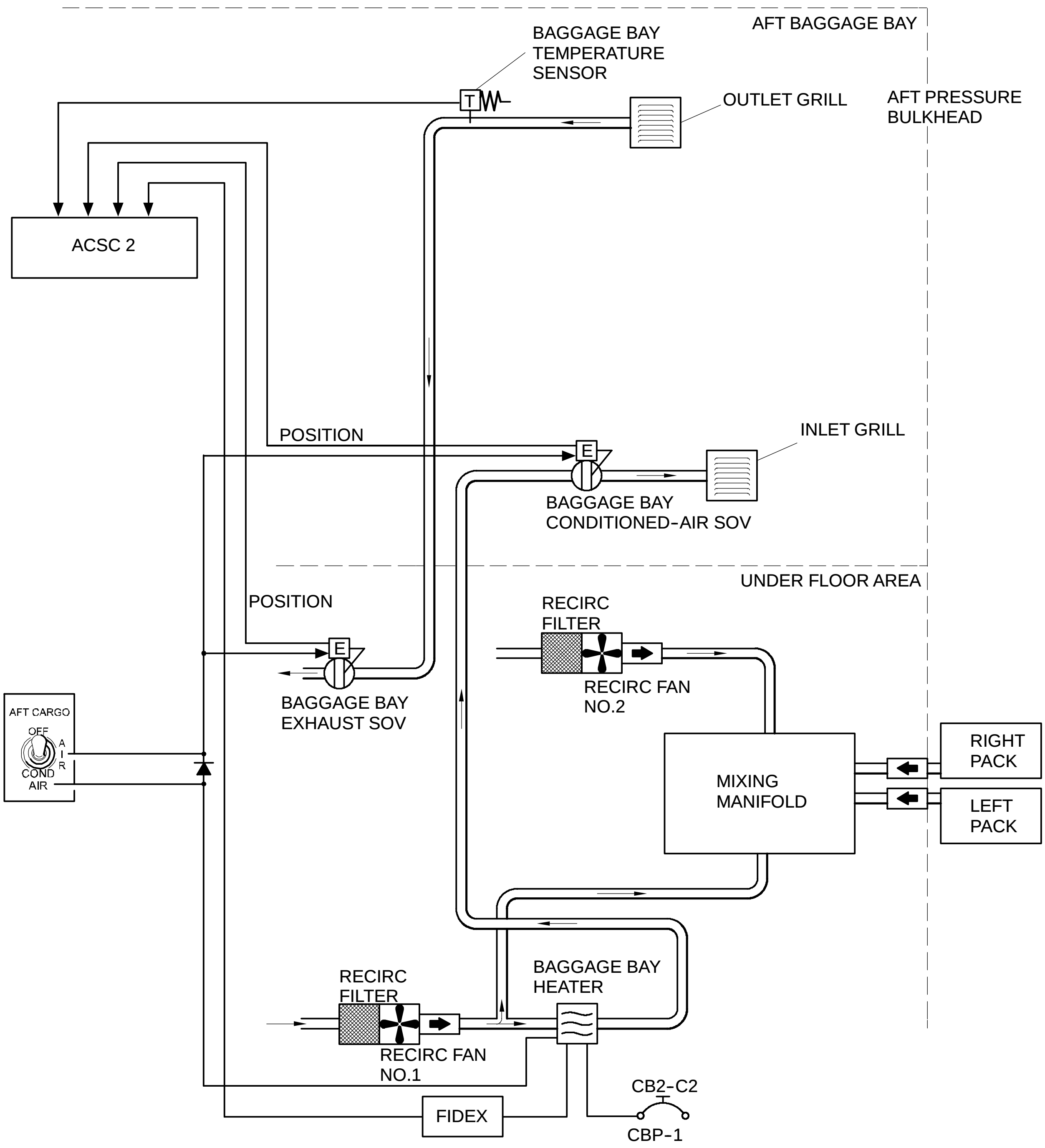
The system consists of an inlet shut–off valve, outlet shut–off valve, heater and an overtemperature switch. The system is supplied with recirculated air from recirc fan1 and/or air from the mixing manifold. <1201>

The system is controlled by an AFT CARGO, 3–position, OFF/AIR/AIR COND switch on the air-conditioning panel. In the OFF position, both shut–off valves are closed and the system is disabled. In the AIR position, both shut–off valves open to allow recirculated air into the aft cargo compartment to maintain the compartment temperature above freezing. In the COND AIR position, both shut–off valves are open and the heater is enabled. The heater will cycle ON and OFF as necessary to maintain the cargo compartment temperature between 16 and 27°C (60 and 80°F). <1201>

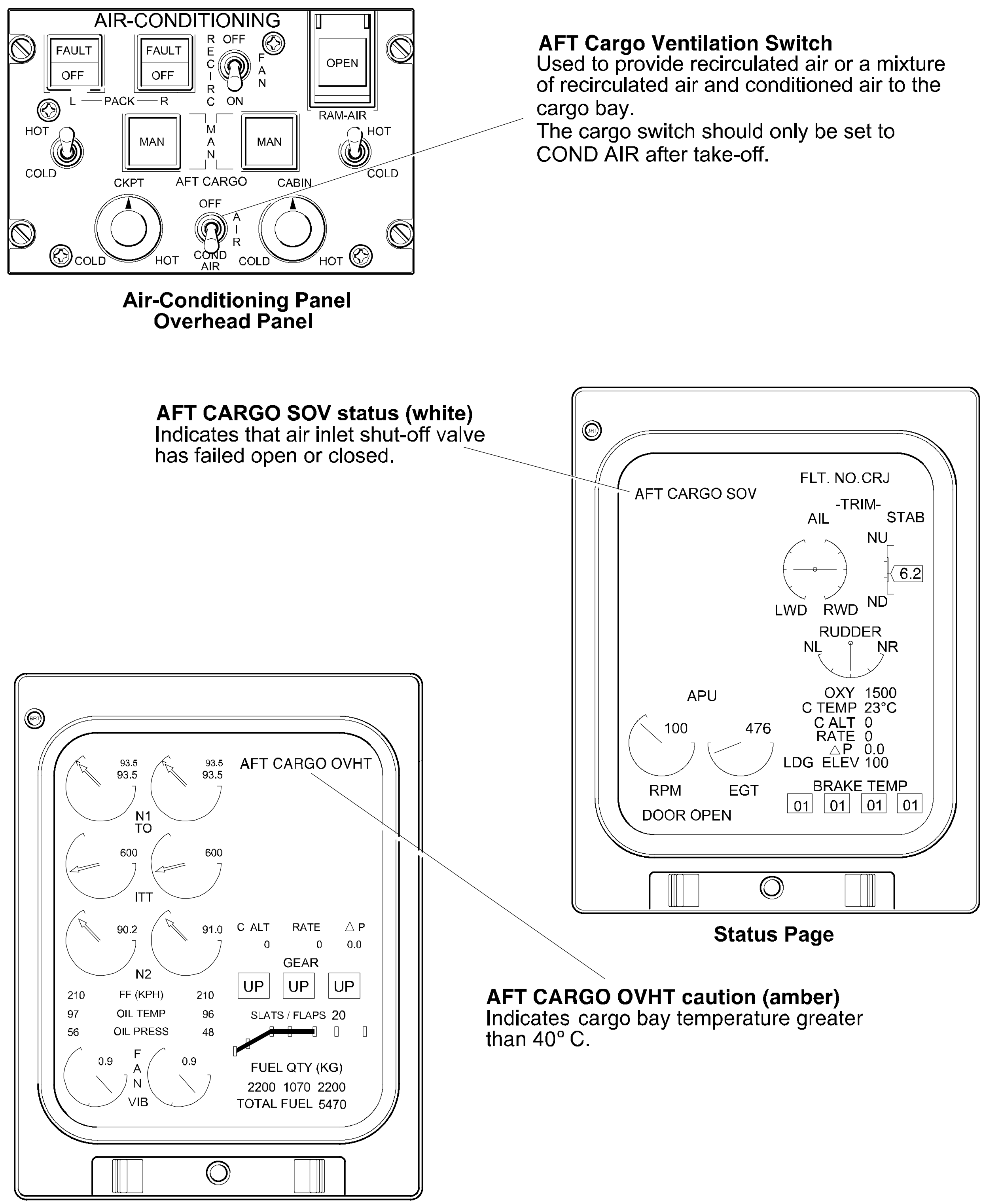
Cargo bay air is exhausted via a ceiling vent, through the outlet valve and ducted beneath the cargo floor to the outflow valves.

The aft cargo compartment temperature is monitored by a temperature sensor. The sensor supplies temperature information to air conditioning system controller 2 (ACSC 2) which controls the operation of the heater. If the temperature in the compartment exceeds 40°C (104°F), the ACSC removes power from the heater and transmits a signal to the DCUs to display an AFT CARGO OVHT caution message on the EICAS primary page. The crew should then select the AFT CARGO switch to the AIR position which will disable the heater power circuit. <1201>

The system interacts with the cargo bay smoke detectors and fire extinguishing system (See Chapter 10, Fire Protection). When smoke is detected, the shut-off valves automatically close to isolate the aft cargo compartment. <1201>



Cargo Compartment Air System Schematic <1201>
Figure 08–40–1



AFT Cargo Bay EICAS Indication <1001,1201>
Figure 08–40–2

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Aft Cargo Bay Ventilation System	Controller	BAGG COMPT CONT	DC BUS 1	1	D8	
	Heater	BAGG COMPT HEATER	AC BUS 1	1	C2	

1. LAVATORY AND GALLEY VENTILATION SYSTEM

Lavatory and galley ventilation is provided by exhaust fans. The fans run whenever aircraft AC power is available. Each fan has an overheat thermal switch which shuts down the fan when the fan motor overheats.

The galley air supply line is fitted with a 1000 watt heater to provide supplementary heat to the galley and service door area. The heater is controlled by a HEATER switchlight on the galley control panel. The heater incorporates an internal, self-resetting, exhaust air temperature switch that removes power to the heater when the heater outlet temperature becomes excessive. The heater also incorporates an internal, overheat protection switch which disables the heater when the internal temperature exceeds a preset limit.

Effectivity:

- *Airplanes **incorporating** Service Bulliten SB 670BA-21-013:*

The galley air supply line heater is reduced to 500 watts power.

A. System Circuit Breakers

<table>
<tr><th>SYSTEM</th><th>SUB-SYSTEM</th><th>CB NAME</th><th>BUS BAR</th><th>CB PANEL</th><th>CB LOCATION</th><th>NOTES</th></tr>
<tr><td rowspan="3">Galley Ventilation</td><td rowspan="2">Heater</td><td>GALLEY HEATER CONT</td><td>DC BUS 2</td><td rowspan="3">2</td><td>F11</td><td></td></tr>
<tr><td>GALLEY HEATER</td><td rowspan="2">AC BUS 2</td><td>B11</td><td></td></tr>
<tr><td rowspan="2">Fan</td><td>GALLEY EXHAUST FAN</td><td>B8</td><td></td></tr>
<tr><td>Lavatory Ventilation</td><td>LAV EXHAUST FAN</td><td>AC BUS 1</td><td>1</td><td>B8</td><td></td></tr>
</table>

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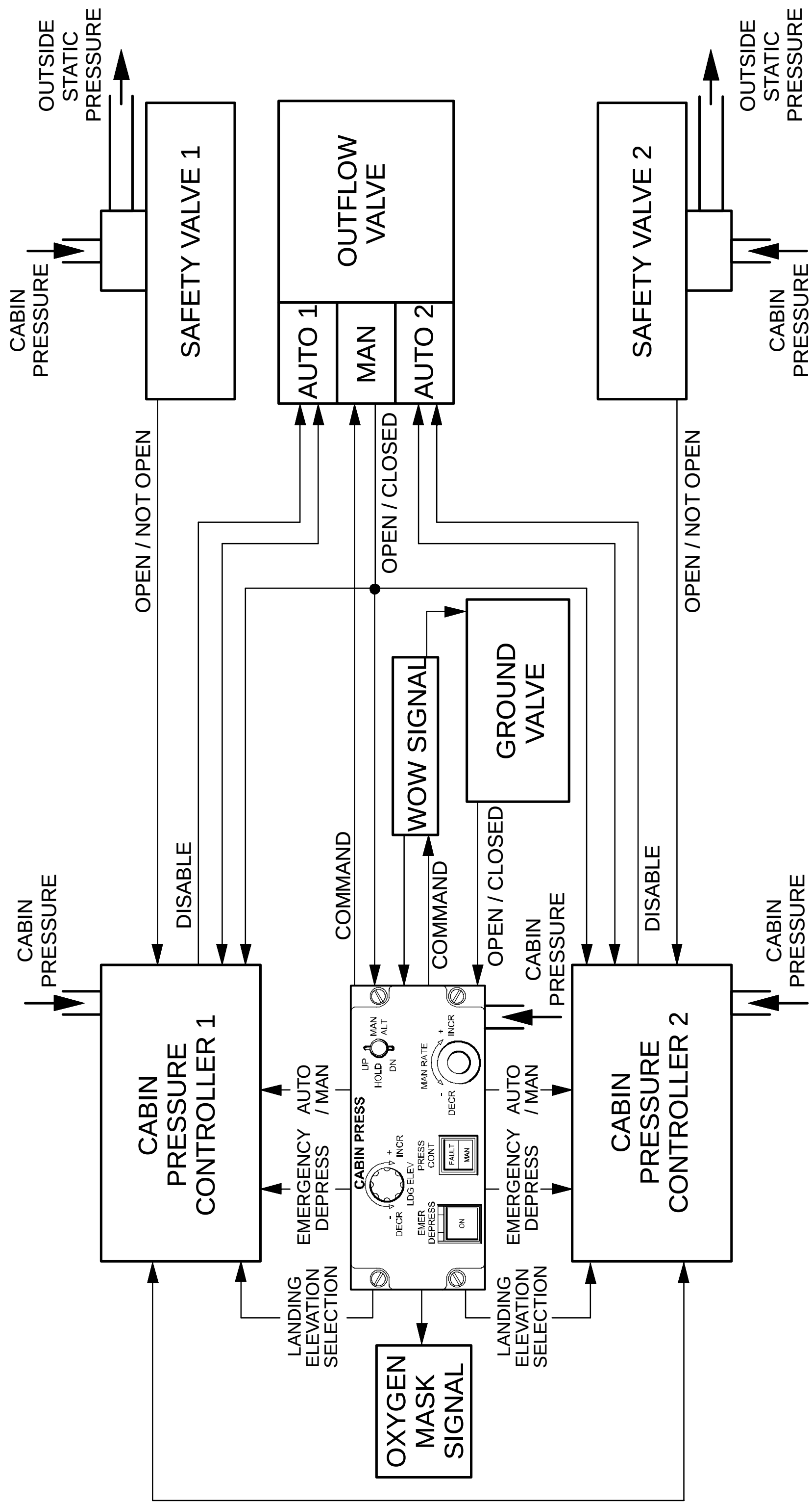
1. PRESSURIZATION SYSTEM

The aircraft is pressurized by bleed air supplied by the air-conditioning system. Pressurization is controlled by opening and closing a single electrically controlled outflow valve to regulate the internal cabin pressure. The outflow valve is controlled by either, of two independent cabin pressure controllers, in automatic mode or by controls on the cabin pressurization control panel in manual mode. When the aircraft is on the ground, differential pressure is limited by a ground valve. Two safety valves provide overpressure and negative pressure relief. If cabin altitude exceeds 14,000 feet, a signal is sent to the passenger oxygen system to deploy the oxygen masks.



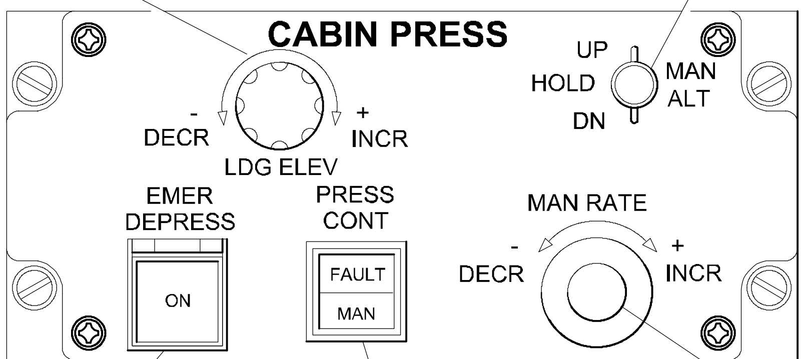
Pressurization System − General
Figure 08−60−1

LDG ELEV
Used to set destination airport altitude.
Setting indicated at LDG ELEV readout on EICAS display.

MAN ALT
Used to control pressurization system in manual (pneumatic) mode.

- UP - Causes outflow valves to open and increases cabin altitude.
- DN - Causes outflow valves to close and decreases cabin altitude.
- HOLD - Disables all previous manual selections.

Cabin Pressurization Control Panel
Overhead Panel



EMER DEPRESS (Guarded)
Used to depressurize airplane during an emergency.

- ON (amber) light indicates emergency depressurization is selected. Outflow valve opens fully to dump cabin pressure. At cruise, valves dump to cabin pressure of 14500 ±500 feet.

PRESS CONTROL
Selects either manual or automatic control of pressurization system.

- MAN (white) light indicates manual mode is selected.
- FAULT (amber) light indicates failure of both cabin pressure controllers. Manual mode data is displayed on EICAS primary display. Automatic mode data is displayed on EICAS secondary display.
  When pressed twice, the redundant controller gains control.

MAN RATE
Pneumatically adjusts outflow valve rate during manual mode.
MAN ALT selected UP - Range is 150 (± 150) fpm to 4000 (± 500) fpm.
MAN ALT selected DN - Range is -100 (± 100) fpm to -2500 (± 500) fpm.

Pressurization Controls
Figure 08–60–2

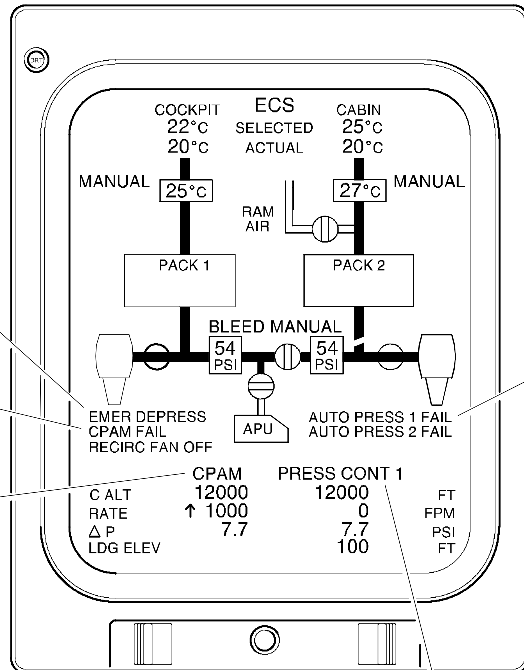
EMER DEPRESS (amber)
Indicates that emergency depressurization has been selected

CPAM FAIL (white)
Indicates failure of cabin pressure control panel indication system.

Monitoring Data Source (white)
Indicates monitoring source:
- CPAM,
- PRESS CONT 1 or
- PRESS CONT 2

If all sources failed, comes on as dashes (amber)

AUTO PRESS 1 or 2 FAIL (white)
Indicates failure of respective controller.



Environmental Control System Page

Active Controller Data Source
Indicates active pressurization controller:
- PRESS CONT 1 (half-intensity cyan),
- PRESS CONT 2 (half-intensity cyan) or
- PRESS MAN (white)

If all sources failed, comes on as dashes (amber)

NOTE
The standby controller becomes the monitoring source.

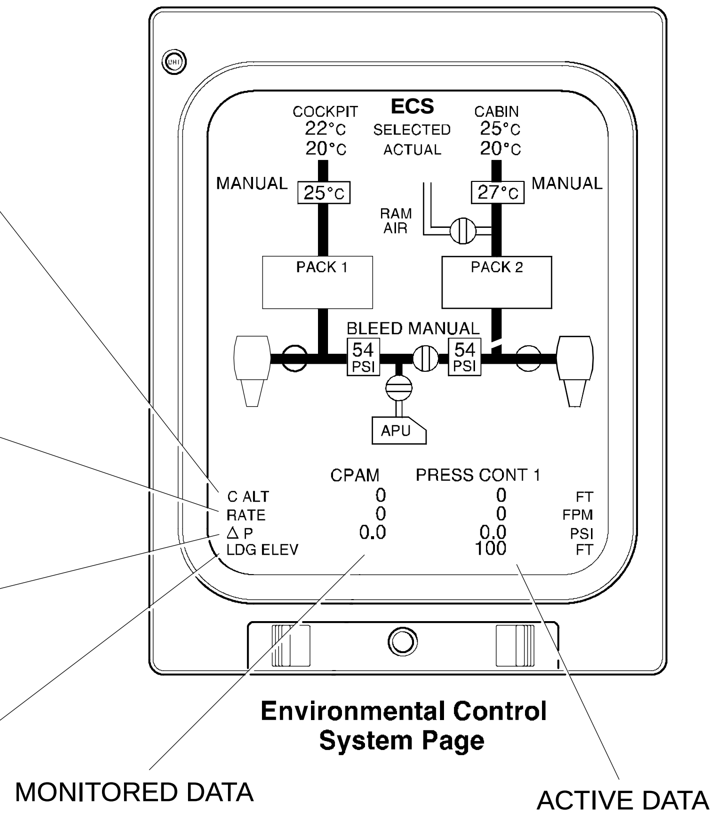
Pressurization EICAS Synoptic Page Message
Figure 08–60–3

C ALT
Displays current cabin altitude (100 foot increments).
Monitored data is displayed green and active data is displayed white. Monitored data will turn amber if altitude is above 8,500 feet and red if altitude is above 10,000 feet. Invalid data is displayed as amber dashes.

RATE
Displays rate of climb or descent in feet per minute (100 fpm increments) and direction via arrow symbol.
Monitored data is displayed green and active data is displayed white. Invalid data is displayed as amber dashes.

DELTA P
Displays cabin to ambient differential pressure (0.1 psi increments).
Monitored data is displayed green and active data is displayed white. Monitored data will turn red if differential exceeds 8.6 psi. Invalid data is displayed as amber dashes.

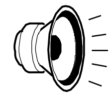
LDG ELEV
Displays elevation in feet as set at LDG ELEV selector (20 foot increments).
Displayed in cyan. Invalid data, elevations above 15,000 feet and elevations below −2000 feet are displayed as amber dashes.



Environmental Control System Page

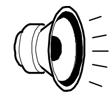
Pressurization EICAS Synoptic Page Elements
Figure 08−60−4

CABIN ALT warning (red)
Indicates that cabin altitude is greater than 10,000 feet. Accompanied by aural warning:

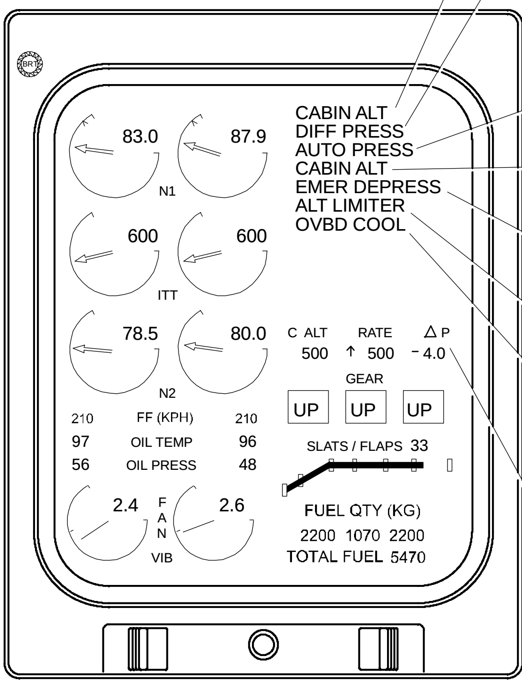


CABIN PRESSURE

DIFF PRESS warning (red)
Indicates that differential pressure is greater than 8.6 psi. Accompanied by aural warning:



CABIN PRESSURE



Primary Page

AUTO PRESS caution (amber)
Indicates that automatic presurization control is inoperative.

CABIN ALT caution (amber)
Indicates that cabin altitude is greater than 8,500 feet but not greater than 10,000 feet.

EMER DEPRESS caution (amber)
Indicates that EMER DEPRESS switch has been selected on.

ALT LIMITER caution (amber)
Indicates that altitude limitation function is inoperative.

OVBD COOL caution (amber)
Ground valve failed OPEN, in flight.

Pressurization Readouts (manual mode)
Comes on when pressurization system is operated in manual mode:
- C ALT – Displays current cabin altitude.
- RATE – Displays rate of climb or descent in feet per minute and direction via arrow symbol.
- DP – Displays cabin to ambient differential pressure.

Landing Elevation readout is not displayed.

NOTE
Readouts removed from primary page when automatic mode selected.

Pressurization EICAS Indications – Primary Page <1001>
Figure 08–60–5

AUTO PRESS 1 or 2 FAIL status (white)
Indicates that respective cabin pressure controller is inoperative

AUTO PRS 1/2 FAIL status (white)
Indicates loss of active channel in manual mode.

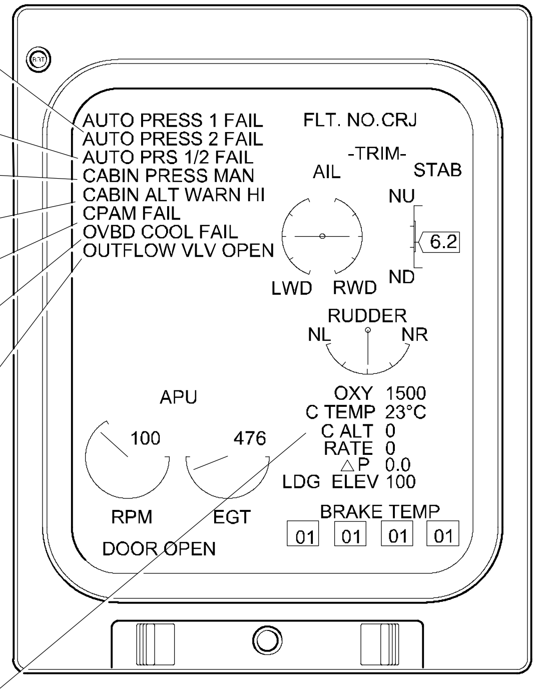
CABIN PRESS MAN status (white)
Indicates that PRESS CONTROL switch is selected to MAN.

CABIN ALT WARN HI status (white)
Indicates that landing elevation is set above 8000 feet.

CPAM FAIL status (white)
Indicates failure of cabin pressure control panel indication system.

OVBD COOL FAIL status (white)
Indicates that the ground valve has failed CLOSED on the ground.

OUTFLOW VLV OPEN status (white)
Indicates outflow valve in full open position.



Status Page

Pressurization Readouts (automatic mode)
Comes on when pressurization system is operated in automatic mode:

- C ALT – Displays current cabin altitude.
- Rate – Displays rate of climb or descent in feet per minute and direction via arrow symbol.
- DP – Displays cabin to ambient differential pressure.
- LDG ELEV – Displays elevation in feet as set at LDG ELEV selector.

Pressurization EICAS Indications – Status Page
Figure 08–60–6

2. CABIN PRESSURE CONTROLLERS

The aircraft is equipped with dual, redundant controllers, which operate only in automatic mode. All controller outputs are sent to the outflow valve. While one controller is in use, the other updates automatically. The active cabin pressure controller commands the outflow valve to a nominal differential pressure of 8.33 psid. Normally, inputs to the pressure controllers are supplied from air data computer 1 (ADC 1). ADC 2 is the backup to ADC 1. If a controller fails, the system will automatically switch over to the other controller. If automatic switch–over fails, select the PRESS CONTROL switch twice. This will enable the redundant controller. If both pressure controllers fail, both outflow valves will go to an isobaric hold mode. When the airplane is on the ground for 3 minutes, automatic pressure controller switch–over will occur.

The pressurization system automatically maintains cabin pressure through all phases of flight. Typical values used in the cabin/flight altitude schedule during manual mode are as follows:

AIRPLANE FLIGHT ALTITUDE (feet)	CABIN PRESSURE ALTITUDE (feet)
10 000	–200
15 000	600
20 000	1500
25 000	2700
30 000	4200
35 000	6000
41 000	8000

A. Automatic Pressurization Modes

- Ground mode: Both the outflow valve and ground valve are driven full open.
- Pre-Pressure mode: When thrust levers are advanced to take-off, the cabin pressure moves towards the scheduled cabin pressure with a pressure rate of change equal to 300 ft/min, limited at a differential pressure of 150 ft/min. During take-off without air-conditioning, the outflow valve and ground valve are driven closed.
- Take-Off abort mode: When the thrust levers are retarded to idle, the cabin ascends at approximately 500 ft/min for 20 seconds, then the outflow valves are driven full open.
- Climb mode: Cabin climb is in accordance with a fixed schedule, cabin altitude vs airplane altitude. The climb rate varies between approximately 500 and 800 ft/min, dependant on the airplane climb speed. The controller compares selected landing elevation to the climb schedule, then selects the highest pressure schedule.
- Flight abort mode: When the airplane has maintained an altitude of up to 6,000 feet above the take-off field altitude for 10 minutes, and then has initiated a descent of 1,000 ft/min, the system will then assume the elevation for the departing airport, regardless of the pre-selected landing elevation.

- Descent mode: The cabin full descent schedule occurs when the airplane is in descent. Cabin altitude decreases at approximately 300 to 750 ft/min, to either landing elevation, or maximum differential, whichever is highest. When the landing elevation exceeds 8,000 feet, cabin altitude will be maintained at maximum differential, until the airplane descends, then the cabin altitude will rate up to the pre-selected landing elevation.

- Landing mode: The cabin altitude is driven below field elevation or the airplane is unpressurized. When the cabin is below field elevation, then the cabin is rated up at approximately 600 ft/min for 30 seconds, then the outflow valve is driven full open.

- Touch and Go mode: On airplane touchdown, the system will assume landing mode; as the thrust levers are advanced, the system will schedule pre-pressure mode.

B. Manual Pressurization Modes

- UP selection: Cabin ascends at selected rate of 150 (±150) to 3,000 (±500) fpm. When the desired cabin altitude is reached, select MAN ALT to HOLD position.

- DN selection: Cabin descends at selected rate -100 (±100) to -2,500 (±500) fpm.. When the desired cabin altitude is reached, select MAN ALT to HOLD position.

- HOLD position: Disables all previous MAN ALT selections.

C. Safety Valves

Two safety valves are installed at the top of the rear pressure bulkhead. The purpose the valves is to make sure that the cabin pressure differential does not exceed its maximum positive and negative pressure limits. Maximum positive differential pressure is limited to 8.6 ±0.1 psid and negative differential pressure is limited to −0.5 psid.

D. Ground Valve

The ground valve is normally open when the aircraft is on the ground and the passenger or service doors are open. The valve is used to limit differential pressure drop by discharging air from the avionics compartment overboard. The valve is driven to the closed position by the CPCP as soon as the passenger and service doors are closed and locked or when the automatic pre-pressurization sequence is initiated Failure of the ground valve to open on the ground will be indicated by an OVBD COOL FAIL status message on the EICAS status page

E. Cabin Altitude Limitation

Altitude limitation closes the outflow valve to prevent an increase in cabin altitude above 14,500 ±500 feet.

F. Emergency Depressurization

Electrical signals from the EMER DEPRESS switch commands the outflow valve to open. If the airplane is at a cruise altitude (above 15,000 feet), the altitude limiters operate to prevent cabin altitude from exceeding 15,000 feet.

G. Cabin Pressure Monitoring

Cabin pressure is monitored using data from the two cabin pressure controllers and the cabin pressurization control panel to display the following on the EICAS displays:

- Cabin altitude
- Cabin altitude rate of change
- Cabin to ambient differential pressure
- Landing elevation

H. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Cabin Pressurization Control	Controller	CABIN PRESS MAN CONT	BATTERY BUS	2	P5	
		CABIN PRESS CONT 1	DC BUS 1	1	F10	
		CABIN PRESS CONT 2	DC BUS 2	2	F10	

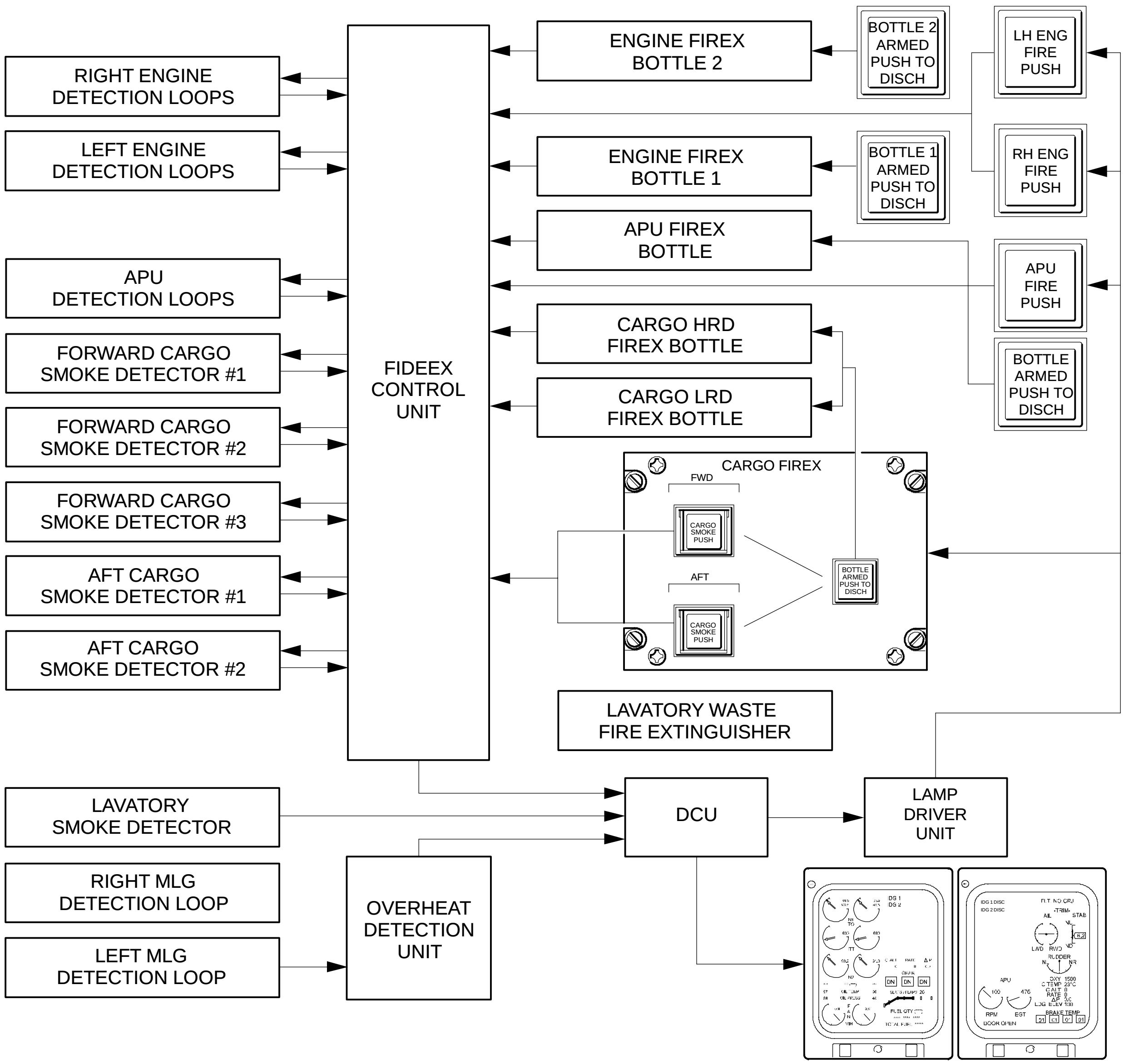
CHAPTER 10 – FIRE PROTECTION

LIST OF ILLUSTRATIONS

1. INTRODUCTION

Fire protection consists of a fire detection and extinguishing (FIDEEX) system for detecting and extinguish a fire in the engine nacelles, the auxiliary power unit (APU) compartment and the forward and aft cargo compartments. An independent system is provided for fire detection and protection in the lavatories. A detection system is also provided for the main landing gear wheel wells.

Indications to alert the crew to fire, smoke and overheat conditions as well as fire protection system health are provided by the EICAS displays and panel lights.



FIDEEX System Block Diagram
Figure 10–10–1

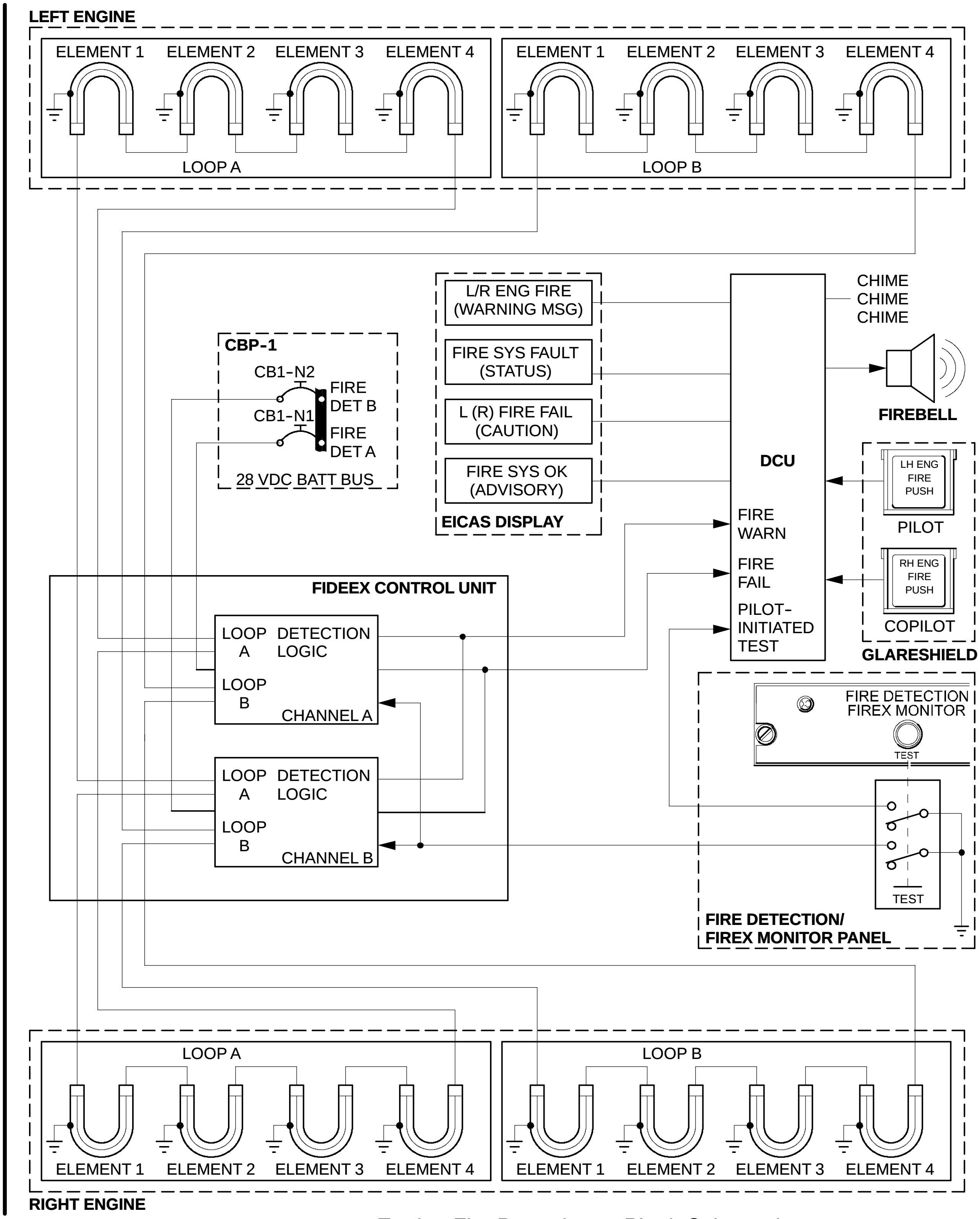
1. FIRE DETECTION AND EXTINGUISHING (FIDEEX)

The fire detection and extinguishing system (FIDEEX) interfaces with the engines, APU and cargo compartment fire protection systems. The FIDEEX uses the interfacing to provide fire detection, smoke detection, fire extinguishing and system indication. The L/R ENG FIRE PUSH and the 1/2 BOTTLE ARMED PUSH TO DISCH switchlights on the glareshield are used by the crew to supply control inputs to the FIDEEX system.

A. Engine

Detection

Engine fire detection is provided by dual heat sensitive detection loops arranged in parallel around the engine combustion section and exhaust pipe. Each loop is connected to the FIDEEX and is monitored continuously for fire or overheat conditions. In normal operation, both detection loops must detect a fire or overheat condition before a fire warning alarm is issued. If a short or open circuit fault is detected in one loop, the FIDEEX control unit will automatically switch to single loop detection and signal the EICAS to display a L/R FIRE FAIL caution message on the EICAS primary page.

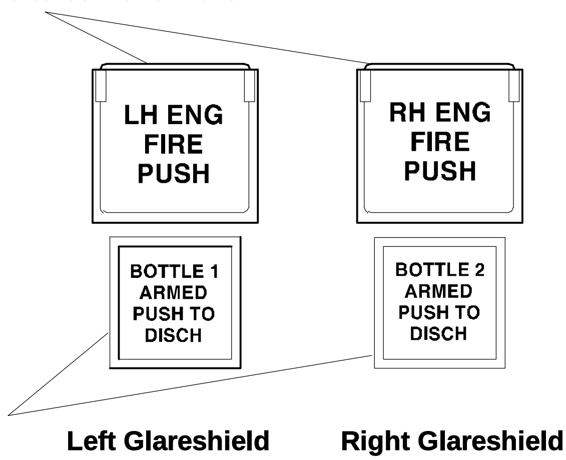


Engine Fire Detection – Block Schematic
Figure 10–20–1

Extinguishing

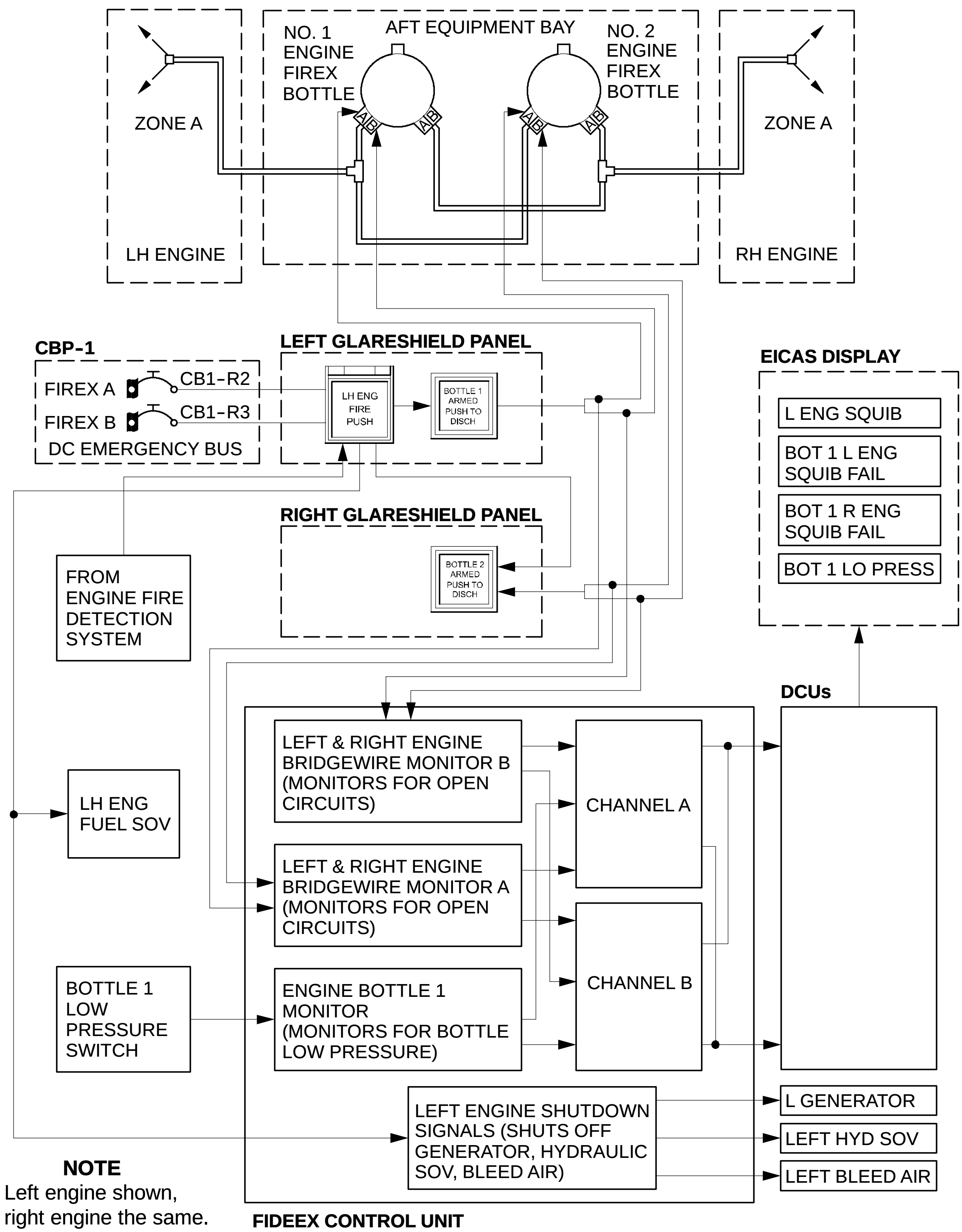
The engine fire extinguishing system provides a means to extinguish fires in the left and right engines. The system consists of two FIREX bottles, located in the aft equipment compartment, a low pressure switch, a bottle pressure gauge and discharge lines. The bottles contain Halon and are pressurized to 600 psi. Each bottle has two firing cartridges (squibs) to permit discharge of the fire extinguishing agent into either engine nacelle. The pressure switches are connected to the FIDEEX, and if the bottle pressure decrease to a preset point, an ENG BTL 1 (2) LO caution message will be displayed on the EICAS primary page.

LH and RH ENG FIRE PUSH
Used to arm left or right squibs of both bottles. Closes engine fuel, bleed air and hydraulic shut–off valves.
- LH and RH ENG FIRE PUSH (red) light indicates that a fire is detected in respective engine.

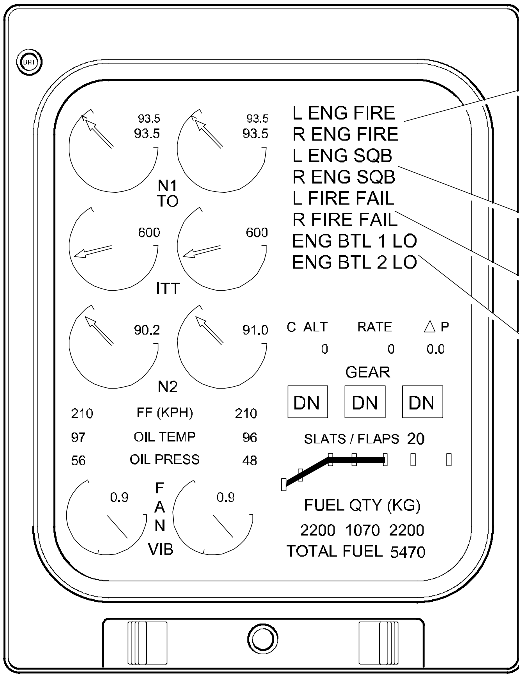


BOTTLE 1 and 2 ARMED PUSH TO DISCH
Used to discharge one bottle.
- BOTTLE 1 or 2 ARMED PUSH TO DISCH (green) light indicates respective squib is armed and bottle is charged.

Fire Detection and Extinguishing (FIDEEX) – Engine Push Buttons
Figure 10–20–2

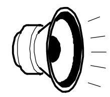


Engine Fire Extinguishing – Schematic
Figure 10–20–3



Primary Page

L or R ENG FIRE warning (red)
Indicates that a fire exists in the left or right engine.

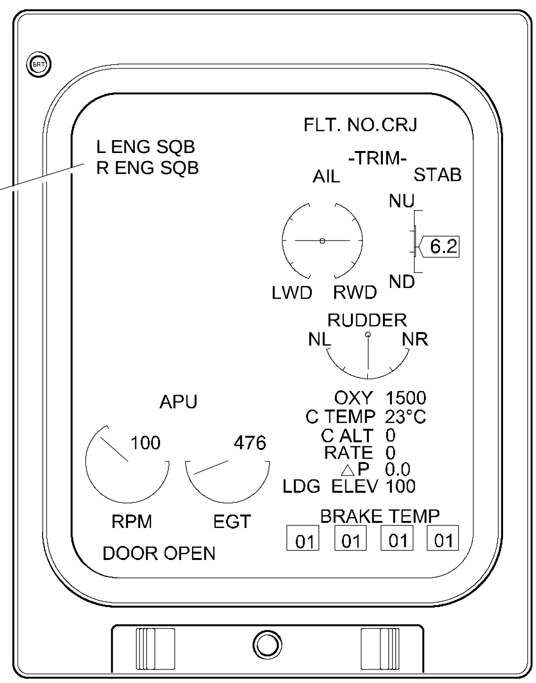


L or R ENG SQB caution (amber)
Indicates that left or right squibs of both bottles have failed or have fired.

L or R FIRE FAIL caution (amber)
Indicates a failure of the respective engine detection system.

ENG BTL 1 or 2 LO caution (amber)
Indicates that respective bottle has discharged.

L or R ENG SQB status (white)
Indicates that one left or right squib has failed or has fired.



Status Page

Fire Detection and Extinguishing (FIDEEX) – EICAS Indications <1001>
Figure 10–20–4

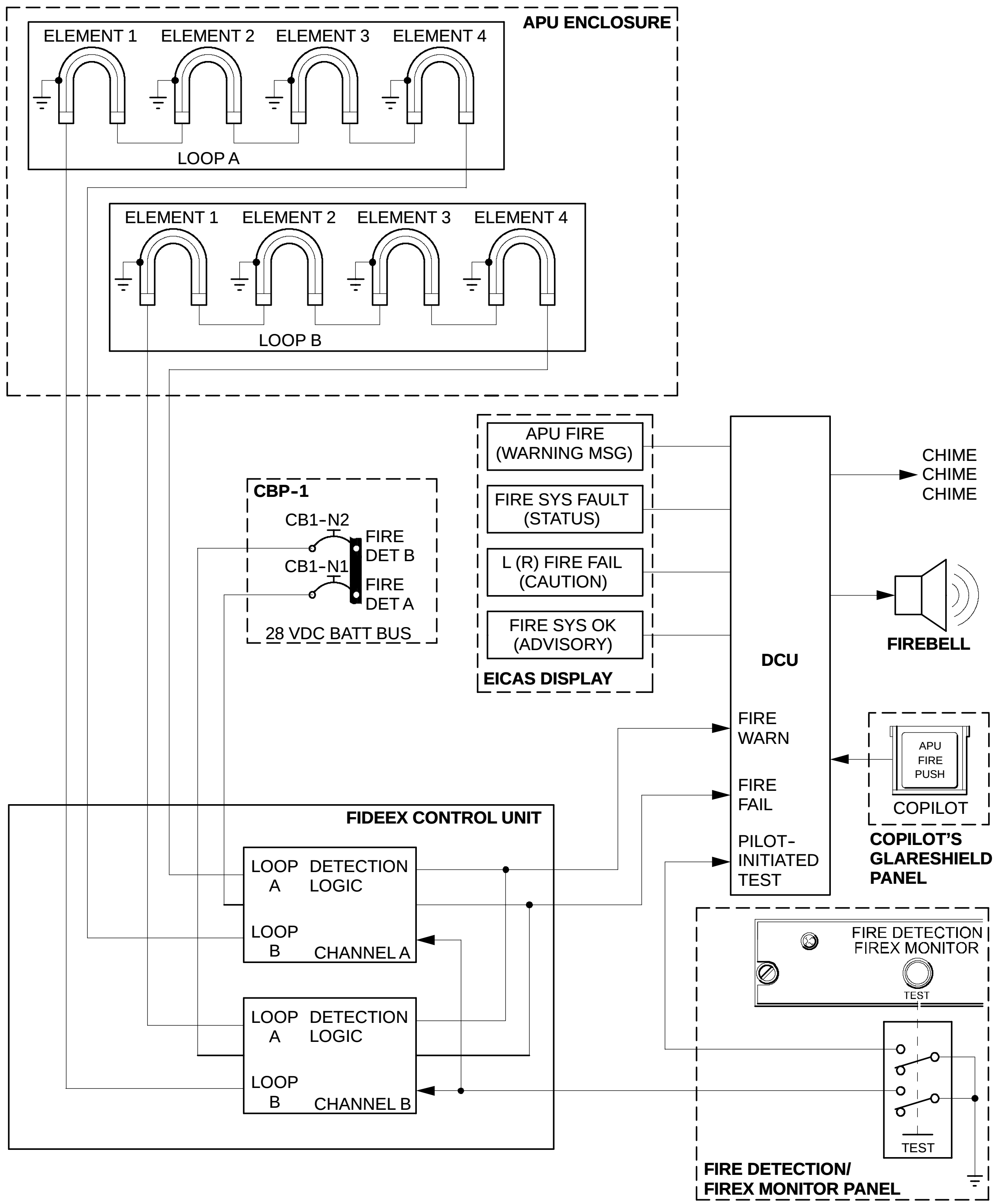
ENGINE FIRE EXTINGUISHING						
EVENT (Left engine fire procedure is described, the right engine fire procedure is similar)		**RESULT**	**GLARESHIELD INDICATIONS**			
			LH ENG FIRE PUSH	BOTTLE 1 ARMED PUSH TO DISCH	BOTTLE 2 ARMED PUSH TO DISCH	MASTER WARNING
1	Fire condition occurs in the left engine fire zone.	– Firebell sounds. – MASTER WARNING and LH FIRE PUSH switchlights come on.	ON	OUT	OUT	ON
2	MASTER WARNING switchlight is pressed in.	– Firebell is silenced. – MASTER WARNING switchlight goes out and the system is reset.	ON	OUT	OUT	OUT
3	Left thrust lever is set to the SHUTOFF position.	– LH ENG FIRE PUSH switchlight remains on.	ON	OUT	OUT	OUT
4	LH ENG FIRE PUSH switchlight is pressed in.	– BOTTLE 1 ARMED PUSH TO DISCH switchlight comes on. – BOTTLE 2 ARMED PUSH TO DISCH switchlight comes on. – Left squibs of bottles 1 and 2 are armed. – Left engine fuel SOV closes. – Left bleed air SOV closes. – Left hydraulic SOV closes.	ON	ON	ON	OUT
5	BOTTLE 1 ARMED PUSH TO DISCH switchlight is pressed in.	– Left squib on bottle 1 fires. – FIREX agent from bottle 1 discharges into left power plant nacelle.	ON	ON	ON	OUT
6	Bottle 1 fully discharges.	– The pressure switch on bottle 1 opens as pressure drops below the set point. – ENG BTL 1 LO is displayed on the EICAS.	ON	OUT	ON	OUT
7	Fire condition in left engine persists.	– LH ENG FIRE PUSH switchlight remains on.	ON	OUT	ON	OUT

ENGINE FIRE EXTINGUISHING						
8	BOTTLE 2 ARMED PUSH TO DISCH switchlight is pressed in.	– Left squib on bottle 2 fires. – FIREX agent from bottle 2 discharges into left engine nacelle.	ON	OUT	ON	OUT
9	Bottle 2 fully discharges.	– The pressure switch on bottle 2 opens as pressure drops below the set point. – ENG BTL 2 LO is displayed on EICAS.	OUT	OUT	OUT	OUT

B. APU

Detection

The APU fire detection system is used to detect a fire or overheat condition in the APU enclosure. The detection system consists of dual heat sensitive detection loops arranged in parallel around the APU and the forward APU firewall and above the two APU compartment doors. Each loop is connected to the FIDEEX and is monitored continuously for fire or overheat conditions. In normal operation, both detection loops must detect a fire or overheat condition before a fire warning alarm is issued. If a short or open circuit fault is detected in one loop, the FIDEEX control unit will automatically switch to single loop detection and signal the EICAS to display a APU FIRE FAIL caution message on the EICAS primary page.

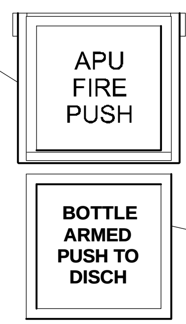


APU Fire Detection – Block Schematic
Figure 10–20–5

Extinguishing

The APU fire extinguishing system provides a means to extinguish fires in the APU enclosure. The system consists of a single FIREX bottle, located in the aft equipment compartment, a low pressure switch, a bottle pressure gauge and discharge lines. The bottle contain Halon and is pressurized to 600 psi. The bottle has a single firing cartridge (squib) to permit discharge of the fire extinguishing agent into APU enclosure. The pressure switch is connected to the FIDEEX, and if the bottle pressure decreases to a preset point, an APU BTL LO caution message will be displayed on the EICAS primary page.

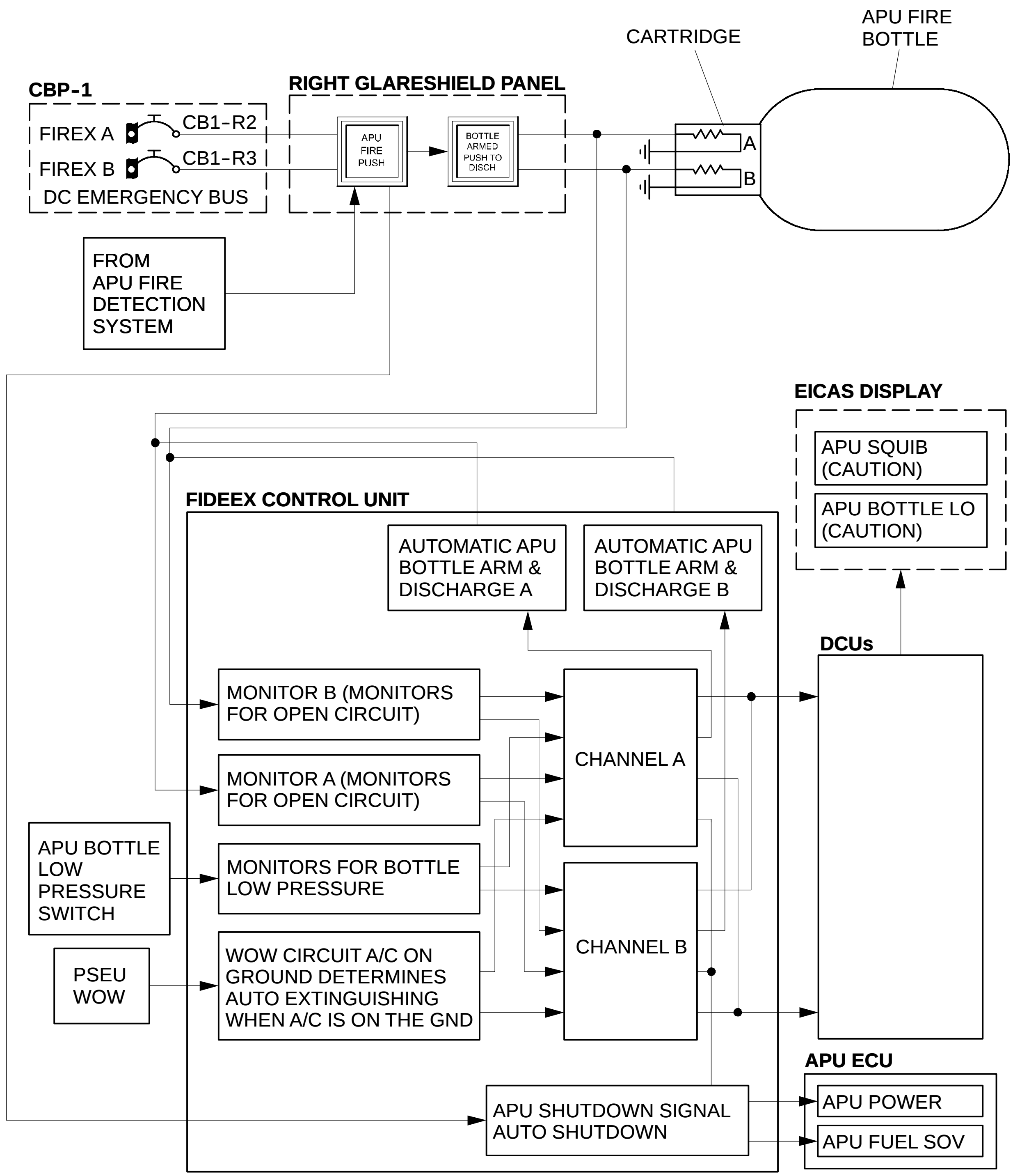
APU FIRE PUSH
Used to arm APU bottle squib. Closes APU bleed air load control valve and turns off the APU fuel pump.
- APU FIRE PUSH (red) light indicates that a fire is detected in the APU compartment.



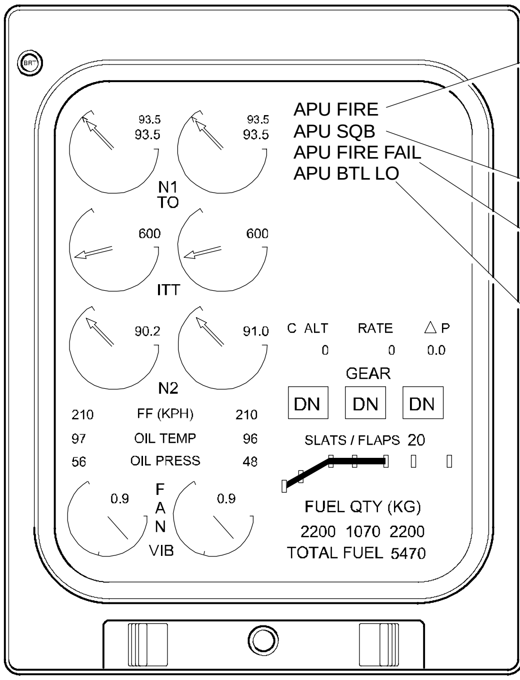
BOTTLE ARMED PUSH TO DISCH
Used to discharge APU bottle.
- BOTTLE ARMED PUSH TO DISCH (green) light indicates the squib is armed and the bottle is charged.

Right Glareshield

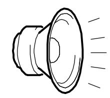
Fire Detection and Extinguishing (FIDEEX) – APU Pushbuttons
Figure 10–20–6



APU Fire Extinguishing – Schematic
Figure 10–20–7



APU FIRE warning (red)
Indicates that a fire exists in the APU compartment.



FIREBELL

APU SQB caution (amber)
Indicates that the APU bottle squib has failed or has fired.

APU FIRE FAIL caution (amber)
Indicates a failure of the APU detection system.

APU BTL LO caution (amber)
Indicates that APU bottle has discharged.

Primary Page

Fire Detection and Extinguishing (FIDEEX) – APU EICAS Indications <1001>
Figure 10–20–8

APU FIRE EXTINGUISHING					
EVENT		RESULT	GLARESHIELD INDICATIONS		
			APU FIRE PUSH	BOTTLE ARMED PUSH TO DISCH	MASTER WARN-ING
1	Fire condition occurs in APU fire zone.	– Firebell sounds. – MASTER WARNING and APU FIRE PUSH lights come on. – Emergency shut down is automatically initiated. If airplane is on the ground: – APU bottle automatically discharges after 5 seconds.	ON	OUT	ON
2	MASTER WARNING is pressed in.	– Firebell is silenced. – MASTER WARNING light goes out and system is reset.	ON	OUT	OUT
3	APU FIRE PUSH is pressed in.	– BOTTLE ARMED PUSH TO DISCH light comes on. – APU squibs are armed. – APU fuel SOV closes. – APU bleed air LCV closes.	ON	ON	OUT
4	BOTTLE ARMED PUSH TO DISCH is pressed in.	– APU squib fires. – FIREX agent discharges into APU compartment.	ON	ON	OUT
5	APU bottle fully discharges.	– Pressure switch on bottle opens as pressure drops below set level. – APU BTL LO is displayed on EICAS.	OUT	OUT	OUT

C. Cargo Compartment

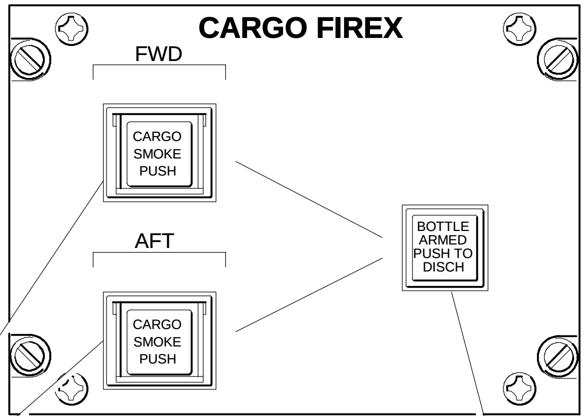
The cargo smoke detection system provides smoke detection in the forward and aft cargo compartments using optical type smoke detectors. Three detectors are located in the ceiling of the forward cargo compartment and two in the ceiling of the aft cargo compartment. All the smoke detector are protected from damage by a steel cage. Each detector is capable of producing an alarm within an established time frame and smoke concentration level. The detectors are positioned to avoid false alarms with overlapping coverage to guard against the failure of one detector.

The FIDEEX control unit monitors the cargo bay smoke detectors. Normally, two detectors must detect smoke to issue a cargo compartment smoke warning. If there is only one serviceable detector within a compartment, the FIDEEX will automatically switch to single smoke detector operation. In the event of a detector fault, a signal will be sent by the FIDEEX control unit to the to the EICAS to display a FIRE SYS FAULT caution message on the EICAS primary page.

NOTE

> Operation of mobile transceivers in close proximity to the smoke detectors may cause a false alarm.

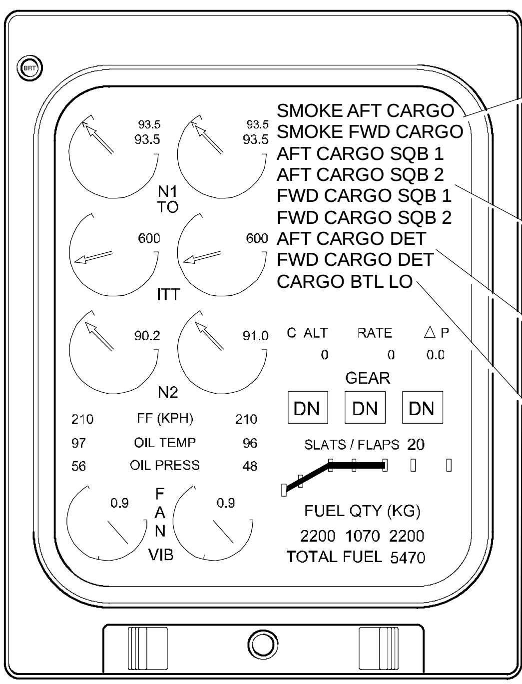
Fire suppression for the forward and aft cargo compartments is provided by a high rate discharge FIREX bottle and a low rate discharge FIREX bottle. Both bottles are located inside the right belly fairing, aft of the main landing gear, and are pressurized to 360 psi with Halon. Each bottle has a forward and aft compartment firing cartridge (squib), used to discharge the extinguishing agent into either compartment. Each bottle has a low pressure switch and a pressure gauge. Both bottles discharge simultaneously. The high rate discharge bottle is designed to quickly deliver extinguishing agent into the cargo compartment for initial fire suppression. The low rate discharge bottle discharges slowly, maintaining a flow of extinguishing agent into the cargo compartment (over a 60 minute period) to prevent reignition and allow for aircraft diversion. The pressure switches are connected to the FIDEEX, and if either bottle pressure decrease to a preset point, an CARGO BTL LO caution message will be displayed on the EICAS primary page.



Cargo Firex Panel
Center Pedestal

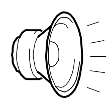
FWD and AFT CARGO SMOKE PUSH
Used to arm the forward or aft squibs of both cargo bottles. AFT CARGO SMOKE PUSH closes the air–conditioning shut–off valve and turns the heater off.
- CARGO SMOKE PUSH (red) light indicates that a smoke condition is detected in respective cargo compartment.

BOTTLE ARMED PUSH TO DISCH
Used to discharge both cargo bottles.
- BOTTLE ARMED PUSH TO DISCH (green) light indicates respective squibs are armed and bottles are charged.



Primary Page

SMOKE AFT or FWD CARGO warning (red)
Indicates that a smoke condition exists in the forward or aft cargo compartment.



SMOKE

AFT or FWD CARGO SQB 1 or 2 caution (amber)
Indicates that the forward or aft cargo bottle squib 1 or 2 has failed or has fired.

AFT or FWD CARGO DET caution (amber)
Indicates a failure of the forward or aft cargo detection system.

CARGO BTL LO caution (amber)
Indicates that one or both cargo bottle(s) have discharged.

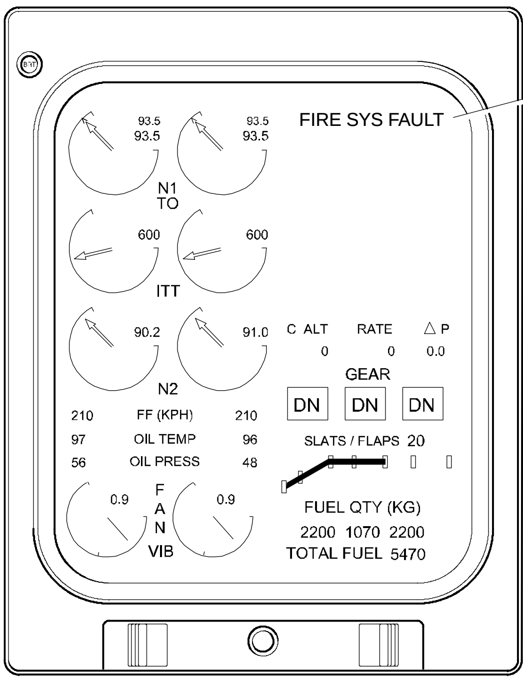
Fire Detection and Extinguishing (FIDEEX) – Cargo Firex <1001>
Figure 10–20–9

CARGO COMPARTMENT FIRE EXTINGUISHING					
EVENT (Aft described; forward similar)		RESULT	INDICATIONS		
			CARGO SMOKE PUSH	BOTTLE ARMED PUSH TO DISCH	MASTER WARN-ING
1	Fire condition occurs in aft cargo compartment.	– “Smoke” aural is annunciated. – MASTER WARNING and AFT CARGO SMOKE PUSH lights come on.	ON	OUT	ON
2	MASTER WARNING is pressed in.	– MASTER WARNING light goes out and system is reset.	ON	OUT	OUT
3	AFT SMOKE CARGO PUSH is pressed in.	– BOTTLE ARMED PUSH TO DISCH light comes on. – Aft squibs of both bottles are armed. For aft cargo compartment: – Cargo bay heater shuts off. – Cargo air-conditioning shut-off valve closes.	ON	ON	OUT
4	BOTTLE ARMED PUSH TO DISCH is pressed in.	– Aft squibs of both bottles fire. – FIREX agent discharges into aft cargo compartment.	ON	ON	OUT
5	One bottle fully discharges.	– Pressure switch on one bottle opens as pressure drops below set level. – CARGO BTL LO is displayed on EICAS. – Remaining bottle continues to discharge for a minimum of 60 minutes.	OUT	OUT	OUT

D. Testing

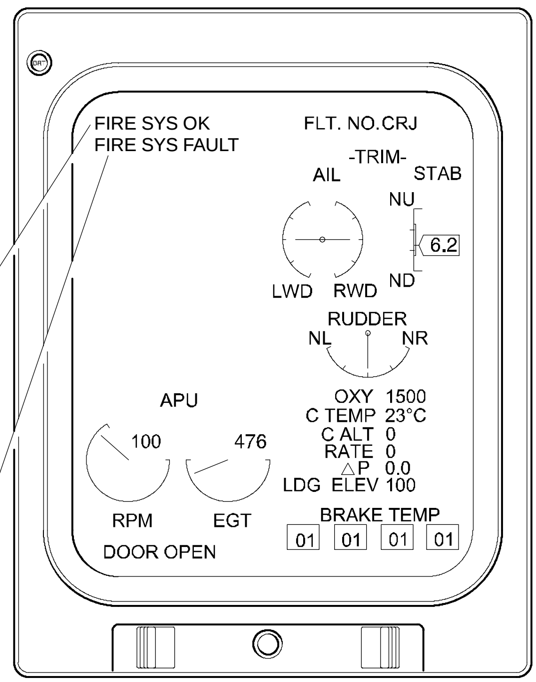
Testing is initiated using the TEST switch located on the Fire Detection / FIREX Monitor Panel, on the overhead panel. Test results are provided on the EICAS displays. The FIDEEX control unit monitors the fire protection systems by automatically performing periodic checks.

Fire Detection/FIREX Monitor Panel
Overhead Panel



Primary Page

FIRE SYS FAULT caution (amber)
Indicates loss of all ARINC communication to the FIDEEX system.



Status Page

FIRE SYS OK advisory (green)
Indicates that FIDEEX system has been tested and is operational.

FIRE SYS FAULT status (white)
Indicates a loss of redundancy in the FIDEEX system.

Fire Detection and Extinguishing (FIDEEX) – Testing <1001>
Figure 10–20–10

E. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
FIDEEX	Cargo Smoke Detection	CARGO SMOKE DET A	BATTERY BUS	1	M8	
		CARGO SMOKE DET B			M9	
	Fire Detection	FIRE DET A			N1	
		FIRE DET B			N2	
	Fire Extinguishing	FIREX A	DC EMERGENCY		R2	
		FIREX B			R3	

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1. LAVATORY FIRE PROTECTION

Lavatory fire detection and protection for each lavatory consists of a ceiling mounted smoke detector and a waste compartment fire extinguisher. <2202>

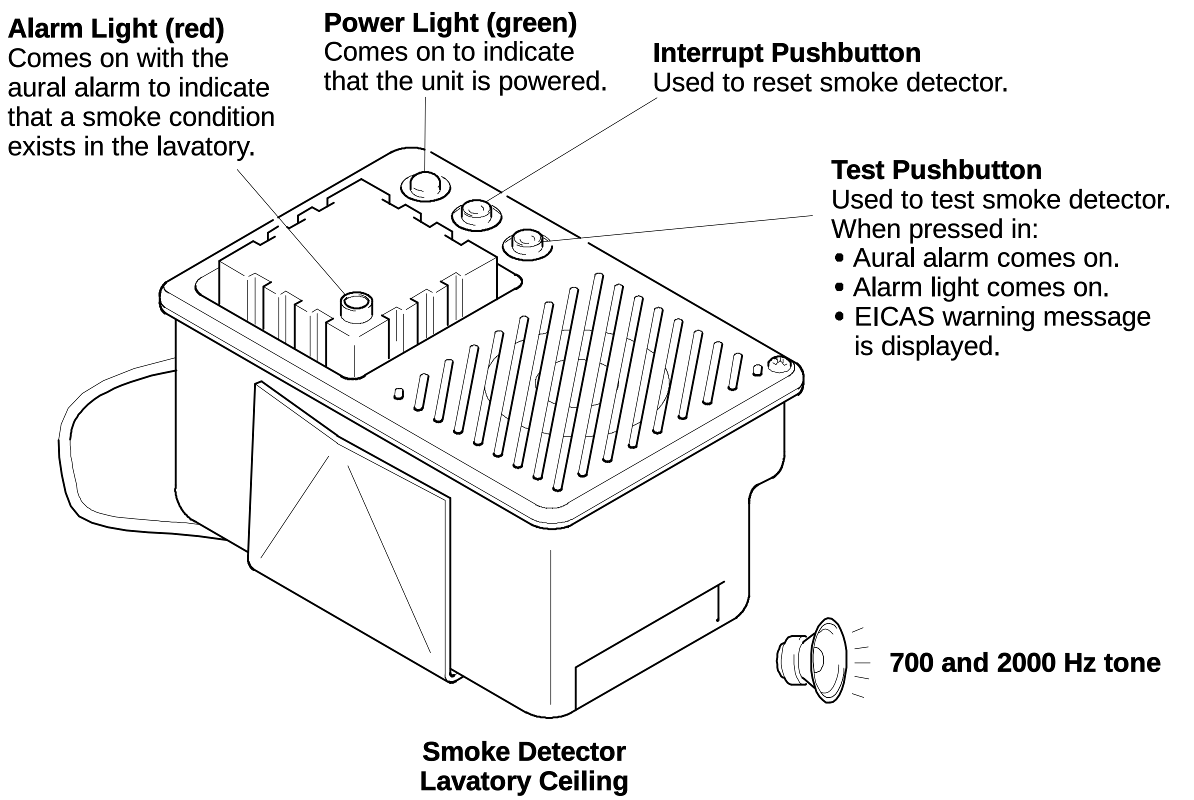
A. Detection

A smoke detector, in each lavatory, monitors for the presence of smoke. When the smoke density exceeds a preset level, the detector sounds an aural alarm and a SMOKE FWD (AFT) LAV warning message is displayed on the EICAS primary page. The lavatory smoke detector is not connected to or monitored by the FIDEEX control unit. <2202>

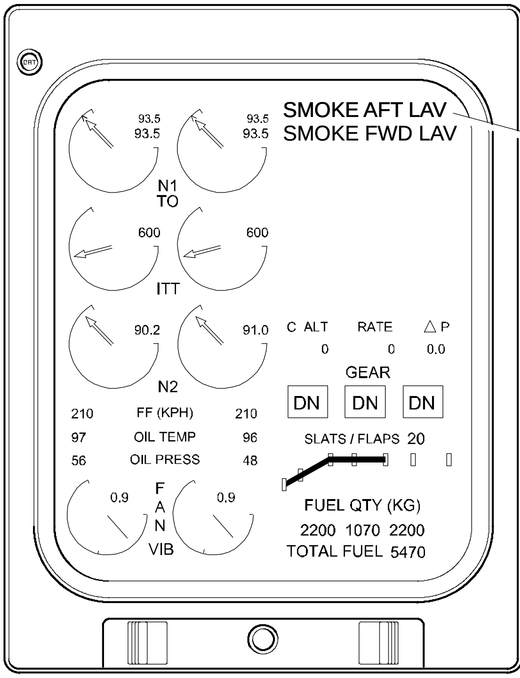
The smoke detectors can be tested by pressing the test button on the detector. During the test, an aural alarm sounds in the lavatory, the red alarm light on the detector comes on and a SMOKE FWD (AFT) LAV warning message is displayed on EICAS primary page. The system is reset by pressing the interrupt button on the detector. <2202>

NOTE

Operation of mobile transceivers in close proximity to the smoke detectors may cause a false alarm.



Smoke Detector
Figure 10–30–1



SMOKE AFT or FWD LAV warning (red)
Indicates that a smoke condition exists in the lavatory.

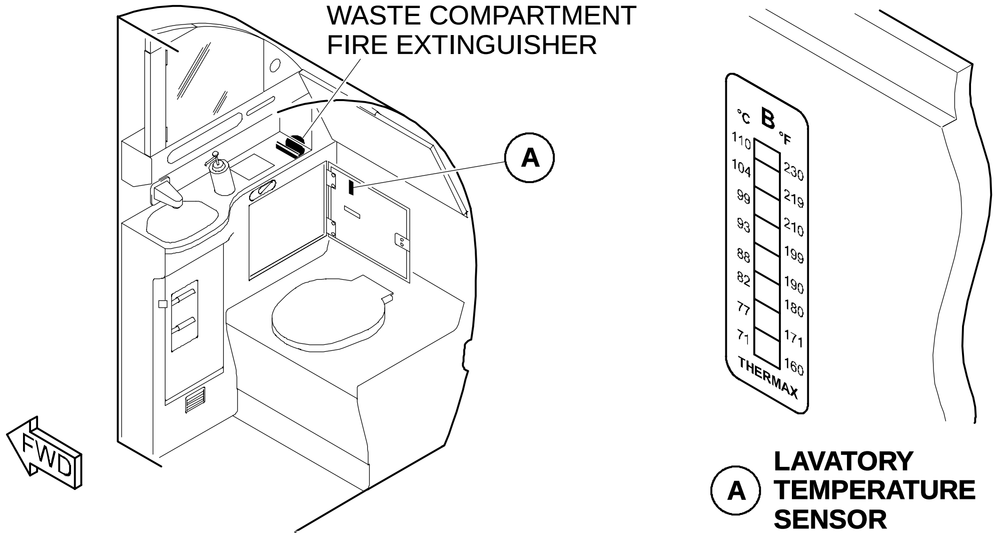
Primary Page

Smoke Detector EICAS Indications <1001,2202>
Figure 10–30–2

B. Extinguishing

Fire extinguishing in the lavatory waste paper towel container is done automatically. The system consists of a disposable extinguisher bottle and a dual discharge nozzle. The bottle is mounted near the waste container with the nozzles extending into the waste container. The end of each discharge nozzle is sealed with a heat sensitive capsule which, when subjected to heat, melts to release the extinguishing agent into the waste container.

A temperature sensor installed on the inside of the waste compartment door is used to provide evidence that high temperature has occurred in the waste compartment and that the extinguisher bottle may have discharged. The sensor is a heat sensitive strip with a temperature scale that turns black when the temperature in the compartment exceeds 160°F (71°C).



Lavatory Waste Compartment Extinguisher
Figure 10–30–3

C. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Lavatory	Smoke Detection	LAV SMOKE DET	DC BUS 1	1	D9	

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1. MAIN LANDING GEAR OVERHEAT DETECTION

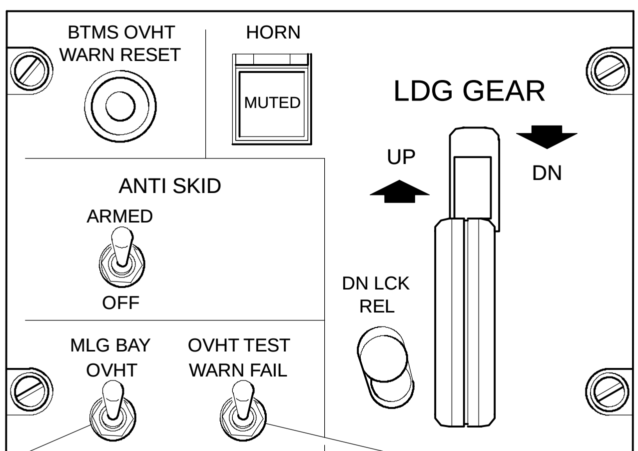
The main landing gear overheat detection system provides indication of overheat conditions in the main landing gear wheel wells that can be caused by overheated brakes or brake fires. The system consists of two overheat detection loops and an overheat detection unit.

The detection loops are installed around the top inner surface of each main wheel bin and are connected in series to the detection unit.

The overheat detection unit is located under the copilots side console. The unit continuously monitors the loops for overtemperature conditions and system faults. If an overheat condition is detected by the unit, in either wheel bin, a signal is sent to display a MLG BAY OVHT warning message on the EICAS primary page. If a system fault is detected by the unit, a signal is sent to display a MLG OVHT FAIL caution message on the EICAS primary page.

The warning of an overheat condition, alerts the pilot to immediately lower the landing gear to reduce the landing gear temperature. The warning message will persist until the temperature in the wheel bin returns to normal limits.

The main landing gear overheat detection system may be tested, from the landing gear control panel, by simulating an overheat condition or a system fault condition. The EICAS will display the applicable warning or caution message during the test.

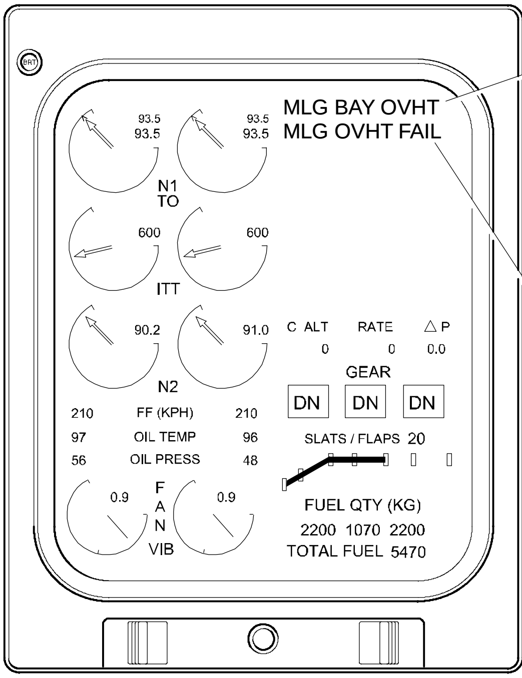


MLG BAY OVHT
Used to simulate an overheat condition in the main landing gear bay. MLG BAY OVHT warning message comes on.

Landing Gear Control Panel
Center Pedestal

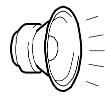
OVHT TEST WARN FAIL
Used to simulate a failure in the main landing gear bay overheat detection system. MLG OVHT FAIL caution message comes on.

Landing Gear Control Panel
Figure 10–40–1



Primary Page

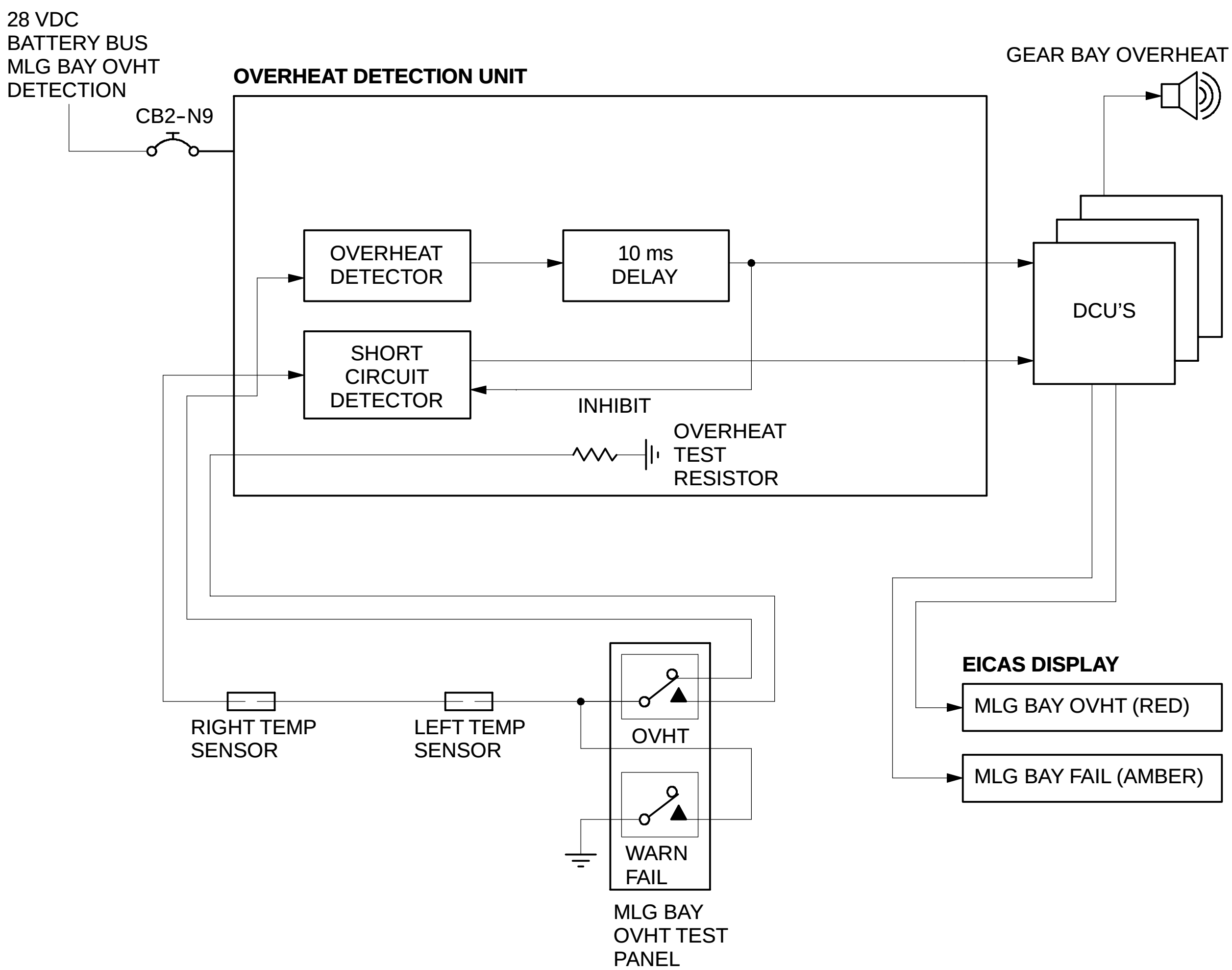
MLG BAY OVHT warning (red)
Indicates that an overheat condition exists in one or both of the main landing gear bays.



GEAR BAY OVERHEAT

MLG OVHT FAIL caution (amber)
Indicates that a fault exists in the main landing gear bay overheat detection system.

Landing Gear EICAS Messages <1001>
Figure 10–40–2



MLG Overheat Indication and Test
Figure 10–40–3

A. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Main Landing Gear	Overheat Detection	MLG BAY OVHT DET	BATTERY BUS	2	N9	

CHAPTER 11 – FLIGHT CONTROLS

Page

LIST OF ILLUSTRATIONS

STALL PROTECTION SYSTEM

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1. INTRODUCTION

Flight controls are operated conventionally with control wheels, control columns and rudder pedals for the pilot and copilot. The control surfaces are actuated either hydraulically or electrically. The flight control systems include major control surfaces, components and subsystems that control the attitude of the aircraft during flight. The flight controls are divided into primary and secondary flight controls.

The primary flight controls include:

- Ailerons (roll control)
- Elevators (pitch control)
- Rudder (yaw control)

The ailerons, elevators and rudder are controlled by a network of cables, pulleys, push/pull rods and levers that transmit control inputs to the related hydraulic power control units.

The aileron and elevator controls are equipped with control disconnects which permit the pilot or the copilot to maintain sufficient lateral and longitudinal control in the event of a control jam. The rudder control is equipped with an anti-jam mechanism that permit both pilots to maintain sufficient directional control, however, additional force is required to obtain surface travel.

In the event of a total electrical power failure, the primary flight controls will remain hydraulically powered ACMP 3B, which will be powered ny the ADG in an emergency.

The secondary flight controls include:

- slats and flaps,
- ground spoilers
- aileron and rudder trim
- horizontal stabilizer trim
- multifunctional spoilers.

NOTE

The multifunctional spoilers consists of two spoilers on each wing. The outboard spoilers are referred to as the SPOILERONS and the inboard spoilers are referred to as the FLIGHT SPOILERS.

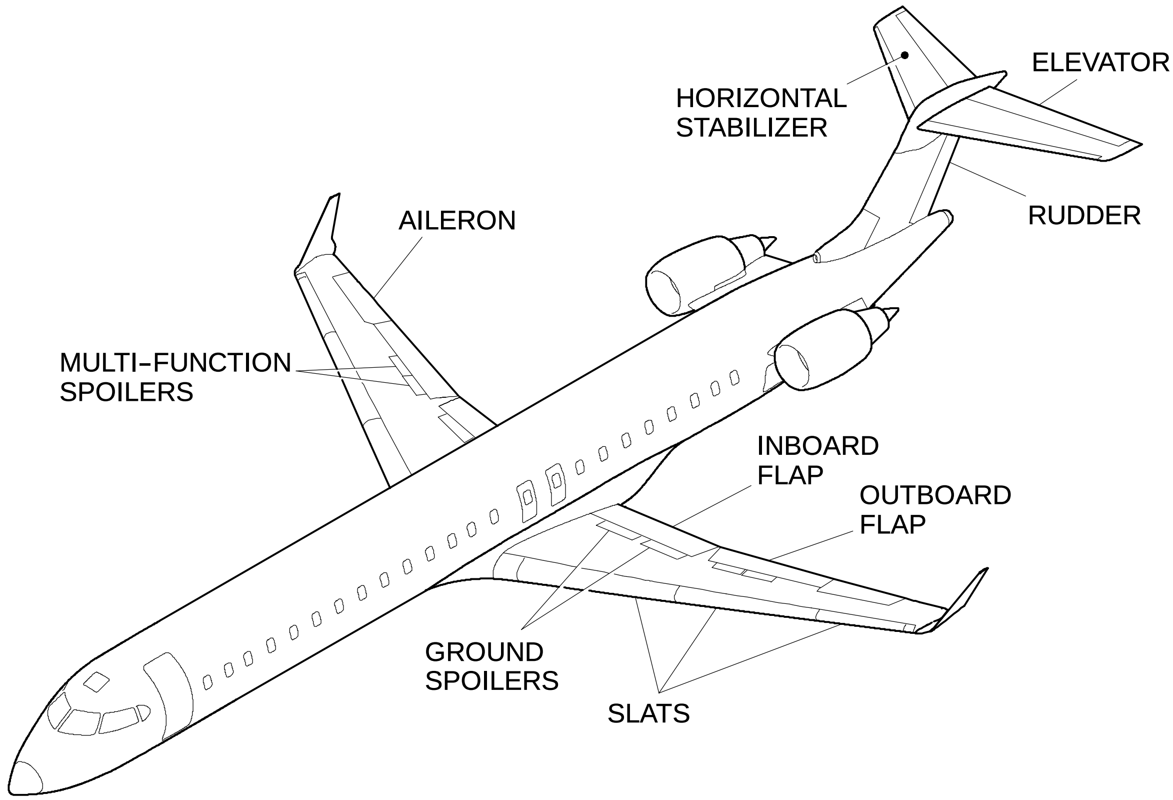
Lateral (roll) control of the aircraft is provided by the ailerons, assisted by the multifunctional spoilers.

Directional (yaw) control of the aircraft is provided by the rudder, assisted by yaw dampers.

Longitudinal (pitch) control of the aircraft is provided by the elevators, assisted by a moveable horizontal stabilizer.

The spoiler control system provides the aircraft with ground lift dumping, roll assist, proportional lift dump and speed reduction in decent for landing. Multifunctional spoilers assist the ailerons for turn coordination and are also used in the ground lift dumping function. The ground spoilers only deploy on the ground as part of the ground lift dumping function.

There are two spoiler/stabilizer control units (SSCUs) that automatically control operation of the spoilers, horizontal stabilizer trim, pitch feel control and rudder travel limiting.



Flight Controls – General
Figure 11–10–1

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1. AILERONS

Lateral control of the aircraft is provided by the ailerons with assist from the multifunction spoilers.

The aileron control systems consist of two control circuits. Under normal conditions, the two systems are interconnected through a roll disconnect mechanism, and there is simultaneous movement of both aileron surfaces from either pilot control wheel. The pilot operates the left aileron system and the copilot operates the right aileron system. Both systems are similar in operation. The autopilot is connected to the right control system only.

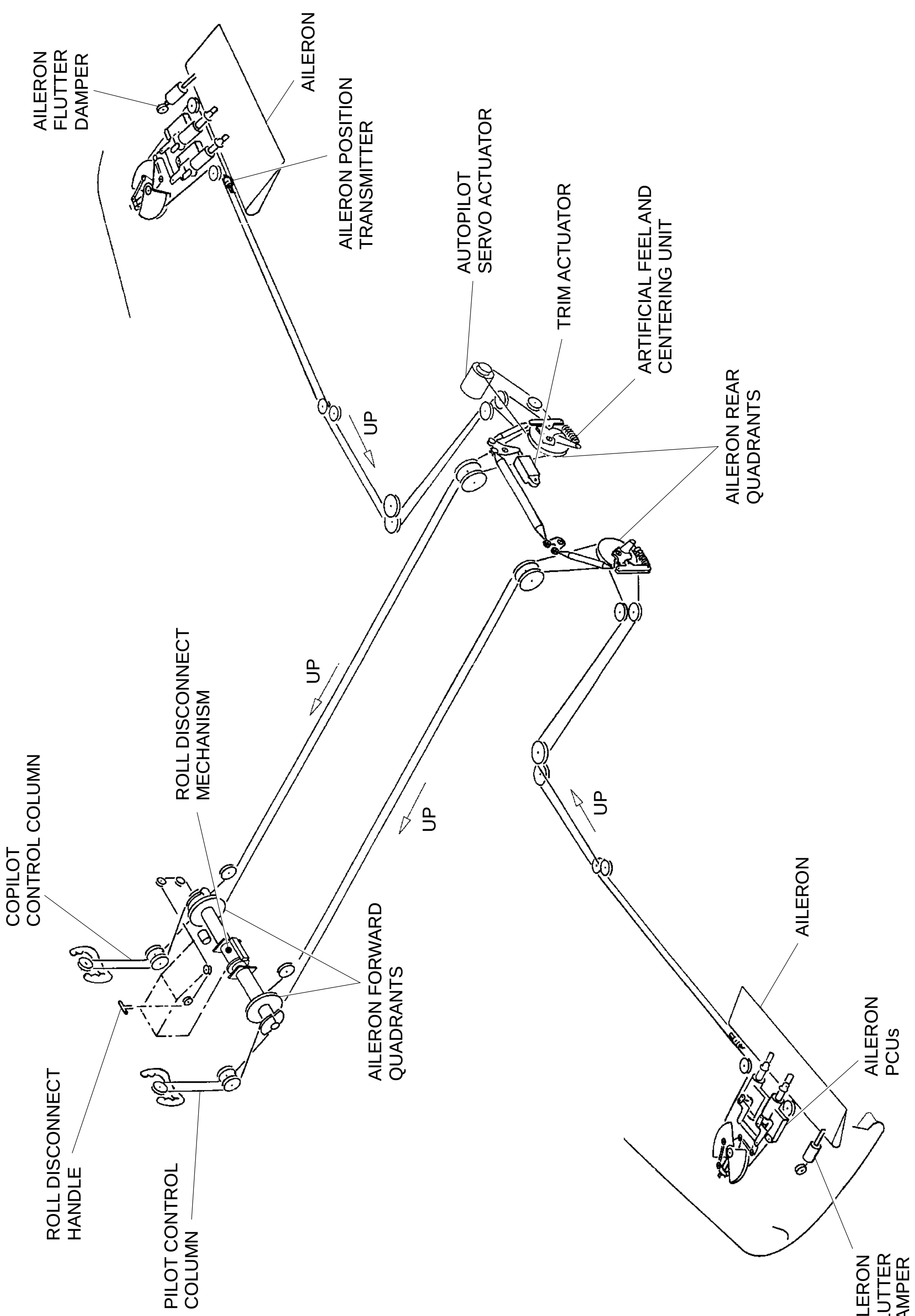
Each aileron is hydraulically powered by two power control units (PCUs) and mechanically controlled by rotation of either control wheel. The left aileron PCUs are powered by hydraulic systems 1 and 3 and the right aileron PCUs are powered by hydraulic systems 2 and 3.

Control wheel movement also generate electrical inputs to the spoiler and stabilizer control units (SSCUs) for roll assist which is provided by the multifunctional spoilers.

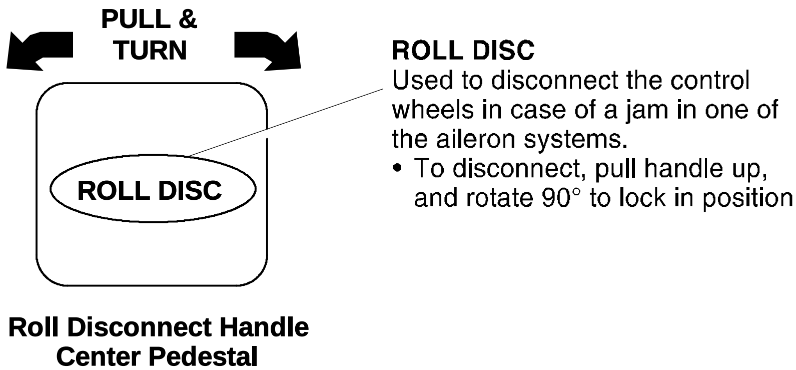
Control wheel centering and artificial feel is provided by mechanical feel units. A flutter damper is attached to each aileron to prevent surface flutter in the event of hydraulic fluid loss at the PCUs during flight. On the ground, flutter dampers provide gust lock function.

In the event of an aileron control jam, the left and right systems can be mechanically separated by pulling a roll disconnect handle. The roll disconnect allows limited lateral control using the unaffected aileron control system and the opposite side spoilerons. Twenty seconds after pulling the roll disconnect handle, two roll select lights on the glareshield illuminate. The flight crew must then select the roll priority on the operable side to obtain control of all spoilerons.

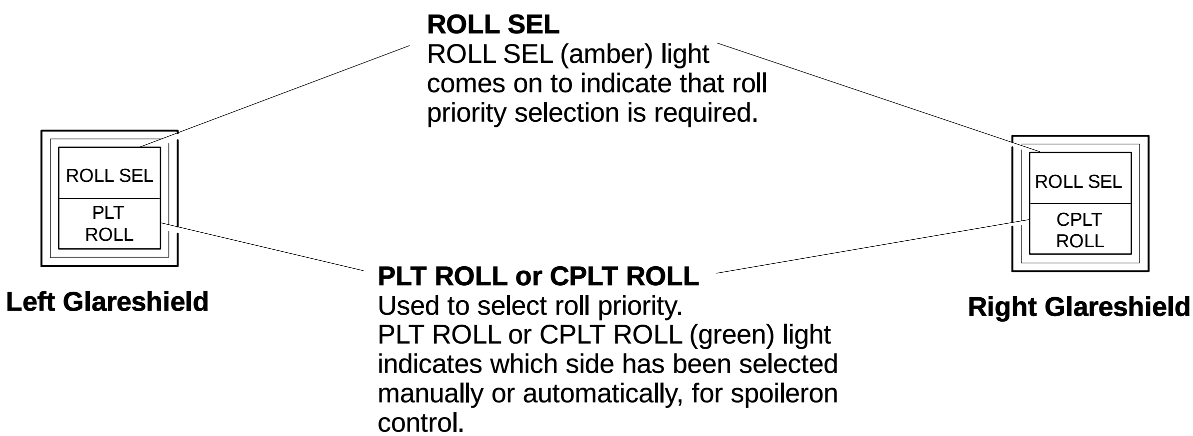
In the event of a PCU runaway, the spoiler and stabilizer control units command the spoilerons on both sides to respond to control inputs. After the roll disconnect handle is pulled, the roll priority should be selected.



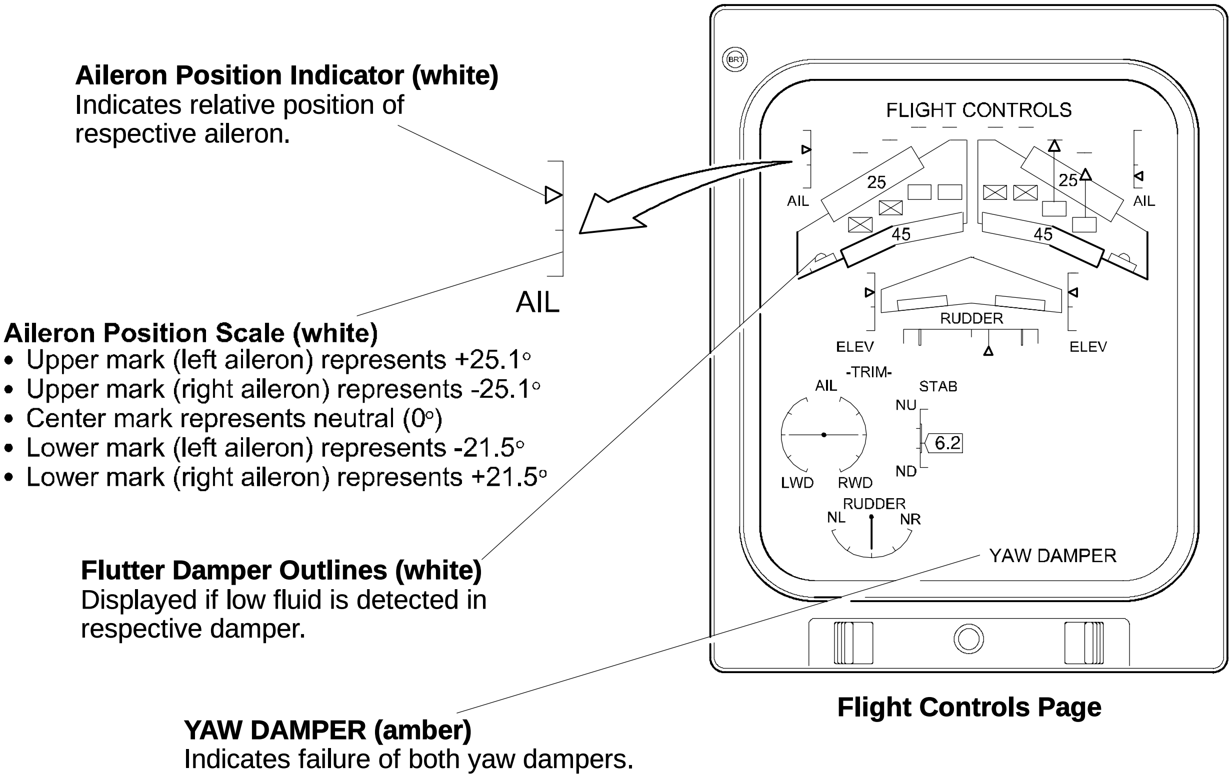
Aileron Control General Arrangement
Figure 11−20−1



Ailerons – Emergency Control
Figure 11–20–2



Ailerons Glareshield Emergency Control
Figure 11–20–3

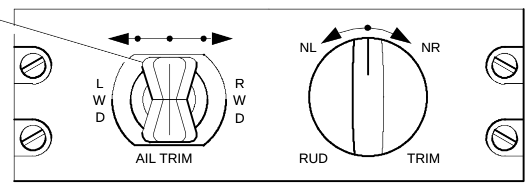


Flight Controls Page

EICAS Flight Control – Synoptic Page
Figure 11–20–4

Aileron trim is electrically operated and manually controlled using the trim selector on the center pedestal. Operation of the aileron trim will cause control wheel rotation.

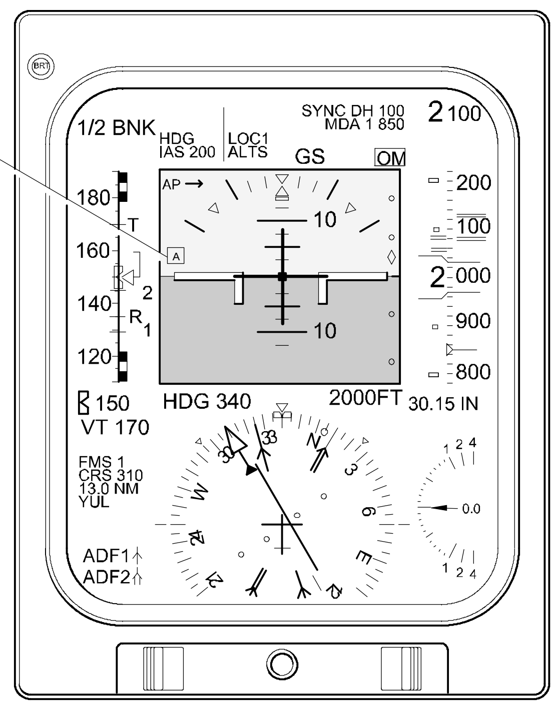
AIL TRIM
Used to control aileron trim.
Spring loaded to center position.
- LWD – Trims left wing down.
- RWD – Trims right wing down.



Aileron / Rudder Trim Panel
Center Pedestal

Aileron Trim Controls
Figure 11–20–5

Aileron Mistrim Indicator (yellow)
Indicates that the ailerons are in a mistrim condition, when the autopilot is engaged.



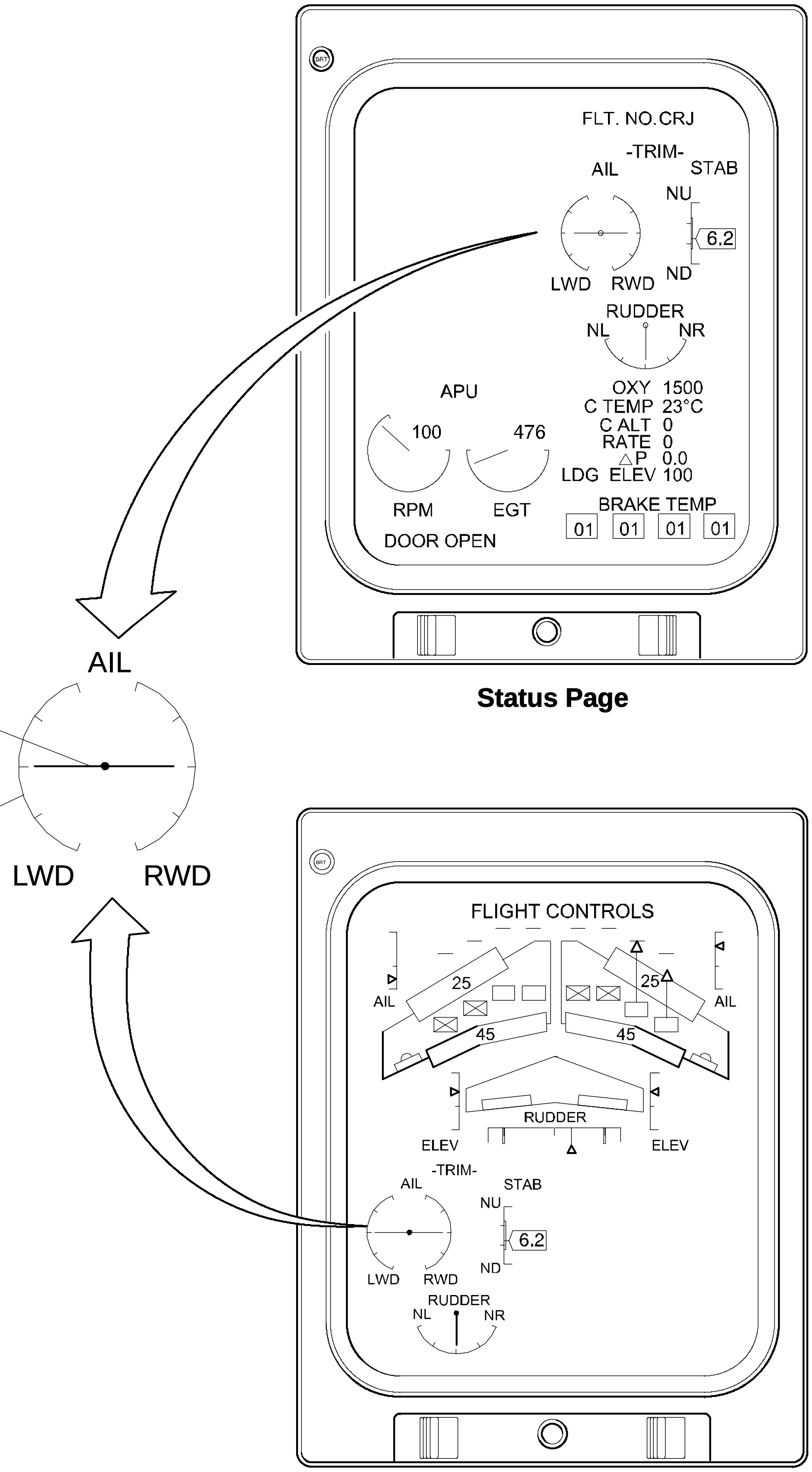
Primary Flight Display
Pilot's and Copilot's Instrument Panels

Aileron Mistrim Flag <1015>
Figure 11–20–6

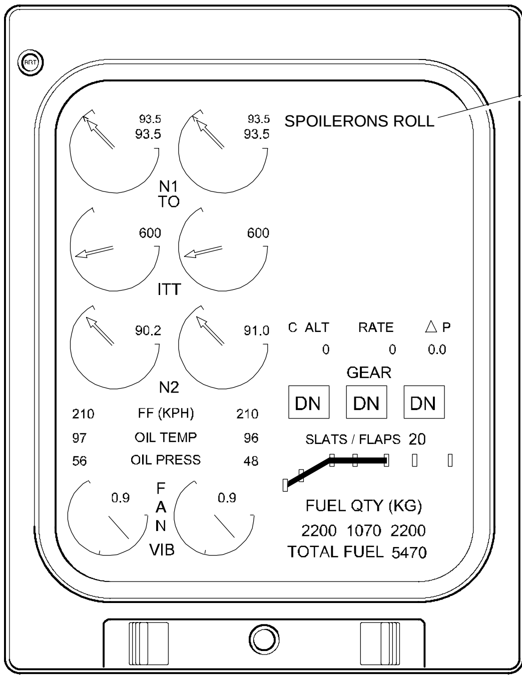
Aileron Trim Pointers (white)
Indicates trim actuator position. Turns green when in neutral position on the ground.

Aileron Trim Scale (white)

- LWD mark – Aileron at maximum left wing down.
- RWD mark – Aileron at maximum right wing down.



Aileron Trim EICAS Indications
Figure 11–20–7

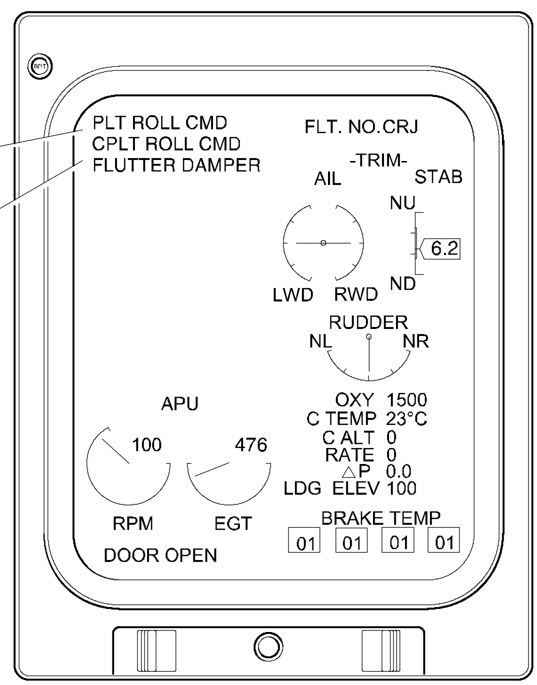


SPOILERONS ROLL caution (amber)
Indicates that roll disconnect has been selected and either no roll priority has been selected or both roll priorities have been selected.

Primary Page

PLT or CPLT ROLL CMD advisory (green)
Indicates that pilot or copilot roll authority has been selected.

FLUTTER DAMPER status (white)
Indicates that low fluid level is detected in a flutter damper. (Refer to the flight controls synoptic page for the affected flutter damper.)



Status Page

Spoilerons and Roll Selection – EICAS Indications <1001>
Figure 11–20–8

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Ailerons	Trim	AIL TRIM	DC BUS 2	2	F3	
	Trim Indication	AIL/RUD TRIM IND	BATTERY BUS	1	L7	

1. RUDDER

Directional (yaw) control is provided by the rudder and assisted by yaw dampers.

The rudder is hydraulically powered by three power control units (PCUs). The PCUs receive mechanical inputs from the rudder pedals. Each hydraulic system powers one of the three PCUs. Both pedal sets move simultaneously when operated from either the pilot or the copilot station.

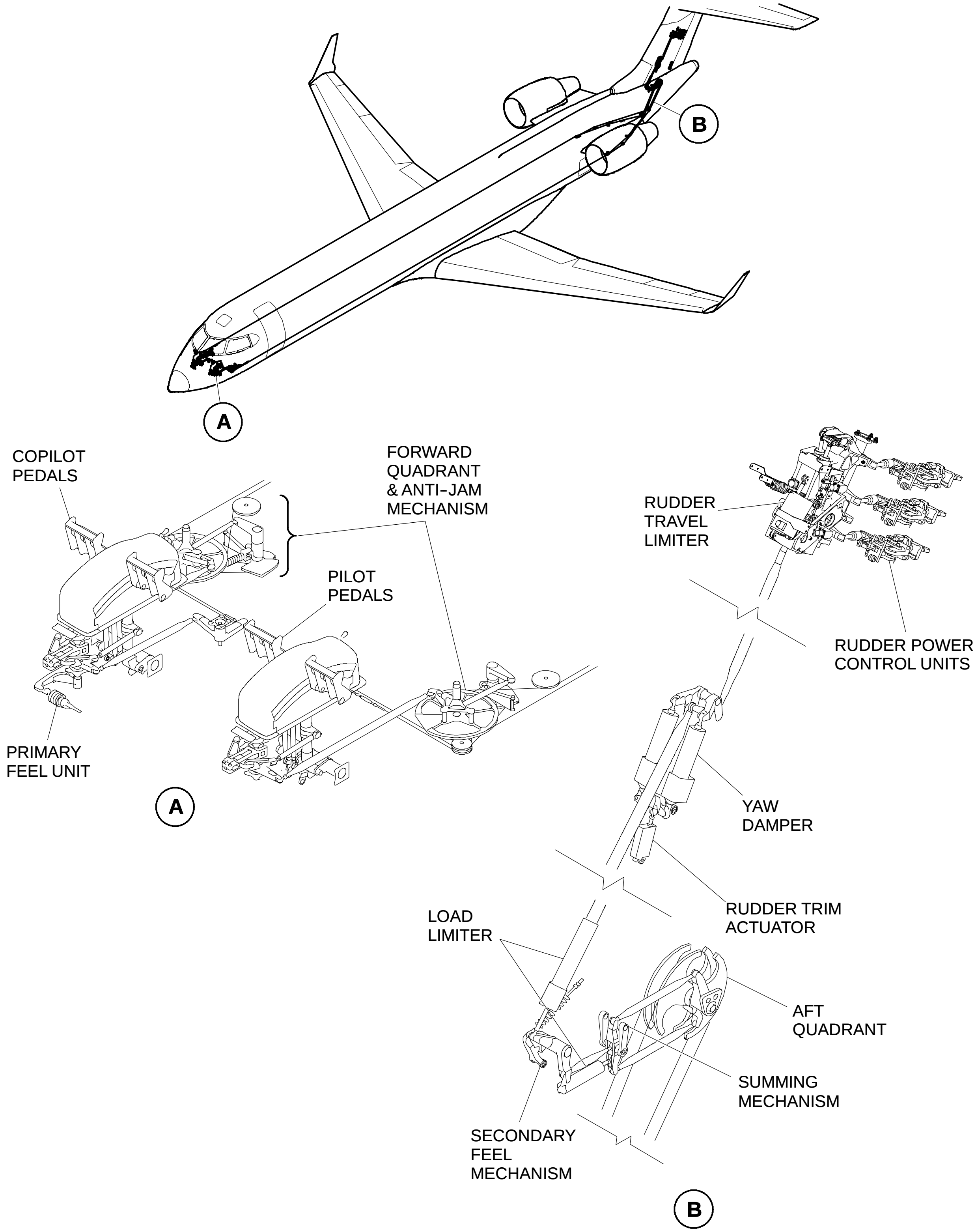
Rudder pedal centering and artificial feel is provided by a primary feel unit, located at the right pedal pivot. A secondary feel unit, located in the aft fuselage, ensures that the rudder remains centered in the event of a control disconnect.

In the event of a control jam, both pilot's and copilot's pedals will remain operable through anti-jam mechanisms, however additional pedal force will be required to obtain rudder deflection.

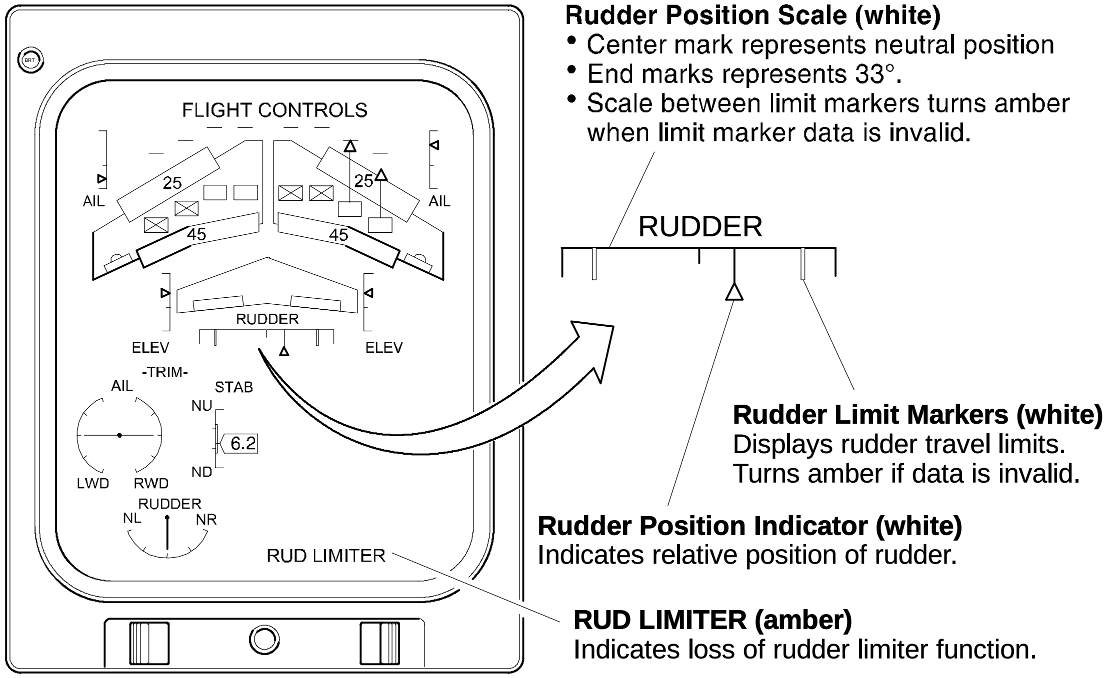
A rudder travel limiter assembly (RTL) is incorporated within PCU assembly to reduce rudder travel. The RTL is automatically controlled, relative to airspeed and flap position, by the spoiler and stabilizer control units (SSCUs). The SSCUs gradually reduce the rudder travel from 33° to 4° (either side of neutral) as the aircraft speed increases. This will avoid overstressing the fuselage at higher airspeeds and prevents the aircraft from entering a severe sideslip.

The rudder trim is electrically operated and manually controlled using the trim selector on the center pedestal. Operation of the rudder trim will not cause rudder pedal deflection.

Two independent yaw damper systems operate continuously in flight to improve the airplane's directional stability and turn coordination by damping out oscillations in yaw. Each yaw damper actuator automatically respond to inputs received from one flight control computer. One yaw damper system must be engaged to engage the autopilot.

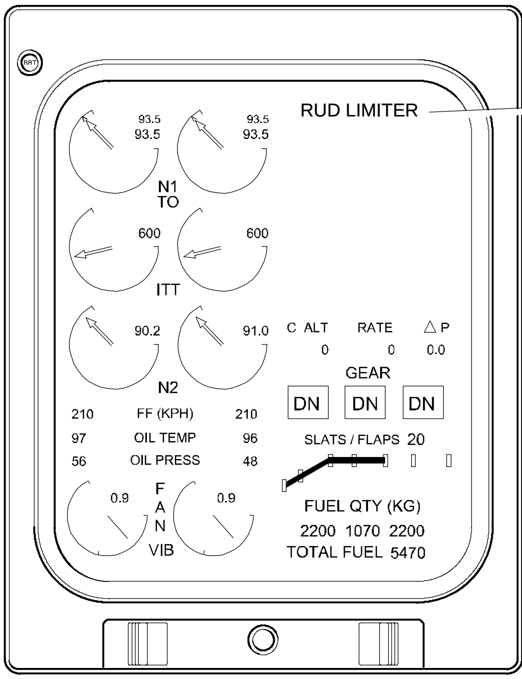


Rudder System
Figure 11-30-1



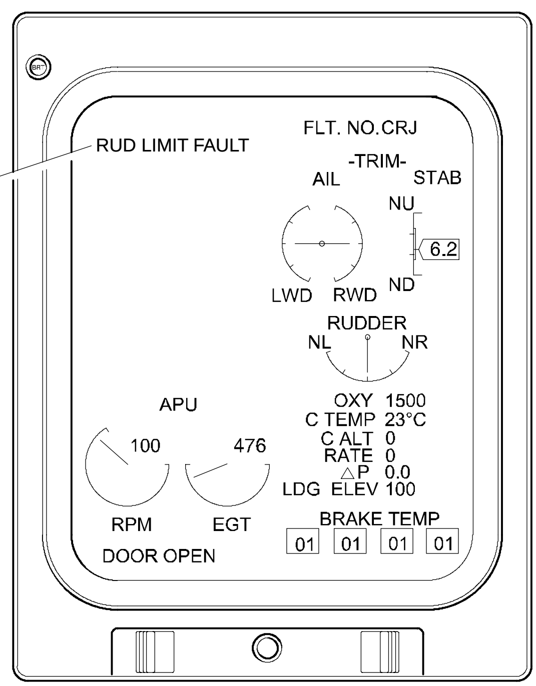
Flight Controls Page

Rudder – Flight Control Synoptic Page
Figure 11–30–2



RUD LIMITER caution (amber)
Indicates loss of rudder limiter function.

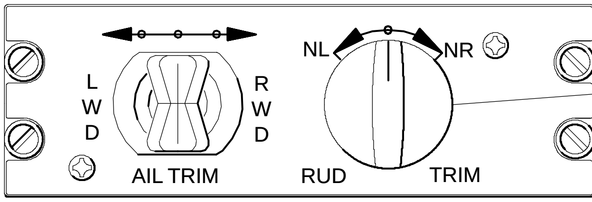
Primary Page



RUD LIMIT FAULT status (white)
Indicates loss of redundancy in rudder limiter.

Status Page

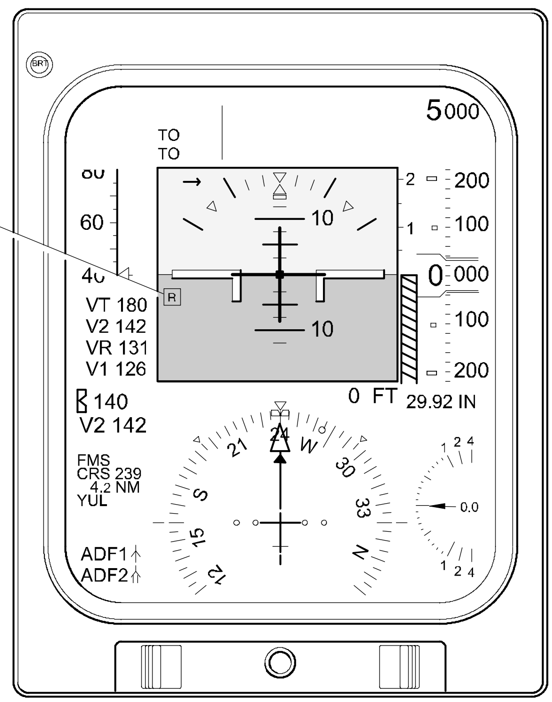
Rudder Limiter – EICAS Indications <1001>
Figure 11–30–3



RUD TRIM
Used to control rudder trim.
Spring loaded to centre position.
- NL – Increases rudder trim to nose left.
- NR – Increases rudder trim to nose right.

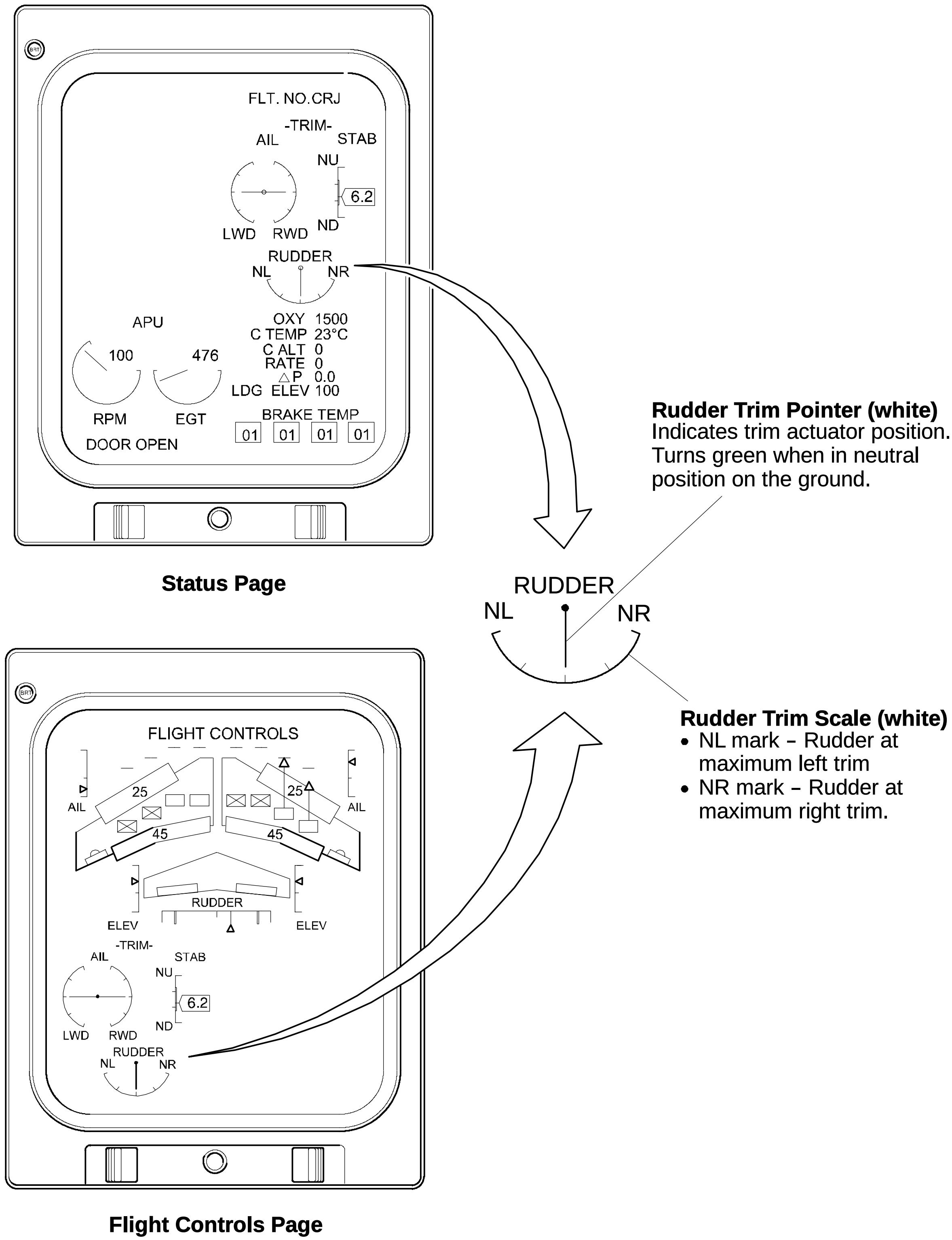
Aileron/ Rudder Trim Control Panel
Center Perdestal

Rudder Mistrim Indicator (yellow)
Indicates that the rudder is in a mistrim condition, when the autopilot is engaged.



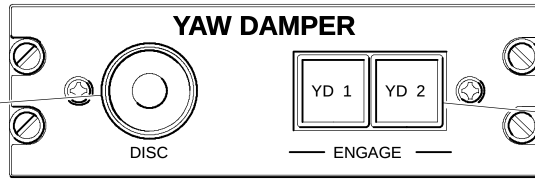
Primary Flight Display
Pilot's and Copilot's Instrument Panels

Rudder Trim Control Panel and Primary Flight Display Flag <1015>
Figure 11–30–4



Rudder Trim – EICAS Indications
Figure 11–30–5

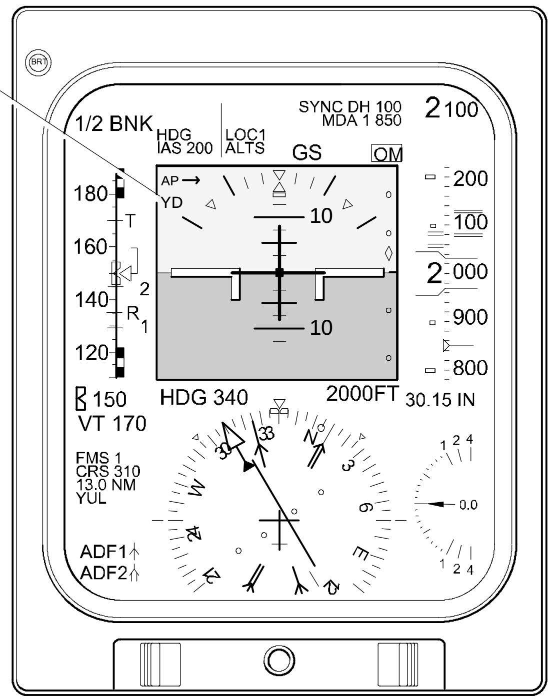
DISC
Used to disengage yaw dampers



ENGAGE
Used to engage respective yaw damper channel.

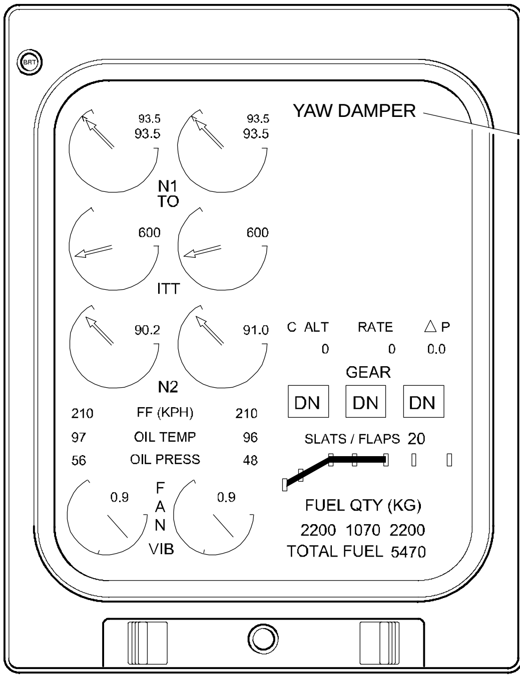
Yaw Damper Panel
Center Pedestal

YD (amber)
Indicates that both yaw dampers have been disengaged.



Primary Flight Display
Pilot’s and Copilot’s Instrument Panels

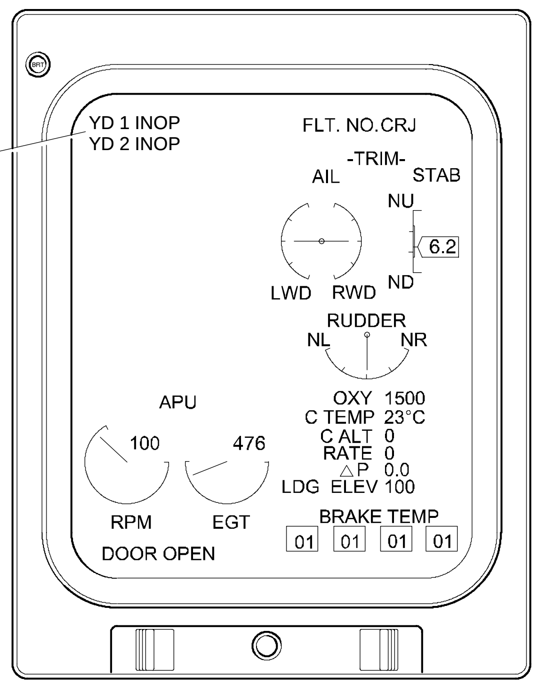
Yaw Damper Controls and Primary Flight Display Flag <1015>
Figure 11–30–6



YAW DAMPER caution (amber)
Indicates both yaw dampers are off or failed.

Primary Page

YD 1 or 2 INOP status (white)
Indicates that respective yaw damper has failed or is off.



Status Page

Yaw Damper – EICAS Indications <1001>
Figure 11–30–7

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Rudder	Trim	RUDDER TRIM	DC BUS 2	2	F2	
	Trim Limiter	PFEEL 2 RTL	DC ESSENTIAL		R5	
	Trim Indication	AIL/RUD TRIM IND	BATTERY BUS	1	L7	

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1. ELEVATORS

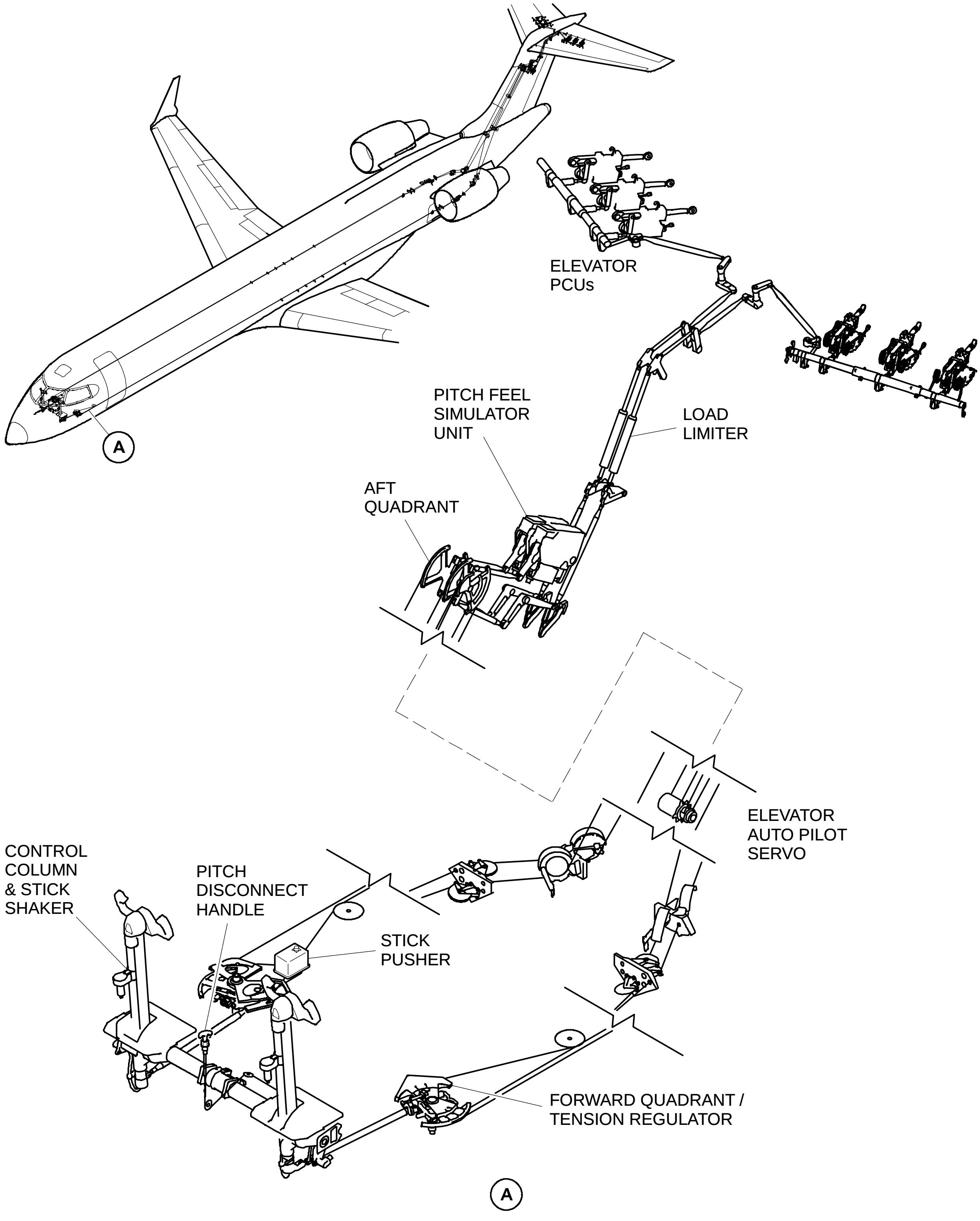
Longitudinal (pitch) control is provided by the elevators, assisted by a moveable horizontal stabilizer.

Two separate elevator control systems are provided. The left elevator system is controlled by the pilot and the right system is controlled by the copilot. Under normal conditions, the two systems are interconnected through a pitch disconnect mechanism. Forward and aft movement of either control column inputs simultaneous movement of both elevator surfaces. Both systems are similar, with the exceptions that the autopilot is connected to the left elevator system and the stall protection system is connected to the right elevator system.

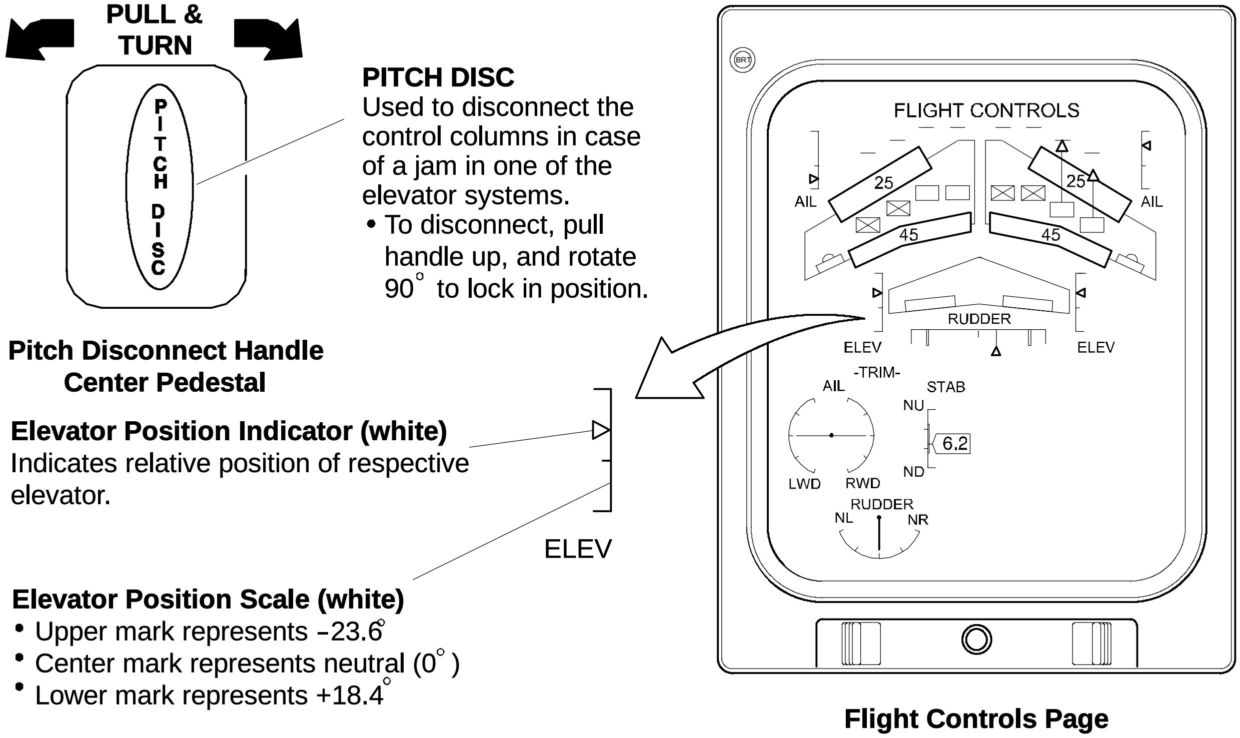
Each elevator is hydraulically powered by three power control units (PCUs) which receive mechanical inputs the control columns. Each hydraulic system powers one of the three PCUs of each elevator. Elevator flutter damping is incorporated in the PCUs.

Control column centering and artificial feel is provided by electro-mechanical pitch feel units. The spoiler and stabilizer control units (SSCUs) automatically vary the control column artificial feel force as a function of the horizontal stabilizer position, flap extension and aircraft acceleration.

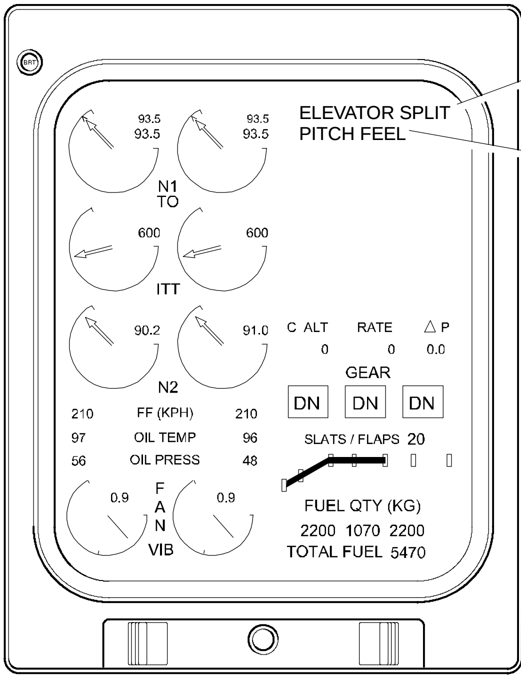
In the event of an elevator control jam, the left and right elevator systems can be mechanically separated by pulling a PITCH DISC handle and turning it 90° to lock the handle in place. The operable side can then be used to maintain pitch control.



Elevator System
Figure 11−40−1



Elevator Emer Controls and Flight Control – Synoptic Page
Figure 11–40–2

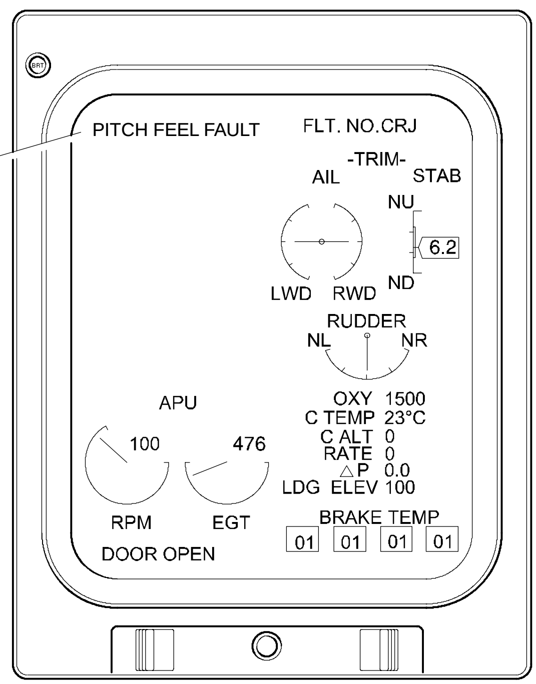


ELEVATOR SPLIT caution (amber)
Indicates that left and right elevator surface mismatch exceeds 6° (below 250 knots) or 3° (above 250 knots).

PITCH FEEL caution (amber)
Indicates a failure of the pitch feel system.

Primary Page

PITCH FEEL FAULT status (white)
Indicates loss of redundancy in the pitch feel system (one actuator failed).



Status Page

Elevator – EICAS Indications <1001>
Figure 11–40–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Elevators	Pitch Feel	PFEEL 1	DC BUS 1	1	F2	
		PFEEL 2 RTL	DC ESSENTIAL	2	R5	

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1. HORIZONTAL STABILIZER TRIM

Horizontal stabilizer trim system provides pitch trim by varying the angle of the horizontal stabilizer. The horizontal stabilizer is positioned by a screw jack driven by two electric motors and controlled by the spoiler and stabilizer control units (SSCUs) through selection of the STAB TRIM engage switches. Each motor has a magnetic brake to prevent trim runaway. Trim range is from +2° (leading edge up) to –13° (leading edge down).

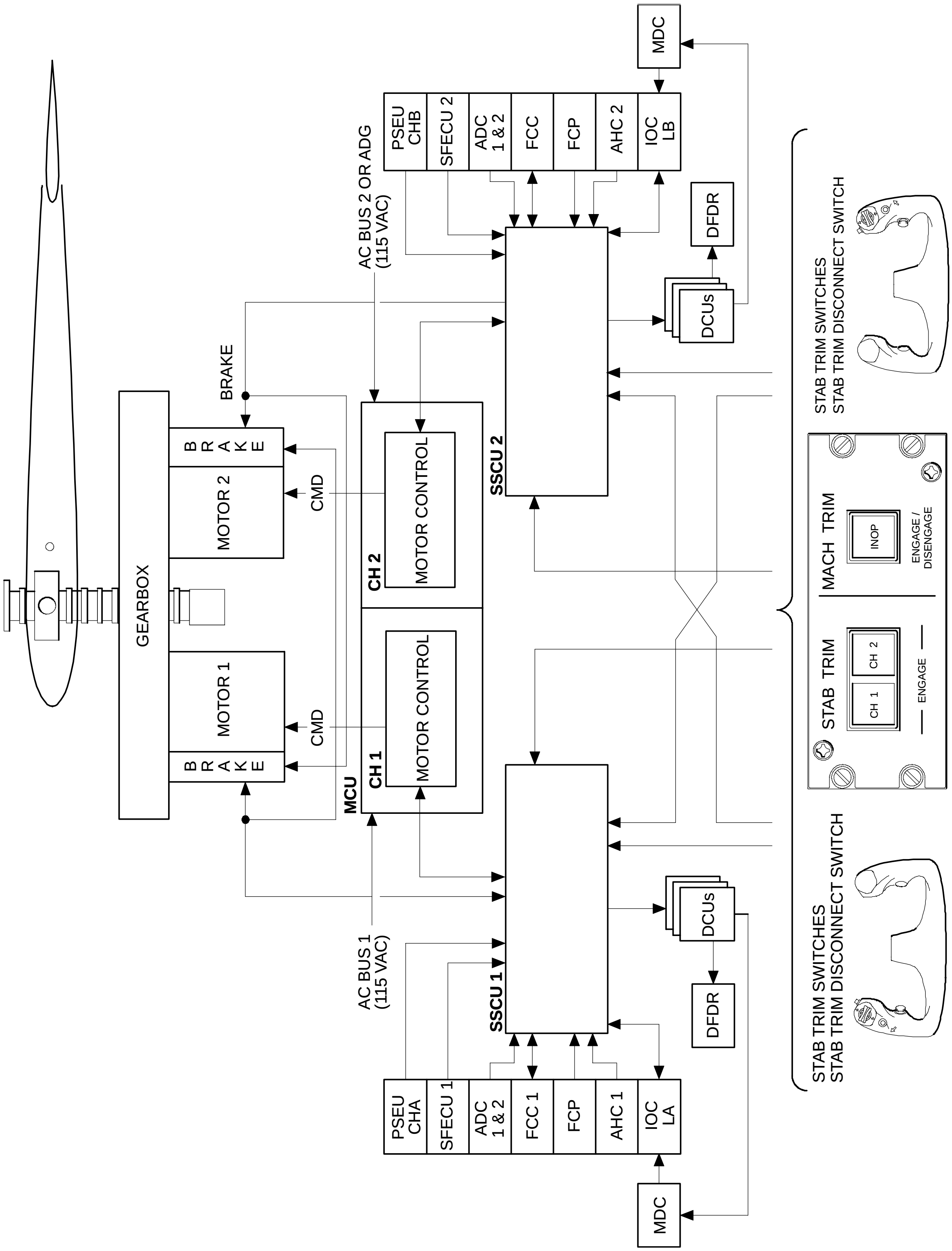
The horizontal stabilizer trim is operated manually by the pilot control wheel trim switches or automatically by the autopilot. Trim disconnect switches are provided on each control wheel.

The SFECU's operate in one of four modes in the following priority:

- Manual trim – Nose–up or nose–down trim commands (from the control wheel switches) are sent to the the slat/flap electronic control unit (SFECU). The SFECU moves the screw jack at a rate that is dependent on Mach airspeed.
- Autopilot trim – When the AP is engaged and air loads begin to build up on the elevator, the flight control computer, through the SSCU, sends signals to the screw jack motor controllers to aerodynamically trim the aircraft.
- AUTO trim – Auto trim occurs when the flaps are moving between 0 and 20° in either direction. When the flaps are extended or retracted, trim commands (via the SSCU's) are sent to the screw jack motor controllers to compensate for aircraft pitching caused by flap configuration changes.
- Mach trim – When the Mach Trim is engaged, the horizontal stabilizer trim is adjusted (at a rate of 0.03° to 0.06° per second) to compensate for the aircraft tendency to pitch down at increasing Mach numbers. The Mach Trim function is disabled when the autopilot is engaged.

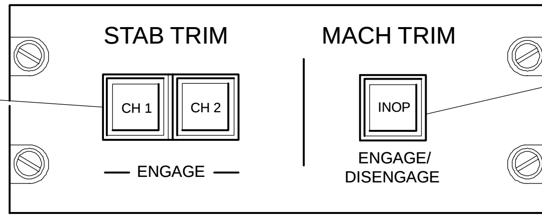
On every aircraft power–up, each SSCU performs a Computer Power–On–Self–Test (CPOST). Following the CPOST, the computer performs a System Power–On–Self–Test (SPOST). The SPOST is divided into two parts, SPOST1 and SPOST2. SPOST1 checks the integrity of specific flight control system components and the check lasts up to 60 seconds. SPOST2 (Pilots SSCU Test) is performed automatically following aircraft power–up, but only once per 50 flight cycles. The SPLR/STAB IN TEST advisory message will only appear for up to 60 seconds during the SPOST2.

If required, SPOST2 may be manually initiated (after SPOST1 is complete) by depressing one Stab Disconnect Switch and the Mach Trim engage switch simultaneously for 5 seconds.



Horizontal Stabilizer Trim Control System Schematic
Figure 11–50–1

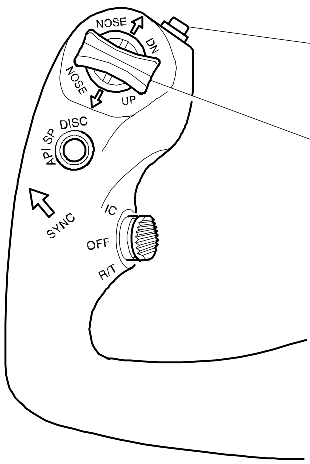
STAB TRIM
Used to engage respective stabilizer trim channel.



MACH TRIM
Used to engage Mach trim function.
- INOP (amber) light indicates that Mach trim is inoperative.

Stabilizer/ Mach Trim Panel
Center Pedestal

Stabilizer/ Mach Trim Control Panel
Figure 11–50–2



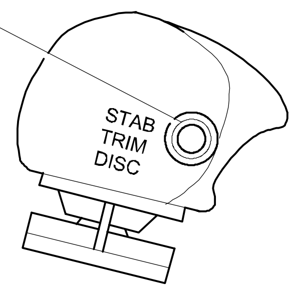
STAB TRIM DISC (red)
Used to disengage stabilizer trim control.

NOSE UP / NOSE DN (black)
Used to manually operate stabilizer trim.

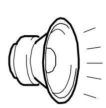
Pending rectification:

CAUTION

Avoid unintentionally pressing the STAB TRIM DISC switches. Briefly pressing these switches can result in disengaging one or both STAB TRIM channels. If this occurs, it will not be possible to re-engage the STAB TRIM channel(s) in flight.



TOP VIEW

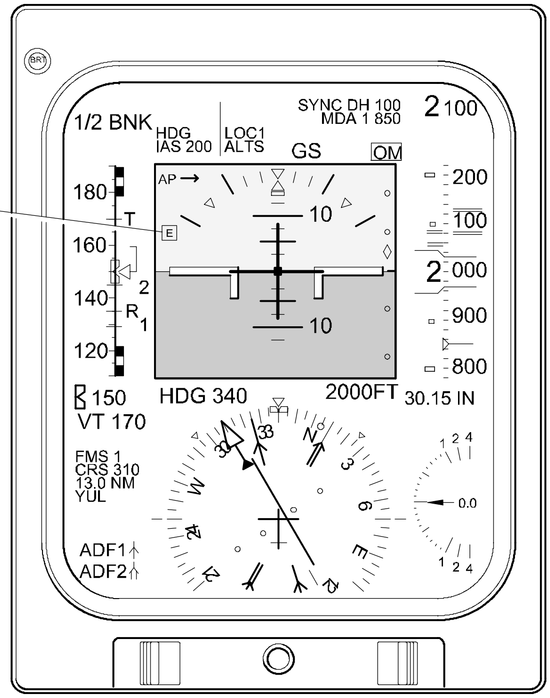


Clacker indicates that stabilizer has been in motion for more that 3 seconds (possible trim runaway condition).

Pilot's Control Wheel
(Copilot's Opposite)

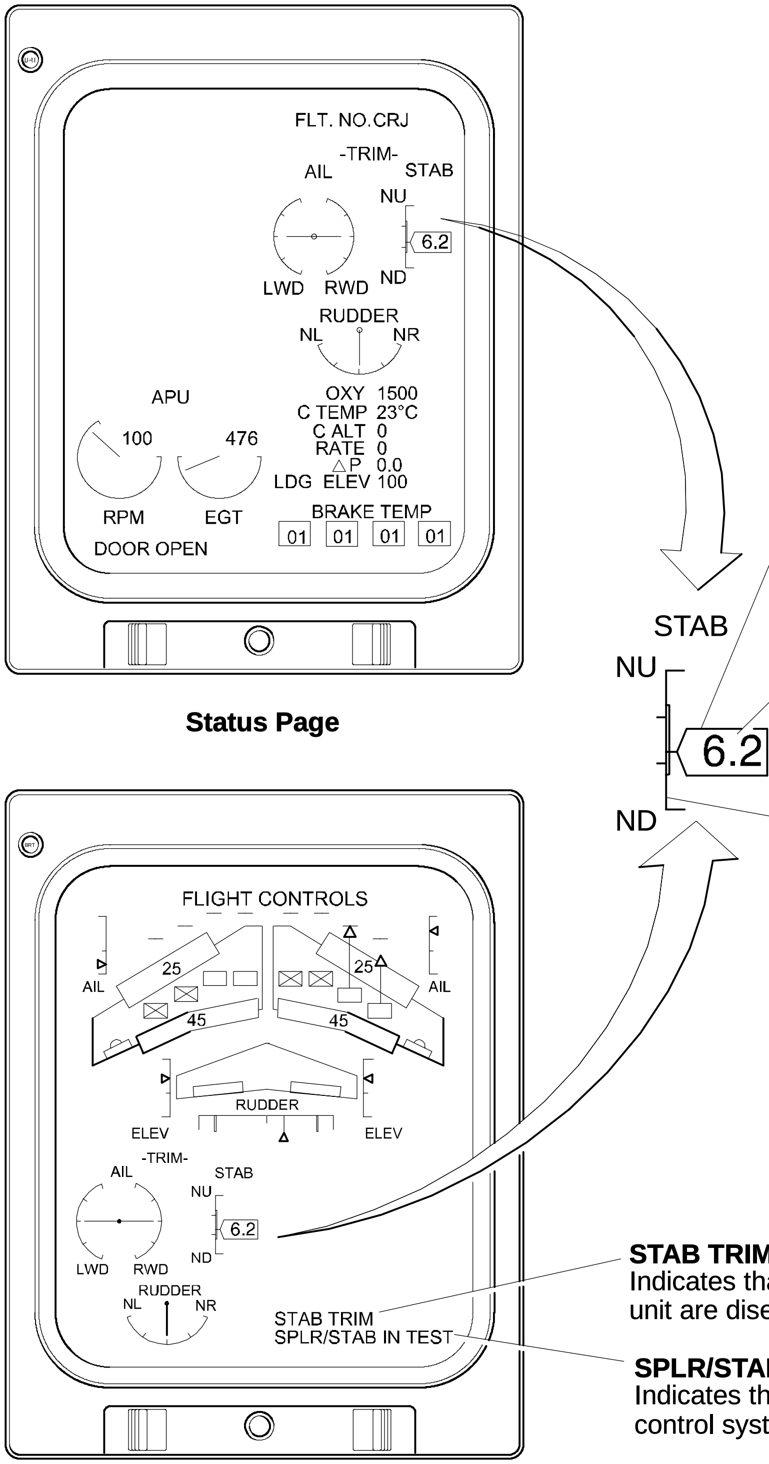
Stabilizer Trim – Pilot's Control Wheel
Figure 11–50–3

Elevator Mistrim Indicator (yellow)
Indicates that the horizontal stabilizer is in a mistrim condition, when the autopilot is engaged.



Primary Flight Display
Pilot's and Copilot's Instrument Panels

Elevator Mistrim Primary Flight Display Flag <1015>
Figure 11–50–4



Status Page

Flight Controls Page

Stabilizer Trim Pointer
Moves up and down along the trim scale to indicate trim position.
- Green – Stabilizer position is in take-off configuration.
- White – Stabilizer position is not in take-off configuration.

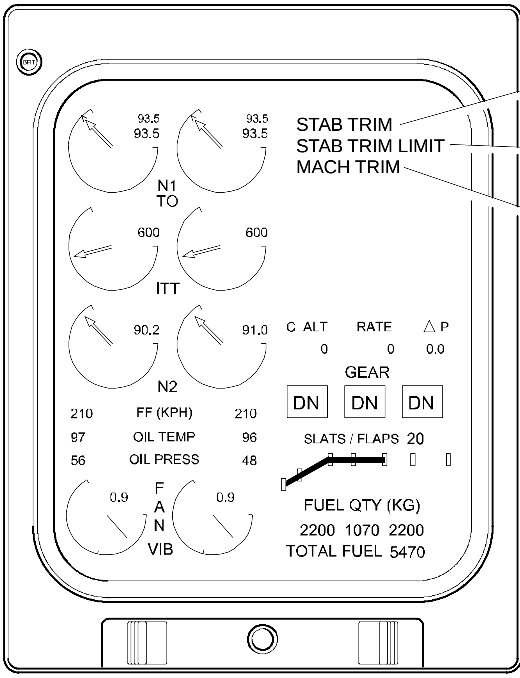
Stabilizer Trim Readout
Displays stabilizer trim position.
- Green – Stabilizer position is in take-off configuration.
- White – Stabilizer position is not in take-off configuration.

Stabilizer Trim Scale (white)
- Green band – Stabilizer trim take-off range.
- ND mark – Stabilizer at maximum nose down trim limit.
- NU mark – Stabilizer at maximum nose up trim limit.
- Intermediate marks – 5 trim units and 10 trim units.

STAB TRIM (amber)
Indicates that both channels of the control unit are disengaged or have failed.

SPLR/STAB IN TEST (green)
Indicates that the spoiler and stabilizer control system is in self test mode.

Stabilizer Trim EICAS Indications
Figure 11–50–5



STAB TRIM caution (amber)
Indicates that both channels of the control unit are disengaged or have failed.

STAB TRIM LIMIT caution (amber)
Indicates that stabilizer trim is at or greater than 14 trim units.

MACH TRIM caution (amber)
Indicates that Mach trim is not engaged or has failed on both channels.

Primary Page

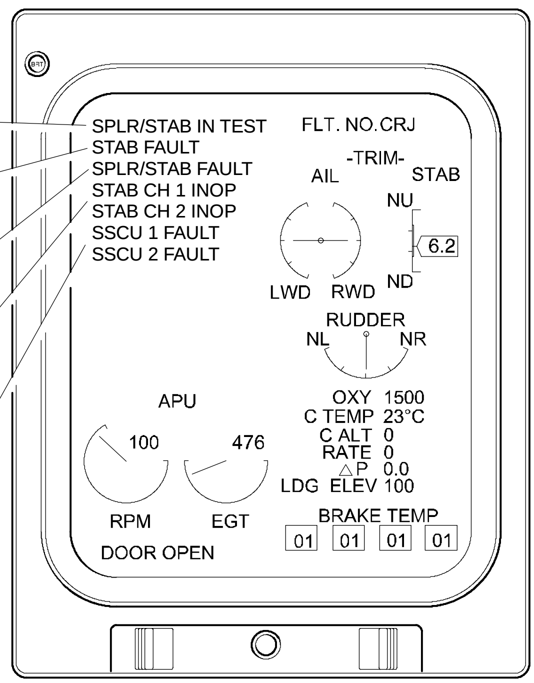
SPLR/STAB IN TEST advisory (green)
Indicates that the spoiler and stabilizer control system is in self test mode.

STAB FAULT status (white)
Indicate loss of redundancy in stabilizer trim control.

SPLR/STAB FAULT status (white)
Indicates a fault in the spoiler and stabilizer control unit.

STAB CH 1 or 2 INOP status (white)
Indicates respective stabilizer trim channel is not engaged or has failed.

SSCU 1 or 2 FAULT status (white)
Indicates that one of two spoiler and stabilizer control modules has failed or is not powered.



Status Page

Stab Trim EICAS Indications <1001>
Figure 11–50–6

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Horizontal Stabilizer Trim	Control Unit	SSCU 1 CH A	DC BUS 1	1	F1	
		SSCU 1 CH B	DC BUS 2	2	F1	
		SSCU 2 CH A	DC ESSENTIAL		R3	
		SSCU 2 CH B			R4	

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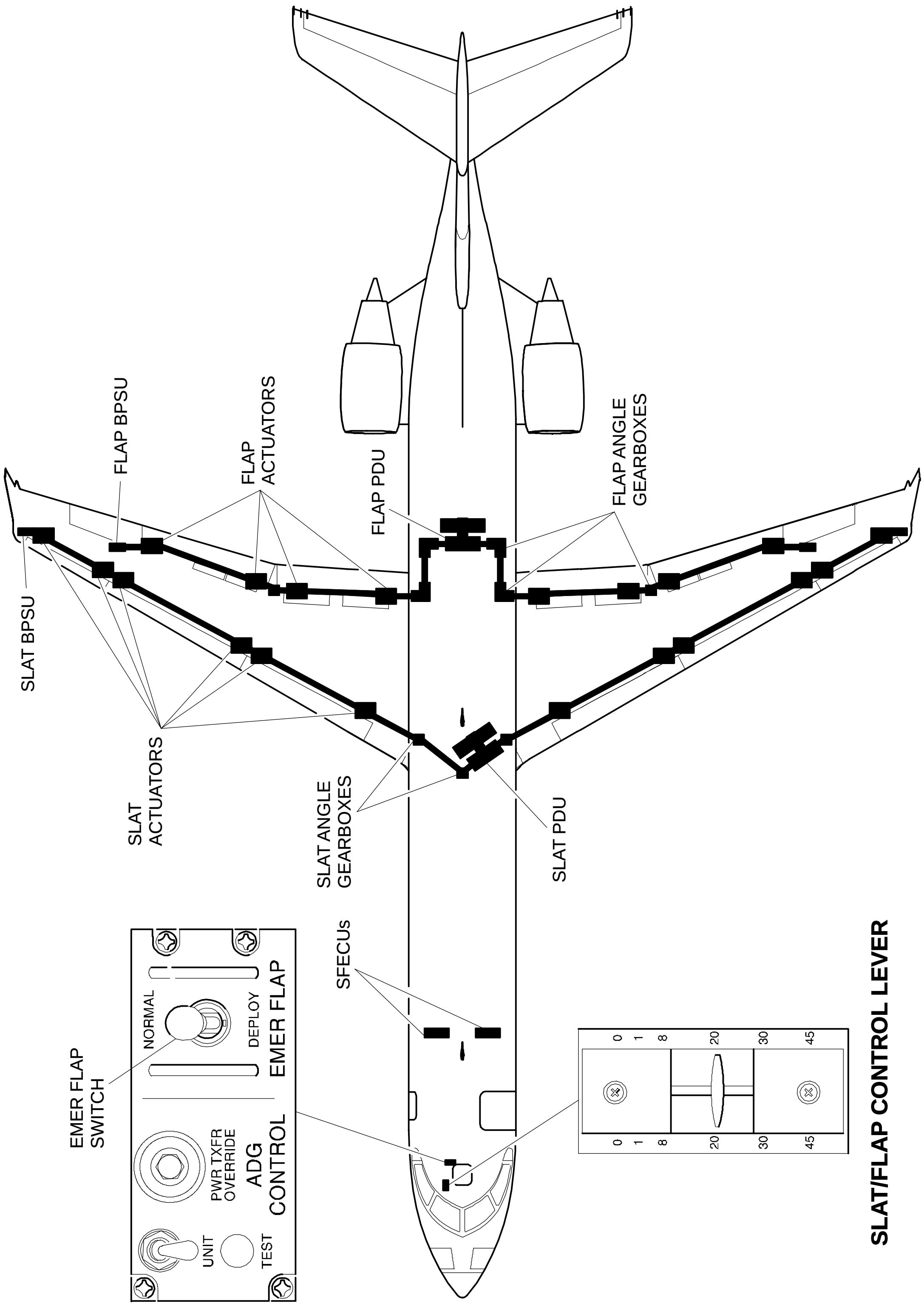
1. FLAPS AND SLATS

The flap and slat systems provide lift augmentation during take-off and landing. Each wing has three leading edge slats and two trailing edge flaps. Both systems are selected and operated by a single electronic slat/flap control lever, located on the center pedestal. During extension, the slats move forward and down on geared tracks, the flaps move slightly aft and down around hinge pivots.

Each system is driven by a dual motor power drive unit. The power drive units drive the flaps and slats through a series of drive shafts, gearboxes and actuators. Brake position sensor units, mounted at the outboard ends of each drive system, provide braking for asymmetric protection and provide surface position feedback to the slat/flap electronic control units (SFECUs). Flap skew sensors and slat disconnect sensors provide fault detection in the event of a failure in a drive system.

When a slat/flap selection is made, the SFECUs release the system brakes and command the power drive units to deploy or retract the slats and flaps to the selected position. An overspeed clacker will sound if the airspeed is too high for the selected flap setting.

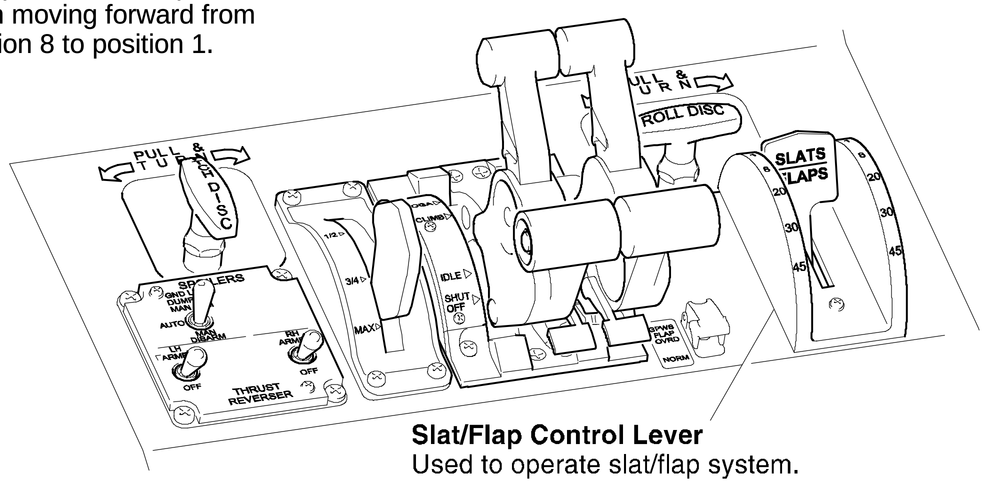
If one of the two power drive unit motors fails, the system will remain functional at half speed. In the event of mechanical failure of the control lever, an emergency flap switch will allow limited slat and flap selection. When the emergency flap switch is actuated, the SFECUs will override the control lever selection, and extend the flaps to 20° and extend the slats. If emergency flap deployment is selected at an airspeed higher than 230 knots, the control unit will delay deployment of the slats and flaps until the airspeed is reduced below 230 knots.



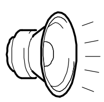
Slats/ Flaps Control System
Figure 11−60−1

NOTE

Gates are provided at positions 8 and 20. Lever must be pushed downward to overcome gate when moving rearward from position 20 to position 30 and when moving forward from position 8 to position 1.



Slat/Flap Control Lever
Used to operate slat/flap system.
Position 0 - slats and flaps fully retract.
Position 1 - slats go to 20°.
Position 8 - flaps go to 8°.
Position 20 - flaps go to 20°.
Position 30 - slats go to 25° (full travel) and flaps go to 30°.
Position 45 - flaps go to 45° (full travel).

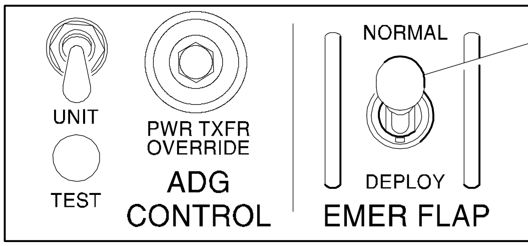


Clacker indicates that airspeed is too high for selected flap setting.

Pending rectification

The overspeed clacker may sound during a go-around maneuver while retracting flaps from 45° (30°) to 8° with IAS at or above 185 KIAS even if the overspeed cue (red/black checkerboard) is set at 220 KIAS. This occurrence is related to the slats transition from 25° to 20°. The clacker sound will discontinue as soon as the slats reach 20° position.

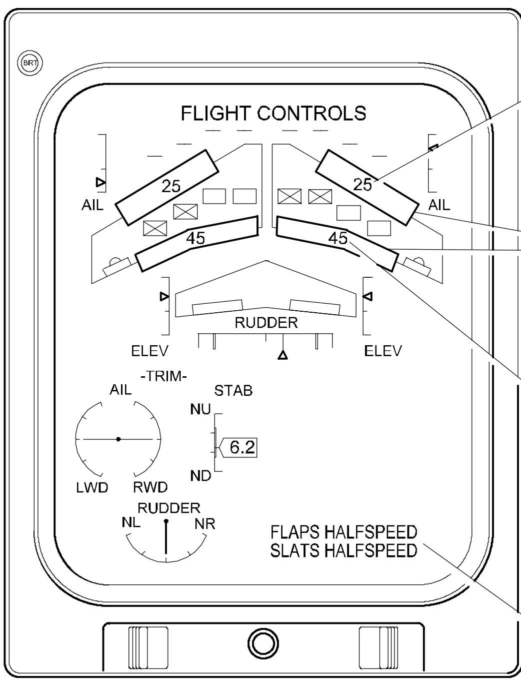
Slats/ Flaps – Control
Figure 11–60–2



EMER FLAP
Used to operate the slats and flaps in the event of a control lever failure.

Emergency Flap Deploy Control
Center Pedestal

Emergency Flap Deploy Control Panel
Figure 11–60–3



Slat Position Readout
Indicates slat position in degrees.
- Green – Normal operation.
- White – Surface mismatch.
- Amber dashes – Invalid data.

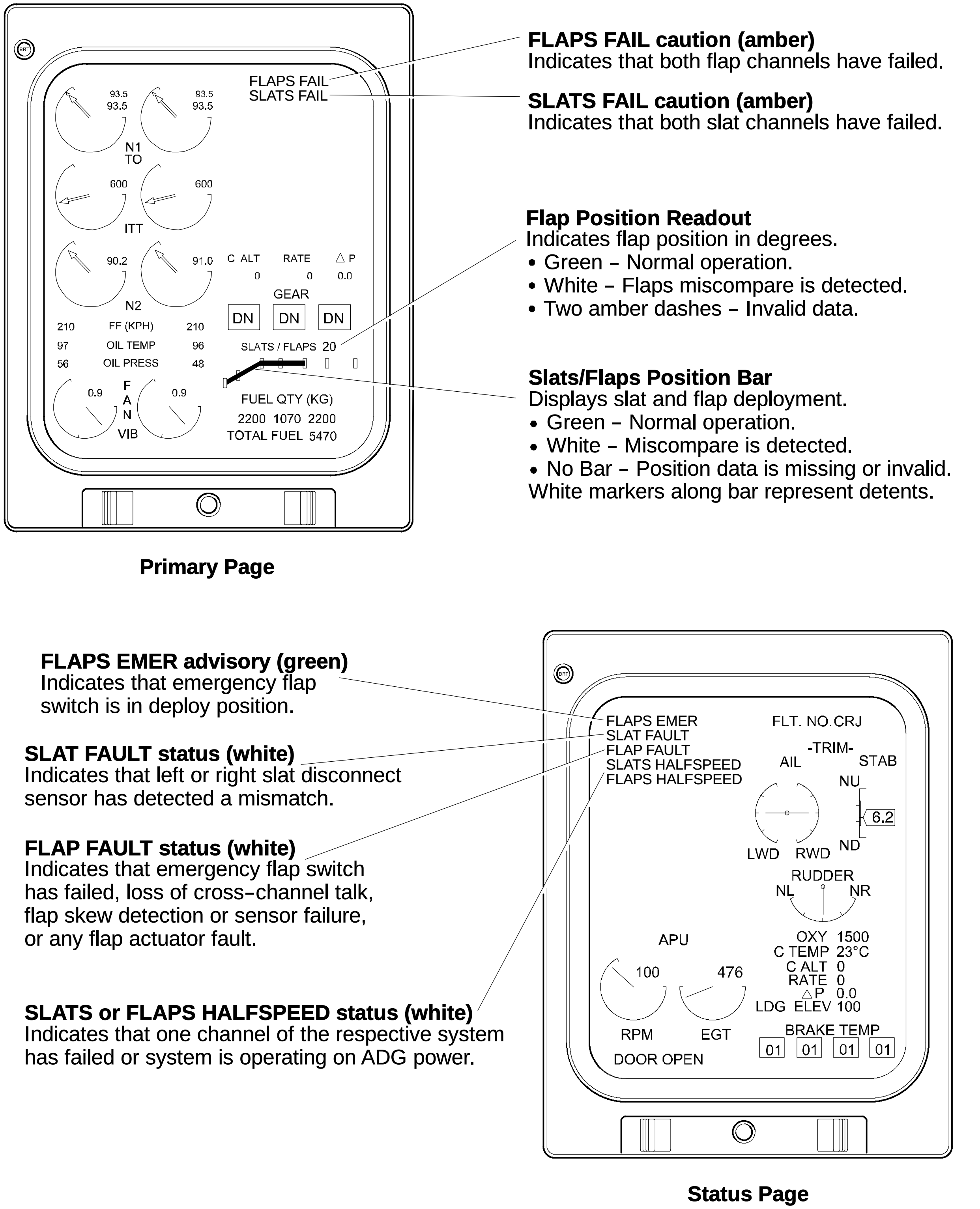
Flap and Slat Outlines
- Green – System fully operational.
- White – System at half speed.
- Amber – System failed.
- Half Intensity Magenta – Invalid data.

Flap Position Readout
Indicates flap position in degrees.
- Green – Normal operation.
- White – Surface mismatch.
- Amber dashes – Invalid data.

SLATS or FLAPS HALFSPEED (white)
Indicates that one channel of the respective system has failed.

Flight Controls Page

Slats/ Flaps Position – Flight/Control Synoptic Page
Figure 11–60–4



Slats/ Flaps EICAS Indication <1001>
Figure 11–60–5

A. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Flaps and Slats	Flaps	FLAPS CONT CH 1	DC ESSENTIAL	2	R1	
		FLAPS CONT CH 2	BATTERY BUS	1	L5	
	Slats	SLATS CONT CH 2			L6	
		SLATS CONT CH 1	DC ESSENTIAL	2	R2	

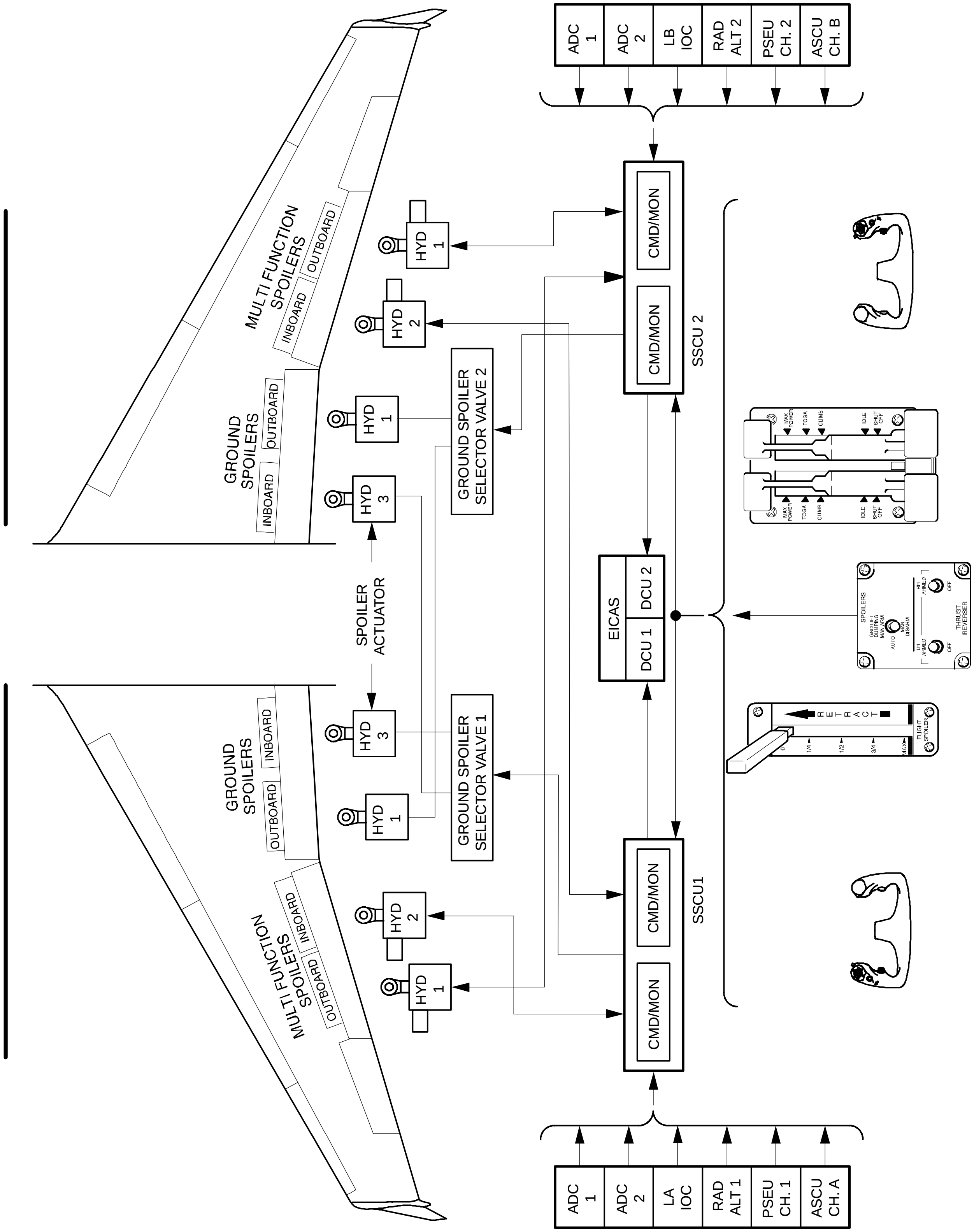
1. SPOILERS

Spoiler control consist of two multi-functional spoilers and two ground spoilers on each wing. Each spoiler is actuated by a single electro–hydraulic power control unit. The multi-functional spoilers provide roll assist and proportional lift dumping functions. The ground spoilers provide ground lift dumping function only. Spoiler operation is controlled by two, dual channel, spoiler and stabilizer control units (SSCUs).

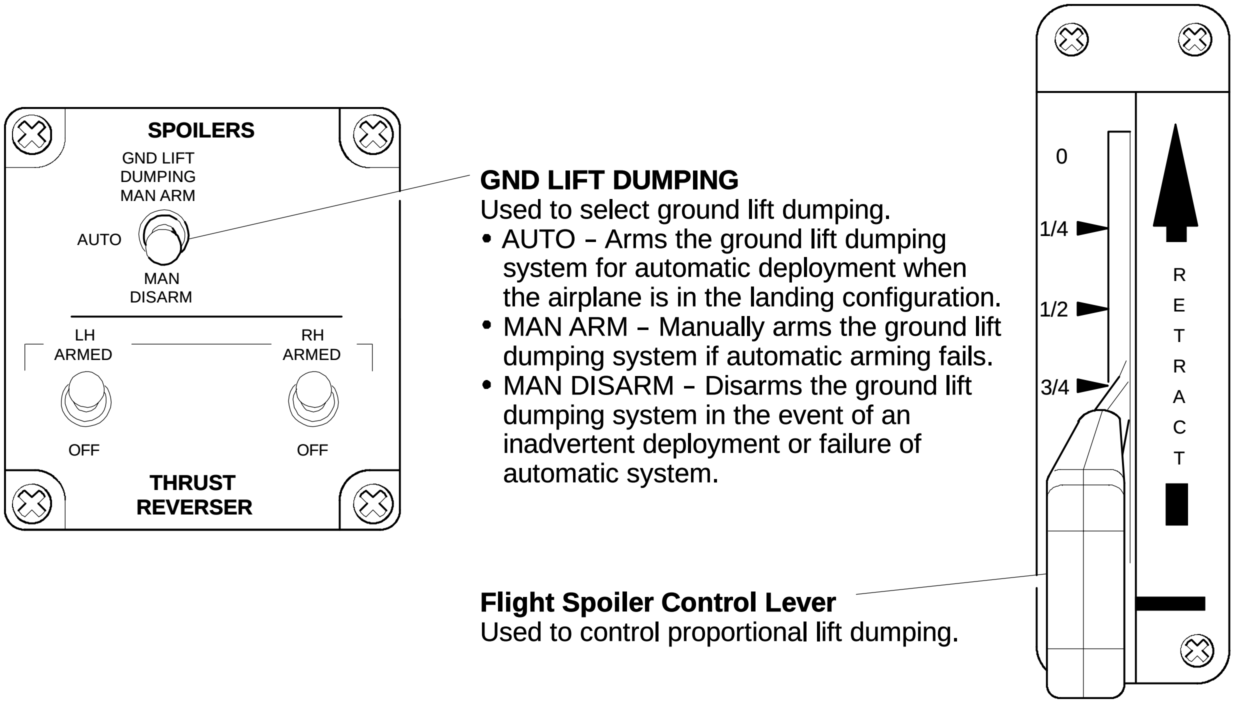
Roll assist is provided by asymmetric deployment of the multi-functions spoilers. Deployment is relative to control wheel inputs, Mach number and flap position. Roll assist is used to improve lateral control of the aircraft at low airspeeds.

Proportional lift dumping is provided by symmetric deployment of the multi-functional spoilers. Deployment is relative to the position of the flight spoiler control lever. Proportional lift dumping is used for speed control and to stabilize the airplane on the glide path or during rapid descents.

Ground lift dumping is used to assist in aircraft braking on the ground. Ground lift dumping is provided by full deployment of multifunctional spoilers and the ground spoilers Ground lift dumping is normally automatic but can be manually controlled by the GND/LIFT DUMPING switch on the center pedestal. Automatic deployment is triggered on the basis of engine throttle position, radio altitude, wheel speed and weight-on-wheels conditions.



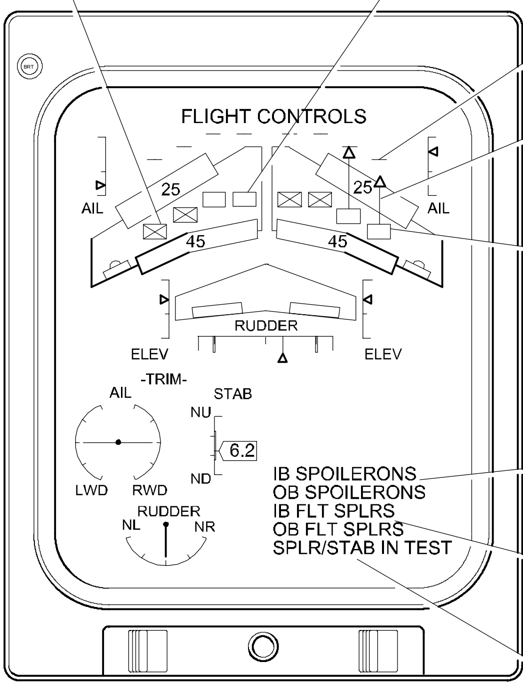
Spoiler Control System
Figure 11–70–1



Spoiler Control Panel and Lever
Figure 11–70–2

Ground Spoiler Outline
- Green – Spoiler is operative.
- White – Loss of redundancy.
- Amber – Spoiler is inoperative.

Spoiler X Marking (amber)
Indicates input data is invalid.



Flight Controls Page

Maximum Spoiler Deployment Mark (white)
Indicates full deployment point of respective spoiler.

Spoiler Position Indicator (white)
Indicates position of respective spoiler. Indicator is not displayed when respective spoiler is retracted or input data is invalid.

Multi–Function Spoiler Outline
- Green – Spoiler is operative.
- White – Loss of roll asist, proportional lift dumping or redundancy.
- Amber – Spoiler is inoperative.

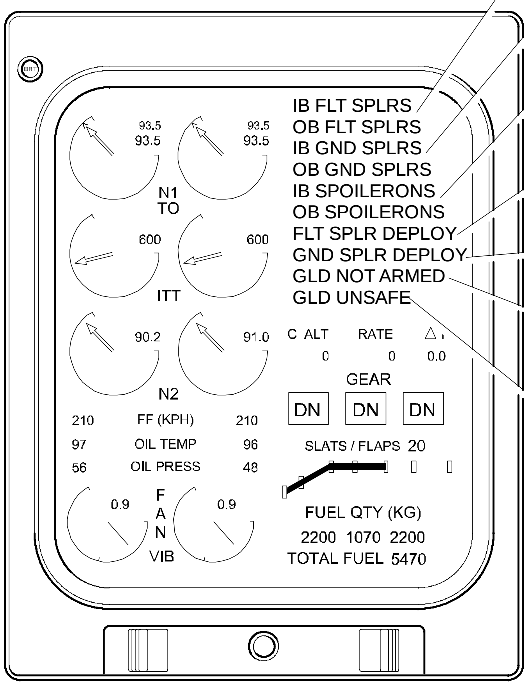
IB or OB SPOILERONS (amber)
Indicates loss of roll assist capability for respective multi–function spoilers.

IB or OB FLT SPLRS (amber)
Indicates loss of proportional lift dumping capability for respective multi–function spoilers.

SPLR/STAB IN TEST (green)
Indicates that the spoiler and stabilizer control system is in self test mode.

NOTE
To prevent nuisance messages, no other cockpit function should be carried out while SPLR / STAB IN TEST is displayed (about 60 seconds)

Spoilers – Flight/Control Synoptic Page
Figure 11–70–3



Primary Page

IB or OB FLT SPLRS caution (amber)
Indicates loss of proportional lift dumping capability for respective multi-function spoilers.

IB or OB GND SPLRS caution (amber)
Indicates that respective ground spoilers are inoperative.

IB or OB SPOILERONS caution (amber)
Indicates loss of roll assist capability for respective multi-function spoilers.

FLT SPLR DEPLOY caution (amber)
Indicates that any flight spoiler is deployed >3 degrees or the flight spoiler handle out of the 0 position with the aircraft either in go-around or the radio altitude is below 300 feet.

GND SPLR DEPLOY caution (amber)
Indicates that a ground spoiler is deployed and airplane is not on the ground.

GLD NOT ARMED caution (amber)
Indicates that ground lift dumping is not armed and airplane is in either approach or take-off configuration.

GLD UNSAFE caution (amber)
Indicates that ground lift dumping mode is unsafe (possible inadvertant deployment of spoilers due to failure of two or more input sensors).

Spoilers – EICAS Indications – Primary Page <1001>
Figure 11–70–4

FLT SPLR DEPLOY advisory (green)
Indicates that any flight spoiler is deployed >3 degrees or the flight spoiler handle out of the 0 position with the aircraft not in go-around or the radio altitude is above 300 feet.

GND SPLR DEPLOY advisory (green)
Indicates that a ground spoiler is deployed and airplane is on the ground.

GLD MAN ARM advisory (green)
Indicates that ground lift dumping is manually armed.

SPLR/STAB IN TEST advisory (green)
Indicates that the spoiler and stabilizer control system is in self test mode.

GLD MAN DISARM status (white)
Indicates that ground lift dumping is manually disarmed.

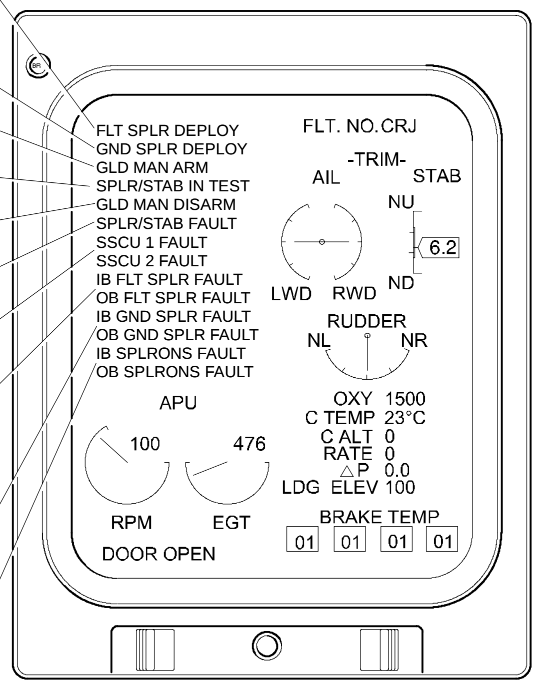
SPLR/STAB FAULT status (white)
Indicates a fault in the spoiler and stabilizer control unit.

SSCU 1 or 2 FAULT status (white)
Indicates that one of two spoiler and stabilizer control modules has failed or is not powered.

IB or OB FLT SPLR FAULT status (white)
Indicates a loss in redundancy of proportional lift dumping capability for respective multi-function spoilers.

IB or OB GND SPLR FAULT status (white)
Indicates a loss in redundancy of respective ground spoilers.

IB or OB SPLRONS FAULT status (white)
Indicates a loss in redundancy of roll assist capability for respective multi-function spoilers.



Status Page

Spoilers – EICAS Indications – Status Page
Figure 11–70–5

A. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Spoilers	Control Unit	SSCU 1 CH A	DC BUS 1	1	F1	
		SSCU 1 CH B	DC BUS 2	2	F1	
		SSCU 2 CH A	DC ESSENTIAL		R3	
		SSCU 2 CH B			R4	

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1. STALL PROTECTION SYSTEM

The purpose of the stall protection system is to provide warning of an impending stall when the aircraft attitude approaches a high angle–of–attack (AOA) and to prevent stall penetration when the aircraft nears the computed stall angle. The system alerts the flight crew by means of visual and aural warnings.

Angle of attack vanes located on each side of the forward fuselage measure the aircraft attitude in relation to the ambient airstream. The stall protection computer uses the AOA information and airspeed to compute the stall angles.

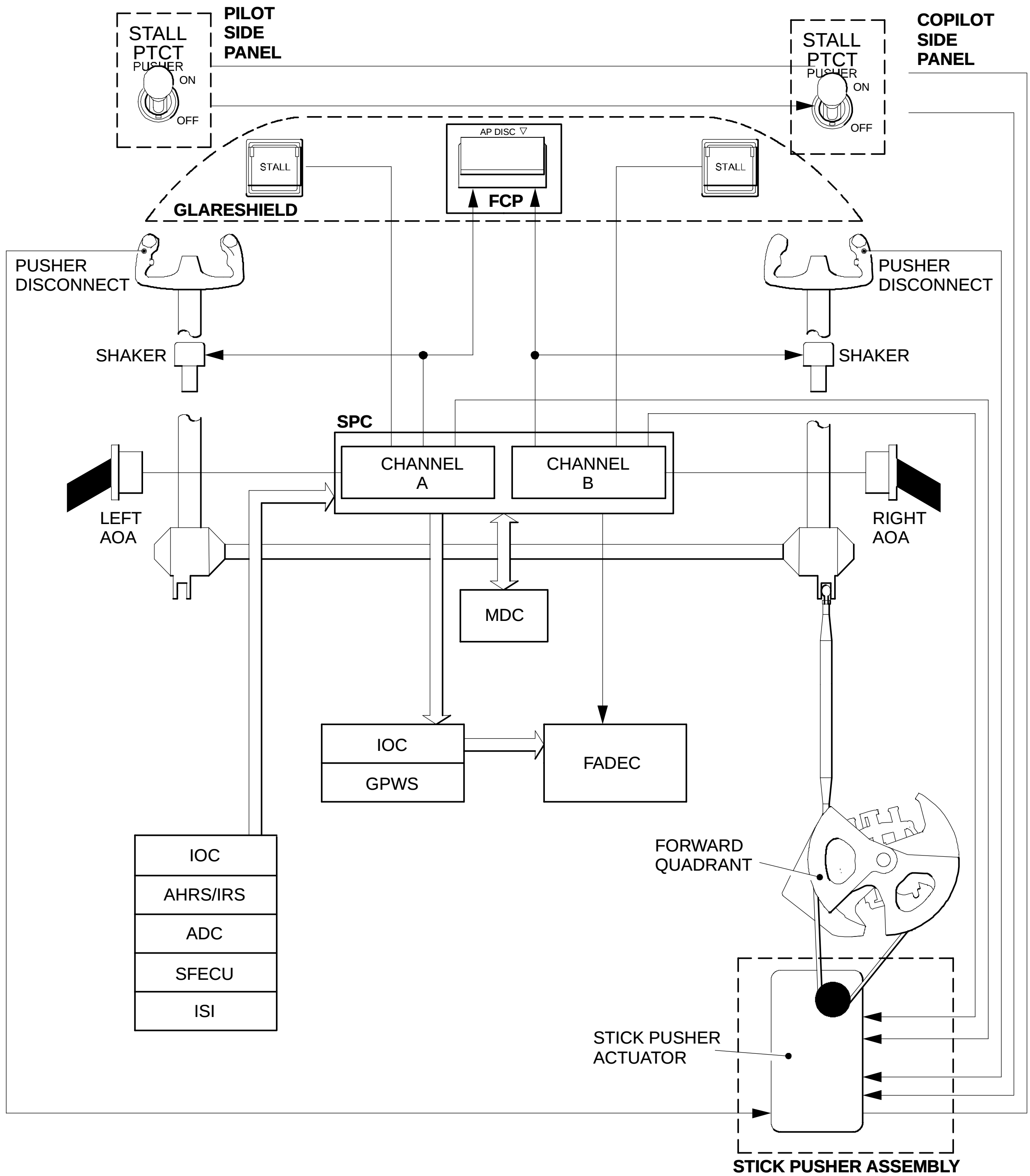
When the aircraft approaches a high AOA, the stall protection computer will:

•Warn the crew of an impending stall through the stick shaker.

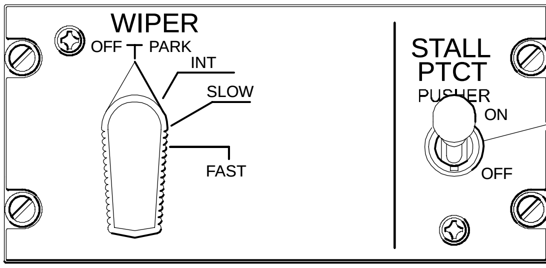
•Activate the engines auto-ignition system.

•Disengage the autopilot.

If the angle of attack continues to approach the critical stall point, the stick pusher is activated to push the control column forward to give the aircraft a pitch down attitude. The stick pusher can be selected off at the stall protection panel.



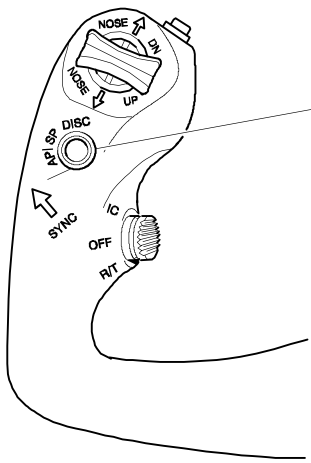
Stall Protection System Schematic
Figure 11–80–1



STALL PTCT PUSHER
Used to control operation of stick pusher.

NOTE
Both pilot and copilot switches must be selected on to engage the stick pusher.

Stall Protection Panel
Pilot and Copilot Side Panels

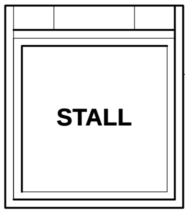


AP/SP DISC (red)
Used to disengage the autopilot and to momentarily deactivate the stall protection system.
- Press to disengage the autopilot and to momentarily disable the stick pusher.
- Release to reactivate the stick pusher.

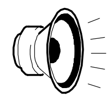
NOTE
When pressed for 4 seconds or longer, the STALL FAIL caution message will come on. The caution message will go out approximately 1 second after the switch is released.

Pilot and Copilot Control Wheels

Stall Protection Controls
Figure 11–80–2



STALL (Guarded)
Used to initiate stall protection system test while airplane is in a weight-on-wheels condition.
- STALL (red) light flashes to indicate an impending stall condition

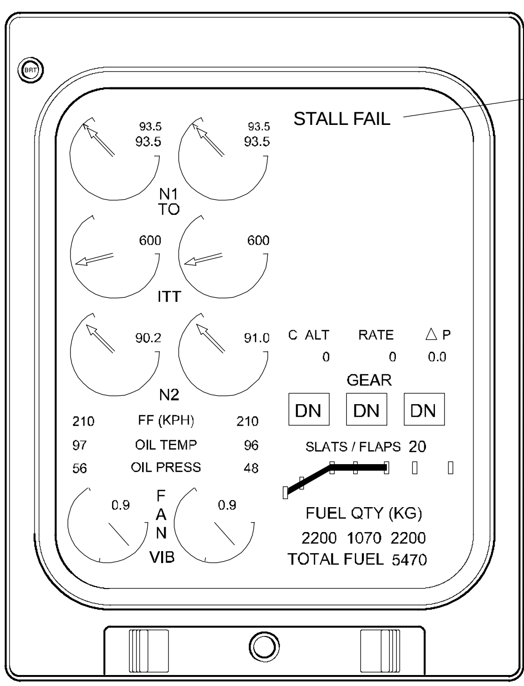


Warbler tone alerts flight crew of impending a stall condition.

Left and Right Glareshield

Stall Test
To initiate stall protection system test, momentarily press STALL light, and verify that:
- Auto-ignition is activated
  (CONT IGNITION status message on EICAS and illumination of ON light on ignition panel.
- Pilot's stick shaker is activated and, after 3 seconds, copilot's stick shaker is activated.
- After approximately 7 seconds, stick pusher is activated and STALL light comes on.
- Press AP/SP DISC to verify stick pusher stops and STALL light goes out.
- 1Pilot's stick shaker stops, copilot's stick shaker stops and auto-ignition is deactivated.

NOTE
Pressing STALL light a second time during the stall protection test, will interrupt the test sequence.



Primary Page

STALL FAIL caution (amber)
Indicates that pusher is deactivated or has failed or one channel of the stall protection computer has failed or angle of attack sensor has failed.

700fcom1_118002ac01.cgm

Stall Protection – Test and EICAS Indications <1001>
Figure 11–80–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Stall Protection System	Pusher	STALL PROT STICK PUSHER	BATTERY BUS	1	Q1	
	Computer	STALL PROT L CH			Q2	
		STALL PROT R CH	DC ESSENTIAL	2	U5	

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CHAPTER 12 – FLIGHT INSTRUMENTS

Page

LIST OF ILLUSTRATIONS

ELECTRONIC FLIGHT INSTRUMENT SYSTEM

AIR DATA SYSTEM

RADIO ALTIMETER SYSTEM

ATTITUDE AND HEADING REFERENCE SYSTEM

STANDBY INSTRUMENTS AND CLOCKS

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1. INTRODUCTION

Flight instruments include the electronic flight instrument systems, standby instruments and clocks. Data for the flight instruments is provided by an air data system, radio altimeter and inertial reference system (IRS). Flight instruments provide the following basic information to the flight crew: <1025>

- Altitude (barometric/radio)
- True Airspeed
- Airspeed (MACH/KIAS)
- Temperature Data
- Airspeed Trend
- Airplane Attitude
- Vertical Speed
- Heading Information
- Overspeed Warning
- Navigation Information

Electronic flight instruments consists of a primary flight display (PFD) and a multifunctional display (MFD) for each pilot. An integrated standby instrument (ISI) provides standby attitude, altitude and airspeed information to the flight crew. An independent standby compass provides aircraft heading in relation to magnetic north. A electronic clock provides the time source for the aircraft avionics equipment.

Air data provided by a pitot-static system and a temperature probe provide the flight instruments with speed, altitude and temperature data. The radio altimeter provides an accurate measurement of height above terrain at low altitudes. The inertial reference system (IRS) provides attitude, heading, position, angular rate and linear acceleration information. <1025>

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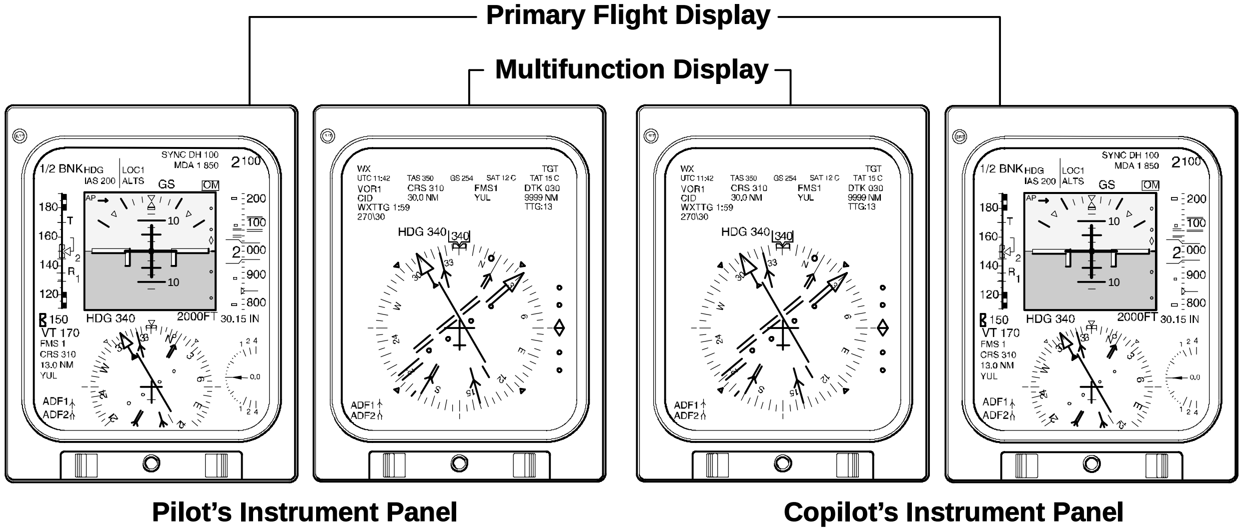
1. ELECTRONIC FLIGHT INSTRUMENT SYSTEM

All basic flight information is presented to the flight crew on Electronic Flight Instrument System (EFIS) displays. Each pilot instrument panel contains a primary flight display (PFD) and a multifunctional display (MFD). All four displays are electronically identical to permit transfer of display data.

Each PFD has the primary function of pictorially showing aircraft attitude, altitude, airspeed, flight director commands and flight mode annunciations.

Each of the MFDs acts as a navigation system display and has a primary function of showing current heading (compass) and course information. The MFDs can also display moving map navigation pictorials, navigation sensor data, weather radar targets, and TCAS traffic (see Chapter 18). Cross-side compass information and backup navigation information can be superimposed on either display. EICAS information can also be displayed on either MFD.



EFIS – General <1015>
Figure 12–20–1

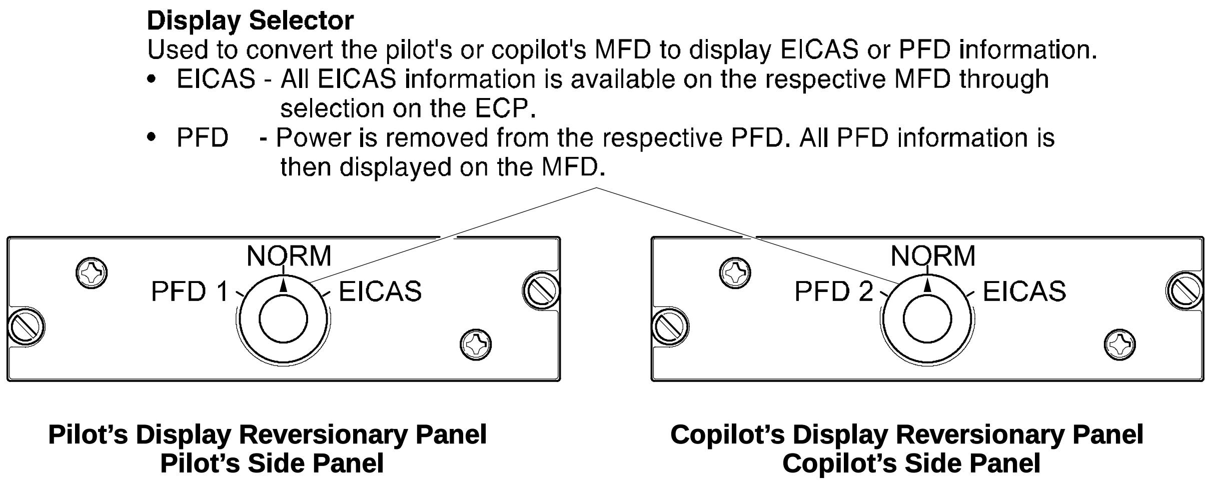
A. Display Reversion

Two display reversionary panels are installed in the flight compartment. One panel is installed on the pilot’s side panel and the other panel is installed on the copilot’s side panel. In the event of a primary flight display (PFD) failure, all data normally displayed on it can be transferred to the adjacent MFD by turning the display selector knob on the respective reversionary panel to the PFD position.

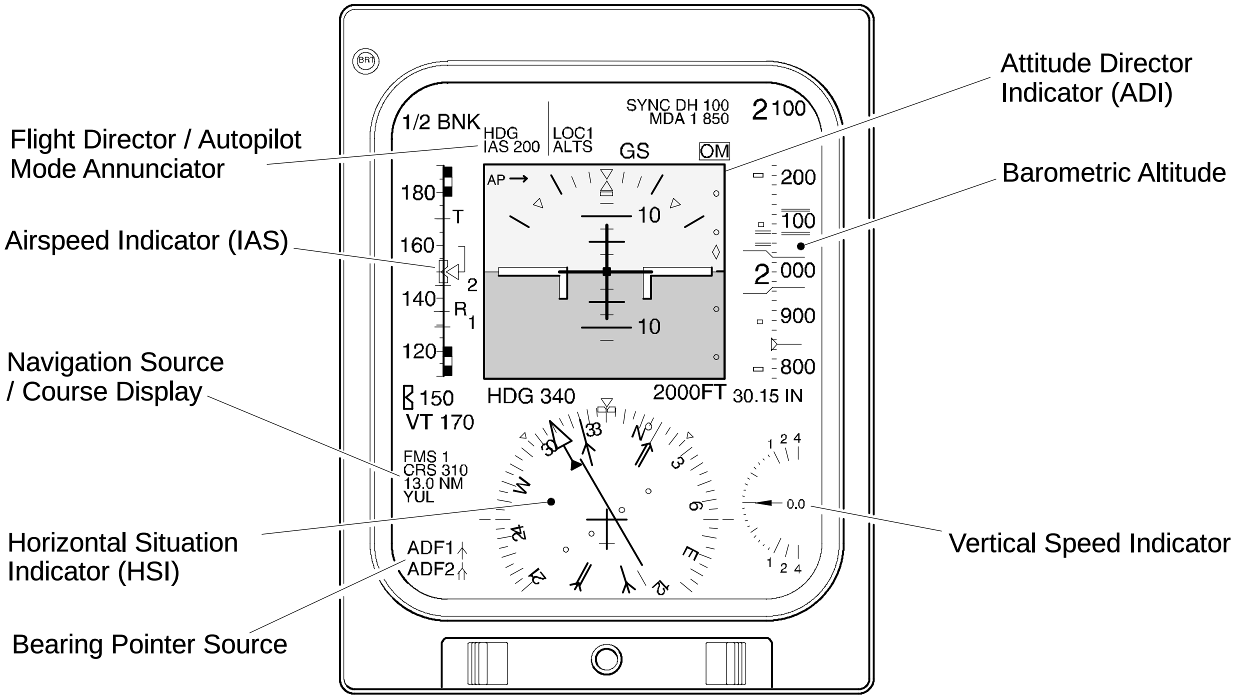
NOTE

The MFD information cannot be transferred to the PFD.

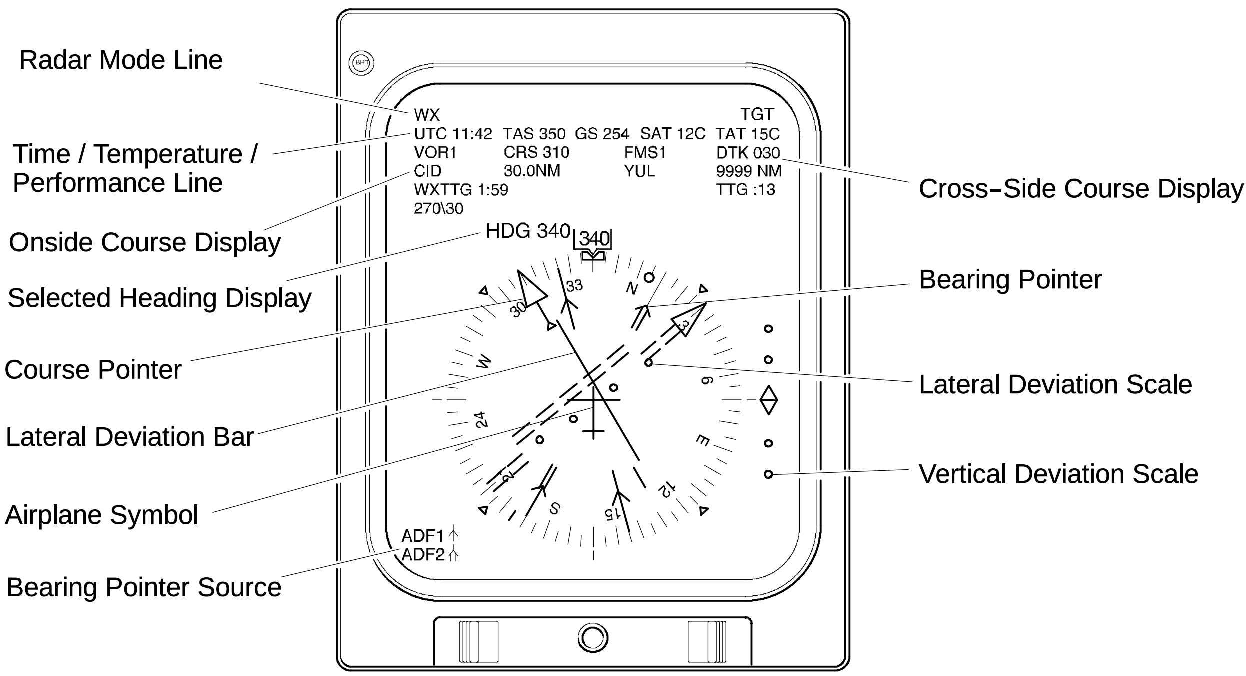
Selecting the EICAS position, on the reversionary panel, will initially display the EICAS status page on the respective MFD. All the other EICAS pages are available for display on the MFD, through selections on the EICAS control panel.



Display Selection
Figure 12–20–2



Primary Flight Display
Pilot's and Copilot's Instrument Panels



Multifunction Display - HSI Mode
Pilot's and Copilot's Instrument Panels

Primary Flight Display and Multifunction Display <1015>
Figure 12-20-3

B. Display Control

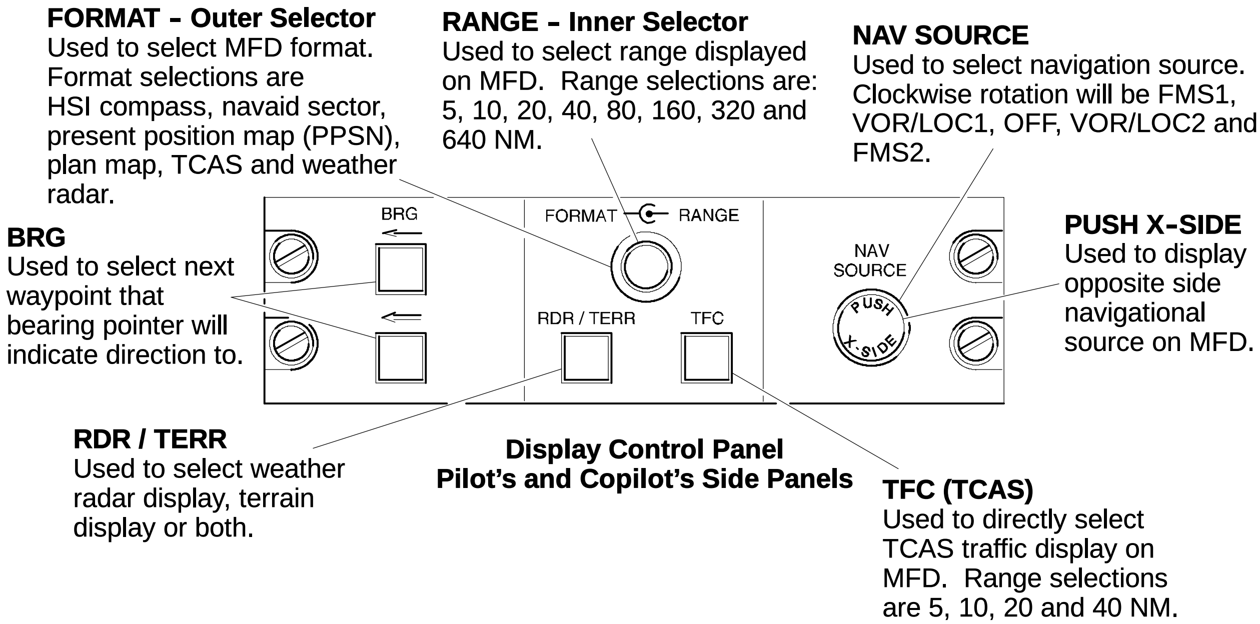
Two display control panels are installed in the flight compartment. One panel is installed on the pilot's side panel and the other panel is installed on the copilot's side panel. Each panel provides the pilot and copilot control of their respective PFD and MFD.

The control selections are as follows:

- MFD format selection
- Bearing pointer selection
- Navigation source selection
- Cross side navigation data and course display

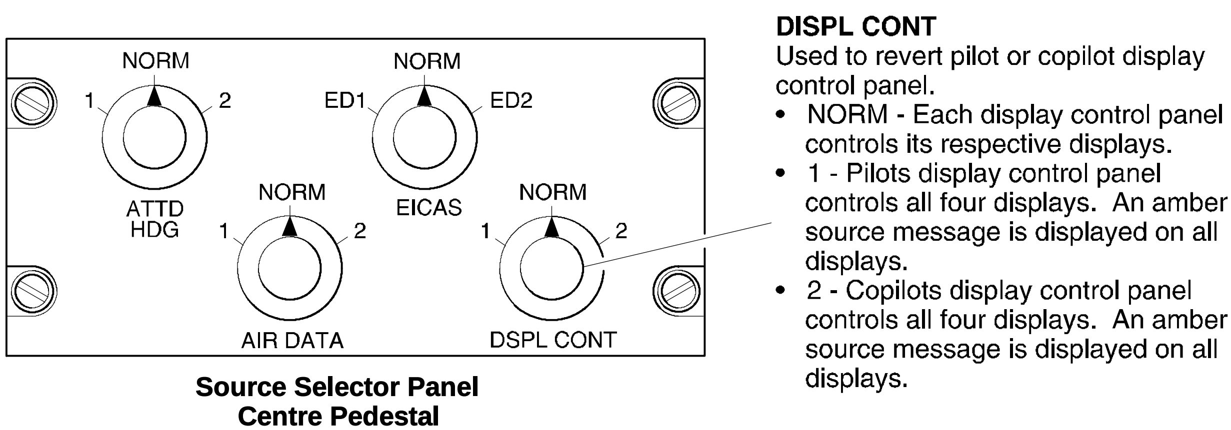
The rotary FORMAT knob can be used to select one of the following navigation formats:

- HSI compass
- Navaid sector map
- TCAS
- FMS present position map
- FMS plan map
- Weather radar

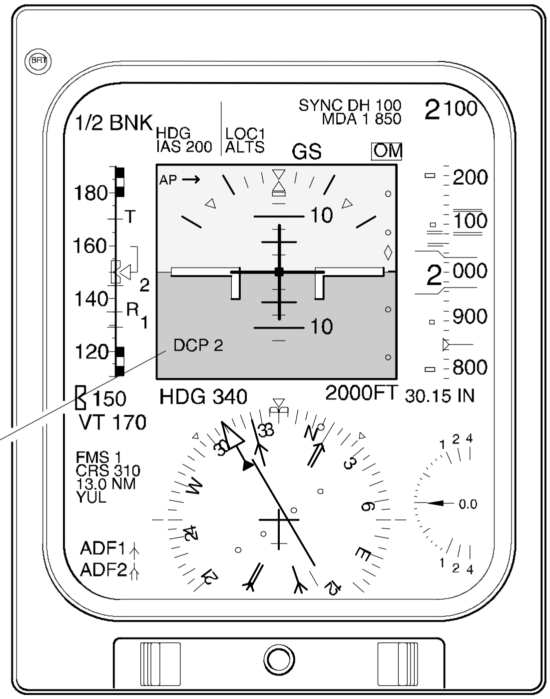


Display Control Panel <2040>
Figure 12–20–4

If one display control panel fails, the other panel can be used to control all four electronic flight displays. This is done by selecting the DSPL CONT knob, on the Source Selector Panel, to the 1 or 2 position as required.



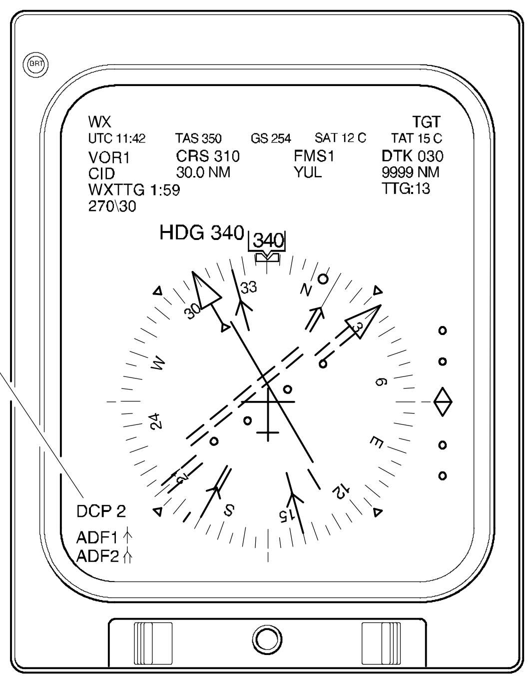
Source Selector Panel
Figure 12–20–5



DCP 1 or 2 (amber)
Indicates that single display control panel source has been selected.

- DCP 1 - Pilot's display control panel selected.
- DCP 2 - Copilot's display control panel selected.

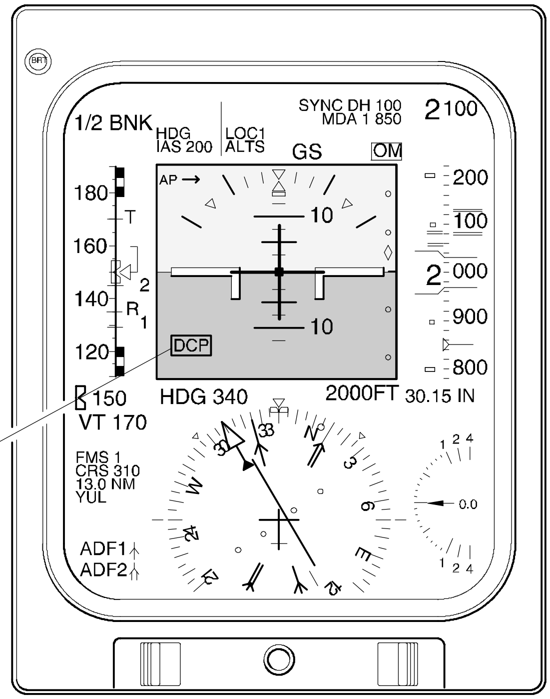
Primary Flight Display
Pilot's and Copilot's Instrument Panels



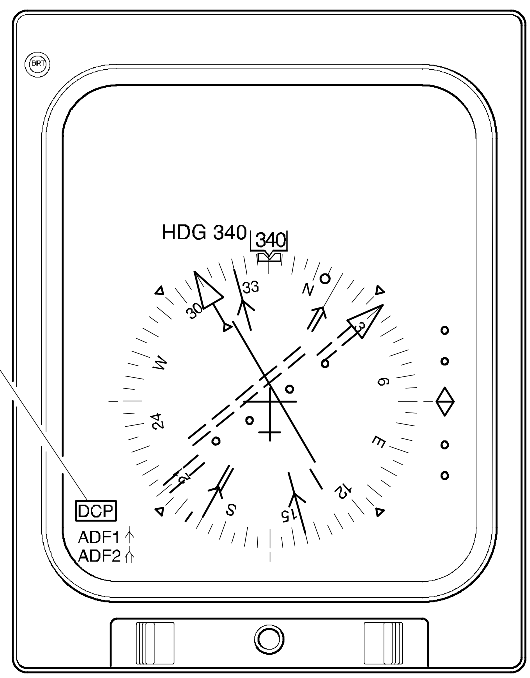
Multifunction Display – HSI Mode
Pilot's and Copilot's Instrument Panels

Display Control Source Indications <1015>
Figure 12–20–6

DCP, DCP 1 or DCP 2 Flag (red)
Indicates that selected display control panel has failed.



Primary Flight Display
Pilot's and Copilot's Instrument Panels



Multifunction Display – HSI Mode
Pilot's and Copilot's Instrument Panels

Display Control Source Flags <1015>
Figure 12–20–7

C. Comparator Function

A comparison of displayed data is performed by each PFD to ensure that the same data is shown on both PFDs. Comparison of roll, pitch, heading, altitude and airspeed information is performed continuously. Comparison for radio altitude, flight director pitch, ILS localizer and ILS glide slope are performed during precision landing. When a miscompare condition is detected, the miscompare indicator on both PFDs will flash amber for 5 seconds then come on steady, as long as the miscompare exists. An EFIS COMP MON caution message is also displayed on the EICAS primary page.

If the comparator monitor function is not available, an EFIS COMP INOP caution message is displayed on the EICAS primary page.

Comparator Indications

<u>Heading (HDG)</u> – The HDG indicator will display when the attitude is < 20 degrees and the difference is > 6 degrees.

<u>Roll Attitude (ROL)</u> – The ROL indicator will display when the difference is > 4 degrees before glideslope capture, and 3 degrees after.

<u>Pitch Attitude (PIT)</u> – The PIT indicator will display when the difference is > 4 degrees before glideslope capture, and 3 degrees after.

<u>Indicated Airspeed (IAS)</u> – An IAS difference of > 10 knots with the IAS > 90 knots will cause the IAS indicator to display. Airspeed indication tolerances are shown in the table that follows:

Airspeed (Knots)	Indicator Tolerances (Knots)	Difference Between Left and Right Indications (Knots)	ISI Tolerances (Knots)
60	±5	±3	±5
80	±3	±3	±4
100	±3	±3	±3
120	±3	±3	±3
140	±3	±3	±3
160	±3	±3	±3
180	±3	±3	±5
200	±3	±3	±5
260	±3	±3	±5
300	±3	±5	±5
360	±3	±5	±6

<u>Altitude (ALT)</u> – An ALT difference of > .002 X ABS (ALT1 + ALT2) will cause the ALT indicator to display. Altitude indication tolerances are shown in the table that follows:

NOTE

The following tables show comparator tolerances and should not be confused with operational tolerances.

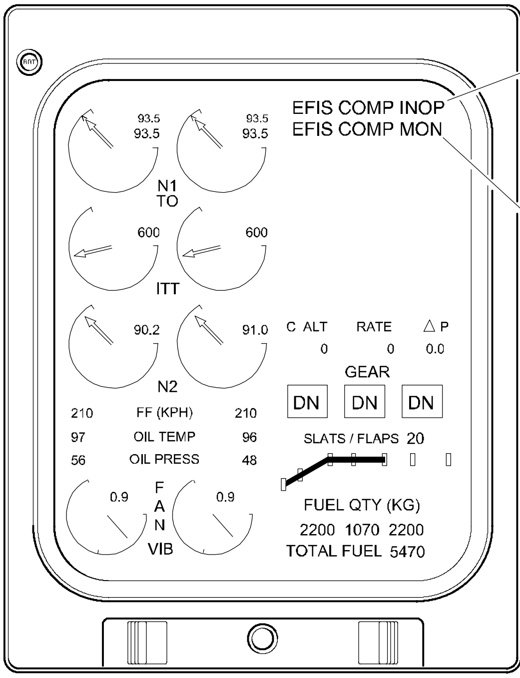
D. Non RVSM Table

ALTITUDE (Feet)	PFD 1 and PFD 2 Tolerance (Feet)	ISI Tolerance (Feet)	The ALT comparator flashes when the altitude difference between the PFD's exceed (Feet)
-1000	±20	±20	64
0	±20	±20	60
1000	±20	±20	64
5000	±31	±30	77
10000	±38	±50	103
15000	±54	±60	130
20000	±62	±75	186
25000	±72	±100	203
30000	±82	±120	220
41000	±110	±153	238

E. RVSM Table

ALTITUDE (Feet)	PFD 1 and PFD 2 Tolerance (Feet)	ISI Tolerance (Feet)	The ALT comparator flashes when the altitude difference between the PFD's exceed (Feet)
-1000	±20	±20	64
0	±20	±20	60
1000	±20	±20	64
4000	±27	±30	77
10000	±30	±50	103
16000	±32	±65	130
22000	±32	±85	155
29000	±32	±110	186
33000	±32	±130	203
37000	±32	±140	220
41000	±32	±153	238

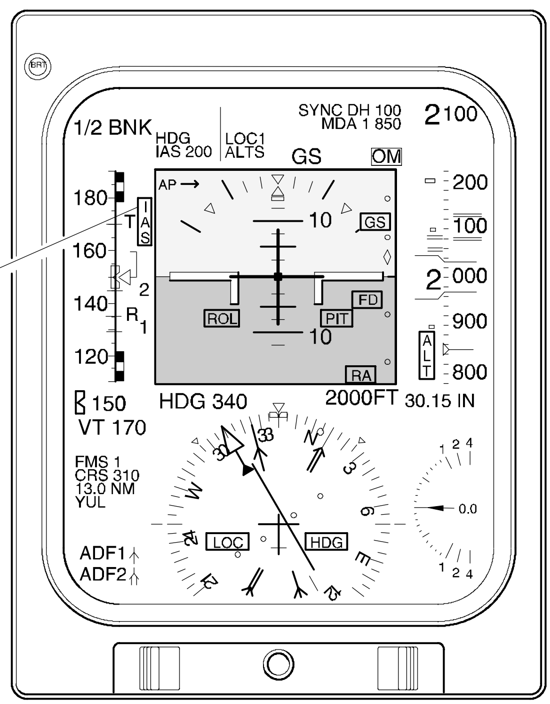
EFIS COMP INOP caution (amber)
Indicates that comparator information for one or both PFDs is not available.



EFIS COMP MON caution (amber)
Indicates that a comparator miscompare has been detected.

Primary Page

Comparator Warnings (amber)
Indicate that a comparator miscompare has been detected.



Primary Flight Display
Pilot's and Copilot's Instrument Panels

EFIS Abnormal Indications <1001, 1015>
Figure 12–20–8

F. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Electronic Flight Instruments	Pilot's Flight Instruments	PFD 1	DC ESSENTIAL	2	V10	
		MFD 1			V11	
	Dimming Control	EFIS CRT DIMMING			U4	
	Display Control Panels	EFIS CONT PNL 1			U7	
		EFIS CONT PNL 2	DC BUS 2		K3	
	Copilot's Flight Instruments	PFD 2			K1	
		MFD 2			K2	

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1. AIR DATA SYSTEM

Two air data computers (ADC 1 and ADC 2) provide the primary flight displays (PFD) with air data consisting of airspeed, altitude and vertical speed. The ADCs also provide computed air data (speed, altitude and temperature data) to various aircraft avionics systems. The ADCs convert pitot and static air pressure to electrical signals. The ADCs use static pressure to produce the altitude data and combine static and pitot pressure to produce the airspeed data. Resistance changes from a total air temperature (TAT) probe provide the ADCs with temperature data. The system is controlled by the air data reference panels and has warning and alert capabilities integrated with the EICAS. Selected speeds and altitude are set using the flight control panel (refer to Chapter 03–20–01).

A. Pitot Static System

The pitot static system supplies pitot and static air pressures to the ADCs, the integrated standby instrument (ISI) and the cabin pressure control panel (CPCP). The system consists of two pitot/static probes, an alternate pitot probe, alternate static ports and a total air temperature probe (TAT).

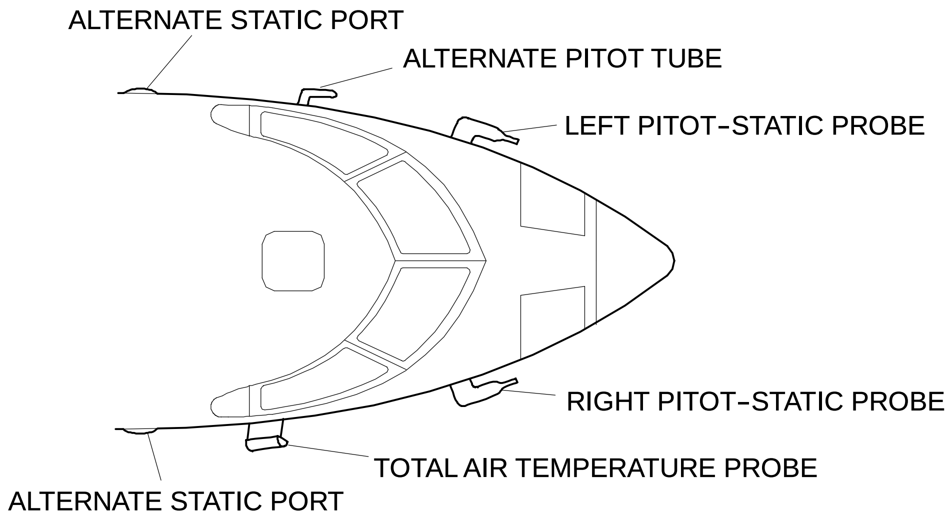
Each pitot static probe consists of a pitot mast and two static ports. Pitot pressure from each probe is supplied to the same side ADC. Static pressure from each probe is supplied to each ADC.

The alternate pitot probe and static ports supply pressure inputs to the integrated standby instrument (ISI).

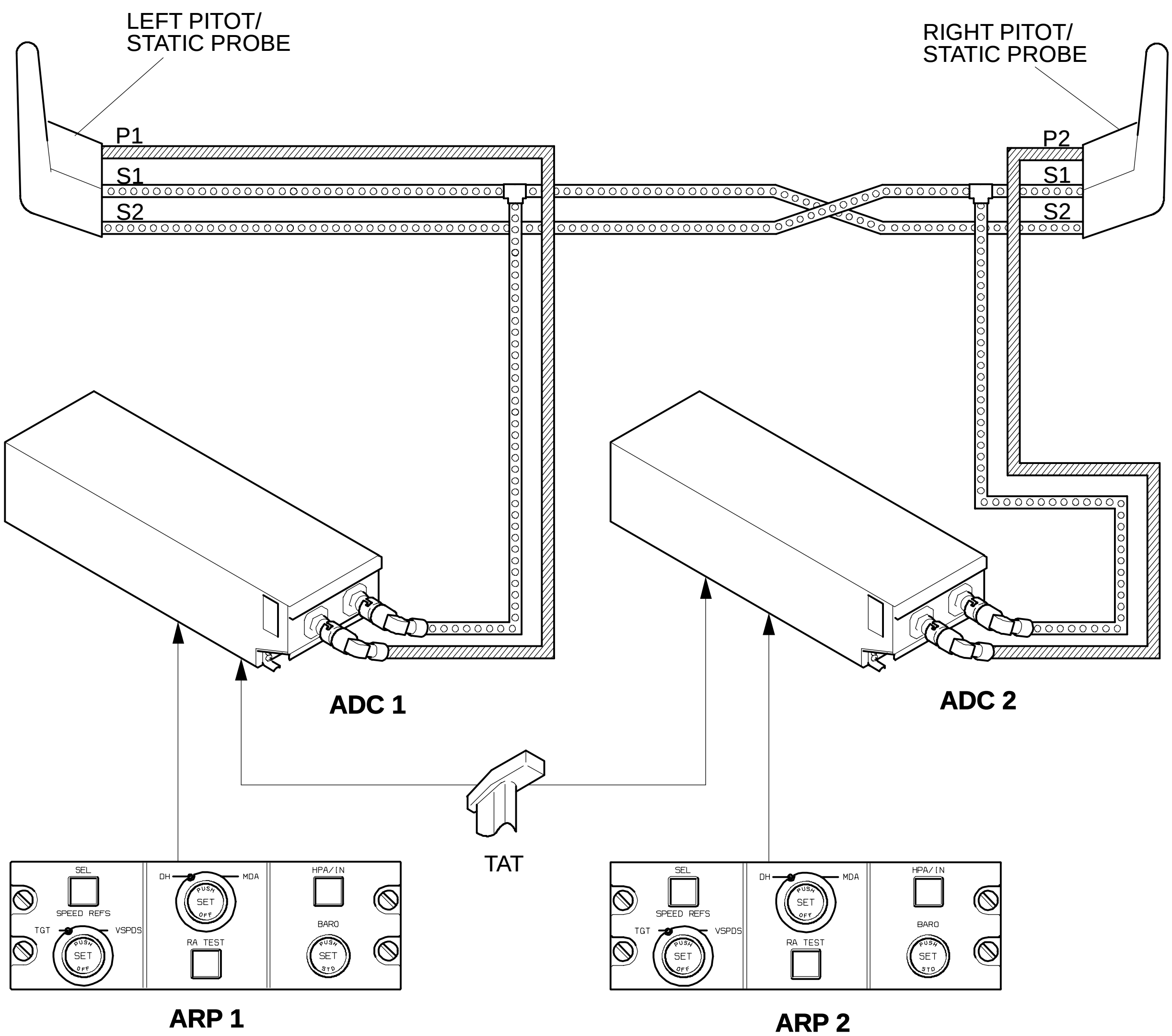
Electric heating elements protect the pitot-static and TAT probes from icing (refer to Chapter 15, Ice and Rain Protection).

NOTE

TAT probe readings are inaccurate when the aircraft is on the ground, due to probe heating to protect it from icing. TAT probe readings cannot be used to obtain the ambient static temperature before take-off.



Pitot Static System – General
Figure 12–30–1



Air Data System (ADS)
Figure 12−30−2

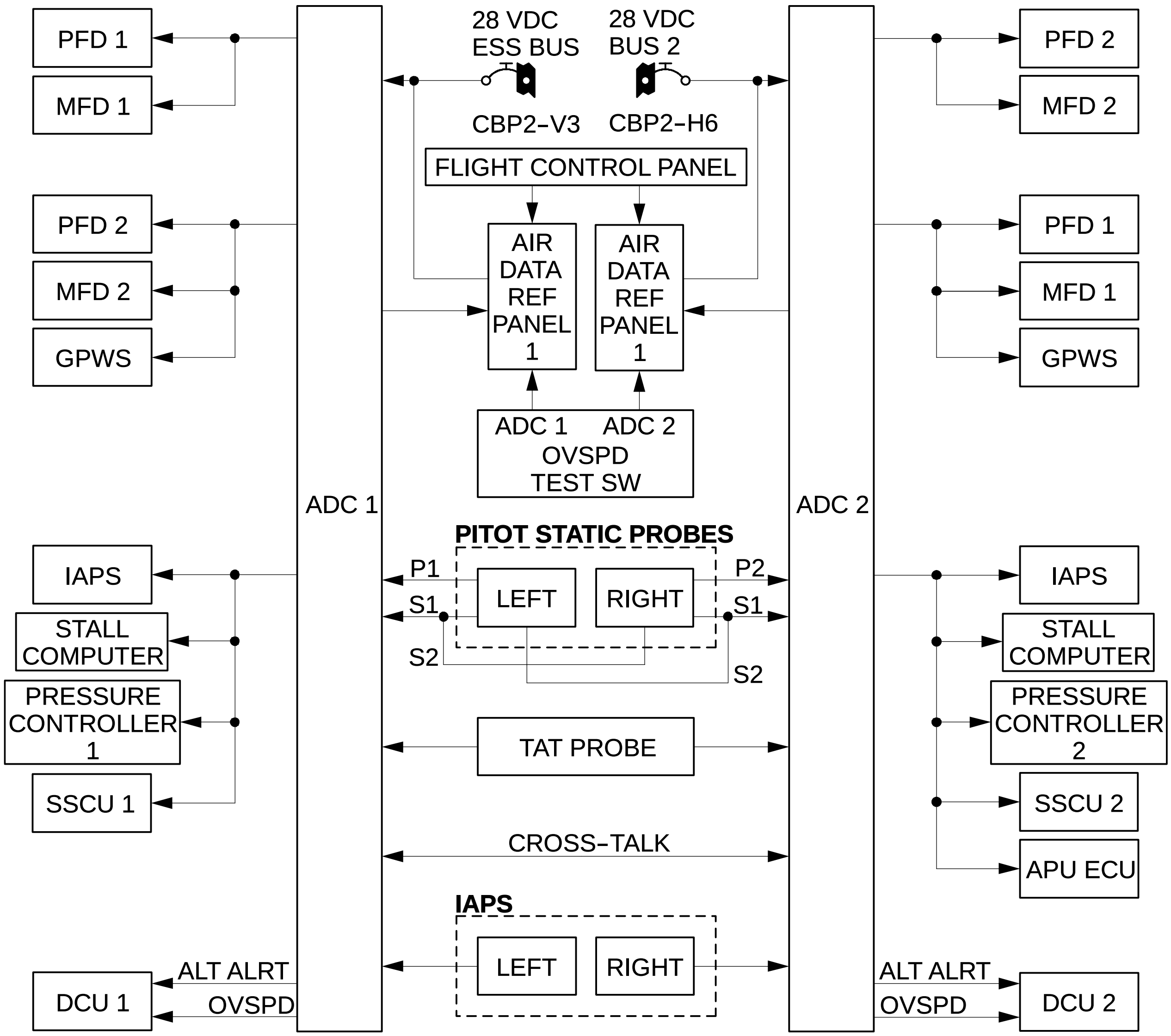
B. Air Data

The air data system provides the following air data parameters:

- Pressure altitude (corrected for static pressure errors)
- Vertical speed
- Calibrated and indicated airspeed (CAS / IAS)
- Mach number
- True airspeed
- Static air temperature (SAT)
- Total air temperature (TAT)
- Temperature variations from international standard atmosphere (ISA)

In addition to the above parameters, the air data system computes and controls the following reference values and parameters:

- Preselect altitude
- Airspeed trend vector
- Maximum allowable speed (V_{MO})
- Maximum allowable Mach (M_{MO})
- Baro corrected value
- Vertical speed references



Air Data System – Block Diagram
Figure 12–30–3

C. Air Data Reference Panels

The air data reference panels (ARP) are located on the pilot's and copilot's side panels. Each ARP is used to enable selection of airspeed reference pointers and barometric correction for altitude.

Each ARP functions with the same-side ADC, display control panel, primary flight display and multifunctional display. The ARP is divided into three sections:

- The speed references section is used to select and input changes to the various target and speed settings (V1, VR, V2 and VT). Both PFDs will display the same values.
- The altitude references section is used to set minimum descent altitude (MDA) and decision height (DH) values and to initiate radio altimeter self test.
- The barometric reference section is used to:
    - select and inputchanges to the ADC barometric pressure.
    - select indicating units (hPa or inHg).
    - set standard barometric pressure.
- Each PFD can have a different barometric pressure setting. The last value selected is retained in the ADC memory for the next power up.

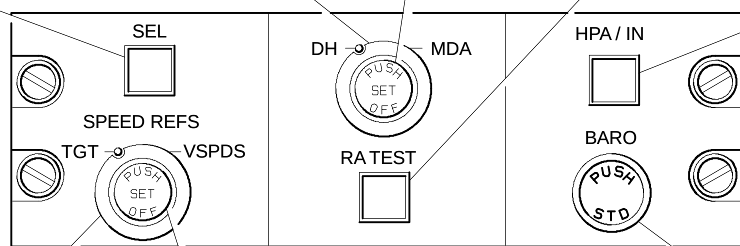
DH / MDA
Used to select decision height or minimum descent altitude.
- DH – Decision height readout is selected to be adjusted.
- MDA – Minimum descent altitude readout is selected to be adjusted.

PUSH / SET / OFF
Used to adjust selected altitude readout.
- When pushed, the selected altitude readout (DH or MDA) is displayed on the PFD.
- When rotated, the selected altitude readout is adjusted (DH in 1–ft. increments, MDA in 10–ft. increments).
- When pushed again, the selected altitude readout is removed.

SEL
Used to alternately select V1, VR or V2 to the edit field when VSPDS is selected.

RA TEST
Used to initiate radio altitude test.

HPA / IN
Used to alternately select the barometric pressure to be displayed in hectoPascals or inches of mercury.



Air Data Reference Panel
Pilot's and Copilot's
Side Panels

BARO
Used to adjust barometric pressure.
- When pushed, the barometric pressure is set to the standard value of 29.92 inHg or 1013 hPa.
- When rotated, the barometric pressure setting is adjusted.

TGT / VSPDS
Used to select target or V speeds.
- TGT – VT speed is selected to be displayed on the edit field.
- VSPDS – V1, VR and V2 speeds are selected to be displayed on the edit field. Alternate selection of V1, VR and V2 is made using SEL.

PUSH / SET / OFF
Used to adjusts the selected speed readout displayed on the edit field.
- When pushed, the selected speed readout is displayed.
- When rotated, the selected speed readout is adjusted.
- When pushed again, the selected speed readout is removed.

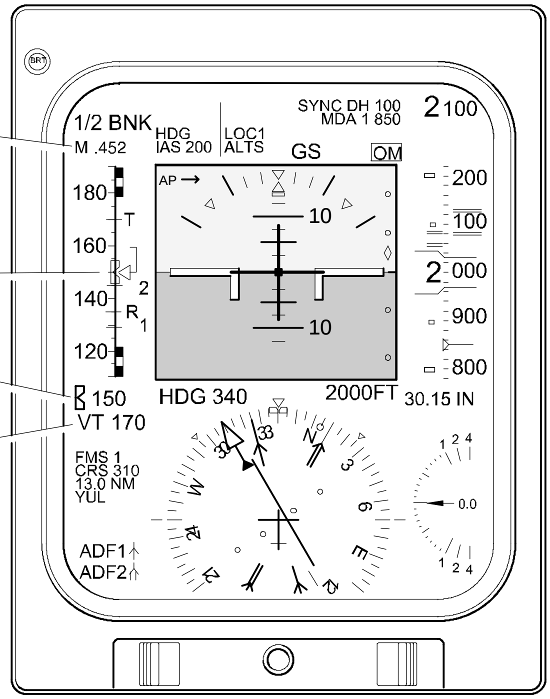
Air Data Reference Control Panel
Figure 12–30–4

Mach Readout (white)
Indicates Mach speed. Displayed when Mach is above 0.45 and is removed when Mach is below 0.40.

Airspeed Indicator

IAS /Mach Reference (magenta)
Indicates airspeed as selected using the speed knob on flight control panel.

Speed Reference (cyan)
Indicates reference speed as set by pilot using the speed reference knob on air data reference panel.



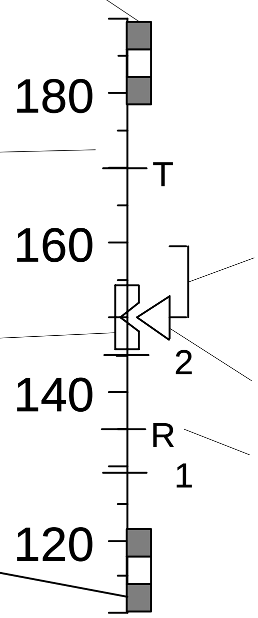
Primary Flight Display
Pilot's and Copilot's Instrument Panels

Overspeed Cue (red/black checkerboard)
Assends from Vmo/Mmo to top of tape window to indicate maximum speed allowable. If speed is more than 3 kts greater than Vmo or equivalent Mmo, overspeed clacker sounds. Warning continues until speed is 3 kts below Vmo/Mmo.

CLACKER TONE

Indicated Airspeed Tape (white)
Moving tape that indicates current airspeed. Tape range is 40 to 400 knots with a display of 80 knots.
- Marks at 5 knot increments.
- Digits at 20 knot increments.

IAS Bug (magenta)
Indicates airspeed reference marker as set by pilot using the speed knob on flight control panel.



Trend Vector (magenta)
Indicates predicated airspeed within next 10 seconds.

Indicated Airspeed Pointer (white)
Indicates current airspeed.

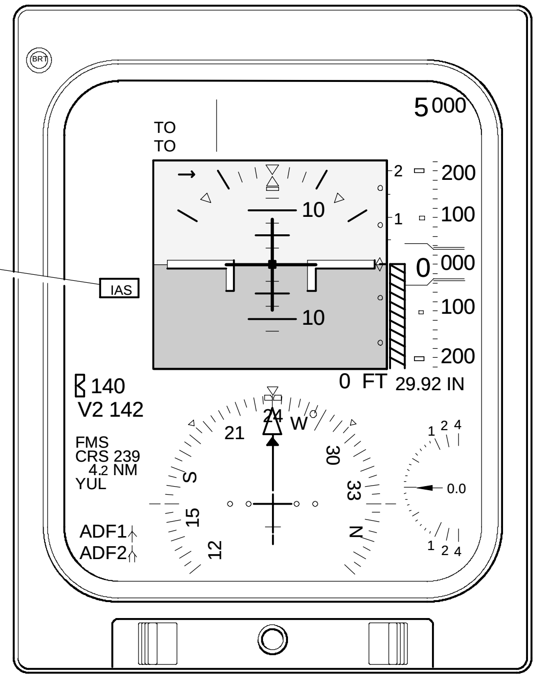
Speed Reference Bugs (cyan)
Removed 7.5 seconds after speed is exceeded (except target speed).
- 1 Takeoff decision speed (V1)
- R Rotate airspeed (VR)
- 2 Take–off safety speed (V2)
- T Target speed (VT)

Low Speed Cue (red/black checkerboard)
Descends from stick shaker speed to edge of tape window and acts as cue to impending stall speed. Displayed 3 seconds after lift–off. If AOA data fails, checkerboard stops at 100 kts. and is replaced by a yellow line up to 120 kts.

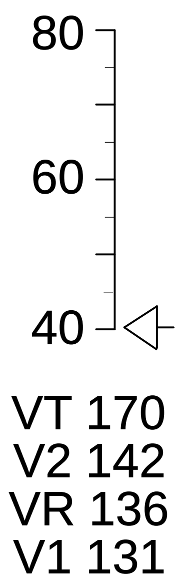
Airspeed Indicator

Indicated Airspeed and Mach Indications <1015>
Figure 12–30–5

IAS Flag (red)
Indicates that airspeed data has failed. Appears in place of airspeed tape.



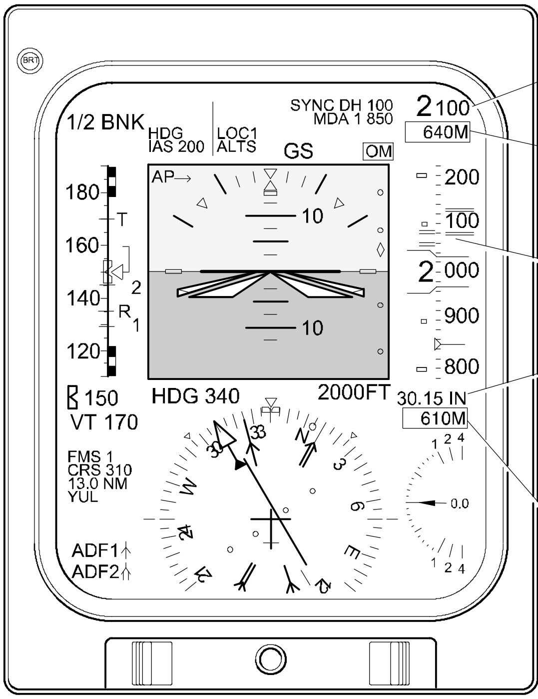
Primary Flight Display
Pilot's and Copilot's Instrument Panels



Speed Reference Table (cyan)
Displayed on ground only.
Indicates reference speeds as set using speed reference knob on the air data reference panel.

Airspeed Indicator

Indicated Airspeed Flag – Primary Flight Director <1015>
Figure 12–30–6



Preselected Altitude Readout (magenta)
Indicates preselected altitude to nearest 100 feet, as set using altitude knob on flight control panel.

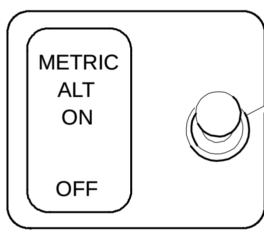
Metric Preselected Altitude Readout (magenta)
Indicates preselected altitude in meters. Displayed when metric altimeter is selected on.

Altitude Indicator

Barometric Pressure Setting Readout (cyan)
Indicates selected barometric pressure expressed in inches of mercury or hectoPascals, as set using barometric knob and on air data reference panel.

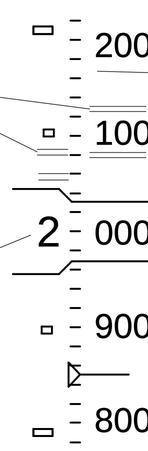
Metric Altitude Readout (white)
Indicates airplane altitude in meters. Displayed when metric altimeter is selected on.

Primary Flight Display
Pilot's and Copilot's Instrument Panels



METRIC ALT
- ON – Metric altitude readout and metric preselected altitude readout are displayed on PFDs.
- OFF – Metric altitude readout and metric preselected altitude readout go out.

Metric Altimeter Switch
Center Pedestal



Preselect Altitude Bug (magenta)
Lines at coarse and fine tape indicate preselected altitude as set using altitude knob on flight control panel.

Altitude Readout (white)
Indicates airplane barometric altitude.

Barometric Altitude Tape (white)
Moving tape with fixed window (digital readout) that indicates barometric altitude from –1,000 to 50,000 feet with a display of 450 feet.

Fine Tape
- Marks at 20 foot increments.
- Digits at 100 foot increments.

Coarse Tape
- Small rectangles at 500 foot increments.
- Large rectangles at 1000 foot increments.

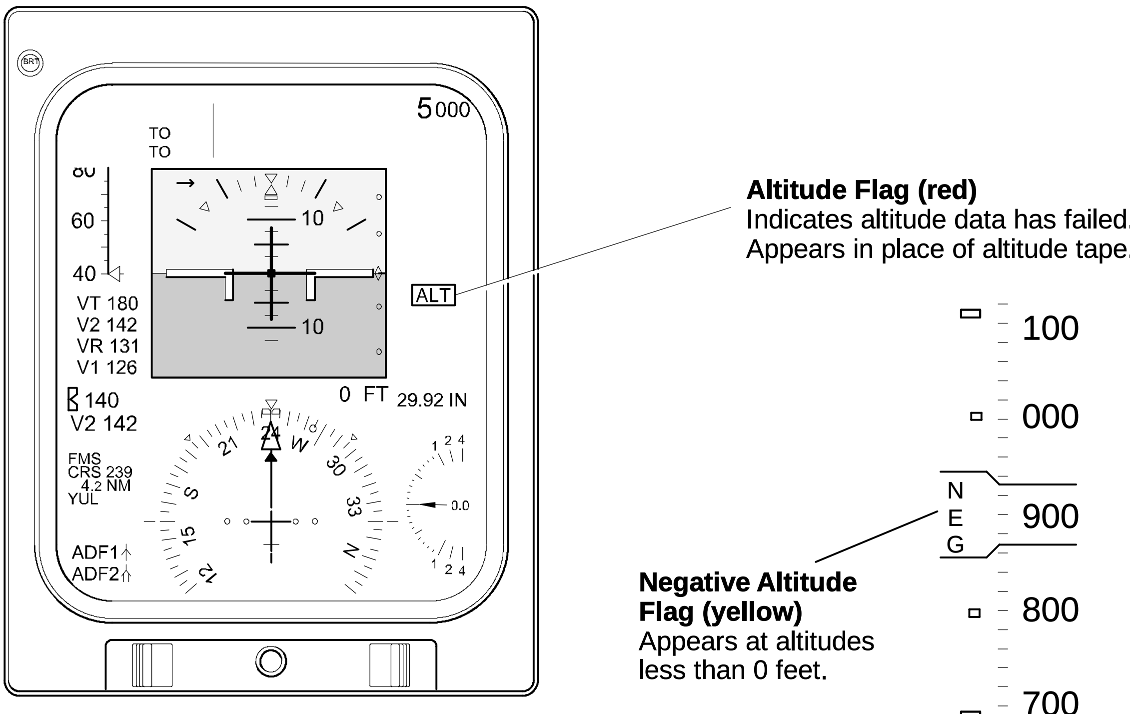
Altitude Indicator

Altitude Indications <1015,1029>
Figure 12–30–7

D. Altitude Alerts

The altitude alert system alerts the flight crew that a preselected altitude has been reached or a deviation from a preselected altitude has occurred. When the aircraft is cleared to change altitude, the preselected altitude is set on the PFD through the flight control panel (FCP). There are three types of alerts that can occur:

- Acquisition mode
- Cross side tracking
- Deviation mode



Primary Flight Display
Pilot's and Copilot's Instrument Panels

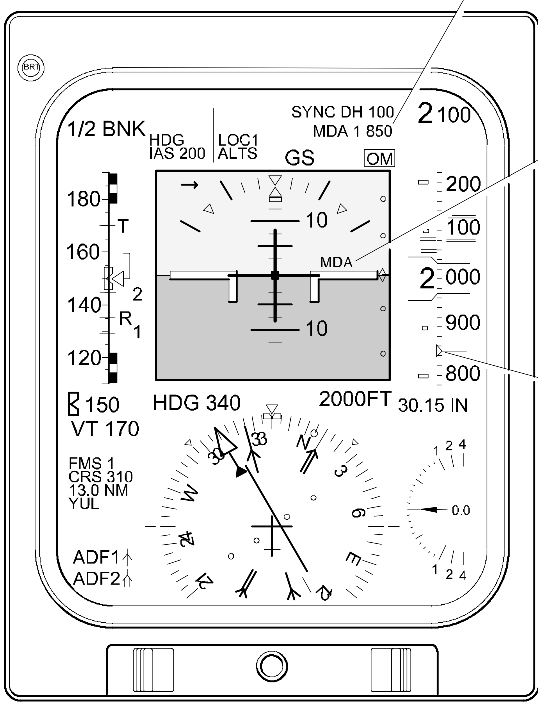
Altitude Indicator

Altitude Flag – PFD <1015>
Figure 12–30–8

Minimum Descent Altitude Readout (cyan)
Indicates MDA as set on the air data reference panel.

Minimum Descent Altitude Alert (amber)
Indicates that airplane has arrived at minimum descent altitude.

Minimum Descent Altitude Pointer (cyan)
Indicates MDA, as set on the air data reference panel.
- Disappears when out of range.
- Flashes during MDA alert.



Primary Flight Display
Pilot's and Copilot's Instrument Panels

Minimum Descent Altitude Indications <1015>
Figure 12–30–9

E. Acquisition Mode

Altitude alerts are inhibited in approach mode, when glideslope is captured and there are valid autopilot steering commands. The ADC will set a one second acquisition alert warning (altitude C-cord warning aural) and flash the preselected altitude readout when the present altitude is within ±1,000 feet of capturing the preselected altitude. The readout will stop flashing when the altitude is within ±200 feet of the preselected altitude. The alert can be cancelled by pressing the altitude knob on the flight control panel.

F. Cross Side Tracking

Each ADC compares the preselected altitude value from both computers for equality. If the values are not equal, the preselected altitude digits on the display change from magenta to cyan.

G. Deviation Mode

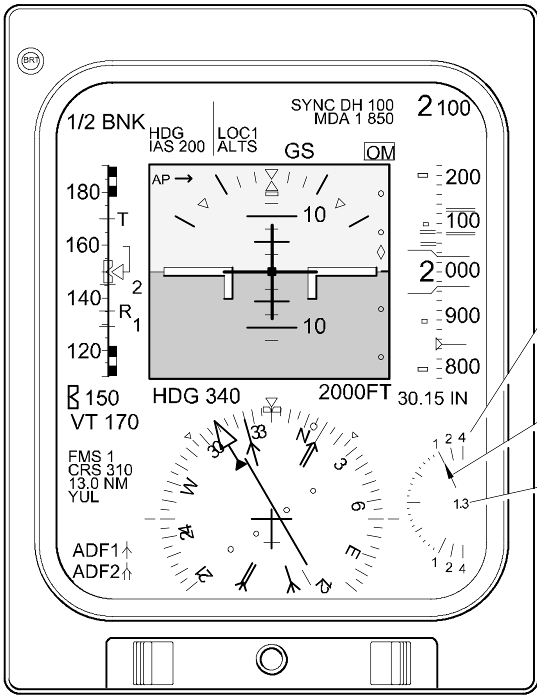
After the preselected altitude is captured, if the altitude deviates from the preselected altitude by more than ±200 feet, a deviation alert warning (aural “C” chord) will be set and the preselected altitude readout and bug will change from magenta to amber and begin to flash. The readout and bug will return to normal once the altitude is back within deviation limits. A deviation alert will also be made if the airplane has gone within the acquisition limits on an altitude capture but then deviates by more than 100 feet from the preselected altitude.

H. Low Speed Cue

The low speed cue provides an indication of the speed margin to stick shaker during normal low speed maneuvers and approaches to stall. The top of the low speed cue corresponds to the onset of the stick shaker.

NOTE

A high pitch rate at low airspeed may cause the stick shaker airspeed to be higher than that indicated at the top of the low speed cue. Respect the stick shaker warning to ensure adequate margin to full stall.



Vertical Speed Scale (white)
Non–linear scale of vertical speed between ± 4,000 feet per minute.

- Small ticks at ± 250 FPM.
- Large ticks at ± 500 FPM.
- Digits at ± 1,000, ± 2,000 and ± 4,000 FPM.

Vertical Speed Pointer (green)
Indicates vertical speed in feet per minute.

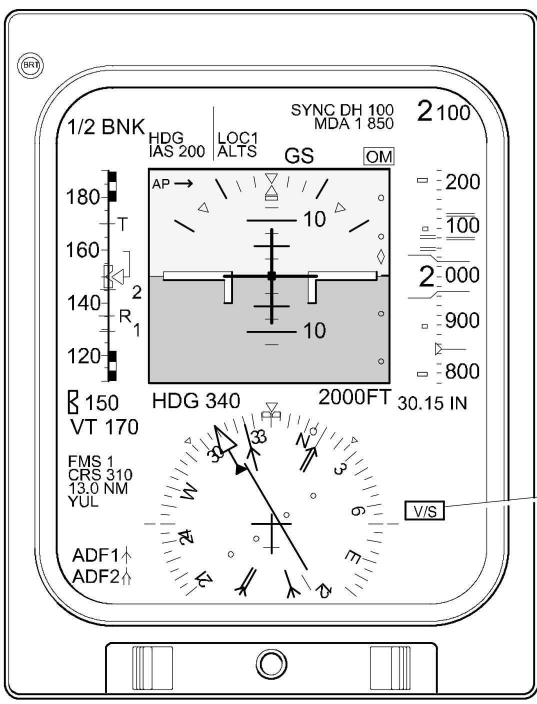
Vertical Speed Readout (green)
Indicates current vertical speed from 0 to 15,000 FPM.

- From 0 to 9,950 FPM, display is at 100 FPM.
- Above 9,950 FPM, display is at 1,000 FPM.
- If rate is greater than 10,000 FPM, decimal point disappears.

NOTE

Vertical speed pointer and readout turn red when a TCAS resolution advisory is issued and speed is not within corrective limits (refer to Chapter 18).

Primary Flight Display
Pilot's and Copilot's Instrument Panels



Vertical Speed Flag (red)
Indicates that vertical speed data has failed. Appears in place of vertical speed scale, pointer and readout.

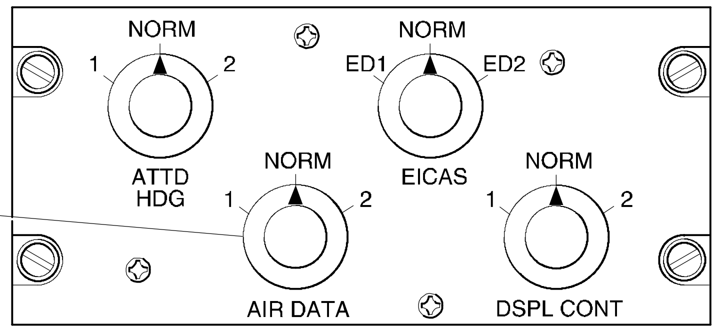
Primary Flight Display
Pilot's and Copilot's Instrument Panels

Vertical Speed Indication and Flag <1015>
Figure 12–30–10

I. Air Data Reversion

Normally, each ADC provides data to the same side PFD. If one ADC should fail, the other computer may be used to supply data to both PFDs. This is done by selecting the AIR DATA knob, to the 1 or 2 position, on the Source Selector Panel.

AIR DATA
- NORM – Each air data computer supplies data to the same side display.
- 1 – Air data computer 1 supplies data to both pilot and copilot displays. An amber source message is displayed on both PFDs.
- 2 – Air data computer 2 supplies data to both pilot and copilot displays. An amber source message is displayed on both PFDs.

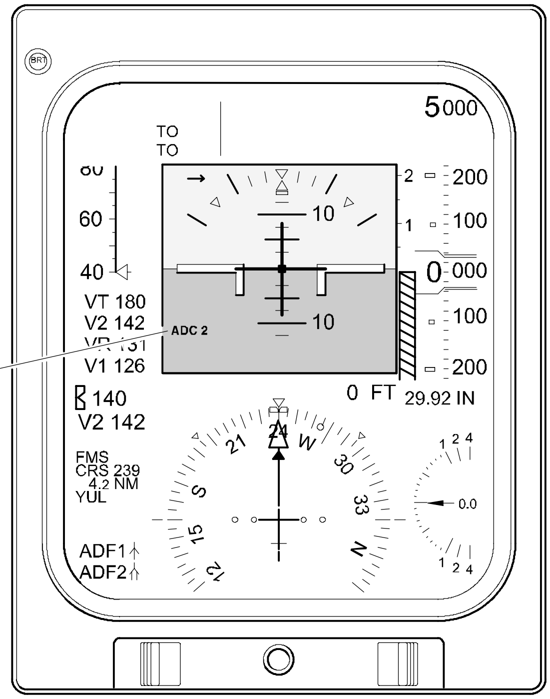


Source Selector Panel
Center Pedestal

Source Selector – Air Data Panel
Figure 12–30–11

ADC 1 or 2 (amber)
Indicates that single air data computer source has been selected.

- ADC 1 – Air data computer 1 selected.
- ADC 2 – Air data computer 2 selected.



Primary Flight Display
Pilot's and Copilot's Instrument Panels

Air Data Flags – Primary Flight Display <1015>
Figure 12–30–12

J. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Air Data	Computer	ADC 1	DC ESSENTIAL	2	V3	
		ADC 2	DC BUS 2		H6	

1. RADIO ALTIMETER SYSTEM

There are two radio altimeter (RAD ALT) systems installed on the aircraft. Each system provides an accurate measurement of absolute altitude (height above terrain) from –20 to 2500 feet AGL. Radio altitude information is supplied from both radio altimeters to the following: <1045>

- PFD's
- Spoiler and Stabilizer control units (SSCUs)
- Enhanced ground proximity warning system (EGPWS) <2040>
- Traffic alert and collision avoidance system(TCAS)

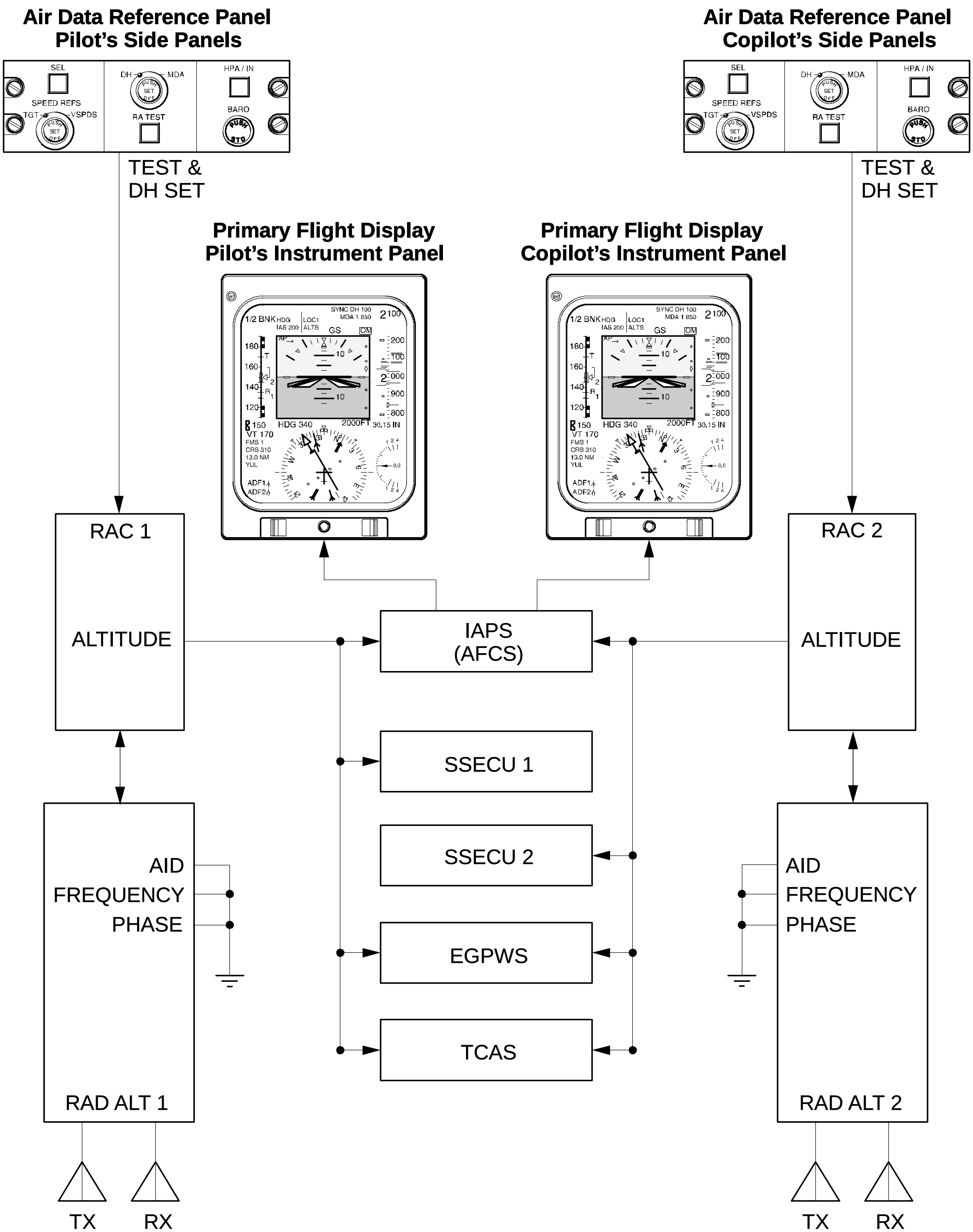
The radio altimeter provides the pilot's and copilot's PFDs with the following:

- Radio altitude readout
- Decision height readout
- Decision height alerts and radio altimeter fail flags

When a failure is detected during flight, a red warning flag is displayed on the PFDs

The radio altitude display is displayed as both a digital and a moving tape readout. The digital readout appears as the aircraft descends through 2,500 feet. The tape is an analog scale that is displayed when the airplane is below an altitude of 1,225 feet.

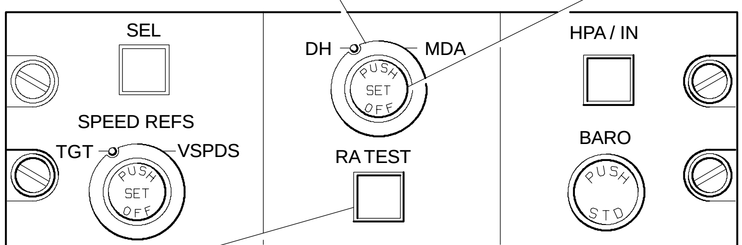
Decision height is set (from 0 to 999 feet) using either pilot's air data reference panel. A test button is provided on the air data reference panel to verify the operation of the radio altimeter system.



Radio Altimeter ISystem – Block Diagram <1045>
Figure 12–40–1

DH / MDA
Used to select decision height or minimum descent altitude.
- DH – Decision height readout is selected to be adjusted.
- MDA – Minimum descent altitude readout is selected to be adjusted.

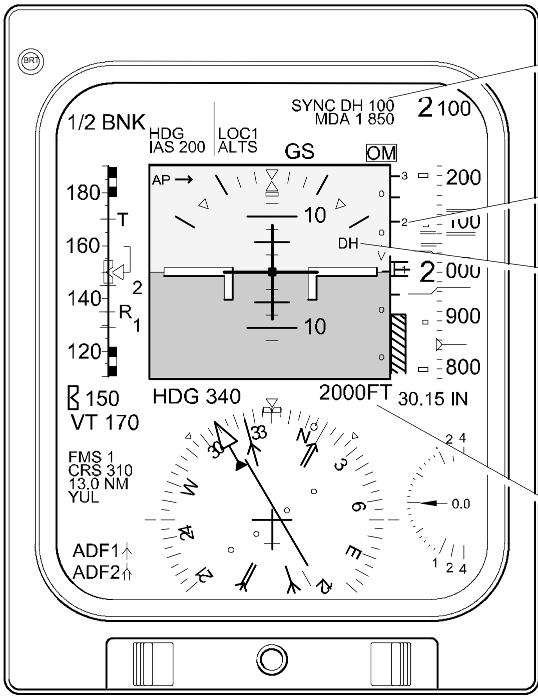
PUSH / SET / OFF
Used to adjusts selected altitude readout.
- When pushed, the selected altitude readout (DH or MDA) is displayed on the PFD.
- When rotated, the selected altitude readout is adjusted (DH in 1 ft increments, MDA in 10 ft increments).
- When pushed again, the selected altitude readout is removed.



RA TEST
Used to initiate radio altitude test.

Air Data Reference Panel
Pilot's and Copilot's Side Panels

Air Data Reference Control Panel
Figure 12–40–2

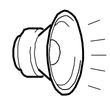


Primary Flight Display
Pilot's and Copilot's Instrument Panels

Decision Height Readout (cyan)
Indicates selected decision height as set on the air data reference panel (range is 0 to 999 feet).
- Red dashes indicate failed input.

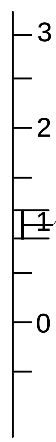
Radio Altimeter
Indicates current radio altitude.
- Displayed upon descent below 1,225 feet RA.

Decision Height Alert (amber)
Indicates that airplane has arrived at decision height.
- During go–around, alert is disabled at decision height +100 feet.
- Alerts inhibited below 5 feet.



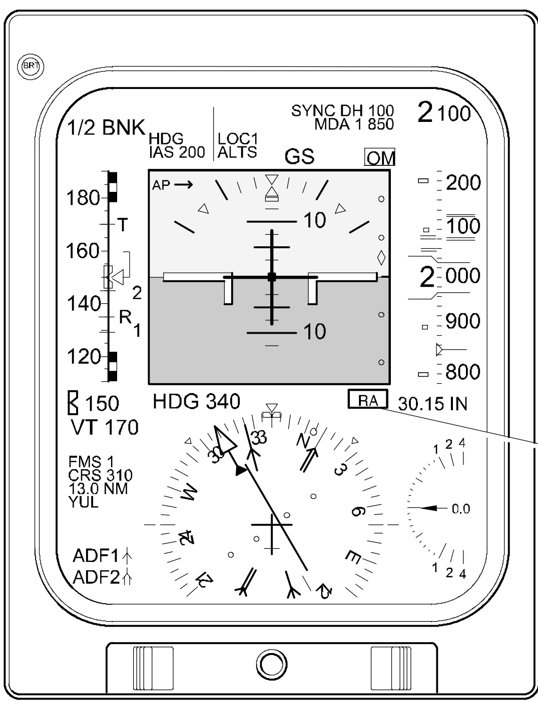
DECISION HEIGHT

Radio Altitude Readout (green)
Indicates radio altitude from 0 to 2,500 feet.
At decision height, readout turns amber.
- Displayed upon descent below 2,500 feet RA.



Decision Height Pointer (cyan)
Indicates selected decision height as set on the air data reference panel.
- Disappears when out of range.

Radio Altimeter



RA Flag (red)
Indicates that radio altitude data has failed.
Appears in place of radio altitude readout.

Primary Flight Display
Pilot's and Copilot's Instrument Panels

Radio Altimeter Indication <1015,JAA>
Figure 12–40–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Radio Altimeter	Altimeter	RAD ALT 1	DC BUS 1	1	J4	
		RAD ALT 2	DC BUS 2	2	J2	<1045>

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2. INERTIAL REFERENCE SYSTEM <1025>

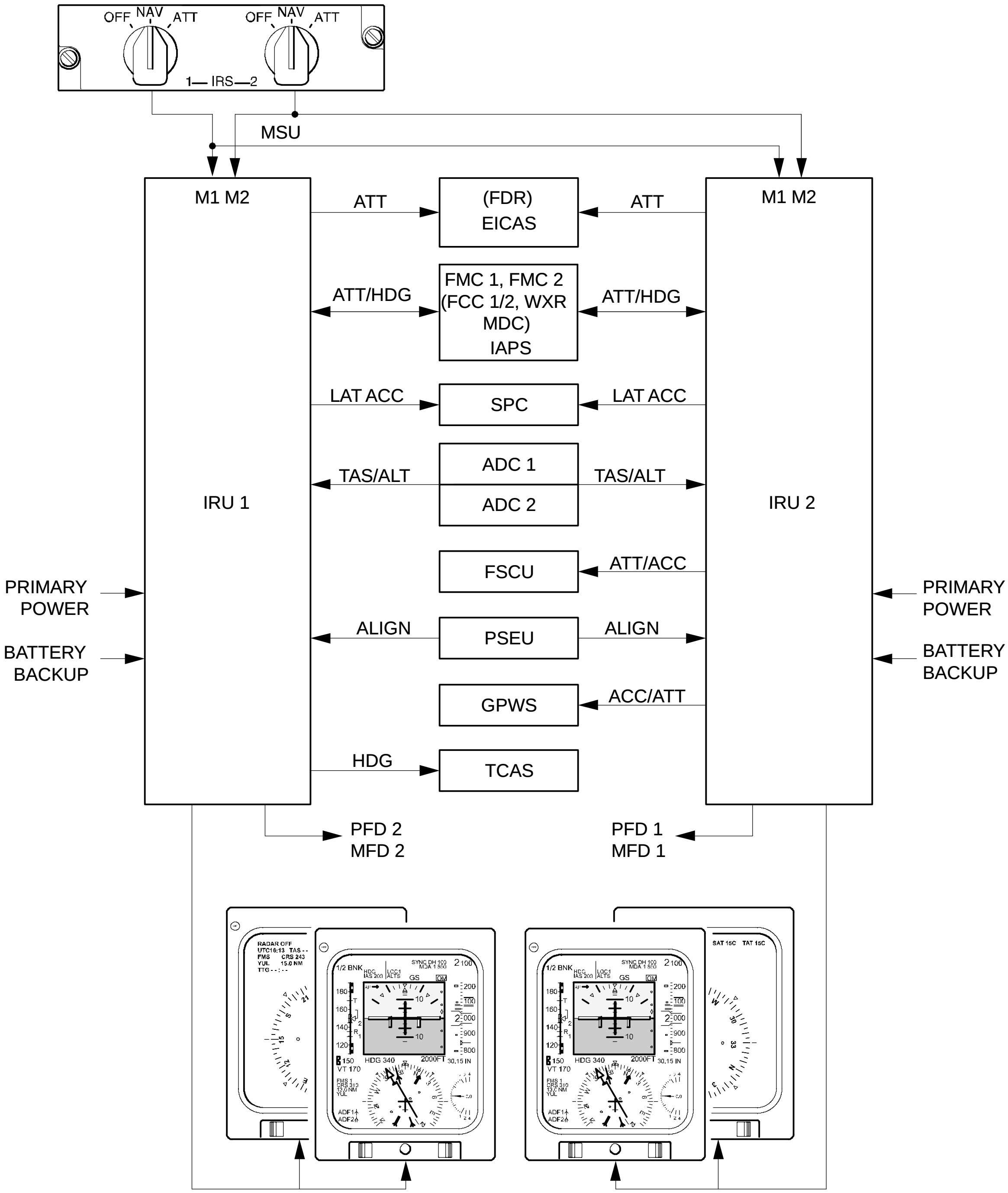
The inertial reference system (IRS) provides inertial outputs of attitude, heading, angular rates, linear acceleration and present position to be displayed on the flight displays and to be used by other avionics systems.

The IRS is a dual system with two inertial reference units (IRU) and a dual mode select unit (MSU). Each IRU receives information from the same side air data system. The IRU measures inertial motion sensed by the inertial instruments and computes attitude and heading data. This information is processed and sent to the integrated avionics processor system which interfaces with the flight control computers and flight management computers. These signals are also routed to the TCAS, EGPWS, fuel system, stall protection system, flight data recorder and data concentrator units. The MSU provides pilot selection of the IRS modes.

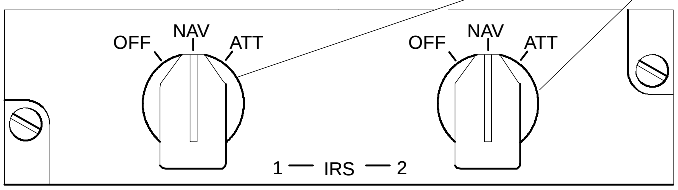
The IRS provides attitude and heading information to the electronic flight instruments. Attitude is displayed on the attitude direction indicator (ADI) of the primary flight displays and heading is displayed on the horizontal situation indicator (HSI) portions of the displays. Heading is selected to magnetic or true using the flight management system (refer to Chapter 18).

The IRS normally operates in navigation mode. In navigation mode, it is not possible to update the IRS position, however, it is possible to perform a rapid realignment while on the ground.

Attitude mode is a reversionary mode, used when the IRU has detected an inertial failure or inaccuracies of the navigation operation in flight. Attitude mode does not provide position data. In attitude mode, the heading may drift and must be corrected using the flight management system (FMS). If the FMS is not available, the EICAS control panel can be used to make heading corrections. Attitude mode is annunciated on the EICAS status page.



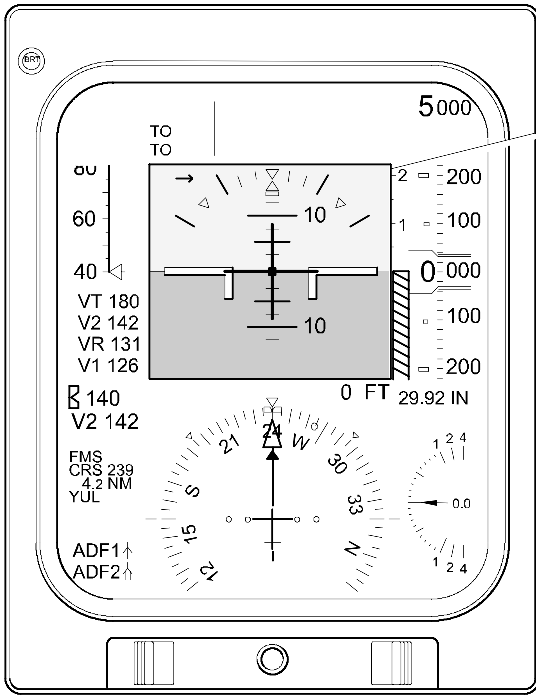
Inertial Reference System Interface <1015,1025>
Figure 12–50–1



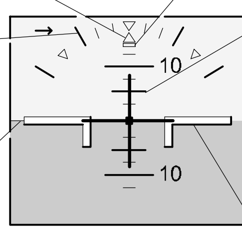
1 – IRS – 2
Used to select IRS mode.
- OFF – Removes power from IRS.
- NAV – IRS operates in navigation mode.
- ATT – IRS operates in attitude mode.

IRS Mode Select Unit
Center Pedestal

Inertial Reference System Mode Select Control Panel <1025>
Figure 12–50–2



Primary Flight Display
Pilot’s and Copilot’s Instrument Panels

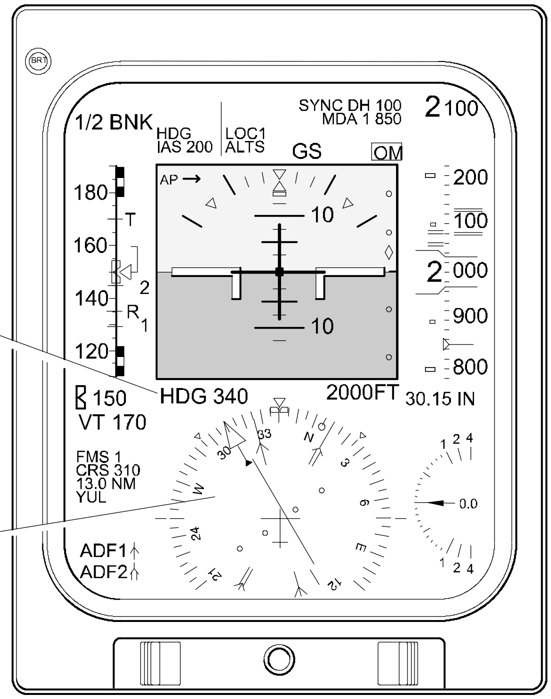


Attitude Director Indicator

Attitude Director Indicator <1015>
Figure 12–50–3

Selected Heading Readout (magenta)
Indicates selected heading as set using heading knob on flight control panel. Removed 5 seconds after heading is selected.

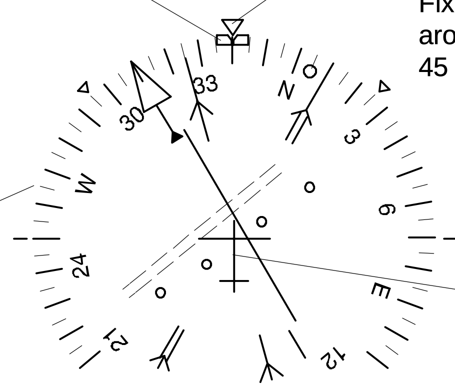
Horizontal Situation Indicator



Primary Flight Display
Pilot's and Copilot's Instrument Panels

Selected Heading Bug (magenta)
Indicates selected heading as set using heading knob on flight control panel. When bug is off scale, a dashed line is displayed from center of compass to selected heading.

Lubber Line (white)
Fixed reference for reading current airplane heading. Fixed index marks are located around compass rose at 45 degree increments.



Compass Rose (white)
Rotating card indicates airplane current magnetic heading under fixed lubber line.
- Small marks at 5 degree increments.
- Larger marks at 10 degree increments.
- Digits and cardinal points at 30 degree increments.

Airplane Symbol (white)
Indicates center of compass rose.

Horizontal Situation Indicator

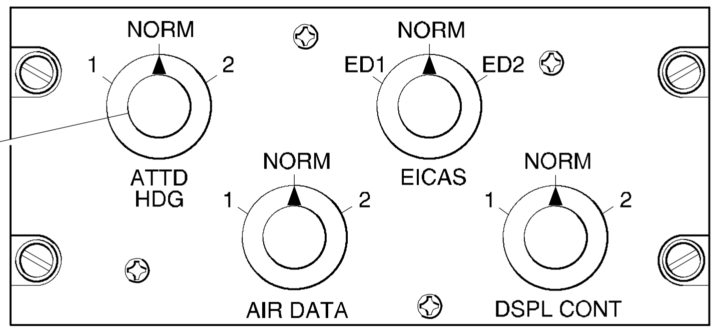
Selected Heading Readout <1015>
Figure 12–50–4

A. Display Reversion

Display capability is maintained when sensor data failure occurs. Either PFD (or MFD when in PFD format) can be configured to display data from either inertial reference system by operation of the ATT HDG knob on the source selector panel. Selection of alternate data sources is indicated to the flight crew by a yellow single source flag on the PFD and MFD.

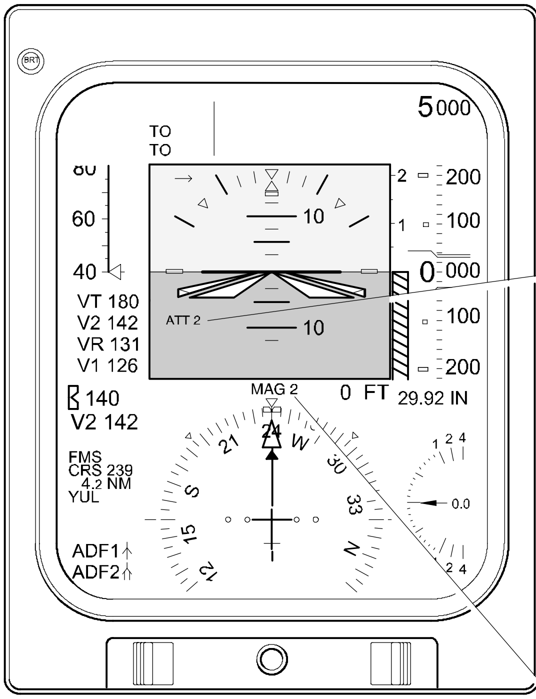
ATTD HDG

- NORM – Each inertial reference unit supplies data to the same side display.
- 1 – Inertial reference unit 1 supplies data to both pilot and copilot displays. An amber source message is displayed on both PFDs.
- 2 – Inertial reference unit 2 supplies data to both pilot and copilot displays. An amber source message is displayed on both PFDs.



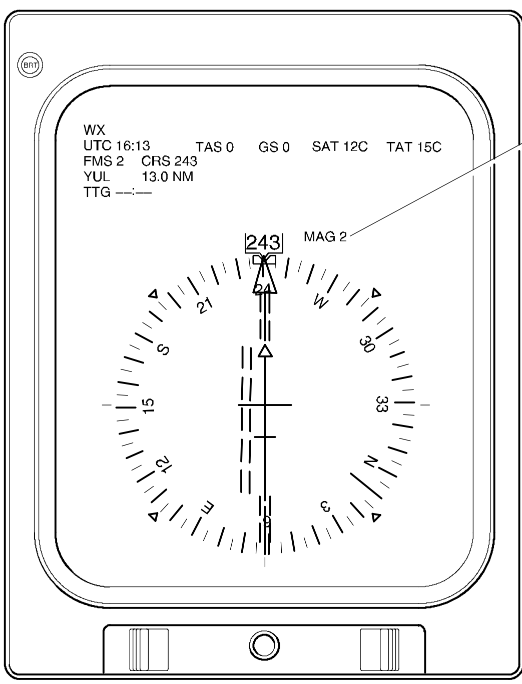
Source Selector Panel
Center Pedestal

Source Selector Panel <1025>
Figure 12–50–5



Primary Flight Display
Pilot's and Copilot's Instrument Panels

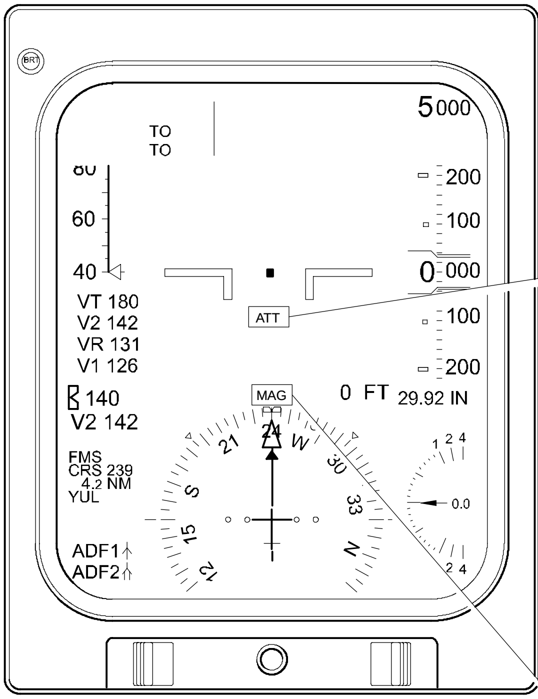
ATT 1 or 2 (amber)
Indicates that single inertial reference source has been selected.
- ATT 1 - Inertial reference unit 1 selected.
- ATT 2 - Inertial reference unit 2 selected



Multifunction Display - HSI Mode
Pilot's and Copilot's Instrument Panels

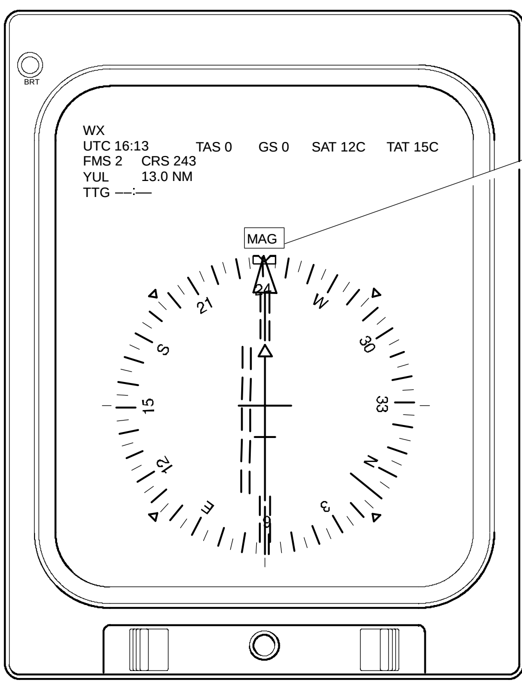
MAG 1, MAG 2, TRU 1 or TRU 2 (amber)
Indicates heading selection when a single Inertial reference source has been selected.

Attitude and Heading Source Selection <1015, 1025>
Figure 12-50-6



Primary Flight Display
Pilot's and Copilot's Instrument Panels

ATT Flag (red)
Indicates that onside or both inertial reference systems have failed.



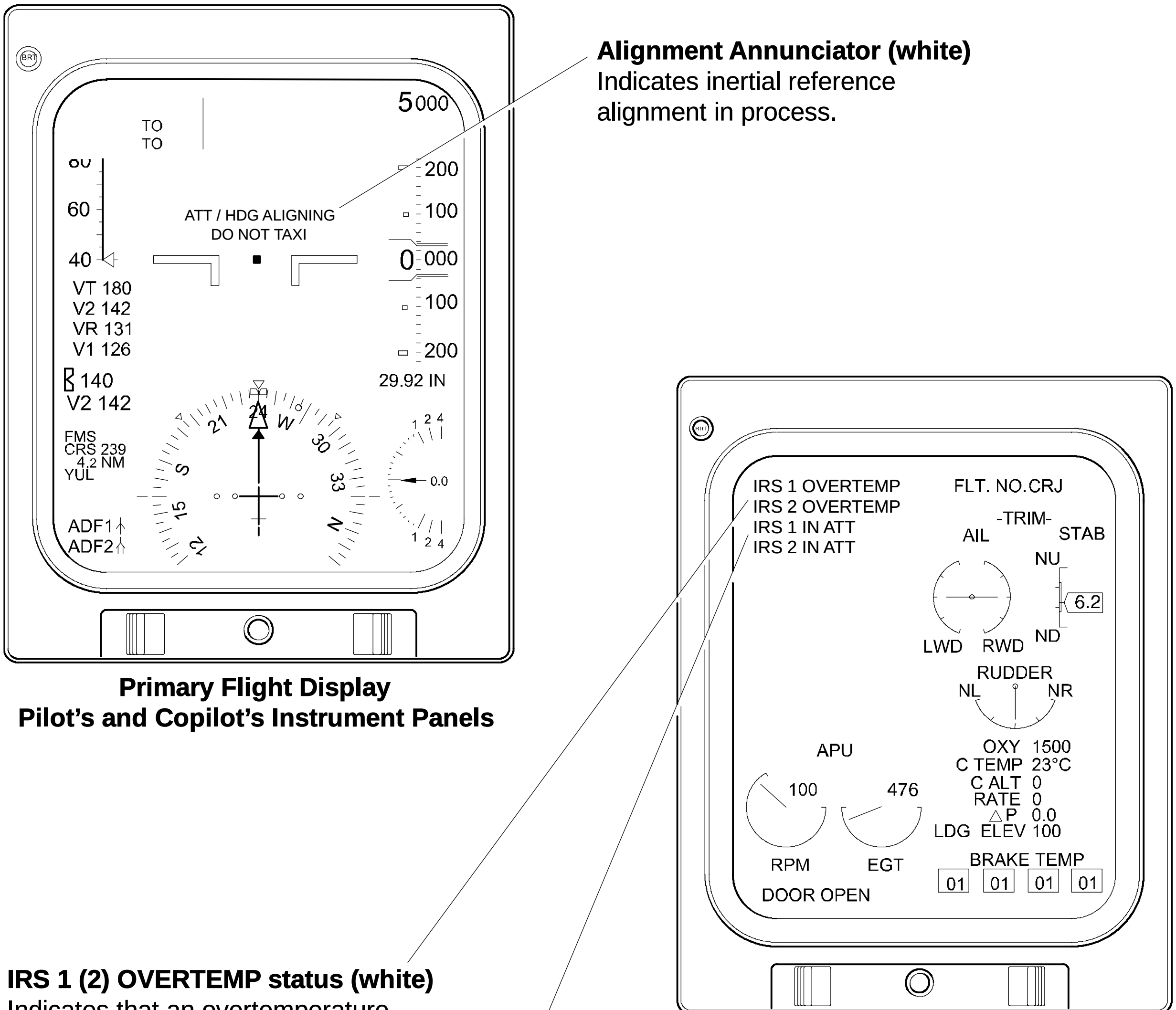
Multifunction Display – HSI Mode
Pilot's and Copilot's Instrument Panels

MAG or TRU Flag (red)
Indicates that onside or both inertial reference systems are faulty or out of tolerance.

Attitude/Heading Source Failure Indications <1015,1025>
Figure 12–50–7

B. Initialization and Alignment

IRS initialization takes about 7 minutes at normal temperature. The IRS requires that the initial position be entered using the flight management system. The primary flight displays present a flashing initialization alignment message during initialization. Upon successful alignment, the IRS will automatically sequence into navigation mode. Attitude alignment takes 1 minute or 34 seconds when switching from navigation to attitude mode, provided the airplane is stationary on the ground or in straight and level flight. <1025>



Alignment Annunciator (white)
Indicates inertial reference alignment in process.

Primary Flight Display
Pilot's and Copilot's Instrument Panels

IRS 1 (2) OVERTEMP status (white)
Indicates that an overtemperature condition exists.

IRS 1 (2) IN ATT status (white)
Indicates that IRS is operating in attitude mode.

Status Page

Attitude/Heading Source Alignment Indication <1015,1025>
Figure 12–50–8

C. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Inertial Reference System	Attitude Heading	ATT HDG 1	DC ESSENTIAL	2	V8	
		ATT HDG 2	DC BUS 2		K4	
	IRS Fan	IRU FAN	AC BUS 2		C12	<1025>

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1. STANDBY INSTRUMENTS AND CLOCKS

An integrated standby instrument is located between the EICAS displays on the center instrument panel. A standby compass is located below the center of the overhead instrument panel. A clock is installed on both the pilot and copilot side panels.

A. Integrated Standby Instrument

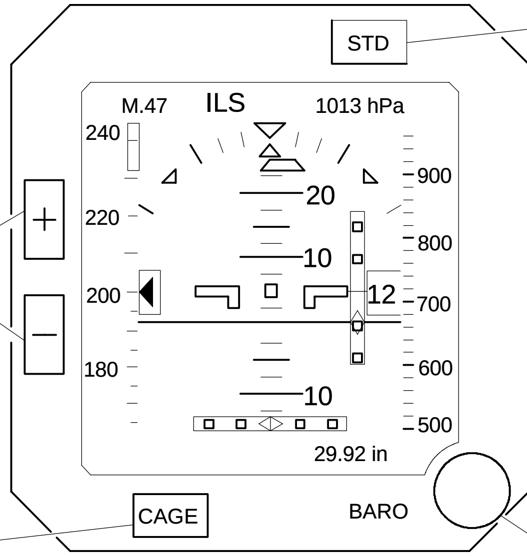
The integrated standby instrument (ISI) provides standby attitude, altitude and airspeed information to the flight crew. To retain full operational capability under emergency conditions the ISI is powered by the battery bus. The ISI uses inputs from the alternate pitot probe and static ports.

The ISI displays the following information:

- Attitude display
- ILS deviation
- Altitude display (corrected)
- VMO display
- Airspeed display
- Static source error correction (SSEC)
- Mach number
- Barometric pressure
- Slip-skid indication

STD
Used to select either standard pressure reference, 1013 hPa (29.92 inHg), or baro–correction pressure reference.

Brightness Controls



CAGE
Used to reset horizon line.Use only during stabilized level flight. Will not operate during power up.

BARO
Used to adjust baro–correction pressure reference.
Setting stored in non–volatile memory to prevent loss during power failure.

Integrated Standby Instrument
Center Instrument Panel

Integrated Standby Instrument
Figure 12–60–1

MACH Number
Displayed when above 0.45 and removed when drops below 0.40.

Roll Scale
Graduations every 5 degrees.

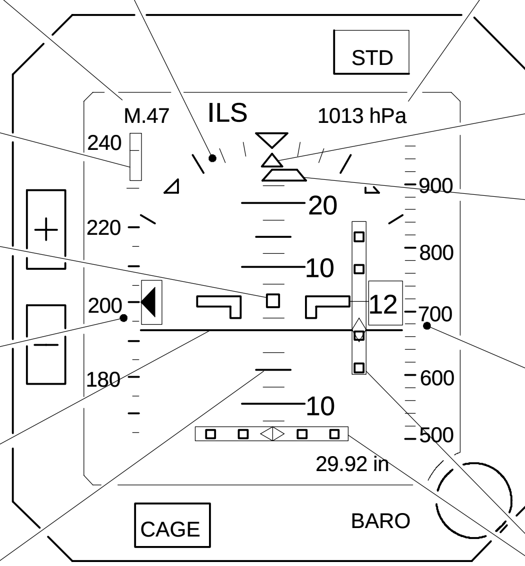
Selected Standard or Baro-corrected Pressure
Pressure displayed above (hPa) and below (inHg) altitude tape.

VMO Band (red)
From Vmo value upwards.

Roll/Sky Pointer

Slip/Skid Indicator
White trapezoid slides left or right depending on lateral acceleration.

Fixed Cross-Pointer



IAS Tape
Range 40 - 520 Kts.
Graduations every 5 Kt.

Altitude Tape
Tape reads hundreds with graduations every 20 feet. Box contains thousands.

Horizon Line

Integrated Standby Instrument
Center Instrument Panel

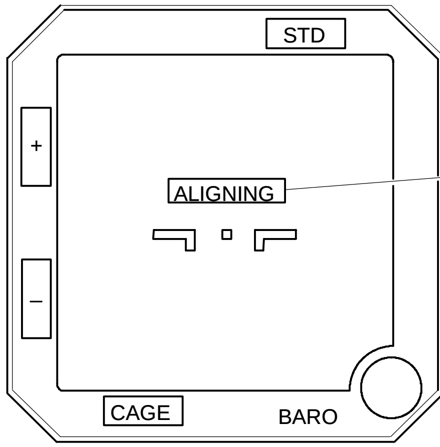
Pitch Scale
Graduations every 2.5 degrees.

ILS Symbols
- **Localizer**
  Green diamond with vertical line on horizontal scale with square deviation dots.
- **Glideslope**
  Displays green diamond on vertical scale with square deviation dots.

NOTE

ILS information is removed when the ILS receiver is not tuned to an ILS frequency.

Integrated Standby Instrument Scales
Figure 12–60–2



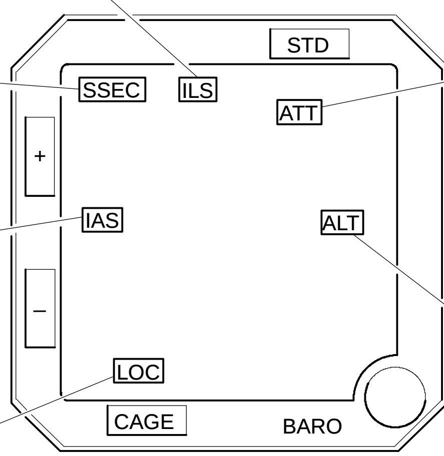
ALIGNING Flag
Displayed during power–up and initialization.

Standby Instrument
Center Instrument Panel

ILS Flag (red)
Displayed when both localizer and glideslope functions fail. Localizer and glideslope scales and pointers are removed.

SSEC Flag (yellow)
Displayed when static source error correction cannot be computed.

ATT Flag (red)
Displayed when an attitude failure is detected.
Blue and brown background, pitch and roll scales and roll/sky pointer are removed.



IAS Flag (red)
Displayed when airspeed cannot be computed or displayed. Airspeed tape and pointer are removed.

ALT Flag (red)
Displayed when a computation or display malfunction is detected. Altitude scale is removed.

G/S Flag (red) G/S
or
LOC Flag (red)
Displayed when a glideslope or localizer failure is detected. Corresponding glideslope or localizer scale and pointer are removed.

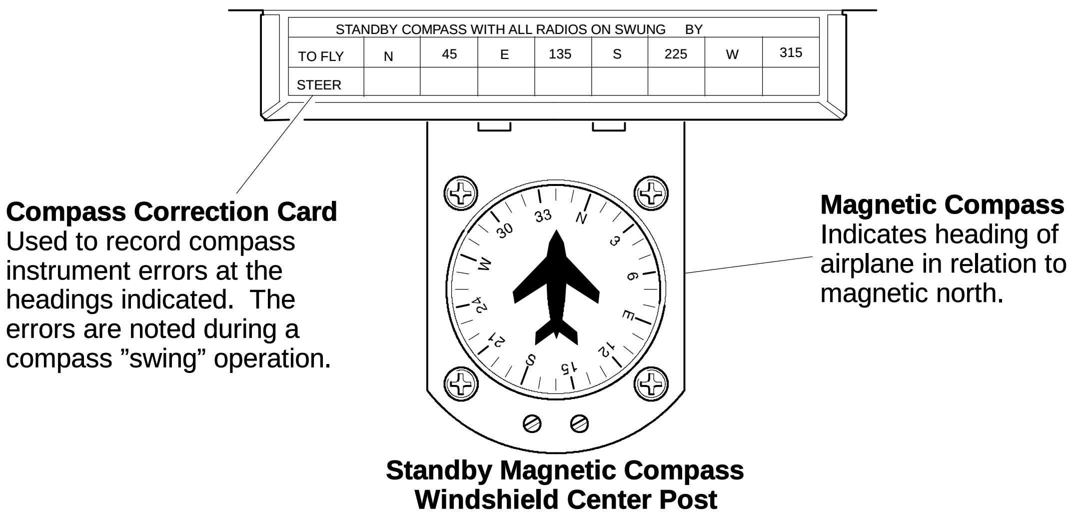
Standby Instrument
Center Instrument Panel

Integrated Standby Instrument Flags
Figure 12–60–3

B. Standby Compass

The standby compass is independent and does not interface with other systems. It is a self contained dry compass which uses eddy current damping to prevent overshooting. A miniature aircraft pointer indicates aircraft heading in relation to magnetic north on a rotating vertical compass card.

A compass correction card, mounted above the instrument, is used to record the values that must be added to or subtracted from the compass indications to correct for the influence of magnetic materials contained in the aircraft and magnetic fields from the avionics systems near the compass. The compass can be illuminated by operating the standby compass switch on the miscellaneous lights panel.



Standby Magnetic Compass
Figure 12–60–4

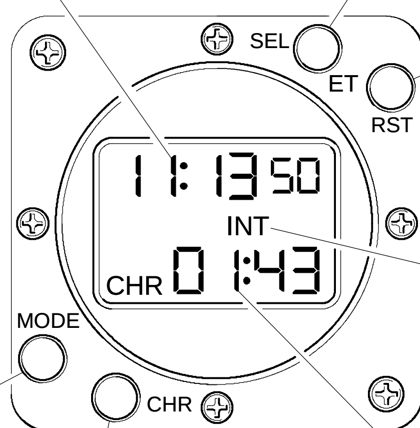
C. Clocks

A digital electronic clock is installed on the pilot and copilot side panels. The clocks have the capability of being synchronized with the Global Positioning System (GPS). Each clock is capable of displaying date (GPS or internal Universal Time Coordinated (UTC), current time (GPS, internal UTC, or local), chronometer (CHR), as well as elapsed time (ET) functions. The clocks are synchronized to the GPS input as soon as valid GPS information is received. In the case of invalid GPS data or signal loss, the clocks will operate in internal (INT) mode using the integrated time base of each clock. If there is a valid GPS signal, the clocks do not need to be set, as this will be done automatically at power up. The flight crew can disable the the GPS signal by entering the time setting mode. The clocks will then ignore the GPS signal until the next primary power reset. The MODE, ET SEL and ET RST buttons are used to set the time and date. To set the clock, push the MODE button for two seconds, then push the MODE button again to toggle between UTC hours and minutes (when the INT is lit), year, month, and day, (when the DT is lit), and local time hours and minutes (when the LT is lit). In any of these modes, the ET SEL button is used to decrease the data and the ET RST button is used to increase the data. Data changes are in increments of one digit for each press of the ET SEL or ET RST button. At any time during the time setting process, pressing the MODE button for a minimum of two seconds will exit the time setting mode and restart the clock operation.

ET SEL
Used to select the elapsed time function when the chronometer function is active.
Also used to decrease the data in one digit increments during manual setting of the clock.

Time/Date Display
Displays GPS time, internal UTC time, local time or date.
- Time is displayed in hours, minutes, and seconds (HH:MMss)
- DATE is displayed as Day/Month/Year.

ET RST
Used to reset the elapsed time function when the airplane is on the ground.
Also used to increase the data in one digit increments during manual setting of the clock.



Mode annunciator
Indicates the present mode of operation.
- DT – date
- GPS – GPS synchronization enabled
- INT – internal time/ date operation (GPS disabled).
- LT – local time

MODE
Used to select the mode of operation (DT, GPS, INT, LT) and also used in conjunction with ET SEL and ET RST buttons to set UTC time, date, and local time.

ET/CHR Display
Displays elapsed time or chronometer time.

CHR
Used to start, stop and reset the chronometer display. Overrides existing elapsed time display.

NOTE
ET time corresponds to airplane flight time and starts when the airplane takes off and stops at touch down. ET can only be reset on ground.

Effectivity:
- *Airplanes 15016 and subsequent.*

Clock Display with GPS Synchronization
Figure 12–60–5

D. System Circuit Breakers

<table>
<tr><th>SYSTEM</th><th>SUB–SYSTEM</th><th>CB NAME</th><th>BUS BAR</th><th>CB PANEL</th><th>CB LOCATION</th><th>NOTES</th></tr>
<tr><td rowspan="5">Standby Instruments and Clocks</td><td rowspan="2">Integrated Standby Instrument</td><td rowspan="2">INT STBY INST</td><td rowspan="3">BATTERY BUS</td><td rowspan="3">2</td><td rowspan="2">N10</td><td rowspan="2"></td></tr>
<tr></tr>
<tr><td rowspan="3">Clocks</td><td rowspan="2">CLOCK 1 (PILOTS)</td><td>N11</td><td rowspan="2"></td></tr>
<tr><td rowspan="2">MAIN BATTERY DIRECT BUS</td><td rowspan="2">6</td><td>B7</td></tr>
<tr><td rowspan="2">CLOCK 2 (COPILOTS)</td><td>B8</td><td></td></tr>
<tr><td></td><td></td><td>DC BUS 2</td><td>2</td><td>H5</td><td></td></tr>
</table>

CHAPTER 13 – FUEL SYSTEM

LIST OF ILLUSTRATIONS

FUEL DISTRIBUTION

REFUELING AND DEFUELING

FUEL QUANTITY GAUGING

1. INTRODUCTION

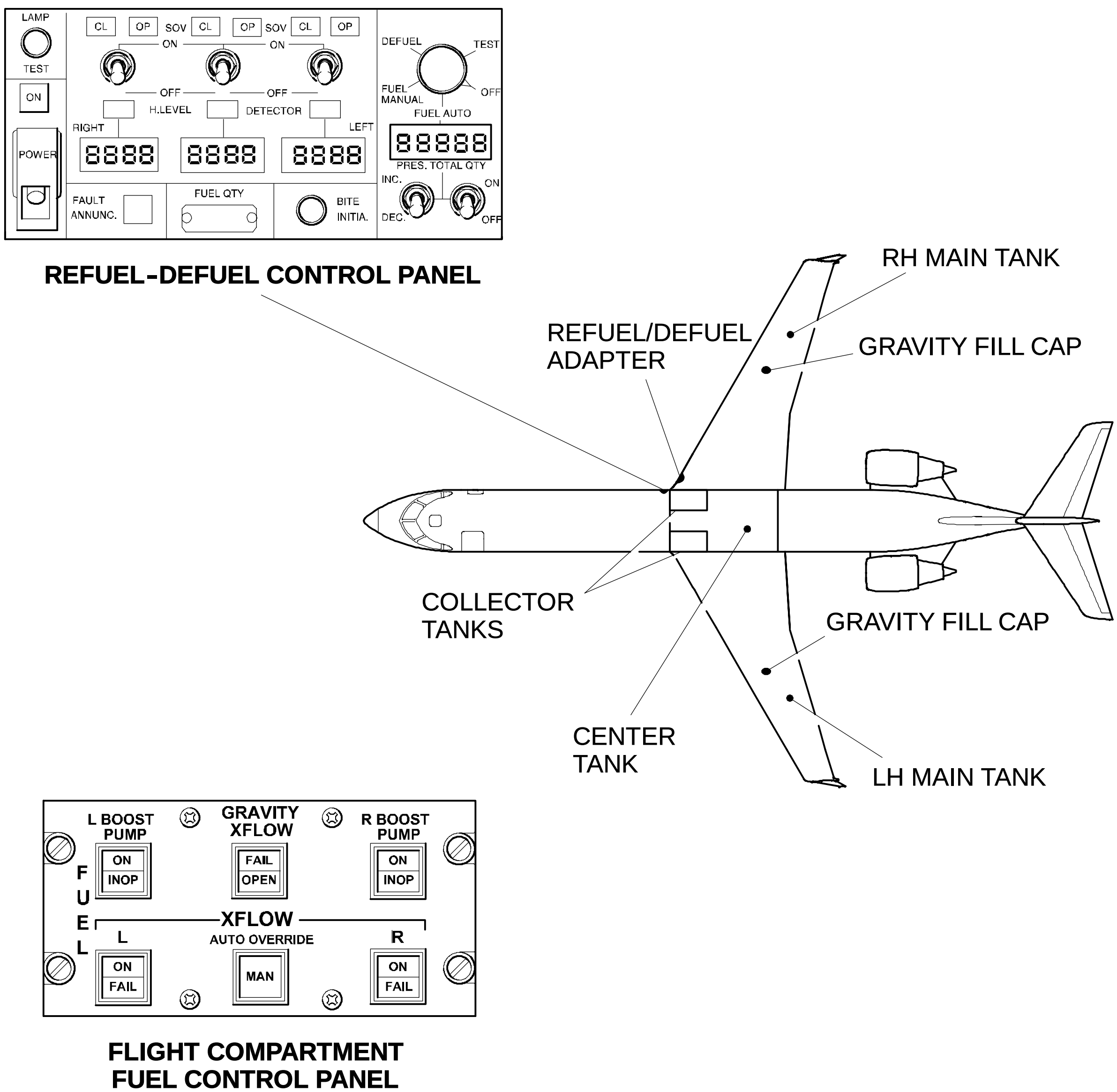
The fuel system consists of three integral tanks within the wing box structure. Ejectors and electrical boost pumps supply fuel to each engine. An independent system provides fuel to the auxiliary power unit (APU). The fuel system also provides facilities for pressure refueling/defueling and gravity refueling/defueling. Power and gravity crossflow systems allow fuel transfer between wing tanks.

A fuel quantity gauging computer (FQGC) automatically controls refueling, powered fuel crossflow and fuel transfer. The FQGC also measures the fuel quantity and temperature for display on the EICAS.

The engine indication and crew alerting system (EICAS) shows a diagram of the fuel distribution system. The operation of the ejectors, pumps and shut off valves are graphically indicated and the resulting fuel flow is depicted. Any fault detected by the fuel quantity gauging computer is annunciated in the form of a visual message.

A. Fuel Tank Quantities

LOCATION	USABLE FUEL	UNUSABLE FUEL	TOTAL FUEL
Left Main Tank	7,493 LB (3,399 Kg)	62 LB (28 Kg)	7,554 LB (3,427 Kg)
Right Main Tank	7,493 LB (3,399 Kg)	62 LB (28 Kg)	7,554 LB (3,427 Kg)
Center Tank	4,610 LB (2,091 Kg)	32 LB (14 Kg)	4,642 LB (2,106 Kg)



Fuel System – General
Figure 13–10–1

1. FUEL STORAGE

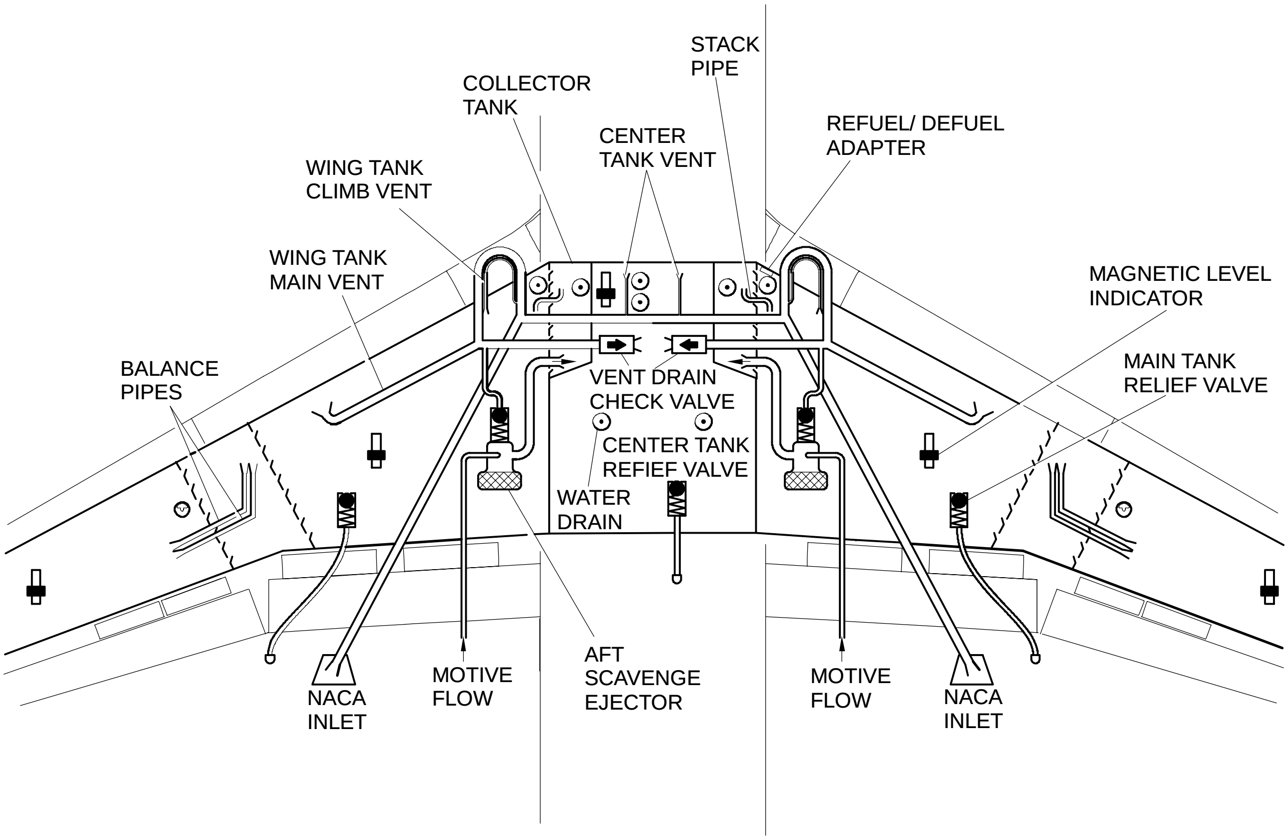
Fuel is stored in two main wing tanks and one center wing tank. For extended range flights fuel is carried in the center tank. In flight, as the wing tank fuel quantity decreases, the FQGC will automatically transfer fuel from the center tank to the wing tanks to maintain lateral balance.

A. Collector Tanks

Two collector tanks are located in the forward section of the center wing tank. Fuel from each wing tank is fed under pressure to its respective collector tank by scavenge ejectors. Fuel can also be fed from the wing tanks to the associated collector tank by gravity. There is no migration of fuel from the center tank into the collector tanks.

B. Venting

The tanks are vented to atmosphere and slightly pressurized by a NACA scoop located on the lower surface of each wing. A climb vent provides ventilation when the airplane is in a nose up attitude. Relief valves eliminate the possibility of pressure build up within the tanks.



Storage and Vent System
Figure 13–20–1

1. FUEL MANAGEMENT

Fuel management is accomplished by fuel transfer from the centre tank to the wing tanks and by fuel crossflow from one wing tank to the other wing tank.

A. Fuel Transfer

Fuel transfer from the centre tank to the wing tanks is provided by transfer ejectors. The ejectors are powered by fuel pressure tapped from the engine supply lines and automatically controlled by transfer shutoff valves. The fuel quantity gauging computer (FQGC) commands the transfer shutoff valve to open when the associated wing tank fuel quantity falls to 93% and commands it to close when the quantity reaches 97%. The FQGC will cycle the transfer system on and off until the centre tank is empty.

In the event of wing tank gauging failure, the fuel quantity gauging computer will use the high level sensors, located at the top of each tank, to control fuel transfer operations.

B. Fuel Crossflow

Powered and gravity crossflow allows fuel transfer between the wing tanks to correct fuel imbalance and to mantain lateral stability. Crossflow operations are controlled and monitored through the fuel control panel located on the overhead panel.

A pump located within the centre tank provides powered crossflow in either automatic or manual mode.

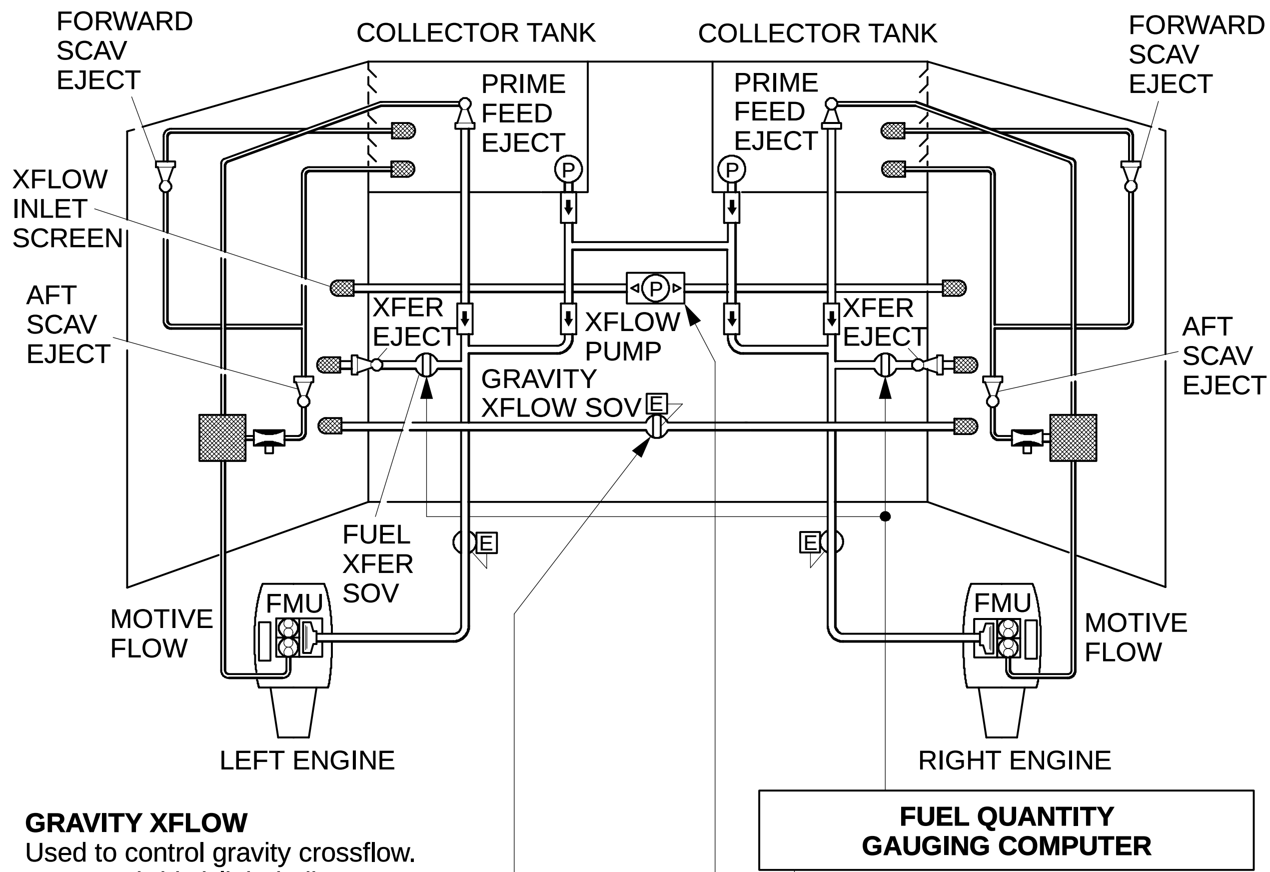
In automatic mode, the fuel quantity gauging computer controls the power crossflow. If the computer detects a fuel imbalance between the wing tanks, the crossflow pump is activated automatically in the required direction to correct the fuel imbalance.

The flight crew can control powered crossflow in manual mode by overriding automatic crossflow. In manual mode, fuel flow can be selected in either direction by selecting the direction of the crossflow pump motor.

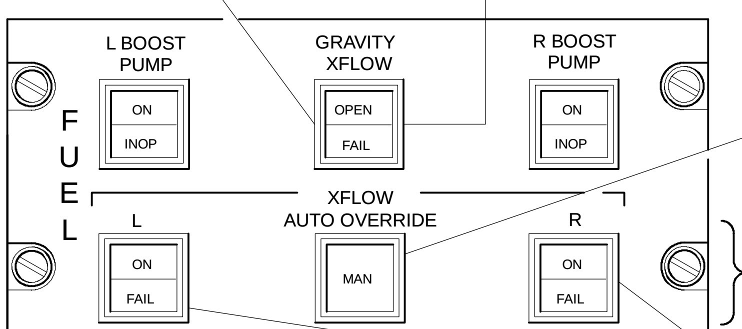
If the powered crossflow system fails, the flight crew can open the gravity crossflow shutoff valve to allow fuel transfer by gravity between wing tanks. Gravity crossflow can be enhanced by using a sideslip maneuver.

NOTE

If crossflow operations is being carried out in manual mode (Auto Override selected), only the required L or R XFLOW switchlight should be selected, not both. If both XFLOW switches are selected, power will be removed from the crossflow pump and the XFLOW PUMP caution message will come on. Also, both XFLOW FAIL switchlights will illuminate. The manual crossflow function will be inhibited until one of the XFLOW switches is deselected or the AUTO OVERRIDE switchlight is deselected.



GRAVITY XFLOW
Used to control gravity crossflow.
- OPEN (white) light indicates gravity crossflow is selected on.
- FAIL (amber) light indicates that the gravity crossflow shut–off valve is not in the selected position.



XFLOW AUTO OVERRIDE
Used to override automatic powered crossflow.
- MAN (white) light indicates manual powered crossflow is armed.

L and R XFLOW
Used to control powered crossflow in manual mode.
- ON (white) light indicates powered crossflow is operating in the indicated direction.
- FAIL (amber) light indicates that powered crossflow has failed.

Fuel Control Panel
Overhead Panel

Fuel Transfer and Crossflow System
Figure 13–30–1

Gravity Crossflow Valve
Position Indicator

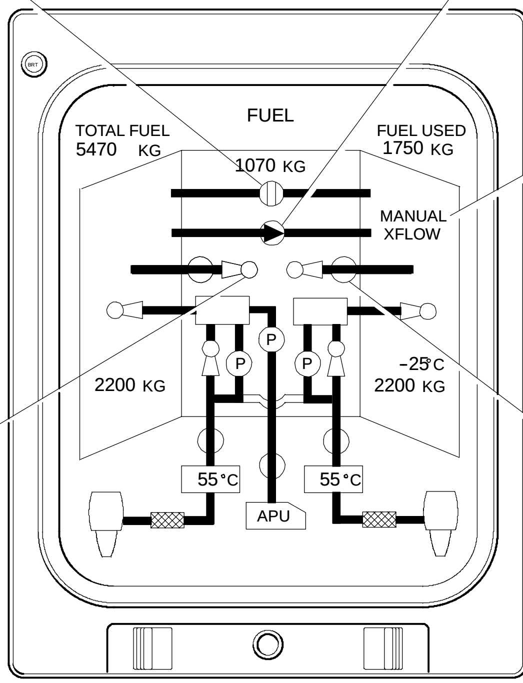
- open (white)
- closed (white)
- failed to attain commanded position (white)
- invalid data (half–intensity magenta)

Powered Crossflow Pump

- White – Pump is off.
- Green – Pump is operating. Arrow indicates flow direction.
- Amber – Pump has failed.
- Half Intensity Magenta – Invalid data.

MANUAL XFLOW (white)
Indicates that manual crossflow has been selected.

AUTO BAL INHIB (white)
Indicates that powered crossflow is inhibited in automatic mode.



Fuel Page

Transfer Ejectors

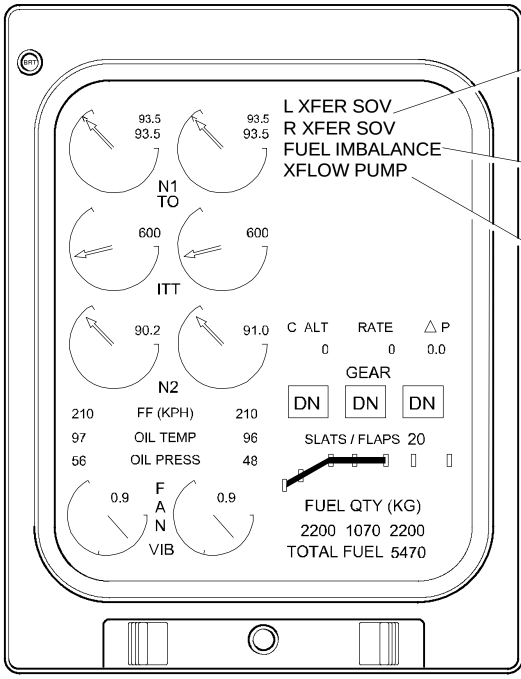
- White – Center tank is empty or respective transfer shut–off valve is closed or respective engine not running.
- Green – Ejector operating at normal pressure with fuel in center tank.
- Amber – Low pressure at respective transfer ejector with respective engine running.
- Half Intensity Magenta – Invalid data.

Transfer Shut–off Valve
Position Indicators

- open (white)
- closed (white)
- invalid data (half–intensity magenta)

Valve outline will turn amber if valve fails to attain commanded position.

Fuel – EICAS – Synoptic Page <1001>
Figure 13–30–2



L or R XFER SOV caution (amber)
Indicates that respective transfer shut–off has failed.

FUEL IMBALANCE caution (amber)
Indicates that a fuel quantity imbalance exists between left and right wing tanks.

XFLOW PUMP caution (amber)
Indicates that the crossflow pump has failed.

Primary Page

GRAV XFLOW OPEN advisory (green)
Indicates that gravity crossflow shut–off valve is open.

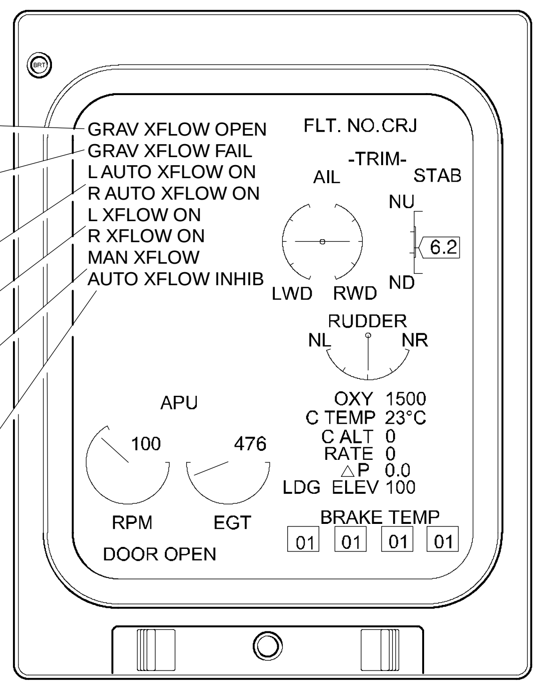
GRAV XFLOW FAIL status (white)
Indicates that gravity crossflow shut–off valve is not in selected position.

L or R AUTO XFLOW ON status (white)
Indicates that automatic powered crossflow is operating on the respective side.

L or R XFLOW ON status (white)
Indicates that crossflow shut–off valve has been manually selected open.

MAN XFLOW status (white)
Indicates that manual crossflow has been selected.

AUTO XFLOW INHIB status (white)
Indicates that powered crossflow is inhibited in automatic mode.



Status Page

Fuel System – EICAS Indications <1001>
Figure 13–30–3

C. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Fuel Management	Transfer	L XFER FUEL SOV	BATTERY BUS	1	N9	
		R XFER FUEL SOV		2	P8	
	Gravity Crossflow	FUEL GRAVITY XFLOW		1	N8	
	Powered Crossflow	CROSSFLOW PUMP	AC ESSENTIAL		S5	
		CROSSFLOW PUMP CONT	DC ESSENTIAL	2	R7	

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1. FUEL DISTRIBUTION

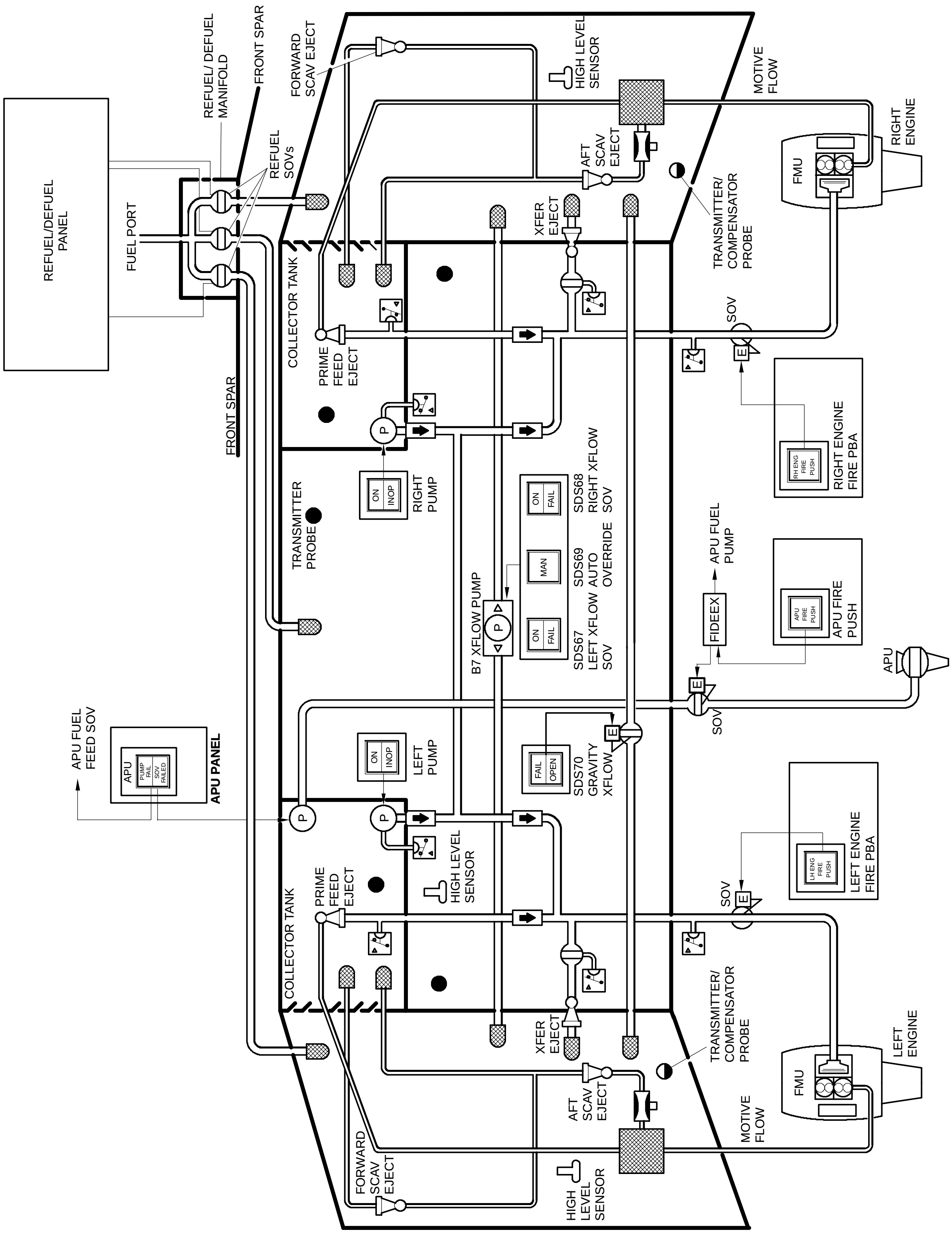
Fuel is distributed to each engine from a respective side collector tank which is an integral part of the center wing tank. Two scavenge ejectors, located at the lowest part of each wing tank, supplies fuel to each collector tank to keep it in a full condition. The collector tank is designed to maintain engine fuel feed under all normal flight and transient maneuver conditions. A main ejector, within each collector tank, supplies fuel to the respective side engine. The main and scavenge ejectors are powered by pressurized fuel tapped from the motive flow line of the respective engine fuel pump.

During engine start, a boost pump within each collector tank supplies fuel to the engines. The fuel control panel, located on the overhead panel, is used to control and monitor boost pump operation. Normally both boost pumps operate simultaneously and are capable of feeding either engine.

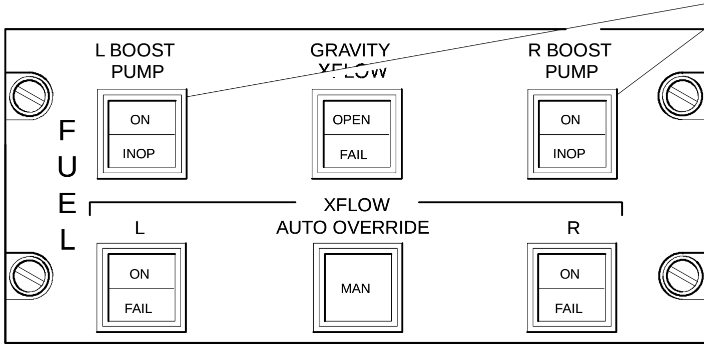
The fuel output pressure from the main ejector is monitored by a pressure switch and when the output pressure is sufficient to supply the engines, the boost pumps are automatically turned off. The boost pumps will remain in standby mode with the engines running, as a back up to the main ejectors in the event of a failure.

A dedicated fuel pump within the left collector tank supplies fuel to the APU. The APU pump is controlled by the APU control panel located on the overhead panel. In the event of fuel pump failure, the APU has suction feed capability.

In the event of a fire, fuel flow to the engine or APU is terminated by the closure of a shut-off valve when the associated fire push switchlight is selected.

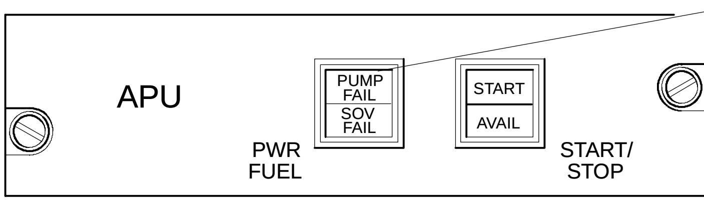


Fuel Distribution Schematic
Figure 13–40–1



L and R BOOST PUMP
Used to control engine boost pump.
- ON (white) light indicates boost pump is operating.
- INOP (amber) light indicates that low pump pressure exists or a pump failure has been detected.

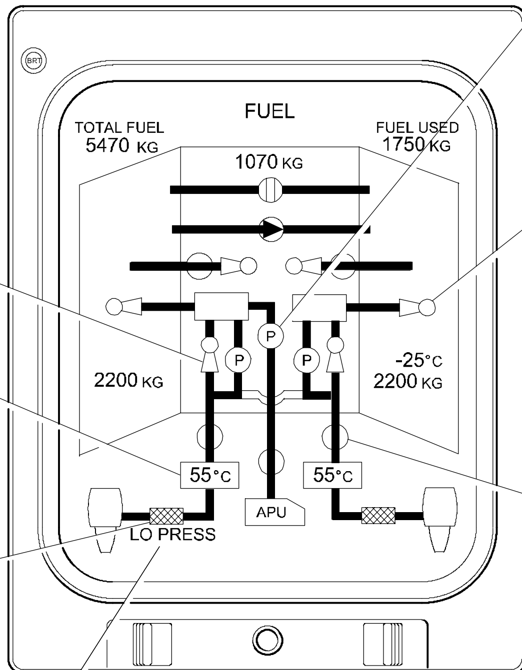
Fuel Control Panel
Overhead Panel



PWR FUEL
Used to control APU fuel pump.
- PUMP FAIL (amber) light Indicates that APU fuel pump has failed.
- SOV FAIL (amber) light Indicates that the APU fuel shut-off valve has failed.

APU Control Panel
Overhead Panel

Fuel Distribution – ENG and APU Control Panels
Figure 13–40–2



Fuel Page

APU and Boost Pumps
- White – Pump is off.
- Green – Pump is operating.
- Amber – Pump has failed or has no power.
- Half Intensity Magenta – Invalid data.

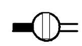
Main Ejectors
- White – Engine not running.
- Green – Ejector operating at normal pressure.
- Amber – Ejector operating at low pressure with respective engine running.
- Half Intensity Magenta – Invalid data.

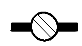
Scavenge Ejectors
- White – Engine not running.
- Green – Ejector operating at normal pressure.
- Amber – Ejector operating at low pressure with respective engine running.
- Half Intensity Magenta – Invalid data.

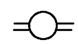
Fuel Feed Temperatures
- Green - Fuel feed temperature is ≥5° C
- Amber - Fuel feed temperature is < 5° C
- Amber dashes - Invalid data (may be intermittent)

Fuel Feed Shut-off Valve Position Indicators

 open (white)

 closed (white)

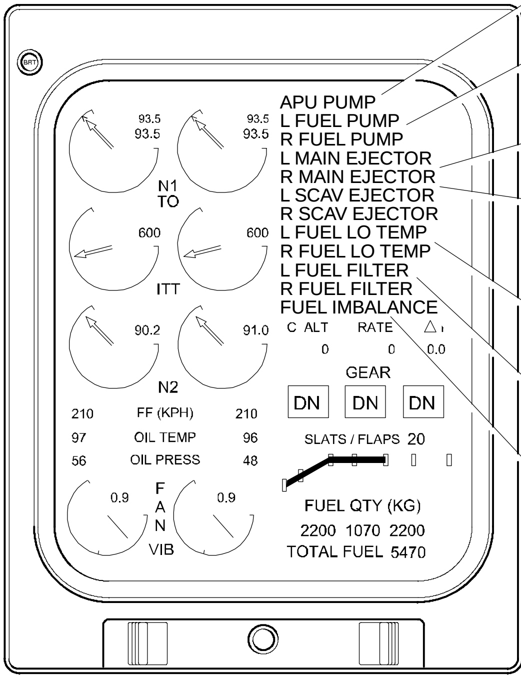
 failed to attain commanded position (amber)

 invalid data (half-intensity magenta)

Fuel Filters
- Green – Normal fuel flow through filter.
- Amber – Fuel pressure drop exists across respective fuel filter.
- Half Intensity Magenta – Invalid data.

LOW PRESS (amber)
Indicates that a low fuel pressure condition has been detected.

Fuel Synoptic Distribution <1001>
Figure 13–40–3



APU PUMP caution (amber)
Indicates that APU pump has failed.

L and R FUEL PUMP caution (amber)
Indicates that the respective engine boost pump has failed.

L and R MAIN EJECTOR caution (amber)
Indicates that a low fuel pressure condition exists at respective ejector with engine running.

L and R SCAV EJECTOR caution (amber)
Indicates that a low fuel pressure condition exists at respective ejector with engine running or a high fuel pressure condition exists at respective ejector with engine not running.

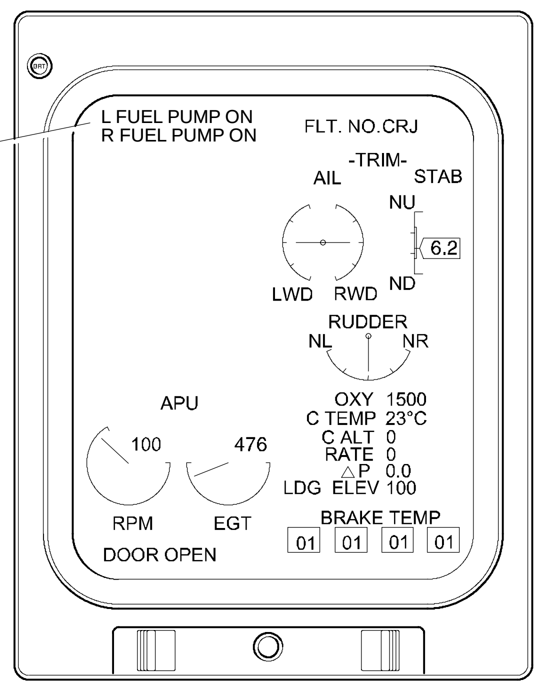
L and R FUEL LO TEMP caution (amber)
Indicates that fuel temperature is less than 4.3° C with respective engine running.

L and R FUEL FILTER caution (amber)
Indicates that a bypass or impending bypass condition exists at respective filter.

FUEL IMBALANCE caution (amber)
Indicates that fuel imbalance greater than 800 lbs is detected by the fuel computer.

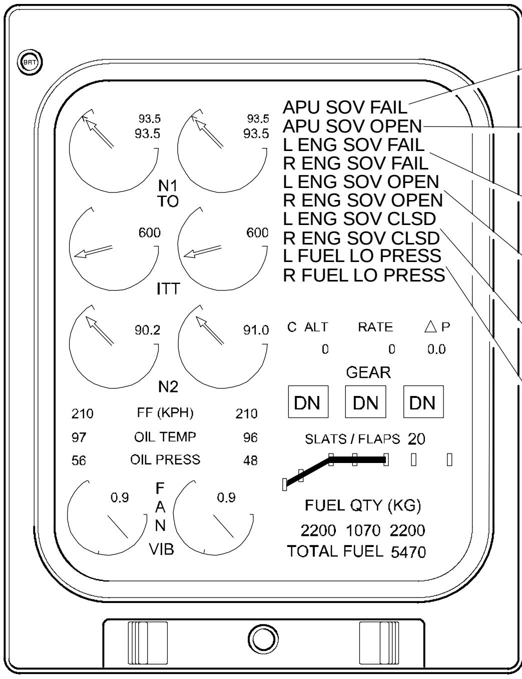
Primary Page

L and R FUEL PUMP ON advisory (green)
Indicates that respective fuel boost pump is operating.



Status Page

Fuel System EICAS Indications <1001>
Figure 13−40−4 Sheet 1



Primary Page

APU SOV FAIL caution (amber)
Indicates that APU shut–off valve is not in commanded position.

APU SOV OPEN caution (amber)
Indicates that APU shut–off valve is open with APU ready to load and an APU fire is detected.

L and R ENG SOV FAIL caution (amber)
Indicates that respective engine fuel shut–off valve is not in commanded position.

L and R ENG SOV OPEN caution (amber)
Indicates that respective engine fuel shut–off valve is open and an engine fire is detected.

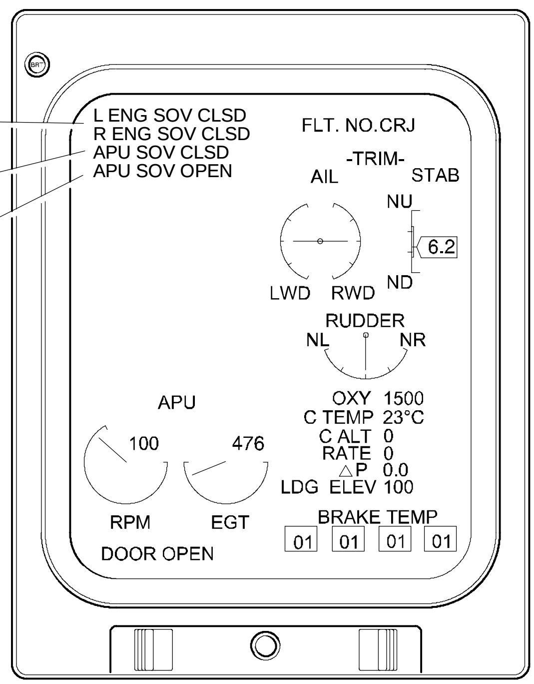
L and R ENG SOV CLSD caution (amber)
Indicates that respective engine fuel shut–off valve is closed and no engine fire is detected.

L and R FUEL LO PRESS caution (amber)
Indicates that a low fuel pressure condition exists at the respective engine inlet.

L and R ENG SOV CLSD advisory (green)
Indicates that respective engine fuel shut–off valve is closed and an engine fire is detected.

APU SOV CLSD advisory (green)
Indicates that APU shut–off valve is closed and an APU fire is detected.

APU SOV OPEN status (white)
Indicates that APU shut–off valve is open with APU not ready to load and no APU fire detected.



Status Page

Fuel System EICAS Indications <1001>
Figure 13–40–4 Sheet 2

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Fuel Distribution	Pumps	L FUEL PUMP	BATTERY BUS	1	M6	
		R FUEL PUMP	DC BUS 2	2	G9	
		APU FUEL PUMP	BATTERY BUS	1	N10	
	Pump Control	L FUEL PUMP CONT			M7	
		R FUEL PUMP CONT	DC BUS 2	2	G10	
	Shut-off Valves	FUEL SOV R ENG	DC EMERGENCY	1	R7	
		FUEL SOV L ENG			R8	
		FUEL SOV APU			R9	

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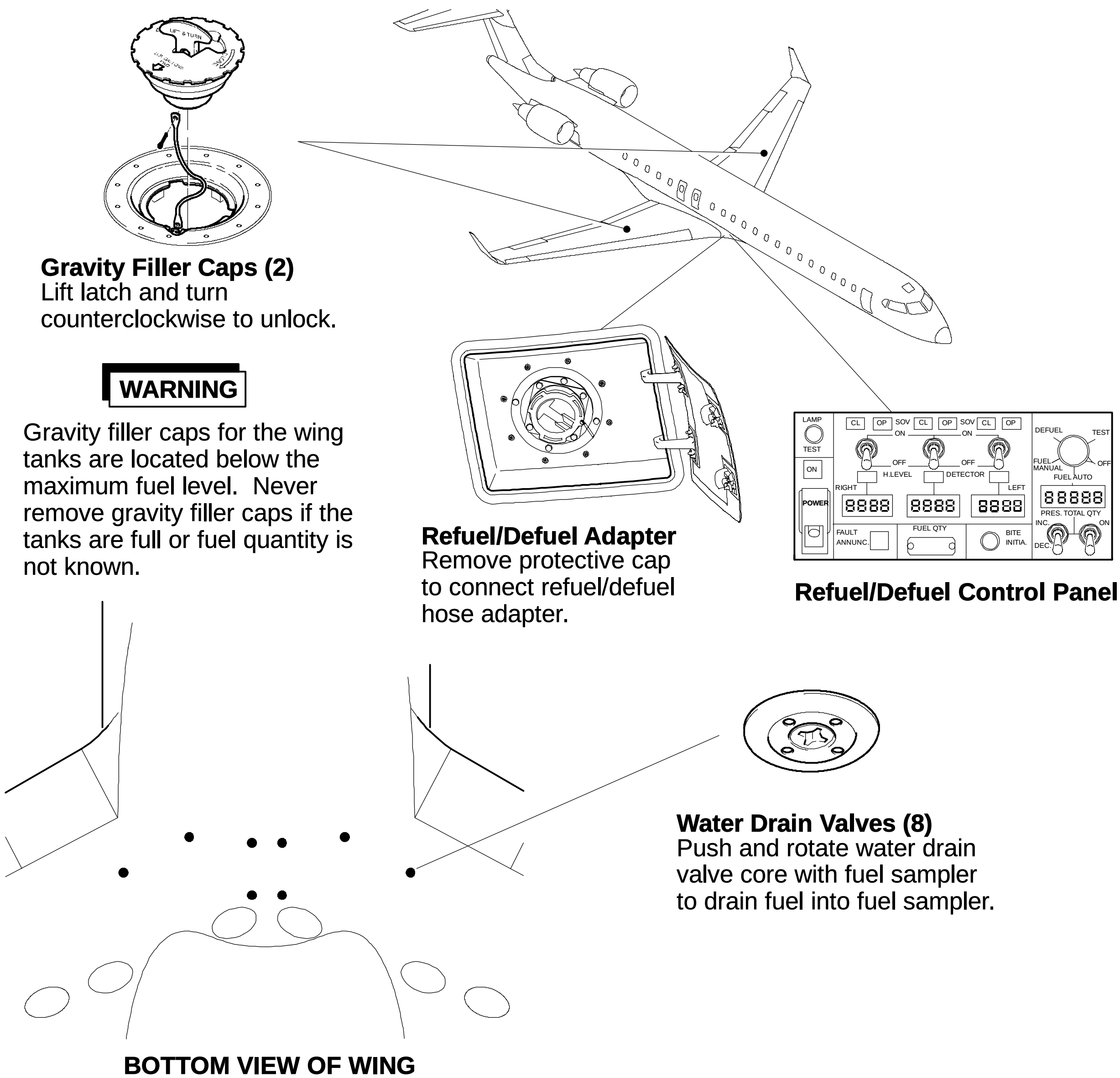
1. REFUELING AND DEFUELING

The refuel/defuel system is controlled by the Fuel Quantity and Gauging Computer (FQGC) through selection on a refuel/defuel control panel. Pressure refueling and suction defueling of the aircraft are accomplished using a refuel/defuel adapter located in the right wing, leading edge, root fairing.

Gravity refueling is carried out through filler caps installed on the upper wing surface. The fuel quantity can be monitored using magnetic level indicators installed in the tanks. Water drain valves are installed at various low points in the tanks. The water drain valves are used to drain out any accumulated water in the tanks and to take fuel samples for testing of the fuel for contamination.



Refuel/ Defuel Components <2224>
Figure 13–50–1

A. Control Panel

The aircraft is fitted with a refuel/defuel control panel installed adjacent to the refuel/defuel adapter on the right wing–to–fuselage fairing. Fuel quantity indications on the panel are displayed in kilograms (kg). <1001>

The refueling operation can be initiated in automatic or manual mode. Automatic mode allows the required total aircraft fuel quantity to be preselected. In automatic mode, the fuel quantity gauging computer controls the distribution of the fuel by filling the wing tanks before allowing any excess to be loaded into the center tank. High level detectors located at the top of each tank prevent fuel tank overfilling during refueling operations by closing the refuel shut-off valves.

Refueling of individual tanks is possible in manual mode by manually opening and closing the refuel shut-off valves from the control panel.

The defuel mode is similar to the manual mode except that defueling is selected.

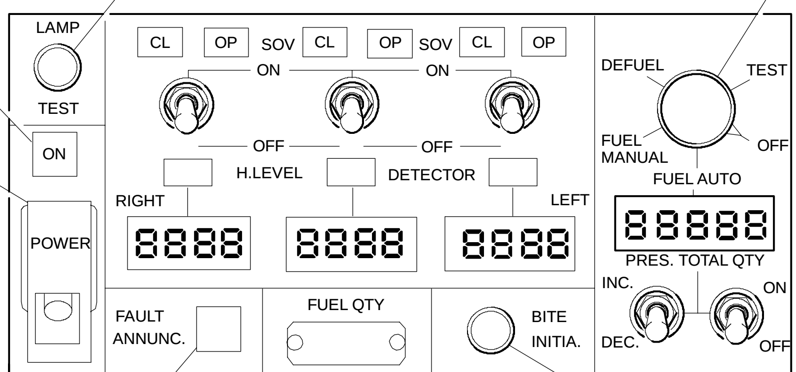
The test mode checks that the fuel quantity gauging computer, high level detectors and refuel/defuel shutoff valves are operating properly.

ON (green)
Indicates that battery bus power has been applied to the panel.

LAMP TEST
Used to test all lights and LED displays on the panel.

Mode Selector
- TEST – Verifies operation of refuel/defuel shut-off valves and high level detectors.

POWER (Guarded)
Supplies power directly from the battery bus to the control panel.



BITE INITIA.
Used to display fault codes on the fuel quantity displays.
Refer to the Airplane Maintenance Manual for code descriptions.

Refuel/Defuel Control Panel

FAULT ANNUNC. (amber)
Indicates that a fault exists in the refuel/defuel system.

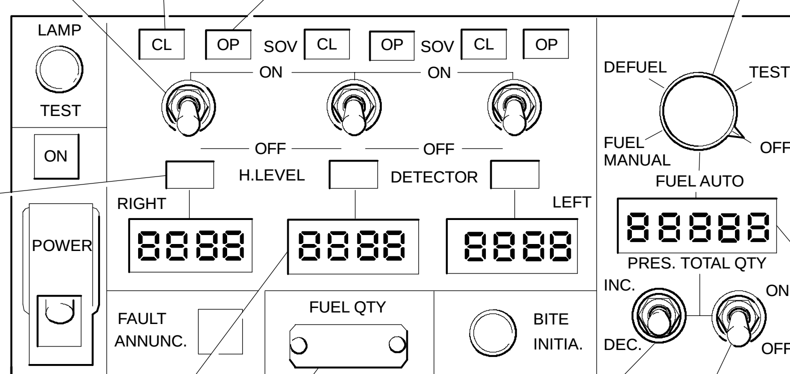
Refuel/ Defuel Control Panel
Figure 13–50–2 Sheet 1

SOV CL (green) (3)
Indicates that the respective refuel/defuel shut-off valves (SOV) are closed.

Mode Selector
- FUEL AUTO – Configures refuel/defuel system for automatic refueling.
- FUEL MANUAL – Configures refuel/defuel system for manual pressure refueling.
- DEFUEL – Configures refuel/defuel system for suction defueling.
- OFF – Shuts off refuel/defuel system.

SOV OP (amber) (3)
Indicates that the respective refuel/defuel shut-off valves (SOV) are open.

SOV switches (3)
- ON – Opens respective shut-off valve (SOV OP light comes on).
- OFF – Closes respective shut-off valve (SOV CL light comes on).



HIGH LEVEL DETECTOR (amber) (3)
Indicates that the fuel level in the respective tank has reached the full capacity.

PRES. TOTAL QTY
Displays the fuel quantity target for automatic refueling.

Fuel Quantity Displays (3)
Displays the fuel quantity of the respective tank.

ON / OFF
Used to start and stop automatic refueling.

Unit of Measure Label
Indicates the unit of measure for the fuel quantity displays.

INC. / DEC.
(spring loaded to center)
Used to increase and decrease the preselected total fuel quantity for automatic refueling.

700fcom1_135002aa02.cgm

Refuel/ Defuel Control Panel
Figure 13–50–2 Sheet 2

B. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Refueling and Defueling	Refuel	EMER REFL	APU BATT DIRECT BUS	5	B5	
	Defuel	FUEL DEFL			B4	

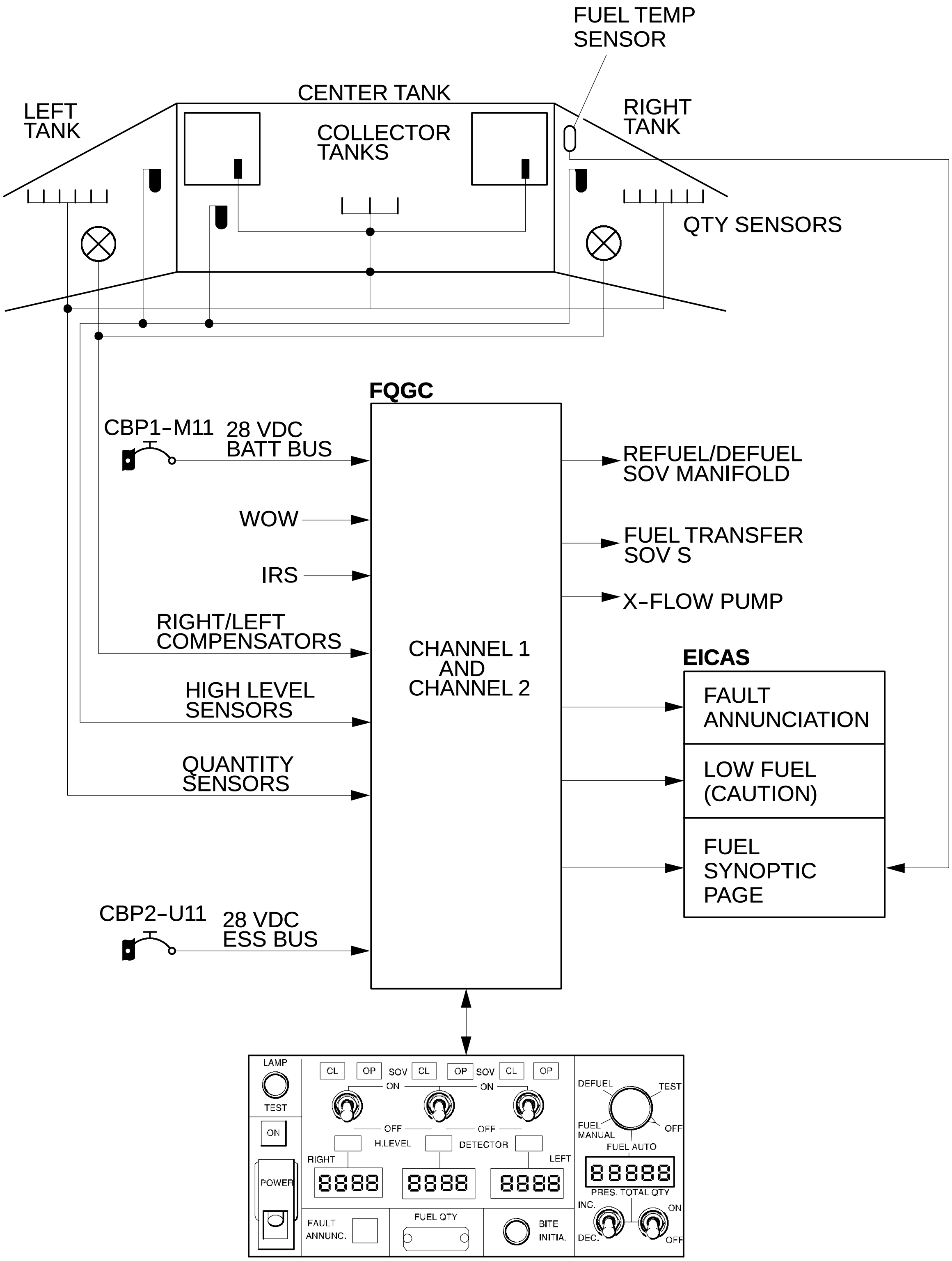
1. FUEL QUANTITY GAUGING

A fuel quantity gauging computer monitors and controls the operation of the fuel system. The computer uses information from the fuel system to calculate the fuel quantity.

Fuel quantity is measured using fuel probes which provide a signal directly proportional to fuel level. There are 6 probes in each wing tank, 1 in each collector tank and 3 in the centre tank. A compensator probe in the bottom of each wing tank supplies data to compute the fuel density correction. The temperature of the fuel is continuously monitored by a fuel temperature sensor installed in the right wing tank.

Fuel quantity gauging is calibrated for both ground and flight operations. The computer receives weight-on-wheel signals to determine if the aircraft is on the ground or in flight. In flight, the computer takes into account the effects of wing deflection and aircraft attitude on the fuel quantity measurement.

Corrected individual tank quantities, total fuel quantity, fuel used quantity and fuel temperature are displayed on the Engine Indication and Crew Alerting System (EICAS) as well as any fault detected in the fuel quantity gauging computer.

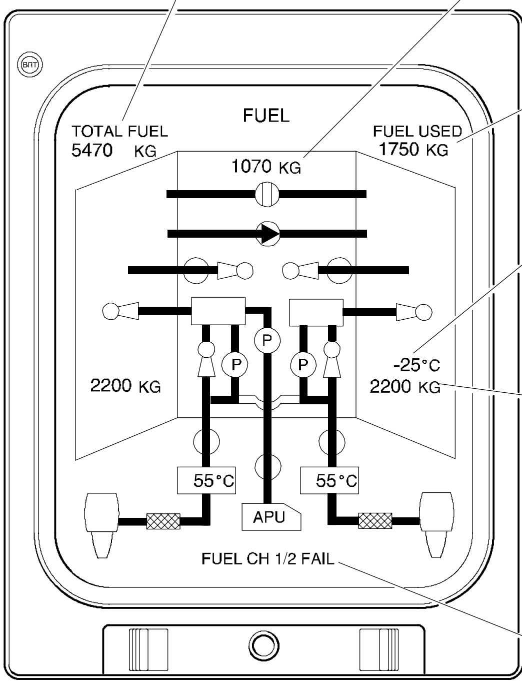


Fuel Quantity System – Schematic <1025>
Figure 13–60–1

TOTAL FUEL
Displays total fuel quantity of all tanks (in 5 kg increments).
- Green - Total fuel quantity is > 408 kg.
- Amber - Total fuel quantity is < 408 kg.

Center Tank Fuel Quantity
Displays fuel quantity of center tank (in 5 kg increments).
- Green - Fuel quantity is > 5 kg.
- White - Fuel quantity is < 5 kg.

FUEL USED (white)
Displays amount of fuel used (in 5 kg increments). Reset to zero through the EICAS MENU page.



Fuel Page

Bulk Fuel Temperature
- Green - Temperature of fuel in right wing tank is -40 °C or greater.
- Amber - Temperature of fuel in right wing tank is less than -40 °C.

Left and Right Tank Fuel Quantity
Displays fuel quantity of respective tank (in 5 kg increments).
- Green - Fuel imbalance between left and right tanks is within limits, respective tank quantity is > 204 kg and total fuel quantity is > 408 kg.
- Amber - Fuel imbalance between left and right tanks exceeds limits, or respective tank quantity is < 204 kg or total fuel quantity is < 408 kg.

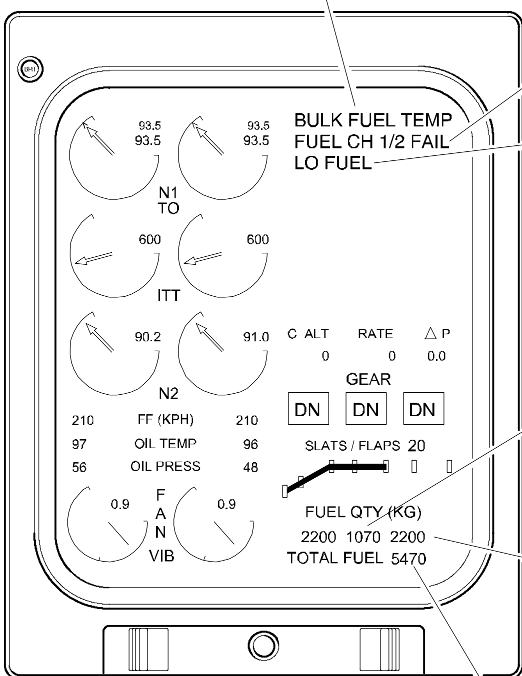
FUEL CH 1 or 2 FAIL (white)
Indicates that respective channel of fuel quantity gauging computer has failed.
FUEL CH 1/2 FAIL (amber)
Indicates that both channels of fuel quantity gauging computer have failed.

Fuel System Synoptic Page – Gauging <1001>
Figure 13–60–2

BULK FUEL TEMP caution (amber)
Indicates that fuel temperature in left wing tank is less than -40 °C.

FUEL CH 1/2 FAIL caution (amber)
Indicates that fuel quantity gauging computer has failed.

LO FUEL caution (amber)
Indicates the following:
- Fuel quantity in either tank is < 272 kg or
- Total fuel quantity is < 544 kg or
- Quantity in both collector cells is low.



Primary Page

FUEL QTY (center tank)
Displays fuel quantity of center tank (in 5 kg increments).
- Green - Fuel quantity is > 5 kg.
- White - Fuel quantity is < 5 kg.

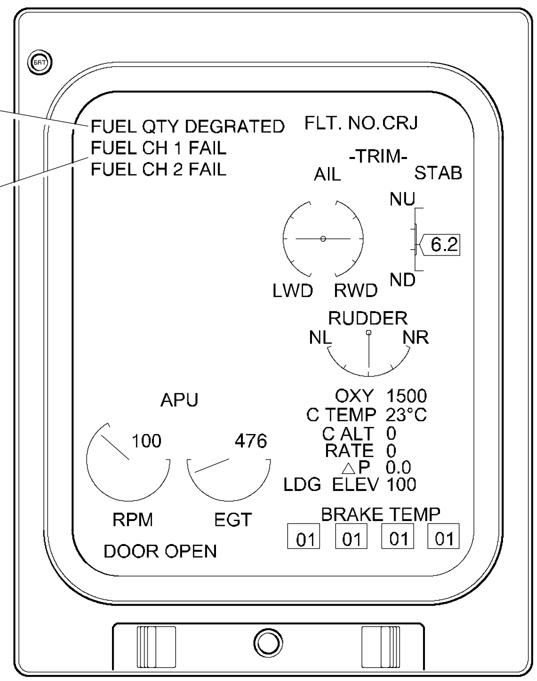
FUEL QTY (left and right tank)
Displays fuel quantity of respective tank (in 5 kg increments).
- Green - Fuel imbalance between left and right tanks is within limits and respective tank quantity is > 204 kg and total fuel quantity is > 408 kg.
- Amber - Fuel imbalance between left and right tanks exceeds limits or respective tank quantity is < 204 kg or total fuel quantity is < 408 kg.

TOTAL FUEL
Displays total fuel quantity of all tanks (in 5 kg increments).
- Green - Total fuel quantity is > 408 kg.
- Amber - Total fuel quantity is < 408 kg.

Fuel System Gauging EICAS Indications – Primary Page <1001>
Figure 13–60–3

FUEL QTY DEGRADED status (white)
Indicates an error in the attitude input to the fuel quantity gauging computer.

FUEL CH 1 or 2 FAIL status (white)
Indicates that respective channel of fuel quantity gauging computer has failed.



Status Page

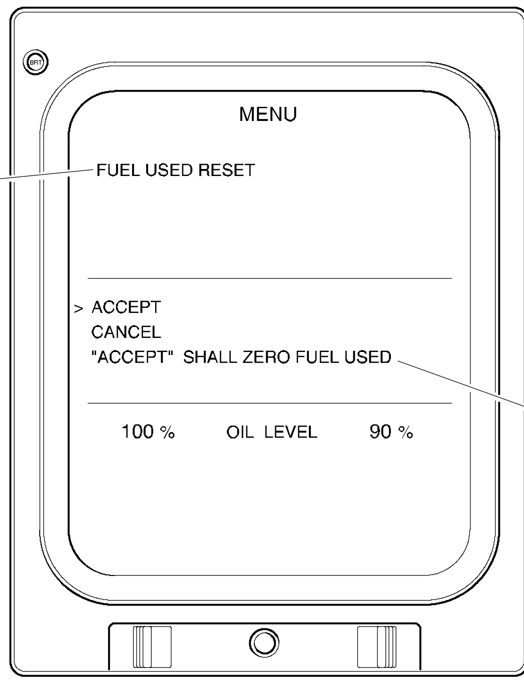
Fuel System Gauging EICAS Indications − Status Page
Figure 13−60−4

FUEL USED RESET

- Accessed through UP/DN keys on EICAS control panel.
- Cursor will go to ACCEPT line and prompt message will appear.
- SEL switch on EICAS control panel is used to confirm selection.

NOTE

1. CANCEL line used to cancel change (not reset fuel used).
2. Fuel synoptic page will display reset value.
3. Fuel used reset through Menu page does not update FMS.



Data Entry Message
Comes on when the cursor goes to the ACCEPT line after selection of the FUEL USED RESET line.

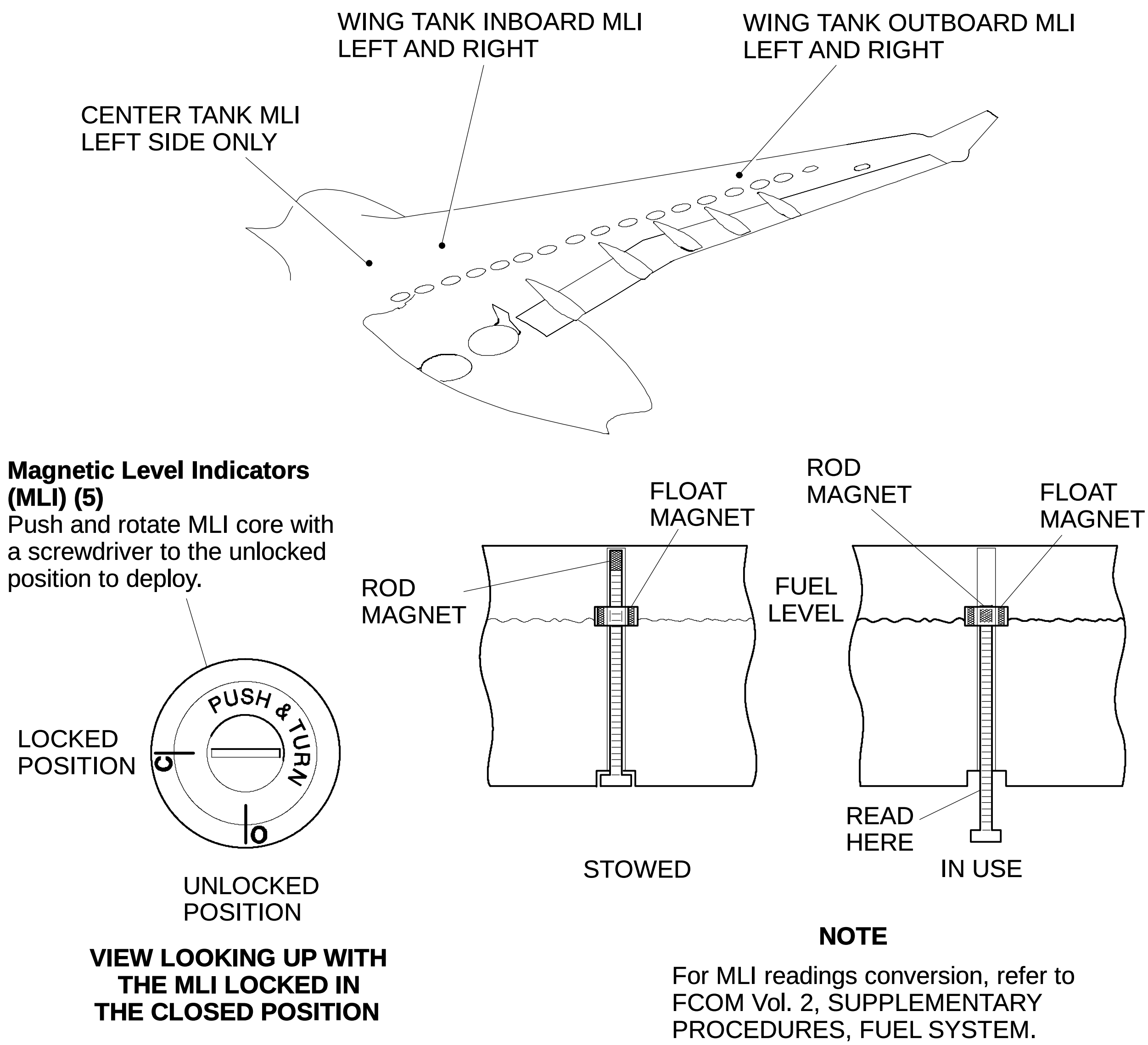
Menu Page

Fuel System – Menu Page
Figure 13–60–5

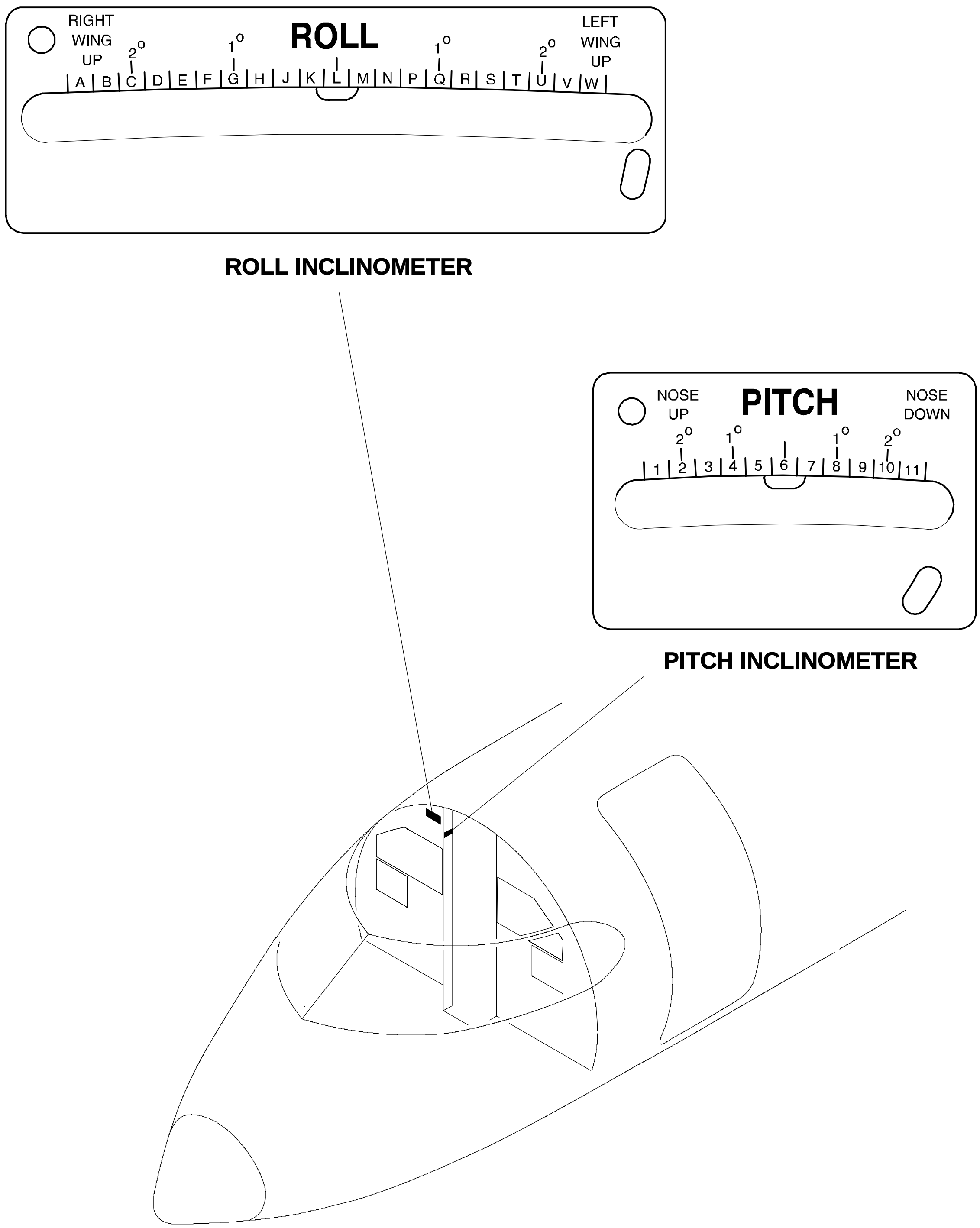
A. Magnetic Level Indicators

Two magnetic level indicators (MLIs) are installed in each wing tank and one is installed in the center tank.The MLIs are located under the wing and are used to manually check the fuel level in each tank.

To make sure that the MLI readings are acurate, the airplane must be level. Pitch and roll inclinometers are provided on the right flight compartment bulkhead to verify that the airplane is level. After the MLI readings are taken they are then converted to units of fuel quantity using tabulated charts contained in FCOM 2, Supplementary Procedures.



Magnetic Level Indicators
Figure 13–60–6



Pitch and Roll Inclinometers
Figure 13−60−7

B. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Fuel Quantity Gauging	Control	FUEL SYST CONT	BATTERY BUS	1	M11	
		FUEL SYST CONT	DC ESSENTIAL	2	U11	

CHAPTER 14 – HYDRAULIC POWER

LIST OF ILLUSTRATIONS

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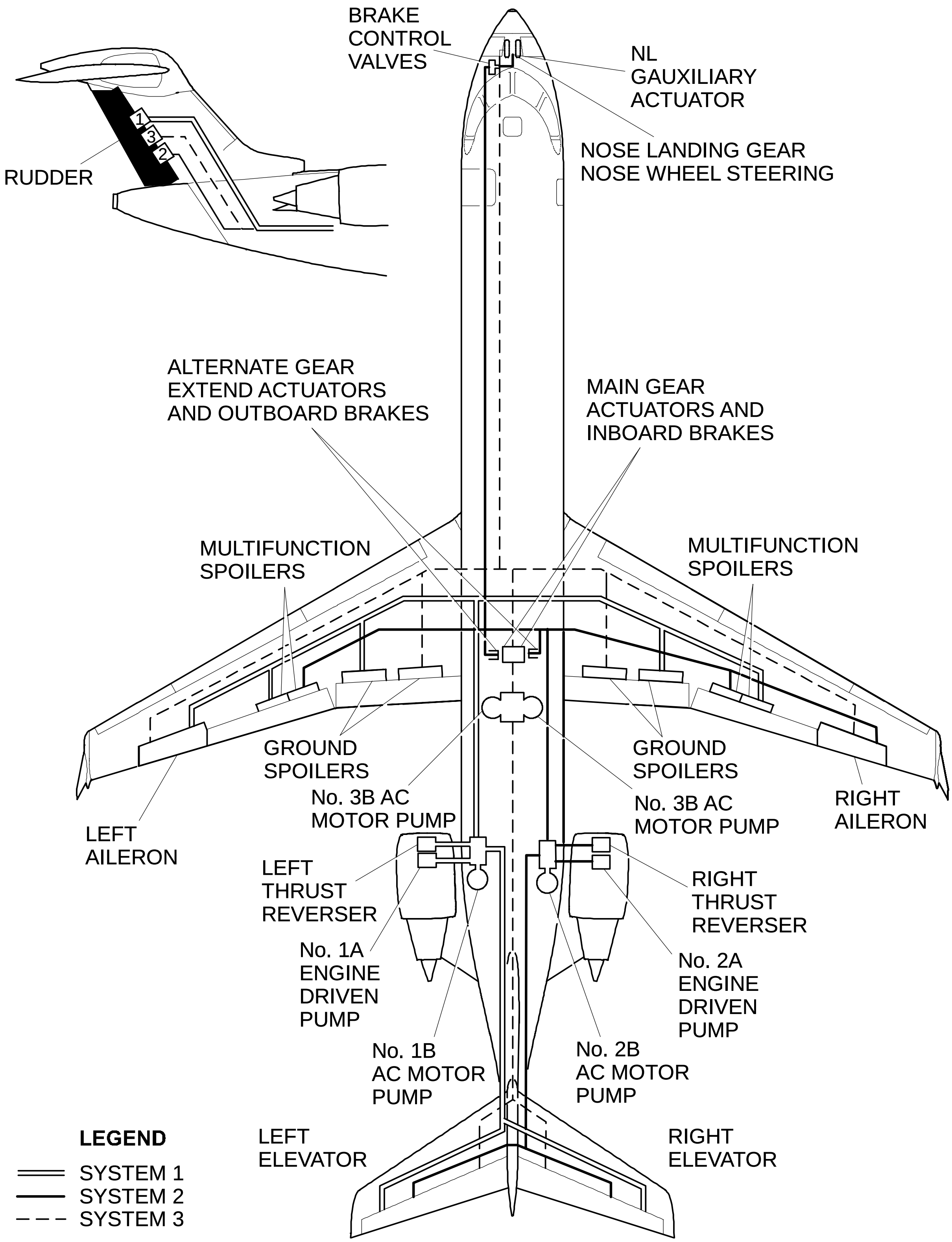
1. INTRODUCTION

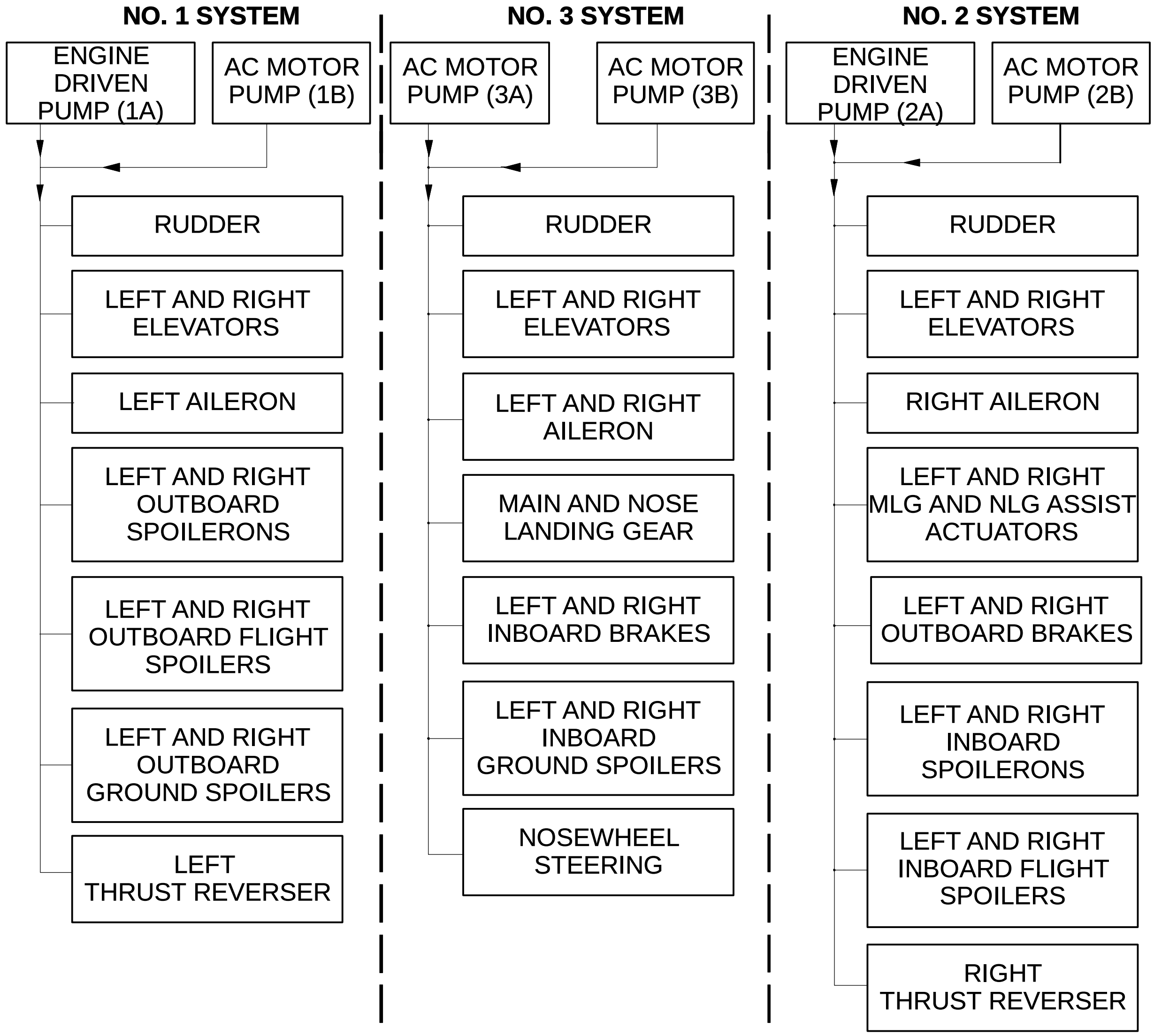
Hydraulic power is provided by three independent systems designated 1, 2 and 3. All systems operate at a nominal pressure of 3000 psi (20,685 kPa). Systems 1 and 2 are serviced by ground service panels located in the aft equipment bay. System 3 is serviced by a ground service panel located on the right side of the fuselage, aft of the wing root.

Each system has two hydraulic pumps; a main pump (A) for normal power and a backup pump (B) for supplementary power. System 1 and 2 main pumps are engine driven pumps (EDP). System 1 EDP (1A) is driven by the left engine and system 2 EDP (2A) is driven by the right engine. System 1 and 2 backup pumps (1B and 2B) are AC motor pumps (ACMP). Both pumps for System 3 are ACMPs. System 3 main pump (3A) normally runs continuously, while the backup pump (3B) is available during periods of high flow requirments. Pump 3B is automatically powered, during an AC power failure, by the air driven generator (ADG) when it is deployed.

The hydraulic systems supply power to operate the rudder, elevators, ailerons, spoilerons, flight spoilers, ground spoilers, thrust reversers, wheel brakes, nosewheel steering and landing gear extension and retraction. Rudder, elevators and ailerons are powered by more than one hydraulic system to prevent loss of critical flight controls.



Hydraulic Systems – Overview
Figure 14–10–1



Hydraulic Systems Diagram
Figure 14–10–2

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1. HYDRAULIC SYSTEMS 1 AND 2

Hydraulic systems (1 and 2) are identical in construction and operation with each system consisting of an:

- Engine driven pump (EDP)
- AC motor pump (ACMP)
- Shutoff valve
- Reservoir
- Accumulator
- Overflow container
- Pressure and return manifolds
- Case drain filters
- Ground servicing panel

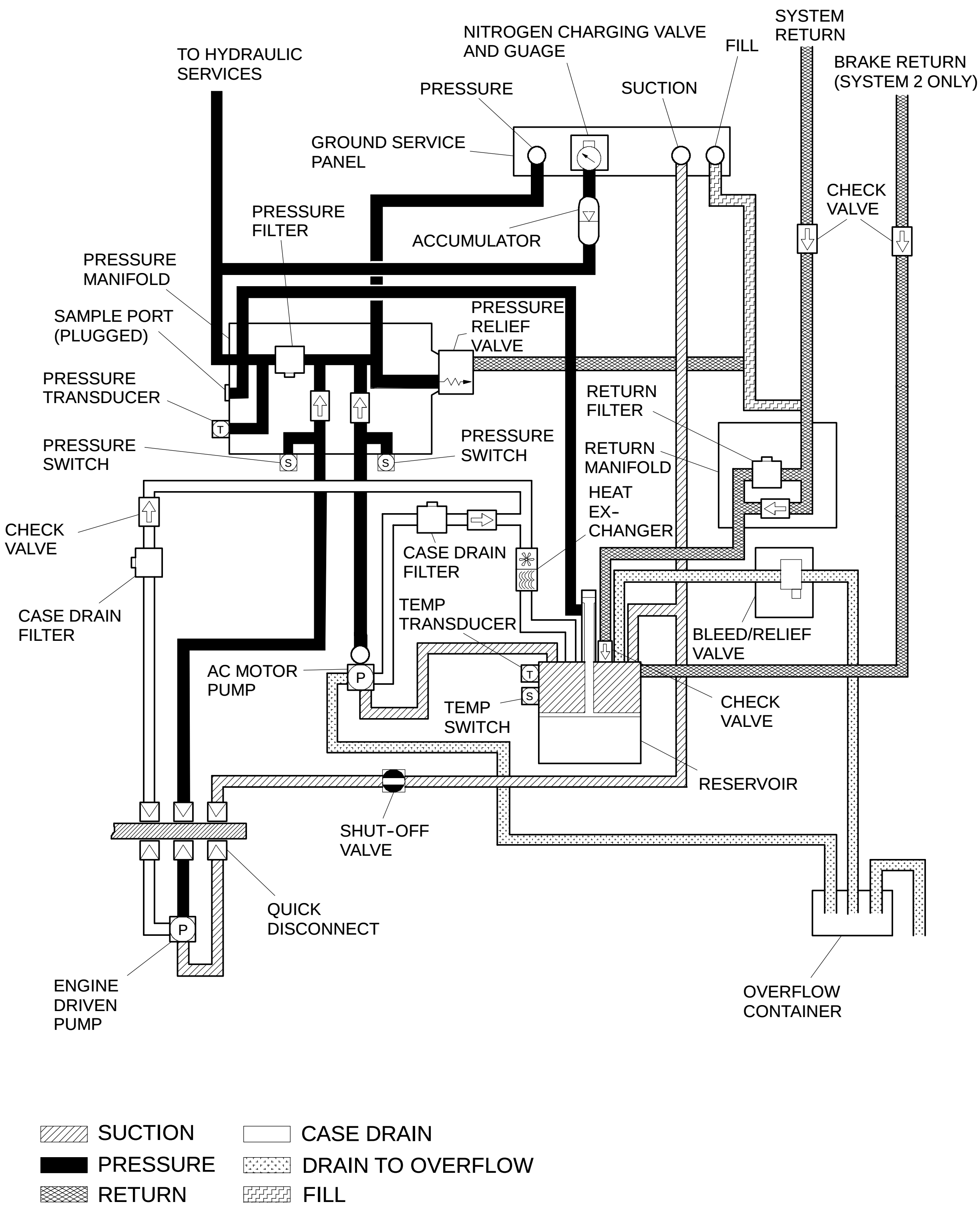
Both systems share a ram air heat exchanger for fluid cooling. Fluid from each system is not mixed with the other system as it passes through the heat exchanger. A fan within the heat exchanger assists in cooling the hydraulic fluid when the aircraft is on the ground.

Each system is monitored by:

- Temperature and pressure switches
- Temperature and pressure transducers
- Quantity transducers and indicating gauges.

NOTE

Figure 14–20–1 represents No. 1 or No. 2 hydraulic system.



Hydraulic System (No. 1/2) – Schematic
Figure 14–20–1

A. Engine Driven Pumps

EDP 1A and 2A draw fluid from their respective reservoirs through firewall shutoff valves. Fluid is pumped to the applicable pressure manifold, filtered and distributed to the airplane's hydraulically actuated components.

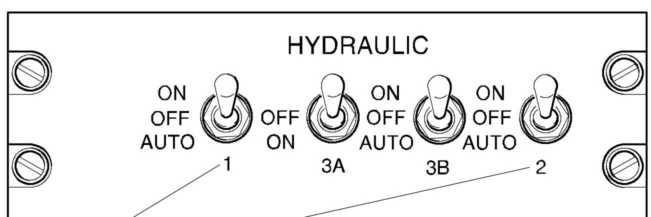
B. AC Motor Pumps

AC motor pump 1B is powered from AC bus 2 and AC motor pump 2B is powered from AC bus 1. Each AC motor pump is controlled by a separate toggle switch on the hydraulic pump control panel located on the overhead panel in the flight compartment. When a pump switch is set to AUTO, the pump will automatically start under the following conditions:

- –AC BUS 2 must be powered for hydraulic pump IB operation,
  –AC BUS 1 must be powered for hydraulic pump 2B operation.
- Flaps are out of the 0° position.

NOTE

AC motor pumps 1B and 2B do not automatically start during or after an engine failure.



AC Motor Pump 1 and 2
Used to control the operation of AC motor pumps 1B and 2B.
- ON - Pump will operate at 3000 psi output
- OFF - Pump inoperative
- AUTO - Pump will operate in AUTO position, when flaps are greater than 0-degrees.

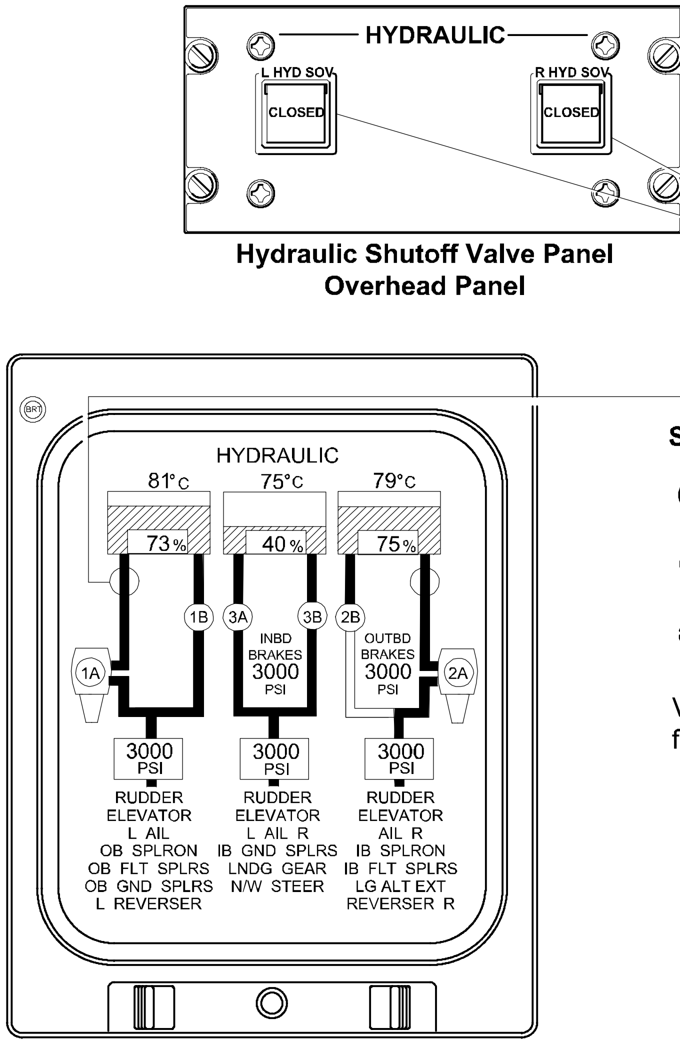
Hydraulic Control Panel
Overhead Panel

Hydraulic Control Panel
Figure 14–20–2

C. Shutoff Valves

Electrically operated ball type shutoff valves are installed in the suction lines of the engine driven pumps (1A and 2A). The valves are normally open. Valve position is indicated on the EICAS, HYD synoptic page.

During an engine fire condition, the corresponding shutoff valve is motored closed when the ENG FIRE PUSH switchlight is pressed in (See Chapter 10, Fire Protection). Each shutoff valve can be manually closed by pressing the L or R HYD SOV switchlight on the hydraulic shutoff panel in the overhead panel.



Hydraulic Shutoff Valve Panel
Overhead Panel

L and R HYD SOV
Used to manually close the hydraulic shutoff valves.
- CLOSED (white) light indicates shutoff valve is selected closed.

Shutoff Valve Position Indicator

valve open (white)

valve closed (white)

failed (half-intensity magenta)

Valve outline will turn amber if valve fails to attain commanded position.

Hydraulic Page

Systems 1 and 2 – Shutoff Valves
Figure 14–20–3

Hydraulic Temperature
Displays reservoir fluid temperature (in 1°C increments).
- Green - < 96°C (205°F).
- Amber - ≥ 96°C (205°F).
- Amber dashes - Invalid data.

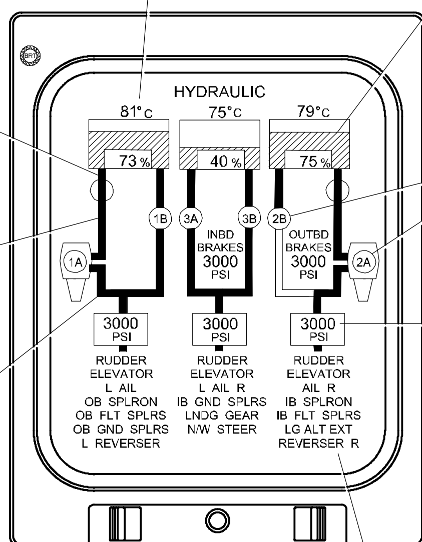
Hydraulic Quantity
Displays reservoir fluid quantity (in 5% increments). Normal quantity is 45 to 85 percent.
- White - Hydraulic quantity < 45% or > 85%.
- Green - Hydraulic quantity ≥ 45% and ≤ 85%.
- Amber dashes - Invalid data.

Reservoir Output Line
- Green - Sufficient quantity (≥ 5%).
- Blank - Insufficient quantity (< 5%).

Pump
Displays pump status.
- White - Pump not operating and selected off.
- Green - Pump output normal.
- Amber - Pump output low.
- Half-intensity magenta - Invalid data.

Engine Driven Pump Input Line
- Green - SOV open.
- Red - SOV not closed with an engine fire.

Pump Output and Pressure Manifold Lines
- Green - Pressure (> 1800 psi).
- Amber - Low pressure (< 1800 psi).



Hydraulic Page

Hydraulic Pressure
Displays hydraulic pressure (in 100 psi increments). Normal operating pressure is 2800 to 3200 psi.
- White - Hydraulic pressure > 3200 psi.
- Green - Hydraulic pressure > 1800 psi and ≤ 3200 psi.
- Amber - Hydraulic pressure ≤ 1800 psi.
- Amber dashes - Invalid data.

System Distribution Table
Displays status of corresponding airplane systems.
- White - Adequate pressure to operate (> 1800 psi).
- Amber - Hydraulic supply to system inadequate (< 1800 psi).
- Half-intensity magenta - Invalid data.

Systems 1 and 2 – Synoptic Page
Figure 14–20–4

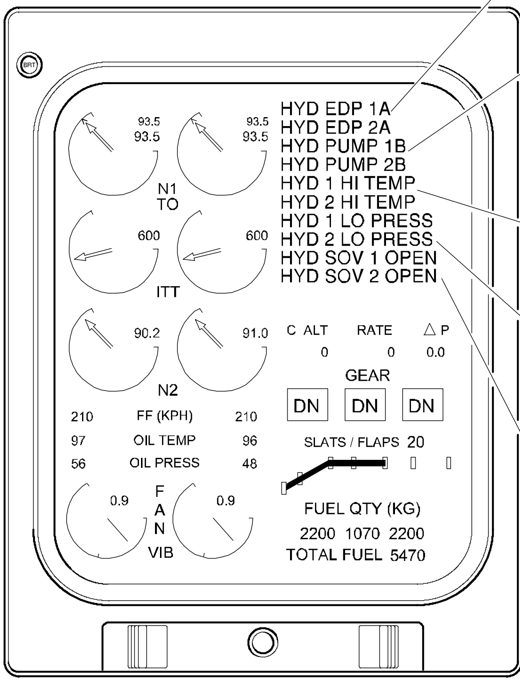
HYD EDP 1A or 2A caution (amber)
Indicates that corresponding engine driven pump has a low pressure output (<1800 psi).

HYD PUMP 1B or 2B caution (amber)
Indicates that corresponding AC motor pump has a low pressure output (<1800 psi).
- With engine driven pump operating and 1B or 2B pump operating ON or AUTO.

HYD 1 or 2 HI TEMP caution (amber)
Indicates that corresponding system has a fluid temperature of 96° C (205° F) or greater.

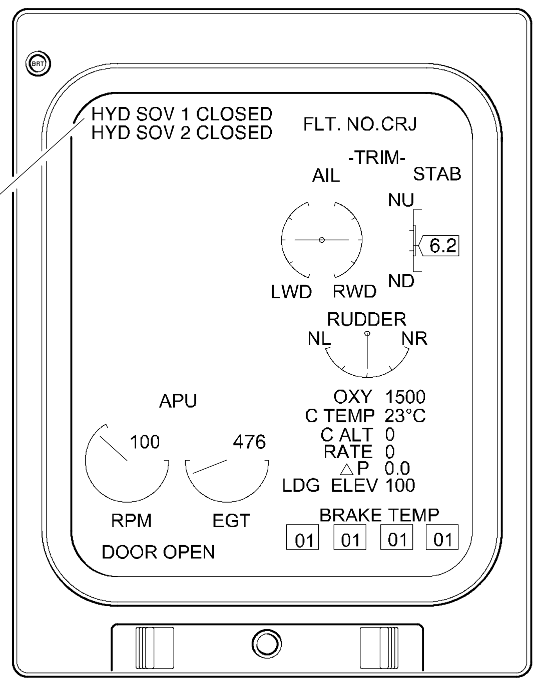
HYD 1 or 2 LO PRESS caution (amber)
Indicates that corresponding system pumps (both EDP and AC motor pump) have a low pressure output (<1800 psi).

HYD SOV 1 or 2 OPEN caution (amber)
Indicates that the respective shut–off valve is open with an associated engine fire.



Primary Page

HYD SOV 1 or 2 CLOSED advisory (green)
Indicates that corresponding shut–off valve has been closed.



Status Page

Systems 1 and 2 EICAS Indications <1001>
Figure 14–20–5

D. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Hydraulic Systems 1 and 2	Pumps	HYD SYST AC PUMP CONT 1	DC BUS 2	2	F13	
		HYD SYST AC PUMP CONT 2	DC BUS 1	1	F14	
	Indication	HYD SYST IND 1	DC BUS 2	2	F12	
		HYD SYST IND 2	DC BUS 1	1	F13	
	Fans	HYD SYST FAN	AC BUS 1		A8	
		HYD SYST FAN CONT	DC BUS 1		F12	
	Shutoff Valves	HYD SOV R ENG	DC EMERGENCY		R5	
		HYD SOV L ENG			R6	

1. HYDRAULIC SYSTEM N0 3

Hydraulic system No. 3 consists of the following components:

- Two AC motor pumps (identified as 3A and 3B
- Reservoir
- Accumulator
- Three overflow containers
- Pressure and return manifolds
- Case drain filters
- Ground servicing panel

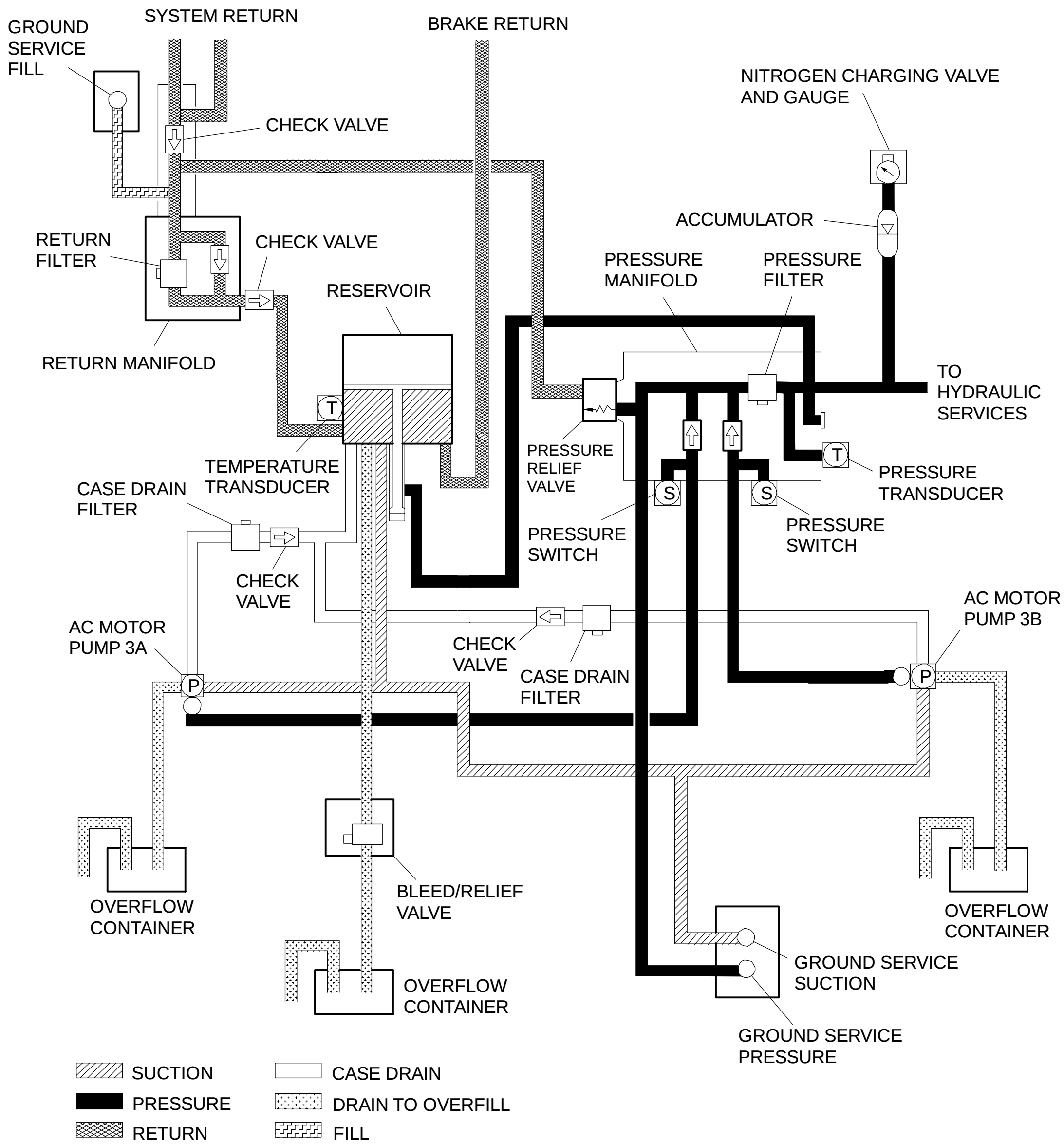
Hydraulic system No. 3 provides pressure to the following systems:

- Ailerons
- Elevators
- Rudder
- Inboard ground spoilers
- Landing gear actuators
- Inboard brakes
- Nosewheel steering

Hydraulic system No. 3 does not have a heat exchanger and does not use the No.1 and No. 2 system heat exchanger for cooling the system fluid. The No. 3 system hydraulic fluid runs through lines that pass through the fuel tanks thereby allowing the fluid to be cooled through natural convection.

No. 3 hydraulic system is monitored by:

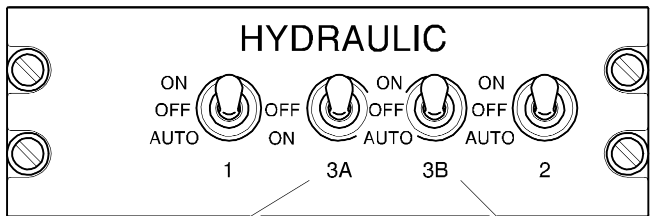
- Temperature and pressure switches
- Temperature and pressure transducers
- A quantity transducer and gauge



Hydraulic System 3
Figure 14–30–1

A. AC Motor Pumps

Hydraulic system No. 3 AC motor pumps (ACMPs) are controlled by switches on the hydraulic control panel. ACMP 3A runs continuously to maintain normal system pressure. ACMP 3B operates during takeoffs and landings. The ADG bus automatically powers ACMP 3B when the ADG is deployed (independent of the flight compartment 3B switch setting).



Hydraulic Pump Panel
Overhead Panel

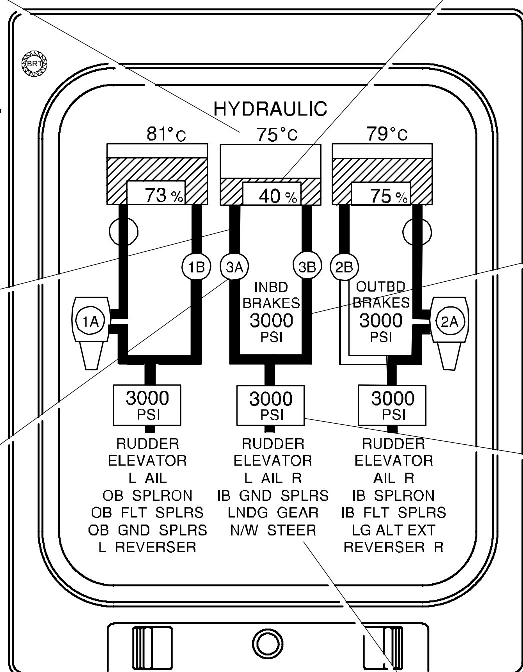
AC Motor Pump 3A
Used to control the operation of AC motor pump 3A.
- ON – Pump will operate at 3000 psi output.
- OFF – Pump inoperative.

AC Motor Pump 3B
Used to control the operation of AC motor pump 3B. Pump will operate irrespective of switch position when ADG is deployed.
- ON – Pump will operate at 3000 psi output.
- OFF – Pump inoperative.
- AUTO – Pump will operate in AUTO position, when flaps are greater than 0-degrees and either IDG 1 or IDG 2 is operating.

Hydraulic Control Panel
Figure 14–30–2

Hydraulic Quantity
Displays reservoir fluid quantity (in 5% increments). Normal quantity is 45 to 85 percent.
- White – Hydraulic quantity < 45% or > 85% .
- Green – Hydraulic quantity ≥ 45% and ≤ 85% .
- Amber dashes – Invalid data.

Hydraulic Temperature
Displays reservoir fluid temperature (in 1° C increments).
- Green - < 96°C (205°F).
- Amber - ≥ 96°C (205°F).
- Amber dashes - Invalid data.



Pump Output and Pressure Manifold Lines
- Green – Pressure > 1800 psi.
- Amber – Low pressure (< 1800 psi).

Reservoir Output Line
- Green – Sufficient quantity (≥ 5%).
- Blank – Insufficient quantity (< 5%).

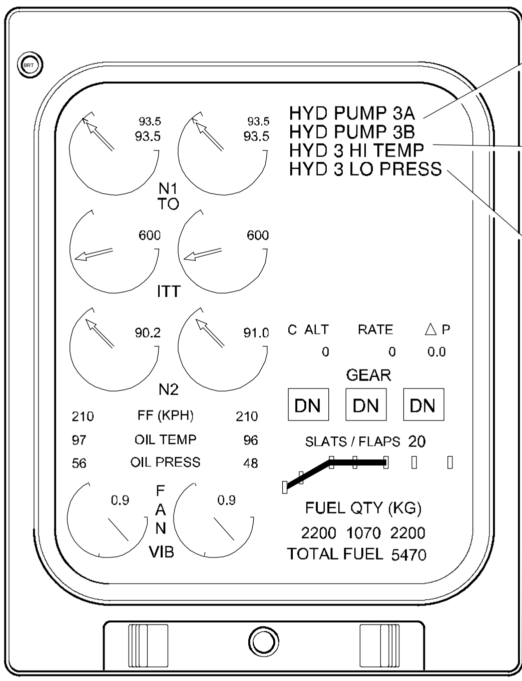
Hydraulic Pressure
Displays hydraulic pressure (in 100 psi increments). Normal operating pressure is 2800 to 3200 psi.
- White – Hydraulic pressure > 3200 psi.
- Green – Hydraulic pressure > 1800 psi and ≤ 3200 psi.
- Amber – Hydraulic pressure ≤ 1800 psi.
- Amber dashes – Invalid data.

Pump
Displays pump status.
- White – Pump not operating and selected off.
- Green – Pump output normal.
- Amber – Pump output low.
- Half–intensity magenta – Invalid data.

Hydraulic Page

System Distribution Table
Displays status of corresponding airplane systems.
- White – Adequate pressure to operate (> 1800 psi).
- Amber – Hydraulic supply to system inadequate (< 1800 psi).
- Half–intensity magenta – Invalid data.

Hydraulic Synoptic Page
Figure 14–30–3



HYD PUMP 3A or 3B caution (amber)
Indicates that corresponding AC motor pump has a low pressure output (< 1800 psi).

HYD 3 HI TEMP caution (amber)
Indicates that corresponding system has a fluid temperature of 96° C (205° F) or greater.

HYD 3 LO PRESS caution (amber)
Indicates that corresponding system pumps (both AC motor pumps) have a low pressure output (< 1800 psi).

Primary Page

Hydraulic EICAS Indications <1001>
Figure 14–30–4

B. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Hydraulic System 3	Pumps	HYD SYST AC PUMP CONT 3A	DC BUS 2	2	F14	
		HYD SYST AC PUMP CONT 3B	DC BUS 1	1	F11	
	Indication	HYD SYST IND 3	BATTERY BUS		L8	

CHAPTER 15 – ICE AND RAIN PROTECTION SYSTEM

Page

LIST OF ILLUSTRATIONS

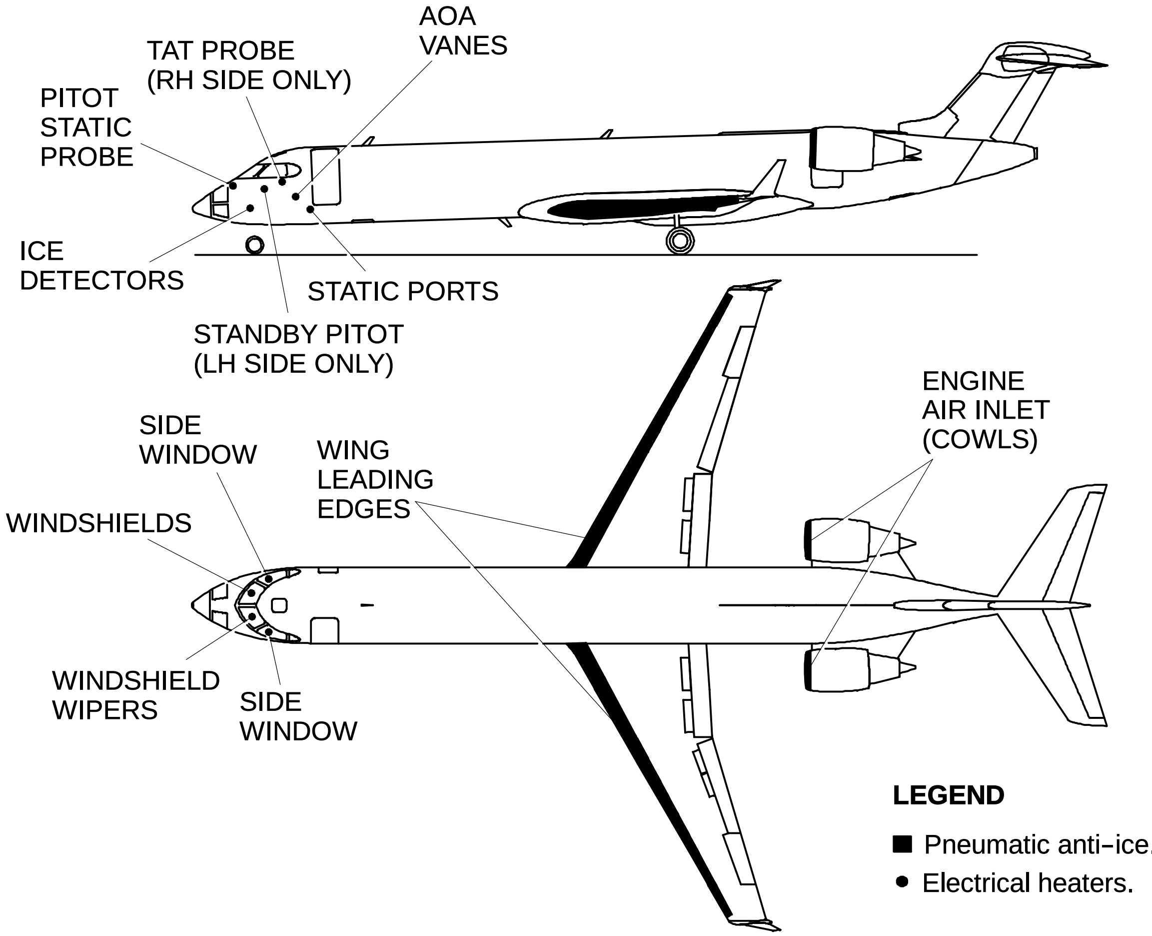
1. INTRODUCTION

Ice and rain protection is provided for the wing leading edges, engine intake cowl, windshields, side windows and the air data probes and sensors. An ice detection system alerts the flight crew of impending icing conditions.

Hot bleed air from the engine compressors is used to anti-ice the wing leading edges and engine intake cowl. Electrical power is used to anti-ice the windshields, side windows, air data probes and sensors. Electrical windshield wipers provide rain removal for the pilot and copilot's windshields.

A bleed air leak detection system monitors the bleed air ducting for leaks and overtemperature (refer to Chapter 19).

Ice and rain protection system warnings and cautions are displayed on the EICAS primary page. Status and advisory messages are displayed on the EICAS status page. A general view of the pneumatic anti-icing system is presented as a diagram on the EICAS A–ICE synoptic page.

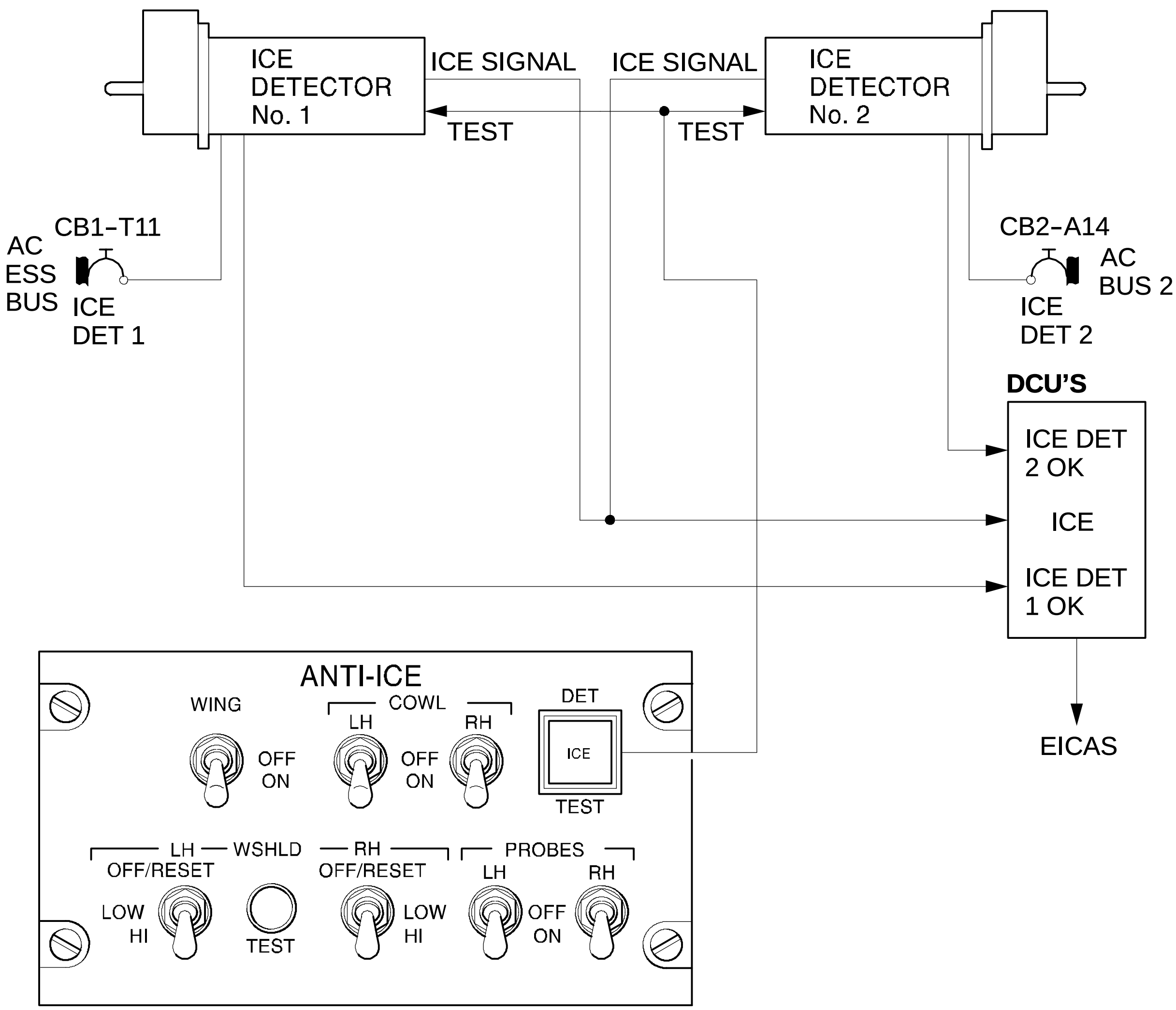


Anti–iced Areas
Figure 15–10–1

1. ICE DETECTION SYSTEM

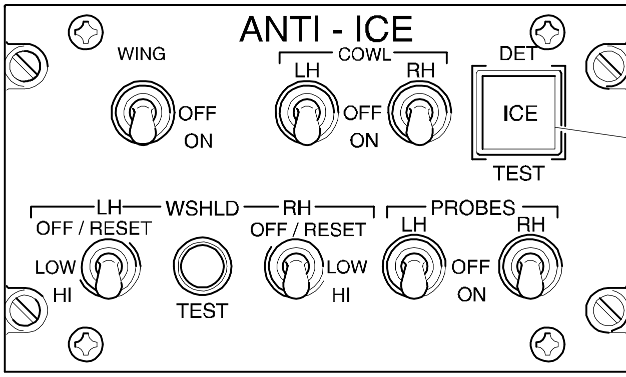
The aircraft is equipped with an ice detection system that alerts the flight crew of impending icing condition. The ice detection system consists of two independent ice detector assemblies located on each side of the forward fuselage. Each detector assembly includes a detector unit and a probe that extends into the airstream. The ice detection system is operational whenever AC power is available on the aircraft.

The ice detectors interface with the data concentrator units (DCU) to provide visual indications of icing conditions. When the probes detect an ice build up, a signal is sent by the unit to the EICAS and at the same time electrical power is used to de–ice the probe. When the probe is de–iced, it is then ready to detect ice formation again.



Anti–Ice Control Panel
Overhead Panel

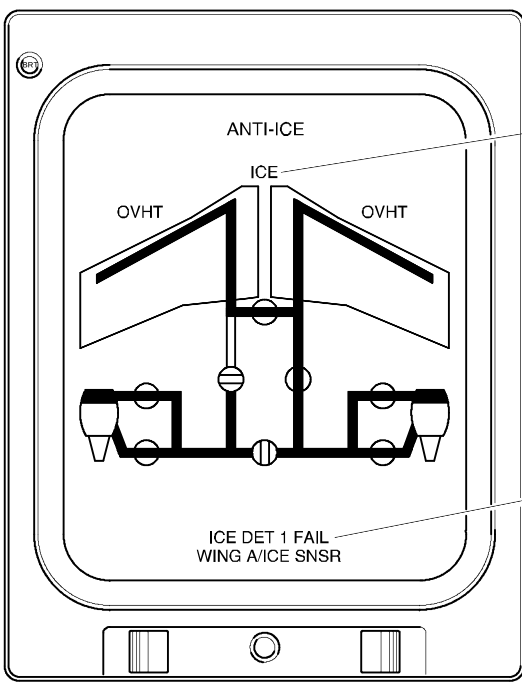
Ice Detection System – Schematic
Figure 15–20–1



DET / TEST
Used to test the ice detection and air data sensor heating systems. When pressed and held for five seconds; the master caution light flashes, the ICE caution message is displayed on EICAS primary page, the ADS HEAT TEST OK advisory message is displayed on EICAS status page, and the ICE light illuminates on the anti-ice panel.

- ICE (amber) light comes on to indicate that an icing condition has been detected and the wing and/ or cowl anti-ice systems are not selected on.

Anti-Ice Panel
Overhead Panel



ICE, ICE 1 or ICE 2 (amber)
Indicates that an icing condition has been detected by the respective detector(s) and wing or cowl anti-ice system is selected off or has failed.

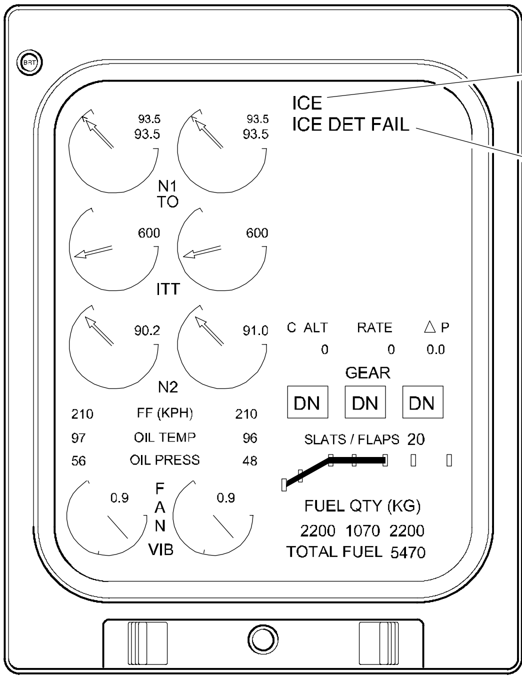
ICE, ICE 1 or ICE 2 (green)
Indicates that an icing condition has been detected by the respective detector(s) with wing and cowl anti-ice selected on and operating normally.

ICE DET 1 or 2 FAIL (white)
Indicates that respective ice detector has failed.

ICE DET FAIL (amber)
Indicates that both ice detectors have failed.

Anti-Ice Page

Ice Detection System
Figure 15-20-2



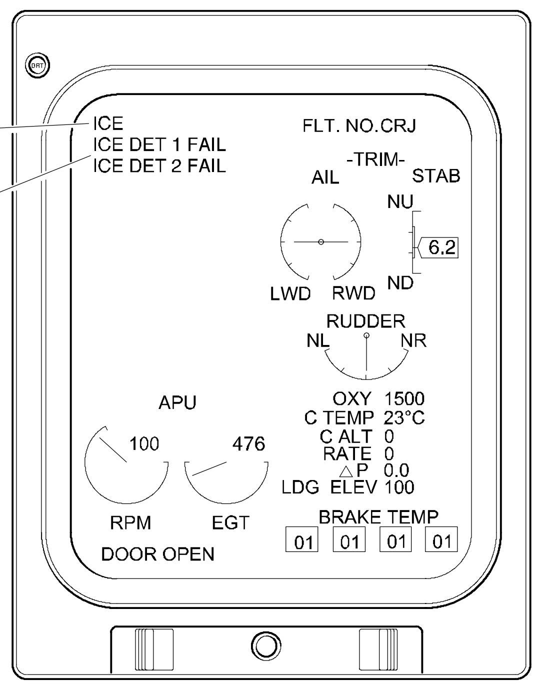
ICE caution (amber)
Indicates that an icing condition is detected and wing or cowl anti-ice system is selected off or has failed.

ICE DET FAIL caution (amber)
Indicates both ice detector systems have failed.

Primary Page

ICE advisory (green)
Indicates that an icing condition is detected with wing and cowl anti-ice selected on and operating normally.

ICE DET 1 or 2 FAIL status (white)
Indicates that respective ice detector system has failed and other system is operating normally.



Status Page

Anti–Ice System EICAS Indications <1001>
Figure 15–20–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Ice Detection System	Ice Detectors	ICE DET 1	AC ESSENTIAL	1	T11	
		ICE DET 2	AC BUS 2	2	A14	

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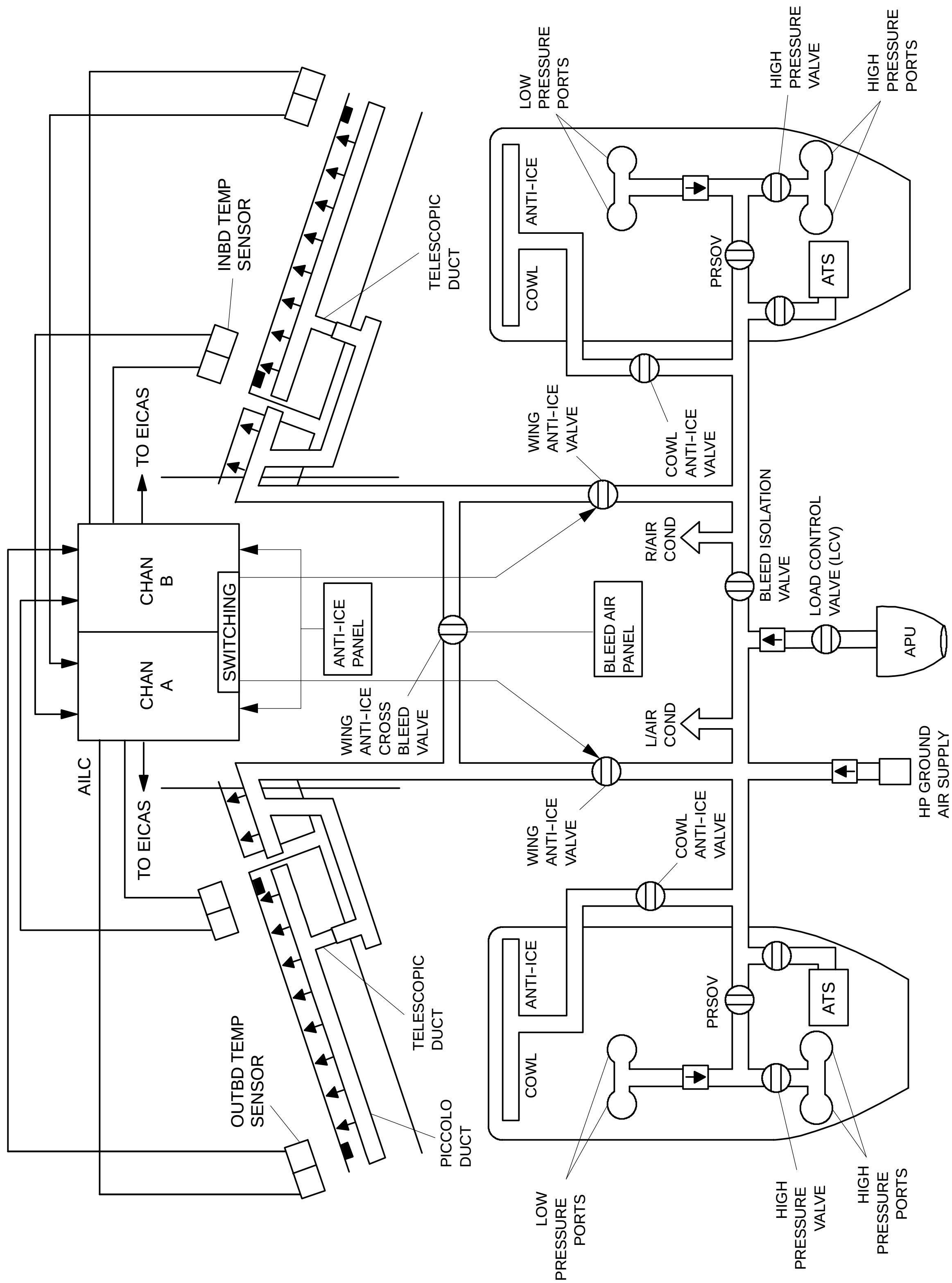
1. WING ANTI-ICE SYSTEM

The wing anti-ice system prevents ice formation on the wing leading edge by heating the surface using hot engine bleed air. The hot bleed air is supplied through insulated ducting and released through piccolo tubes to the inner surface of the wing and slat leading edges.

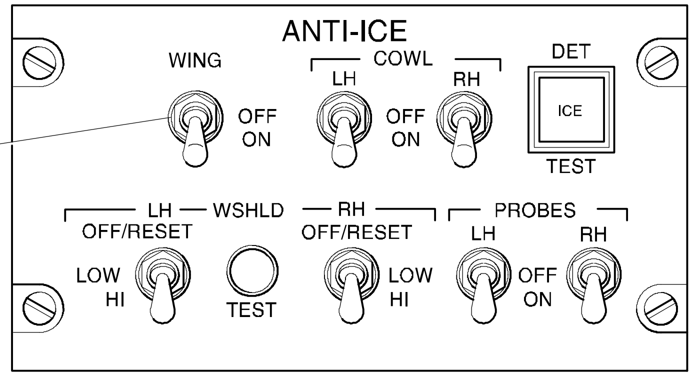
The wing anti-ice system is divided into identical left and right systems. In normal operation, each engine supplies bleed air to its respective wing anti-ice system. The systems are connected by a, normally closed, wing anti-ice cross bleed valve. In the event one system fails, the cross bleed valve is opened to permits cross bleed between systems. This ensures that wing anti-icing is maintained to both systems.

The system is manually activated and is automatically controlled by a dual channel digital anti-ice and leak detection controller (AILC). The AILC controls the wing anti-ice system using electrical inputs received from skin temperature sensors located at each wing leading edge. The AILC modulates the respective wing anti-ice valve open or closed as necessary to prevent ice formation. Each of the two channels of the AILC has the capability to control both left and right anti-ice valves.

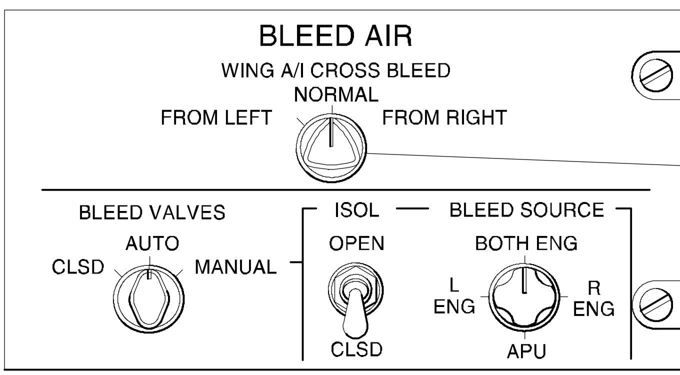


Wing Anti–Ice System Schematic
Figure 15–30–1

WING
Used to control wing anti-ice systems.



Anti-Ice Panel
Overhead Panel

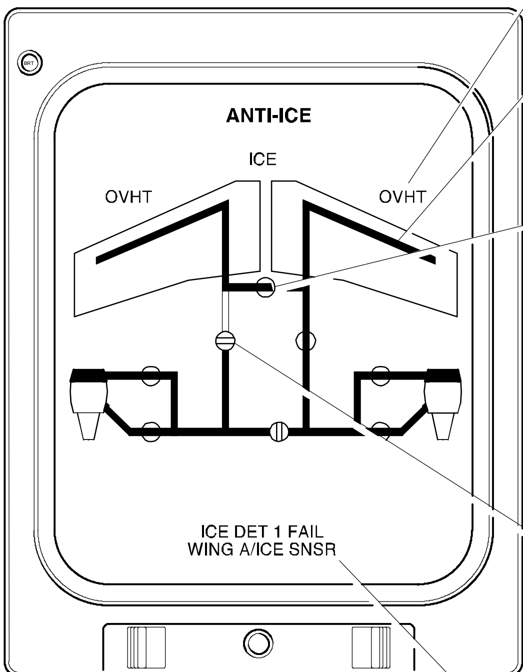


Bleed Air Panel
Overhead Panel

WING A/I CROSS BLEED
Used to control wing cross bleed valve.

- FROM LEFT - Wing cross bleed valve open and right wing anti-ice valve closed.
- NORMAL - Wing cross bleed valve closed.
- FROM RIGHT - Wing cross bleed valve open and left wing anti-ice valve closed.

Wing Anti–Ice Controls
Figure 15–30–2



Anti-Ice Page

OVHT (red)
Indicates that an overheat condition has been detected in the respective anti-ice system.

Wing Anti-Ice Flow Lines
- Green - System is selected on and is operating normally.
- Amber - Valve failed closed or low temperature detected when anti-ice is selected on
- Red - Bleed leak or overheat condition detected.

Wing Cross-Bleed Valve
Position Indicator

open (white)
closed (white)
failed to attain commanded position (half-intensity magenta)

NOTE

In case of an AILC Channel B failure, as indicated by a WING A/I FAULT status (white) message, the wing cross-bleed valve open position on the A/ICE synoptic page will not be available.

Wing Anti-Ice Valve
Position Indicator

open (white)
failed open (amber)
closed (white)
failed closed (amber)
valve not in selected position (half-intensity magenta)

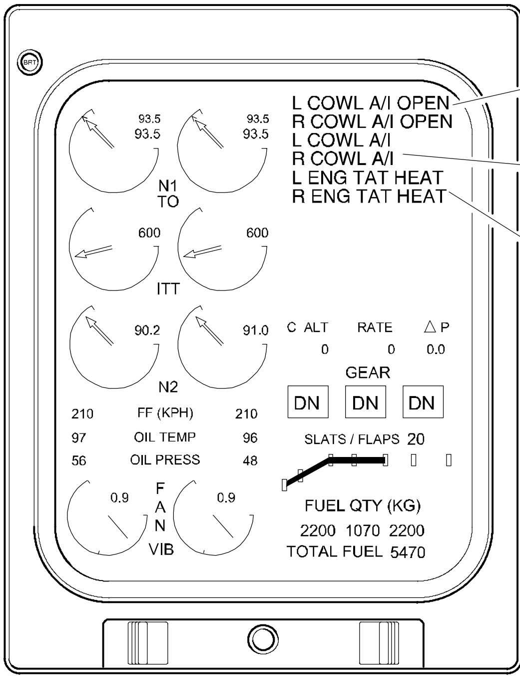
WING A/ICE SNSR (amber)
Indicates failure of both channels of left or right outboard wing temperature sensors with wing anti-ice selected on.

PENDING RECTIFICATION

NOTE

During Wing A/I Cross Bleed operations, both wings flow lines can be displayed amber with a L or R WING A/I caution message.

Anti−Ice Synoptic Page
Figure 15−30−3



L or R COWL A/I OPEN caution (amber)
Indicates that respective cowl anti-ice valve failed to close when selected off.

L or R COWL A/I caution (amber)
Indicates that the respective cowl anti-icevalve failed to open when selected on or valve position can not be determined.

L or R ENG TAT HEAT caution (amber)
Indicates that the respective T2 heater has failed.

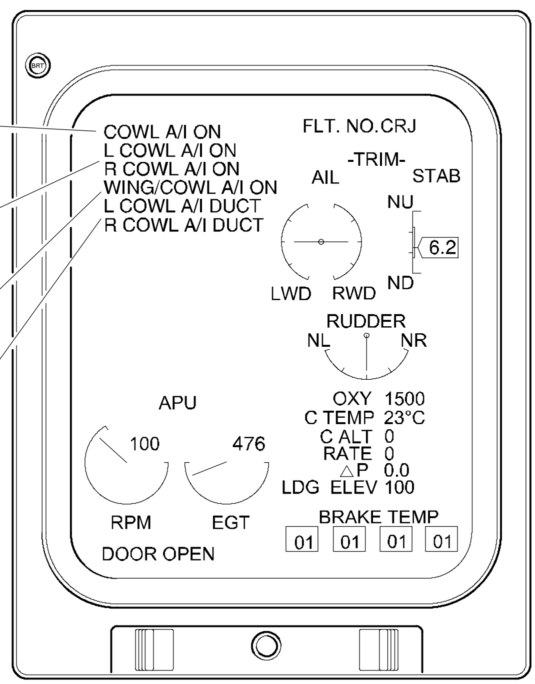
Primary Page

COWL A/I ON advisory (green)
Indicates that both left and right cowl anti-ice valves are open when selected on.

L or R COWL A/I ON advisory (green)
Indicates only the left or the right cowl anti-ice valve is open when both are selected on.

WING/COWL A/I ON advisory (green)
Indicates that both wing and cowl anti-ice systems are on and operating normally.

L or R COWL A/I DUCT status (white)
Indicates that respective cowl duct pressure is less than 3.12 psig or greater than 53.1 psig with battery bus powered.



Status Page

Wing Anti−Ice System EICAS Indications <1001>
Figure 15−30−4

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Wing Anti-Ice	Isolation Valve	WING A/ICE ISOL	BATTERY BUS	2	N5	
	Controller	A/ICE CONT CH A	DC BUS 1	1	D7	
		A/ICE CONT CH B	DC ESSENTIAL	2	T1	

1. ENGINE COWL ANTI-ICE SYSTEM

The engine cowl anti-ice system is used to prevent ice formation on the engine intake leading edges. This is done by using hot engine bleed air to heat the leading edge surface. The hot bleed air is supplied to the intake leading edges through respective L/R cowl anti-ice shutoff valves. Bleed air is distributed through insulated ducting and an air mixing tube before entering a double walled duct in the engine cowl leading edge. The inner portion of the duct carries the bleed air. In the event of a rupture of the inner wall, a bleed leak detector transducer mounted in the outer wall supplies a bleed leak signal to the EICAS to illuminate the L/R COWL A/I DUCT warning message.

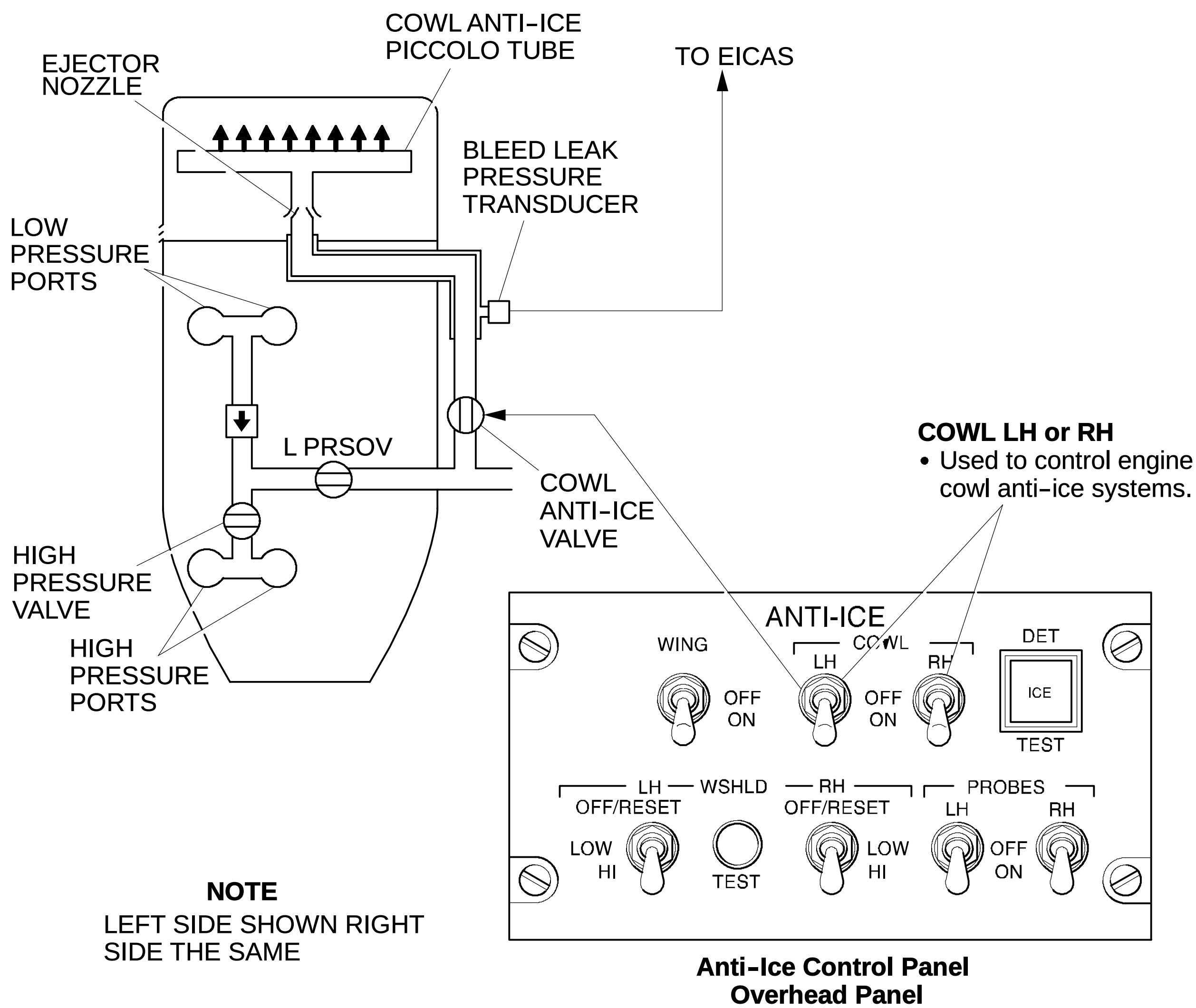
The left and right cowl anti-ice shutoff valves are manually controlled by respective LH and RH COWL switches on the ANTI-ICE control panel. Crew activation of each system, opens the respective engine cowl anti-ice shutoff valve. The shutoff valves are electrically controlled and pneumatically operated. Valve status is displayed on the EICAS, ANTI-ICE synoptic page.

2. T2 SENSOR PROBE ANTI-ICING

A fan inlet temperature sensing probe (T2), mounted on the engine cowling, is used to provide temperature data to the FADEC. The FADEC uses the information as one of the sensing parameters to set engine power and to control the compressor variable geometry stator vanes. The probe also contains a built-in heating element that is used to anti-ice the probe. Electrical heating power to the probe heating element is controlled by the FADEC.

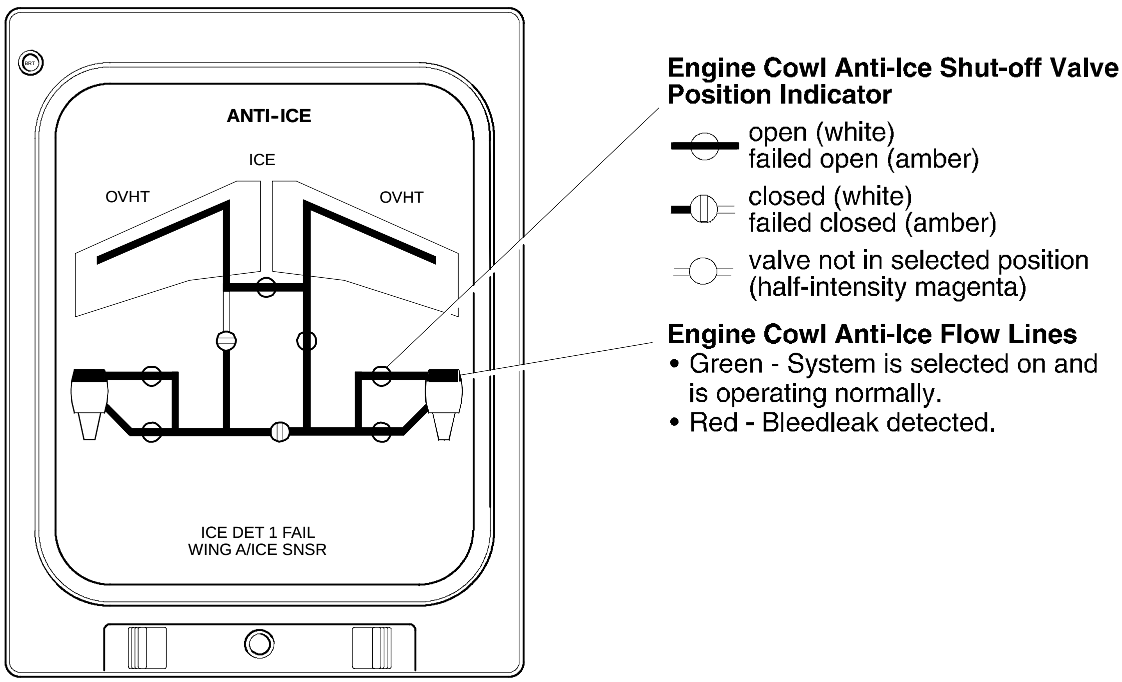
Testing of the T_2 heater function is done automatically by the FADEC, which initiates a system check after engine shutdown on the ground. Following right engine shutdown, electrical power must be maintained on the aircraft for at least one minute to make sure that the FADEC has sufficient time to successfully complete the test. The FADEC verifies T_2 heater function by energizing the heater and looking for an appropriate temperature rise during a 30 second period.

Following a successful test, the next test will be initiated after the next ground engine shutdown. If the FADEC (through channel A) cannot energize the T_2 heater, the FADEC will automatically switch to channel B to conduct the test (after a 30 second time delay). If the T_2 heater test fails on both channels, the respective L/R ENG TAT HEAT caution message will be displayed on the EICAS primary page and the FADEC will not attempt to energize the T_2 heater.



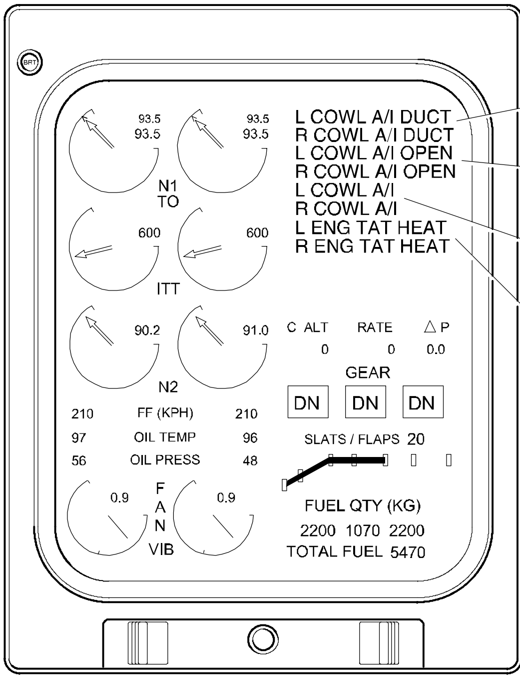
Anti-Ice Control Panel
Overhead Panel

Engine Cowl Anti-Ice System – General
Figure 15-40-1



Anti-Ice Page

Anti-Ice Synoptic Page
Figure 15-40-2



L or R COWL A/I DUCT warning (red)
Indicates that a bleed leak is detected by the leak pressure transducer in the cowl anti-ice duct.

L or R COWL A/I OPEN caution (amber)
Indicates that respective cowl anti-ice valve failed to close when selected off.

L or R COWL A/I caution (amber)
Indicates that the respective cowl anti-ice valve failed to open when selected on or valve position can not be determined.

L or R ENG TAT HEAT caution (amber)
Indicates that the respective T2 heater has failed.

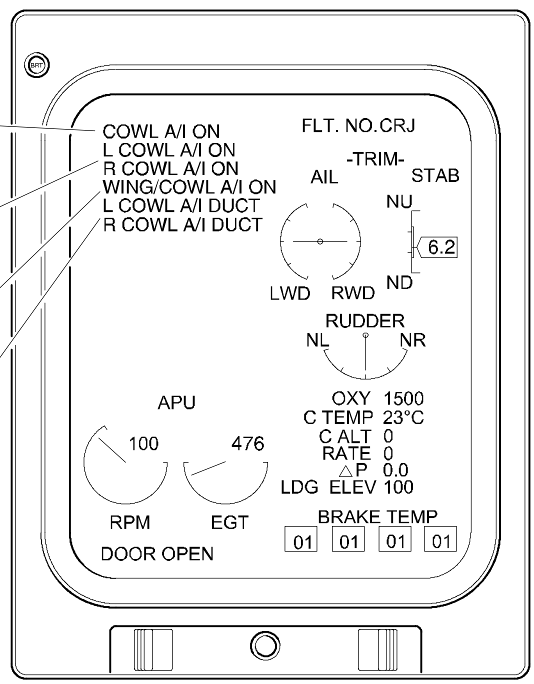
Primary Page

COWL A/I ON advisory (green)
Indicates that both left and right cowl anti-ice valves are open when selected on.

L or R COWL A/I ON advisory (green)
Indicates that the left or the right cowl anti-ice valve is open.

WING/COWL A/I ON advisory (green)
Indicates that both wing and cowl anti-ice systems are on and operating normally.

L or R COWL A/I DUCT status (white)
Indicates that respective cowl duct pressure is less than 3.12 psig or greater than 53.1 psig with battery bus powered.



Status Page

Engine Cowl – Anti–Ice EICAS Indications <1001>
Figure 15–40–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Engine Cowl Anti-Ice	Anti-Ice Valves	A/ICE VALVE L ENG	BATTERY BUS	2	N3	
		A/ICE VALVE R ENG			N4	
	T2 Heaters	T2 HEATER L	DC BUS 1	1	F4	
		T2 HEATER R	DC BUS 2	2	F4	

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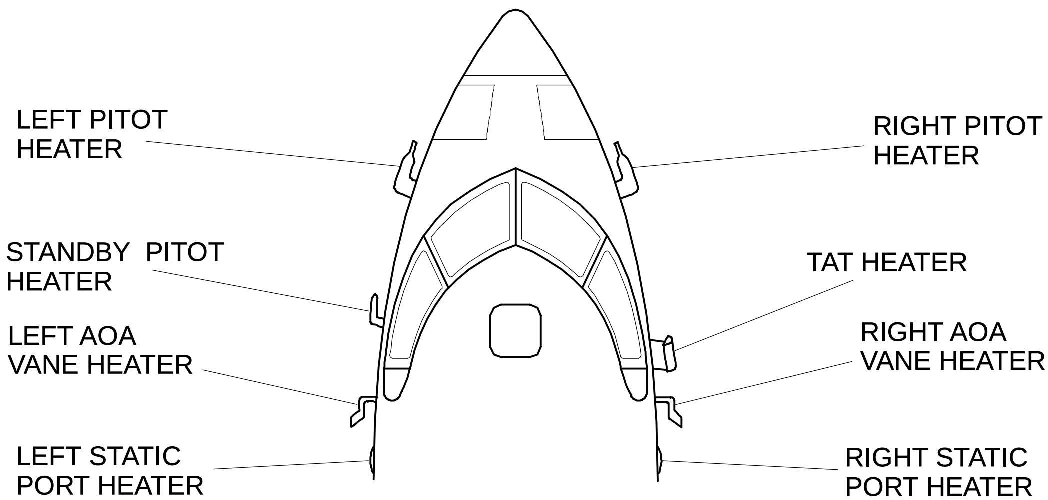
1. AIR DATA ANTI-ICE SYSTEM

Air data probes and sensors are located on the left and right sides of the forward fuselage and extend into the airstream. The air data sensor (ADS) anti-ice system consists of integral, self regulating, heating elements for the air data sensors and probes. The ADS heaters prevent ice formation that may cause erroneous air data information. ADS anti-icing is achieved by electronically controlling the heating elements. The air data sensor heating system is activated automatically on the ground and in flight.

The ground mode has two operational heating modes, automatic and manual. In automatic mode, when either engine generator is on and the LH and RH PROBES switches, (on the ANTI-ICE control panel) are OFF, the LH and RH pitot probes and the standby pitot probe are heated at half power (automatic mode is not functional when the aircraft is being powered by the APU generator or external power). The static ports and the AOA vanes are not powered automatically in the ground mode. For manual mode, the static ports and the AOA vanes can be heated by selecting the LH and RH PROBES switches to ON.

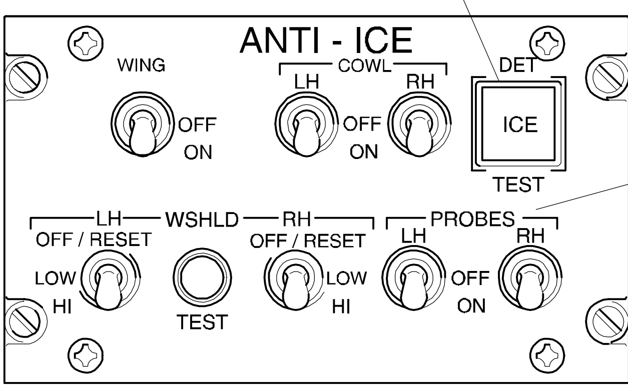
In the flight mode, the automatic control function is completely independent of the control switches. The controllers automatically supply full power to all the air data probes and sensors. The LH and RH PROBES switches have no effect on the function of the controllers.

The air data probes and sensors are monitored and controlled by three independent and identical controllers. Controller 1 monitors the heater elements for the left pitot, left angle of attack (AOA) vane and left static port. Controller 2 monitors the right pitot, right AOA vane and right static port. Controller 3 monitors the standby pitot and total air temperature (TAT) probe.



DET / TEST
Used to test the ice detection and air data sensor heating systems. When pressed and held for five seconds, the master caution light flashes, the ICE caution message is displayed on EICAS primary page, the ADS HEAT TEST OK advisory message is displayed on EICAS status page, and the ICE light illuminates on the anti-ice panel.

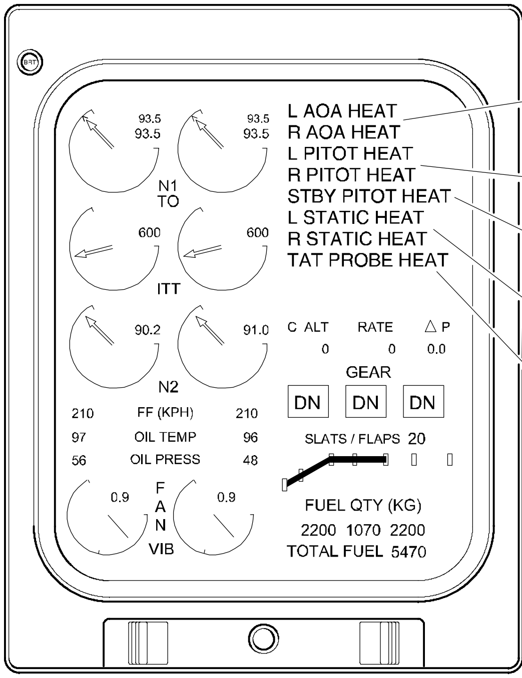
- ICE (amber) light comes on to indicate that an icing condition has been detected and the wing and/or cowl anti-ice systems are not selected on.



Anti-Ice Control Panel
Overhead Panel

PROBES LH and RH
Used to manually activate the air data sensor anti-ice systems. During normal flight operations, all heaters are automatically controlled, regardless of switch position.

Air Data Sensor Anti-Ice System
Figure 15-50-1



L or R AOA HEAT caution (amber)
Indicates that respective angle of attack heater is off or has failed.

L or R PITOT HEAT caution (amber)
Indicates that respective pitot tip heater is off or has failed. Also indicates that respective pitot base heater is off or has failed in flight.

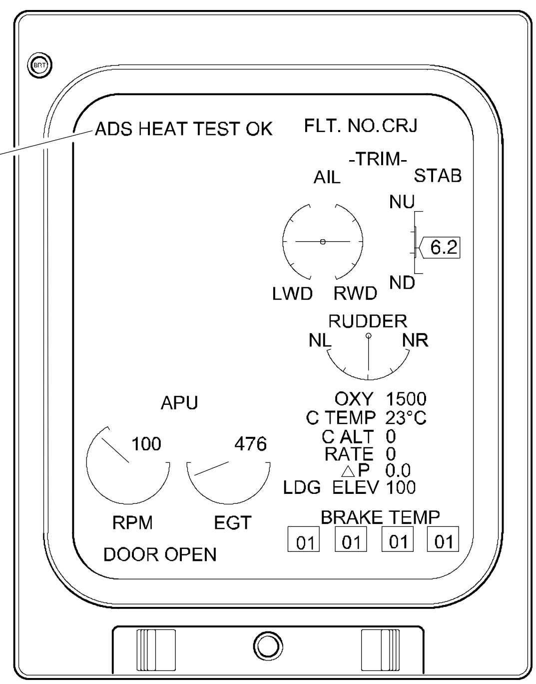
STBY PITOT HEAT caution (amber)
Indicates that standby pitot heater is off or has failed.

L or R STATIC HEAT caution (amber)
Indicates that respective static port heater is off or has failed.

TAT PROBE HEAT caution (amber)
Indicates that total air temperature probe heater has failed with AC bus 1 powered.

Primary Page

ADS HEAT TEST OK advisory (green)
Indicates that the air data sensor anti-ice system was tested successfully.



Status Page

Air Data Sensor Anti–Ice EICAS Indications <1001>
Figure 15–50–2

A. System Circuit Breakers

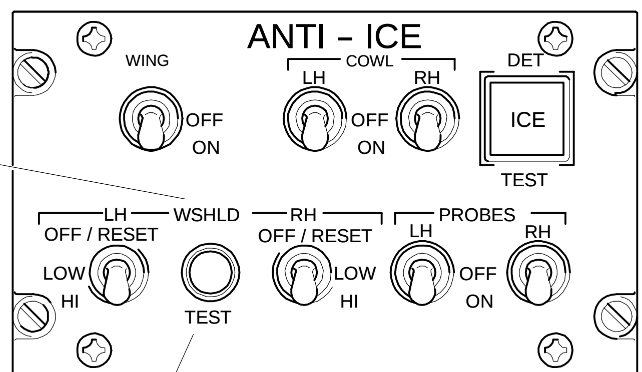
SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Air Data Sensor Anti-Ice	TAT Heater	HEATERS TAT	AC BUS 1	1	A12	
	Pitot Heaters	HEATERS PITOT R			A14	
		HEATERS PITOT L	AC ESSENTIAL		T7	
		HEATERS PITOT STBY			T9	
	AOA Heaters	HEATERS AOA L			T8	
		HEATERS AOA R	AC BUS 1		A13	
	Static Heaters	HEATERS STATIC R	DC BUS 1		G14	
		HEATERS STATIC L	DC ESSENTIAL	2	S1	
	Controllers	HEATERS ADS CONT 1			S2	
		HEATERS ADS CONT STBY			S3	
		HEATERS ADS CONT 2	DC BUS 1	1	G13	

1. WINDSHIELD AND SIDE WINDOW ANTI-ICE SYSTEM

Windshield and side window anti-icing is achieved by electrically heating the windshield and side windows. Each windshield and side window incorporates an electrical heating element and three temperature sensors. One sensor is used for normal temperature control and another is used for overheat detection. The third sensor is a spare, and is used should one of the other sensors fail.

The amount of heat supplied to the windshields and side windows is controlled by four identical temperature controllers, one for each window. The controllers automatically regulate power to the heating elements as selected by the LOW/HI WSHLD switches on the ANTI-ICE control panel. When an overheat condition is detected, the associated controller removes the power to the heater element and posts a caution message on the EICAS primary page.

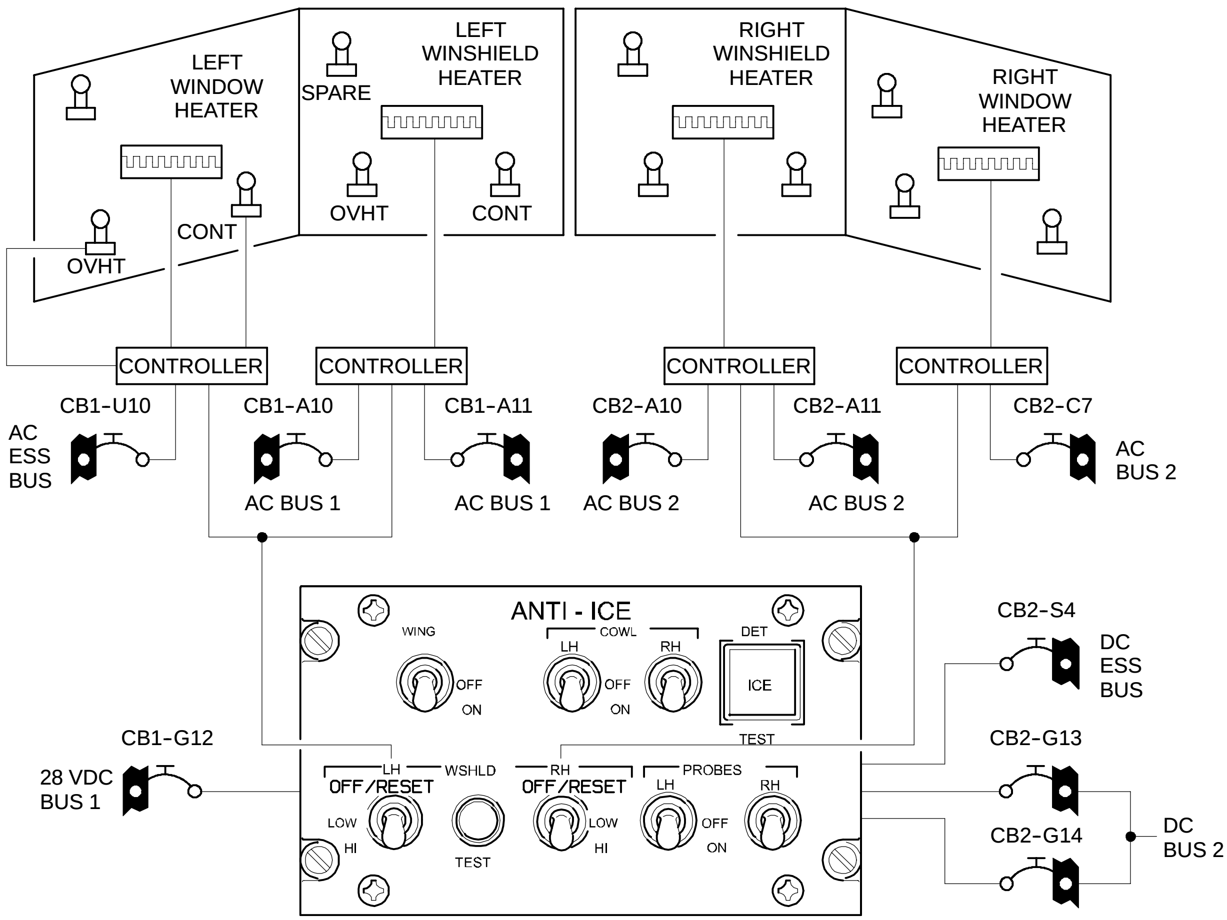
WSHLD LH and RH
Used to control windshield and side window anti-ice systems.
- LOW - Used for de-misting and de-fogging of the windshield and side window.
- HI - Used for de-icing of the windshield only. The side window remains at the low setting.
- OFF/RESET - Removes power and resets the controllers.



Anti-Ice Control Panel
Overhead Panel

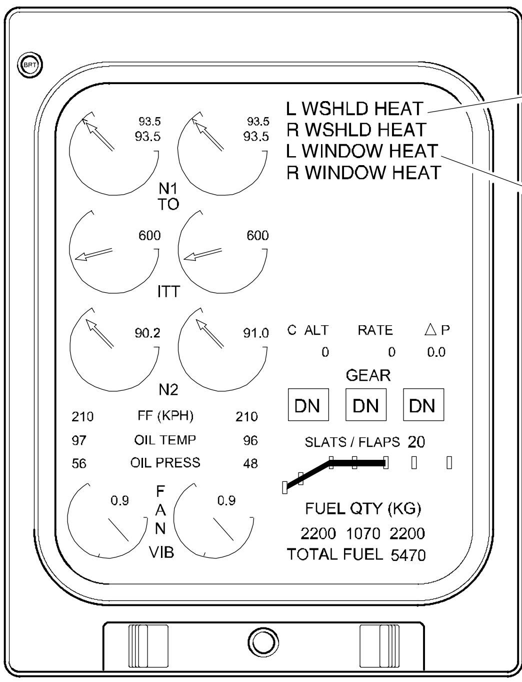
TEST
Used to test the windshield and side window anti-ice system.
Caution messages appear during test.

Windshield and Side Window Anti-Ice Controls
Figure 15-60-1



Anti-Ice Panel
Overhead Panel

Windshield Temperature Control
Figure 15-60-2



L or R WSHLD HEAT caution (amber)
Indicates an overheat or a no heat condition at the respective windshield heater.

L or R WINDOW HEAT caution (amber)
Indicates an overheat or a no heat condition at the respective window heater.

Primary Page

Windshield and Side Window Anti–Ice EICAS Indications <1001>
Figure 15–60–3

A. System Circuit Breakers

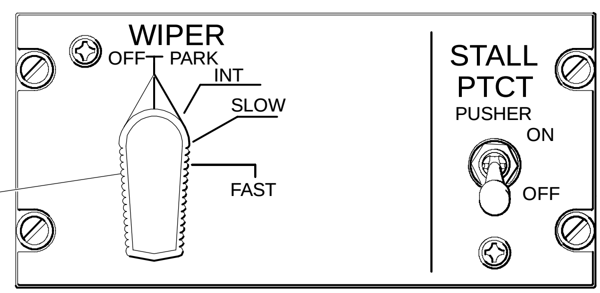
SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Windshield and Side Window Anti-Ice	Heaters	HEATERS L WSHLD	AC BUS 1	1	A10-A11	
		HEATER L WIND	AC ESSENTIAL		U10	
		HEATERS R WSHLD	AC BUS 2	2	A10-A11	
		HEATER R WIND			C7	
	Controllers	HEATERS CONT L WSHLD	DC BUS 1	1	G12	
		HEATERS CONT L WIND	DC ESSENTIAL	2	S4	
		HEATERS CONT R WSHLD	DC BUS 2		G13	
		HEATERS CONT R WIND			G14	

1. WINDSHIELD WIPER SYSTEM

The windshield wiper system is designed to remove rain and/or snow from the pilot and co-pilot's windshields at speeds up to 250 knots.

The windshield wiper system consists of independent pilot and copilot systems. Each system consists of a windshield wiper and motor with both systems being controlled by an electronic control unit. Each pilot has a selector, located on the WIPER control panel that actuates both wipers. Under normal operations, both wipers will operate in the same mode when selected from either panel. If each selector is set to a different mode, the last selection made overrides the previous selection. If one wiper system fails, the remaining system will still be functional.

WIPER
- OFF-PARK - Stows the wiper blades and stops the motors.
- INT - Wipers operate at one cycle every 5 seconds.
- SLOW - Wipers operate at 80 cycles per minute.
- FAST - Wipers operate at 125 cycles per minute.



WIPER CONTROL PANEL

Windshield Wiper Control Panel
Figure 15–70–1

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Windshield Wiper System	Wipers	WIPER PILOT	DC BUS 1	1	G5	
		WIPER C/PLT	DC BUS 2	2	G5	

CHAPTER 16 – LANDING GEAR

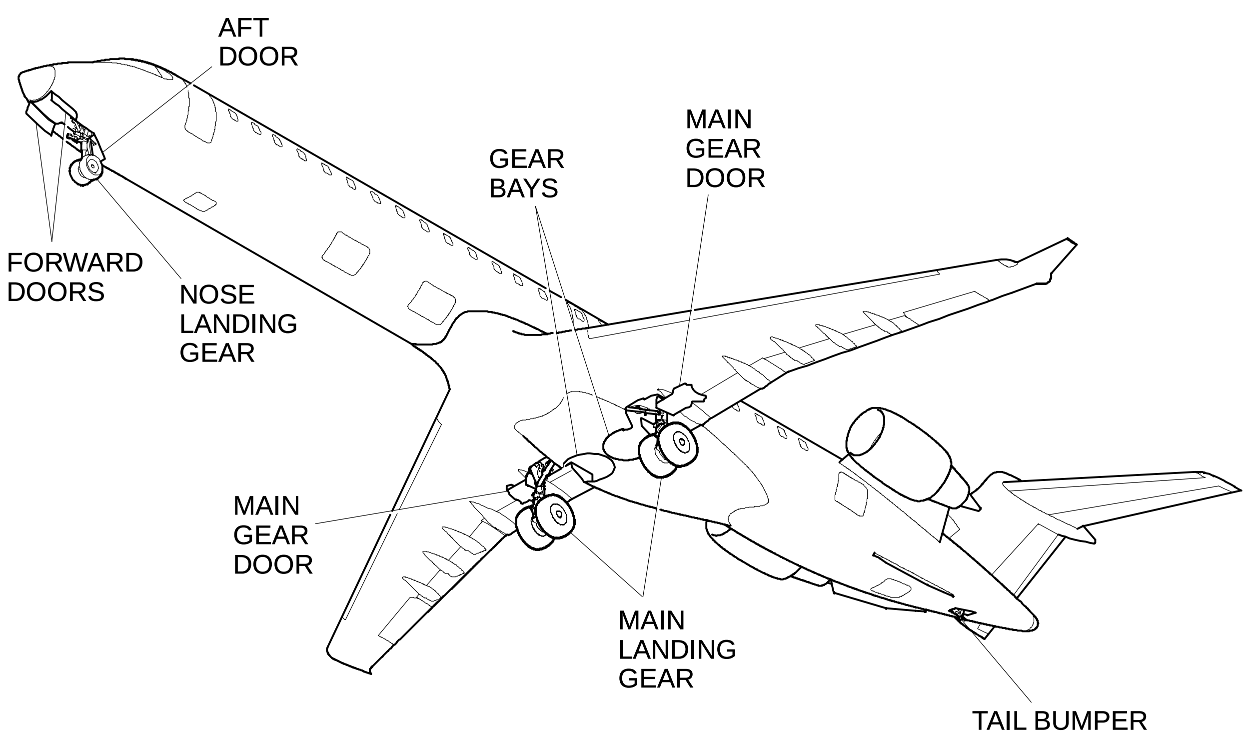
LIST OF ILLUSTRATIONS

1. INTRODUCTION

The landing gear is a retractable tricycle type consisting of two wing root mounted main landing gear assemblies and a forward fuselage mounted steerable nose landing gear assembly. Each gear assembly has two wheels. The main landing gear assemblies retract inboard and the nose landing gear assembly retracts forward. Each landing gear has a shock strut to absorb and dissipate the shock loads encountered when the aircraft lands. The main landing gear are fitted with steel multi-disc brakes.

Landing gear extension and retraction is electrically activated by the landing gear selector lever and controlled by the proximity sensing electronic unit (PSEU). Sensors for the PSEU are mounted on the landing gear and landing gear doors. The PSEU also provides landing gear position indication on the EICAS display. The landing gear is hydraulically actuated by hydraulic system 3, in normal operation. An alternate independent means of extending the landing gear is available should the normal extension system fail.

A tail bumper protects the aircraft tail structure from tail strikes caused by over-rotation of the aircraft on take-off. The tail bumper consists of a shock absorber, a skid assembly and a strike indicator.



Landing Gear Assemblies
Figure 16–10–1

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1. NOSE AND MAIN LANDING GEAR

Normal extension or retraction of the landing gear is initiated by landing gear control handle selection. The retraction or extension signal is sent to the proximity sensing electronic unit (PSEU) which monitors various landing gear proximity sensing inputs and weight-on-wheels inputs. If the correct parameters are met, the PSEU energizes a selector valve to retract or extend the landing gear using hydraulic system No. 3 pressure.

The landing gear control handle is equipped with a solenoid lock which prevents an up selection of the landing gear control handle with the aircraft on the ground. In the event of a solenoid lock malfunction, a downlock release on the landing gear control panel, permits up selection of the landing gear control handle by overriding the solenoid lock.

Retraction and extension of each landing gear is driven by a retract/extend actuator. An auxiliary actuator, powered by hydraulic system No. 2 provides a backup means of extending the main landing gear.

Tension springs assisted by a downlock actuator ensure that the main gear locks in the down position. The lock is released at the start of the retraction cycle. An uplock assembly locks the main gear in the retracted position. An uplock release actuator releases the uplock assembly at the start of the extension cycle.

The nose landing gear locks in both the extended or retracted positions with a spring-loaded, over-centre type locking mechanism. A lock actuator moves the locking mechanism out of the over-center condition at the beginning of each cycle.

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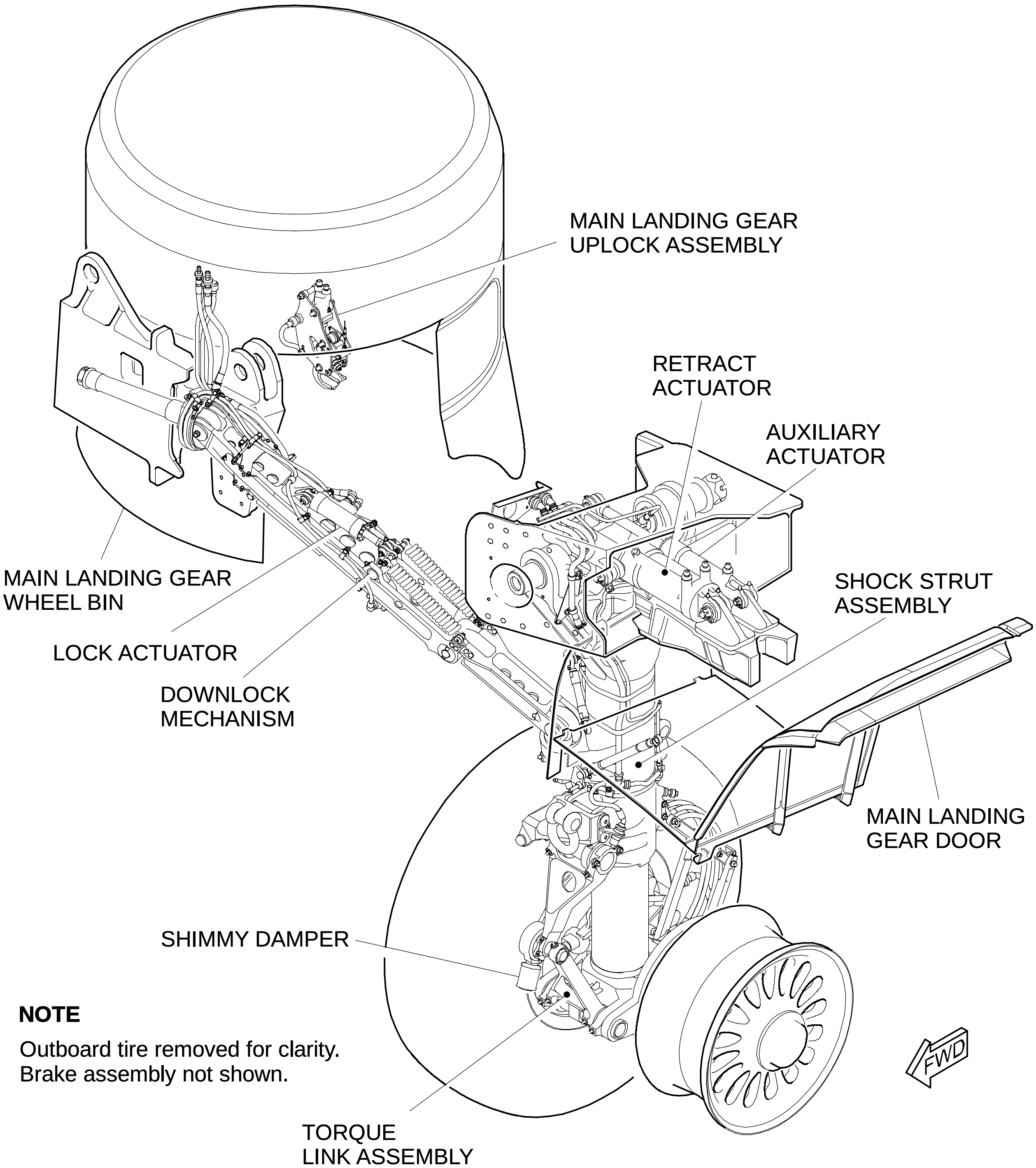
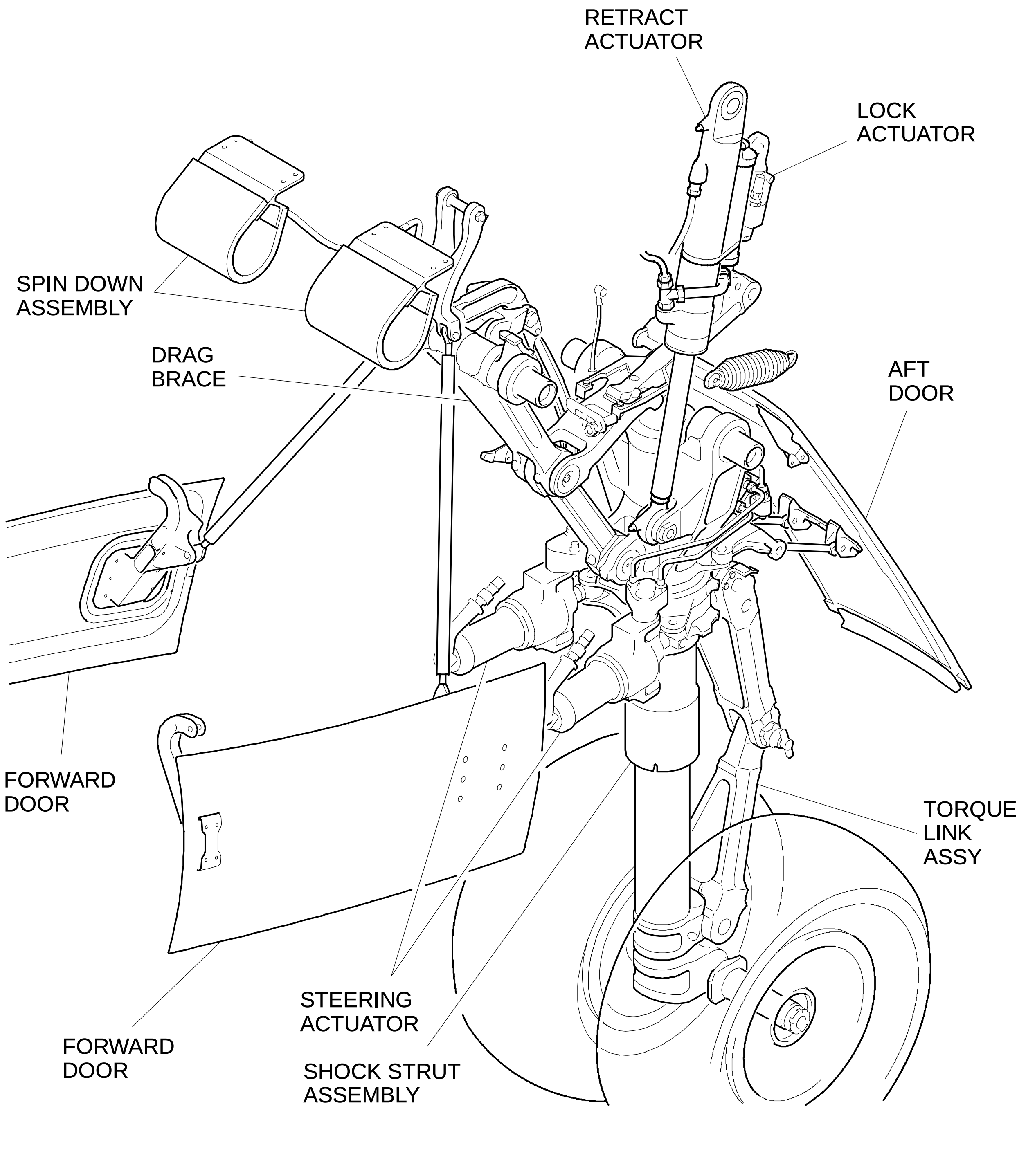
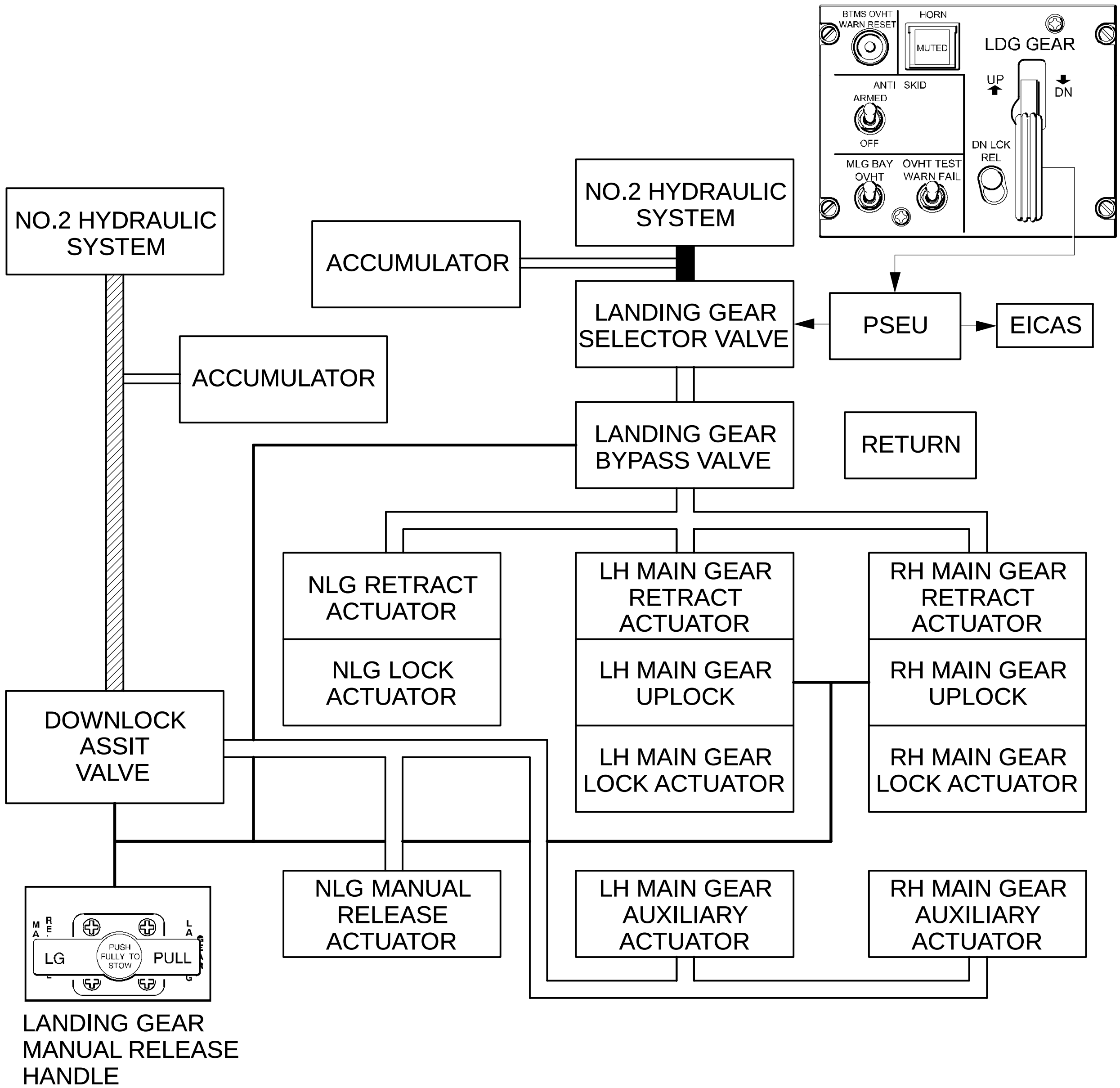


Main Landing Gear
Figure 16−20−1



Nose Landing Gear
Figure 16–20–2



Landing Gear Retraction and Extension – Schematic
Figure 16–20–3

For landing gear retraction:

Once the aircraft is airborne, with no weight-on-wheels signal, the PSEU commands and monitors the following events:

- The landing gear control handle solenoid downlock is released to permit UP selection of the landing gear control handle.
- The landing gear selector valve energizes the nose and main landing gear retract/extend actuators, releases the downlocks and retracts the landing gear. Hydraulic pressure from the landing gear up line is routed to activate the brake control valves to stop main wheel rotation. The tire spin–down assembly in the nose landing gear bay stops nose wheel rotation.
- Uplocks are engaged to secure the landing gears in the retracted position.

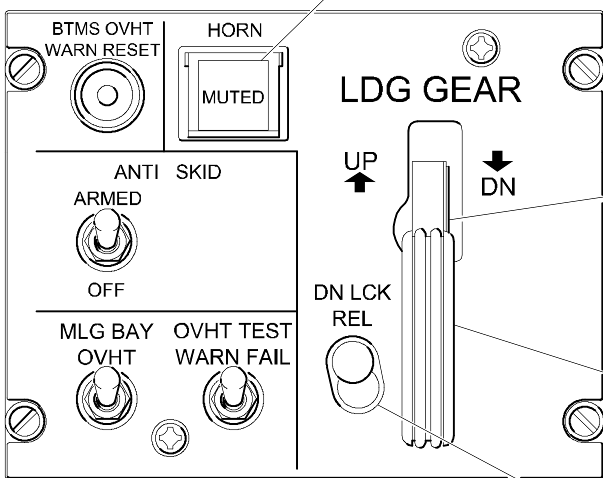
For landing gear extension:

The PSEU commands and monitors the following events:

- The landing gear control handle is manually selected to the DN position.
- The landing gear selector valve energizes the nose and main landing gear retract/extend actuators, releases the uplocks and extends the landing gear.
- Downlocks are engaged to secure the landing gear in the extended position.

To prevent the landing gear from retracting when the aircraft is on the ground, ground lock pins are inserted by the ground crew.

HORN
Used to mute landing gear warning horn.
- MUTE (white) light indicates that landing gear warning horn has been muted.

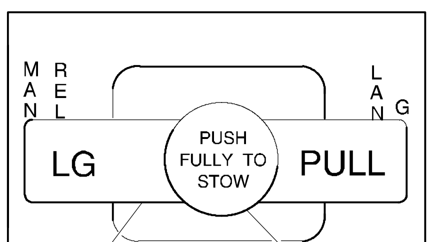


Landing Gear Lever Down Lock
Prevents inadvertent landing gear up selection when on ground.
When airborne, a weight-off-wheels signal from the PSEU disengages the lock to permit a gear up selection.

Landing Gear Lever
Used to retract and extend landing gear.

Landing Gear Control Panel
Centre Instrument Panel

DN LCK REL
Used to manually release the landing gear lever down lock.



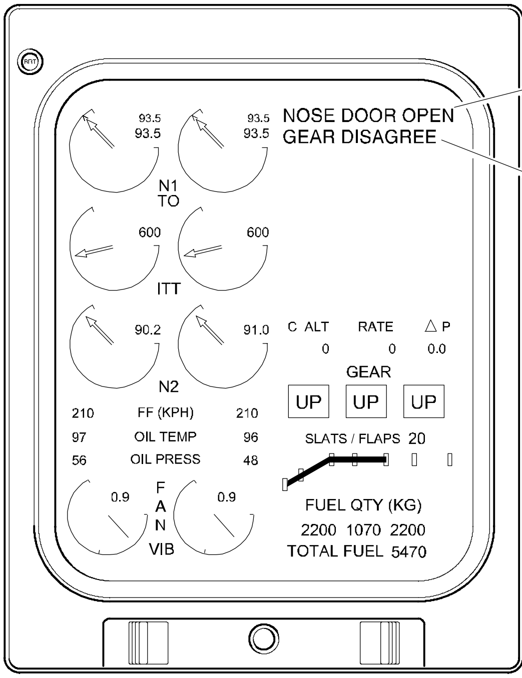
Landing Gear Manual Release
Used to manually lower the landing gear.
- Pull and hold handle in the fully extended position until EICAS indicates the nose and main landing gear are down and locked.

NOTE

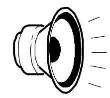
Considerable force is required to operate the landing gear manual release system.

PUSH FULLY TO STOW
Used to reset the manual release system.
- Hold handle, press button and then slowly return handle to the stowed position.

Landing Gear Controls
Figure 16−20−4

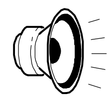


NOSE DOOR OPEN warning (red)
Indicates that either nose landing gear door is not closed after gear is up.



NOSE DOOR

GEAR DISAGREE warning (red)
Indicates that landing gear position does not agree with landing gear control handle position.

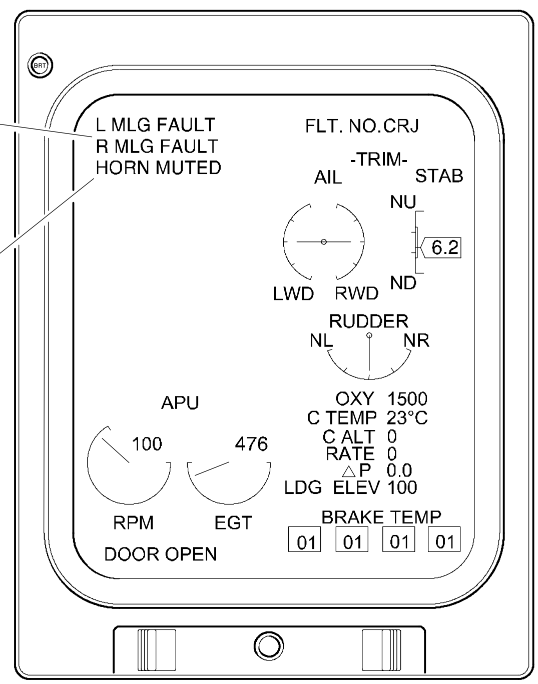


GEAR DISAGREE

Primary Page

L or R MLG FAULT status (white)
Indicates that left or right actuator shuttle valve or the pressure switch have failed in the closed position (for MLG downlocked)
OR
Left or right actuator pressure switch has failed in open position (for MLG uplocked).

HORN MUTED status (white)
Indicates that landing gear warning horn has been manually muted.



Status Page

Landing Gear EICAS Indications <1001>
Figure 16–20–5

A. Alternate Landing Gear Extension

If a failure occurs in the landing gear control system or in hydraulic system No. 3, the landing gear can still be extended by pulling the landing gear manual release handle.

When the manual release handle is pulled, the main landing gear uplocks are released by mechanical means, and at the same time a bypass valve dumps hydraulic system No. 3 pressure from the normal extension and retraction hydraulic circuits. This will permit the landing gear to partially extend under its own weight. The manual release handle also positions a downlock assist valve to direct hydraulic system No. 2 pressure to the main landing gear auxiliary actuators and to the nose gear uplock manual release actuator.

The main landing gear is assisted to the down-and-locked position by the main gear auxiliary actuators and the nose landing gear is assisted to the down-and-locked position by airflow and two tension springs.

B. Wheels and Tires

Each wheel has a pressure relief plug (overpressure valve) and an inflation valve. Refer to the Aircraft Maintenance Manual for tire pressure adjustment.

Four heat sensitive fusible plugs are installed in each main wheel to release excessive air pressure caused by heat build–up. The fusible plugs protect the main wheel against tire burst that could occur under heavy braking activity.

C. Landing Gear Doors

The landing gear doors are mechanically linked to the landing gear. The doors close when the gear retracts and open when the gear extends.

1. PROXIMITY SENSING SYSTEM

The proximity sensor system (PSS) includes the proximity sensor electronics unit (PSEU) and associated proximity sensors and proximity switches installed throughout the aircraft. The PSS provides five basic functions:

- Normal landing gear positioning control
  The PSS provides the signals that command the landing gear extend and retract solenoids to change the position of the landing gear.

- Landing gear position indication
  The PSS monitors landing gear position and provides indication of the position status of the landing gear.

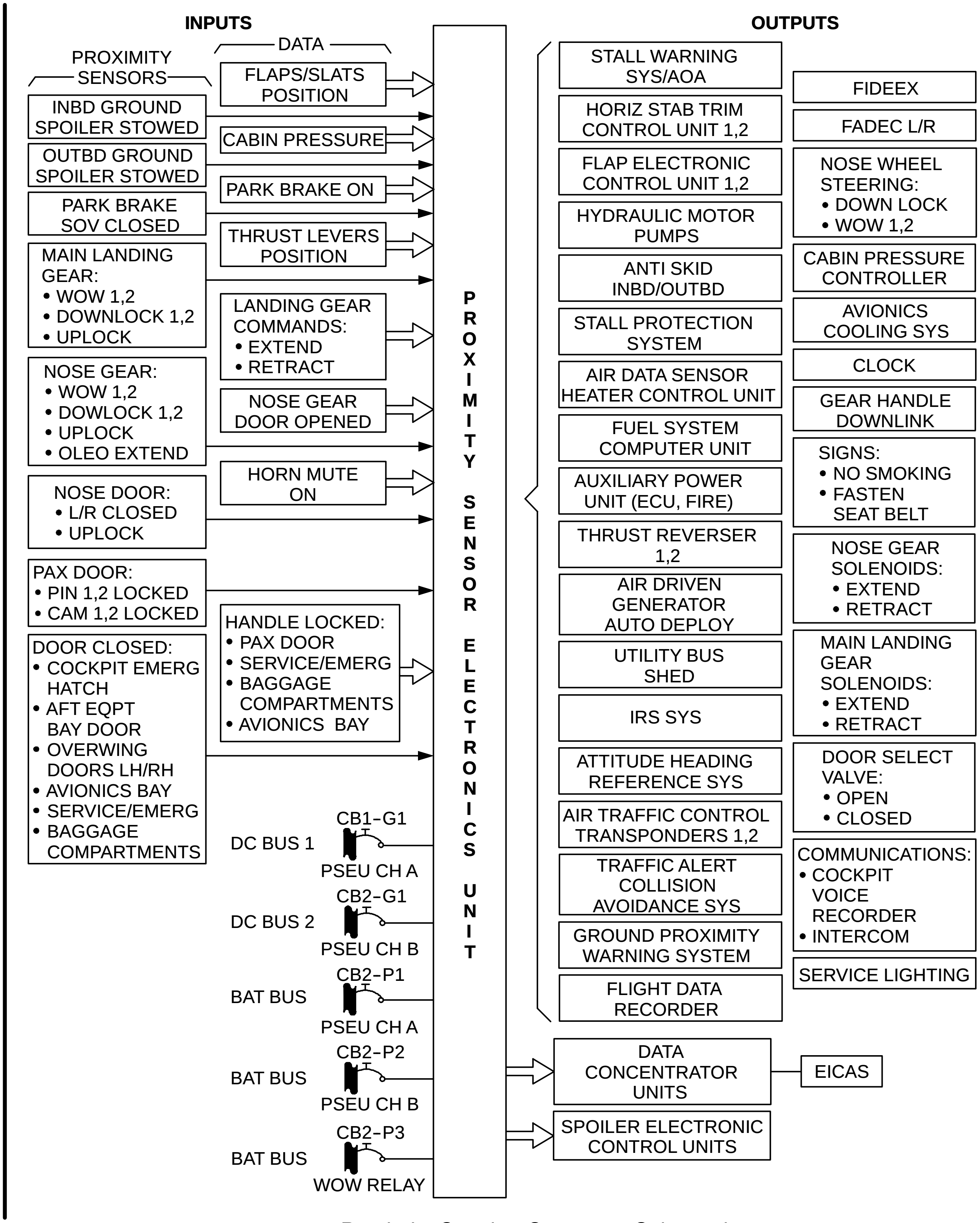
- Weight-on-wheels indication
  The PSS monitors landing gear strut compression and provides indication of air or ground status of the aircraft.

- Fuselage door indication
  The PSS monitors fuselage door position, latches and lock status and provides indication of the status of the doors (refer to Chapter 6).

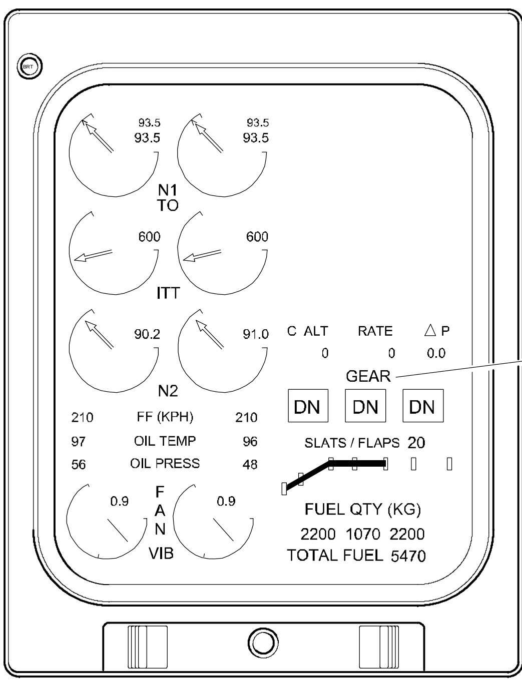
- Thrust reverser indication
  The PSS monitors and reports to EICAS the stowed/unstowed status of the left and right thrust reversers (refer to Chapter 20).

The PSEU, after processing sensor inputs, generates outputs that are used to control landing gear position, report status and provide control data for other systems.

Continuous and periodic tests are performed by the PSEU to monitor specific aircraft systems health and status. Landing gear position and status are displayed on the engine indication and crew alerting system (EICAS) primary page. The landing gear position indication is removed 30 seconds after the landing gear is in the up and locked position with the flaps at 0 degrees.



Proximity Sensing System – Schematic <1025>
Figure 16–30–1

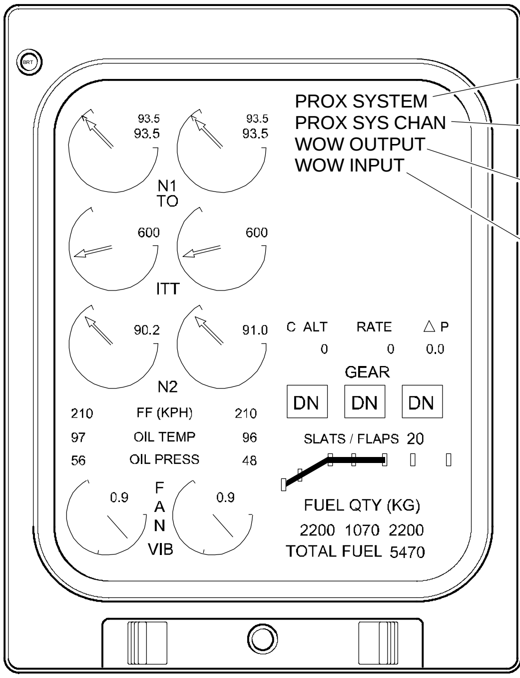


Primary Page

Landing Gear Position Indicator

- UP (white) – Indicates that respective landing gear is in the up and locked position.
- DN (green) – Indicates that respective landing gear is in the down and locked position.
- (amber) – Indicates that respective landing gear is in transition.
- (red) – Indicates that respective landing gear is not safe.
- – – (amber dashes) – Indicates that respective landing gear is in unknown position.

Landing Gear Position Indicator <1001>
Figure 16–30–2



Primary Page

PROX SYSTEM caution (amber)
Indicates loss of both PSEU channels.

PROX SYS CHAN caution (amber)
Indicates loss of one PSEU channel or input/output of a critical system.

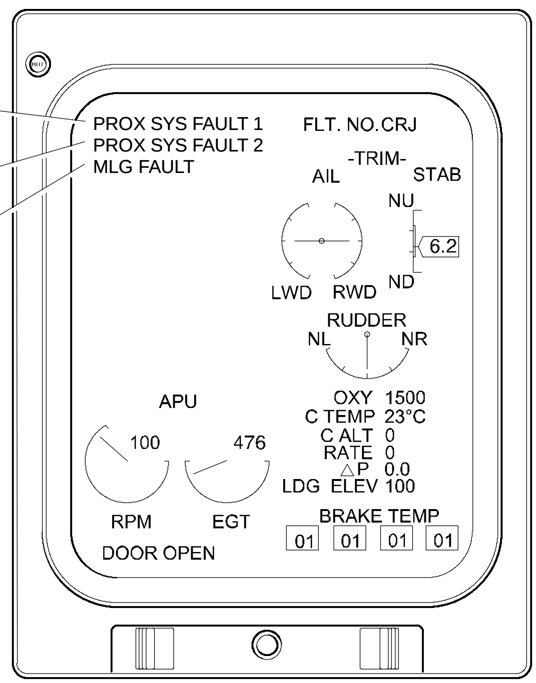
WOW OUTPUT caution (amber)
Indicates that WOW output failed or disagrees with another critical output.

WOW INPUT caution (amber)
Indicates that two or more WOW sensors disagree or have failed.

PROX SYS FAULT 1 status (white)
Indicates a failure of any one PSEU input or output related to a critical aircraft system.

PROX SYS FAULT 2 status (white)
Indicates that any one non–critical sensor or an input or output is failed or unreasonable.

MLG FAULT status (white)
Indicates PSEU has detected a fault in the main landing gear shuttle valve.



Status Page

Proximity Sening System EICAS Indications <1001>
Figure 16–30–3

A. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Proximity Sensing	Electronics Unit	PSEU CH A	DC BUS 1	1	G1	
		PSEU CH B	DC BUS 2	2	G1	
		PSEU CH A	BATTERY BUS		P1	
		PSEU CH B			P2	
	Weight On Wheels	WOW RELAY			P3	

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1. BRAKE SYSTEM

Each wheel of the main landing gear is equipped with self-adjusting multi-disc brakes. The brakes of the inboard wheels are powered by hydraulic system 3 and the brakes of the outboard wheels are powered by hydraulic system No. 2.

Brake application is initiated by pressing the rudder pedals which are mechanically linked to the associated brake control valves. The brake control valves meter hydraulic pressure, proportional to the pedal pressure, to the four main wheel brake units, through four independent anti-skid control valves and four hydraulic fuses.

If a leak occurs in a brake line, the associated hydraulic fuse will close off the hydraulic line, preventing loss of the entire system fluid.

With the loss of one hydraulic system, the aircraft has 50% symmetric braking capability with full anti-skid control to the working brakes. In the event of a failure of both hydraulic systems 2 and 3, accumulators in each hydraulic system will provide reserve pressure for braking. During landing roll or rejected takeoff, reverse thrust and the ground spoilers will decelerate the aircraft, if the brakes are degraded or fail completely.

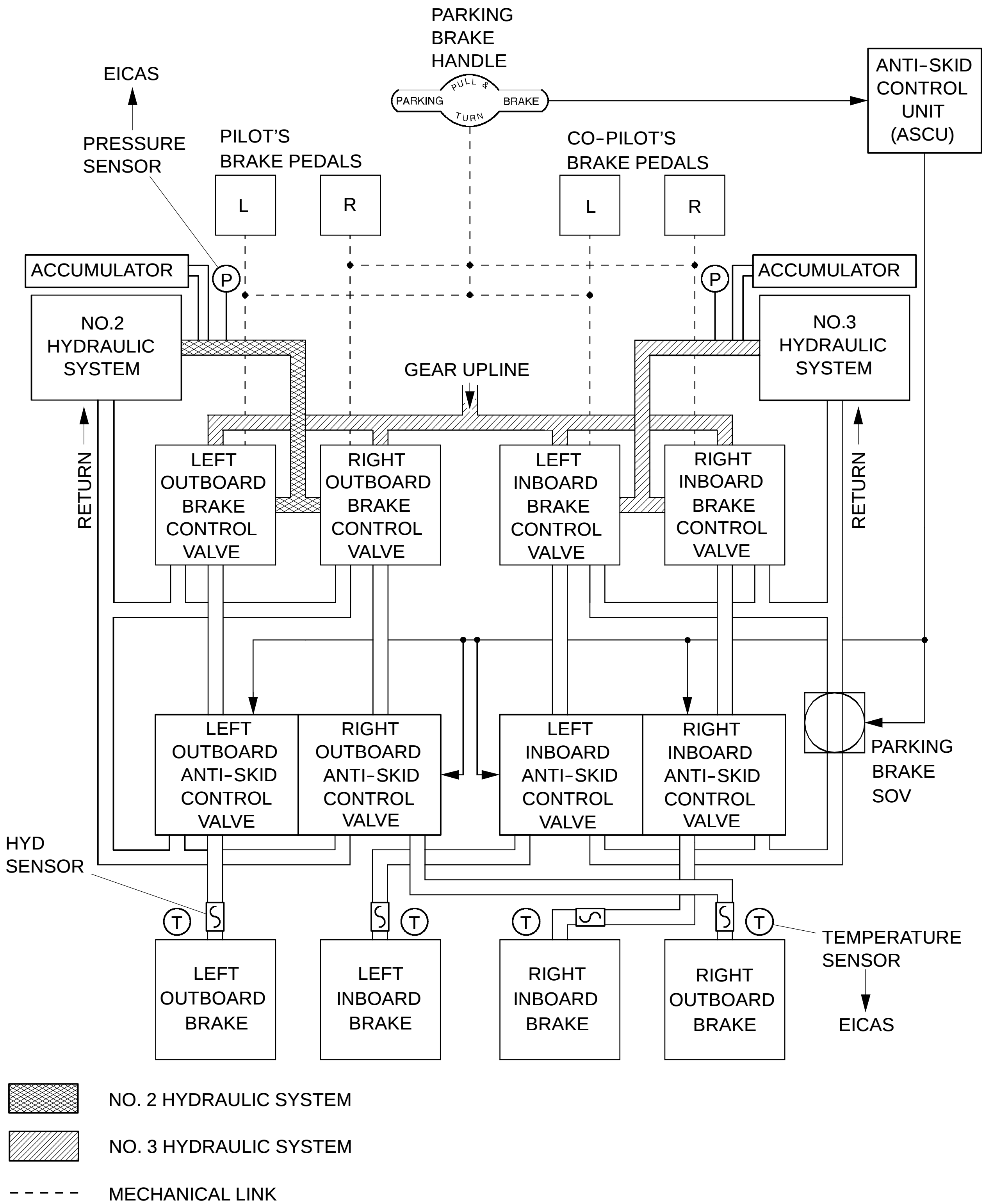
Available inboard and outboard brake pressure is continuously monitored and displayed on EICAS on the hydraulic synoptic page, and any abnormal brake pressure detected is displayed on EICAS in the form of a visual message.

During landing gear retraction, hydraulic pressure is applied to the main wheel brake control valves to stop main wheel spin. A rubber spin-down pad assembly in the nose landing gear wheel well provides resistance to stop the nose wheel from spinning after gear retraction.

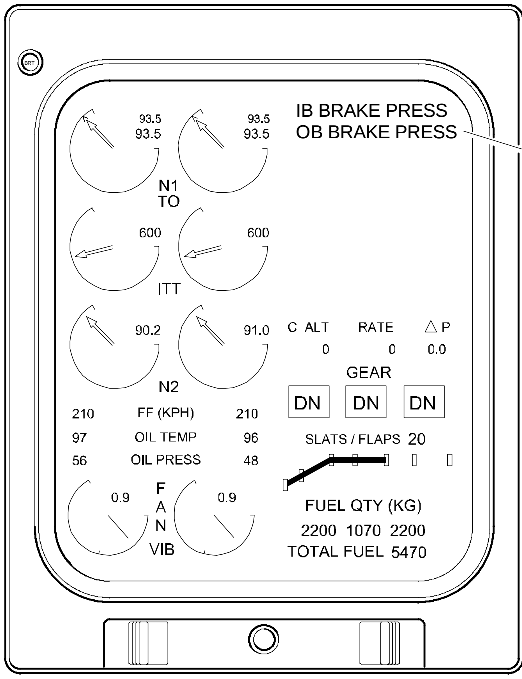
Two brake wear indicator pins installed on each brake assembly provide a visual indication of brake wear.

NOTE

The brake wear indicator pins must be checked with the brakes applied and No. 2 and No. 3 hydraulic systems pressurized.

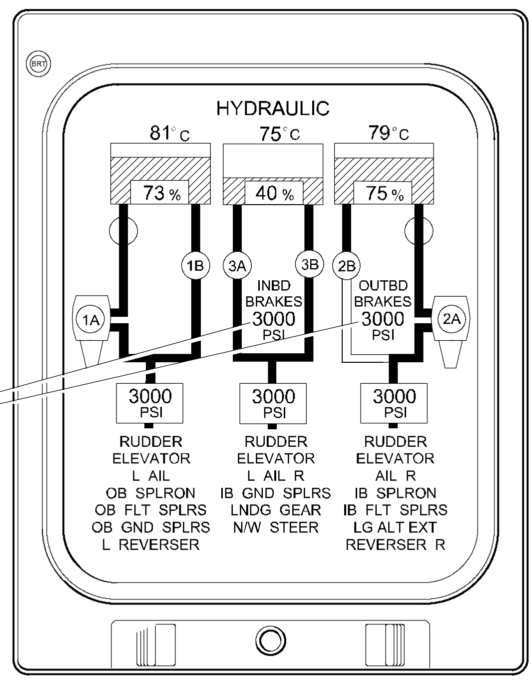


Brake System – Schematic
Figure 16–40–1



IB or OB BRAKE PRESS caution (amber)
Indicates that brake pressure of the respective system is less than 1800 psi and DC bus 2 is powered.

Primary Page



Brake Pressure Readout
Displays brake pressure of respective system (in 100 psi increments).
- Green – Between 1800 psi and 3200 psi
- White – Greater than 3200 psi
- Amber – 1800 psi or less
- Amber dashes – Invalid data

Hydraulic Page

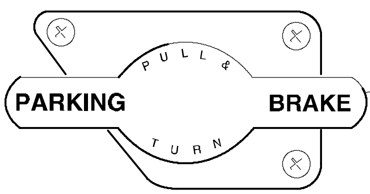
Brake System EICAS Indications <1001>
Figure 16–40–2

A. Parking Brake

Inboard brake control valves and the parking shutoff valve are used to provide braking when the aircraft is parked. Pulling the parking brake handle while fully depressing both rudder pedals and turning the handle 90 degrees in either direction, locks both brake control valves in the applied position.

When the hydraulic systems are shut down, hydraulic pressure slowly leaks away via the anti-skid return lines. The parking brake shutoff valve closes when the parking brake is applied, ensuring that hydraulic system 3 accumulator pressure is maintained on the inboard brakes for a prolonged period of time.

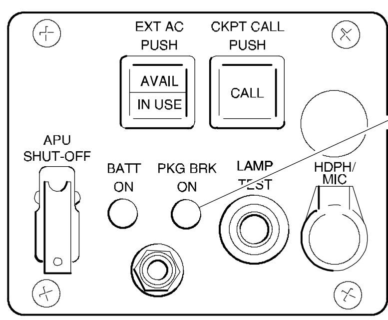
Parking brake configuration and operational condition are continuously monitored and any detected fault is displayed on EICAS in the form of a visual and/or aural message.



Parking Brake Handle
Centre Pedestal

PARKING BRAKE
Used to set parking brake.
To engage parking brake:
- While fully depressing both rudder pedals on the pilot's or copilot's side, pull parking brake handle and rotate it 90 degrees to the locked position.

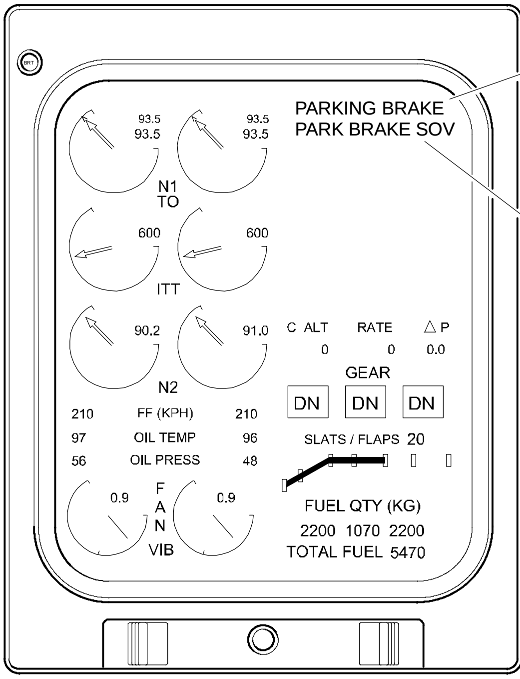
To disengage parking brake:
- While fully depressing both rudder pedals on the pilot's or copilot's side, rotate the parking brake handle to the unlocked position and push it in.



External Service Panel
Right Forward Fuselage

PKG BRK ON Light
Indicates that the parking brake is set.

Parking Brake Controls <1205>
Figure 16–40–3



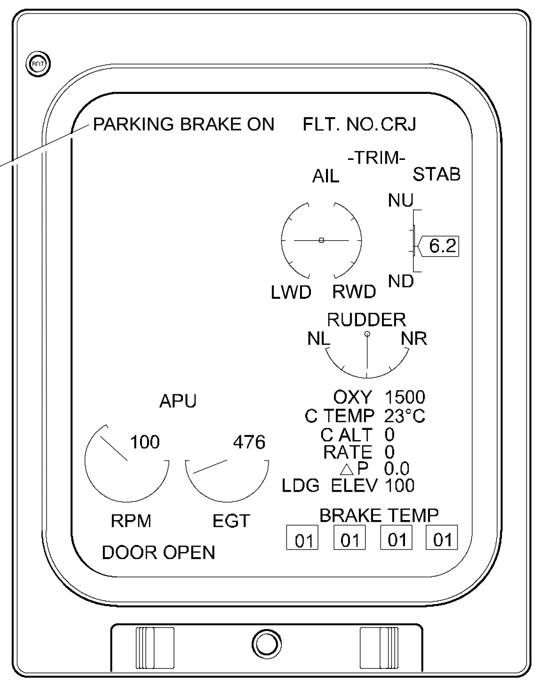
PARKING BRAKE warning (red)
Indicates that the parking brake is set with the airplane configured for takeoff or in the air.

BRAKES

PARK BRAKE SOV caution (amber)
Indicates that the parking brake shutoff valve has failed open with inboard brake pressure greater than 800 psi and the parking brake set.

Primary Page

PARKING BRAKE ON advisory (green)
Indicates that the parking brake is set with the airplane on the ground, both engines not at take–off power and inboard brake pressure greater than 800 psi.



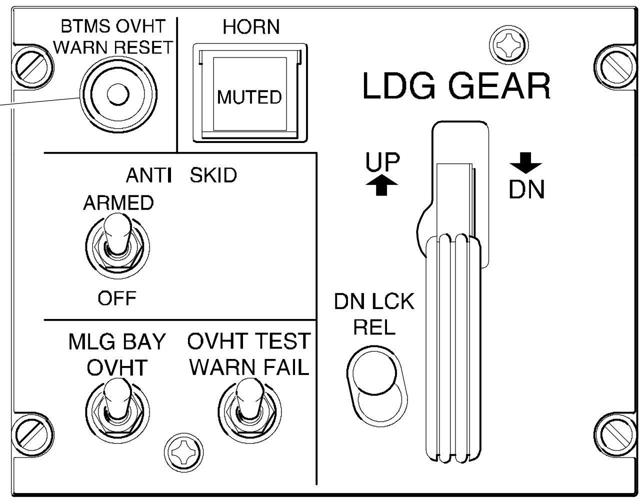
Status Page

Parking Brake EICAS Indications <1001>
Figure 16–40–4

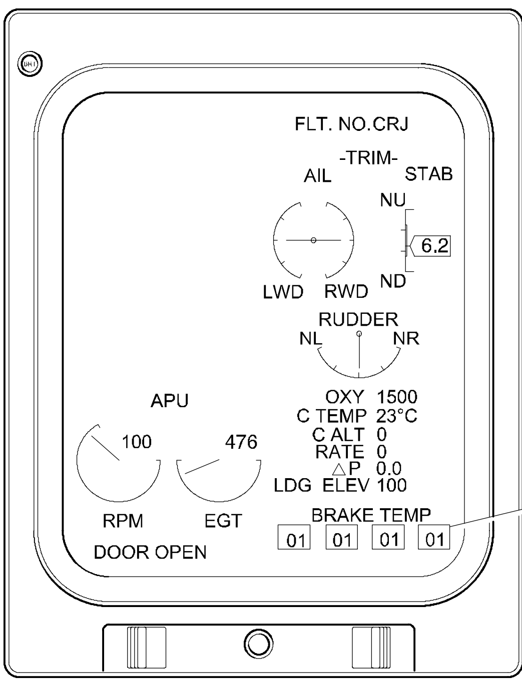
B. Brake Temperature Monitoring System

The brake temperature monitoring system (BTMS) provides an indication to the crew of the main wheel brake temperatures. Individual brake temperatures are displayed as a color coded numerical readout on the status page of the EICAS secondary display. The brake temperature readout will be displayed when the landing gear and slats/flaps position indications are being displayed on EICAS primary page. A BTMS overheat warning reset switch, on the landing gear control panel, is used to reset the system when the brake overheat condition no longer exists.

BTMS OVHT WARN RESET
Used to reset BTMS. The BTMS can only be reset if the brake overheat condition or the brake temperature difference has discontinued.



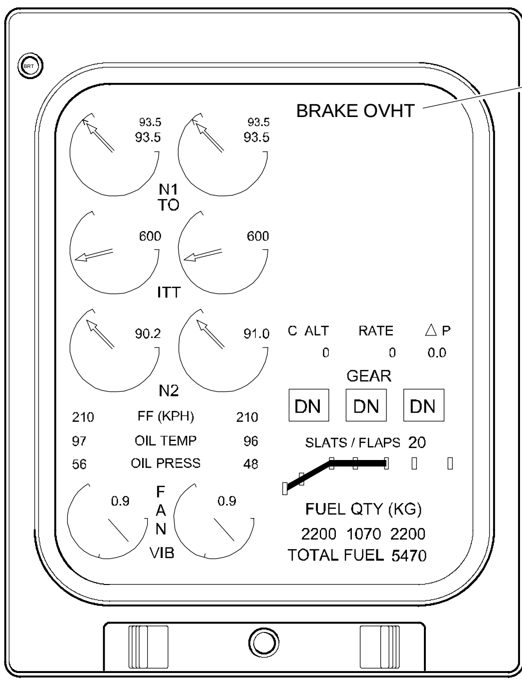
Landing Gear Control Panel
Center Pedestal



Brake Temperature Readout
Indicates temperature value of respective brake.
- Green - 06 and less (≤220 °C)
- White - 07 to 14 (between 221 and 492 °C)
- Red - Overheat warning or more than 14 (≥493 °C)

Status Page

BTMS Controls
Figure 16–40–5



BRAKE OVHT warning (red)
Indicates an overheat condition at any one of the brakes.

BRAKES

Primary Page

BTMS EICAS Indications <1001>
Figure 16–40–6

C. Anti–Skid System

The anti-skid system controls hydraulic pressure to the four main wheel brakes to provide anti-skid protection. The anti-skid system consists of a dual channel (inboard wheel control and outboard wheel control) anti-skid control unit (ASCU), four wheel speed transducers and two dual anti-skid control valves. The anti-skid system performs the following functions:

- Individual wheel anti-skid control: Prevents skids from developing.
- Touchdown protection: Prevents landing with locked wheels in the event that the pilot(s) are depressing the brake pedals during touchdown.
- Locked wheel protection: Allows a wheel to recover from a deep skid.

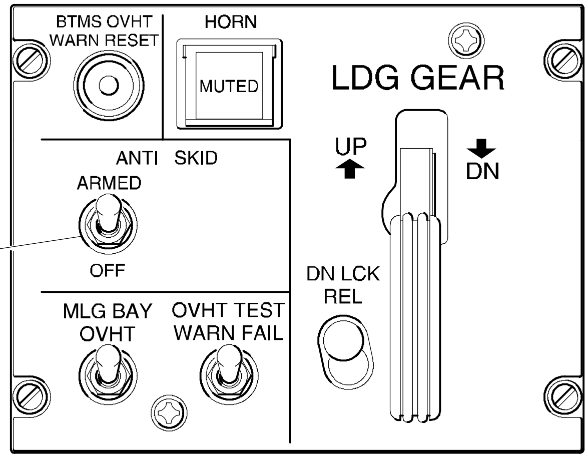
Selecting the anti–skid switch, on the landing gear control panel, to the ARMED position enables the ASCU (provided the parking brake is not engaged and both main landing gear are down and locked). In the event of a failure that causes loss of braking, manual braking is restored by selecting the anti-skid system off.

By monitoring each wheel speed individually, the ASCU can detect tire skidding. The ASCU independently reduces the braking pressure at the skidding wheel by modulating the pressure outputs of the appropriate anti-skid control valve. This modulation is controlled by the individual wheel speed and deceleration monitored through the wheel speed transducers.

In the air, with no weight-on-wheels signal, the anti-skid control valves dump pressure to prevent wheel lock-up on touchdown. The system becomes operational once a 35 knots wheel spin-up signal is present or a weight-on-wheels signal is present after a 5 second delay.

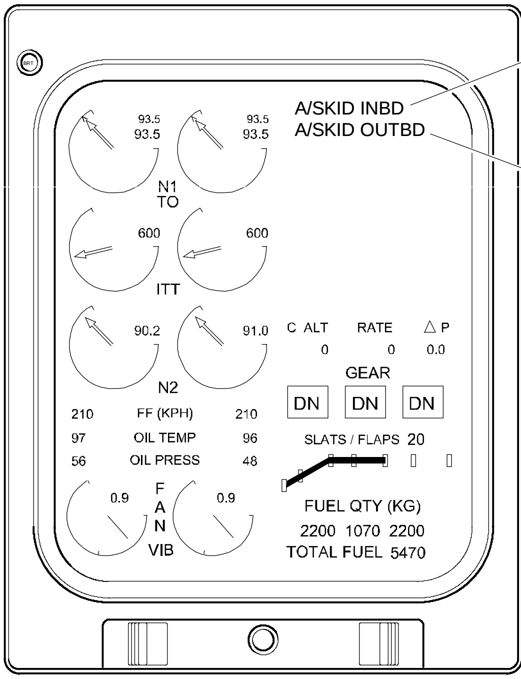
The ASCU continuously monitors the anti-skid system and any detected faults are displayed on the EICAS in the form of a visual message.

ANTI–SKID
Used to arm anti–skid system. System is activated with wheel spin–up (35 kt).



Landing Gear Control Panel
Center Pedestal

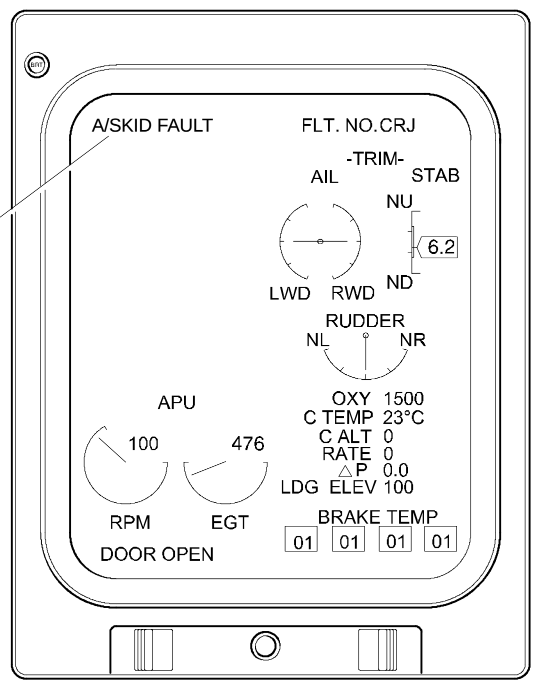
Anti–Skid System Controls
Figure 16–40–7



A/SKID INBD caution (amber)
Indicates that the inboard channel of the anti–skid system has failed, parking brake shut–off valve failed closed or loss of ASCU output.

A/SKID OUTBD caution (amber)
Indicates that the outboard channel of the anti–skid system has failed or loss of ASCU output.

Primary Page



A/SKID FAULT status (White)
Indicates loss of redundancy of ASCU, loss of weight–on–wheels input, spin down fail or loss of internal communication.

Status Page

Anti–Skid System EICAS Indications <1001>
Figure 16–40–8

D. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Brakes	Pressure	BRAKE PRESS APPL	DC BUS 1	1	E13	
		BRAKE PRESS IND	DC BUS 2	2	G3	
	Anti-Skid	ANTI SKID			G4	
		ANTI SKID	DC BUS 1	1	G4	

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1. NOSE WHEEL STEERING SYSTEM

The nose wheel steering system is controlled by a steering control unit and powered by hydraulic system No. 3. The nosewheel steering arming switch is located on the pilots left side panel. Selecting the switch to the ARMED position activates the steering system control unit.

The steering control unit controls the nose wheel position based on inputs from either the steering tiller on the pilot's side console or the rudder pedals. The steering tiller turns the nose wheel up to 80 degrees either side of center, and is intended for low speed taxiing. Steering with the rudder pedals is limited to 8 degrees either side of center and is intended for high speed taxi and take-off and landing rolls.

After take-off, the steering control unit generates a straight ahead command, which centers the nose wheel prior to landing gear retraction. A centering cam on the nose wheel strut maintains the nose wheel center position when hydraulic power is shut down.

Powered steering using the steering tiller is available when the steering switch on the pilot's side panel is armed and a nose weight-on-wheels signal is present.

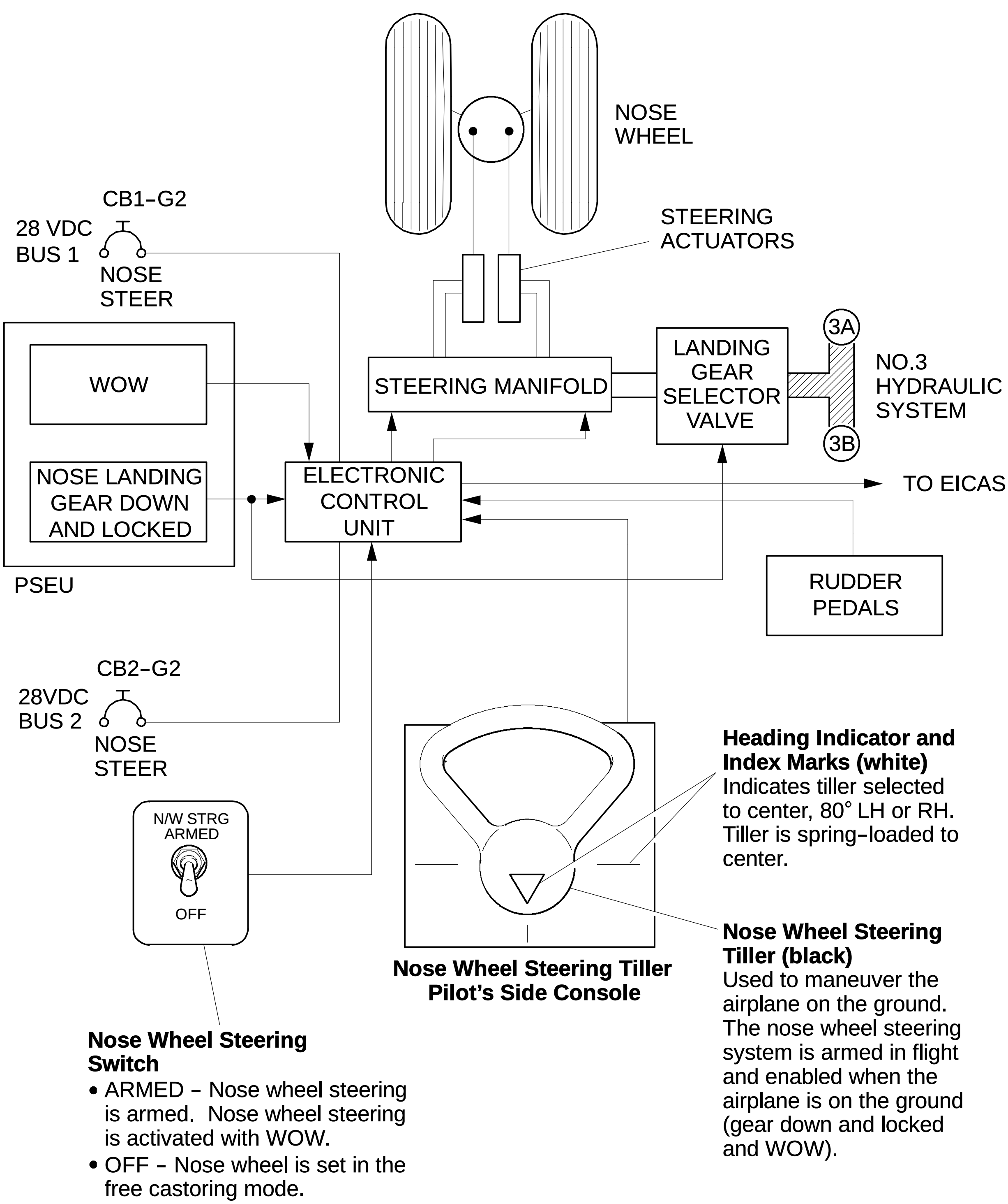
If a failure is detected by the steering control unit, the system reverts to free castoring mode. The pilot then maintains ground directional control through rudder control and differential braking.

In the event of failure of hydraulic system No. 3, the nose wheel is centered mechanically by the centering cams. Rudder, differential braking and differential thrust will be used for directional control.

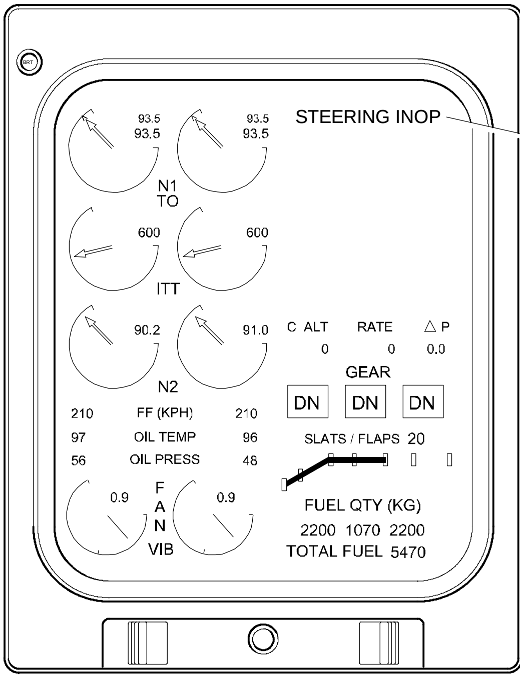
The steering control unit continuously monitors the nose wheel steering system, and any detected faults are annunciated on EICAS in the form of a visual messages. Fault detection will result in steering system shutdown which will revert the system to free castoring mode.

NOTE

Prior to landing, the "STEERING INOP" caution message may come on if the nose wheel steering tiller is moved more than 2 degrees.



Nose Wheel Steering System – Schematic
Figure 16–50–1



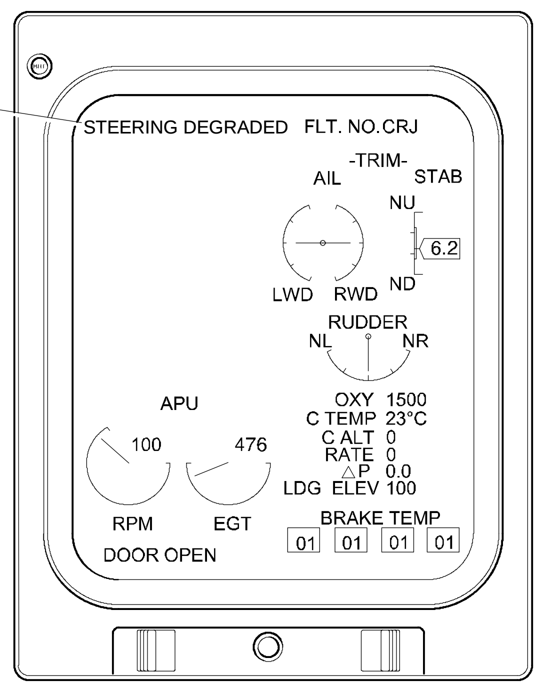
STEERING INOP caution (amber)
Indicates that the steering control unit has detected a fault.

Primary Page

STEERING DEGRADED status (white)
Indicates possible intermittent loss of steering due to nose wheel bouncing.

NOTE

Aft CG and / or light weight are possible conditions for this message to come on.



Status Page

Nose Wheel Steering EICAS Indications <1001>
Figure 16–50–2

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Nose Wheel Steering	Control Unit	NOSE STEER	DC BUS 1	1	G2	
		NOSE STEER	DC BUS 2	2	G2	

CHAPTER 17 – LIGHTING

LIST OF ILLUSTRATIONS

FLIGHT COMPARTMENT LIGHTING

PASSENGER COMPARTMENT LIGHTING

EXTERNAL LIGHTING

EMERGENCY LIGHTING

1. INTRODUCTION

Aircraft lighting consists of the following systems:

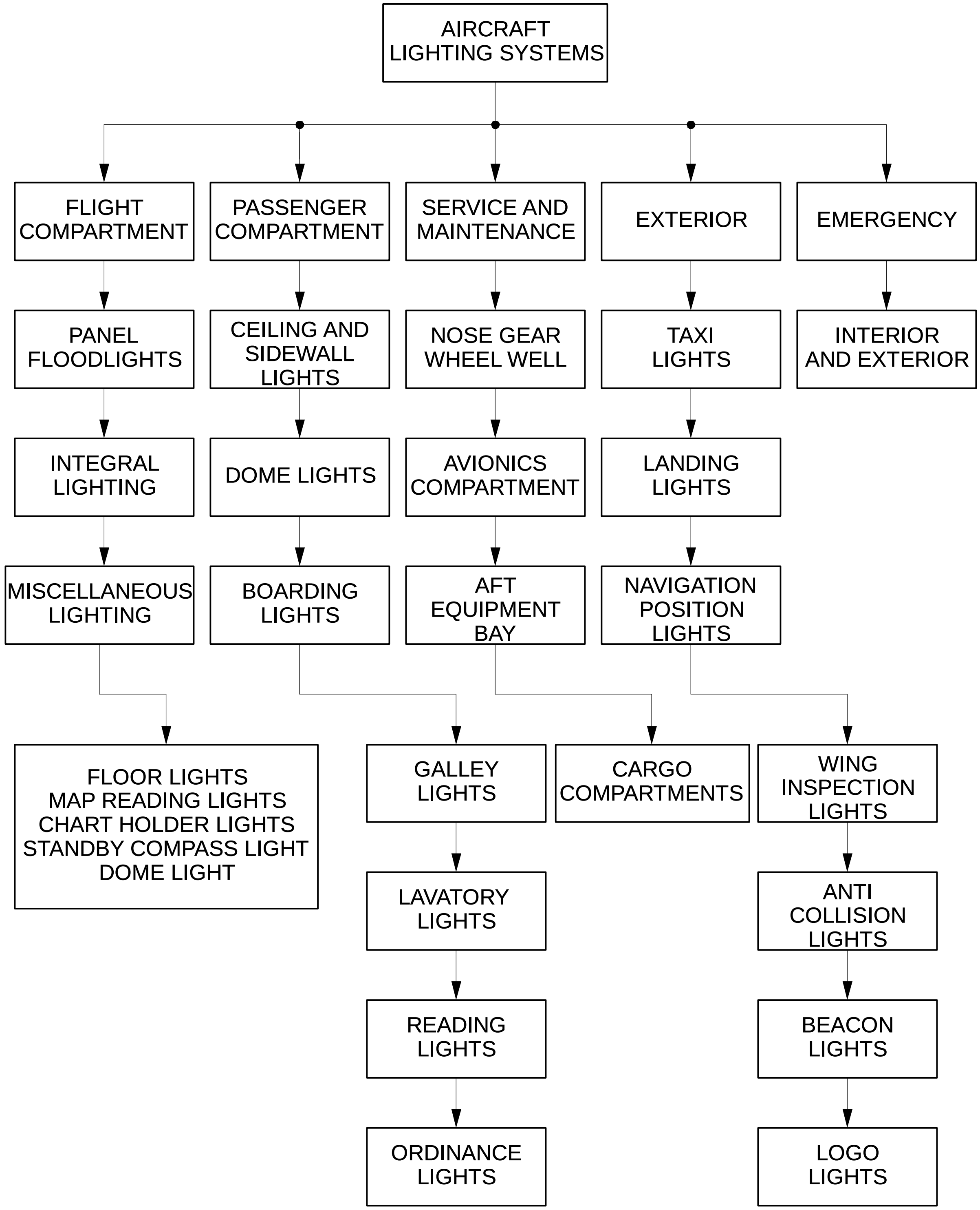
- Flight Compartment Lighting
- Passenger Compartment Lighting
- Service and Maintenance Lighting
- External Lighting
- Emergency Lighting

Lighting control panels for the flight compartment, passenger signs and external lighting are located in the flight compartment overhead panel. Passenger compartment lights are controlled from the forward attendant's panel.

Emergency lighting is controlled from the flight compartment and may also be controlled from the forward attendant's panel. When armed, the emergency lights will come on automatically if essential electrical power is lost.

Service and maintenance lighting is provided for the avionics compartment, baggage compartments, aft equipment compartment and in the landing gear wheelwells. Controls for the lights are located in the area that they illuminate.

Lighting messages are presented on the engine indication and crew alerting system (EICAS) displays.



Lighting Systems – General <1020, 1021>
Figure 17–10–1

1. FLIGHT COMPARTMENT LIGHTING

Flight compartment general area illumination is provided by dome and floor lights. Instrument and control panel lighting is provided by flood lights and integral lighting. Map and reading lights are provided for miscellaneous lighting requirements.

Control panels for the flight compartment lights are located on the overhead panel, at the pilot and copilot side panels and on the center pedestal. Each panel controls the lighting adjacent to the panels location. The controls provide dimming for electronic displays, integral panel lighting and panel flood lighting. Dimming is not provided for floor lighting.

There are three flight compartment dome lights. One light is located in the overhead of the flight compartment entrance and one light is located on each side of the overhead panel. A two position ON/OFF switch on the overhead MISC LTS panel controls the flight compartment entrance light. The pilot's and copilot's dome lights are controlled using the OFF/BRT knob on the respective DM LT panel on each side of the overhead panel.

Floor lighting illuminates the floor area between the rudder pedals and the seat of each pilot. Floor lighting is controlled by a switch on the pilot and copilot side panels.

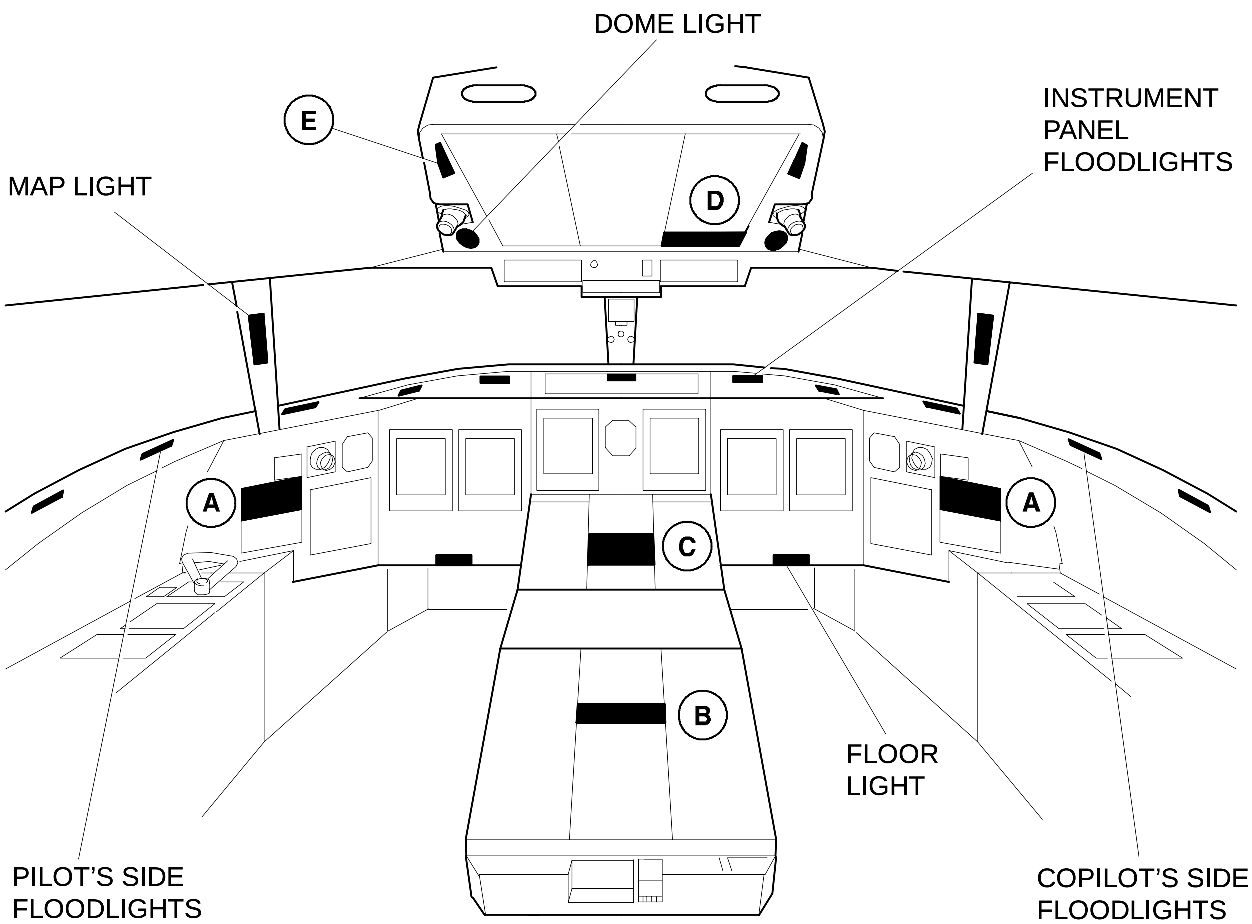
Panel integral lighting with dimming controls supply all the edge lighting for the instrument panels and control panels. The integral lights illuminate the panel names and switch positions to make them more visible for the flight crew.

Cockpit flood lights are operated by dimmers on the pilot and copilot side panels and on the center pedestal lighting panel. The pilots dimmer switch controls the four flood lights on the left side of the flight compartment. The copilots dimmer switch controls the four flood lights on the right side of the flight compartment. The dimmer switch on the center pedestal controls the three flood lights for the instrument panel.

A map light is mounted on each side window post to light the pilot and copilot lap areas. An observers map light, mounted at the cockpit entrance, pivots and swivels for use by any crew member. Light intensity is controlled by a button at the top of the light head and the circular illumination area is controlled by a lever at the bottom of the light head.

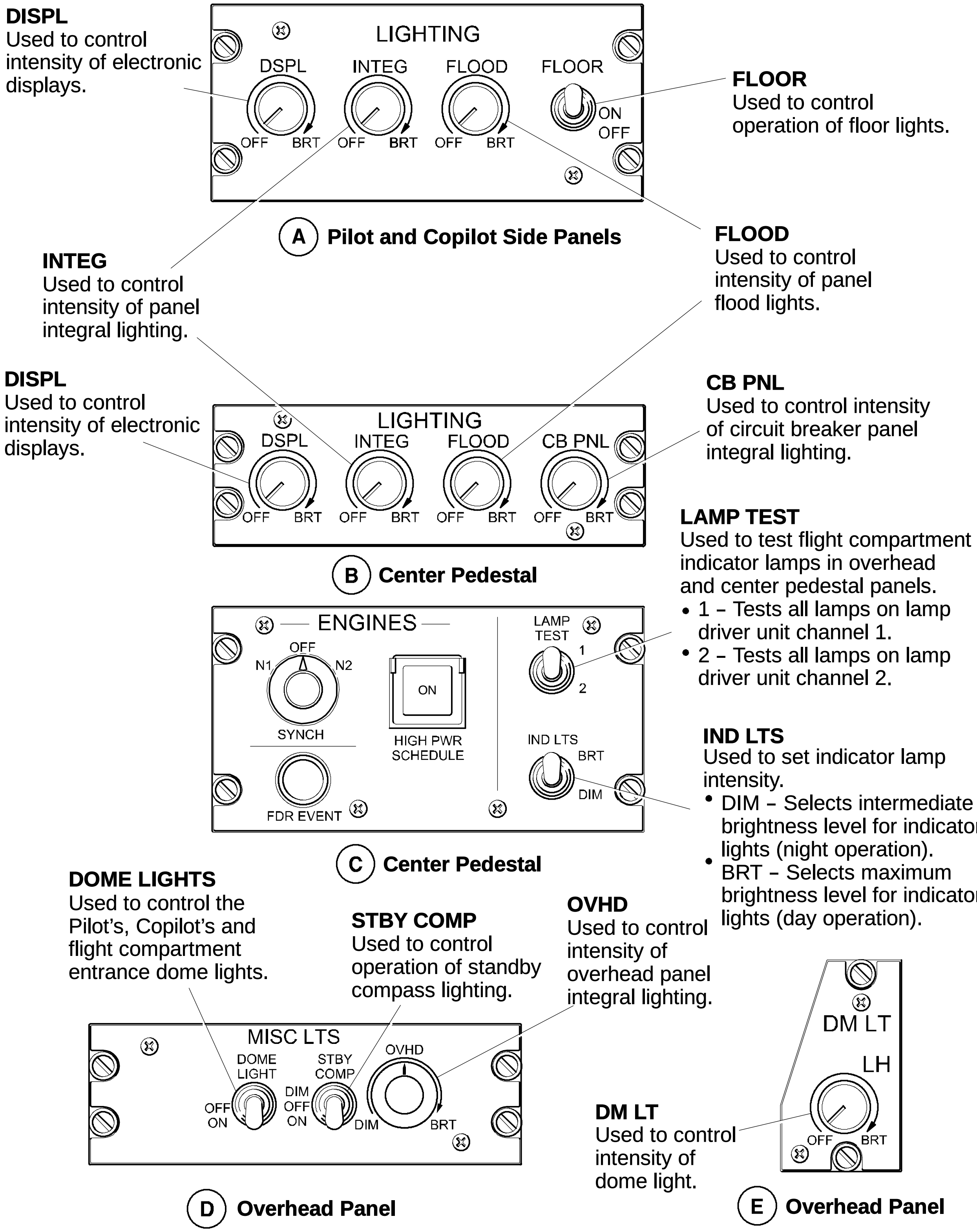
When AC power is not available the following will be illuminated by the battery bus:

- Fuel control panel
- Fire detection panel
- Engine start and ignition control panel
- Electrical power panel
- APU control panel
- Bleed air control panel
- Standby compass light
- EICAS control panel
- RTU dimming
- Pilot and observer map lights



Flight Compartment Lighting and Lighting Control Panels

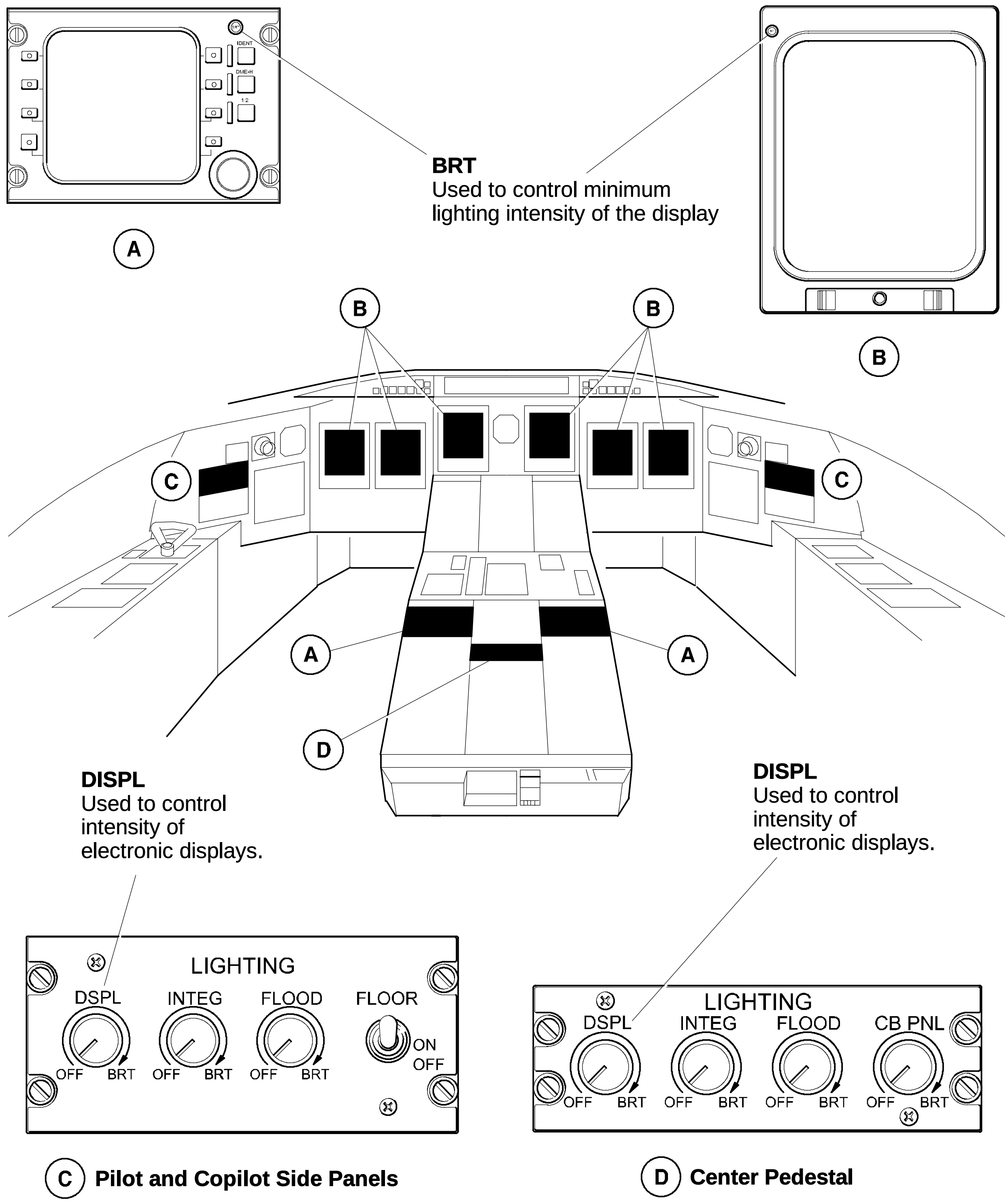
Flight Compartment and Lighting Control Panels
Figure 17–20–1



Flight Compartment Lighting Controls
Figure 17–20–2

2. CRT LIGHTING ADJUSTMENT

Two separate control switches are used to adjust display lighting intensity. In the upper left corner of the display unit, a BRT adjustment knob is used to set the minimum lighting intensity for the associated screen. After adjusting the BRT knob to a minimum level, the pilot can select the desirable level of lighting for the EFIS and EICAS displays by using the DSPL knob located on the associated lighting panel.



CRT Lighting Intensity Adjustment
Figure 17−20−3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Flight Compartment Lighting	Dome Lights	CKPT DOME LIGHTS	MAIN BATTERY DIRECT BUS	6	B5	
		CKPT DOME LIGHT	DC BUS 1	1	E4	
	Floor Lights	LIGHTS CKPT FLOOR			G7	
	Flood Lights	INST FLOOD LTS	DC ESSENTIAL	2	U2	
	Instrument Lights	INTEG LTS CB PNLS	AC ESSENTIAL	1	V4	
		INTEG LTS PLT PNLS			V5	
		INTEG LTS CTR PNLS			V6	
		INTEG LTS O/H PNLS			V7	
		INTEG LTS C/PLT PNLS	AC BUS 2	2	B14	
		LIGHTS O/H PNL	BATTERY BUS	1	P5	
		LIGHTS EICAS/RTU DIMMING			P6	
	Map Lights	LIGHTS PLT MAP			P2	
		LIGHTS C/PLT OBS MAP			P3	
		LIGHTS C/PLT MAP	DC BUS 2	2	G7	
	Chart Holder Lights	LIGHTS CHART HOLDER			G6	

1. PASSENGER COMPARTMENT LIGHTING

Passenger compartment lighting is supplied by ceiling and sidewall fluorescent lights. Some of the ceiling lights are powered by the AC essential bus and remain available in the event that the AC service bus becomes lost. Entrance lighting consists of six fluorescent lights in the entrance ceiling panels and three lights in the stairs of the passenger door. Ceiling, sidewall and entrance lighting is controlled from the forward flight attendant's panel.

Two reading lights are installed in each passenger service unit (PSU). They supply personal lighting for passenger use and can be controlled independently. The passenger reading lights can be tested and reset using switches on the forward flight attendants panel. Each flight attendant station is equipped with a reading light controlled by a switch on the attendant's panel.

Lighted NO SMOKING and FASTEN SEAT BELTS ordinance signs are installed in each PSU, in the lavatories, and in the main entrance. The lavatories also have return to seat symbols. Control of the ordinance signs is provided on the PASS SIGNS overhead panel in the flight compartment.

The lavatory is illuminated by three fluorescent lights (two in the vanity and one above the counter). The lights come on dim when aircraft power is applied. With the lavatory door locked, the vanity light assembly will come on bright.

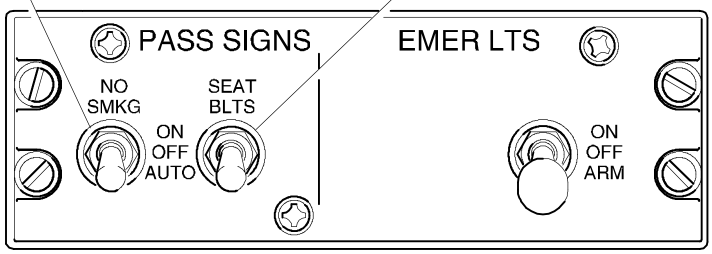
Galley lighting is provided by six fluorescent lights in the galley ceiling panel. Two switches on the galley control panel control the galley lights. Lights in the wardrobe and stowage compartments are controlled by micro-switches in the doors, so that the lights come on when the door is opened.

NO SMKG Switch

- AUTO - The corresponding signs located throughout the cabin come on when the landing gear is extended or cabin altitude is greater than 10,000 feet.
- OFF - Turns off all NO SMOKING signs.
- ON - Turns on all NO SMOKING signs.

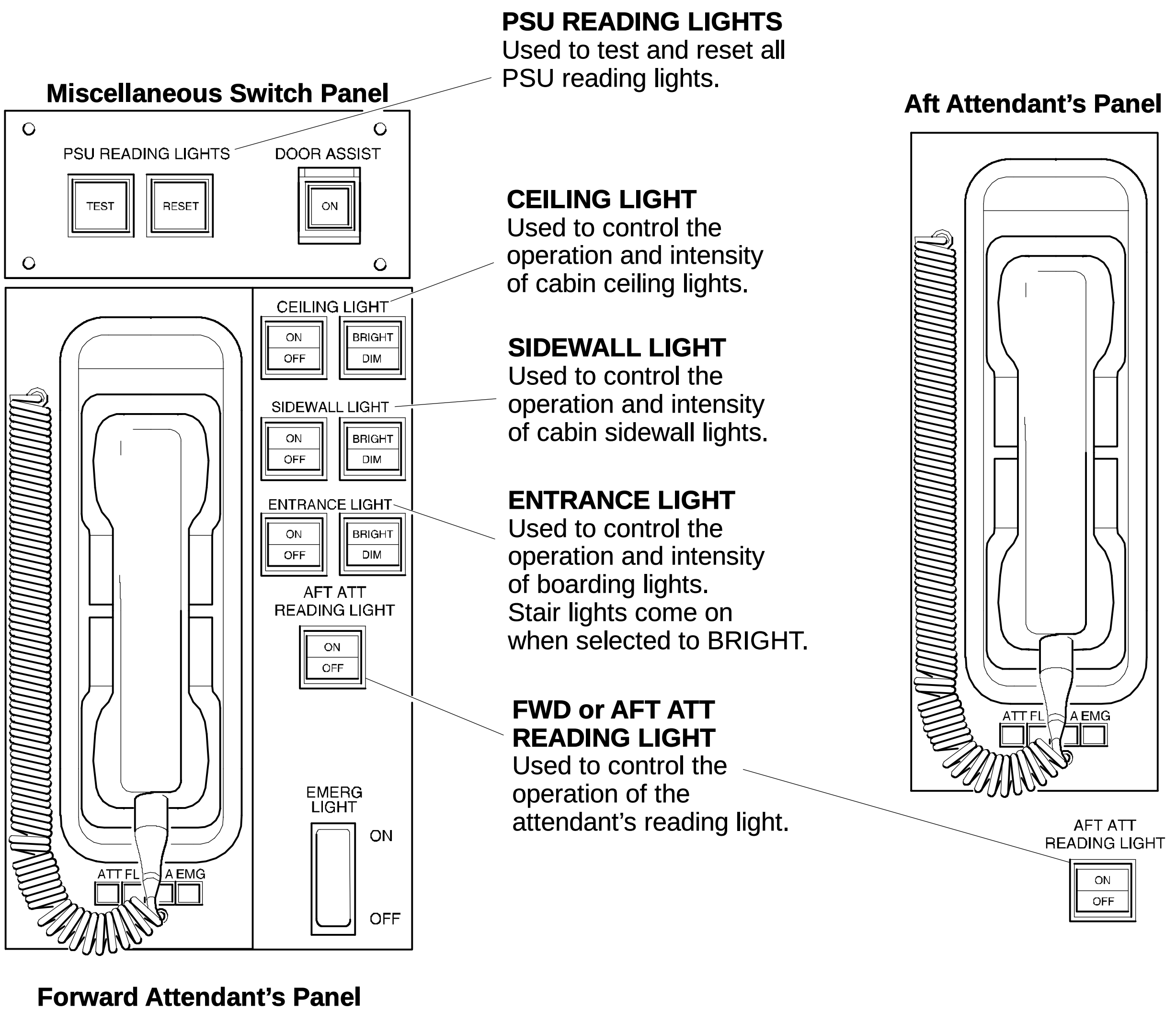
SEAT BLTS Switch

- AUTO - The corresponding signs throughout the cabin come on when cabin altitude is greater than 10, 000 feet, when the landing gear is extended or when flaps are greater than 0 degrees.
- OFF - Turns off the SEAT BELT signs and RETURN TO SEAT sign in the lavatory.
- ON - Turns on the SEAT BELT signs and RETURN TO SEAT sign in the lavatory.



Passenger Signs and Emergency Lights Panel
Overhead Panel

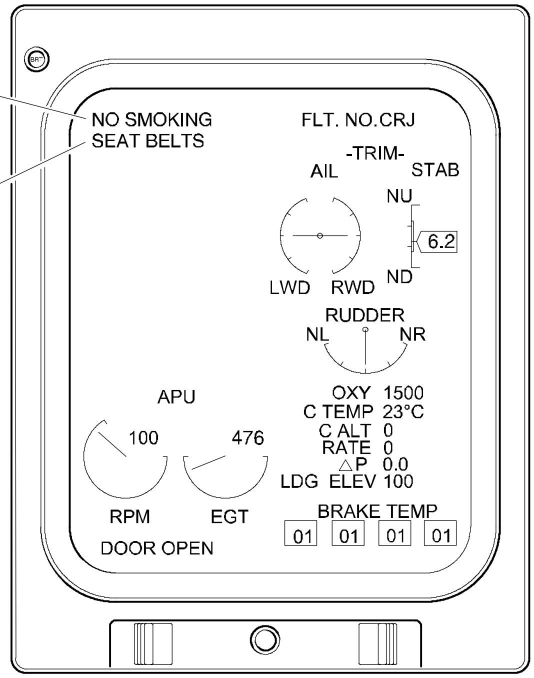
Passenger Signs and Emergency Lights Panel
Figure 17–30–1



Flight Attendant's Panels
Figure 17–30–2

NO SMOKING status (white)
Indicates that the no smoking signs have been selected on, automatically or manually.

SEAT BELTS status (white)
Indicates that the seat belts signs have been selected on, automatically or manually.



Status Page

No Smoking and Seat Belts EICAS Messages
Figure 17–30–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Passenger Compartment Lighting	Cabin Lighting	CABIN LIGHTING CEILING	AC ESSENTIAL	1	T10	
		CABIN LIGHTING CEILING	AC SERVICE	2	D14	
		CABIN LIGHTING SIDEWALL			E14	
		LIGHTS CAB UTIL	BATTERY BUS	1	P4	
	Passenger Signs	PASS SIGNS			M10	
	Passenger Reading Lights	R CABIN READING LIGHTS FWD	DC UTILITY	2	L3	
		R CABIN READING LIGHTS AFT			L4	
		L CABIN READING LIGHTS FWD	DC BUS 1	1	E2	
		L CABIN READING LIGHTS AFT			E3	
	Boarding Lights	LIGHTS BOARD	DC SERVICE	2	M3	
	Lavatory Lights	LIGHTS TOILET			M5	
	Galley Lights	LIGHTS GALLEY AREA			M6	

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1. SERVICE AND MAINTENANCE LIGHTING

Service lighting is provided for the cargo compartments and external loading area. Maintenance lighting is provided for the landing gear bays, APU compartment, aft equipment compartment and the underfloor avionics compartment. <2046>

A. Service Lighting

Two lights illuminate the forward cargo compartment. The forward cargo compartment lights are controlled by a switch located at the inside forward edge of the forward cargo door opening. Activation requires a weight-on-wheels signal to ensuring that the lights are off when the aircraft is in flight.

Two lights illuminate the aft cargo compartment. The aft cargo compartment lights are controlled by a switch located at the inside forward edge of the cargo door. Activation requires a weight-on-wheels signal to ensuring that the lights are off when the aircraft is in flight.

External loading area lighting consists of a forward cargo compartment loading area light and an aft cargo compartment loadng area light. The lights are designed to illuminate the cargo compartment loading areas. <2046>

The forward cargo compartment loading area light and switch is installed within the forward cargo compartment. The light illuminates the loading area and the ground immediately below the loading area, when the forward cargo door is open. <2046>

The aft cargo compartment loading area light is installed under the left engine pylon and angled to illuminate the loading area and the ground immediately below the aft cargo door. The light switch is located inside the aft cargo compartment. <2046>

B. Maintenance Lighting

Six flood lights are installed down the length of the underfloor avionics compartment. The lights are controlled by a switch located in the compartment.

Two lights and a control switch are installed in the aft equipment compartment.

Two lights and a control switch are installed on the APU rear bulkhead to illuminate the APU compartment area.

Two high intensity halogen lights are installed in each main landing gear bay. Each light has a control switch located next to it. A single high intensity halogen light and switch is installed in the nose landing gear bay.

NOTE

At this time, the main landing gear maintenance lights have been disabled through SB670-31-003.

C. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Service and Maintenance	Maintenance	LIGHTS MAINT	DC BUS 1	1	G10	
	Service	LIGHTS FWD SERV	DC SERVICE	2	M1	
		LIGHTS AFT SERV			M2	
		SERV AREA			M7	

1. EXTERNAL LIGHTING

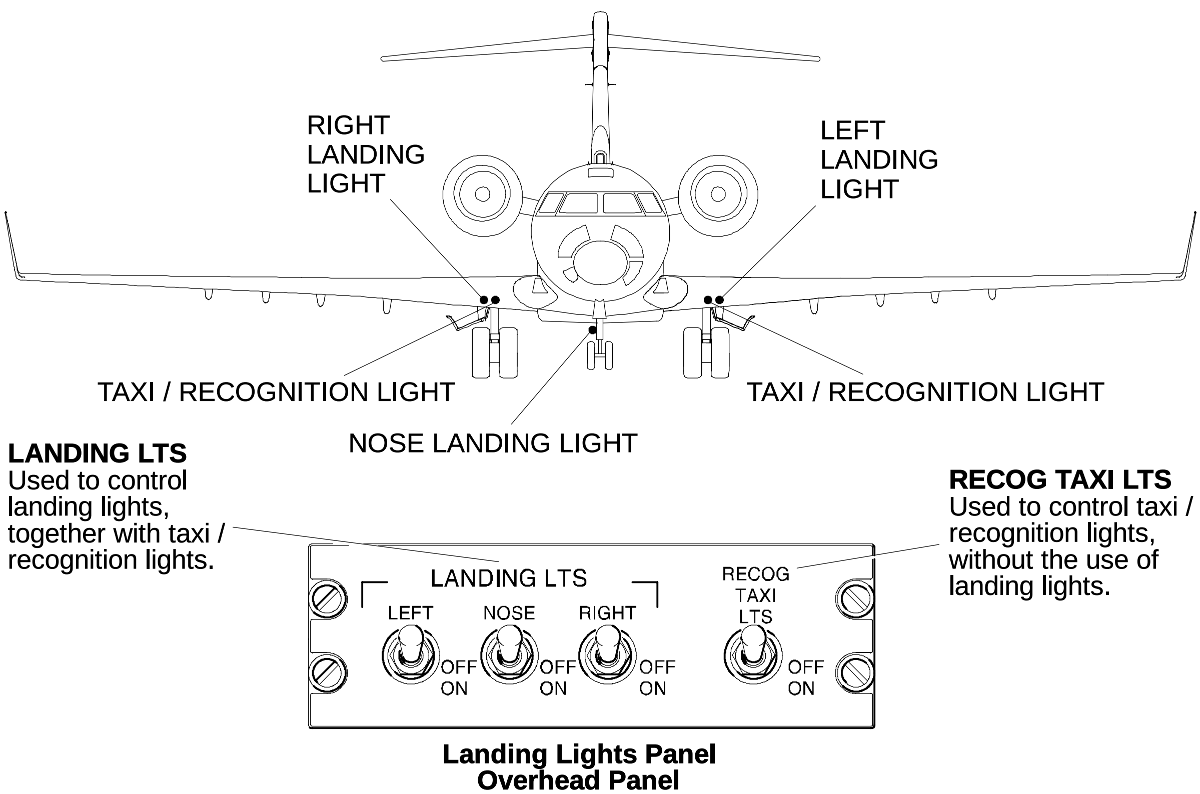
External lighting consists of landing, taxi, navigation, beacon, anti-collision strobe, logo and wing inspection lights. Control of the landing and taxi lights is provided by switches on the LANDING LTS panel located on the overhead panel. All other external lighting is controlled by switches on the EXTERNAL LTS panel, also located on the overhead panel. <1020,1021>

A. Landing and Taxi Lighting

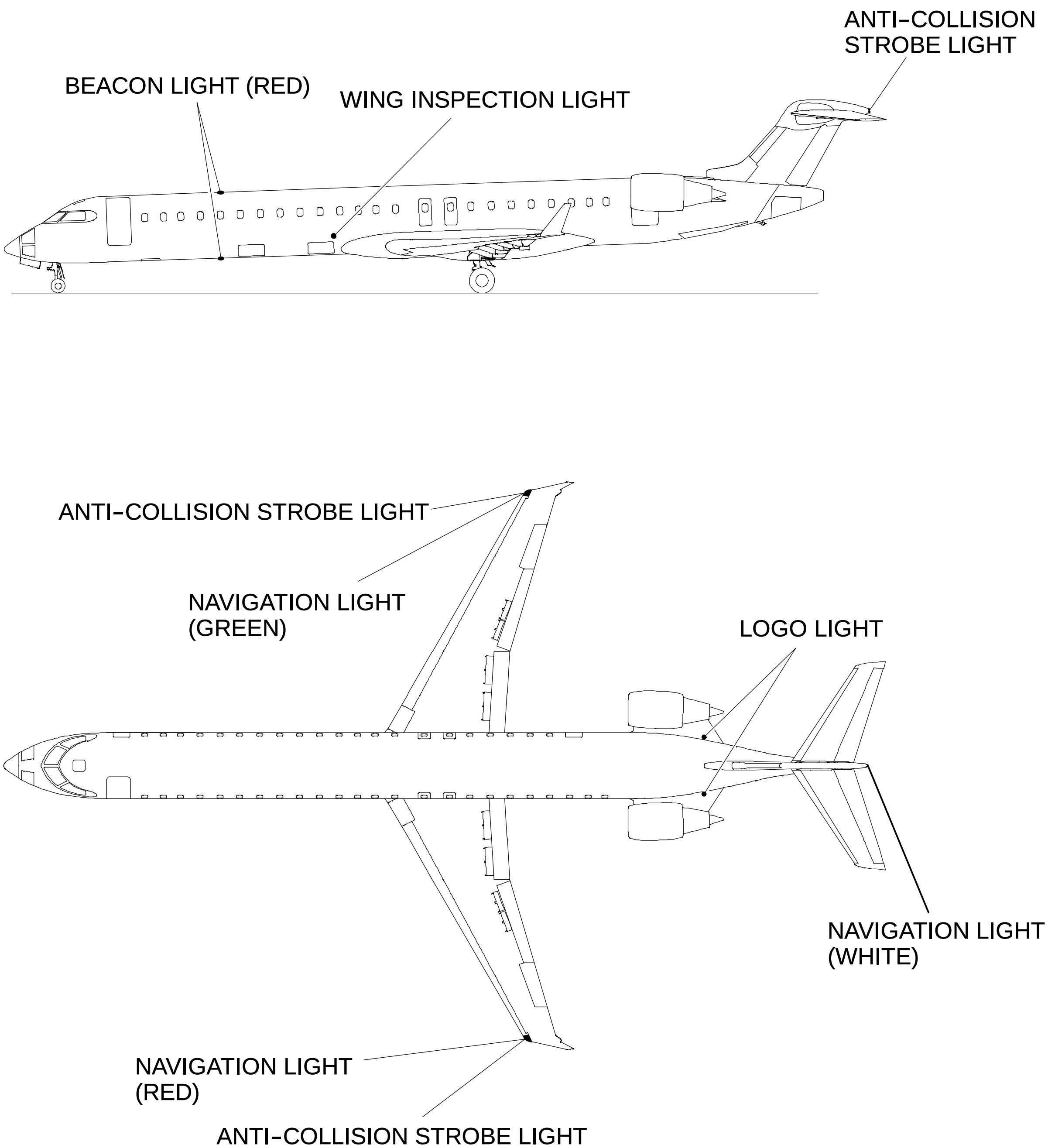
One landing light is installed in the leading edge of each wing and one is installed on the nose landing gear. The taxi lights are installed inboard of the wing landing lights, in the same wing compartments. The taxi lights also serve as recognition lights.

The nose gear landing light is installed on a bracket on the nose gear and is designed to illuminate the ground during landing and take-off. Activation requires a gear downlock signal to prevent the light from being on when the landing gear is retracted.

The wing landing lights and taxi lights are high intensity discharge lamps. The landing lights are controlled by the LEFT, RIGHT and NOSE landing light switches on the LANDING LTS panel. The taxi lights are controlled, separately from the landing lights, by the RECOG/TAXI LTS switch on the same panel.



Landing and Taxi Lights
Figure 17–50–1



External Lighting <1020, 1021>
Figure 17–50–2

B. Navigation Lighting

A dual navigation light system is installed in the aircraft for additional dispatch reliability. The navigation lights consists of two red lights in the left wing tip, two green lights in the right wing tip and two white lights on the aft end of the vertical stabilizer. The lights provide visual tracking and orientation of the aircraft in relation to an observer. The navigation lights are controlled by a NAV switch on the EXTERNAL LTS panel.

C. Beacon Lights

Two red beacon lights are installed on the aircraft to permit the aircraft to be seen from a distance. One light is installed on the top of the fuselage and one light is installed on the bottom of the fuselage. The lights are controlled by a BEACON switch on the EXTERNAL LTS panel. The lights are also used during ground operations to provide indication that the aircraft is powered and may have engines running. <1021>

D. Anti-Collision Strobe Lights

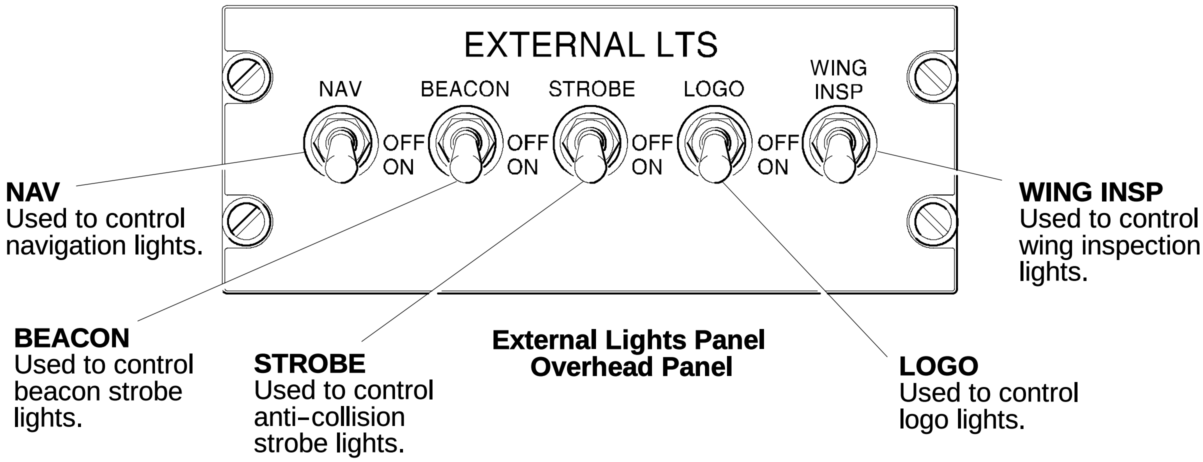
There are three white anti-collision strobe lights on the aircraft. One light is installed in each wing tip and one is installed on the aft end of the vertical stabilizer next to the tail navigation lights. They are synchronous lights that flash continuously. The light are controlled by a STROBE switch on the EXTERNAL LTS panel.

E. Logo Lighting

A white logo light is installed on the upper surface of each engine pylon to illuminate the airline logo on each side of the vertical stabilizer. The lights are controlled by a LOGO switch on the EXTERNAL LTS panel <1020>

F. Wing Inspection Lighting

A white wing inspection light is installed on each side of the fuselage just forward of the wing. The lights are controlled by a WING INSP switch on the EXTERNAL LTS panel and allow the pilots to monitor the wing leading edges for ice accumulation.



External Lights Panel <1020, 1021>
Figure 17–50–3

G. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
External Lighting	Landing Lights	LIGHTS LDG WINGS	BATTERY BUS	1	P1	
		LIGHTS LDG NOSE	DC BUS 1		G6	
	Taxi Lights	TAXI LTS			F5	
	Wing Inspection Lights	LIGHTS WING INSP			G9	
	Anti-Collision Strobe Lights	LIGHTS REAR A/COLL			G8	
		LIGHTS WING A/COLL	DC BUS 2	2	G8	
	Navigation Lights	LIGHTS NAV	DC SERVICE		M4	
	Beacon Lights	BEACON LIGHTS			M8	<1021>
	Logo Lights	LOGO LIGHTS	AC SERVICE		D11	<1020>

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1. EMERGENCY LIGHTING

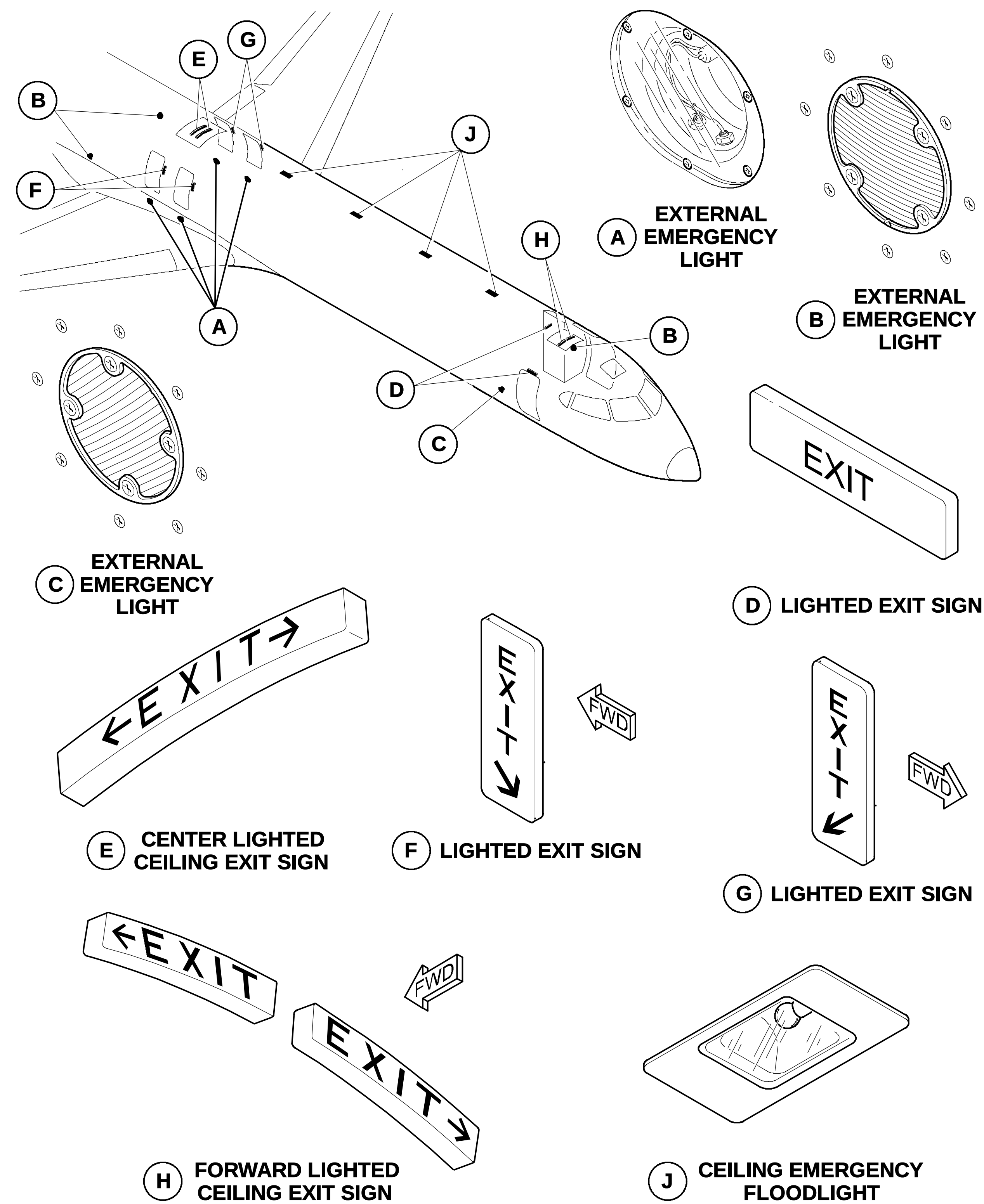
Emergency lighting is provided in the event of an emergency evacuation of the passengers and crew from the aircraft.

External emergency lights provide illumination of the overwing evacuation exit paths and exterior areas around the forward passenger door and service door. <2224>

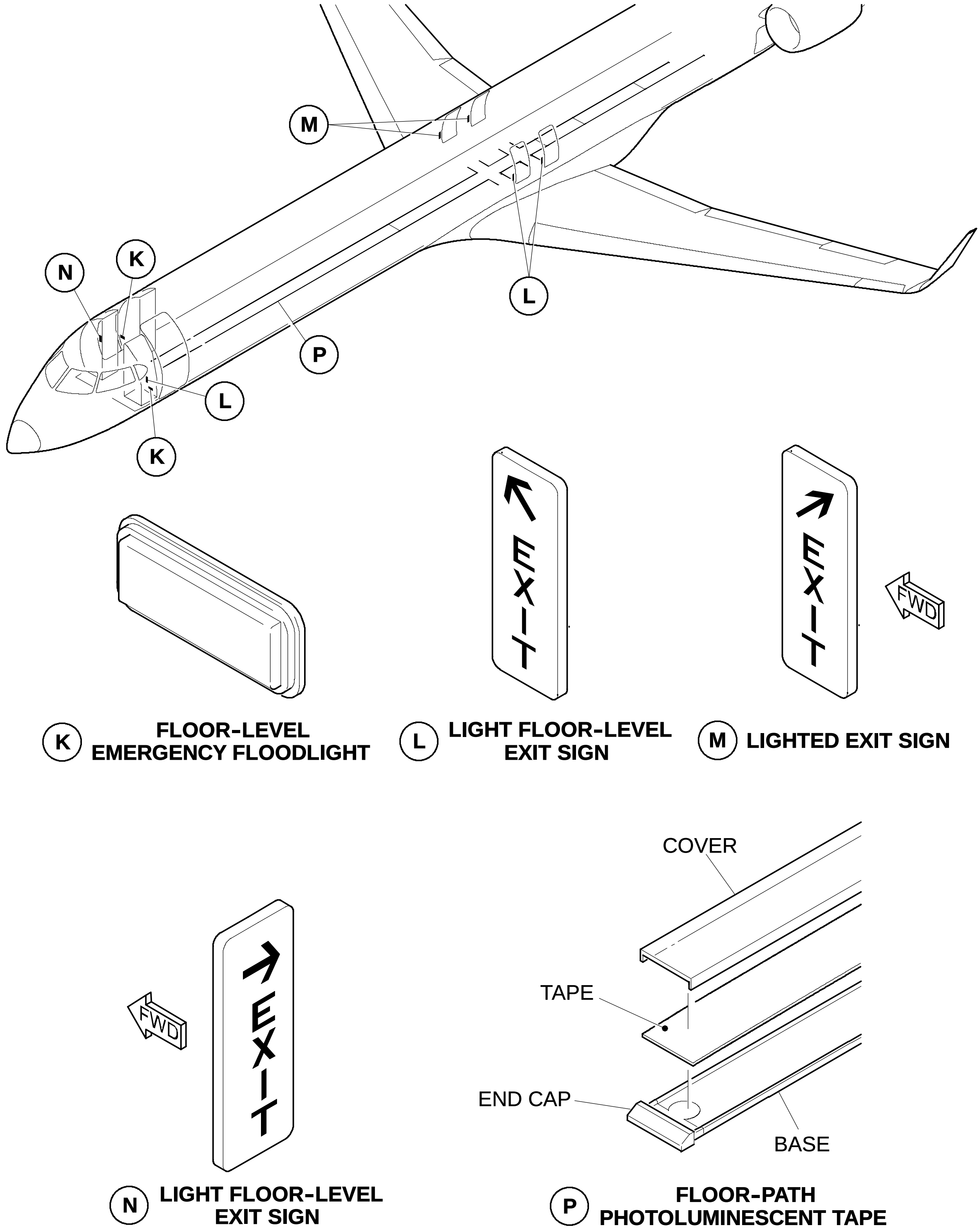
Internal emergency lighting provides emergency lighting to the passenger cabin, emergency exits and interior exit paths. The internal emergency lights include lighted exit signs near all six emergency exits at floor level, at eye level and on the ceiling. There are ceiling flood lights installed along the length of the passenger compartment and floor-level flood lights at the passenger door and service door. Photoluminescent strips are installed along the floor on both sides of the aisle to provide illuminated escape path routing to each emergency exit. The Photoluminescent strips are sufficiently charged after 15 minutes of exposure to interior cabin lighting. <2224>

Electrical power for all emergency lighting is supplied by five self-contained battery packs. The battery packs contain 6-Volt nickel-cadmium batteries that are supplied with a trickle charge from the DC essential bus. The battery packs are designed to illuminate all emergency light systems for approximate 10 minutes.

Emergency lighting is controlled by a cockpit switch on the EMERG LTS panel located on the overhead panel or by a guarded EMERG LIGHTS switch on the forward attendant’s panel. The emergency lights can be manually turned on using either switch. With the cockpit switch in the ARM position, the emergency lights will come on automatically if AC or DC essential power is lost.

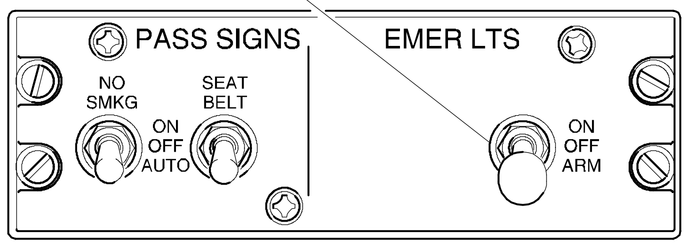


External and Internal Emergency Exit Lights
Figure 17−60−1 (Sheet 1)

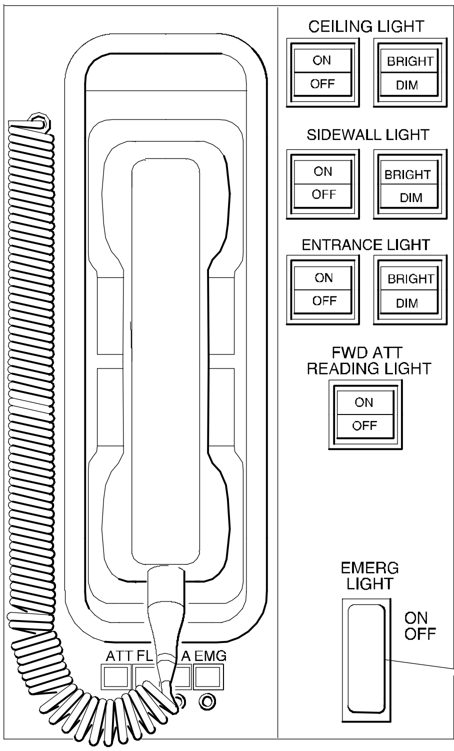


External and Emergency Exit Lights
Figure 17−60−1 (Sheet 2)

EMER LTS
Used to control operation of emergency lighting system.
- ON - Turns on all emergency lights.
- OFF - Prevents actuation of emergency lights system.
- ARM - Emergency lights come on automatically if AC or DC essential power is lost.



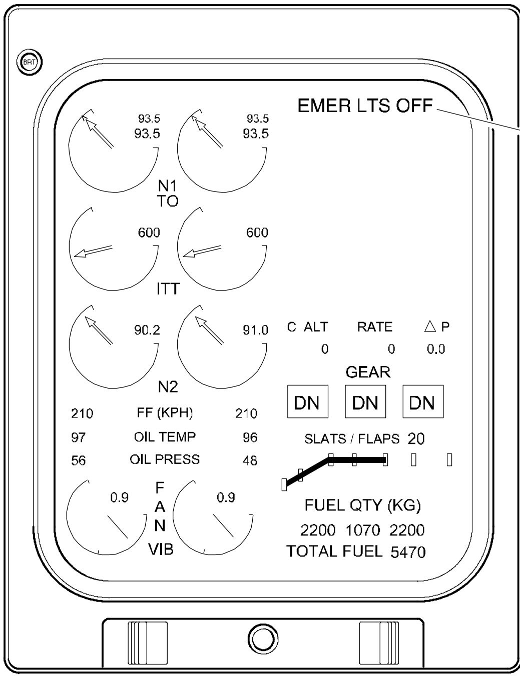
Passenger Signs and Emergency Lights Panels
Overhead Panel



Forward Attendant's Panel

EMERG LIGHT (Guarded)
Used to manually control emergency lighting system.

Emergency Lighting Controls
Figure 17–60–2

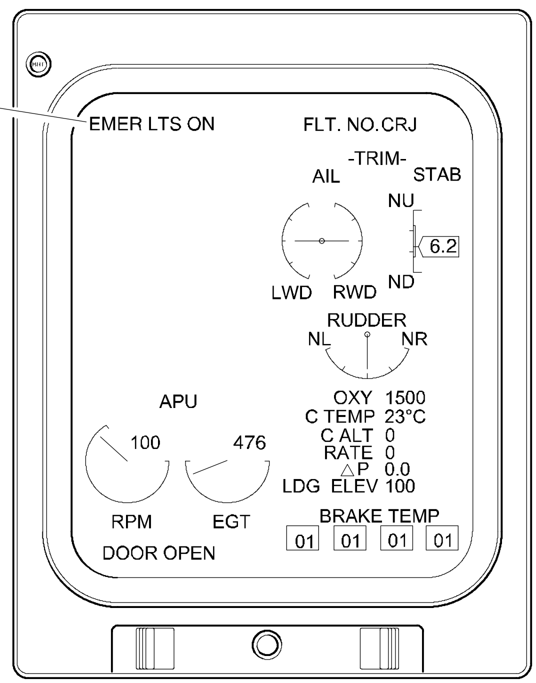


Emer LTS OFF (amber)
Indicates that the emergency lighting system has been selected off.

- Battery pack voltage is < 4.5 volts,
- Lights are off.

Primary Panel

EMER LTS ON status (white)
Indicates that emergency lighting system is operational and battery pack voltage is > 4.5 volts.



Status Page

Emergency Lights EICAS Indications <1001>
Figure 17–60–3

A. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Emergency Lighting	Emergency Lights	EMER LTS	DC ESSENTIAL	2	U3	

CHAPTER 17 – LIGHTING

LIST OF ILLUSTRATIONS

1. INTRODUCTION

Aircraft lighting consists of the following systems:

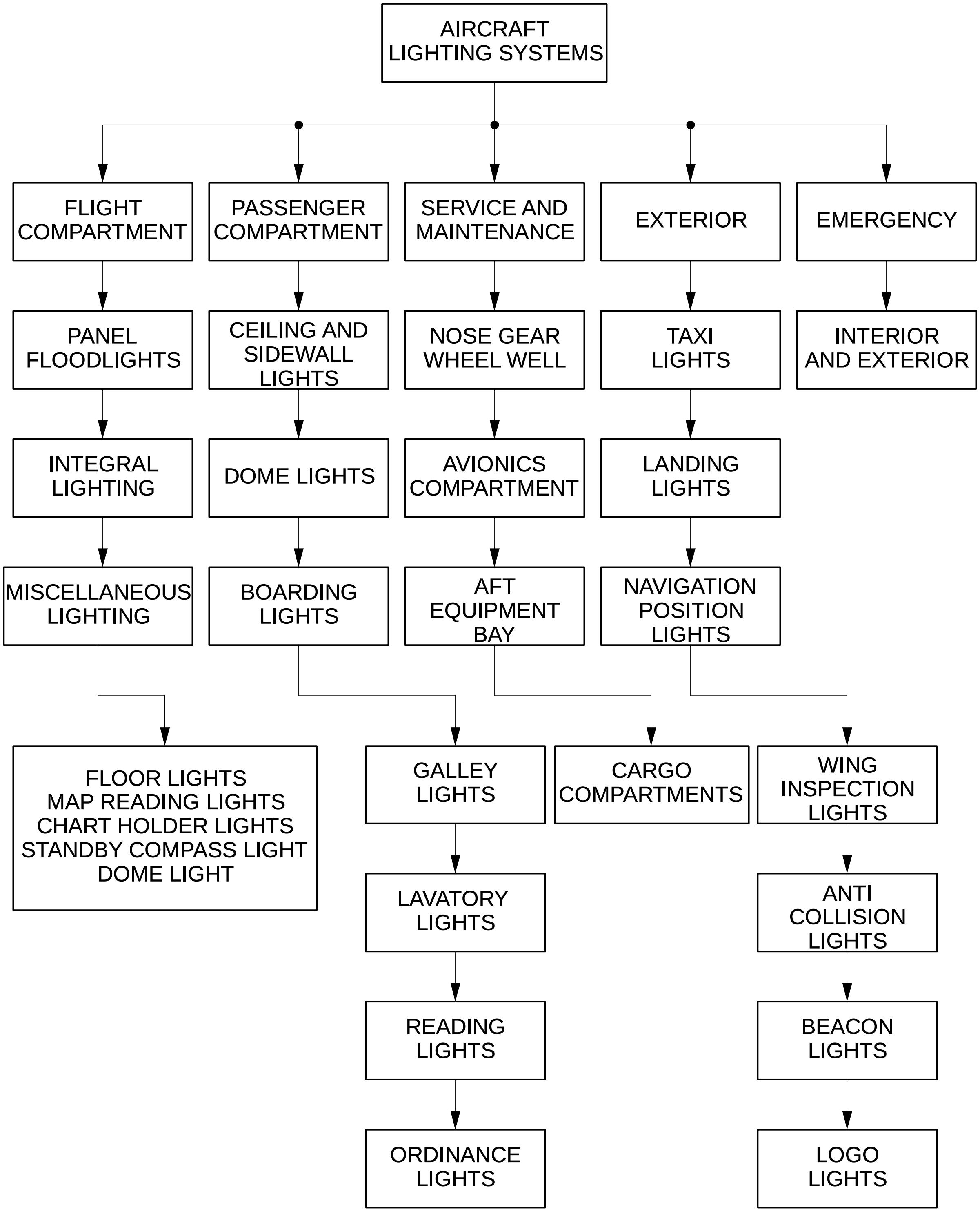
- Flight Compartment Lighting
- Passenger Compartment Lighting
- Service and Maintenance Lighting
- External Lighting
- Emergency Lighting

Lighting control panels for the flight compartment, passenger signs and external lighting are located in the flight compartment overhead panel. Passenger compartment lights are controlled from the forward attendant's panel.

Emergency lighting is controlled from the flight compartment and may also be controlled from the forward attendant's panel. When armed, the emergency lights will come on automatically if essential electrical power is lost.

Service and maintenance lighting is provided for the avionics compartment, baggage compartments, aft equipment compartment and in the landing gear wheelwells. Controls for the lights are located in the area that they illuminate.

Lighting messages are presented on the engine indication and crew alerting system (EICAS) displays.



Lighting Systems – General <1020, 1021>
Figure 17–10–1

1. FLIGHT COMPARTMENT LIGHTING

Flight compartment general area illumination is provided by dome and floor lights. Instrument and control panel lighting is provided by flood lights and integral lighting. Map and reading lights are provided for miscellaneous lighting requirements.

Control panels for the flight compartment lights are located on the overhead panel, at the pilot and copilot side panels and on the center pedestal. Each panel controls the lighting adjacent to the panels location. The controls provide dimming for electronic displays, integral panel lighting and panel flood lighting. Dimming is not provided for floor lighting.

There are three flight compartment dome lights. One light is located in the overhead of the flight compartment entrance and one light is located on each side of the overhead panel. A two position ON/OFF switch on the overhead MISC LTS panel controls the flight compartment entrance light. The pilot's and copilot's dome lights are controlled using the OFF/BRT knob on the respective DM LT panel on each side of the overhead panel.

Floor lighting illuminates the floor area between the rudder pedals and the seat of each pilot. Floor lighting is controlled by a switch on the pilot and copilot side panels.

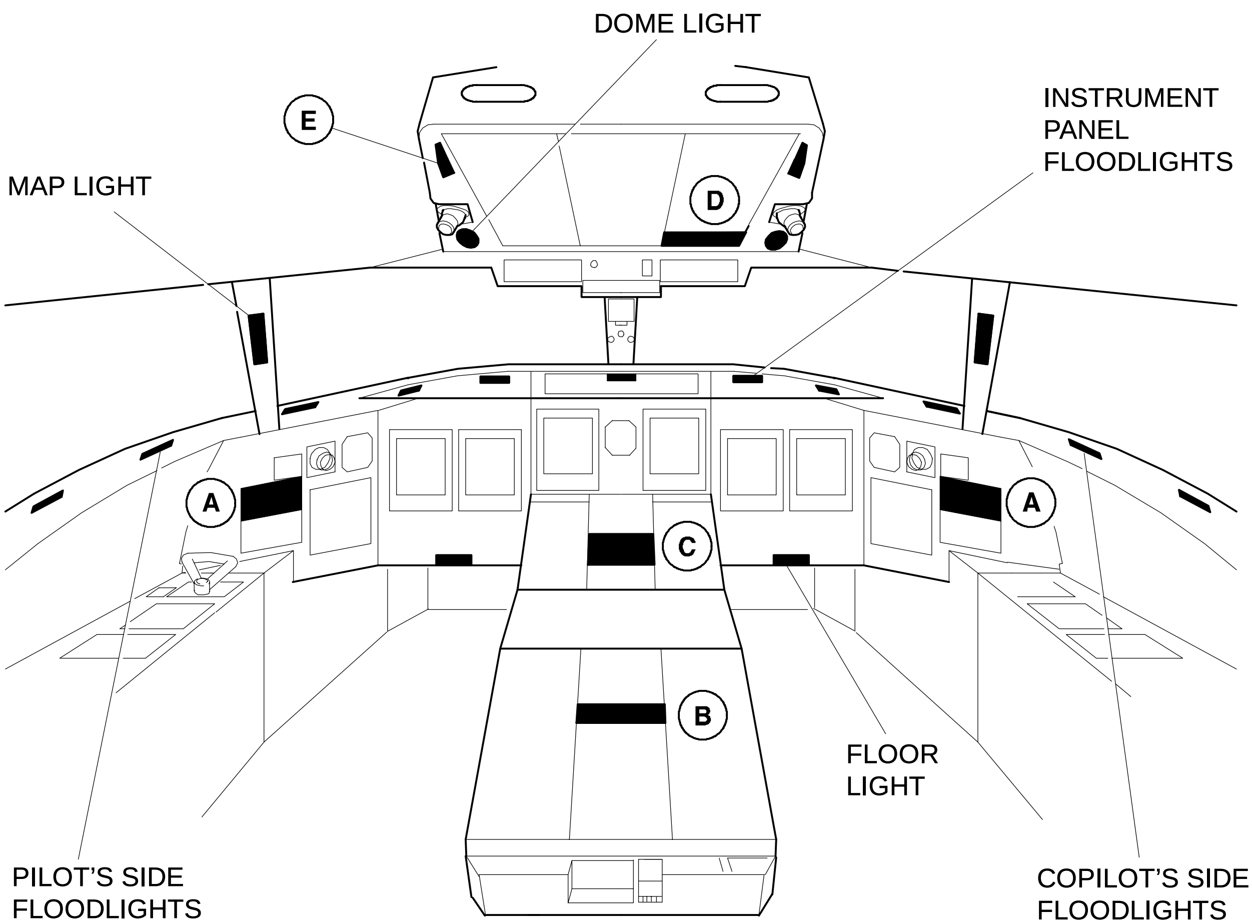
Panel integral lighting with dimming controls supply all the edge lighting for the instrument panels and control panels. The integral lights illuminate the panel names and switch positions to make them more visible for the flight crew.

Cockpit flood lights are operated by dimmers on the pilot and copilot side panels and on the center pedestal lighting panel. The pilots dimmer switch controls the four flood lights on the left side of the flight compartment. The copilots dimmer switch controls the four flood lights on the right side of the flight compartment. The dimmer switch on the center pedestal controls the three flood lights for the instrument panel.

A map light is mounted on each side window post to light the pilot and copilot lap areas. An observers map light, mounted at the cockpit entrance, pivots and swivels for use by any crew member. Light intensity is controlled by a button at the top of the light head and the circular illumination area is controlled by a lever at the bottom of the light head.

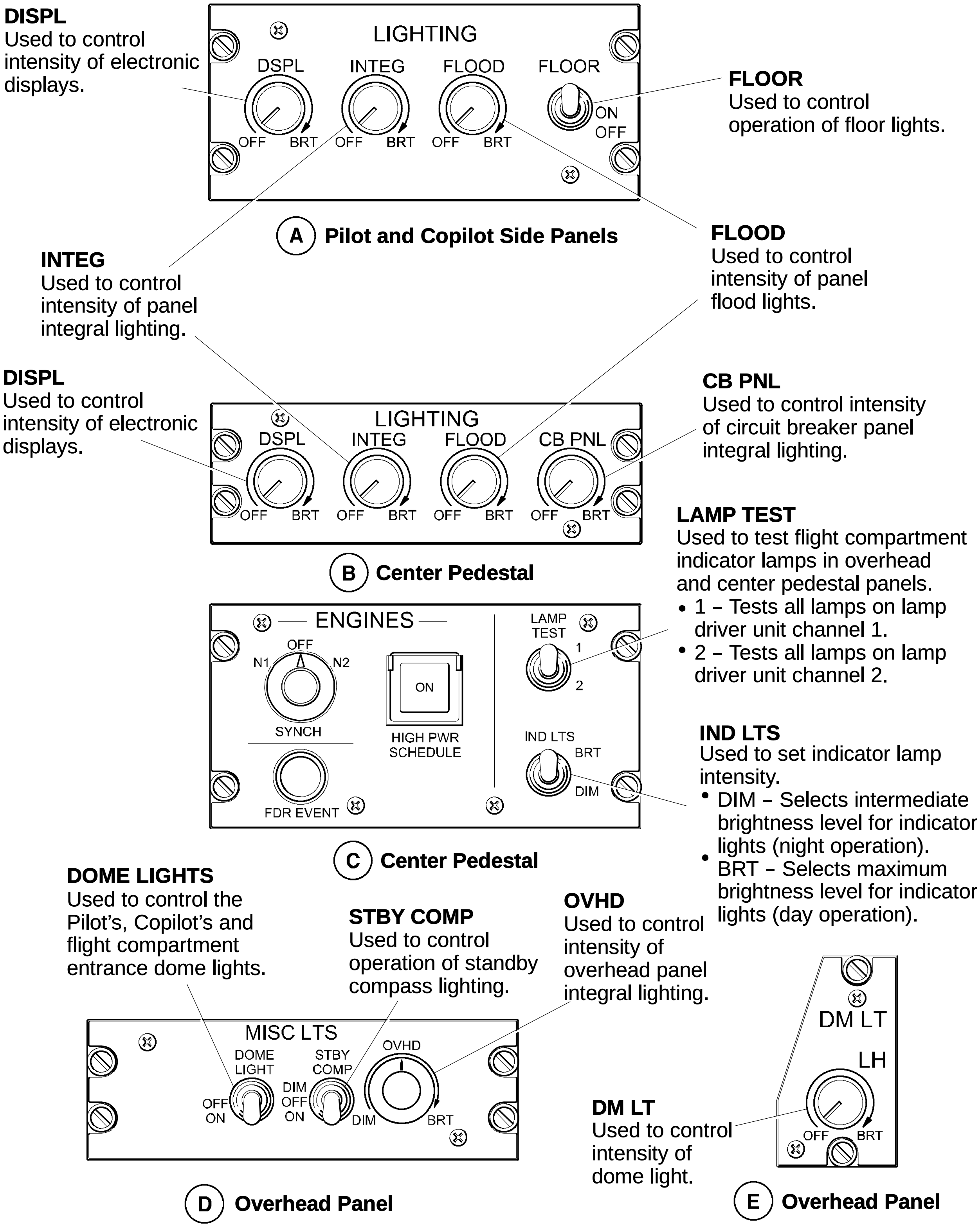
When AC power is not available the following will be illuminated by the battery bus:

- Fuel control panel
- Fire detection panel
- Engine start and ignition control panel
- Electrical power panel
- APU control panel
- Bleed air control panel
- Standby compass light
- EICAS control panel
- RTU dimming
- Pilot and observer map lights



Flight Compartment Lighting and Lighting Control Panels

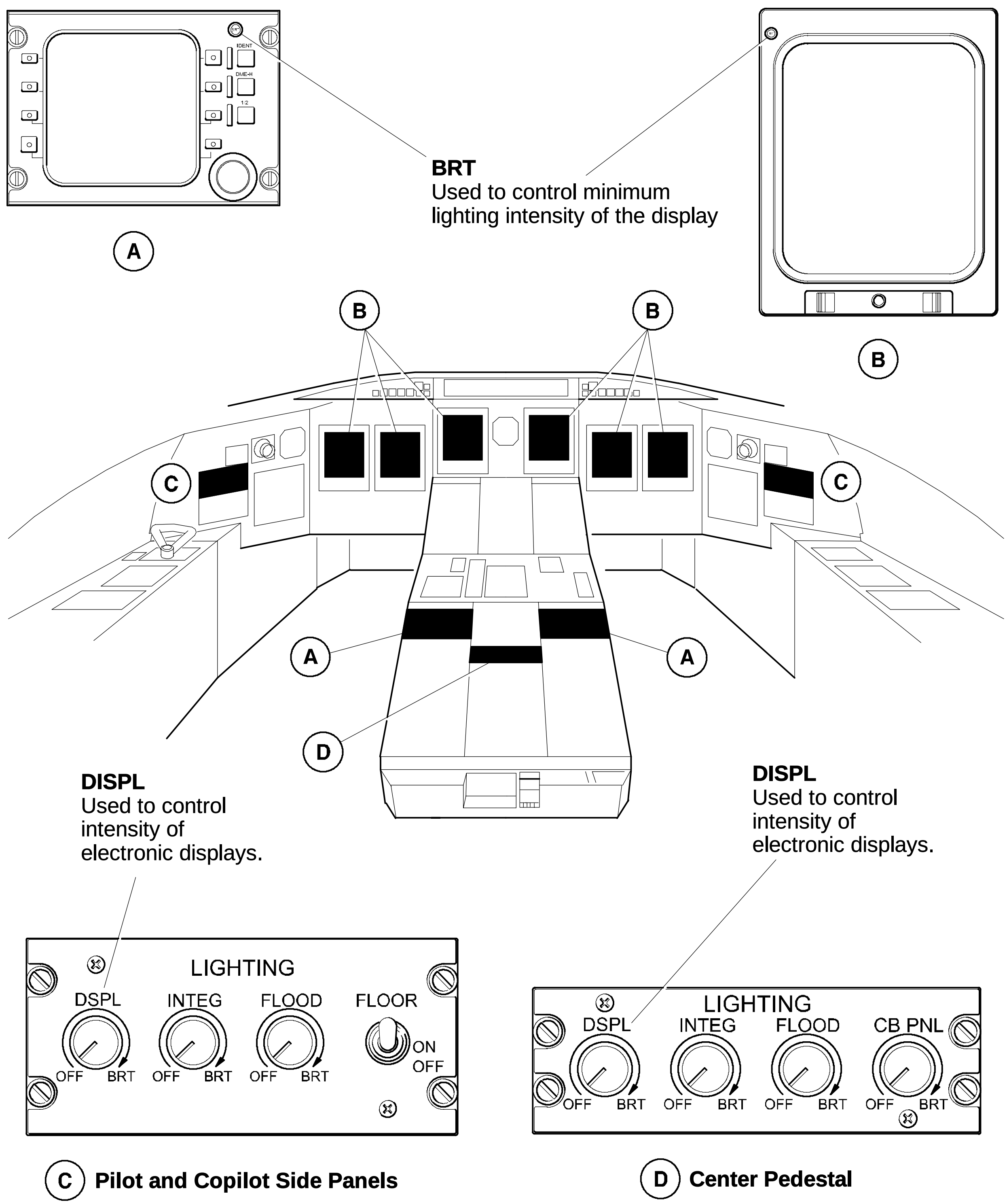
Flight Compartment and Lighting Control Panels
Figure 17−20−1



Flight Compartment Lighting Controls
Figure 17–20–2

2. CRT LIGHTING ADJUSTMENT

Two separate control switches are used to adjust display lighting intensity. In the upper left corner of the display unit, a BRT adjustment knob is used to set the minimum lighting intensity for the associated screen. After adjusting the BRT knob to a minimum level, the pilot can select the desirable level of lighting for the EFIS and EICAS displays by using the DSPL knob located on the associated lighting panel.



CRT Lighting Intensity Adjustment
Figure 17–20–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Flight Compartment Lighting	Dome Lights	CKPT DOME LIGHTS	MAIN BATTERY DIRECT BUS	6	B5	
		CKPT DOME LIGHT	DC BUS 1	1	E4	
	Floor Lights	LIGHTS CKPT FLOOR			G7	
	Flood Lights	INST FLOOD LTS	DC ESSENTIAL	2	U2	
	Instrument Lights	INTEG LTS CB PNLS	AC ESSENTIAL	1	V4	
		INTEG LTS PLT PNLS			V5	
		INTEG LTS CTR PNLS			V6	
		INTEG LTS O/H PNLS			V7	
		INTEG LTS C/PLT PNLS	AC BUS 2	2	B14	
		LIGHTS O/H PNL	BATTERY BUS	1	P5	
		LIGHTS EICAS/RTU DIMMING			P6	
	Map Lights	LIGHTS PLT MAP			P2	
		LIGHTS C/PLT OBS MAP			P3	
		LIGHTS C/PLT MAP	DC BUS 2	2	G7	
	Chart Holder Lights	LIGHTS CHART HOLDER			G6	

1. PASSENGER COMPARTMENT LIGHTING

Passenger compartment lighting is supplied by ceiling and sidewall fluorescent lights. Some of the ceiling lights are powered by the AC essential bus and remain available in the event that the AC service bus becomes lost. Entrance lighting consists of six fluorescent lights in the entrance ceiling panels and three lights in the stairs of the passenger door. Ceiling, sidewall and entrance lighting is controlled from the forward flight attendant's panel.

Two reading lights are installed in each passenger service unit (PSU). They supply personal lighting for passenger use and can be controlled independently. The passenger reading lights can be tested and reset using switches on the forward flight attendants panel. Each flight attendant station is equipped with a reading light controlled by a switch on the attendant's panel.

Lighted NO SMOKING and FASTEN SEAT BELTS ordinance signs are installed in each PSU, in the lavatories, and in the main entrance. The lavatories also have return to seat symbols. Control of the ordinance signs is provided on the PASS SIGNS overhead panel in the flight compartment.

The lavatory is illuminated by three fluorescent lights (two in the vanity and one above the counter). The lights come on dim when aircraft power is applied. With the lavatory door locked, the vanity light assembly will come on bright.

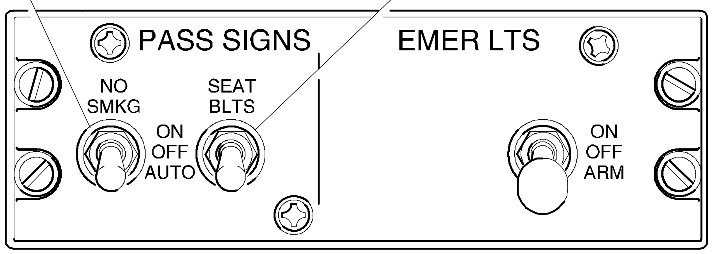
Galley lighting is provided by six fluorescent lights in the galley ceiling panel. Two switches on the galley control panel control the galley lights. Lights in the wardrobe and stowage compartments are controlled by micro-switches in the doors, so that the lights come on when the door is opened.

NO SMKG Switch

- AUTO - The corresponding signs located throughout the cabin come on when the landing gear is extended or cabin altitude is greater than 10,000 feet.
- OFF - Turns off all NO SMOKING signs.
- ON - Turns on all NO SMOKING signs.

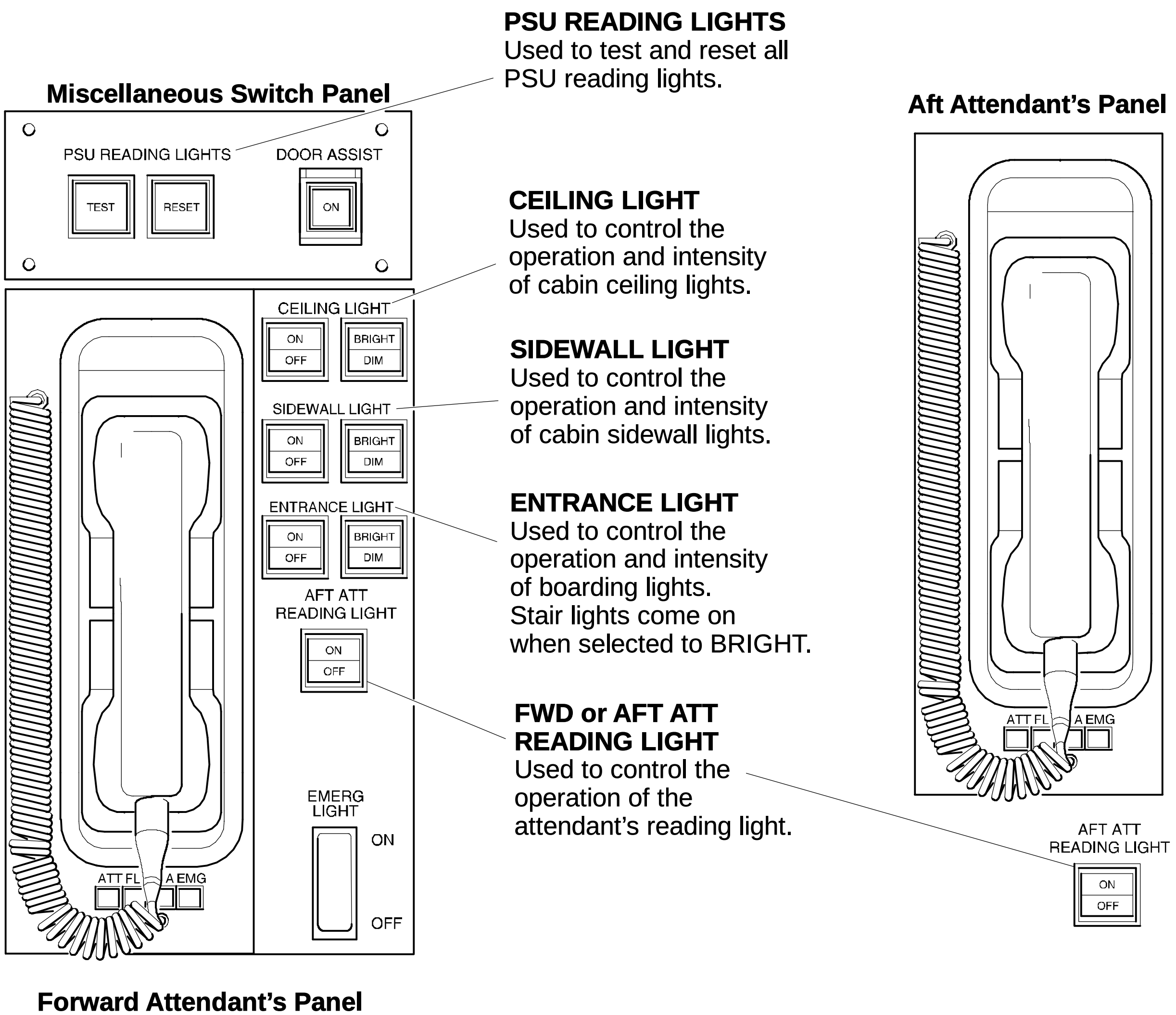
SEAT BLTS Switch

- AUTO - The corresponding signs throughout the cabin come on when cabin altitude is greater than 10, 000 feet, when the landing gear is extended or when flaps are greater than 0 degrees.
- OFF - Turns off the SEAT BELT signs and RETURN TO SEAT sign in the lavatory.
- ON - Turns on the SEAT BELT signs and RETURN TO SEAT sign in the lavatory.



Passenger Signs and Emergency Lights Panel
Overhead Panel

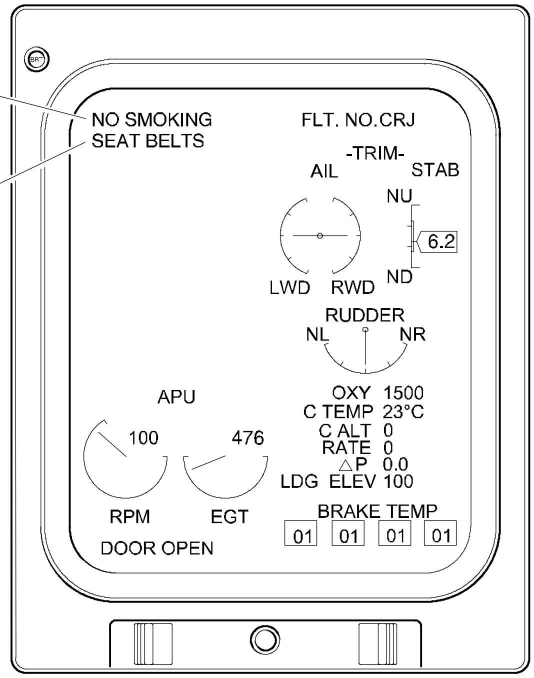
Passenger Signs and Emergency Lights Panel
Figure 17–30–1



Flight Attendant's Panels
Figure 17–30–2

NO SMOKING status (white)
Indicates that the no smoking signs have been selected on, automatically or manually.

SEAT BELTS status (white)
Indicates that the seat belts signs have been selected on, automatically or manually.



Status Page

No Smoking and Seat Belts EICAS Messages
Figure 17–30–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Passenger Compartment Lighting	Cabin Lighting	CABIN LIGHTING CEILING	AC ESSENTIAL	1	T10	
		CABIN LIGHTING CEILING	AC SERVICE	2	D14	
		CABIN LIGHTING SIDEWALL			E14	
		LIGHTS CAB UTIL	BATTERY BUS	1	P4	
	Passenger Signs	PASS SIGNS			M10	
	Passenger Reading Lights	R CABIN READING LIGHTS FWD	DC UTILITY	2	L3	
		R CABIN READING LIGHTS AFT			L4	
		L CABIN READING LIGHTS FWD	DC BUS 1	1	E2	
		L CABIN READING LIGHTS AFT			E3	
	Boarding Lights	LIGHTS BOARD	DC SERVICE	2	M3	
	Lavatory Lights	LIGHTS TOILET			M5	
	Galley Lights	LIGHTS GALLEY AREA			M6	

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1. SERVICE AND MAINTENANCE LIGHTING

Service lighting is provided for the cargo compartments and external loading area. Maintenance lighting is provided for the landing gear bays, APU compartment, aft equipment compartment and the underfloor avionics compartment. <2046>

A. Service Lighting

Two lights illuminate the forward cargo compartment. The forward cargo compartment lights are controlled by a switch located at the inside forward edge of the forward cargo door opening. Activation requires a weight-on-wheels signal to ensuring that the lights are off when the aircraft is in flight.

Two lights illuminate the aft cargo compartment. The aft cargo compartment lights are controlled by a switch located at the inside forward edge of the cargo door. Activation requires a weight-on-wheels signal to ensuring that the lights are off when the aircraft is in flight.

External loading area lighting consists of a forward cargo compartment loading area light and an aft cargo compartment loadng area light. The lights are designed to illuminate the cargo compartment loading areas. <2046>

The forward cargo compartment loading area light and switch is installed within the forward cargo compartment. The light illuminates the loading area and the ground immediately below the loading area, when the forward cargo door is open. <2046>

The aft cargo compartment loading area light is installed under the left engine pylon and angled to illuminate the loading area and the ground immediately below the aft cargo door. The light switch is located inside the aft cargo compartment. <2046>

B. Maintenance Lighting

Six flood lights are installed down the length of the underfloor avionics compartment. The lights are controlled by a switch located in the compartment.

Two lights and a control switch are installed in the aft equipment compartment.

Two lights and a control switch are installed on the APU rear bulkhead to illuminate the APU compartment area.

Two high intensity halogen lights are installed in each main landing gear bay. Each light has a control switch located next to it. A single high intensity halogen light and switch is installed in the nose landing gear bay.

NOTE

At this time, the main landing gear maintenance lights have been disabled through SB670–31–003.

C. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Service and Maintenance	Maintenance	LIGHTS MAINT	DC BUS 1	1	G10	
	Service	LIGHTS FWD SERV	DC SERVICE	2	M1	
		LIGHTS AFT SERV			M2	
		SERV AREA			M7	

1. EXTERNAL LIGHTING

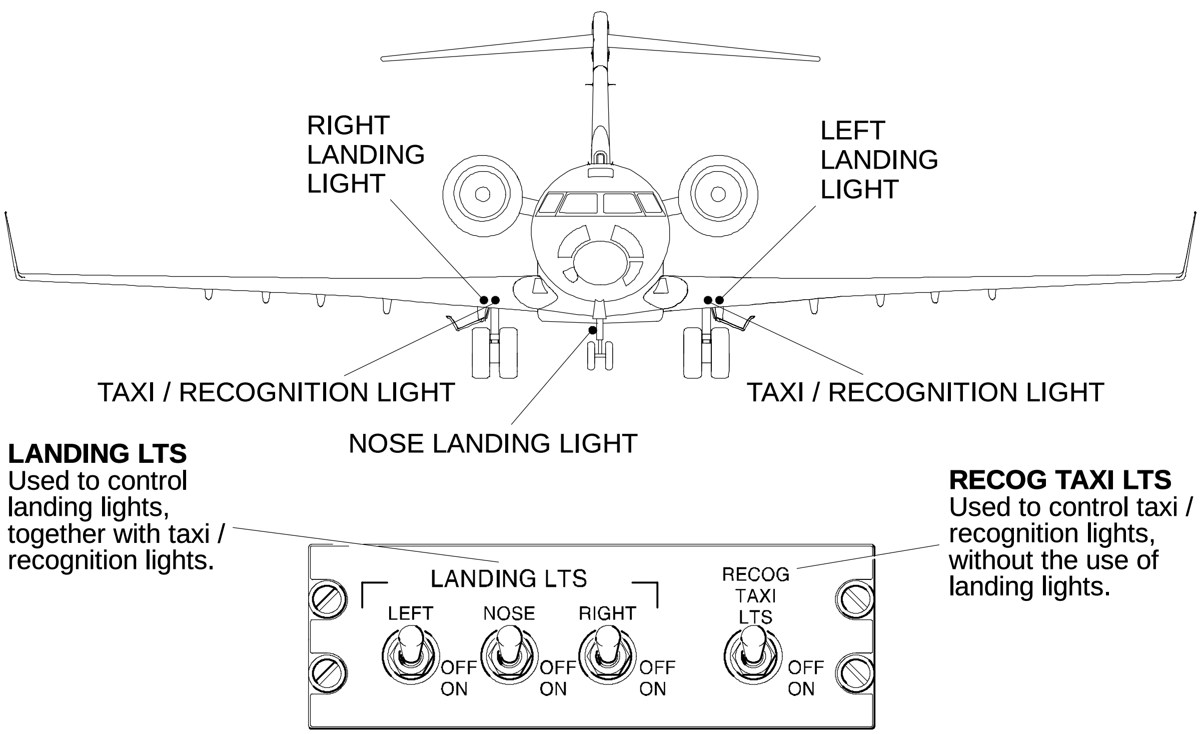
External lighting consists of landing, taxi, navigation, beacon, anti-collision strobe, logo and wing inspection lights. Control of the landing and taxi lights is provided by switches on the LANDING LTS panel located on the overhead panel. All other external lighting is controlled by switches on the EXTERNAL LTS panel, also located on the overhead panel. <1020,1021>

A. Landing and Taxi Lighting

One landing light is installed in the leading edge of each wing and one is installed on the nose landing gear. The taxi lights are installed inboard of the wing landing lights, in the same wing compartments. The taxi lights also serve as recognition lights.

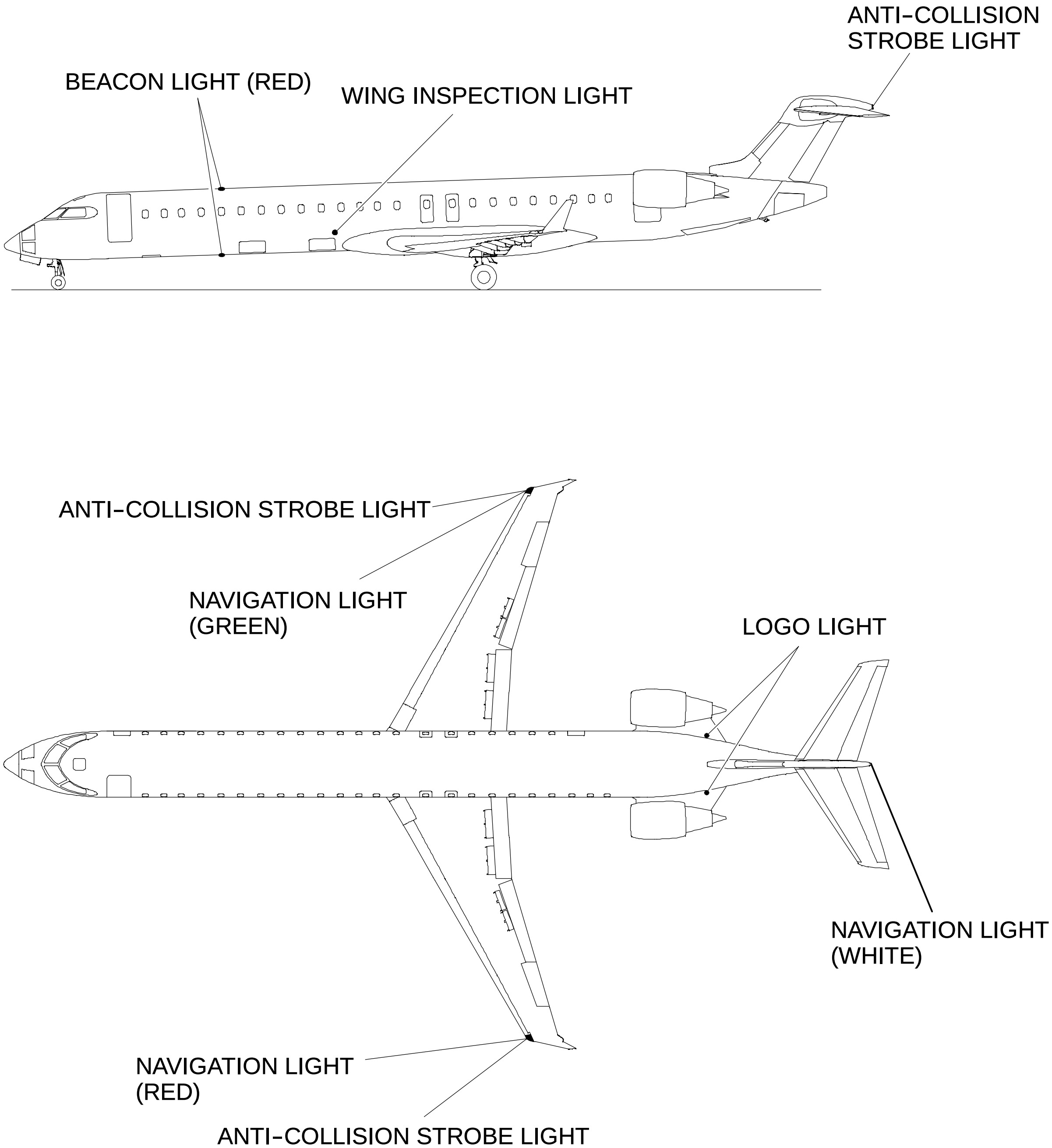
The nose gear landing light is installed on a bracket on the nose gear and is designed to illuminate the ground during landing and take-off. Activation requires a gear downlock signal to prevent the light from being on when the landing gear is retracted.

The wing landing lights and taxi lights are high intensity discharge lamps. The landing lights are controlled by the LEFT, RIGHT and NOSE landing light switches on the LANDING LTS panel. The taxi lights are controlled, separately from the landing lights, by the RECOG/TAXI LTS switch on the same panel.



Landing Lights Panel
Overhead Panel

Landing and Taxi Lights
Figure 17–50–1



External Lighting <1020, 1021>
Figure 17–50–2

B. Navigation Lighting

A dual navigation light system is installed in the aircraft for additional dispatch reliability. The navigation lights consists of two red lights in the left wing tip, two green lights in the right wing tip and two white lights on the aft end of the vertical stabilizer. The lights provide visual tracking and orientation of the aircraft in relation to an observer. The navigation lights are controlled by a NAV switch on the EXTERNAL LTS panel.

C. Beacon Lights

Two red beacon lights are installed on the aircraft to permit the aircraft to be seen from a distance. One light is installed on the top of the fuselage and one light is installed on the bottom of the fuselage. The lights are controlled by a BEACON switch on the EXTERNAL LTS panel. The lights are also used during ground operations to provide indication that the aircraft is powered and may have engines running. <1021>

D. Anti–Collision Strobe Lights

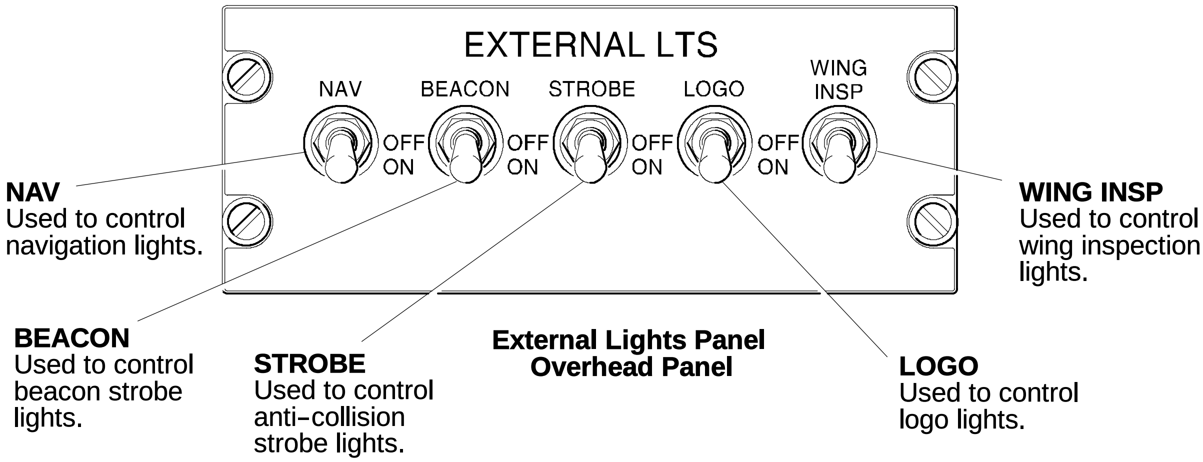
There are three white anti-collision strobe lights on the aircraft. One light is installed in each wing tip and one is installed on the aft end of the vertical stabilizer next to the tail navigation lights. They are synchronous lights that flash continuously. The light are controlled by a STROBE switch on the EXTERNAL LTS panel.

E. Logo Lighting

A white logo light is installed on the upper surface of each engine pylon to illuminate the airline logo on each side of the vertical stabilizer. The lights are controlled by a LOGO switch on the EXTERNAL LTS panel <1020>

F. Wing Inspection Lighting

A white wing inspection light is installed on each side of the fuselage just forward of the wing. The lights are controlled by a WING INSP switch on the EXTERNAL LTS panel and allow the pilots to monitor the wing leading edges for ice accumulation.



External Lights Panel <1020, 1021>
Figure 17–50–3

G. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
External Lighting	Landing Lights	LIGHTS LDG WINGS	BATTERY BUS	1	P1	
External Lighting	Landing Lights	LIGHTS LDG NOSE	DC BUS 1	1	G6	
External Lighting	Taxi Lights	TAXI LTS	DC BUS 1	1	F5	
External Lighting	Wing Inspection Lights	LIGHTS WING INSP	DC BUS 1	1	G9	
External Lighting	Anti-Collision Strobe Lights	LIGHTS REAR A/COLL	DC BUS 1	1	G8	
External Lighting	Anti-Collision Strobe Lights	LIGHTS WING A/COLL	DC BUS 2	2	G8	
External Lighting	Navigation Lights	LIGHTS NAV	DC SERVICE	2	M4	
External Lighting	Beacon Lights	BEACON LIGHTS	DC SERVICE	2	M8	<1021>
External Lighting	Logo Lights	LOGO LIGHTS	AC SERVICE	2	D11	<1020>

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1. EMERGENCY LIGHTING

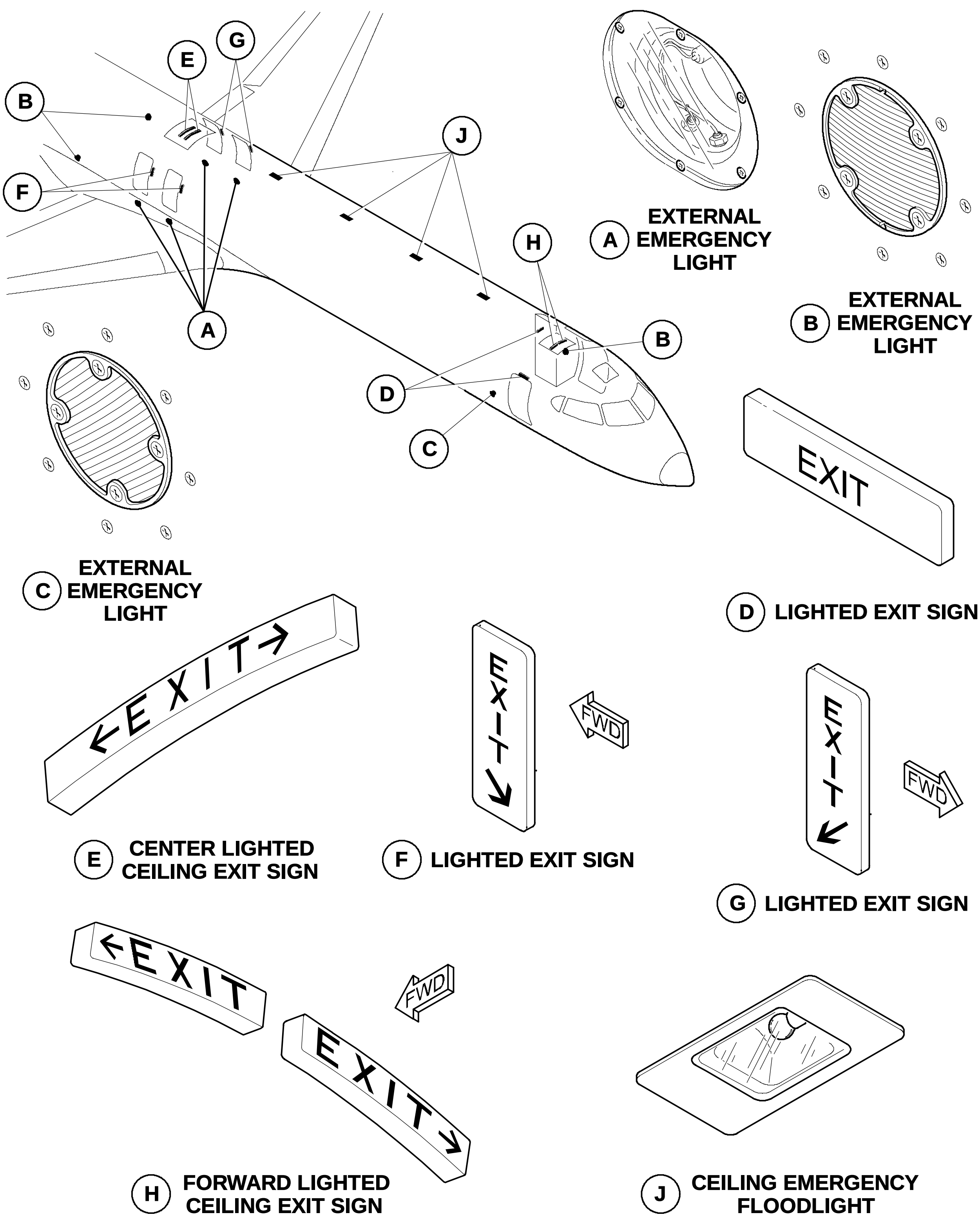
Emergency lighting is provided in the event of an emergency evacuation of the passengers and crew from the aircraft.

External emergency lights provide illumination of the overwing evacuation exit paths and exterior areas around the forward passenger door and service door. <2224>

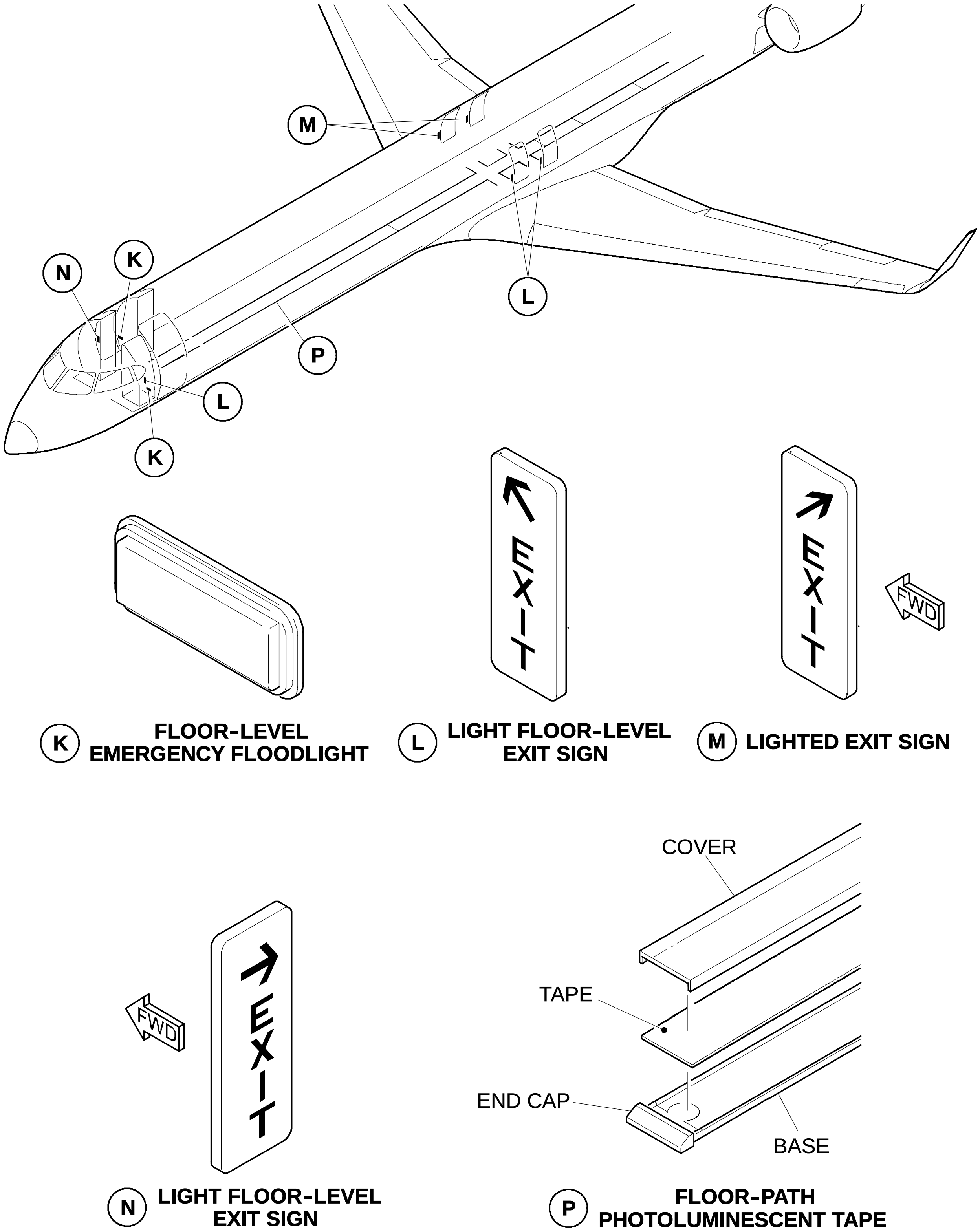
Internal emergency lighting provides emergency lighting to the passenger cabin, emergency exits and interior exit paths. The internal emergency lights include lighted exit signs near all six emergency exits at floor level, at eye level and on the ceiling. There are ceiling flood lights installed along the length of the passenger compartment and floor-level flood lights at the passenger door and service door. Photoluminescent strips are installed along the floor on both sides of the aisle to provide illuminated escape path routing to each emergency exit. The Photoluminescent strips are sufficiently charged after 15 minutes of exposure to interior cabin lighting. <2224>

Electrical power for all emergency lighting is supplied by five self-contained battery packs. The battery packs contain 6-Volt nickel-cadmium batteries that are supplied with a trickle charge from the DC essential bus. The battery packs are designed to illuminate all emergency light systems for approximate 10 minutes.

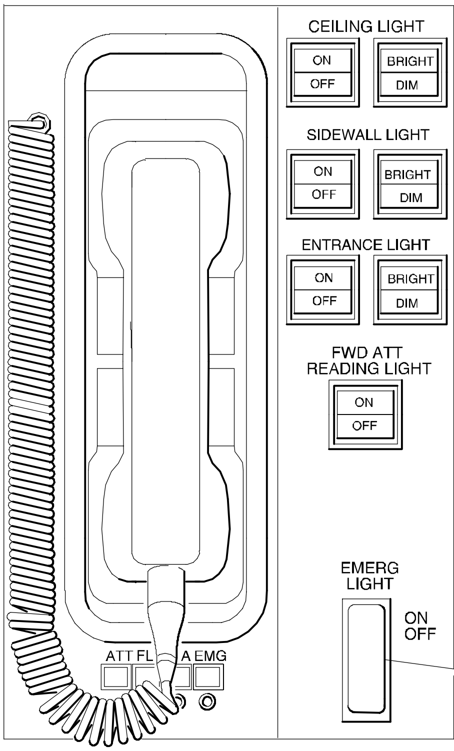
Emergency lighting is controlled by a cockpit switch on the EMERG LTS panel located on the overhead panel or by a guarded EMERG LIGHTS switch on the forward attendant's panel. The emergency lights can be manually turned on using either switch. With the cockpit switch in the ARM position, the emergency lights will come on automatically if AC or DC essential power is lost.



External and Internal Emergency Exit Lights
Figure 17−60−1 (Sheet 1)

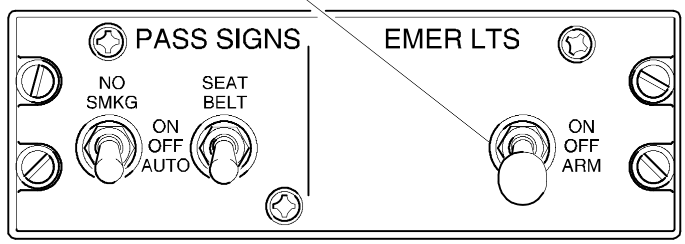


External and Emergency Exit Lights
Figure 17–60–1 (Sheet 2)



Forward Attendant's Panel

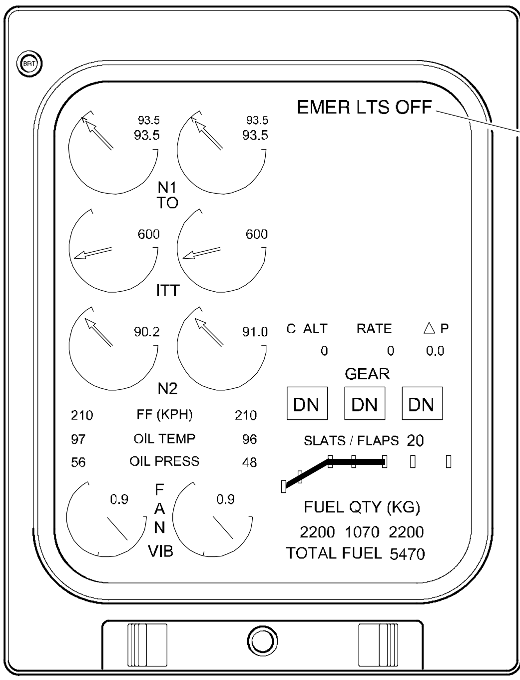
EMER LTS
Used to control operation of emergency lighting system.
- ON - Turns on all emergency lights.
- OFF - Prevents actuation of emergency lights system.
- ARM - Emergency lights come on automatically if AC or DC essential power is lost.



Passenger Signs and Emergency Lights Panels
Overhead Panel

EMERG LIGHT (Guarded)
Used to manually control emergency lighting system.

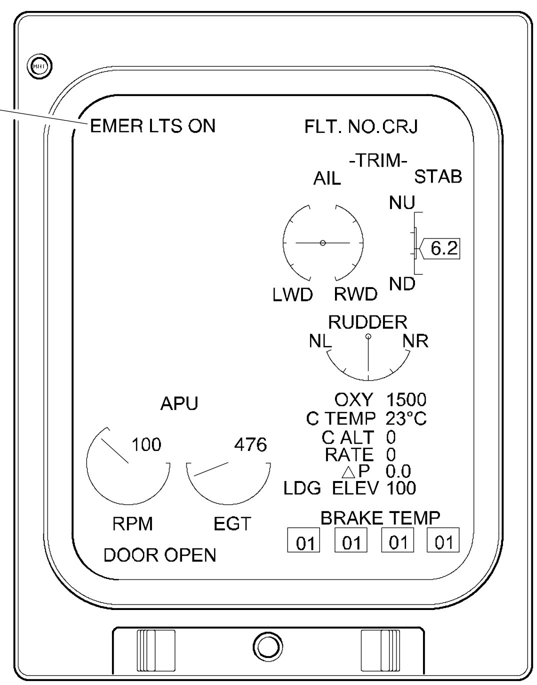
Emergency Lighting Controls
Figure 17–60–2



Emer LTS OFF (amber)
Indicates that the emergency lighting system has been selected off.
- Battery pack voltage is < 4.5 volts,
- Lights are off.

Primary Panel

EMER LTS ON status (white)
Indicates that emergency lighting system is operational and battery pack voltage is > 4.5 volts.



Status Page

Emergency Lights EICAS Indications <1001>
Figure 17–60–3

A. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Emergency Lighting	Emergency Lights	EMER LTS	DC ESSENTIAL	2	U3	

CHAPTER 18 – NAVIGATION SYSTEMS

LIST OF ILLUSTRATIONS

AIR TRAFFIC CONTROL TRANSPONDER SYSTEM

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM

GROUND PROXIMITY WARNING SYSTEM

WEATHER RADAR SYSTEM

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1. INTRODUCTION

The navigation systems contain the radios and controls used for navigation purposes. The navigation systems provided are as follows:

- Flight Management System (FMS) <1214>
- Global Positioning System (GPS) <1027>
- VHF Navigation (VNAV)
- Automatic Direction Finder (ADF)
- Distance Measuring Equipment (DME)
- Air Traffic Control Transponder System (ATC)
- Traffic Alert and Collision Avoidance System (TCAS)
- Enhanced Ground Proximity Warning System (EGPWS) <2040>
- Weather Radar System (WXR)

The two separate VHF systems provide for radio navigation. They have been designed and installed so that the failure of one system does not prevent the operation of the other. Both systems are connected to the onside and cross-side flight compartment displays and controls.

The navigation receivers are tuned by two radio tuning units and navigation data is displayed on the primary flight displays (PFDs) and multifunctional displays (MFDs).

Frequency selection is accomplished through two radio tuning units. In the event of a failure of one or both radio tuning units, radio communication and navigation can be controlled by a backup tuning unit.

Display control panels permit control over the multifunctional display format, navigation source and bearing source display.

Audio monitoring is provided by three audio control panels.

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1. FLIGHT MANAGEMENT SYSTEM

NOTE

For complete flight management system operating instructions, refer to the FMS-4200 Pilot's Guide

The flight management system (FMS) provides lateral navigation with advisory vertical guidance, flight plan creation and monitoring, enroute map display support, autopilot steering commands and control signals, radio navigation and radio communication tuning and control, and non-precision approach lateral navigation.

The FMS consists of two flight management computers and two control display units located in the center console. The flight management computers collect information from the navigation sensors and perform all computations, control and command functions. The control display units provides the pilot interface for data input and control functions, and provides display of functions, modes and flight data. Pictorial data is displayed on the multifunctional displays. A data loader is used to transfer data to and from the FMS. <1214>

The system uses all available sensors and provides the pilot with control of which sensors are used in the position computation. If no sensor data is available, the system continues to estimate a dead reckoning position using heading and true airspeed.

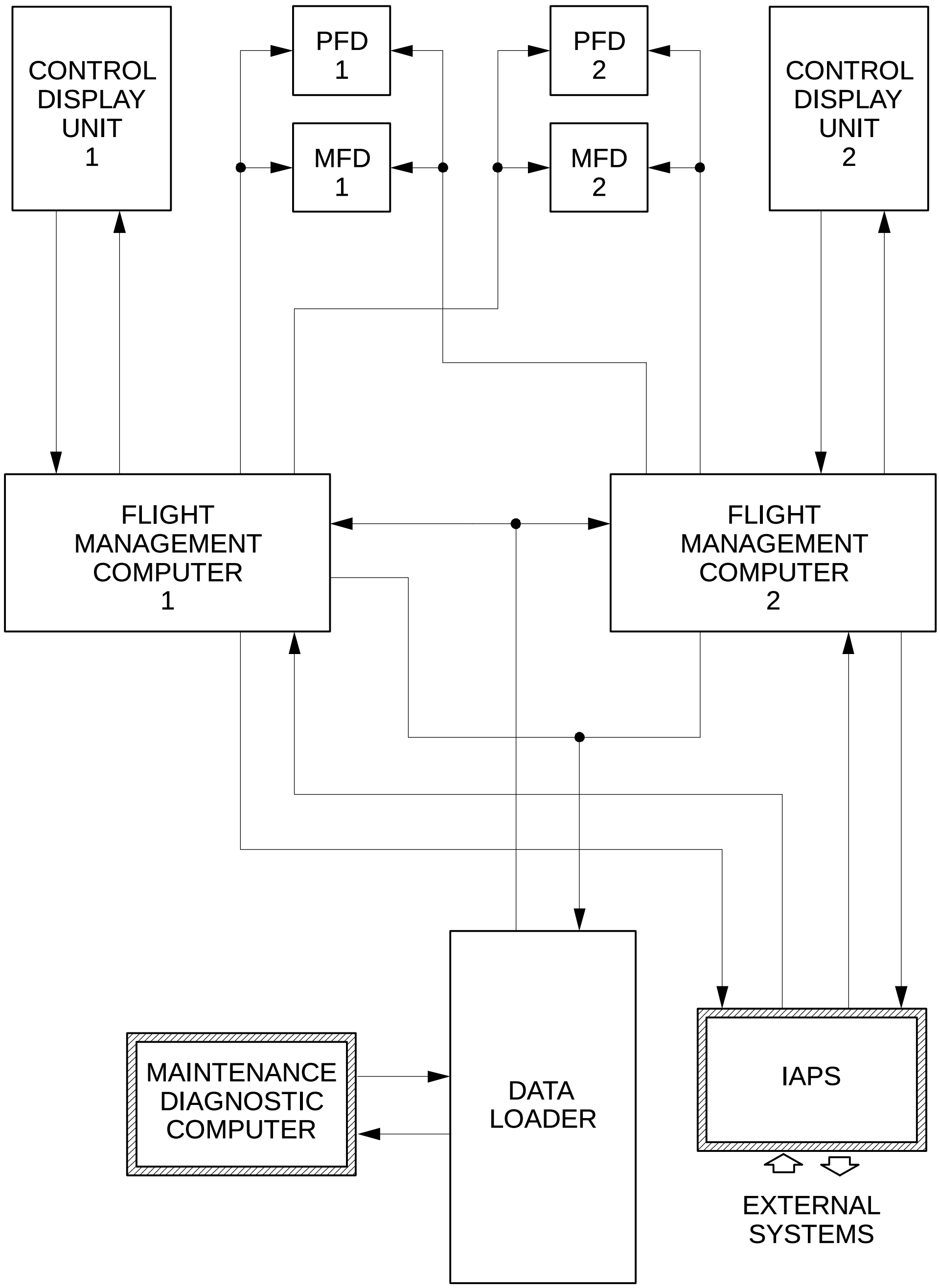
FMS Performance Database

The FMS performance database is advisory only.

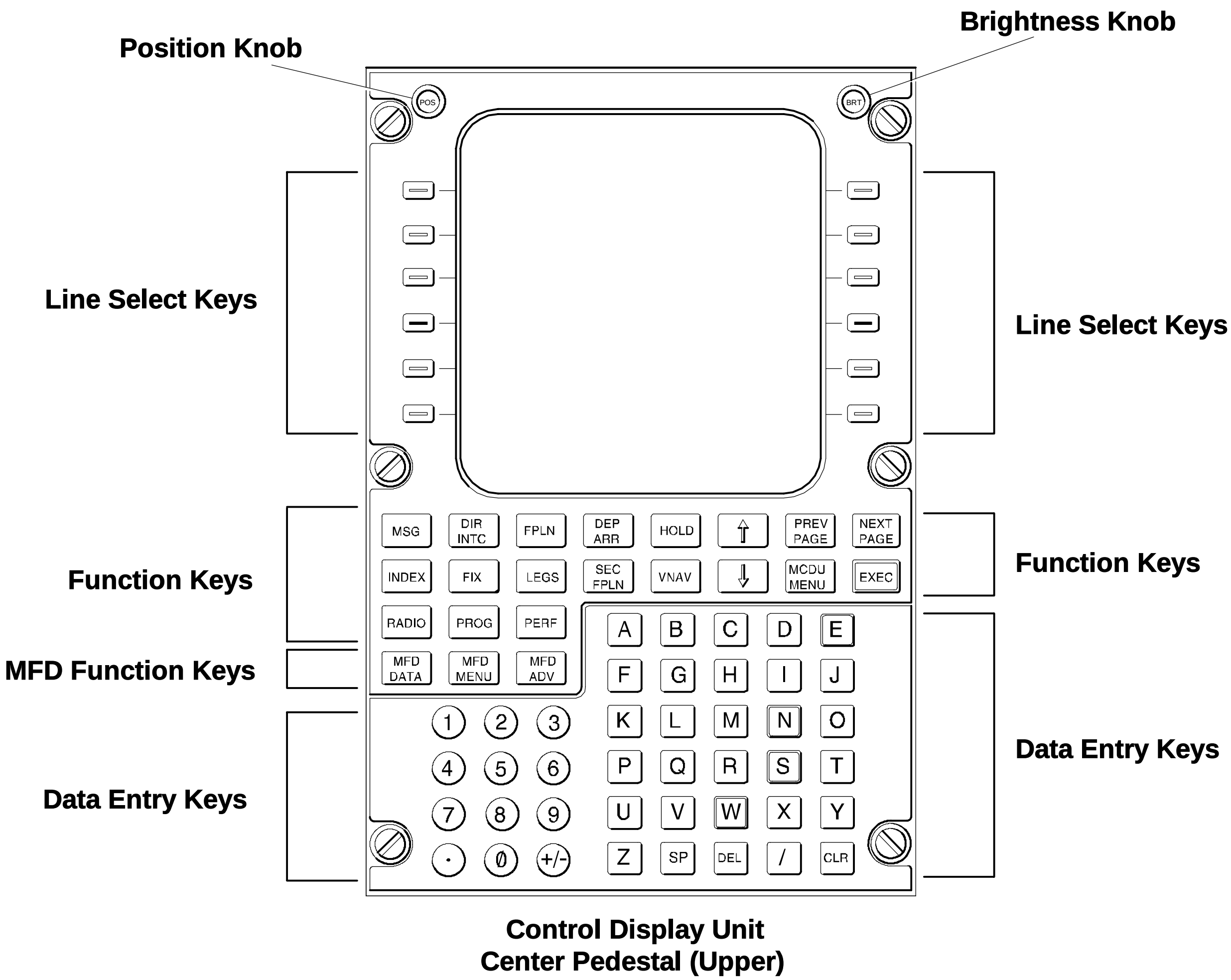
Climb, cruise, and descent performance information stored in the FMS database allows the crew to predict time and remaining fuel at each waypoint of the flight plan, destination and alternate destination.

The performance data given in Flight Planning and Cruise Control Manual corresponds to the FMS database as follows:

Flight Planning and Cruise Control Manual	Performance Database Part Number
CSP C–015 (Metric Version) Revision 1, Jun 12/02	815–5913–001



Flight Management System Block Schematis <1214>
Figure 18−20−1



Flight Management System Control Display Unit<1214>
Figure 18–20–2

A. System Circuit Breakers

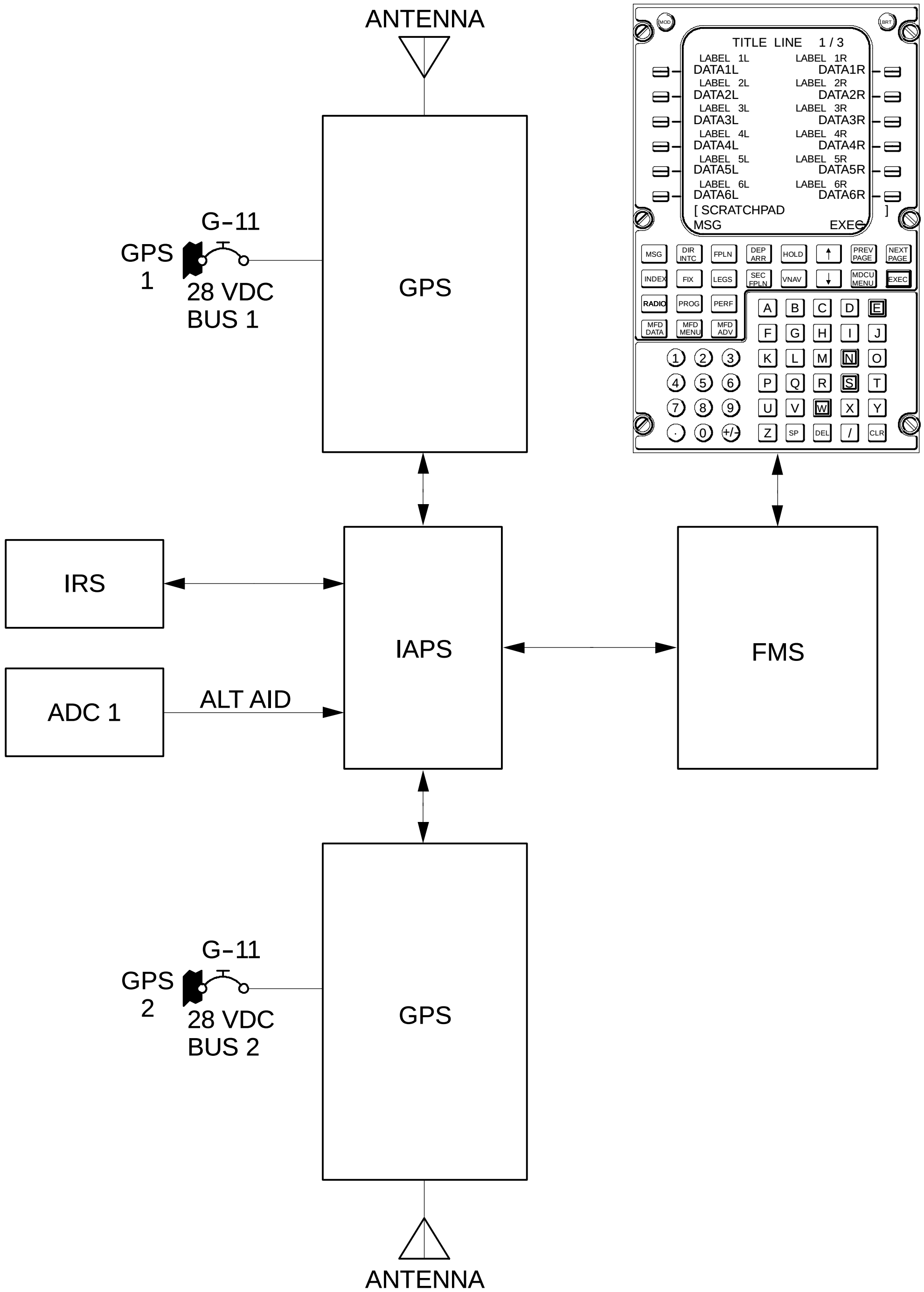
SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Flight Management System	Control Display Unit	CDU 1	DC BUS 1	1	H9	

1. GLOBAL POSITIONING SYSTEM <1027>

The Global Positioning System (GPS) is a satellite navigation system that computes the position of the aircraft relative to orbiting satellites. The GPS provides highly accurate three-dimensional position, velocity and time information to the integrated avionics processor system (IAPS).

The GPS consists of two antennas and two receivers. The antennas supply signals to their respective receivers. The receivers process the signals and supply continuous navigation updates to the inertial reference system (IRS) and to the flight management system (FMS). The FMS uses the GPS and other available navigation and position sensors to provide navigation, position information and guidance. <1212><1025><1027>

The FMS control display units provides the pilots with access to GPS data and control settings. GPS information is displayed on the multifunctional displays. For more information, refer to the FMS Pilot's Guide. <1214>



Dual Global Positioning System <1025,1027,1212>
Figure 18–25–1

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Global Positioning System	Receiver	GPS 1	DC BUS 1	1	G11	
		GPS 2	DC BUS 2	2	G11	<1027>

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1. VHF NAVIGATION

There are two VHF navigation systems installed on the aircraft and are identified as VHF/NAV 1 and VHF/NAV 2. The systems provide the following functions:

- VHF omnidirectional range (VOR)
- Localizer/glideslope (LOC/GS)
- Marker beacon (MB)

The VHF/NAV receivers are installed in the avionics compartment and contain the logic to control the VOR/LOC receiver, glideslope receiver and the marker beacon receiver.

Frequency tuning and mode selection is done by two radio tuning units (RTU), a single backup tuning unit or the FMS control display unit. The radio tuning units are the primary radio communication system radio tuning source (Refer to Chapter 05–30–01 for additional information).

The VOR/LOC receivers operate in the following frequency ranges:

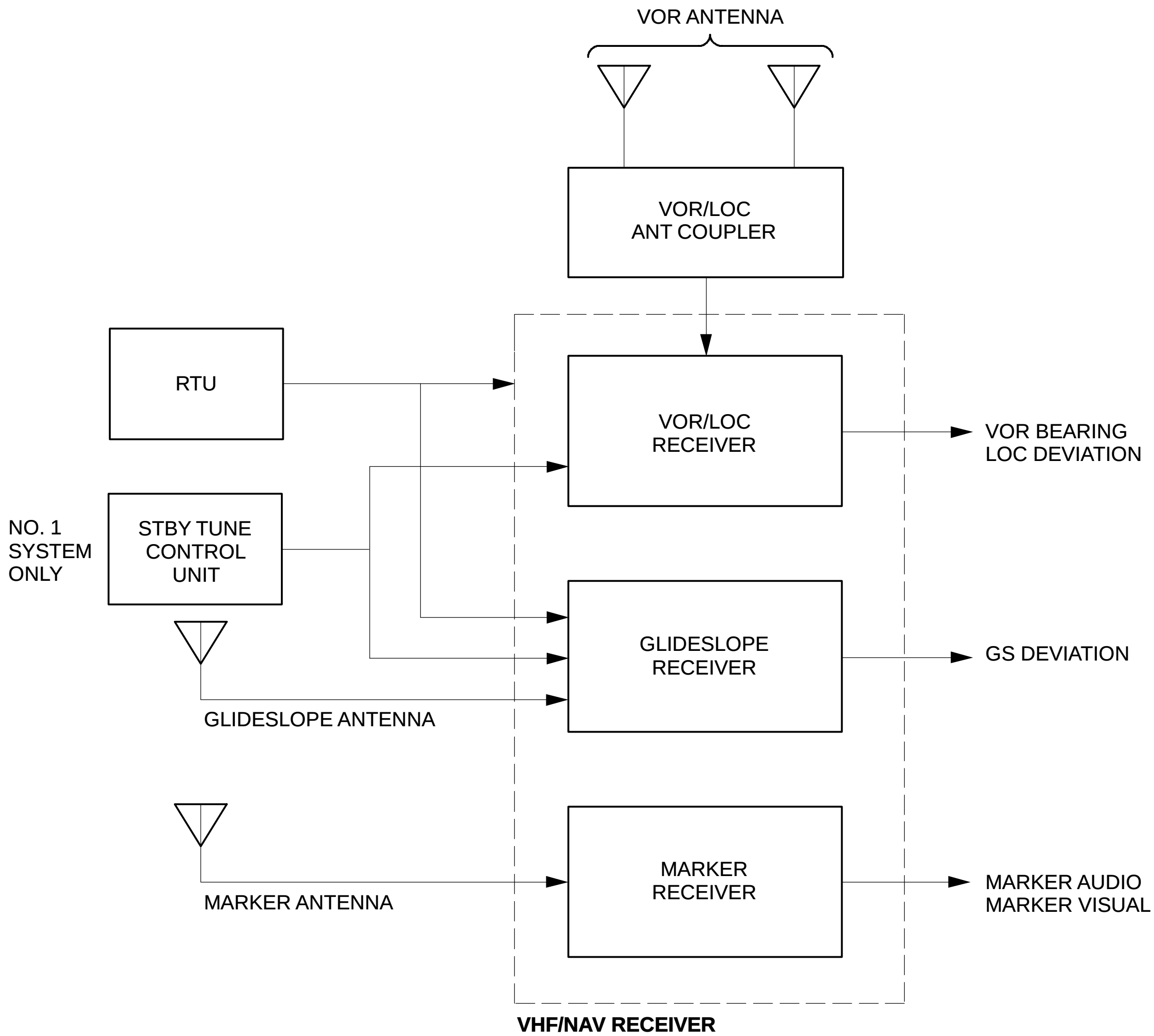
- VOR frequencies – All even frequencies from 108.00 to 111.90 MHz and all frequencies from 112.00 to 117.95.
- LOC frequencies – All odd frequencies from 108.10 to 111.95 MHz

The NAV receivers monitor the selected VOR stations and provide enroute and terminal area navigation. The VOR data is displayed on the pilots and copilots PFD and MFD.

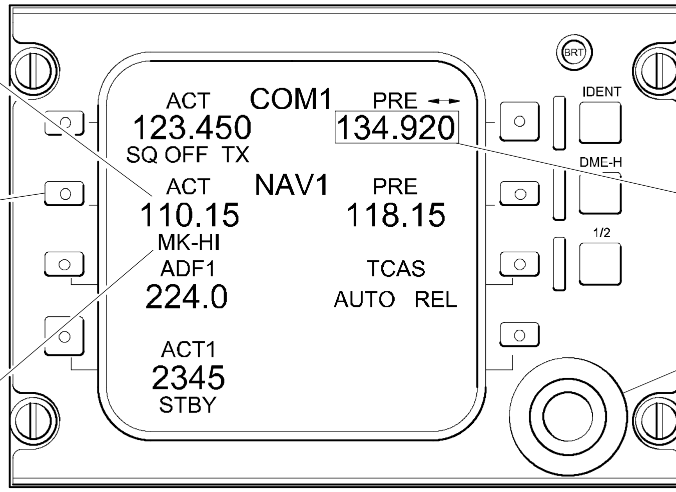
In LOC and GS modes, the NAV receivers supply final approach guidance data. Localizer signals are monitored for horizontal deviation and glideslope signals are monitored for vertical deviation. When the the navigation receiver is tuned to a localizer frequency, the paired glideslope frequency is automatically tuned. The LOC/GS data is displayed on the pilots and copilots PFD and MFD.

The Marker Beacon system provides information on distance to the runway. The MB antennas receive signals from the outer, middle and inner MB ground transmitters. The signals are then supplied to the MB receivers. MB information is displayed on the pilots and copilots PFD. MB sensitivity can be adjusted at the radio tuning units.

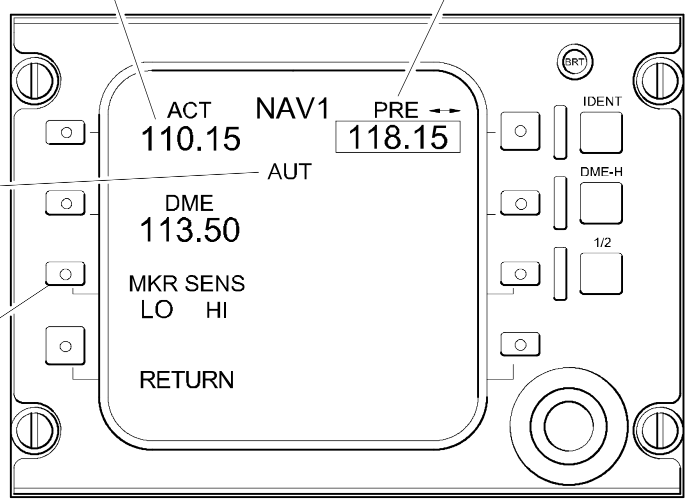
The VHF/NAV system also supplies VOR/LOC and MB station identification to the audio integrating system.



VHF/NAV System
Figure 18−30−1



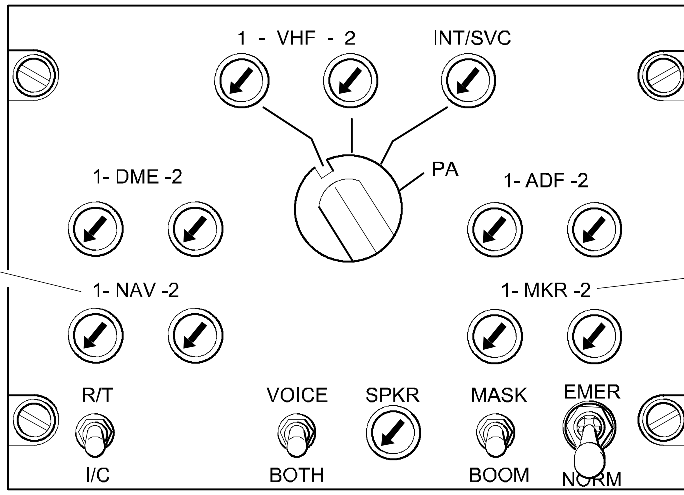
Radio Tuning Unit – Top Level Page
Center Pedestal



Radio Tuning Unit – NAV Main Page
Center Pedestal

VHF Navigation – Radio Tuning Unit <1012>
Figure 18–30–2

1 – NAV – 2
Press to monitor navigation receiver. When lit, rotate to increase volume. Press again to deselect navigation receiver audio.

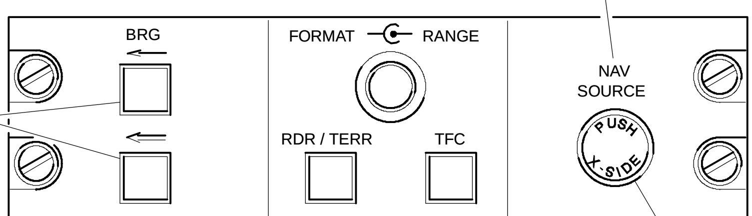


1 – MKR – 2
Press to monitor marker beacon signals. When lit, rotate to increase volume. Press again to deselect marker beacon signals.

Audio Control Panel
Center Pedestal

NAV SOURCE
Used to select navigation source. Clockwise rotation will be FMS1, VOR/LOC1, OFF, VOR/LOC2 and FMS2.

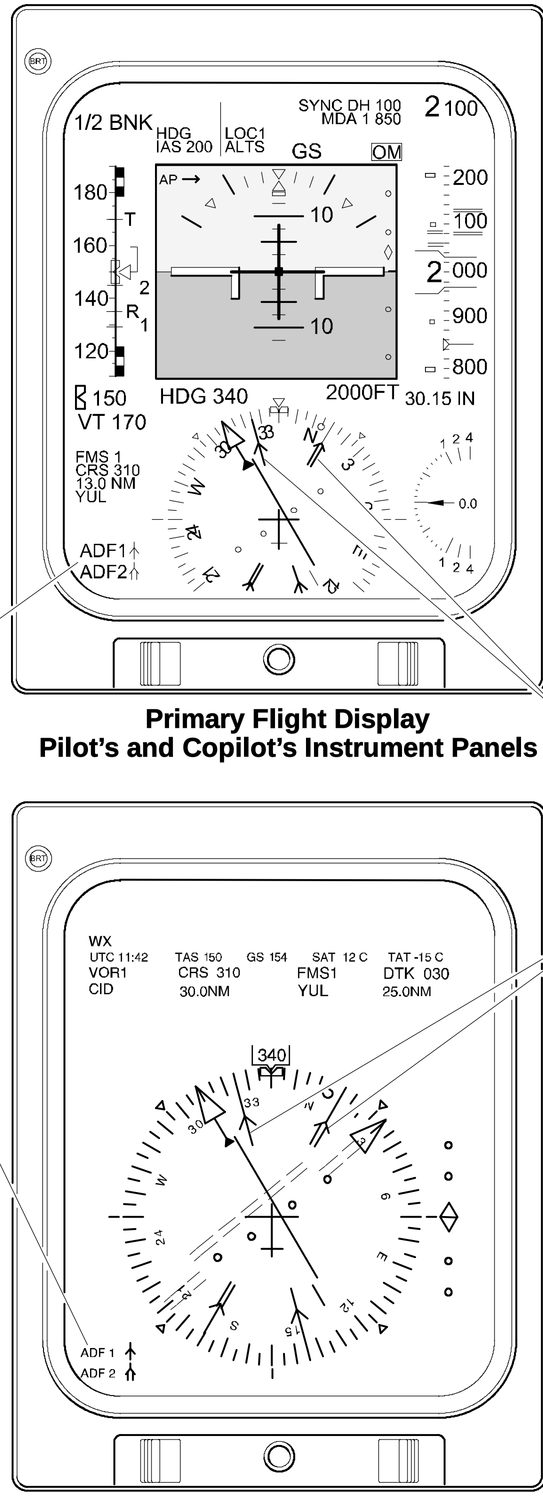
BRG
Used to select next waypoint that bearing pointer will indicate direction to.



Display Control Panel
Pilot's and Copilot's Side Panels

PUSH X–SIDE
Used to display opposite side navigational source on MFD.

VHF Navigation < 2040>
Figure 18–30–3



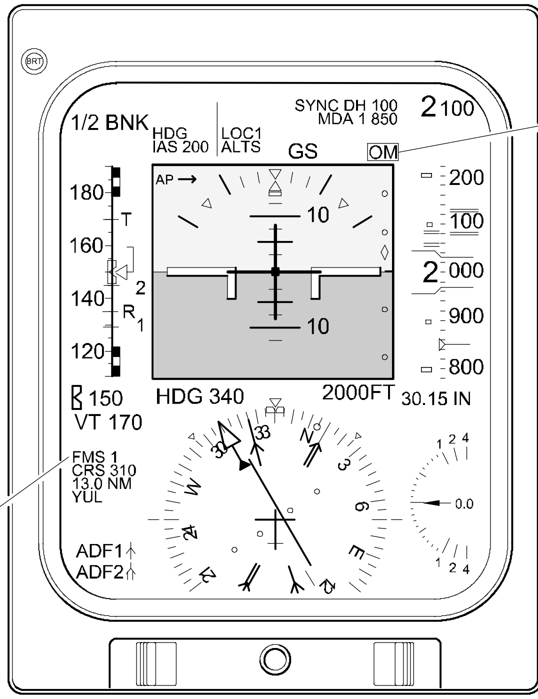
Bearing Source
Indicates navigation source selected to obtain bearings. Single line (bearing No. 1) is magenta. Double line (bearing No. 2) is cyan.

Primary Flight Display
Pilot's and Copilot's Instrument Panels

Bearing Pointers
Indicates direction of selected bearing.
Single line (bearing No. 1) is magenta. Double line (bearing No. 2) is cyan.

Multifunction Display – HSI Mode
Pilot's and Copilot's Instrument Panels

VHF Navigation Bearing Source<1015>
Figure 18–30–4

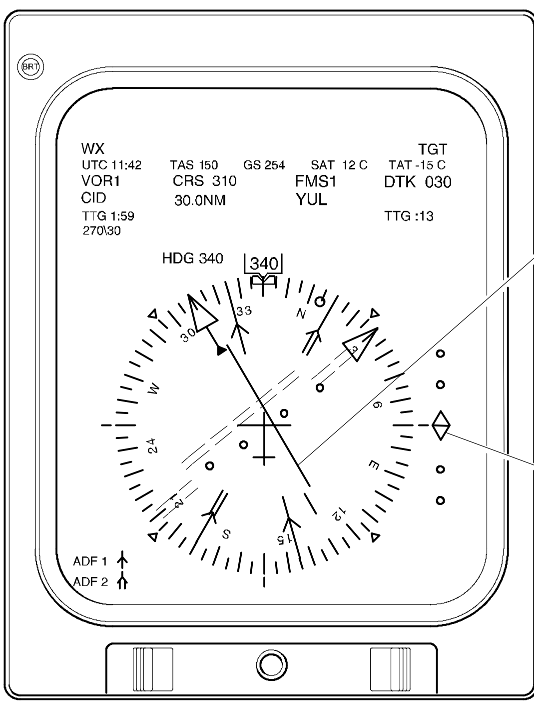


Marker Beacon Indicator

- OM - Outer marker (cyan)
- MM - Middle marker (yellow)
- IM - Inner marker (white)

Navigation Source Indicator
Indicates navigation source setting of navigation source knob on display control panel.

Primary Flight Display
Pilot's and Copilot's Instrument Panels

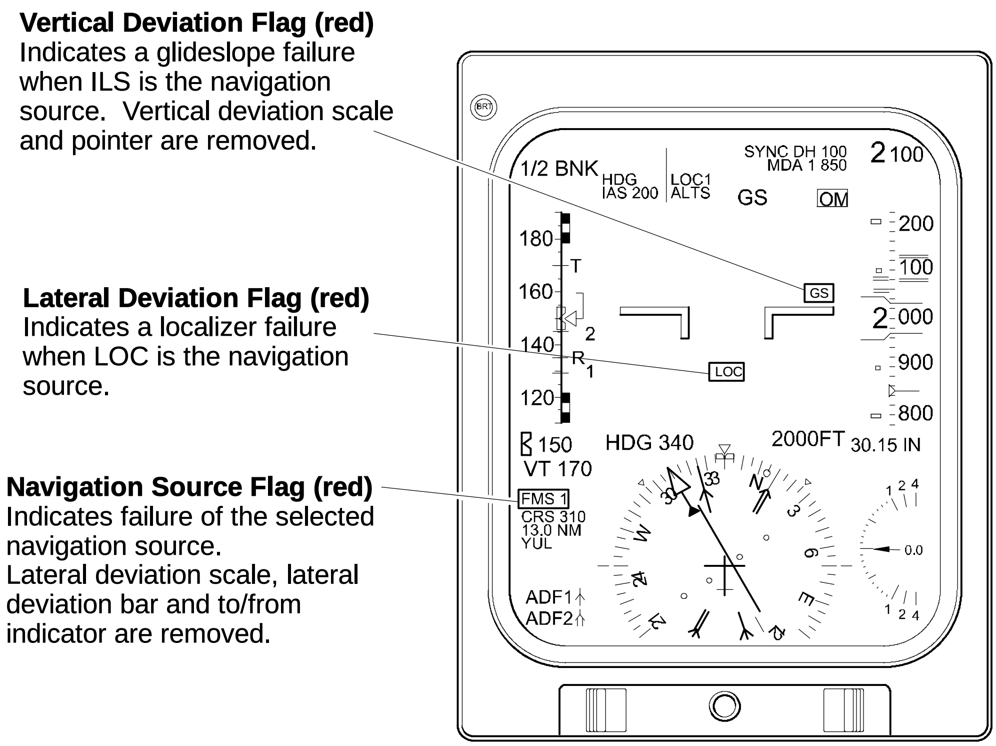


Lateral Deviation Bar
Indicates lateral deviation from selected course. Color matches navigation source.

Vertical Deviation Indicator
Indicates vertical deviation pointer from selected course. Color matches navigation source. Flashes during excessive deviation.

Multifunction Display – HSI Mode
Pilot's and Copilot's Instrument Panels

VHF Navigation Deviation/Source Indication<1015>
Figure 18–30–5



Primary Flight Display
Pilot's and Copilot's Instrument Panels

VHF Navigation Vertical Deviation Flag <1015>
Figure 18–30–6

A. System Circuit Breakers

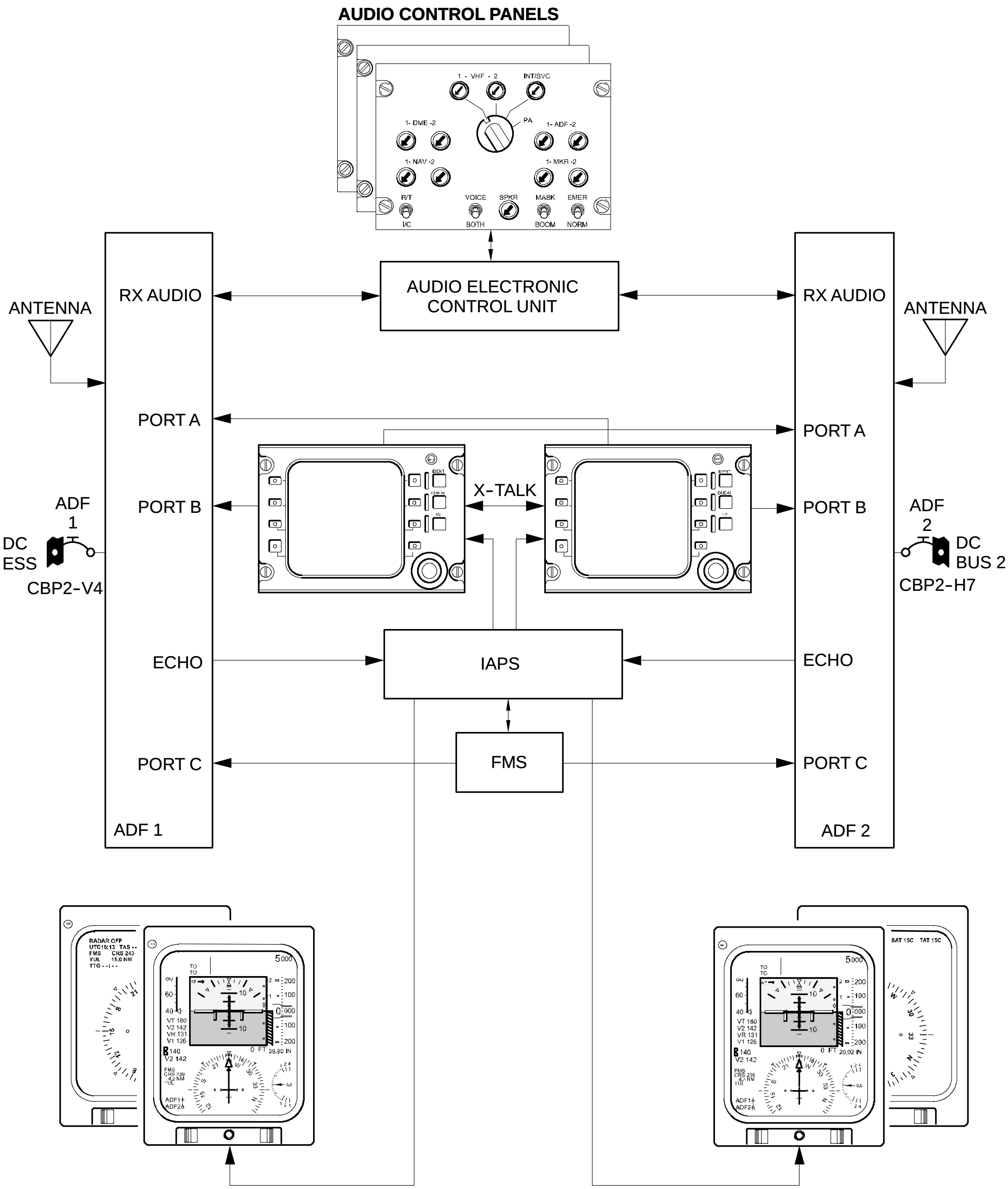
SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
VHF Navigation	Receiver	VHF NAV 1	DC ESSENTIAL	2	V6	
		VHF NAV 2	DC BUS 2		H11	

1. AUTOMATIC DIRECTION FINDER

The automatic direction finder (ADF) system is a dual, low frequency radio system designated as ADF 1 and ADF 2. The ADF system is used indicate relative bearing from the aircraft to a selected ground station.

The transmitting stations can be nondirectional beacons (NDBs) or standard amplitude modulation (AM) broadcast stations in the frequency range of 190.0 to 1799.5 kHZ. Frequency tuning and ADF mode selections is made through the radio tuning units. Frequency tuning can also be made on the FMS control display unit. Station audio is controlled through the audio control panels.

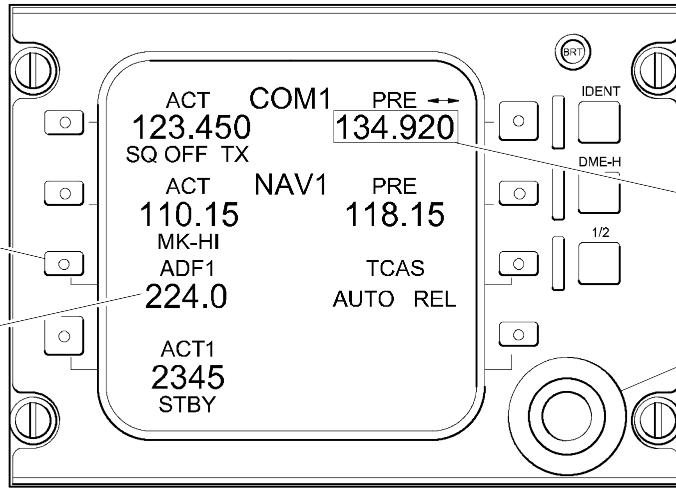
Bearing selection can be made on either the pilot and copilots display control panel (DCP). The bearing-to-station data is displayed on the HSI portion of the pilot and copilots primary flight display (PFD) and on the multifunctional displays (MFD). in HSI, navaid sector and present position map formats,



Automatic Direction Finder System Interface <1015>
Figure 18−40−1

ADF Key
Push key once to directly tune active frequency with tuning knobs.
Push key twice to select ADF main page.

ADF Frequency Readout (green)



TUNING WINDOW

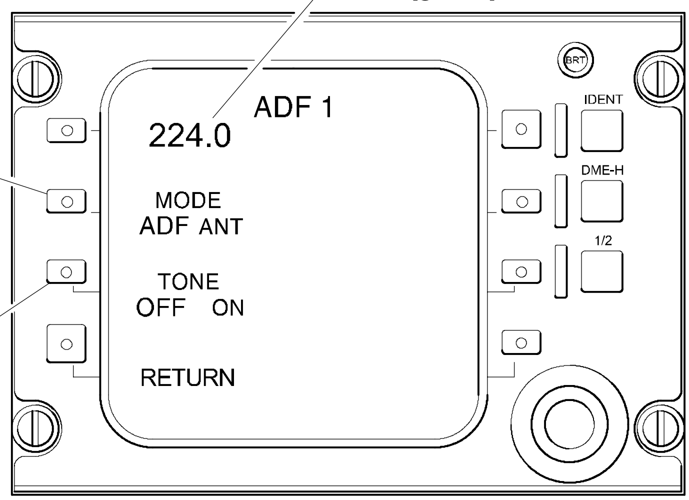
TUNING KNOB

Radio Tuning Unit - Top Level Page
Center Pedestal

ADF Mode Key
Used to select either ADF or antenna functions.
Selected setting is displayed in cyan.
- ANT - Used for range navigation, optimum station tuning, or monitoring commercial broadcast.
- ADF - Used to select directional antenna. Bearing to selected station is displayed as a pointer on the HSI portion of the primary flight display and the multifunction display.

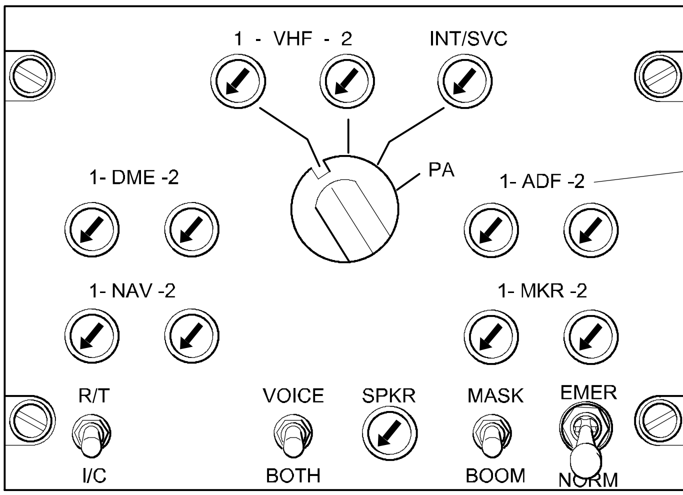
ADF Tone Key
Used to select tone circuit on or off. When selected on, an aural signal is superimposed on the unmodulated carrier wave to aid in precise frequency selection. Selected setting is displayed in cyan.

ADF Frequency Readout (green)



Radio Tuning Unit - ADF Main Page
Center Pedestal

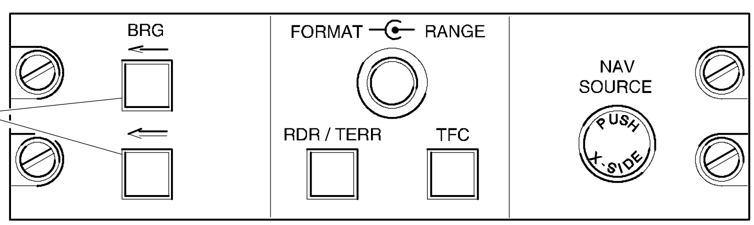
Automatic Direction Finder (ADF) − Radio Tuning Unit <1012>
Figure 18−40−2



1 – ADF – 2
Press to monitor selected ADF receiver. When lit, rotate to increase volume. Press again to deselect ADF receiver audio.

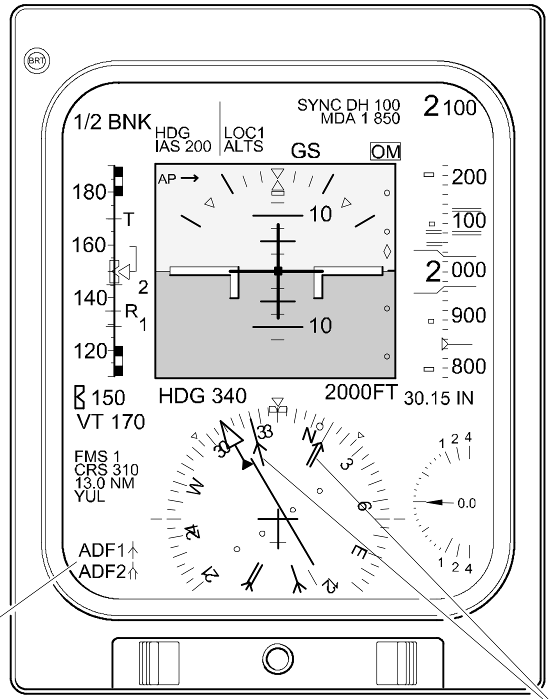
Audio Control Panel
Center Pedestal

BRG
Used to select next waypoint that bearing pointer will indicate direction to.



Display Control Panel
Pilot's and Copilot's Side Panels

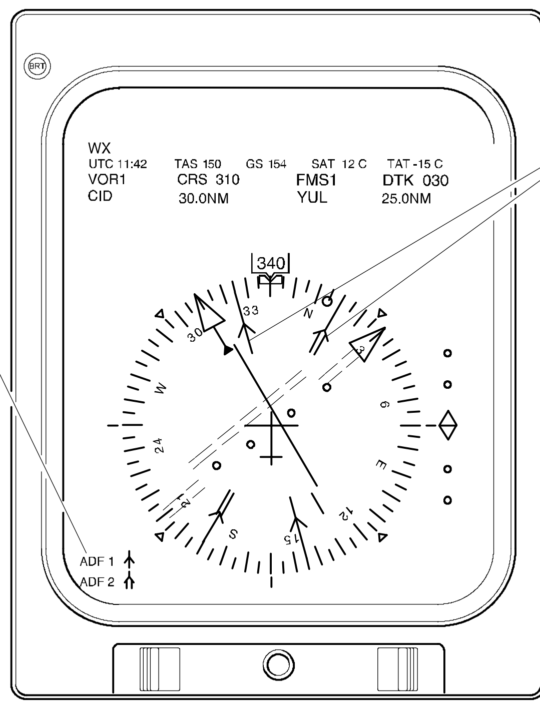
Automatic Direction Finder – Controls <2040>
Figure 18–40–3



Bearing Source
Indicates navigation source selected to obtain bearings. Single lined (bearing No. 1) is magenta. Double lined (bearing No. 2) is cyan.

Primary Flight Display
Pilot's and Copilot's Instrument Panels

Bearing Pointers
Indicates direction of selected bearing.
Single lined (bearing No. 1) is magenta. Double lined (bearing No. 2) is cyan.



Multifunction Display – HSI Mode
Pilot's and Copilot's Instrument Panels

Automatic Direction Finder – Controls <1015>
Figure 18–40–4

A. System Circuit Breakers

<table>
<tr><th>SYSTEM</th><th>SUB–SYSTEM</th><th>CB NAME</th><th>BUS BAR</th><th>CB PANEL</th><th>CB LOCATION</th><th>NOTES</th></tr>
<tr><td rowspan="2">Automatic Direction Finder</td><td rowspan="2">Receiver</td><td>ADF 1</td><td>DC ESSENTIAL</td><td rowspan="2">2</td><td>V4</td><td></td></tr>
<tr><td>ADF 2</td><td>DC BUS 2</td><td>H7</td><td></td></tr>
</table>

1. DISTANCE MEASURING EQUIPMENT

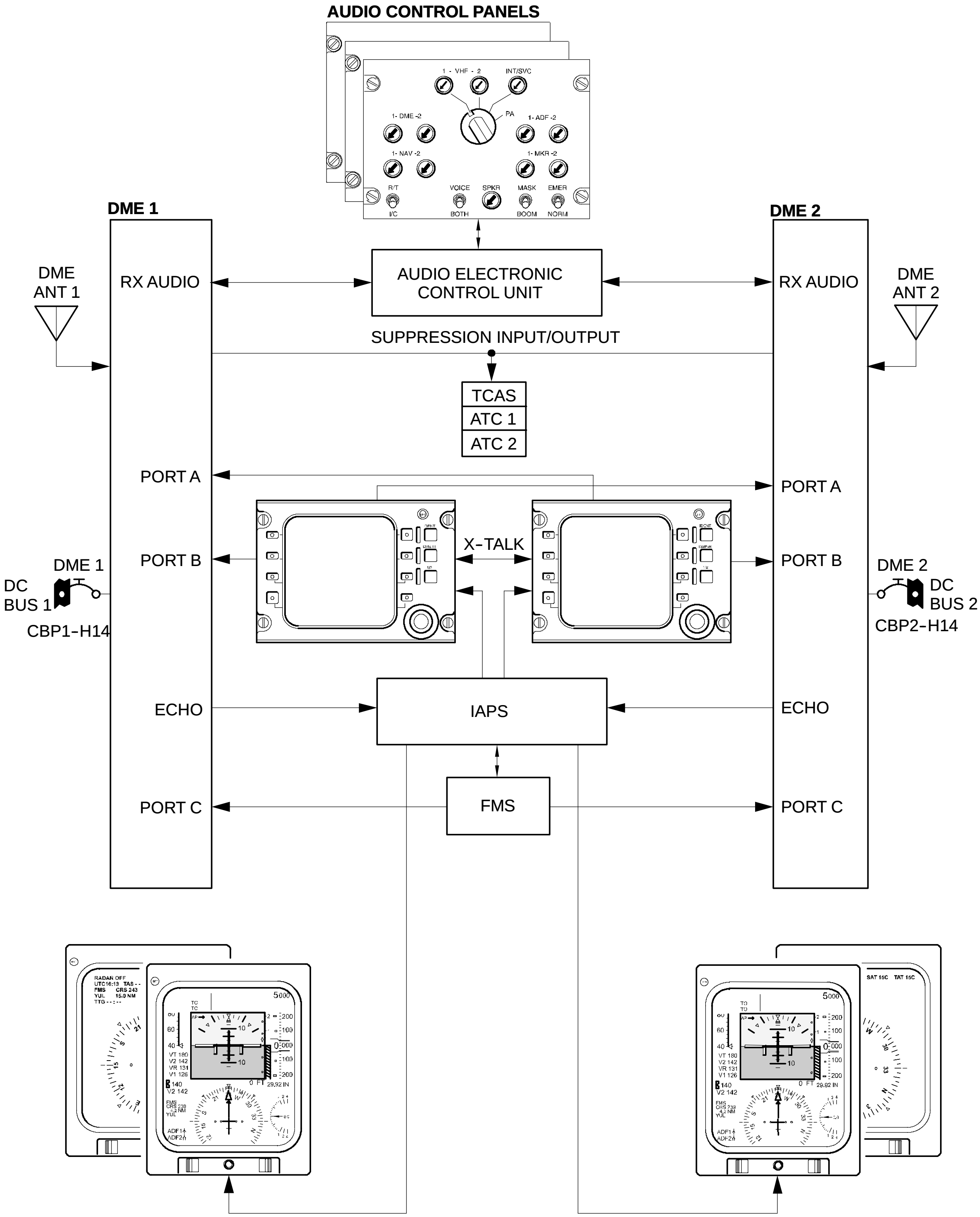
There are two identical distance measuring equipment (DME) systems installed in the aircraft. The DME system computes and displays the straight line distance between the aircraft and a selected DME ground station. The DME system also provides ground speed, time to station and station identification.

There are two DME transceivers installed in the avionics compartment that operate in the frequency range of 962 to 1213 MHz with a range of 300 nautical miles. Each transceiver has three channels that can track up to three stations simultaneously. Channel 1 of each DME is paired with the onside VOR and can be manually tuned by either the radio tuning units, backup tuning unit or the FMS. The other two channels are automatically tuned by the FMS for multisensor navigation. If Autotune is selected on the control display unit, the FMS will automatically tune VOR/DME channel 1.

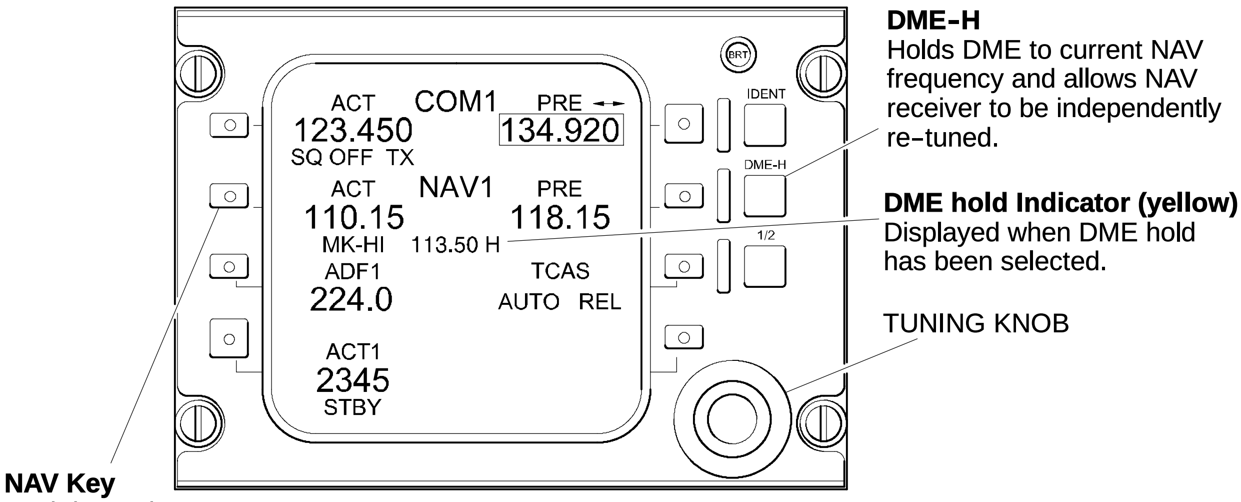
The DME transceivers interrogate the ground stations by transmitting a 63 MHz pulse signal at a specific repetition rate. The ground station replies by transmitting an exact replica of the signal it recieved. When a reply is received by the DME, it measures the elapsed time between transmit signal and the reply, then computes slant distance, ground speed and time–to–go.

DME hold allows the pilot to use DME channel 2 for distance measuring and allows the normally paired VOR frequency of channel 1 to be tuned to a different VOR frequency for bearing information.

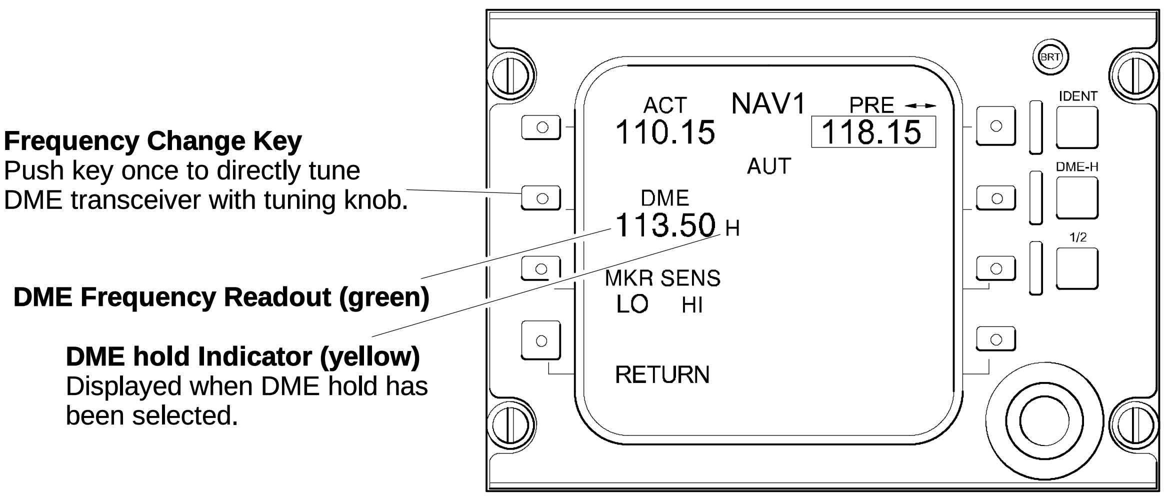
Frequency tuning and DME hold selections are through the radio tuning units. The DME frequency channels are paired with the VHF navigation channels. The frequency selection is done with the pilot's or copilot's RTUs in the frequency range of 108.00 to 117.95 MHz. Station audio is monitored through the audio control panels. Visual indications of tuned stations, distance readouts and DME hold indications are provided on the primary flight displays and multifunctional displays.



Distance Mesuring Equipment System Interface <1015>
Figure 18–50–1



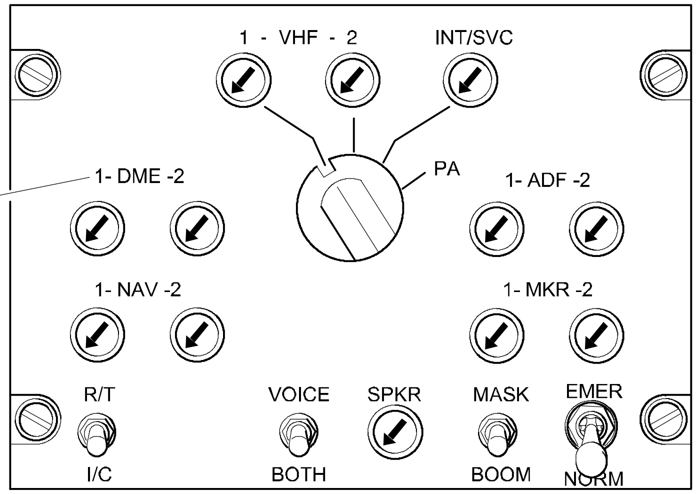
Radio Tuning Unit – Top Level Page
Center Pedestal



Radio Tuning Unit – NAV Main Page
Center Pedestal

Distance Measuring Equipment Radio Tuning Unit<1012>
Figure 18–50–2

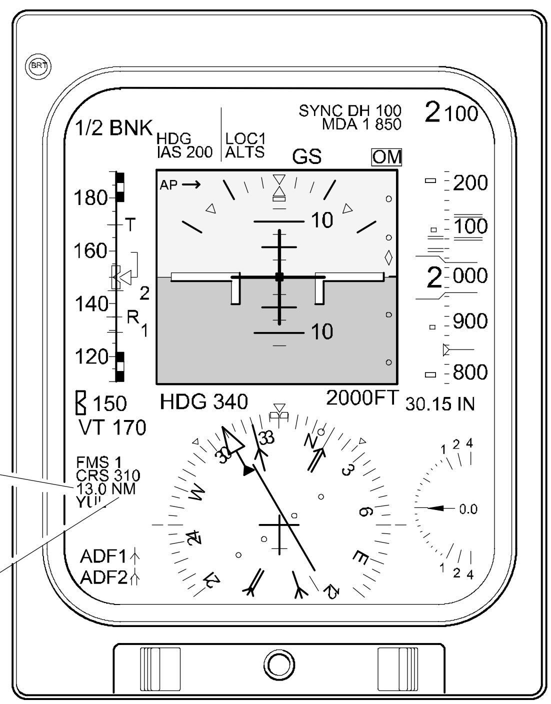
1 – DME – 2
Press to monitor selected DME transceiver. When lit, rotate to increase volume. Press again to deselect DME station identification audio.



Audio Control Panel
Center Pedestal

Distance Readout
Indicates distance to tuned navaid or next waypoint, in nautical miles. Color matches navigation source.

DME Hold (H) Symbol (yellow)
When DME hold is selected, H replaces NM legend on distance readout. Not displayed if FMS is navigation source.



Primary Flight Display
Pilot's and Copilot's Instrument Panels

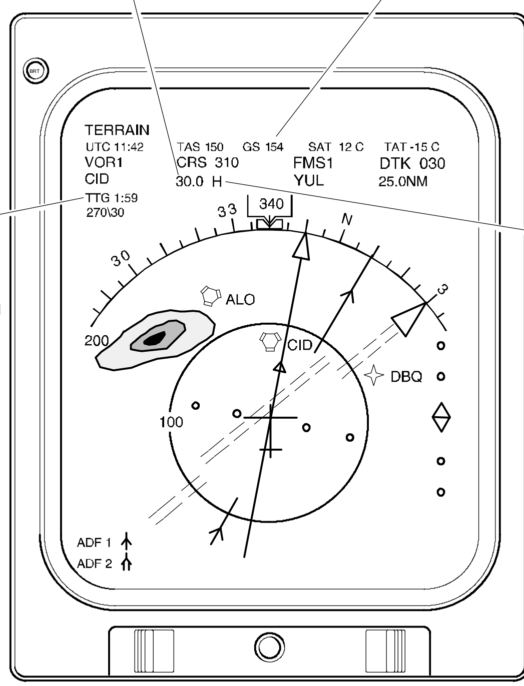
Distance Measuring Equipment <1015>
Figure 18–50–3

Distance Readout
Indicates distance to tuned navaid or next waypoint, in nautical miles. Color matches navigation source.

Ground Speed Readout (white)
Color of GS prefix matches navigation source.

Time To Go
Indicates time to tuned navaid or next waypoint. Color matches navigation source.

DME Hold (H) Symbol (yellow)
When DME hold is selected, H replaces NM legend on distance readout. Not displayed if FMS is navigation source.



Multifunction Display – Navaid Sector Mode
Pilot's and Copilot's Instrument Panels

Distance Measuring Multifunction Display
Figure 18–50–4

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Distance Measuring Equipment	Transceiver	DME 1	DC BUS 1	1	H14	
		DME 2	DC BUS 2	2	H14	

1. AIR TRAFFIC CONTROL TRANSPONDER SYSTEM

The two air traffic control transponders (ATC 1 and ATC 2) provide ground radar beacon systems with coded identification responses in the following modes:

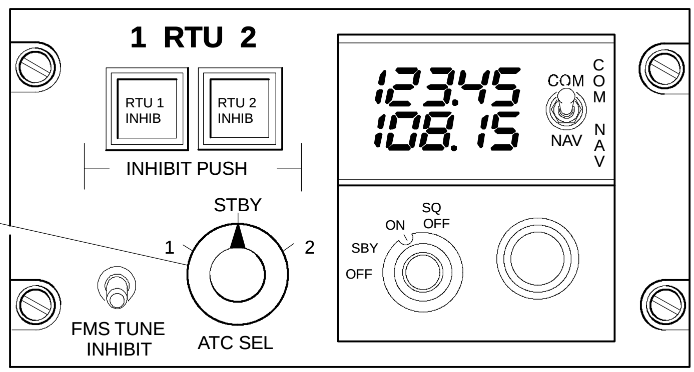
- Mode A – Aircraft identify reporting
- Mode C – Altitude reporting
- Mode Select (S) – Data link with other mode S transponders for the traffic alert and collision avoidance system (TCAS).

Mode S data link includes air-to-air, ground-to-air (data uplink or comm A), air-to-ground (data downlink or comm B), and multisite (ground station to ground station) messages.

Transponder activation is made on the backup tuning unit.

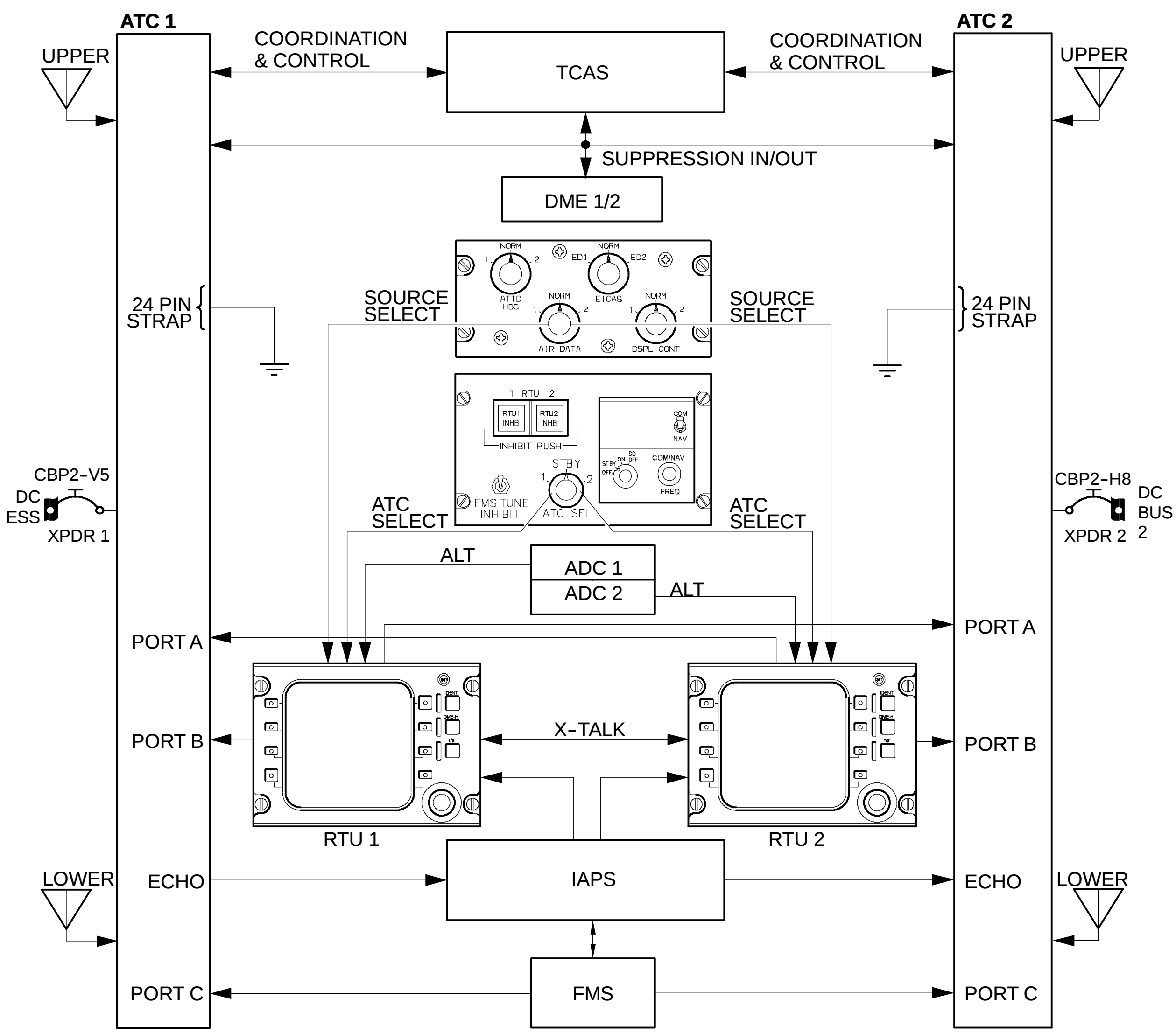
Transponder codes are set on the top level page of the radio tuning units and can also be set using the FMS control display unit. ATC identification is selected using the IDENT button on the radio tuning unit.

ATC SEL
Used to select ATC transponders.
- 1 – ATC 1 transponder is activated and ATC 2 transponder is on standby.
- STBY – Both transponders are on standby.
- 2 – ATC 2 transponder is activated and ATC 1 transponder is on standby.



Backup Tuning Unit
Center Pedestal

Air Traffic Control Transponder System – Controls
Figure 18–60–1



ATC Transponder Interface
Figure 18–60–2

2. MODE S TRANSPONDER (FLIGHT ID) <1096>

Mode S also has the capability to display either a 4-digit squawk code or the flight identification (FLT ID) on line 4 of the RTU Top Level Page. Selection of either the squawk code or the FLT ID for display on the Top Level Page is made on the ATC Main Page.

To access the ATC Main Page from the Top Level Page, the ATC Line Select Key is pressed twice. Once the Main Page is displayed, the DISPLAY Line Select Key is pressed to select either the SQUAWK or FLT ID (the selected function will be displayed larger). The selected function is then displayed on line 3 of the Main Page, line 4 of the Top Level Page and on the FLT ID Page. To modify the squawk code or the FLT ID on the Top Level Page, the ATC Line Select Key is pressed, which will cause a tune window to surround the left character. The small Tuning Knob is then used to change the character displayed in the tune window. The RTU then waits 2 seconds after knob rotation stops before locking in the new character. Rotating the large tune knob cycles the tune window from character to character.

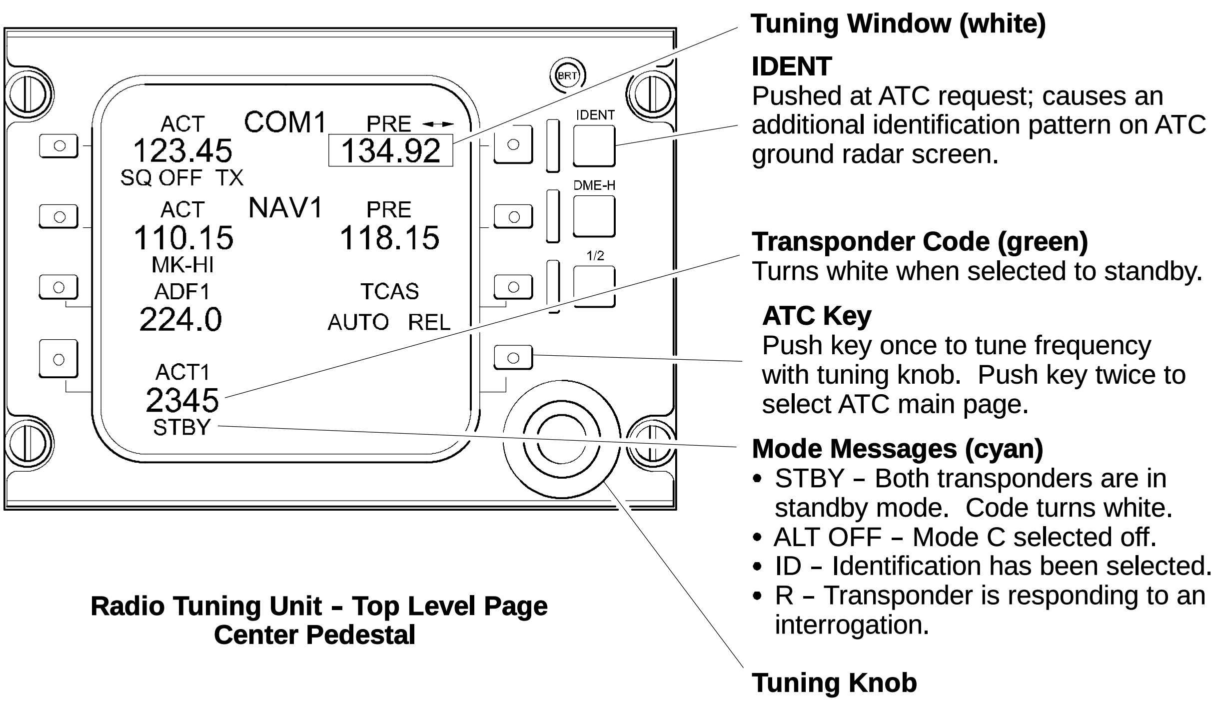
To access the FLIGHT ID Main Page from the ATC Main Page, the FLT ID key is pressed twice. On the FLIGHT ID Main Page, the RTU displays an Active and Preset Flight ID. By pressing the top right line-select key the ACTIVE and Preset FLT ID will swap when the tune window is on a Preset Flight ID character.

The FMS can also display the FLIGHT ID on the ”RADIO TUNING PAGE” page 2 of 2, adjacent to the top right line select key on the CDU. To input the FLIGHT ID data:

(a) Press the top right line select key on the CDU so that the selection box highlights the FLIGHT ID information field.

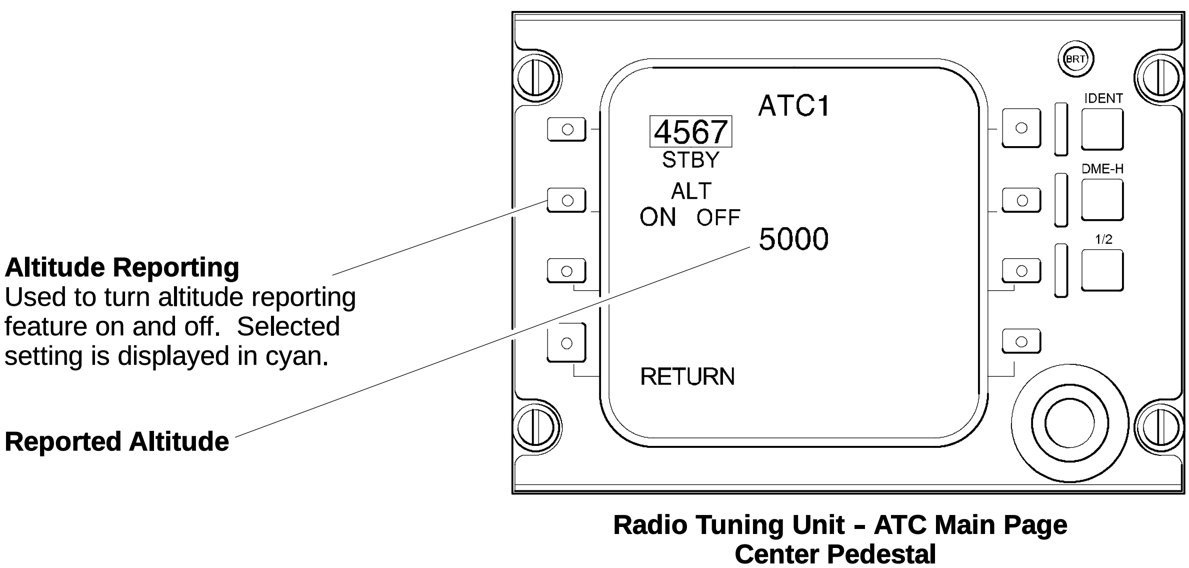
(b) Input the FLT ID data, via the CDU keypad, where it will appear on the bottom left corner of the page (in brackets).

(c) After the FLT ID has been inputted, press the top right line select key and check that the proper FLT ID appears adjacent to the top right line select key.



Air Traffic Control Transponder System – Radio Tuning Unit
Figure 18–60–3

Mode C, altitude reporting selection is made on the ATC main page of the radio tuning unit.



Air Traffic Control Transponder System –
Radio Tuning Unit – ATC Main Page
Figure 18–60–4

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Air Traffic Control	Transponder	XPDR 1	DC ESSENTIAL	2	V5	
		XPDR 2	DC BUS 2		H8	

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1. TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM

The traffic alert and collision avoidance system (TCAS) is an airborne system that interrogates the air traffic control transponders of nearby aircraft to identify and display potential and predicted collision threats. TCAS surveillance range is up to 40 nautical miles and can detect and track up to 30 aircraft simultaneously. The system computes range, bearing and closure rates of other transponder equipped aircraft.

A mode “S” Transponder is installed on the aircraft. The transponder provides air-to-air communications for coordinating the resolution maneuvers between TCAS equipped aircraft. The TCAS system provides no indication of traffic conflicts if the intruder aircraft is without an operative transponder.

TCAS provides symbology that depicts surrounding airplanes in terms of relative altitude, range, clock position, and vertical rate. The flight compartment displays also provide data on closure rates. The system displays four types of traffic.

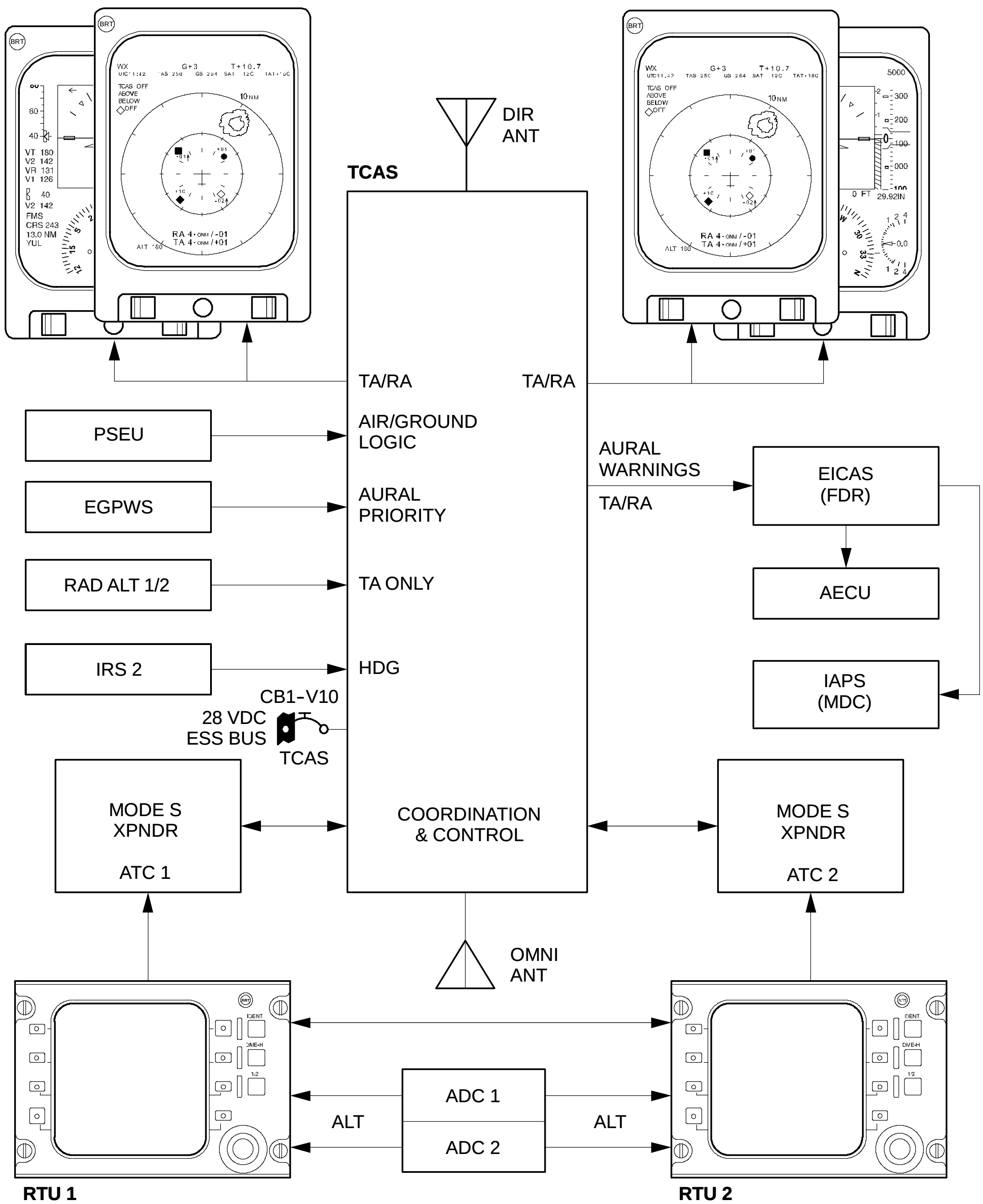
TCAS DISPLAY THREAT LEVELS AND DATA TAGS

SYMBOL	COLOR	THREAT LEVEL	THREAT LEVEL DEFINITION	CAUSE
+01 ↓ ■	RED	Resolution Advisory (RA)	Intruding aircraft 25 seconds from closest point of approach	Intruding aircraft is above by 100 feet and descending at least 500 feet per minute
+00 ●	AMBER	Traffic Advisory (TA)	Intruding aircraft 40 seconds from closest point of approach	Intruding aircraft level with and not climbing or descending
◆ −12 ↑	CYAN	Proximate Traffic	Any traffic within surveillance range and ±1,200 feet vertical	Traffic below 1,200 feet and climbing at least 500 feet per minute
+27 ↓ ◇	CYAN	Other Traffic	Any traffic within TCAS range limit	Traffic above 2,700 feet and descending at least 500 feet per minute

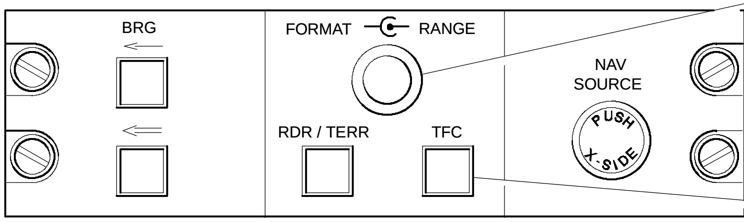
Traffic Collision Avoidance System − Threat Level and Data Tags
Figure 18−70−1

The display control panels are used to activate TCAS and to set range display. Weather radar data can be overlaid on the multifunctional display, in TCAS mode.

TCAS mode and altitude format are displayed on the top level page of the radio tuning units and can also be overlaid on any map display. Testing and setting changes are made on the TCAS main page.



Traffic Colision Avoidance System Interface
Figure 18–70–2

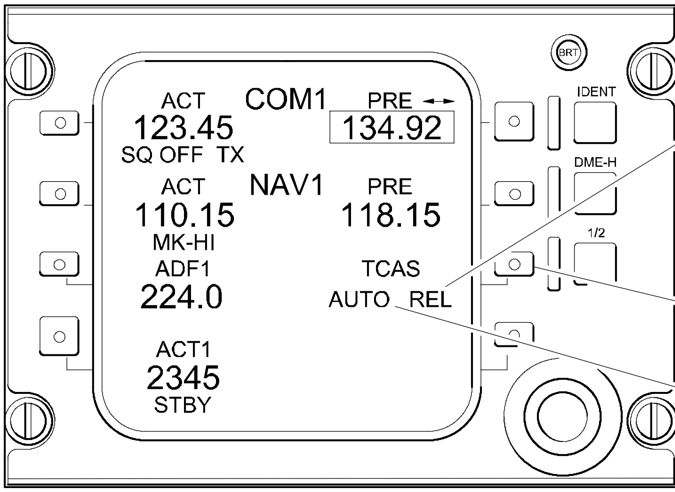


RANGE – Inner Selector
Used to select range displayed on MFD. Range selections are: 5, 10, 20 and 40 NM.

TFC (TCAS)
Used to directly select TCAS traffic display on MFD.

Display Control Panel
Pilot's and Copilot's Side Panels

Traffic Collision Avoidance System – Controls <2040>
Figure 18–70–3



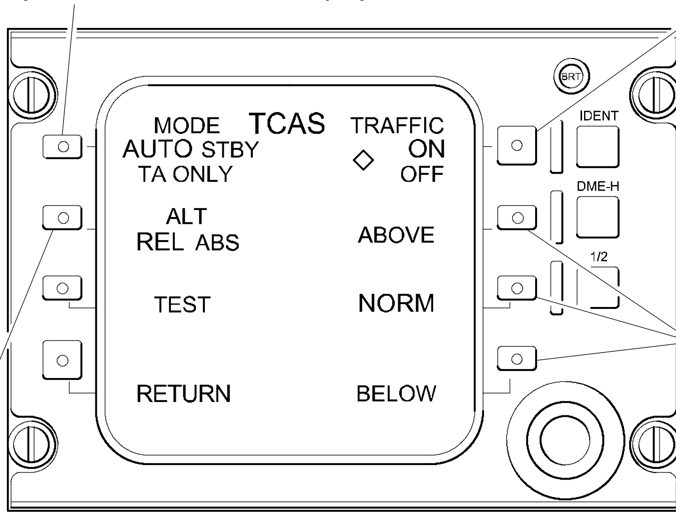
Altitude Format (cyan)
Displays the selected altitude format. (relative or absolute)

TCAS Key
Used to select TCAS main page.

TCAS Mode (cyan)
Displays the selected TCAS mode.

Radio Tuning Unit – Top Level Page
Center Pedestal

Mode Selection
Used to select TCAS mode. Selected mode is displayed in cyan.
- AUTO – All advisories are displayed.
- STBY – All interrogations are inhibited.
- TA ONLY – Only traffic advisories are displayed.



Traffic Selection
Used to select traffic display mode. Selected setting is displayed in cyan.
- ON – Displays all transponder traffic (advisory, proximate and others).
- OFF – Displays advisory traffic only.

Altitude Range
Used to select surveillance airspace relative to own air plane altitude. Selected setting is displayed in cyan.
- ABOVE – 9,900 feet above and 2,700 feet below.
- NORM – 2,700 feet above and below.
- BELOW – 2,700 feet above and 9,900 feet below.

Radio Tuning Unit – TCAS Main Page
Center Pedestal

Altitude Format
Used to select altitude format.
- REL – Relative to own airplane altitude.
- ABS – Absolute with respect to barometric altitude.

Traffic Collision Avoidance System – Radio Tuning Unit
Figure 18–70–4

A. Traffic Advisory

The traffic advisory (TA) is issued to indicate the relative positions of intruding airplanes that are about 45 seconds from the closest point of approach.

The traffic advisory allows the flight crew an opportunity to visually locate the intruding aircraft. The advisory is always displayed on the PFDs or can be displayed on the TCAS page of the MFD if selected from the display control panel.

Traffic advisory will be displayed automatically when the airplane is 1000 feet or below, and will revert to pre-selected mode automatically when the airplane is above 1000 feet.

B. Resolution Advisory

Resolution advisories (RA) will direct the flight crew to resolve a threat by executing an aircraft maneuver that will increase separation. This occurs when the TCAS computer predicts that the intruding aircraft is within about 30 seconds from the closest point of approach.

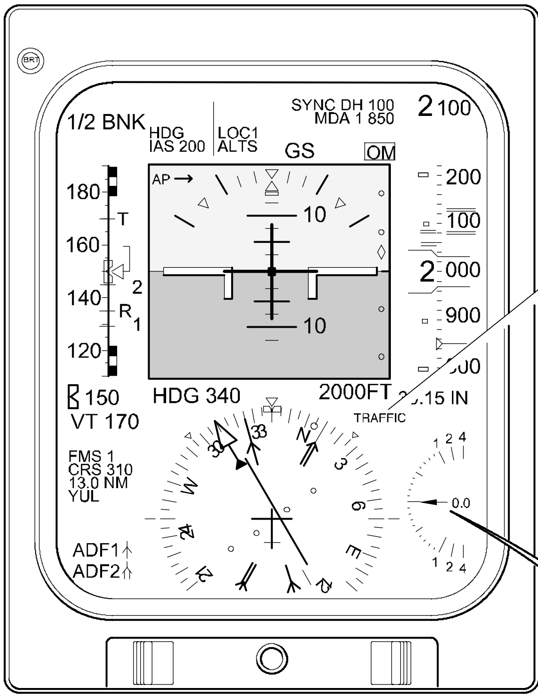
Resolution advisories are displayed on the vertical speed indicator (VSI) portion of the PFD. The VSI shows the appropriate vertical maneuver to avoid the threat. The VSI provides vertical guidance to maintain safe vertical separation as follows:

- Corrective RAs – Fly from the red zone to the green zone.
- Preventive RAs – Do not fly into the red zone.

The vertical maneuver is also accompanied by TCAS voice warnings.

NOTE

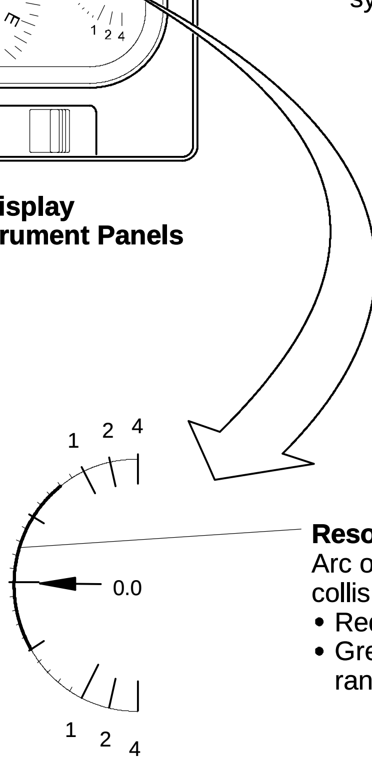
The TCAS resolution advisory programs are based on the pilot initiating the RA maneuver within approximately 5 seconds. If an additional corrective resolution advisory is issued (e.g. a reversal), the maneuver must be initiated within 2.5 seconds.



Primary Flight Display
Pilot's and Copilot's Instrument Panels

TCAS Message Area

- TRAFFIC (red) – Indicates TCAS resolution advisory (flashes for first 10 seconds).
- TRAFFIC (amber) – Indicates TCAS traffic advisory (flashes for first 10 seconds).
- TCAS FAIL (amber) – Indicates TCAS system failure.
- TCAS RA FAIL (amber) – Indicates PFD is unable to display TCAS resolution advisory.
- TA ONLY (white) – Indicates that TCAS has been selected to traffic advisory only mode, or has been automatically selected when the aircraft is below 1,000 feet. Flashes amber when traffic advisory is present.
- TCAS OFF (white) – Indicates that TCAS has been selected to standby mode.
- TCAS TEST (white) – Indicates that TCAS system is in test.



Resolution Advisory
Arc on vertical speed scale displays collision avoidance instructions.

- Red band – Range to be avoided.
- Green band – Target range or range to be maintained.

NOTE:

Vertical speed pointer and readout turn red when a TCAS resolution advisory is issued and speed is not within corrective limits.

Traffic Collision Avoidance System – Primary Function Display Indications <1015>
Figure 18–70–5

TCAS Mode (white)
Displays mode selected on radio tuning unit.
- TCAS OFF – Mode selected to standby.
- TA ONLY – Mode selected to traffic advisory only.

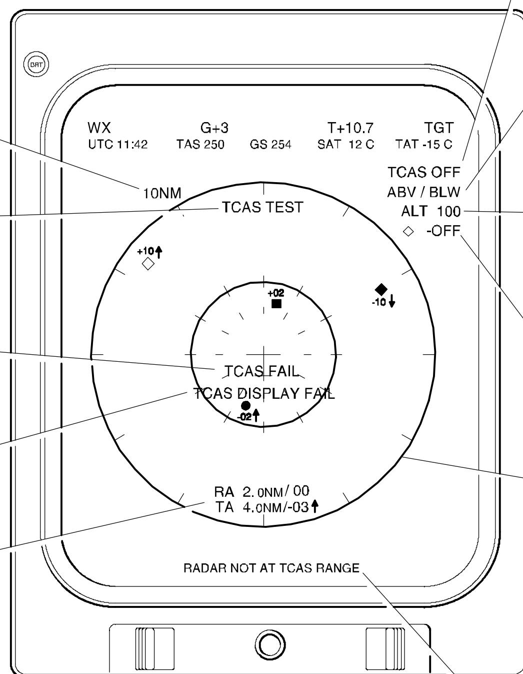
Range Readout (white)
Indicates range selected at the display control panel.

TCAS TEST (white)
Indicates TCAS system is in test.

TCAS FAIL (amber)
Indicates TCAS system failure.

TCAS DISPLAY FAIL (amber)
Indicates TCAS display mode is not available.

TCAS No Bearing Table
Displayed when intruder bearing information can not be detected or calculated. Indicates intruder type, range and altitude. Traffic advisory displayed in amber and resolution advisory displayed in red. Only two nearest intruders are displayed.



Multifunction Display – TCAS Mode
Pilot's and Copilot's Instrument Panels

Altitude Range (white)
Displays altitude range selected on radio tuning unit.

Current Altitude (white)
Displays current altitude in thousands of feet, when altitude format is selected to absolute.

Traffic Selection (white)
Displayed when other traffic is selected off.

Range Rings (white)
Outer ring indicates range selected at the display control panel. Inner ring indicates half range (not available at 5 NM range selection). Inner markings indicate 3 mile range (not available at 40 NM range selection).

RADAR NOT AT TCAS RANGE (cyan)
Weather radar control has been transferred and range disagrees with TCAS range.

NOTES

1. Weather radar can be displayed on the MFD when in TCAS mode (range: 5,10, 20 and 40 nm).
2. TCAS can be overlaid on any map display mode.
3. During an electrical transient, TCAS display range may default to 10 nm.

Traffic Collision Avoidance System – Multifunction Display Indications
Figure 18–70–6

C. Aural Warning

The system provides appropriate aural warnings to the flight crew when the TCAS computer analysis of an aircraft signal predicts a penetration of TCAS protected airspace. The voice warnings cannot be cancelled or reduced in volume.

TA voice warning is TRAFFIC – TRAFFIC

RA voice warnings are:

- CLIMB, CLIMB, CLIMB
- DESCEND, DESCEND
- MONITOR VERTICAL SPEED
- CLIMB – CROSSING CLIMB, CLIMB – CROSSING CLIMB
- DESCEND – CROSSING DESCEND, DESCEND – CROSSING DESCEND
- INCREASE CLIMB, INCREASE CLIMB
- INCREASE DESCENT, INCREASE DESCENT
- CLIMB – CLIMB NOW, CLIMB – CLIMB NOW
- DESCEND – DESCEND NOW, DESCEND – DESCEND NOW
- MAINTAIN VERTICAL SPEED, MAINTAIN
- MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN
- ADJUST VERTICAL SPEED, ADJUST

The clear advisory is CLEAR OF CONFLICT

Test voice messages are TCAS SYSTEM TEST OK or TCAS SYSTEM TEST FAIL.

D. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Traffic Alert and Collision Avoidance System	Transmitter / Receiver	TCAS	AC ESSENTIAL	1	V10	

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1. ENHANCED GROUND PROXIMITY WARNING SYSTEM (EGPWS) <2040>

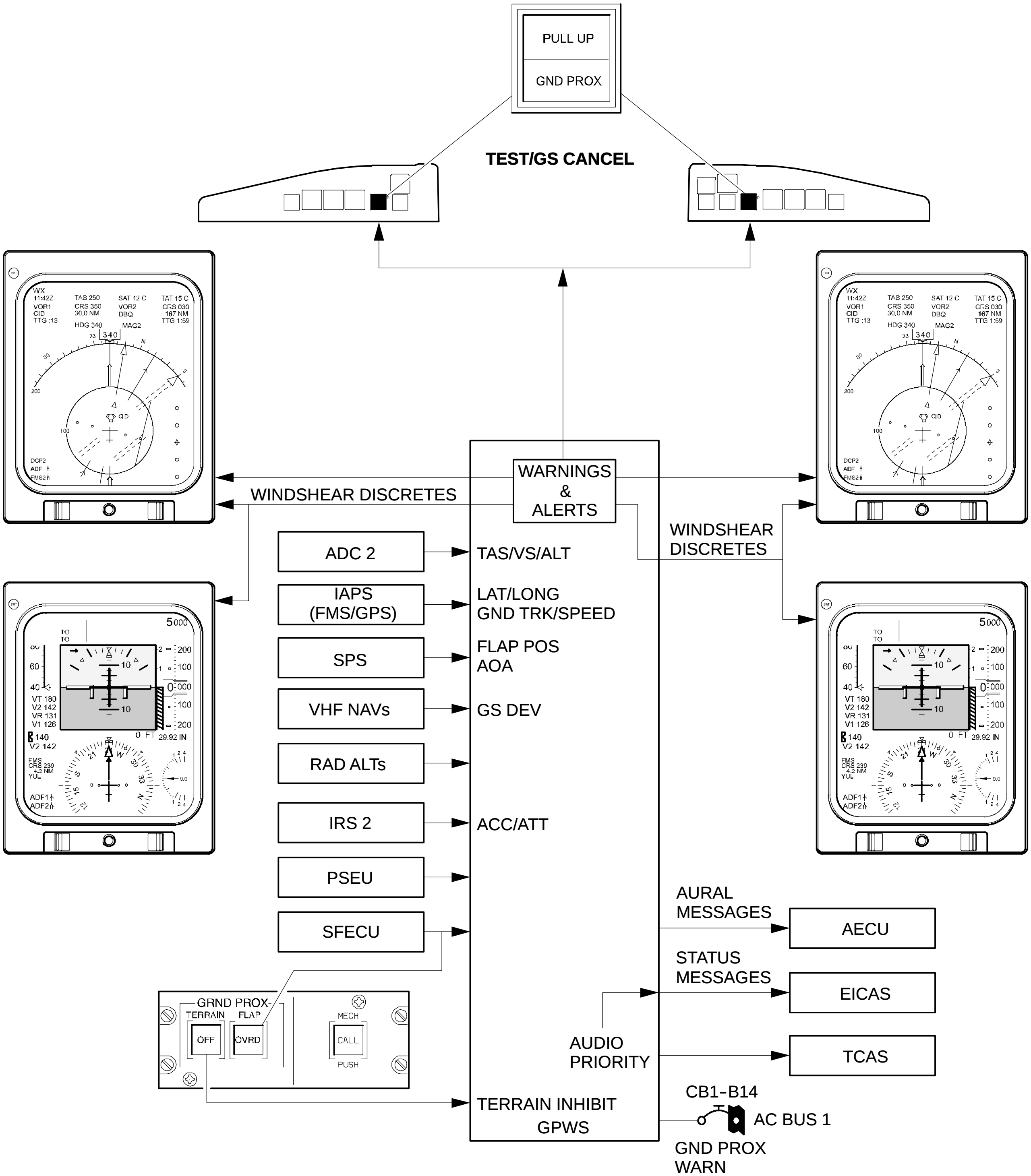
The enhanced ground proximity warning system (EGPWS) is used to help prevent accidents caused by unsafe flight maneuvers in proximity of terrain or severe windshear. The EGPWS computer generates alerts and warnings by comparing the actual aircraft position (programmed by the FMS) to terrain features and obstacles that are stored in the computer database. The aural alerts, messages and visual annunciations are generated when the boundaries of the following alerting envelopes are exceeded: <2040>

- Mode 1 Excessive descent rate
- Mode 2 Excessive terrain closure rate
- Mode 3 Altitude loss after take-off
- Mode 4 Unsafe terrain clearance
- Mode 5 Below glideslope alert
- Mode 6 Callouts (descent below minimums, altitude callouts and bank angle alert)
- Mode 7 Windshear detection and alerting
- Terrain clearance floor and terrain / obstacle awareness alerting and display

Radar or terrain information is displayed on the multifunctional displays by pressing the RDR/TERR button on the display control panel.

NOTE

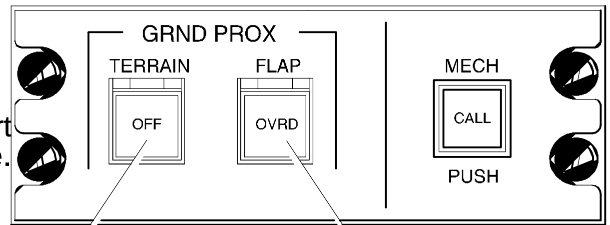
In the event of a momentary loss of AC electrical power, the TERRAIN FAIL status message may be displayed while the GPS satellites are reacquired (approximately 75 seconds) and the FMS aircraft position is re–entered.



Ground Proximity Warning System Interface Diagram <1015, 1025,2040>
Figure 18–80–1

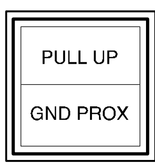
NOTE
The GRND PROX TERRAIN switch should be selected OFF when within 15nm of an airport that has no approved instrument approach procedures or an airport that is not in the GPWS database.

Ground Proximity Warning Panel
Centre Pedestal



GRND PROX TERRAIN (Guarded)
Used to inhibit the terrain map display (terrain clearance floor and terrain / obstacle awareness alerting and display functions). Basic GPWS modes (1–6) and windshear mode (7) remain active.
- OFF light indicates inhibit is selected.

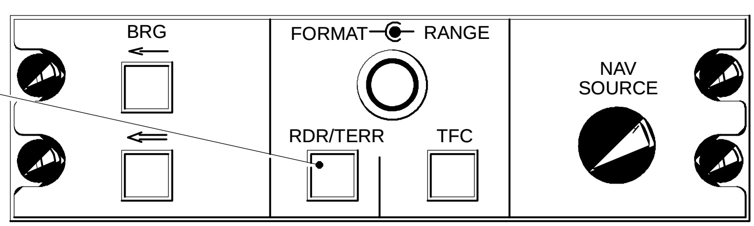
GRND PROX FLAP (Guarded)
Used to mute TOO LOW FLAPS or TERRAIN aurals.
- OVRD light indicates override is selected.



PULL UP / GND PROX
PULL UP – Flashes (red) during ground proximity warnings. Will stop flashing when airplane has recovered from warning envelope.
GND PROX – Flashes (amber) during ground proximity cautionary alerts. Will stop flashing when airplane has recovered from the caution envelope.
Switch is also used to initiate GPWS system test (on ground), or to provide the glideslope cancel function (when airborne).

Left and Right Glareshield

RDR / TERR
Used to alternately select or deselect a radar or terrain on the MFD display.



Display Control Panel
Pilot's and Copilot's Side Panels

Ground Proximity Warning System <2040>
Figure 18–80–2

A. Mode 1 – Excessive Descent Rate

Mode 1 is used for the approach phase of flight and is independent of the aircraft configuration. Mode 1 alerts are generated when the aircraft has an excessive descent rate close to the terrain. Mode 1 has two boundaries. Penetration of outer boundary activates the GND PROX lights and generates a SINKRATE, SINKRATE aural alert. Penetrating the inner boundary activates the PULL UP lights and the repeated (WHOOP, WHOOP) PULL UP aural, until the inner warning boundary has been exited. <2040>

B. Mode 2 – Excessive Terrain Closure Rate

Mode 2 alerts are generated when the aircraft is closing with terrain at an excessive rate. Mode 2 has two sub-modes referred to as Mode 2A and Mode 2B.

Mode 2A is active during climbout, cruise, and initial approach (flaps not in landing configuration and the aircraft is not on glideslope centerline). Penetrating the outer boundary activates the GND PROX lights and generates the TERRAIN, TERRAIN aural. Continued penetration of the envelope will activate the PULL UP lights and generate a repeated (WHOOP, WHOOP) PULL UP aural. <2040>

Upon leaving the PULL UP warning area, if terrain clearance continues to decrease, the TERRAIN aural will be generated until terrain clearance stops decreasing. The GND PROX lights will remain on until 300 feet of barometric altitude has been achieved, or 45 seconds has elapsed, or the GND PROX FLAP OVRD has been selected, or the flaps are in a landing configuration. <2040>

Mode 2B is activated when flaps are in landing configuration, when making an ILS approach with glideslope and localizer deviation less than 2 dots, and for the first 60 seconds after take-off. Penetration of the Mode 2B boundary with either gear or flaps not in a landing configuration, activates the GND PROX lights and generates a TERRAIN, TERRAIN aural. If the aircraft continues to penetrate the boundary the PULL UP lights are activated and a (WHOOP, WHOOP) PULL UP aural is repeated until the warning envelope is exited. <2040>

If the aircraft penetrates the Mode 2B boundary with both gear and flaps in a landing configuration, the GND PROX lights are activated and a TERRAIN aural is repeated until the envelope is exited. <2040>

C. Mode 3 – Altitude Loss After Take–off

Mode 3 provides alerts when the aircraft loses a significant amount of altitude after take-off, or low altitude go-around with gear or flaps not in a landing configuration. The amount of altitude loss permitted before an alert is generated depends on the height of the aircraft above the terrain.

The alert activates the GND PROX lights and generates a DON'T SINK, DON'T SINK aural. The DON'T SINK, DON'T SINK aural is only repeated if the altitude loss continues. The GND PROX lights will go out once a positive rate of climb is achieved. <2040>

D. Mode 4 – Unsafe Terrain Clearance

Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight, configuration and speed. Mode 4 has three sub-modes referred to as Mode 4A, Mode 4B and Mode 4C.

Mode 4A is active during cruise and approach with the gear and flaps not in the landing configuration. The boundary for Mode 4A is 500 feet radio altitude and increases linearly with airspeed, to a maximum of 1000 feet radio altitude. If the envelope is penetrated at less than 190 knots, the GND PROX lights flash and the TOO LOW GEAR aural alert is generated. If the envelope is penetrated at more than 190 knots, the GND PROX lights flash and a TOO LOW TERRAIN aural alert is generated. <2040>

Mode 4B is active during cruise and approach, with gear down and flaps not in the landing configuration. The boundary for Mode 4B is 245 feet radio altitude and increases linearly with airspeed, to a maximum of 1000 feet radio altitude. If the envelope is penetrated at less than 159 knots, the GND PROX lights flash and the TOO LOW FLAPS aural is generated. The flight crew may override the TOO LOW FLAPS alert by selecting the GND PROX FLAP OVRD. If the envelope is penetrated at more than 159 knots, the GND PROX lights flash and the TOO LOW TERRAIN aural alert is generated. <2040>

Mode 4C is active during the take-off phase with either gear or flaps not in the landing configuration. Mode 4C alerts the pilot when the terrain is rising more steeply than the aircraft is climbing. Mode 4C is based upon a minimum terrain clearance floor, that increases with radio altitude. If the aircraft radio altitude decreases to the value of the minimum terrain clearance floor, the GND PROX lights flash and the TOO LOW TERRAIN aural is generated. <2040>

The GND PROX lights will continue to flash until the alert envelope is exited. Subsequent alerts will only occur if the envelope penetration increases by 20%. <2040>

E. Mode 5 – Below Glideslope Alert

Mode 5 provides two levels of alerting during airplane descents below the glideslope on front course ILS approaches.

The first alert level occurs when the aircraft is more than 1.3 dots below the glideslope and is called a “soft” alert. The GND PROX lights flash and the GLIDESLOPE aural is generated at approximately one half the volume of other aurals. <2040>

The second alert level occurs when the aircraft is below 300 feet radio altitude and is more than 2 dots below the glideslope and is called a “hard” alert. The GND PROX lights flash and the GLIDESLOPE aural is generated at the normal aural volume. <2040>

The GND PROX lights will go out once the glideslope deviation is less than 1.3 dots. <2040>

Mode 5 can be inhibited by pushing either PULL UP / GND PROX light while the aircraft is below 2000 feet radio altitude. Modes 1 through 4 aurals have priority over Mode 5 aurals. <2040>

F. Mode 6 – Callouts

Mode 6 provides different combinations of programmable advisory callouts covering the following:

- Transition through approach minimums
- Altitude Callouts on Approach
- Excessive Bank Angle

(1) Transition through approach

Mode 6 provides audio alerts for descent below minimums altitude, DH or MDA, and prompts a voice warning. The function is enabled between 1000 and 10 feet radio altitude for DH callouts and when corrected altitude exceeds the MDA value by 200 feet. The landing gear must be down to activate the callouts.

(2) Altitude Callouts

The altitude callout function generates aurals for descent below predetermined altitudes. Altitude callouts are generated only once and are reset by ascending to 1000 feet, or in the event that a transition from approach mode to take-off mode occurs.

(3) Excessive Bank Angle Alerting

If enabled, excessive bank angle alerting is a function of roll angle with respect to altitude above ground level. Upon penetration of the alert envelope boundaries, the BANK ANGLE, BANK ANGLE aural is generated. The aural is issued once, and then only repeated if the roll angle increases by 20%.

G. Mode 7 – Windshear Detection and Alerting

Mode 7 monitors for windshear conditions during take-off and final approach between radio altitudes of 10 to 1500 feet.

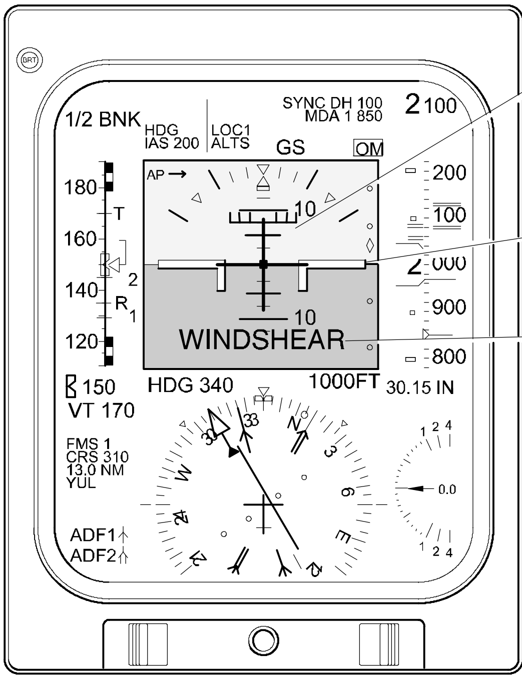
Windshear warnings are triggered for tail wind and down draft conditions. Windshear warnings generate a siren, a WINDSHEAR, WINDSHEAR, WINDSHEAR aural and a red WINDSHEAR warning on the primary flight displays (PFDs).

Windshear alerts are triggered for headwind and updraft conditions. Windshear alerts generate a amber WINDSHEAR alert on the PFDs.

Flight director command bars provide escape guidance automatically when a windshear warning occurs or when the TOGA (take-off/go-around) switch(s) on the thrust levers are pressed. Pitch limit indicators (alpha-margin indicators) will appear on both primary flight displays for a windshear warning or alert.

The autopilot is automatically disengaged two seconds after windshear warning (if autopilot not already disengaged). During those two seconds, the autopilot will follow the windshear escape guidance.

Windshear warnings take priority over all other aural alerts and warnings, except a stall warning.



Pitch Limit Marker (amber) (alpha-margin indicator)
Displayed during windshear warning or alert. Displays amount of pitch attitude change that can be made before the airplane reaches stall angle of attack.

Flight Director Command Bars (magenta)
Provide escape guidance during a windshear warning or when TOGA is selected on thrust levers.

Windshear Message
Flashes (amber) then comes on steady to indicate that the airplane is entering an increasing performance windshear condition.
Flashes (red) then comes on steady to indicate that a severe decreasing performance windshear condition has been encountered. Accompanied by aural warning.

(SIREN)
WINDSHEAR
WINDSHEAR
WINDSHEAR

Primary Flight Display
Pilot's and Copilot's Instrument Panels

WindshearGround Proximity Warning System – Detection and Alerting <1015, 2040>
Figure 18–80–3

H. Terrain / Obstacle Awareness Alerting and Display <2040>

The terrain awareness alerting function uses airplane geographical position, aircraft altitude, and a terrain database to predict potential conflicts between the aircraft flight path and the terrain.

The terrain awareness alerting continuously computes terrain clearance envelopes ahead of the aircraft. Two envelopes are computed, one corresponding to a terrain caution alert level and one corresponding to a terrain warning alert level.

Terrain data is displayed on the multifunctional displays by pressing RDR / TERR on the display control panel. The terrain display can be overlaid on the multifunctional display in navaid sector and present position map formats. The terrain display is depicted as variable density dot patterns in green, yellow or red. The density and color are a function of how close the terrain is relative to airplane altitude. When the conditions for either a terrain awareness caution or warning are detected, the terrain display automatically “pops-up” on both multifunctional displays and the range defaults to 10nm.

Terrain more than 2000 feet below the airplane, or within 400 feet (vertical) of the nearest runway elevation is not displayed.

At altitudes safely above all terrain within the display range chosen, the terrain displayed regardless of the aircraft altitude. Two elevation numbers (in hundreds of feet MSL) indicating the highest and the lowest terrain currently being displayed are overlaid on the display. Terrain within 400 feet (vertical) of the nearest runway elevation is not displayed. <2040>

When the airplane penetrates the caution envelope boundary, the GND PROX lights flash and the CAUTION TERRAIN, CAUTION TERRAIN aural is generated. Terrain caution areas are shown in solid yellow on the terrain display.

When the aircraft penetrates the warning envelope boundary, the PULL UP lights flash and the TERRAIN, TERRAIN, PULL UP aural is generated. Terrain warning areas are shown in solid red on the terrain display.

An obstacle database is included within the terrain database. When an obstacle caution threat is detected the GND PROX lights flash and a CAUTION OBSTACLE, CAUTION OBSTACLE aural is generated. Obstacle cautions are shown in solid yellow on the terrain display. When an obstacle warning threat is detected the PULL UP lights flash and an OBSTACLE, OBSTACLE, PULL UP aural is generated. Obstacle warnings are shown in solid red on the terrain display.

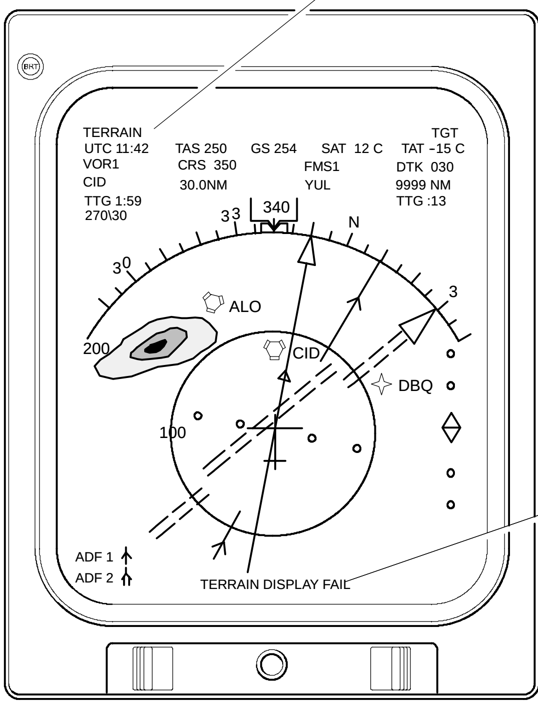
I. Terrain Clearance Floor <2040>

Terrain clearance floor is an increasing terrain clearance envelope around the nearest runway directly related to the distance from that runway. Terrain clearance floor alerts are based upon current airplane position, nearest runway centre point position, radio altitude, and a database of hard-surfaced runways whose length is greater than 3500 feet. Terrain clearance floor compliments Mode 4 alerts by covering insufficient terrain clearance even when in a landing configuration.

Penetration of the alert envelope activates the GND PROX lights and generates a TOO LOW TERRAIN aural. The aural will occur once upon initial envelope penetration and one time thereafter for each 20% degradation in altitude. The GND PROX lights remain on until the aircraft exits the alert envelope.

Terrain Display Annunciations

- TERRAIN (cyan) - Terrain display has been selected.
- TERRAIN TEST (cyan)- GPWS is in self test.
- TERRAIN NOT AVAIL (white) - Terrain has been selected for display but the estimated navigation accuracy is insufficient.
- TERRAIN OFF (white)- Terrain has been selected for display but terrain functions have been manually inhibited.



TERRAIN DISPLAY FAIL (amber)
Terrain has been selected for display and the required data is either failed, missing, or invalid.
TERRAIN RANGE XXX NM (amber)
Terrain range disagrees with display control panel range.

Multifunction Display - Navaid Sector Mode
Pilot's and Copilot's Instrument Panels

Ground Proximity Warning System Terrain Display <2040>
Figure 18−80−4

WINDSHEAR FAIL status (white)
Indicates a failure in the windshear detection system.

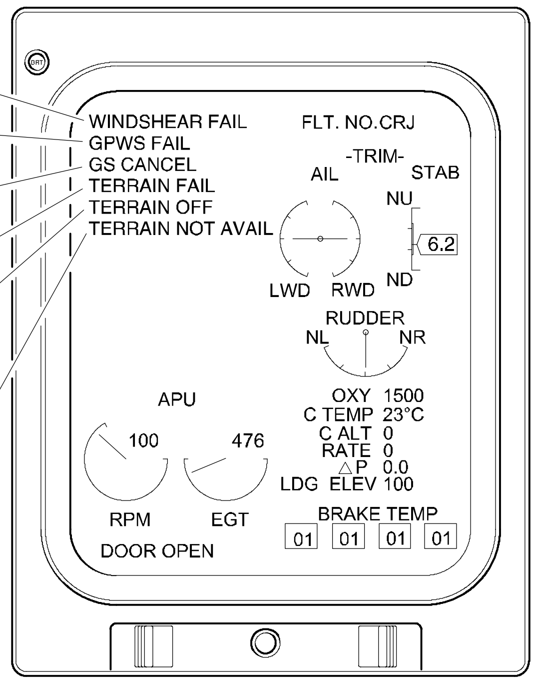
GPWS FAIL status (white)
Indicates a failure in the basic ground proximity warning modes.

GS CANCEL status (white)
Indicates that glideslope Mode 5 alerts have been inhibited.

TERRAIN FAIL status (white)
Indicates a failure in the terrain map display.

TERRAIN OFF status (white)
Indicates that the terrain map display has been selected and the terrain functions have been inhibited.

TERRAIN NOT AVAIL status (white)
Indicates that the terrain map display is not available due to position inaccuracy.



Status Page

Ground Proximity Warning System Status Page <2040>
Figure 18–80–5

J. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Ground Proximity Warning System	Computer	GND PROX WARN	AC BUS 1	1	B14	

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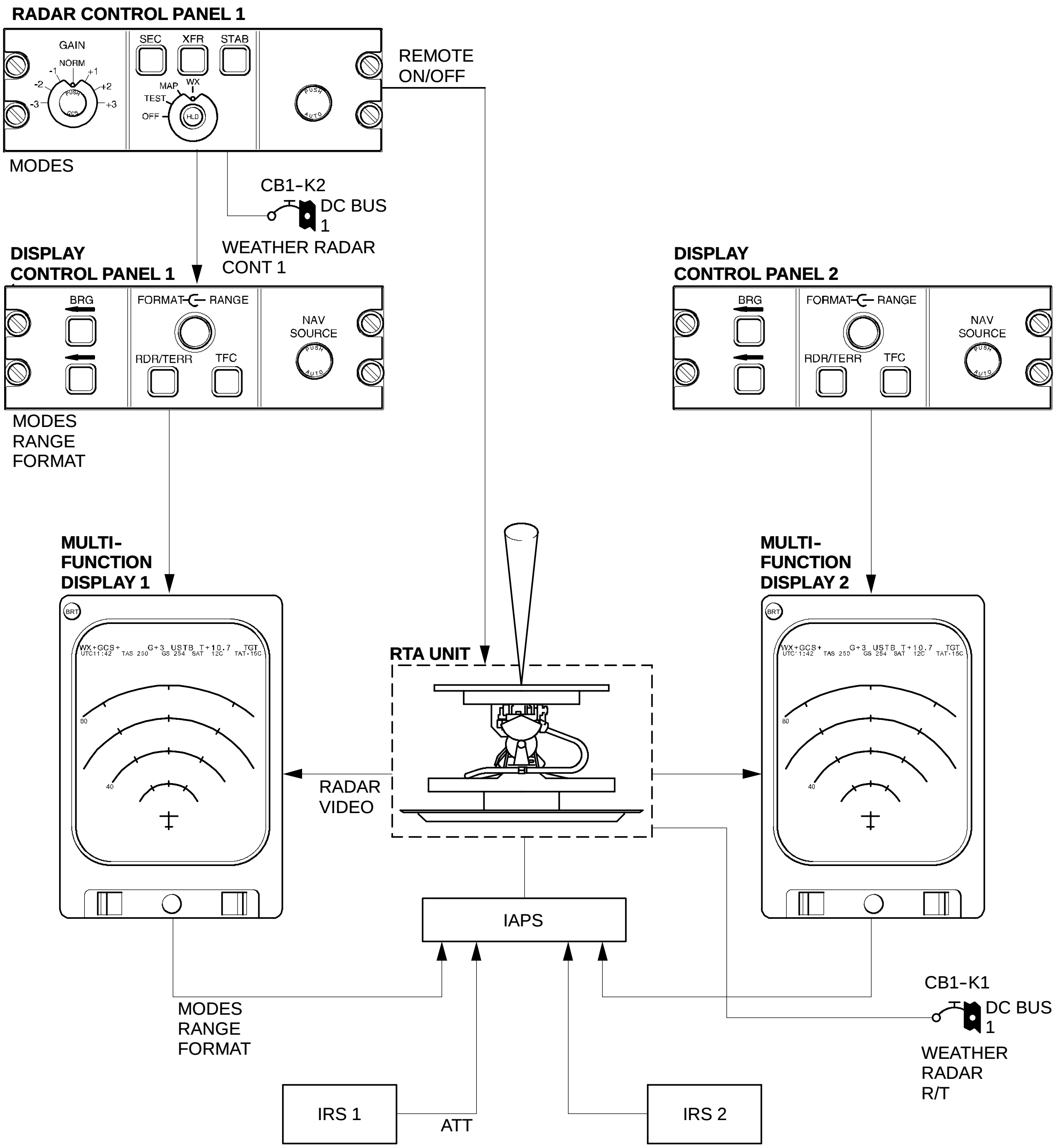
1. WEATHER RADAR SYSTEM

The weather radar system provides the flight crew with a color-coded display of radar detectable precipitation and ground mapping along the airplane's flight path. System range is up to 320 nautical miles and up to 60 degrees on either side of the airplane's flight path. The display control panel is used to select the weather radar format on the multifunctional displays (MFDs). Weather radar data can also be overlaid in navaid sector, present position map and TCAS modes. Control is provided using the weather radar control panel.



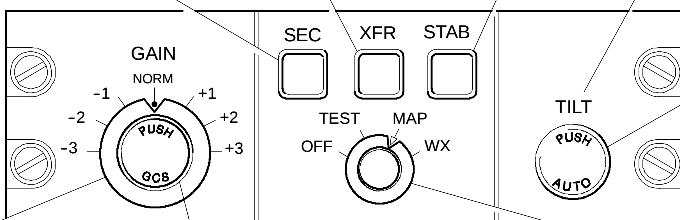
Weather Radar System <1025, 2040>
Figure 18–90–1

XFR
Used to transfer control of display range to opposite side display control panel. Controlling side range values are displayed in white and non–controlling side values are displayed in yellow.

STAB
Used to deselect radar stabilization by disconnecting attitude reference signal in the event of an attitude system failure.

SEC
Used to select 30° sector scan instead of the normal 60° sector scan. Display refresh or update rate doubles.

TILT
Used to change antenna tilt up or down angle for desired radar scanning. Tilt limits are ±15°.



AUTO
When pushed in, tilt is automatically adjusted for changes made in altitude or range.

Weather Radar Control Panel
Center Pedestal

GAIN
Used to control receiver gain.
- NORM – Display colors accurately present detected rainfall levels.
- –1, –2, –3 Positions: Reduces sensitivity to eliminate weaker weather targets.
- +1, +2, +3 Positions: Increases sensitivity to enable crew to differentiate between rainfall levels.

GCS
When pressed in during WX mode, ground cluster suppression (GCS) reduces the intensity of ground returns and permits clearer definition of precipitation. Suppression lasts approximately 12 seconds. Any mode or range change cancels GCS.

Mode Select
Used to select radar mode of operation.
- OFF – Removes power from the transmitter and places radar in standby mode.
- TEST – Starts radar self–test. Test pattern displayed on MFD.
- MAP – Ground targets are displayed on MFD in cyan, green, yellow or magenta (depending on strength).
- WX – Detectable weather displayed in green, yellow, red or magenta (depending on estimated rainfall rate).

Weather Radar System Control Panel
Figure 18–90–2

The colors used on the radar display to represent rainfall intensity are as follows:

DISPLAY COLOR	RAINFALL RATE INCHES/HR (MM/HR)	VIDEO INTEGRATED PROCESSOR (VIP) CATEGORIZATIONS		
		STORM CATEGORY	VIP LEVEL	RAINFALL RATE INCHES/HR (MM/HR)
MAGENTA	> 2.0 (> 51)	EXTREME	6	> 5.0 (> 127)
		INTENSE	5	2.0 – 5.0 (51 – 127)
RED	0.47 – 2.0 (12 – 51)	VERY STRONG	4	1.02 – 1.97 (26 – 50)
		STRONG	3	0.48 – 1.02 (12 – 26)
YELLOW	0.16 – 0.47 (4 – 12)	MODERATE	2	0.1 – 0.48 (2.5 – 12)
GREEN	0.04 – 0.16 (1 – 4)	WEAK	1	0.01 – 0.1 (0.25 – 2.5)

Radar Mode (cyan)
- RADAR OFF – Loss of weather radar input.
- STBY – Weather radar in standby mode.
- WX – Weather radar mode.
- MAP – Ground mapping mode.
- TEST – Radar test mode.

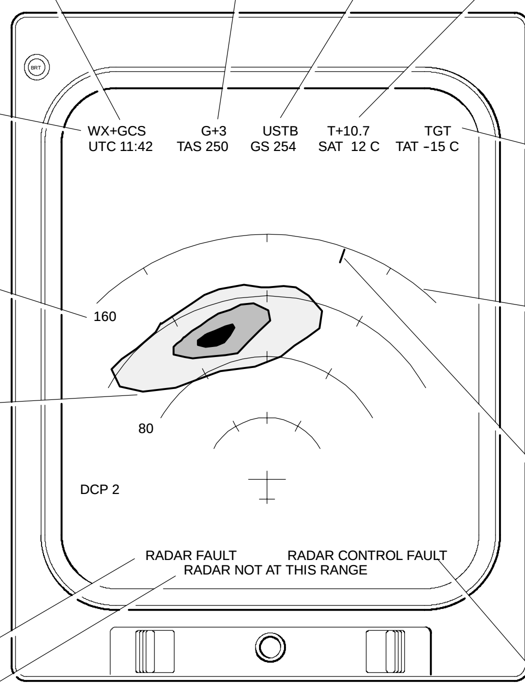
USTB (amber)
Indicates an attitude system failure. Turns cyan when radar stabilization has been deselected.

Receiver Gain (cyan)
Indicates selected gain. Prefixed by a “”G”.

+GCS (cyan)
Indicates that ground clutter suppression has been selected.

Antenna Tilt (cyan)
Indicates antenna tilt angle. Prefixed by a ”“T”. Suffixed by an “”A” if auto tilt is enabled.

Radar Status Line



TGT
Indicates target alert.

Range (white)
Indicates range as selected on display control panel.

Range Arcs (white)
Indicates range increments. Marks placed at 30° intervals.

Radar Returns
Indicates rainfall intensity or ground targets. A yellow arc is displayed when the radar cannot accurately determine rainfall levels.

Dynamic Sweep Mark (cyan)
Represents position of weather radar antenna.

RADAR FAULT (cyan)
Internal fault detected.

Multifunction Display – Weather Radar Mode
Pilot’s and Copilot’s Instrument Panels

RADAR NOT AT THIS RANGE (cyan)
Radar control has been transferred and range disagrees with display control panel range.

RADAR CONTROL FAULT (amber)
Radar range disagrees with display control panel range.

Weather Radar System – MFD Indications
Figure 18–90–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Weather Radar	Receiver / Transmitter	WEATHER RADAR R/T	DC BUS 1	1	K1	
	Control	WEATHER RADAR CONT 1			K2	

CHAPTER 19 – PNEUMATIC

TABLE OF CONTENTS

Page

LIST OF ILLUSTRATIONS

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1. INTRODUCTION

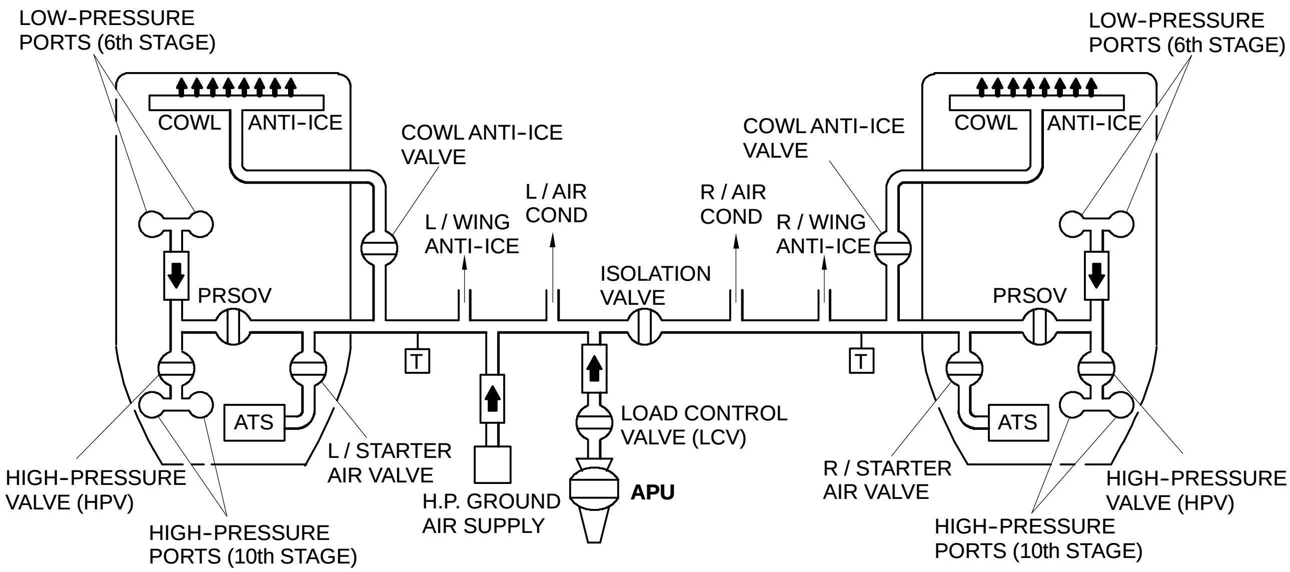
The pneumatic system is supplied bleed air from the engine compressors or from the APU compressor. The supplied air is used for:

- The aircraft environmental control system
- Wing and cowl anti–ice systems.

The pneumatic system can also receive conditioned air from a ground air cart.<1007>

Bleed air management is fully automatic. Two air conditioning system controllers monitor system health and regulate bleed air pressure to ensure air is supplied at a level of pressure compatible with proper operation of the pneumatic systems currently connected. Under non-normal situations, system isolation and manual selection of the bleed air source is possible using the bleed air panel.

The bleed air leak detection system monitors the pneumatic ducting for high temperature bleed air leaks. The system will automatically shut down the respective bleed system when a leak is detected to protect the system components.

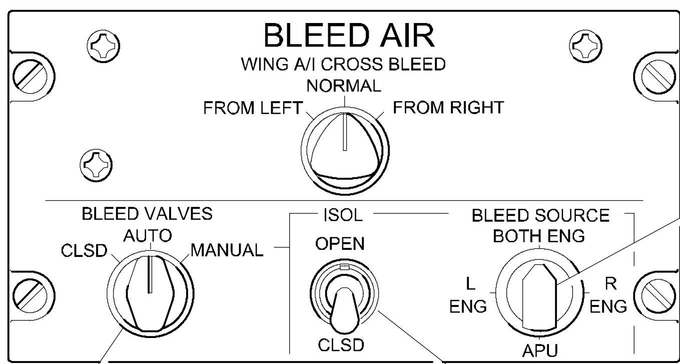


Bleed Air System Schematic
Figure 19-10-1

1. BLEED AIR SYSTEM

The bleed air system receives pressurized air from the engine compressors, APU compressor or from an external high pressure ground source.

The bleed air is supplied to various systems through a common manifold which can be divided into two sections by an bleed isolation shut–off valve. Pneumatically operated aircraft systems include engine starting, cowl and wing anti-icing, air-conditioning and pressurization. Two air-conditioning system controllers (ACSC) manage the distribution of the bleed air and control the air-conditioning systems. Bleed air selection is made using the BLEED AIR panel located on the overhead panel.



BLEED SOURCE
Used to select bleed air source.
- L ENG - Left engine only
- BOTH ENG - Both left and right engines
- R ENG - Right engine only
- APU - APU only.

Bleed Air Panel
Overhead Panel

BLEED VALVES
Used to select bleed air mode.
- CLSD - Closes all bleed sources. Must be selected when using external ground source to prevent damage to engines or APU.
- AUTO - Controller manages system requirements.
- MANUAL - Allows pilot to manually configure the system.

ISOL
Used to isolate or interconnect the left and right pneumatic systems. Only operative in manual mode.

Bleed Air System Control Panel
Figure 19–20–1

A. Engine Bleed Air

The engine can supply either low or high pressure bleed air from the compressor depending on the position of the engine high pressure valve (HPV). When an engine is selected as the bleed air source, the ACSC determines whether the system will bleed air from the high pressure (10th stage) compressor port or from the low pressure (6th stage) compressor port. The ACSC will open or close the HPV depending on the bleed air manifold pressure and aircraft system requirements.

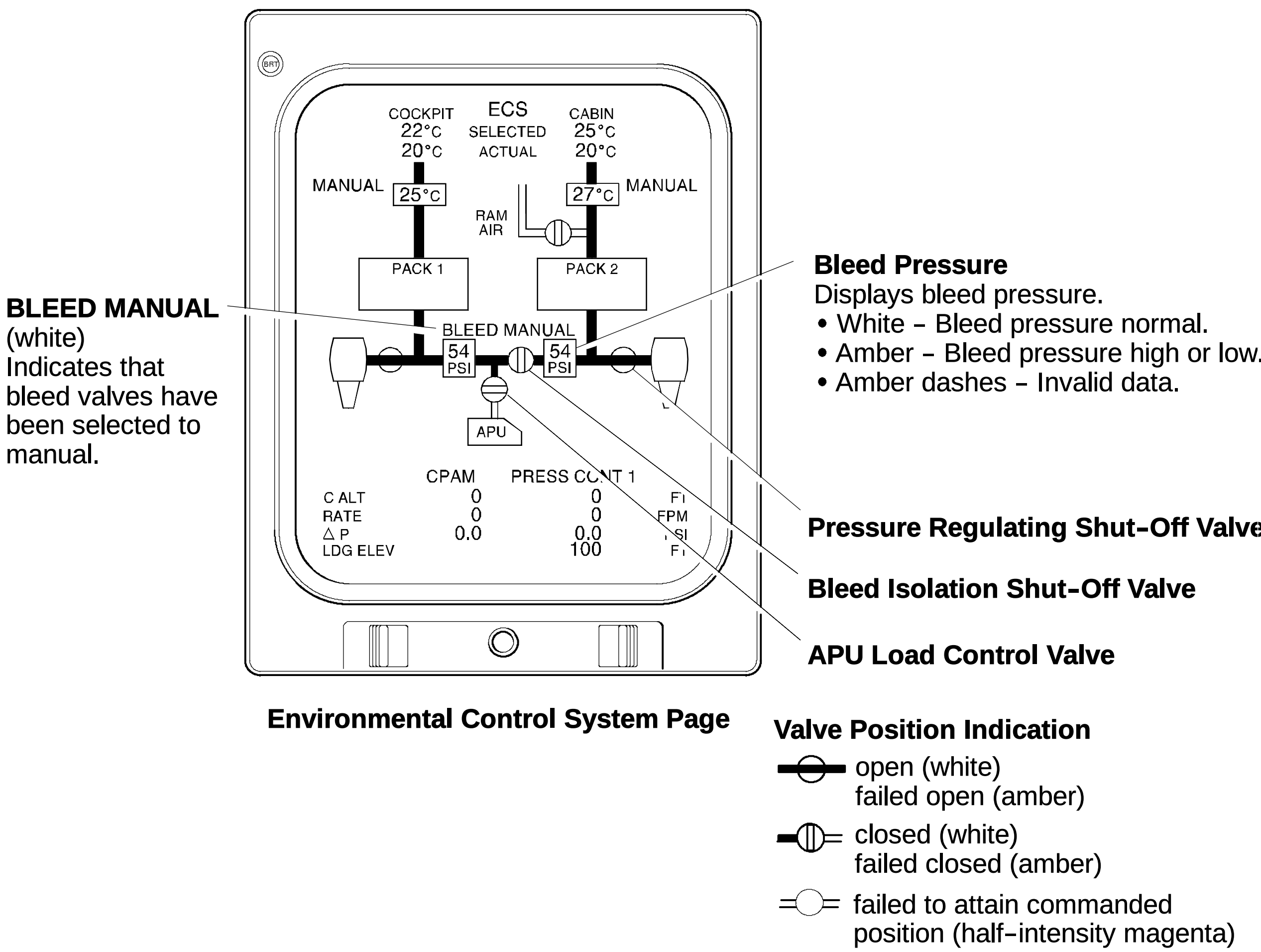
Manifold pressure is regulated to about 45 psig by the pressure regulating shut-off valve (PRSOV). When the demand cannot be supplied by the low pressure port, the ACSC commands the engine HPV open. When the 6th stage air pressure is high enough to satisfy the requirements of the connected systems, the ACSC commands the HPV closed.

B. APU Bleed Air

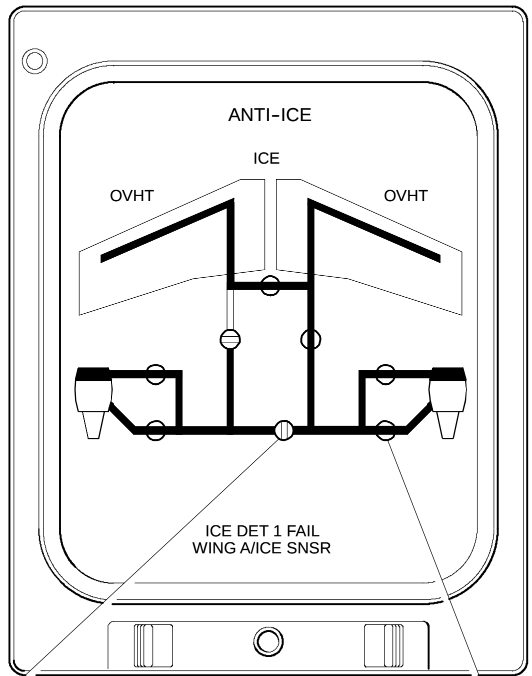
The APU can be used on the ground to supply the pneumatic system with a compressed air source for air-conditioning or engine starting. Under certain limitations, the APU can also be used in flight. When the APU is selected as the bleed air source, the bleed air is supplied through a load control valve (LCV) to the bleed air manifold. The ECU modulates the LCV to limit APU exhaust gas temperature. To prevent compressor surge, a small quantity of compressed air is vented overboard through a surge control valve.

C. High Pressure Ground Air Connection

An external high pressure ground power cart can be used to supply the bleed air manifold with compressed air for engine starting. For ground cart operation, the bleed valves must be selected closed to avoid reverse flow to the engines. Air pressure is indicated on the EICAS, ECS synoptic page, when AC power is available.



Bleed Air System Environmental Control System Synoptic Page
Figure 19–20–2



Anti-Ice Page

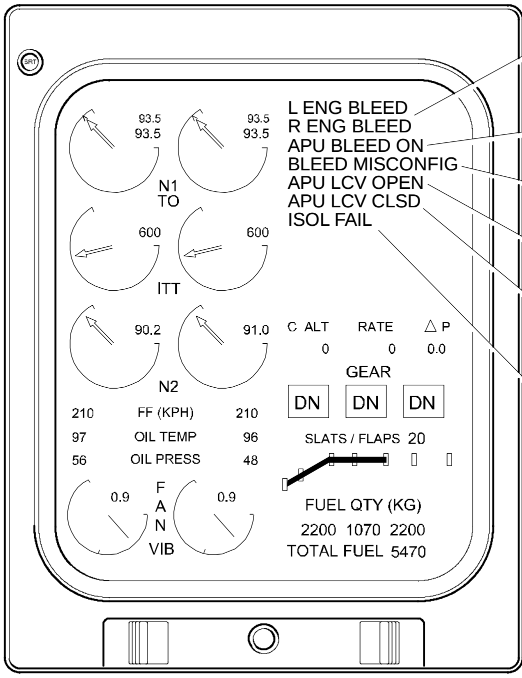
Bleed Isolation Shut-Off Valve Position Indication

- open (white)
  failed open (amber)
- closed (white)
  failed closed (amber)
- failed to attain commanded position (half-intensity magenta)

Pressure Regulating Shut-Off Valve Position Indicator

- open (white)
- closed (white)
- failed to attain commanded position (half-intensity magenta)

Bleed Air System Anti/Ice Synoptic Page
Figure 19-20-3



L or R ENG BLEED caution (amber)
Indicates failure of high pressure valve, pressure regulating shut-off valve or controller.

APU BLEED ON caution (amber)
Indicates APU bleed is selected above maximum altitude (25,000 feet).

BLEED MISCONFIG caution (amber)
Indicates an impossible bleed configuration in manual mode.

APU LCV OPEN caution (amber)
Indicates that APU load control valve failed to close when commanded to close.

APU LCV CLSD caution (amber)
Indicates that APU load control valve failed to open when commanded to open.

ISOL FAIL caution (amber)
Indicates that bleed isolation shut-off valve failed to attain selected position.

Primary Page

L or R ENG BLEED CLSD status (white)
Indicates that respective engine bleed is not selected with respective high pressure valve and pressure regulating shut-off valve closed.

L or R ENG BLEED SNSR status (white)
Indicates respective pack inlet pressure sensor has failed.

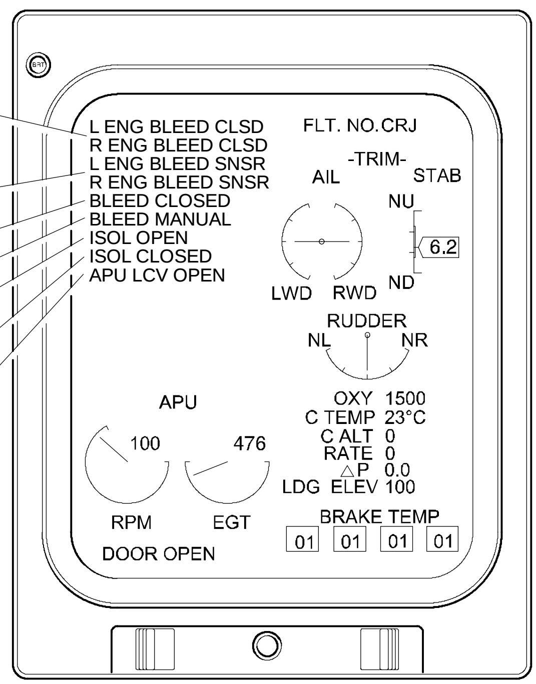
BLEED CLOSED status (white)
Indicates that all bleeds are closed.

BLEED MANUAL status (white)
Indicates that bleed system is in manual mode.

ISOL OPEN status (white)
Indicates that bleed isolation shut-off valve is fully open.

ISOL CLOSED status (white)
Indicates that bleed isolation shut-off valve is fully closed.

APU LCV OPEN status (white)
Indicates that APU load control valve is not closed.



Status Page

Bleed Air System EICAS Indications <1001>
Figure 19−20−4

D. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Bleed Air	Shut-Off Valves	L BLEED SOV	DC ESSENTIAL	2	S10	
		R BLEED SOV			S11	

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1. BLEED AIR LEAK DETECTION

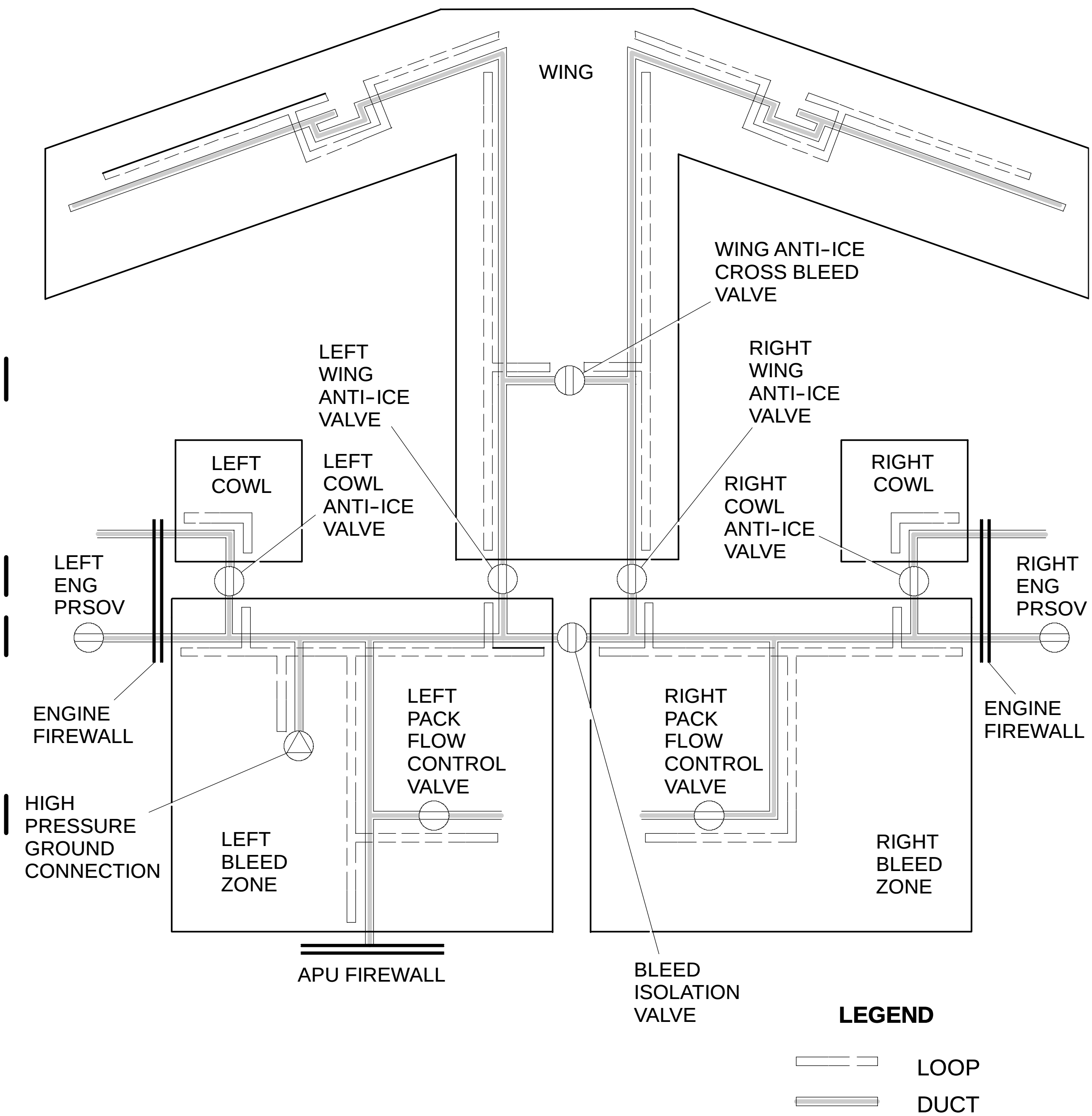
The bleed air leak detection system monitors the pneumatic and anti-ice ducting for high temperatures associated with bleed air leakage. EICAS messages and system control is provided by an anti-ice and leak detection controller (AILC).

The bleed leak detection consists of continuous sensing loops routed in parallel along the pneumatic ducting. The system is divided into five zones and each zone can be isolated by means of a shut-off valve. The five zones are left and right bleed zone, left and right cowl anti-ice zones and wing anti-ice zone. The wing anti-ice zone is subdivided into four loops. They are left and right fuselage loops and left and right wing loops. The supply ducting is encased in a protective cover. If a leak occurs, holes in the protective cover directs the hot bleed air towards the sensing loops.

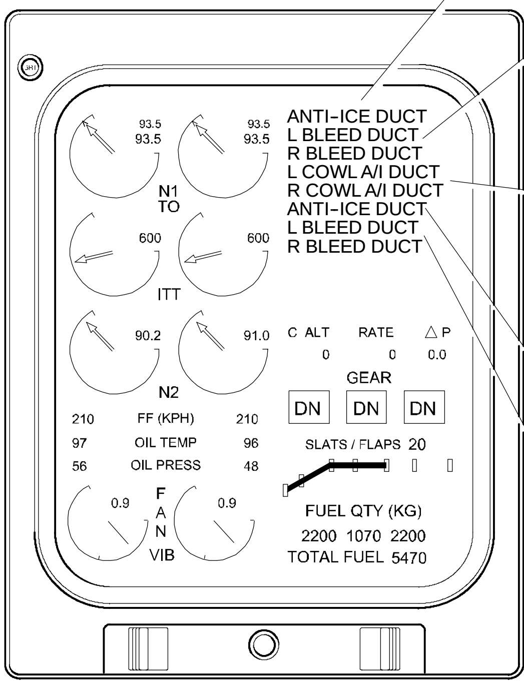
The dual sensing loops are used to ensure dispatch reliability and to minimize system false warnings. To prevent false indications, both loops must detect a leak before an EICAS message is posted. The leak detection sensing loops consists of two wires mounted coaxially inside a flexible metal tube. The ends of each sensing loop are connected to the controller. When hot air escapes from a leak in the ducting it is sensed by the controller which posts a EICAS message identifying the leakage zone. The duct is then isolated by closing the appropriate shut-off valve.

For normal wing anti-icing, hot bleed air from the supply ducting is released through piccolo tubes to heat the wing leading edges. The dual loops and a skin temperature sensor located in the wing leading edge are used to detect failures in the wing anti-ice ducting.

The cowl anti-ice ducts, located in the engine pylons, consist of inner and outer ducts. Bleed air for anti-icing travels through the inner the duct. The area between the inner and outer duct is monitored by a pressure transducer. In the event of a failure or crack of the inner duct, the pressure transducer will sense the air pressure change and send a signal to the AILC to post an EICAS warning message.



Bleed Air Leak Detection System
Figure 19-30-1



Primary Page

ANTI–ICE DUCT warning (red)
Indicates that a bleed air leak has been detected by the anti–ice and leak detection controller in the wing anti–ice ducting or piccolo tubes.

ANTI–ICE DUCT

L or R BLEED DUCT warning (red)
Indicates a bleed air leak has been detected by the anti–ice and leak detection controller in the respective engine bleed ducting.

BLEED AIR DUCT

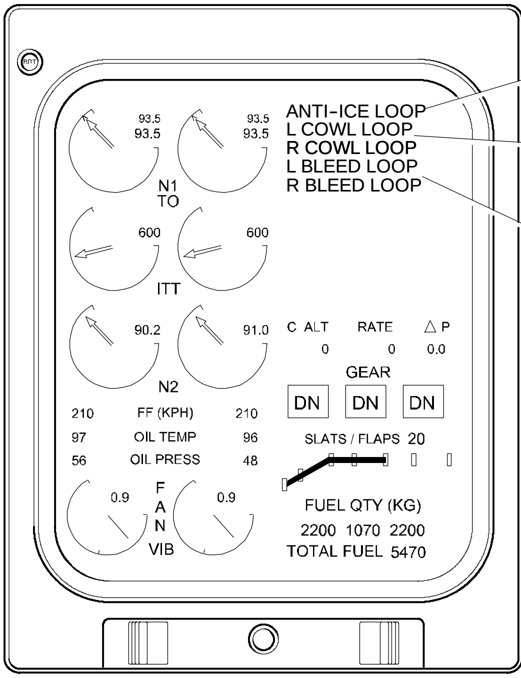
L or R COWL A/I DUCT warning (red)
Indicates that the respective cowl anti–ice duct pressure is above 17 psig or a bleed air leak has been detected by the anti–ice and leak detection controller.

ANTI–ICE DUCT

ANTI–ICE DUCT caution (amber)
Indicates bleed shutdown after bleed leak detected and system not selected off.

L or R BLEED DUCT caution (amber)
Indicates respective bleed shutdown after bleed leak detected and system has not been reconfigured.

Bleed Air Leak Detection Anti–Ice – Duct EICAS Indications <1001>
Figure 19–30–2

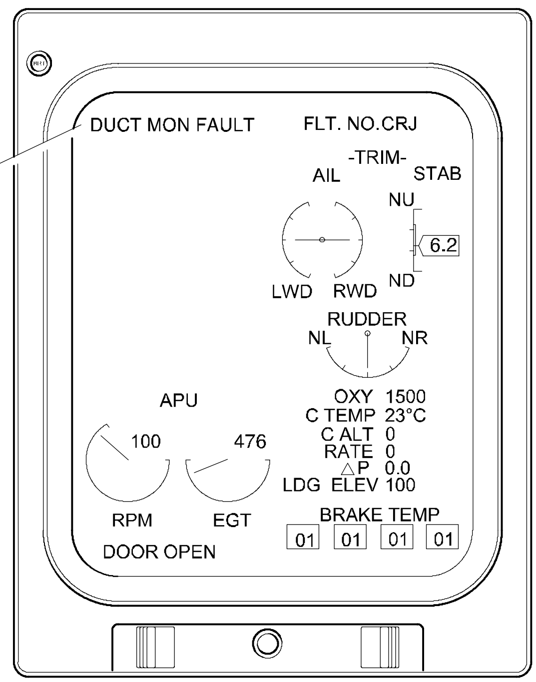


ANTI–ICE LOOP caution (amber)
Indicates loss of both wing anti–ice leak detection loops during power–up test.

L (R) COWL LOOP Caution (amber)
Indicates a loss of both left or right cowl bleed air leak detection loops during power–up test.

L (R) BLEED LOOP Caution (amber)
Indicates a loss of both left or right engine bleed air leak detection loops during power–up test.

Primary Page



DUCT MON FAULT status (white)
Indicates a loss of redundancy in bleed leak detection system.

Status Page

Bleed Air Leak Detection – Loop EICAS Indication <1001>
Figure 19–30–3

CHAPTER 20 – POWER PLANT

LIST OF ILLUSTRATIONS

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1. INTRODUCTION

The airplane is equipped with two General Electric CF34–8C5 high bypass ratio turbofan engines which have a normal take-off thrust rating of 13,600 pounds. The engines are controlled by a full authority digital electronic control system (FADEC). In the event of an engine failure during takeoff, an automatic power reserve (APR) function of the FADEC, will increase the thrust on the remaining engine to 14,510 pounds.

The engine is a dual rotor assembly consisting of a fan rotor (N1) and a compressor rotor (N2). The N1 rotor consists of a single-stage fan connected through a shaft to a 4-stage low pressure turbine. The N2 rotor is a 10-stage axial flow compressor connected through a shaft to a 2-stage high pressure turbine.

For normal engine function, intake airflow is accelerated through the single-stage N1 fan and is divided into two airflow paths:

- Bypass air – Air that is ducted around the engine to produce most of the thrust. Thrust reversers are used to divert the bypass air forward to assist in braking on the ground.

- Core air – Air that enters the engine core section is compressed, mixed with fuel and ignited. The gases pass through the high pressure turbine which drives the compressor. Air from the high pressure turbine passes through the low pressure turbine which drives the N1 fan. The exhaust gases are then accelerated through the exhaust nozzle to produce a portion of engine thrust.

A variable geometry (VG) system regulates airflow through the compressor by changing the position of the compressor inlet guide vane and the variable geometry stator vanes on the first four stages of the compressor. This is done to prevent compressor stall and surge by optimizing the angle of attack of the vanes. The VG system is controlled by FADEC and positioned by actuators through a mechanical linkage. High pressure fuel from the engine fuel metering unit is used to hydraulically move the actuators.

An operability bleed valve provides additional compressor airflow control by extracting bleed air to off–load the compressor during starts and high aerodynamic loads. The operability bleed valve is controlled by FADEC and hydraulically actuated by high pressure fuel from the fuel metering unit.

The N2 compressor drives the accessory gearbox. Mounted on the gearbox are:

- Engine lubrication pump and integral oil reservoir

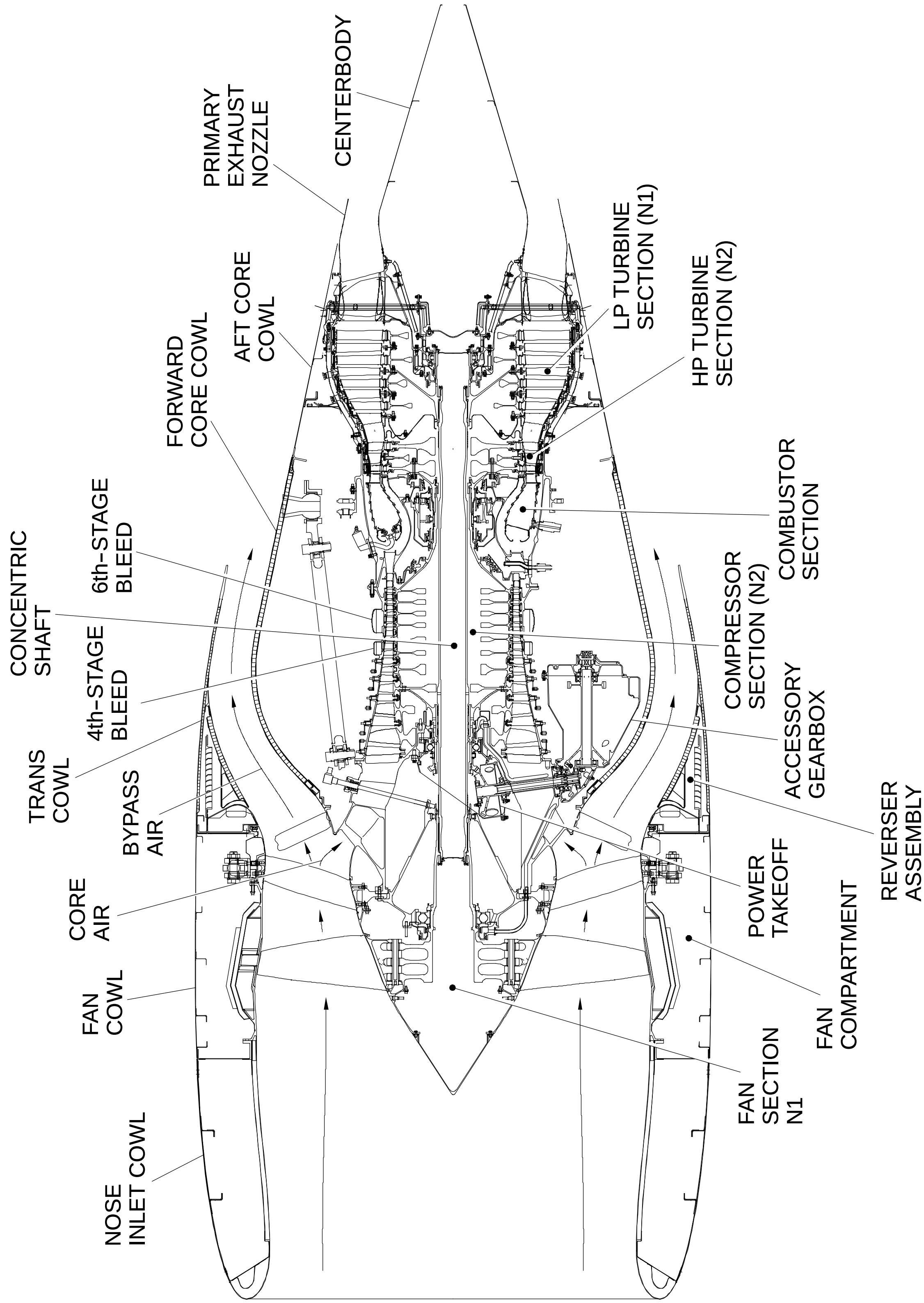
- FADEC alternator

- Hydraulic pump

- Engine fuel pump and fuel metering unit

- Integrated drive AC generator

- Air turbine starter



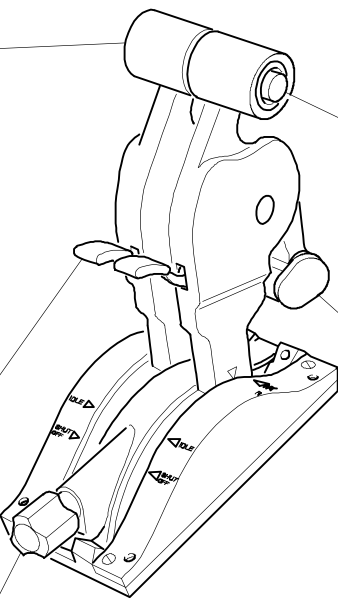
Power Plant – Cross Section
Figure 20–20–1

1. THRUST CONTROL

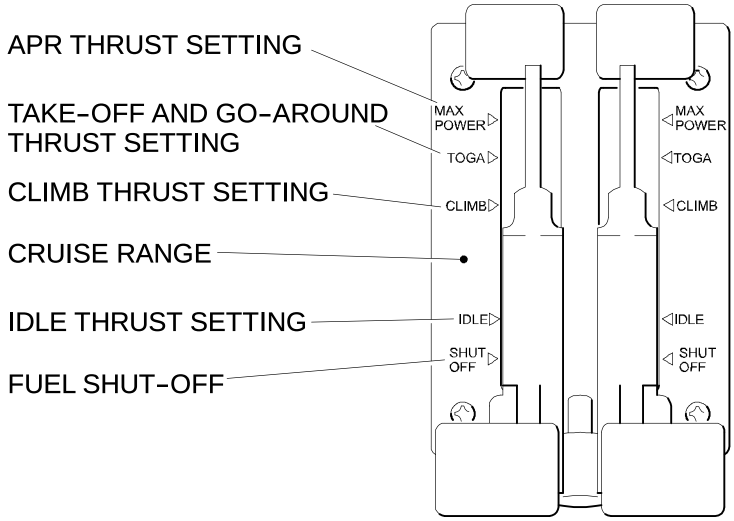
Thrust control is provide using thrust levers and managed by a full authority digital electronic control system (FADEC).

A. Thrust Levers

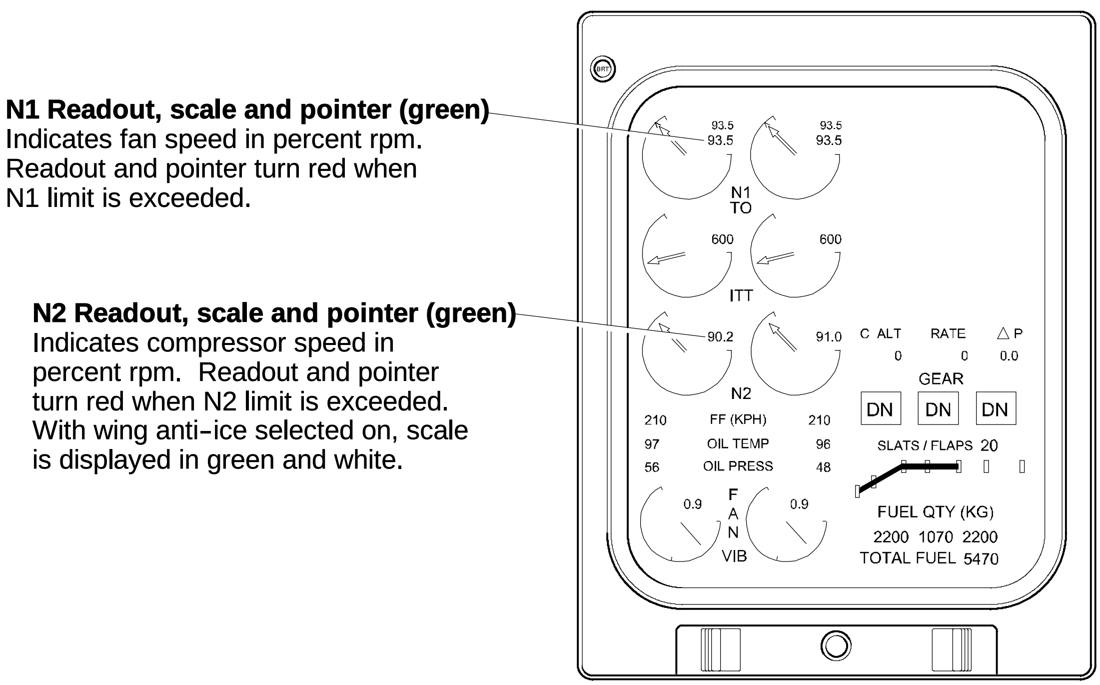
Thrust levers control the application of forward thrust. Idle / shutoff release latches are used to remove mechanical locks that guard against inadvertent movement of the thrust levers. Lever position is monitored by the FADEC which uses the information to compute a target thrust rating. Thrust indications are displayed on the EICAS primary page.



Thrust Control – Thrust Levers
Figure 20–20–1



Thrust Control – Throttle Quadrant Setings
Figure 20–20–2



Primary Page

Thrust Control – N1 & N2 Readout Scale and Pointer <1001>
Figure 20–20–3

B. Full Authority Digital Electronic Control

Each power plant has its own dual channel FADEC computer. One FADEC channel provides engine control and the other channel operates as a standby channel. Both channels share information through a cross-channel data link. Channel control is alternated on each successive engine start.

The FADEC system is powered by the aircraft electrical system until N_2 reaches 50% rpm. Above 50% N_2 rpm, a gearbox mounted alternator supplies power to the FADEC.

On the ground, normal-rated takeoff thrust is calculated when electrical power is first applied to the aircraft. The target N_1 is continuously updated for changes in Mach number, ambient temperature and pressure altitude.

When the thrust lever is placed in idle, the minimum optimal N_2 idle rpm is programmed by the FADEC system. Idle rpm is dependant upon atmospheric information, bleed air load and phase of flight.

The FADEC computes the optimal target thrust rating for each thrust lever position and presents the target or maximum value on the N_1 gauge of the EICAS primary page.

The thrust mode annunciation on the EICAS primary page identifies the position of the thrust levers during most phases of operation, or may indicate an armed condition prior to lift off and on approach. Annunciated thrust modes are: CRZ (thrust levers are in the cruise range), CLB (the thrust levers are in the climb detent), TO (ground operations or the thrust levers are in the TOGA detent for takeoff). GA (thrust levers are in the TOGA detent for in flight go around), MCT (thrust levers are in the climb detent and OEI is active or high power has been selected), FLX (flex power programmed).

With both engines operating, the thrust levers are normally moved together and a single thrust mode annunciation is presented. When the thrust levers are moved separately, the thrust mode annunciation reflects the position of each thrust lever. When the thrust lever is in the SHUTOFF position, a solid amber line is displayed.

Flex power is routinely used for takeoff when weather and runway conditions are favorable. Flex thrust takeoffs reduce fuel consumption and extend the usable life of the engine.

Flex power is selected by entering an assumed temperature on the PERF MENU page of the FMS CDU. If the FMS is not available, the assumed temperature can be entered on the EICAS menu page using the EICAS control panel. The assumed temperature for Flex power can only be entered when:

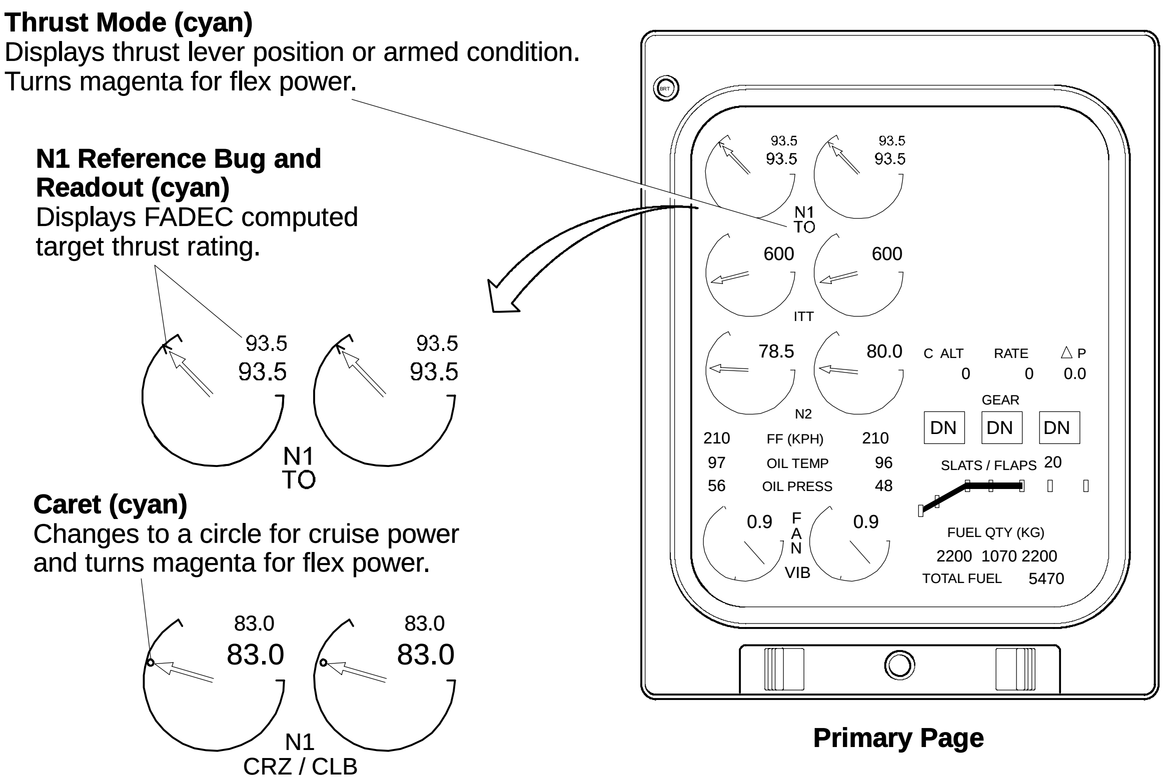
- The thrust levers are in the IDLE or SHUTOFF detents
- The aircraft has been in a weight on wheels (WOW) configuration for at least one minute
- The assumed temperature entered is greater than the actual OAT
- The airspeed is less than 65 knots

The assumed temperature can be cleared by selecting DEL on the FMS CDU or if the FMS is not available, by selecting FLX RESET on the EICAS menu page. To clearly identify flex power from other thrust modes, the flex indications are displayed in magenta on the N_1 gauges.

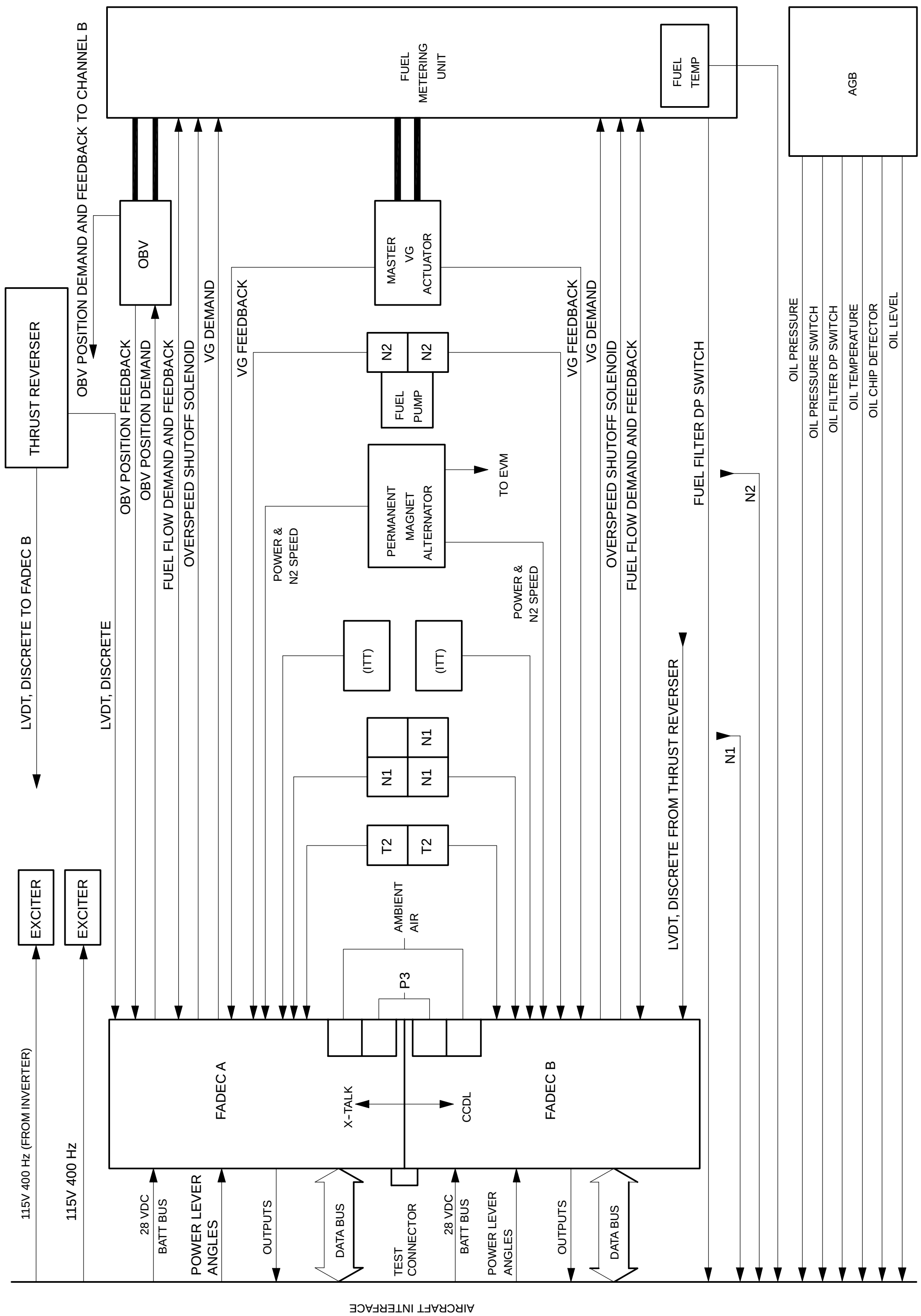
NOTE

The FLX indications on the EICAS menu page are only displayed if the FMS has failed or is not available.

When programmed, the FLX power setting is activated by the FADEC when the thrust levers are in the TOGA detents.



Thrust Control N1 Reference Bug and Readout <1001>
Figure 20–20–4



FADEC/FMU Interface
Figure 20-20-5

C. Automatic Power Reserve

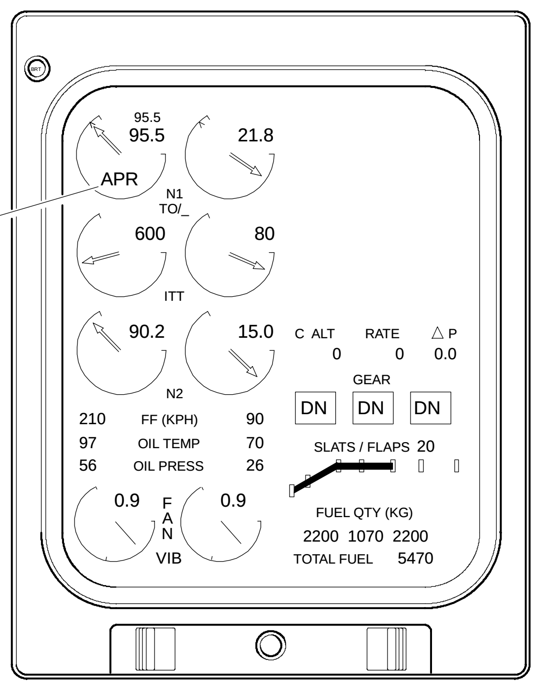
The automatic power reserve (APR) system (which is a feature of the FADEC) monitors for engine failures and/or power loss during takeoff and climb. The APR feature is armed during takeoff when the N_1 rpm of both engines are within 8% of the take off N_1 reference value. On the approach, the APR system is armed for the go-around with either engine available and flaps greater than 20° or landing gear down.

A failure is detected when an engine N1 speed decreases below 15% of the set power. If the detected failure was due to an N1 mismatch, the failure signal is cleared when the N1 mismatch becomes less than 13%.

When an engine fails, the APR will automatically increase the thrust on the good engine to maximum continuous thrust (MCT). The amount of the increased thrust depends on the position of the thrust levers at the time of the engine failure. This automatic increase in thrust is divided into three categories:

- APR power when the thrust levers are in the TOGA detents
- Automatic increase to maximum continuous thrust (MCT) when the thrust levers are in the climb detent
- Proportional increase in power when operating with thrust levers in the cruise range

APR (Icon) (green)
Displayed when APR system is activated by an engine failure, or when a thrust lever is set to the MAX POWER detent.



Primary Page

Thrust Control Automatic Performance Reserve <1001>
Figure 20-20-6

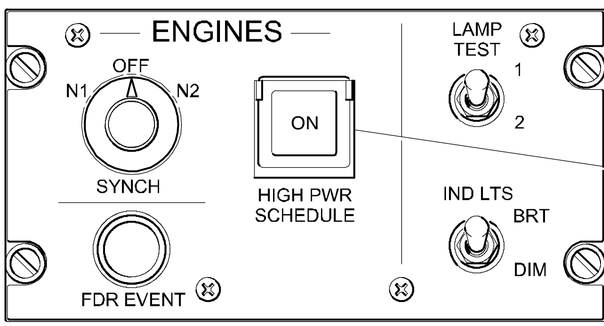
D. High Power Schedule

NOTE

There are no operational procedures in which the use of this switch is required. Use of this switch is also prohibited by limitations.

CAUTION

Use of APR may adversely affect engine life under certain conditions (Refer to the Flight Crew Operating Manual, Volume 2 – LIMITATIONS, Power Plant).



HIGH PWR SCHEDULE (Guarded)
If selected, engines will operate on the one engine inoperative power schedule. Engine power (both) will advance to MCT if thrust levers are in the CLIMB detent. Engine power (both) will advance to APR if thrust levers are in the TOGA detent.

Engine / Miscellaneous Test Panel
Center Pedestal

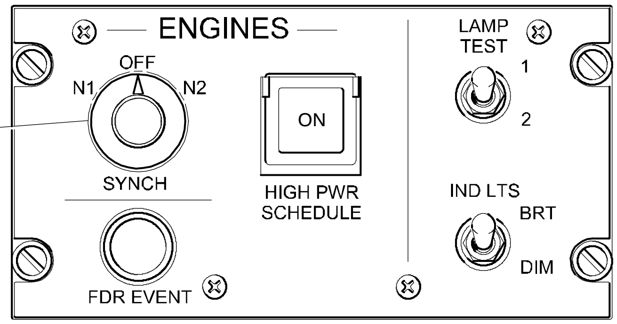
High Power Schedule Pushbutton
Figure 20–20–7

E. N_1 and N_2 Synchronization

In the cruise range, thrust is set to a specific value by the FADEC based on throttle position. Synchronization allows the FADEC to match the fan (N1) or the core (N2) speed of the two engines for noise reduction. Synchronization is selected by using the SYNCH switch on the engine control panel . The left engine is designated as the master engine and the right engine will be slaved to it.

For N_1 synchronization to be enabled, the right engine N_1 must be within 1.5% of the left engine N1.

For N_2 synchronization to be enabled, the right engine N_2 must be within 7.5% of the left engine N1.



SYNCH
Used to select engine synchronization.
- N1 – Matches the fan speed of the right engine to the fan speed of the left engine.
- OFF – Selects synchronization off.
- N2 – Matches the core speed of the right engine to the core speed of the left engine.

Engine / Miscellaneous Test Panel
Center Pedestal

Engine Synchronization Switch – Engine/Micscellaneous Test Panel
Figure 20–20–8

F. Engine Overspeed Protection

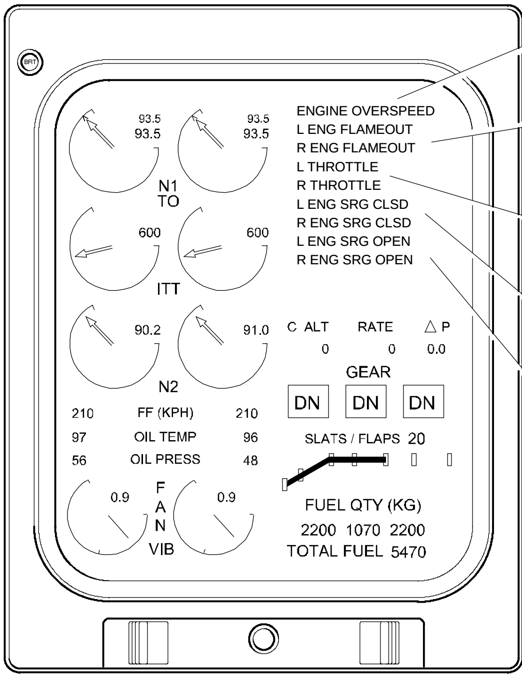
Engine overspeed protection is provided by the FADEC when the N2 exceeds 107%. When an overspeed condition is detected, the FADEC energizes the overspeed solenoid which closes the overspeed shutoff valve which causes the pressurizing and shutoff valve to close (see section 55 of this chapter). This stops fuel flow to the combustor and the engine flames out. The FADEC, detecting the flame out, turns the ignition ON. When the N2 speed decreases below the overspeed threshold, the overspeed solenoid is deenergized and fuel is readmitted to the engine for automatic relight.

The overspeed circuits of both FADEC channels are active regardless of which FADEC channel is in control. The FADEC will also close the pressurizing and shutoff valve if three or more overspeed conditions have been detected within 30 seconds.

G. Engine N2 Indications When Using Wing Anti–Ice

Under certain flight conditions, when the engines are operating at idle, the engines may not be able to provide sufficient bleed air flow to the wing anti–ice system

When the wing anti–ice is selected ON, the FADEC will provide a signal (based on ambient conditions) to the N2 indicators which will display a partial white band below the normal green band. Maintaining the N2 in the green operating range will ensure sufficient bleed air flow is available to the wing anti–ice system. If the N2 decreases into the white range, the N2 pointers and digital indications will turn white and the L (R) WING A/1 caution message may be displayed momentarily until the N2 is increased back into the normal green range.



ENGINE OVERSPEED warning (red)
Indicates that N1 or N2 has exceeded redline for more than four seconds.

L or R ENG FLAMEOUT caution (amber)
Indicates flameout of respective engine, FADEC was not successful with re-light and thrust lever not at shut-off.

L or R THROTTLE caution (amber)
Indicates failure of respective thrust lever. FADEC will maintain last power level setting until approach.

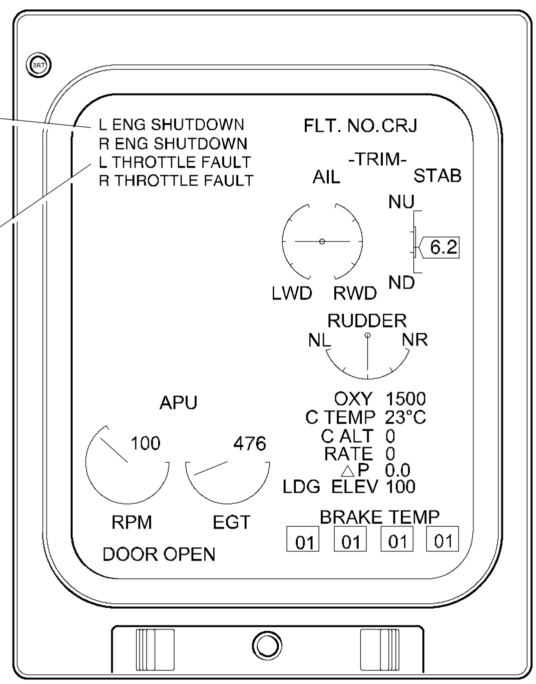
L or R ENG SRG CLSD caution (amber)
Indicates that respective operability bleed valve has failed closed.

L or R ENG SRG OPEN caution (amber)
Indicates that respective operability bleed valve has failed open.

Primary Page

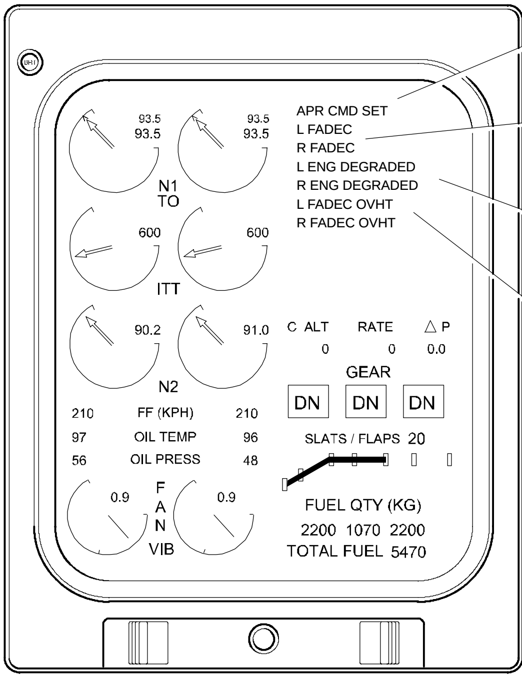
L or R ENG SHUTDOWN status (white)
Indicates that respective engine has shut down.

L or R THROTTLE FAULT status (white)
Indicates a fault in respective thrust lever.



Status Page

Thrust Control Engine Overspeed Warning <1001>
Figure 20−20−9



APR CMD SET caution (amber)
Indicates an uncommanded APR activation.

L or R FADEC caution (amber)
Indicates overspeed test failed or a combination of faults that may affect engine in-flight performance.

L or R ENG DEGRADED caution (amber)
Indicates that FADEC detected a combination of faults that may result in reduced engine control authority.

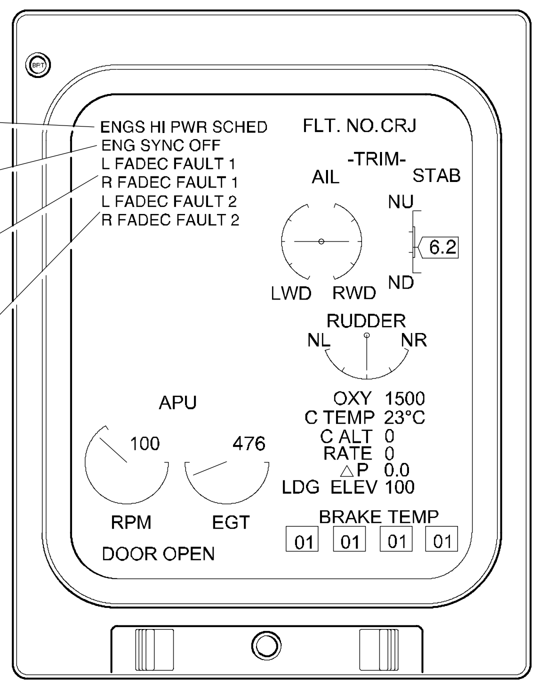
L or R FADEC OVHT caution (amber)
Indicates an overheat condition of respective FADEC.

ENGS HI PWR SCHED advisory (green)
Indicates that both engines are at a high power schedule.

ENG SYNC OFF status (white)
Indicates that engine synchronization manually selected off by flight crew.

L or R FADEC FAULT 1 status (white)
Indicates that one FADEC channel is inoperative or a combination of faults that may affect flight performance.

L or R FADEC FAULT 2 status (white)
Indicates a combination of faults that are less serious than the faults covered by a FAULT 1 status message.



Thrust Control APR CDM Set Caution <1001>
Figure 20−20−10

H. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Thrust Control	FADEC	FADEC R CH A	BATTERY BUS	5	B6	
		FADEC R CH B			B7	
		FADEC L CH A			B8	
		FADEC L CH B			B9	

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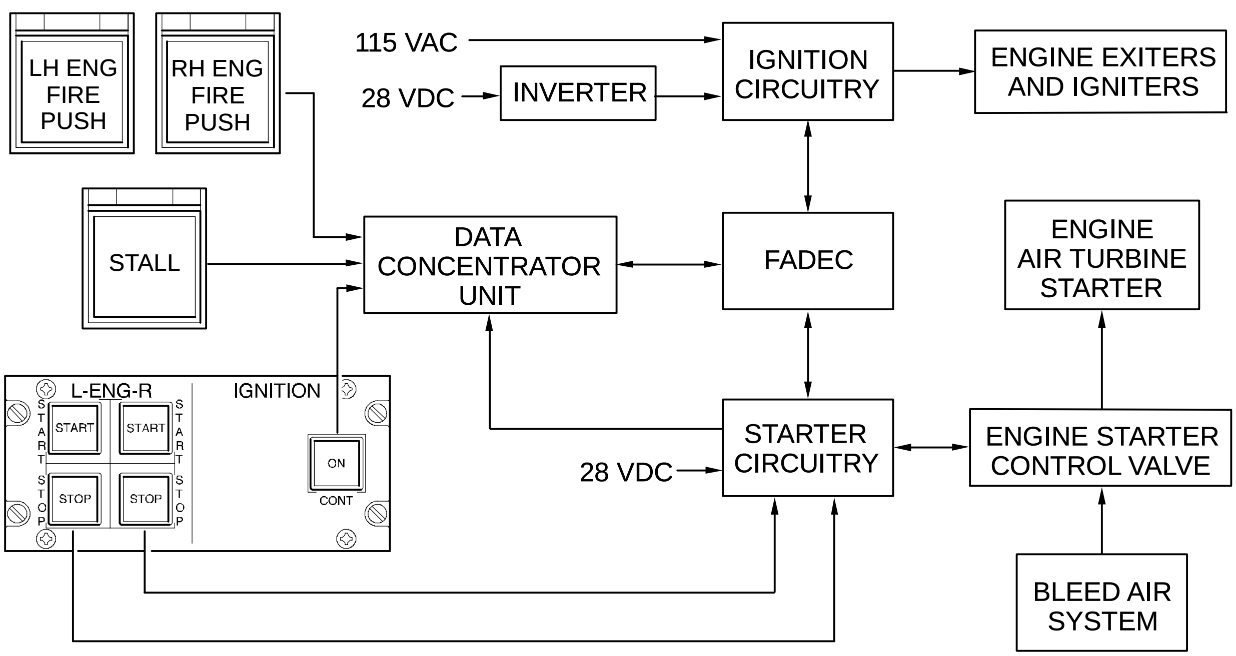
1. STARTING AND IGNITION SYSTEMS

The starting and ignition systems are controlled by the Full Authority Digital Electronic Control (FADEC).

A. Starting System

Pressurized air and DC electrical power are required for starter operation. The engines can be started using air from the auxiliary power unit, from a ground source, or by using cross bleed air from a running engine. Pneumatic pressure indications are shown on the EICAS ECS synoptic page. Engine starting is initiated by respective START switchlights on the Start/Ignition panel, located on the overhead panel. The start sequence may be terminated at any time by pressing the engine STOP switchlight.

When the engine START switchlight is pressed, the FADEC opens the starter control valve which allows pressure from the pneumatic manifold to rotate the starter. The starter drives the engine accessory gearbox, which in turn drives the engine N_2 core section. When the engine has accelerated to 20% N_2 rpm, the thrust lever is advanced to the idle position to turn the fuel on. The FADEC will then enable the ignition system for engine light-off. As the engine accelerates to the idle speed condition, the starter will cut-out at 50% N_2 rpm.



Starting and Ignition Systems Block Diagram
Figure 20-30-1

B. Ignition System

The engine ignition system provides high–energy electrical sparking to ignite the fuel/air mixture in the combustion chamber during start. The system also provides continuous ignition during icing conditions, in-flight restarts and/or when the aircraft approaches a high angle of attack (stall).

Each engine has two independently controlled AC ignition systems. Each system (A and B) consists of two ignition exciters and two igniter plugs. Ignition system A is powered by the AC essential bus and ignition system B is powered from the battery bus through a static inverter. Each system supplies electrical power to fire a dedicated igniter in both engines. The ignition systems are automatically controlled by the FADEC but if required, can be manually activated by selecting the CONT switchlight on the Start/Ignition panel which will activate both ignition systems on both engines. The engines are normally started using only one of the systems. Logic within the FADEC causes the ignition system to alternate between A and B system on each successive start.

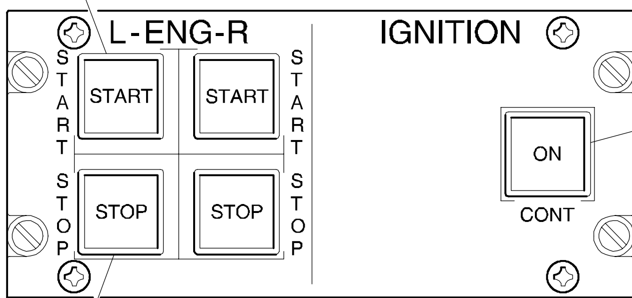
During engine start, if the FADEC senses a failed ignitor it will automatically switch to the other ignitor after a 15 second time delay and a L or R IGN A or B FAULT status message will be posted on the EICAS status page.

NOTE

During start, if the throttle is selected to SHUT OFF or the STOP switchlight is pressed before the 15 second time delay has elapsed, the IGN FAULT status message will not be posted on the EICAS.

In the event of an engine fire, each engine FIRE PUSH switchlight, on the glareshield, supplies a command signal to the FADEC to disable both ignition systems on the affected engine.

L ENG and R ENG START
Used to initiate engine start sequence.
- START (white) light indicates start is selected.



IGNITION CONT
Used to select continuous ignition of both ignitors on both engines.
- ON (white) light indicates continuous ignition is selected on.

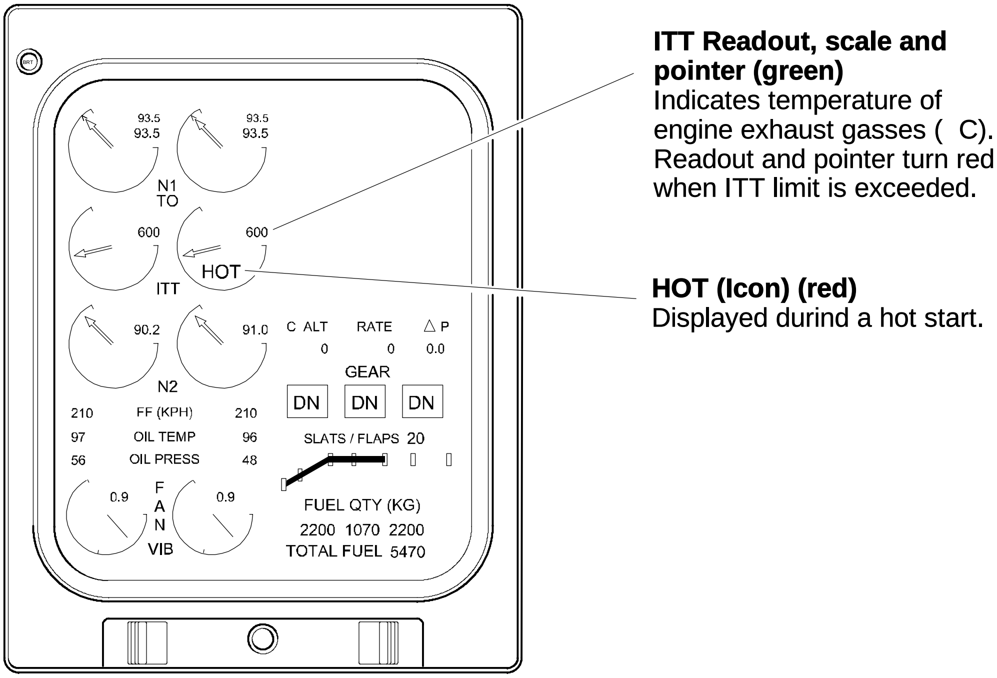
Engine Start/Ignition Panel
Overhead Panel

L ENG and R ENG STOP
Used to stop engine start sequence.
- STOP (white) light indicates stop is selected.

Starting and Ignition Systems – Controls
Figure 20–30–2

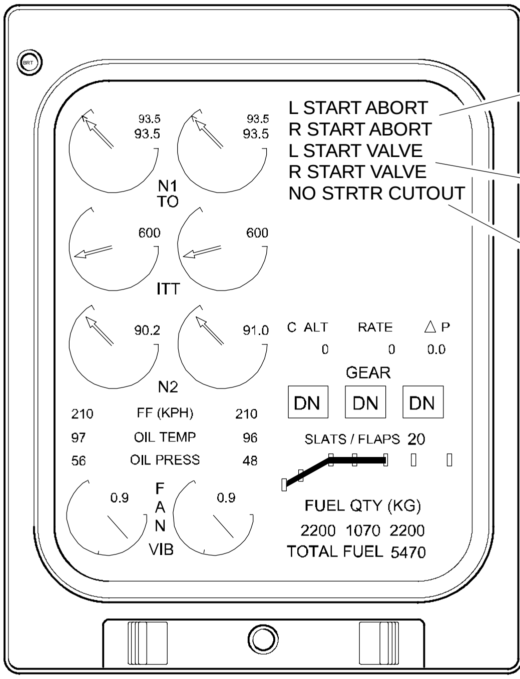
Start Protection

On the ground, start protection functions are automatically provided by the FADEC to prevent engine damage due to either hot or hung starts. In flight, the start protection functions are inhibited to allow in-flight emergency engine starts.



Primary Page

Primary Page ITT Readout Scale and Pointer <1001>
Figure 20–30–3



L or R START ABORT caution (amber)
Indicates a FADEC aborted start or an aborted start due to a hot or hung start (on ground only).

L or R START VALVE caution (amber)
Indicates that respective starter valve did not open when commanded.

NO STRTR CUTOUT caution (amber)
Indicates that starter valve is not closed with engine running.

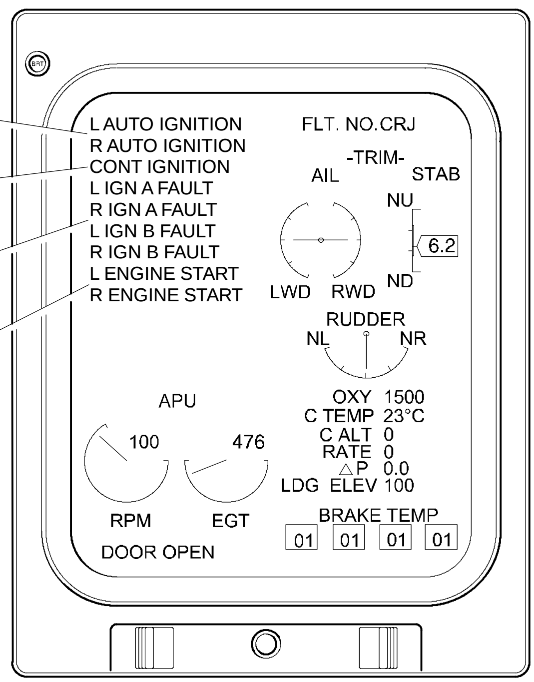
Primary Page

L or R AUTO IGNITION advisory (green)
Indicates that FADEC has selected ignition on.

CONT IGNITION status (white)
Indicates that all ignitors have been selected on.

L or R IGN A or B FAULT status (white)
Indicates a fault in the respective ignition driver.

L or R ENGINE START status (white)
Indicates that engine start has been selected.



Status Page

L or R Start Abort and Ignition EICAS Messages <1001>
Figure 20–30–4

C. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Starting	Control Valves	ENG START L	BATTERY BUS	1	M5	
		ENG START R			M4	
Ignition	Igniters	ENG IGN A	AC ESSENTIAL		U7	
		ENG IGN B	BATTERY BUS	5	B10	

1. OIL SYSTEM

Each engine has an independent lubrication supply system. Each system consists of an oil pump and an oil reservoir which is integral to the accessory gearbox. The pressure pump draws oil from the reservoir and supplies it to the various engine components for cooling and lubrication. A usable oil quantity of 7.2 quarts (6.8 liters) allows 36 hours of operation at the maximum allowable oil consumption rate of 0.05 U.S. gallons per hour (189 ml/hr).

Oil temperature and pressure indications are displayed on the EICAS primary page. Oil filter impending bypass and chip detector indications are provided on the engine fault panel in the aft equipment compartment.

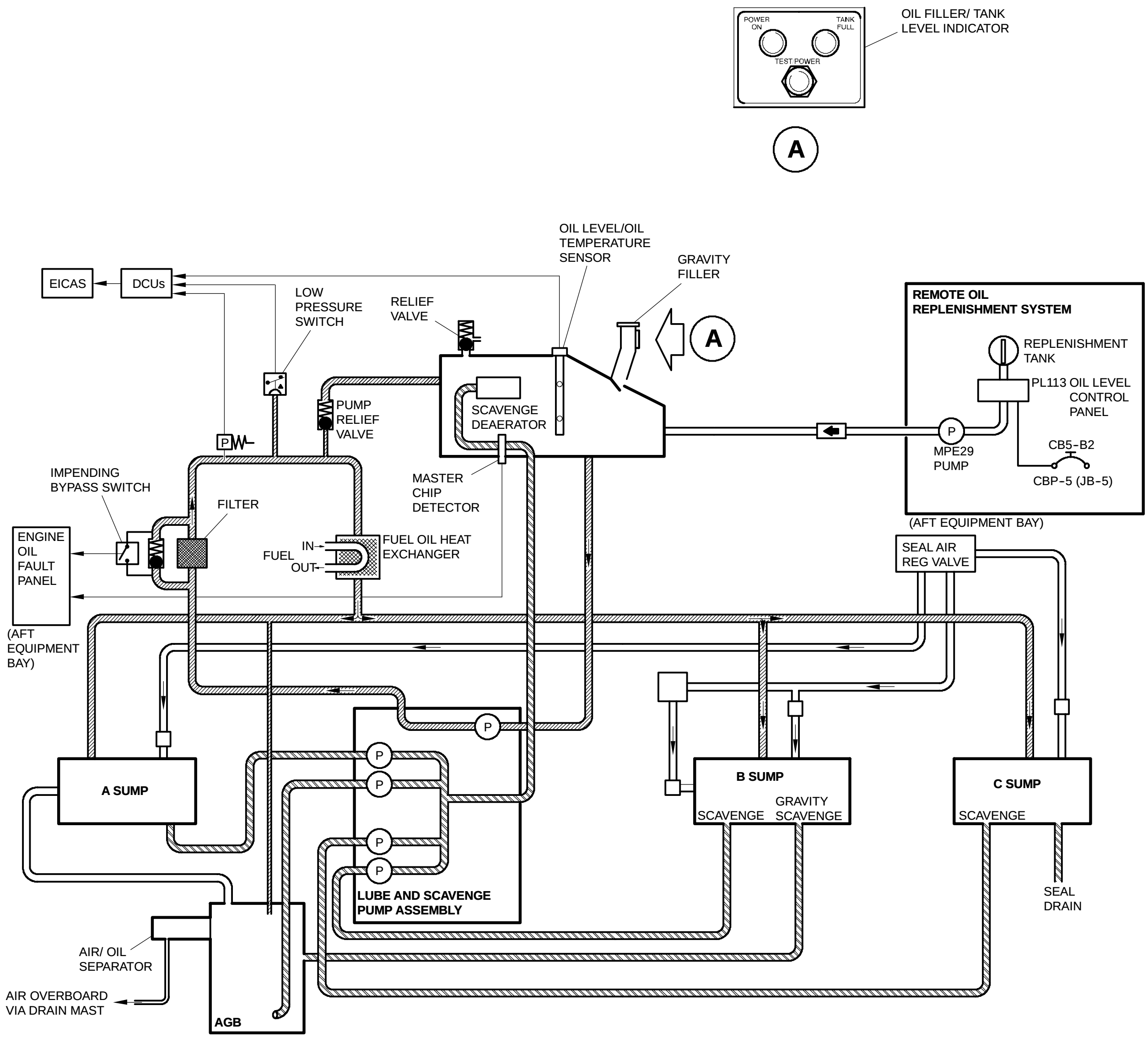
The lubrication system is pressurized by the main lube pump. The oil flows from the pump, passes through an oil filter and the oil/fuel heat exchanger. The oil then continues through the engine, for cooling and luricating, then to the engine sumps. Scavenge pumps return the oil to the reservoir after passing through a chip detector and de-aerator.

Sensors for the oil pressure indication and EICAS messages are located in the oil filter module mounted on the forward side of the oil tank. The chip detector also mounts on the accessory gearbox, in the scavenge oil return line.

During engine start, the oil pressure indications on the EICAS primary page are displayed with an analog gauge and a digital readout. When both engines are started and oil pressure is normal, the oil pressure gauges revert to N1 vibration gauges. The digital oil pressure indication remains.

Left and right engine oil tank quantities are shown on the EICAS MENU page.

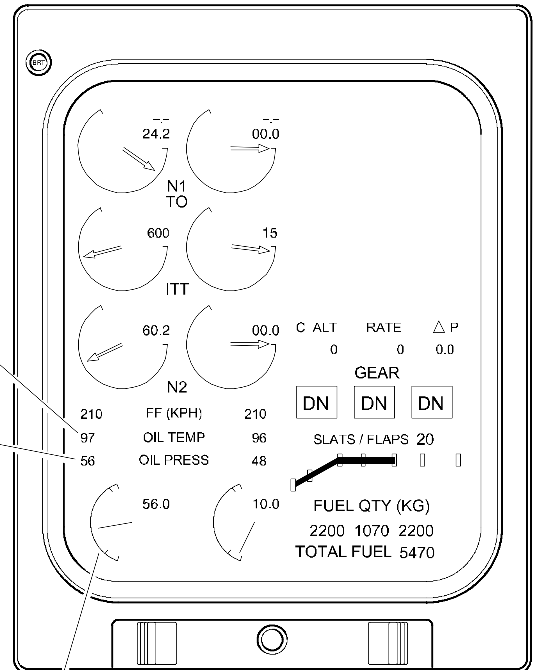
OIL LEVEL INDICATION AND DURATION TABLE		
ENGINE OIL LEVEL INDICATION, %		
STOPPED [1]	**RUNNING**	**DURATION OF AVAILABLE OIL UNTIL NEXT SERVICE, HOURS**
100%	77%	36 hrs
80%	57%	26 hrs
50%	27%	10 hrs (1 day)
40%	17%	5 hours (1 flight)
< 40% DO NOT DISPATCH	< 17% DO NOT DISPATCH	
28 % Do not operate, service the oil tank [1]	15% Complete the flight, monitor oil temp and pressure.	**NOTE:** There is no EICAS OIL LEVEL indication if the oil quantity is less than 15%.
[1] The engine oil level check should be accomplished within 3 minutes to 1 hour after engine shutdown.		



Oil Distribution System – Schematic <1213>
Figure 20–40–1

OIL TEMP
Displays engine oil temperature (in 1 °C increments).
- Green, -40 to 155 °C
- Amber, 156 to 163 °C
- Red, greater than 163 °C
- Amber dashes - Invalid data.

OIL PRESS
Displays engine oil pressure (in 1 psi increments).
- Red, 0 to 24 psi
- Green, 25 to 116 psi
- Amber, >116 psi
- Amber dashes - Invalid data.



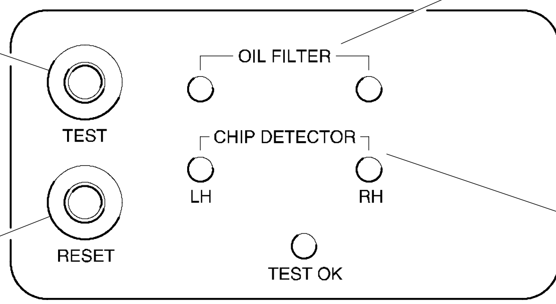
Primary Page

Oil Pressure Gauges
Indicates engine oil pressure. Replaced by FAN VIB gauges when both engines are running and oil pressure is above 24 psi.

Oil System – Oil Temp and Pressure EICAS Indications <1001>
Figure 20–40–2

TEST
Used to test indicating system. Oil filter and chip detector, LED indicators, indicate that the system is operational. LEDs remain ON until RESET is pressed.

OIL FILTER
- Indicator OFF – Respective oil filter operating normally.
- Indicator ON – Respective oil filter impending bypass is indicated.



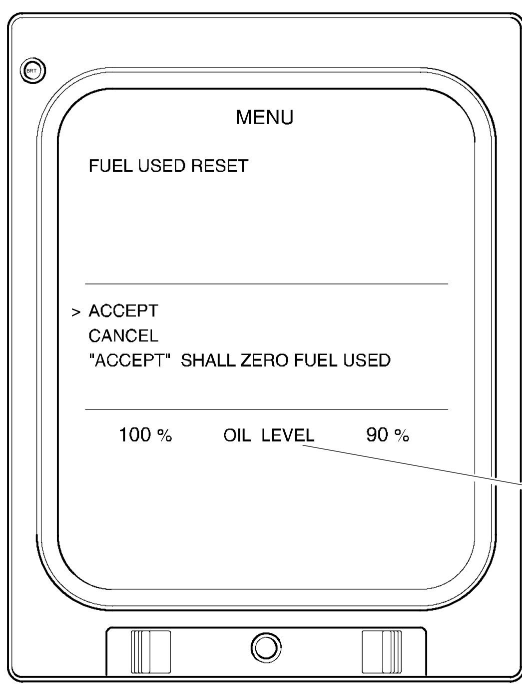
RESET
Used to reset oil filter and chip detect LEDs to normal indication.

CHIP DETECTOR
- Indicator OFF – Respective oil system operating normally.
- Indicator ON – Chip detection on the detection on the respective side is indicated.

Engine Oil Fault Panel
Aft Equipment Bay

NOTE

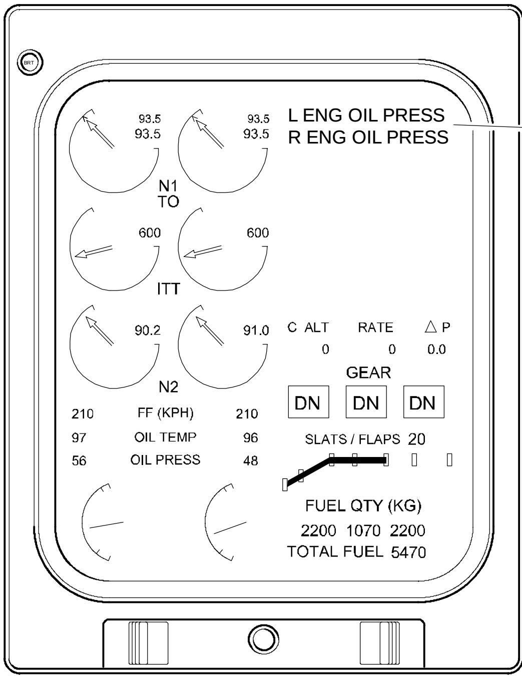
Do not reset detector flags unless instructed by maintenance or unless conducting maintenance functional check.



OIL LEVEL
Displays engine oil level as a percent of the maximum quantity.

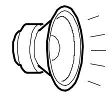
Menu Page

Oil System – Oil Test and Oil Levels Controls and Indications
Figure 20–40–3



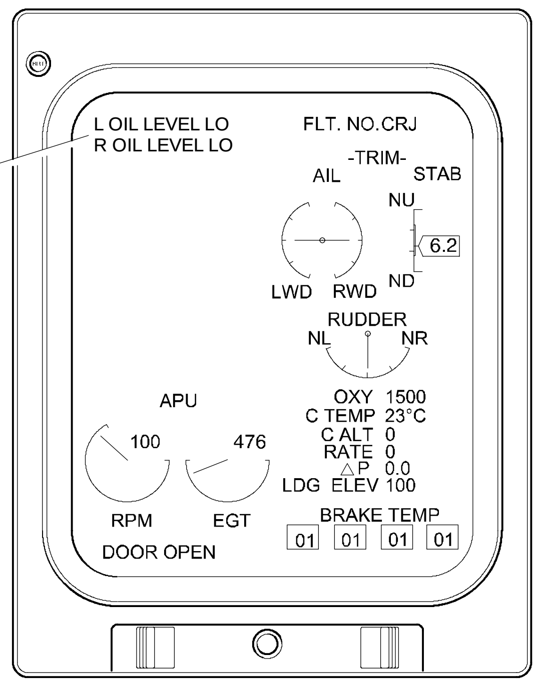
Primary Page

L or R ENG OIL PRESS warning (red)
Indicates oil pressure is less than 25 psi.



ENGINE OIL

L or R OIL LEVEL LO status (white)
Indicates oil level is below 57% with engine running or below 80% with engine not running.



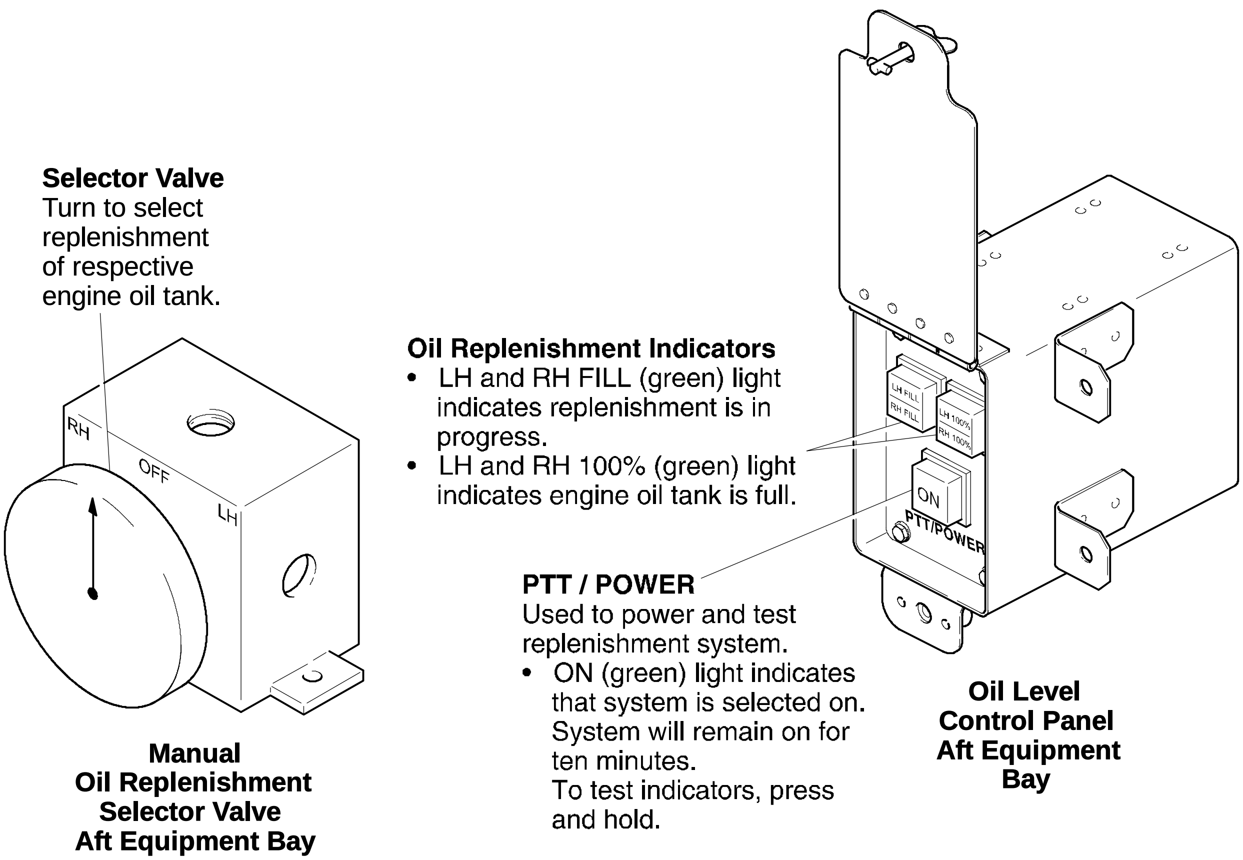
Status Page

Oil System - EICAS Indications 1001
Figure 20−40−4

A. Oil Replenishing System

The engine oil reservoir is manually replenished through an oil fill cap on the top of each engine. Access to the fill cap is gained by opening the engine cowlings. There is an oil level indicator adjacent to the fill cap.

The engine oil replenishment system is located in the aft equipment bay. The system enables the engine oil tanks to be filled remotely. The system includes a storage tank with sight glass level indicator, an electric pump, a control panel and an engine selector valve. <1213>



NOTE

The engine oil level check should be accomplished within 3 minutes to 1 hour after engine shutdown. The engines must be dry motored if the replinishment period is exceeded.
Do not allow more than 1.9 liters (2 U.S. quarts) to flow into the engine without dry motoring the engine for at least 30 seconds (prior to adding more oil).

Oil Replenishment System <1213>
Figure 20-40-5

B. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Oil System	Pressure	L ENG OIL PRESS	BATTERY BUS	1	M1	
		R ENG OIL PRESS	DC ESSENTIAL	2	S7	
	Indication	ENG OIL IND	APU BATTERY DIRECT	5	B2	
	Replenishment <1213>	ENG OIL REPL			B3	

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1. FUEL SYSTEM

Fuel from the collector tanks is supplied to the respective engine fuel pump unit by a main ejector or an electric booster pump, through the engine fuel feed shutoff valve.

Engine fuel distribution is controlled by a gearbox-driven fuel pump unit and a fuel metering unit. Pressurized fuel from the centrifugal pump goes through the heat exchanger, a filter then back to the fuel pump unit. The fuel/oil heat exchanger is used to cool engine oil and heat the combustion fuel.

The fuel pressure is then increased by the primary pump then sent to the fuel metering unit, operability bleed valve, VG actuator circuit and the overspeed circuit. Metered fuel is then supplied to the combustion chamber in relation to commands from the Full Authority Digital Electronic Control (FADEC). The FADEC receives input signals from thrust levers, air temperature and pressure altitude data from the air data system and information from internal engine sensors. The FADEC uses the information to regulate the fuel flow to the engine to obtain the desired engine thrust.

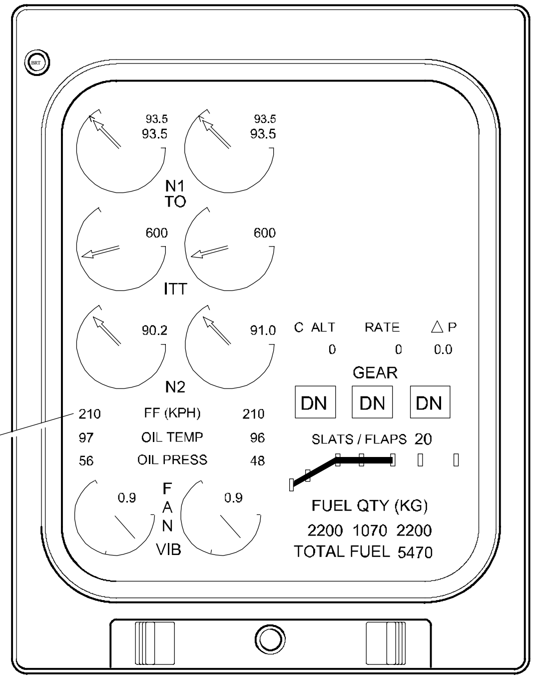
Eighteen dual-orifice (primary and secondary) fuel injectors are installed on each engine. The primary orifice is used to spray fuel into the combustor at low power settings. At power settings above idle, the secondary orifice is opened and both the primary and secondary orifices then spray fuel into the combustor.

Combustion fuel can be shut off by moving the thrust lever to the shutoff position or by selecting the engine fire push switch. Moving the thrust lever to the shutoff position, closes the shutoff valve of the fuel metering unit. The engine fire push switch closes the engine fuel feed shutoff valve.

Fuel is also used to control and actuate the operability bleed valve and variable geometry linkages for engine compressor surge and stall protection. Fuel is used to actuate and lubricate components within the fuel system.

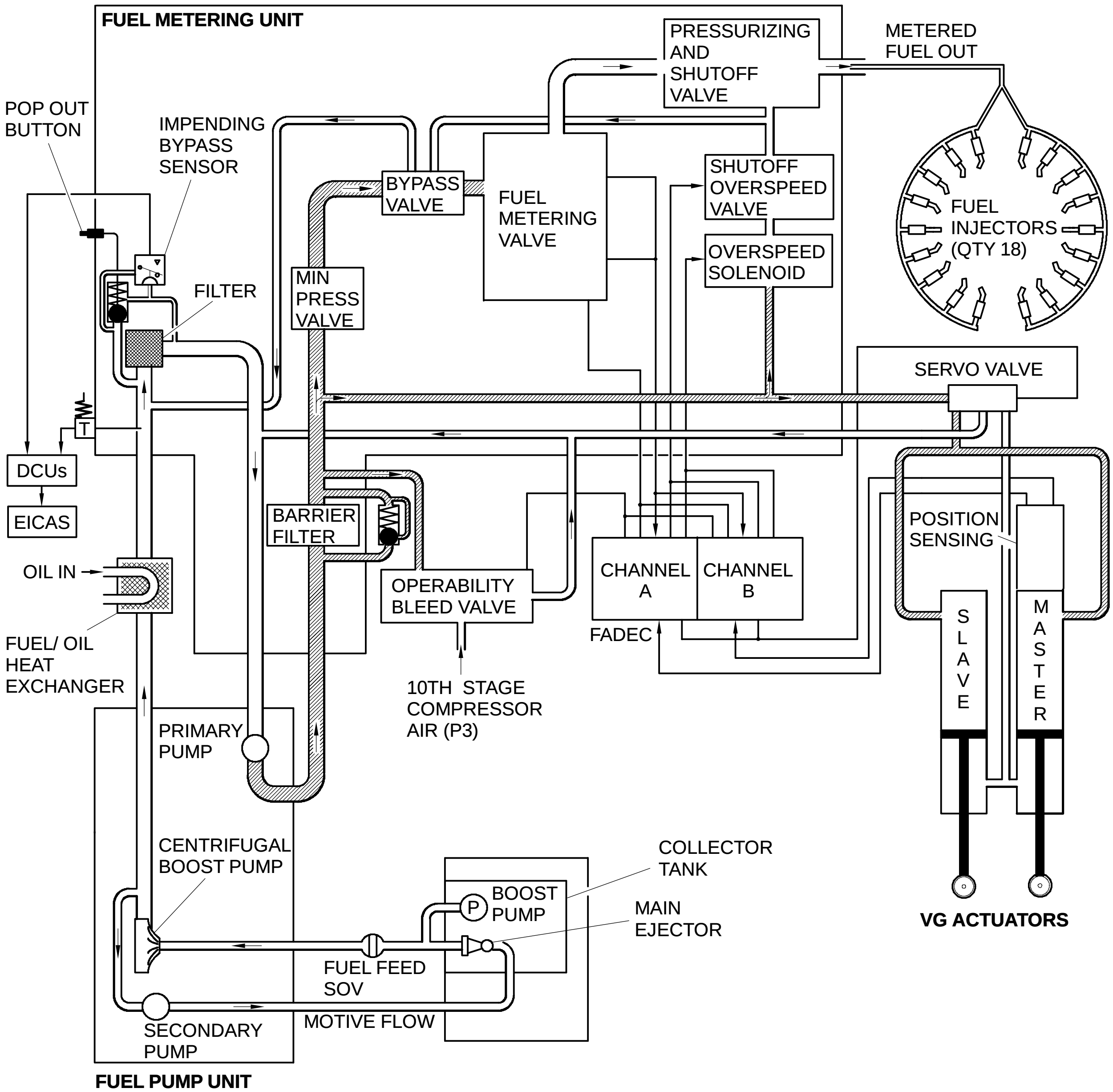
Fuel not used for combustion is returned to the fuel system to provide motive flow for the main and scavenge ejectors in the fuel tanks.

FF (green)
Indicates rate of fuel flow. Amber dashes indicates invalid data.



Primary Page

Fuel system – EICAS Indications <1001>
Figure 20–50–1



Fuel Distribution System Schematic
Figure 20–50–2

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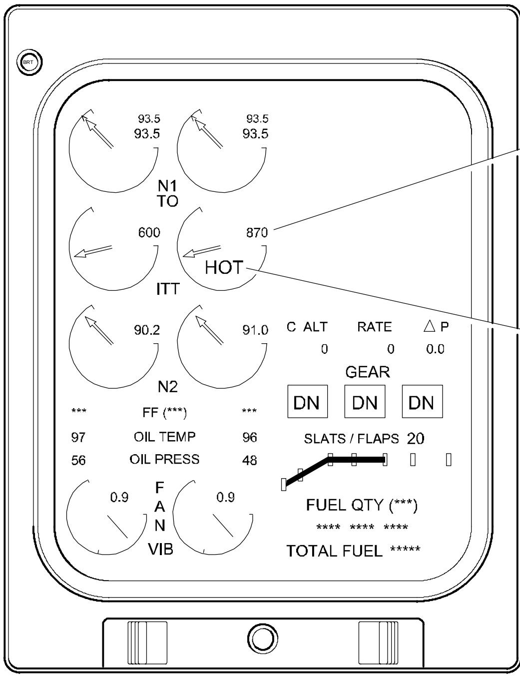
1. INTERTURBINE TEMPERATURE (ITT) MONITORING

The engine ITT is measured by five probes mounted around the engine turbine section. The probes measure the gas path temperature at the exit of the high-pressure turbine (HPT). Each probe generates a voltage signal which is sent to the FADEC where the signals are averaged, converted to a digital output signal and then sent to the DCUs for the ITT display on the EICAS primary page.

The FADEC will detect ITT exceedances into the different areas of the exceedance chart (refer to figure 20-55-2) based on the tracking time verses temperature subsequent to an initial exceedance of 1006°C. The FADEC will supply an input to the EICAS (status message) to indicate each type of exceedance. Each eceedance into the B1 area is announciated for 4 seconds. Since the ITT must exceed the ITT Redline in order to be detected as an area C exceedance, it is possible to encounter multiple area B1 exceedances in one transit if the ITT remains elevated.

If there is an ITT exceedance into area B or C, the respective ITT EXCEED status message will be latched for the remainder of the flight. The message will be removed on engine shutdown when the N2 decreases below 2%.



ITT Readout, scale and pointer (green)
Indicates temperature of engine exhaust gases (°C). Readout and pointer turn red when ITT limit is exceeded.

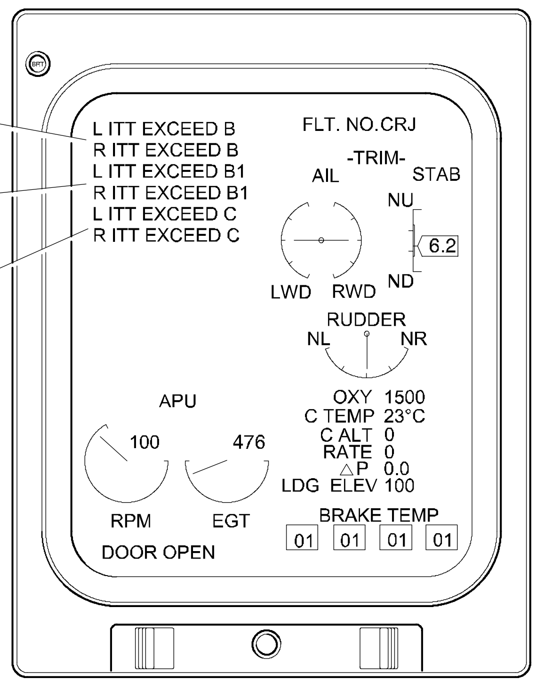
HOT (Icon) (red)
Displayed during a hot start.
When the ITT exceeds 1,460°F. (810°C)
The HOT icon remains until
ITT decreases below 289°F. (143°C)

Primary Page

L or R ITT EXCEED B status (white)
Indicates that category B ITT exceedance has occurred.

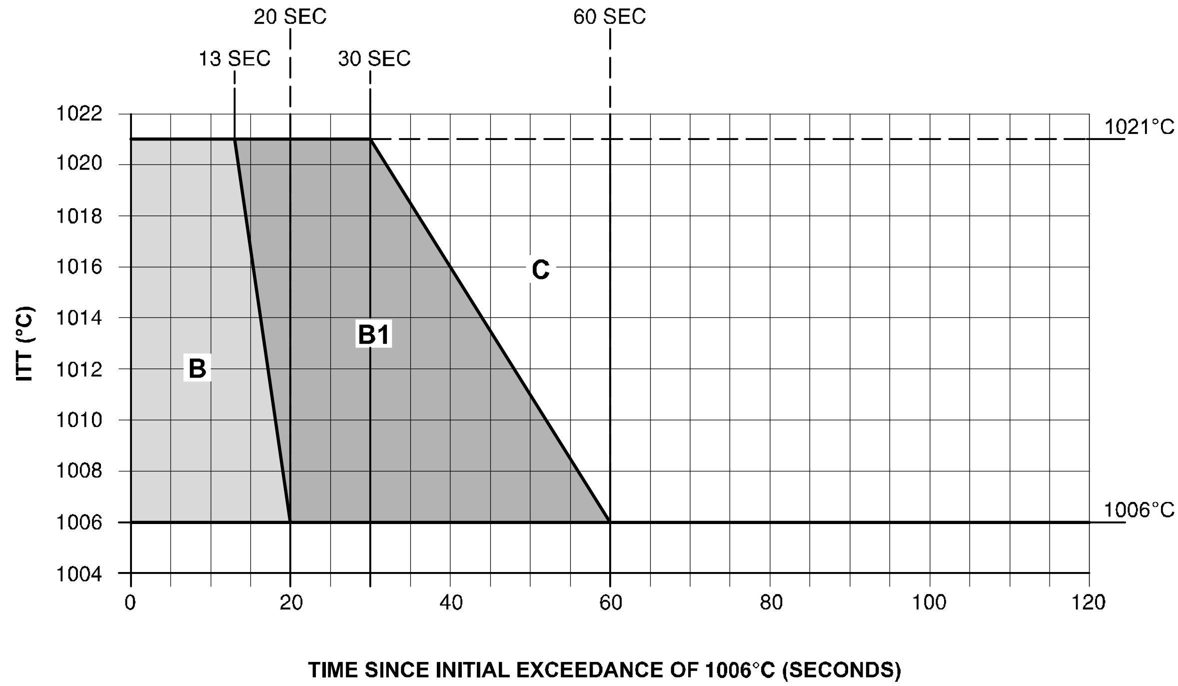
L or R ITT EXCEED B1 status (white)
Indicates that category B1 ITT exceedance has occurred.

L or R ITT EXCEED C status (white)
Indicates that category C ITT exceedance has occurred.



Status Page

Interturbine Temperature (ITT) Monitoring EICAS Indications
Figure 20–55–1



ITT Exceedance Detection

ITT Exceedance Detection
Figure 20−55−2

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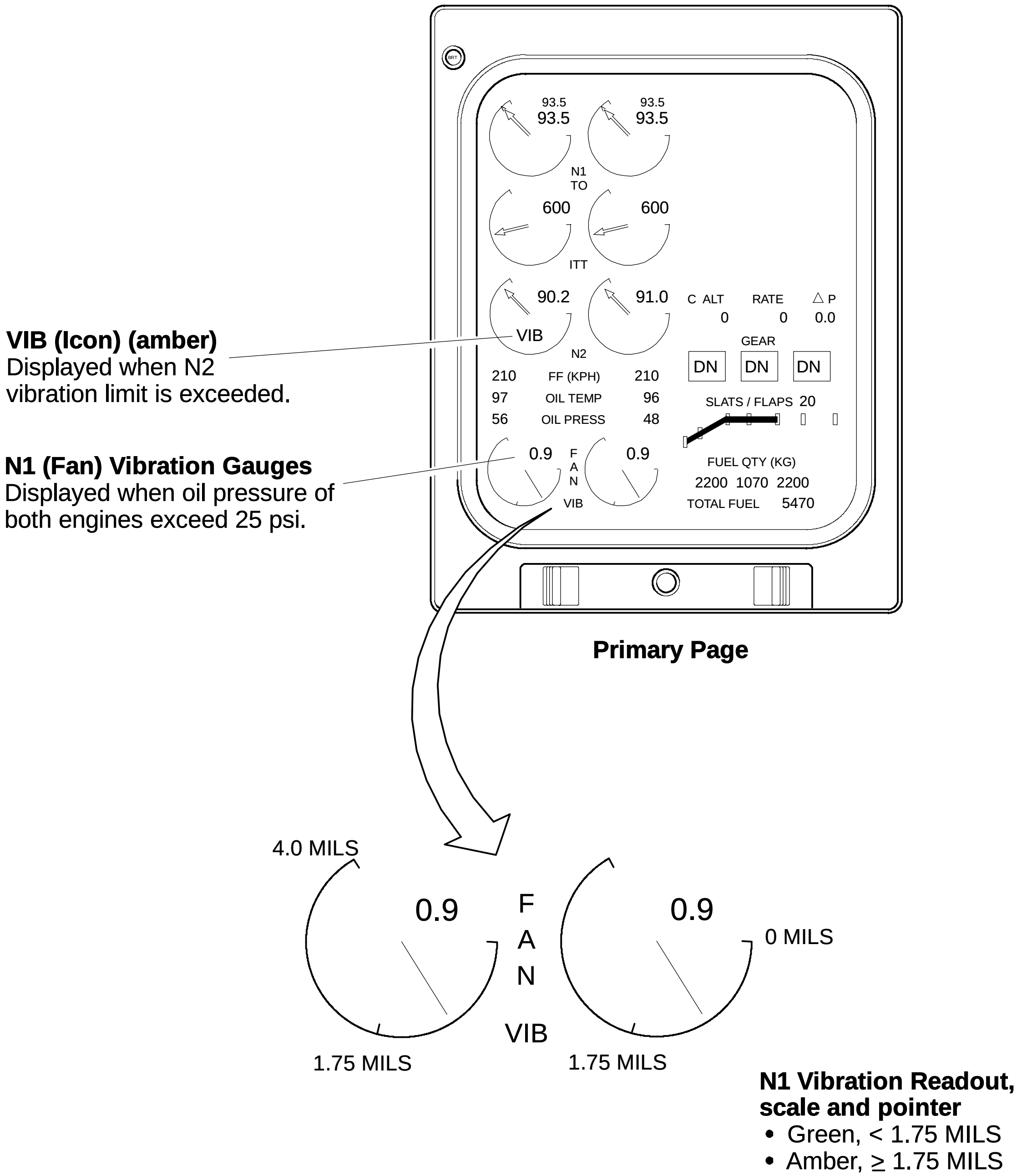
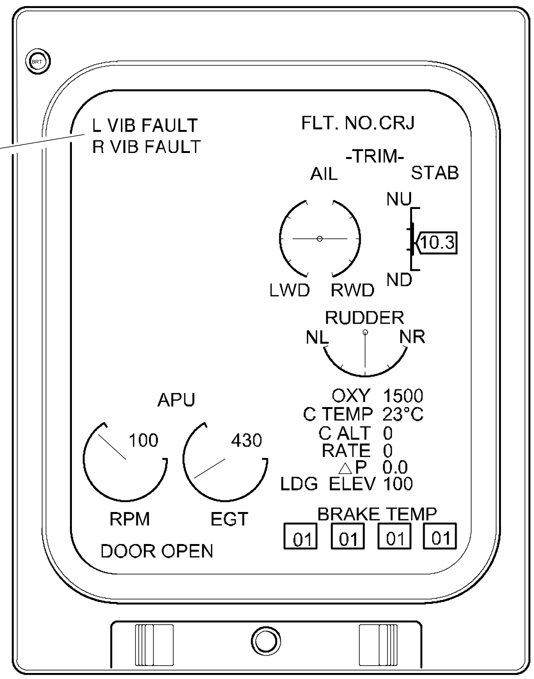
1. VIBRATION MONITORING

An engine vibration monitoring computer, mounted in the avionics compartment, monitors the vibration levels in each engine. Each engine provides the computer with signals from an accelerometer, an N1 fan speed sensor and an N2 core speed sensor. The computer processes the signals and provides a vibration velocity amplitude signal to the EICAS for display on the primary page.



Vibration Monitoring VIB Icon <1001>
Figure 20–60–1

L or R VIB FAULT status (white)
Indicates that respective engine N1 or N2 speed sensor has failed.



Status Page

Vibration Monitoring
Figure 20-60-2

A. System Circuit Breakers

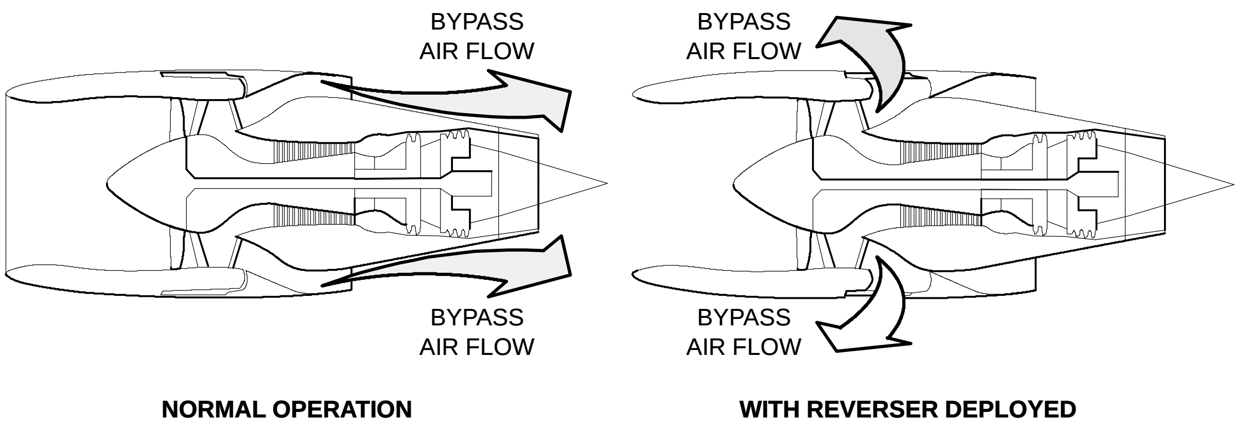
SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Vibration Monitor	Computer	ENG VIB MON	AC BUS 1	1	C7	

1. REVERSE THRUST

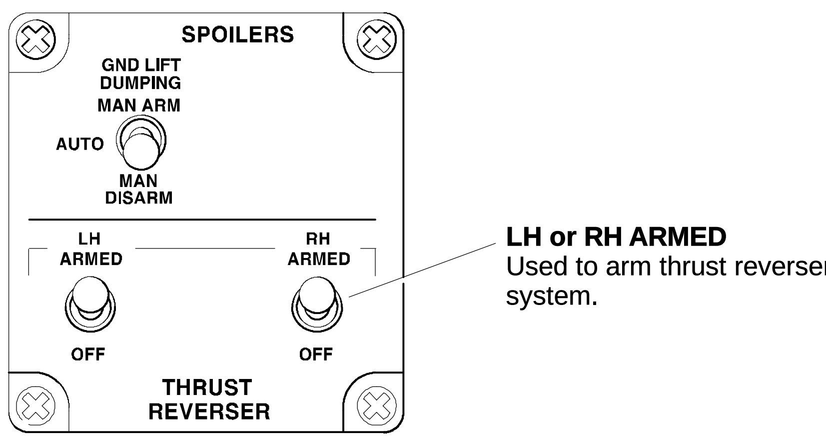
Reverse thrust assists in stopping the aircraft during landing rollout or during a rejected take-off.

Reverse thrust is accomplished by hydraulic actuators moving the engine translating cowl assemblies aft to block the rearward discharge of fan bypass air. As the translating cowls move rearward, cascade vanes are uncovered to redirect the fan bypass air forward.

The thrust reverser system is armed using the thrust reverser LH and RH switches on the THRUST REVERSER panel and controlled using the thrust reverser levers on the throttle quadrant.



Reverse Thrust – General
Figure 20–70–1



Thrust Reverser Subpanel
Center pedestal

Reverse Thrust – Thrust Reverser Subpanel
Figure 20–70–2

Thrust Reverser Levers
With thrust levers at IDLE, pulling on thrust reverser levers deploys thrust reversers if the following conditions are met:

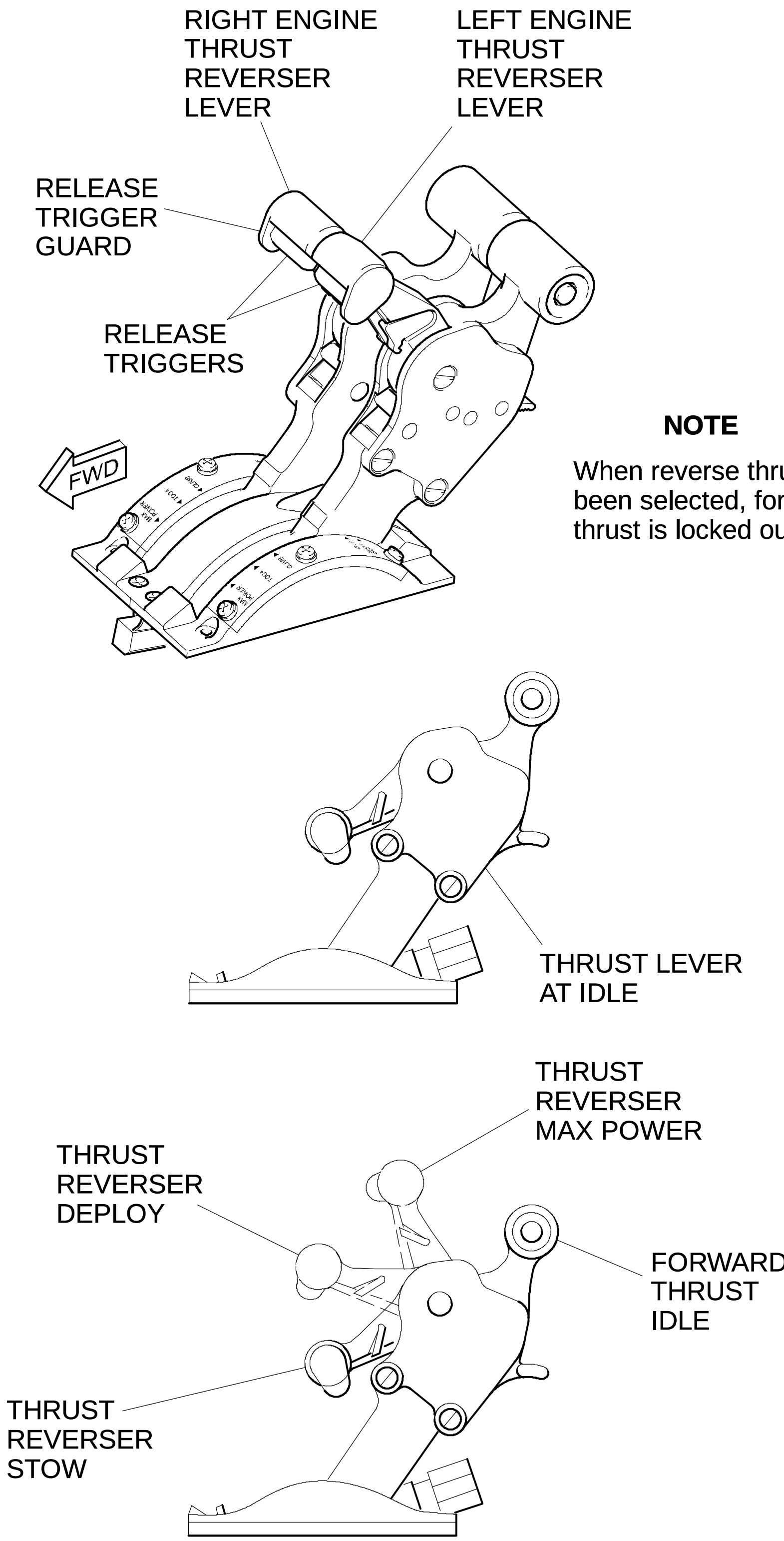
- Thrust reverser system is armed.
- Aircraft is on ground or wheel spin–up exceeds 20 kt.

Thrust lever solenoids prevent thrust reverser lever movement beyond the deploy position until reverser assemblies are fully deployed.

Once reversers are fully deployed, thrust reverser levers regulate reverse thrust from reverse idle to maximum reverse power.

Returning thrust reverser levers to forward IDLE (fully down) stows reversers.

Once reversers are stowed, thrust levers can be moved forward to increase thrust.



NOTE

When reverse thrust has been selected, forward thrust is locked out.

Reverse Thrust – Thrust Reverser Levers
Figure 20–70–3

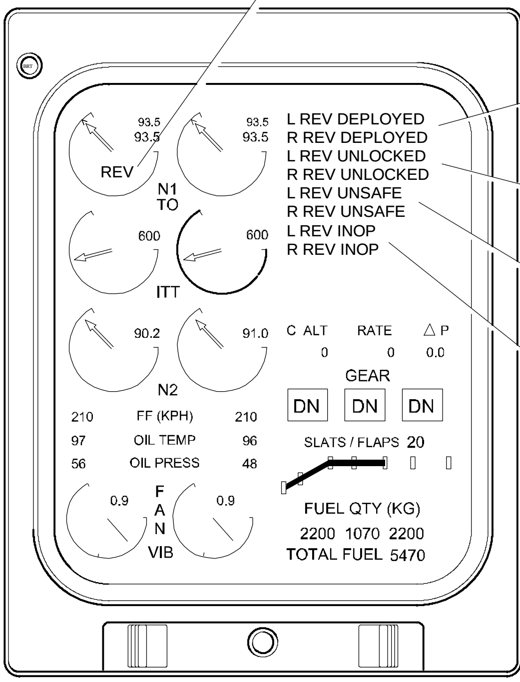
REV (Icon)
Red – Uncommanded thrust reverser deployment.
Amber – Thrust reverser unlocked.
Green – Thrust reverser deployed.

L or R REV DEPLOYED warning (red)
Indicates that respective thrust reverser has not been commanded to deploy and is not stowed and locked.

L or R REV UNLOCKED caution (amber)
Indicates that respective thrust reverser has not been armed and is unlocked.

L or R REV UNSAFE caution (amber)
Indicates respective thrust reverser is unsafe to arm in flight.

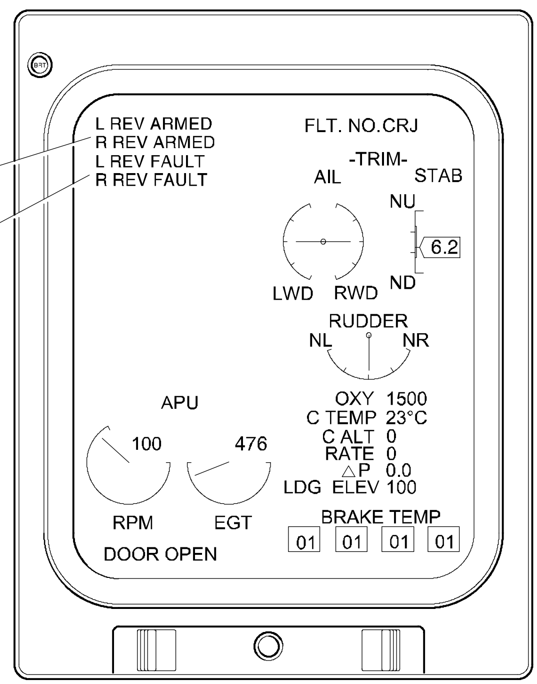
L or R REV INOP caution (amber)
Indicates that respective thrust reverser has been armed and is not operational.



Primary Page

L or R REV ARMED advisory (green)
Indicates that respective thrust reverser has armed.

L or R REV FAULT status (white)
Indicates a fault in respective thrust reverser system.



Status Page

Reverse Thrust – EICAS Indications <1001>
Figure 20–70–4

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Reverse Thrust	Actuators	THRUST REV 1	DC ESSENTIAL	2	S5	
		THRUST REV 2			S6	

CHAPTER 21 – WATER AND WASTE SYSTEMS

Page

LIST OF ILLUSTRATIONS

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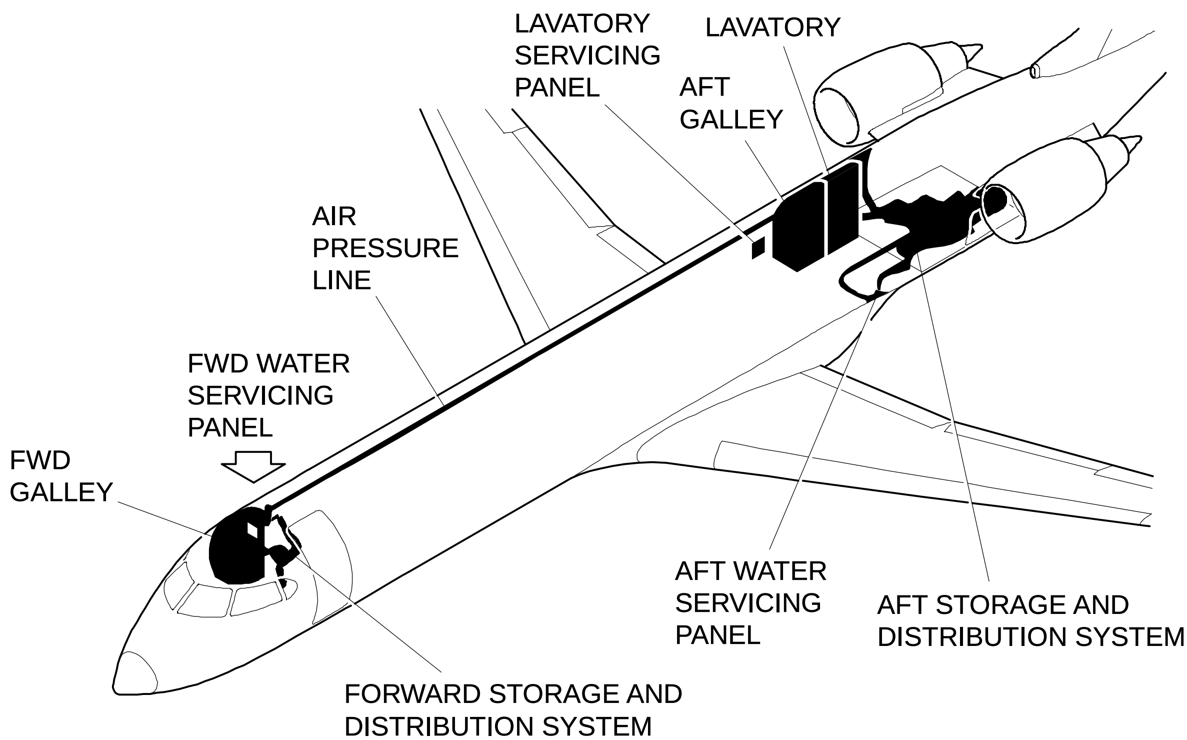
1. INTRODUCTION

The water and waste systems include potable water, lavatory waste equipment and controls.

Two lavatory waste systems are provided to drain, rinse, prime and flush the toilets. Each toilet has a holding tank containing flushing fluid. Each system is serviced at external servicing panels located on the external fuselage.

Two potable water systems store and supply potable water to the galley and lavatories. The forward water system supplies potable water to the water dispenser and coffee maker in the galley and to the forward lavatory sink. The aft water system supplies wash water to the aft lavatory sink. Both water systems are controlled from a single control panel located in the galley. Each water system has a servicing panel provided on the external fuselage to permit filling and draining of the potable water systems.



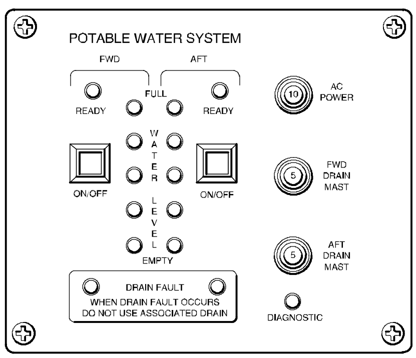
Water and Waste – General
Figure 21–10–1

1. POTABLE WATER SYSTEM

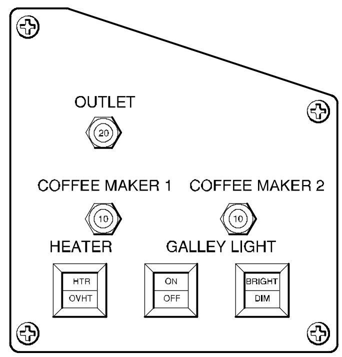
The potable water system stores, supplies, and controls the flow of water to the galley and lavatories. Potable water for the beverage maker, water dispenser and wash basin is stored in forward and aft pressurized water tanks. The systems are controlled from a single potable water system controller/panel in the forward galley The forward and aft systems are independent, except for a common air supply for system pressurization.

Normally, source air to pressurize the water systems is regulated bleed air from the environmental control system. In the event that supplied bleed air is not available, a back-up compressor is used to provide pressurized air to the system.

Water tank level indicators for both systems are located on the galley control panel. Water levels of empty, 1/4, 1/2, 3/4 and full are indicated. Level sensors are installed at each level in both tanks. When the water level falls below the empty sensor, the empty indicator changes from green to amber and all other level indicators are off.



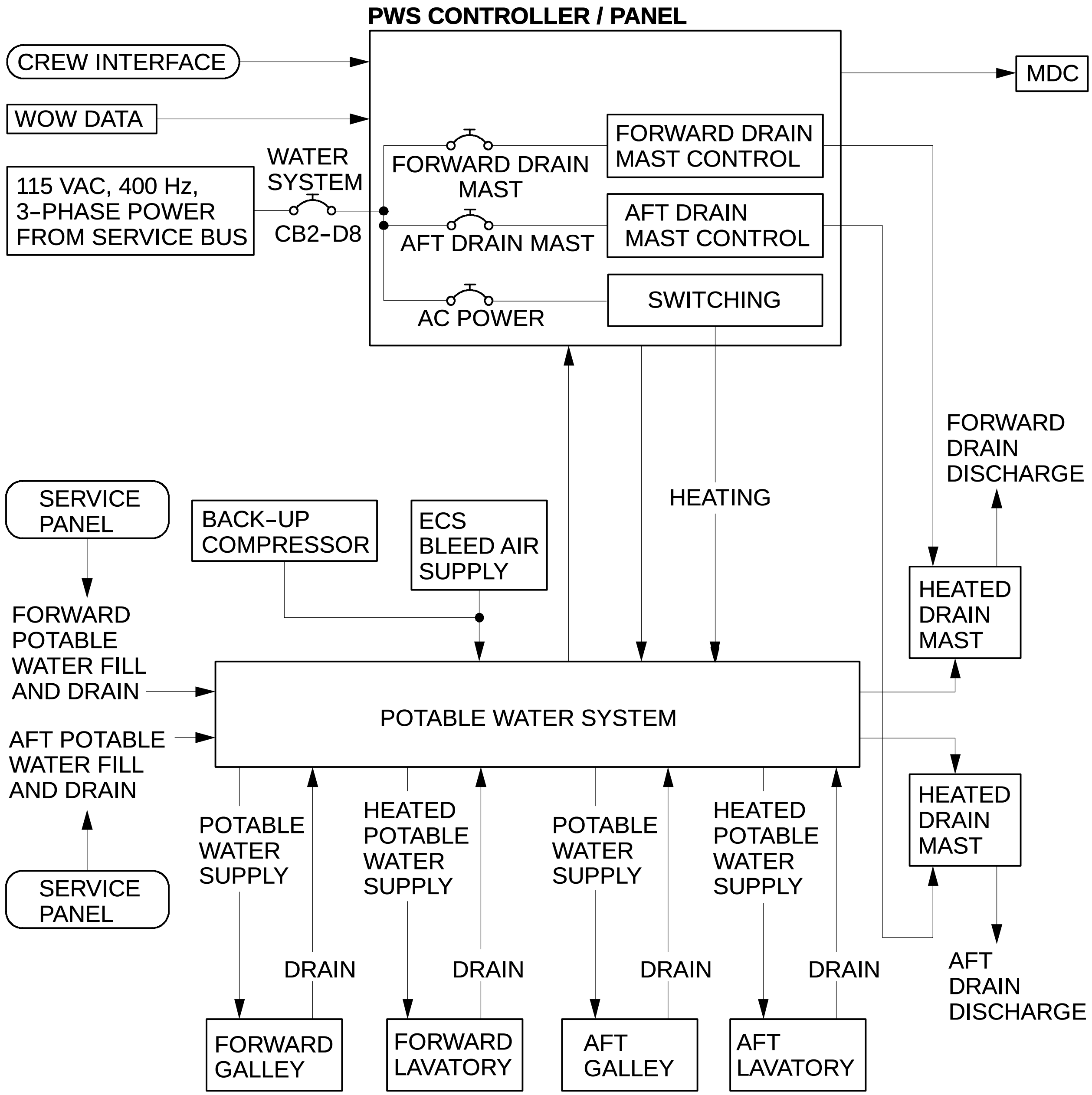
Potable Wash/Water System Controller Panel



Portable Wash/Water System – Controls
Figure 21–20–1

Electrical power to the forward and aft systems is controlled by ON/OFF switchlights on the galley control panel. This provides power to operate the electrical heaters, compressor and level indication system. Wash basin water is heated to 25 ±5°C (68 – 86°F) by a water heater in each lavatory cabinet.

The systems provide drainage of used water overboard through drain masts on the bottom of the fuselage. All components likely to freeze are heated and/or insulated to maintain temperatures above freezing. An electronic controller monitors temperatures by zone and controls heater temperatures to prevent ice formation. The drain masts are connected directly to the AC service bus. Each drain mast contains a thermal fuse for overheat protection which removes power when the temperature exceeds a preset point. Power can be removed from the drain masts by opening the circuit breakers on the potable water system control panel or by removing power from the AC service bus. The controller uses weight-on-wheels information to determine the power application to the drain masts. When the airplane is on the ground, power to the drain masts is reduced.



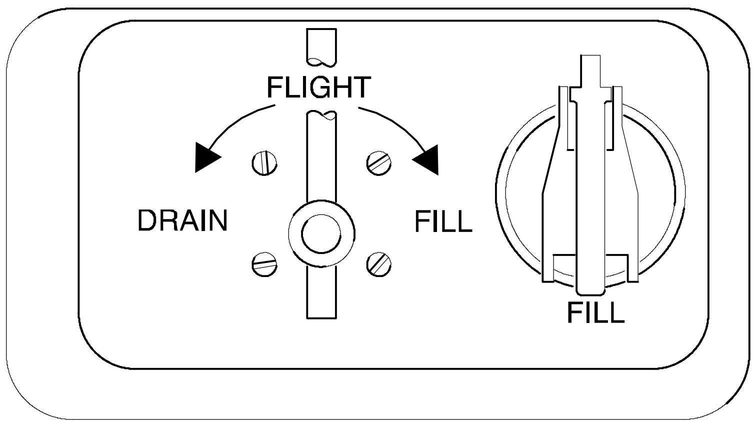
Potable Water System – Block Schematic
Figure 21–20–2

The diagnostic light, on the galley control panel, will come on when the potable wash/water system controller panel detects a fault in the system. It will remain on until the fault is corrected. Drain mast faults are indicated by separate lights to identify the failed mast.

Each potable water system has a service panel located on the exterior fuselage. The forward service panel is located on the right forward lower side of the fuselage. The aft service panel is located on the left side under a panel in the wing root fairing. Each service panel has a fill adaptor and a control handle.

When the control handle is placed in the FILL position, water can be pumped into the system using the fill adapter. When the tank is full, water flows out through the overboard drain mast. The control handle must be returned to the FLIGHT position after filling is complete or the service panel door will not close. System inlet fill pressure is limited to 50 psig.

When the control handle is placed in the DRAIN position, the potable water is drained from the tanks through the drain mast.



Potable Water Service Panel
Exterior Lower Fuselage

Portable Water System Service Panel
Figure 21–20–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Potable Water System	Controller	WATER SYSTEM	AC SERVICE	2	D8	

1. LAVATORY WASTE SYSTEM

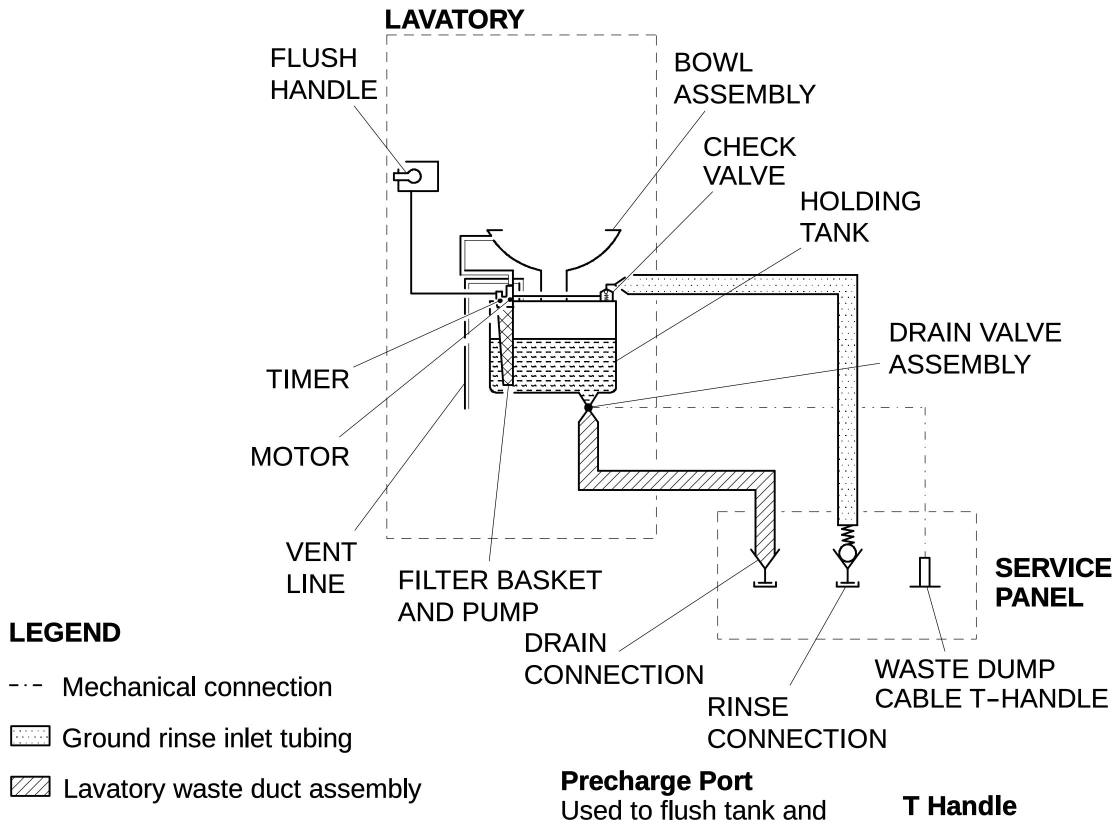
The lavatory waste system provides a means of flushing the toilet and holding waste material from the forward and aft lavatory toilets. Each system consists of a seat and bowl assembly, tank assembly, flush handle and service panel. The tank assembly is self-contained and consists of a electric pump, timer and filter. The tank holds the deodorant flushing solution and waste material until removed by ground servicing personnel.

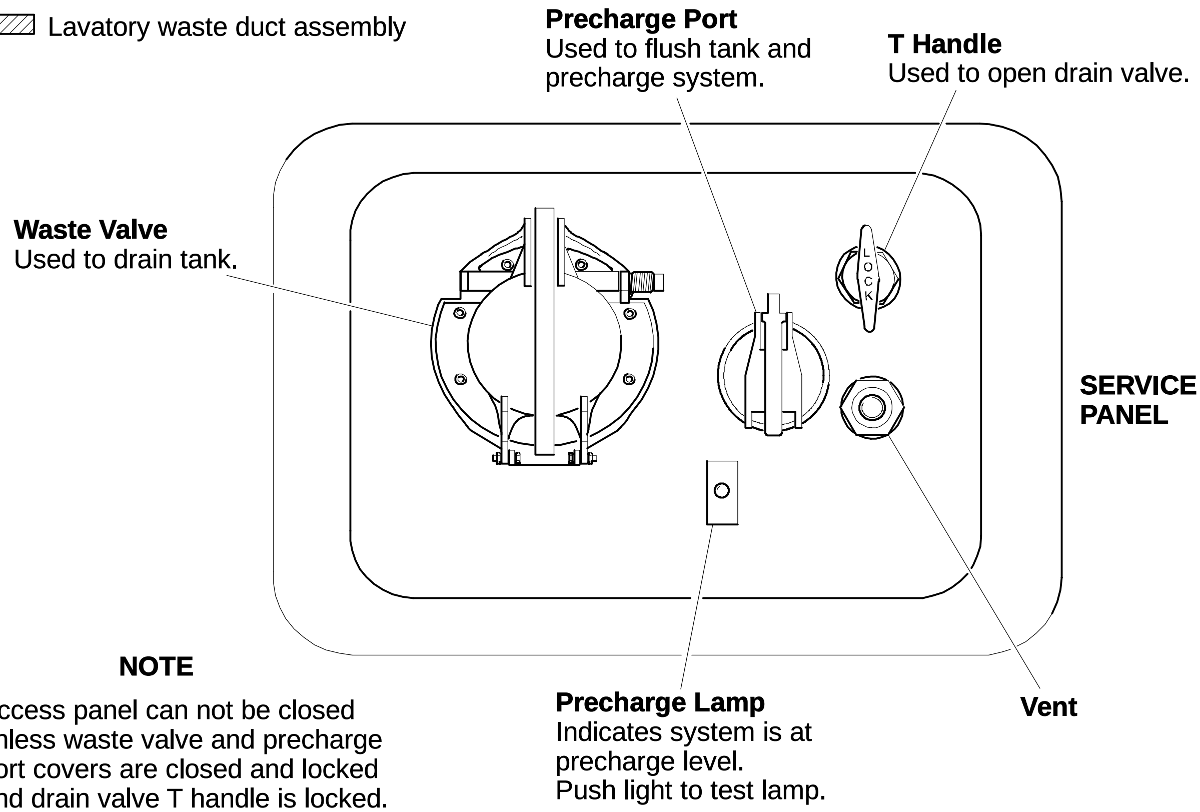
When the toilet flush handle is pushed, a timer energizes the electric pump for 10 seconds. The pump draws the flushing fluid from the tank, through a filter basket, and sends it out through the bowl assembly flush ring.

The systems are serviced by means of lavatory service panels, located on the right side of the forward and aft fuselage. When the service vehicle drain line is connected to the drain port, the T-handle is rotated to the left and pulled. This opens the drain valve, located at the bottom of the holding tank, allowing the tank to empty through the drain line.

Once the holding tank is emptied, rinsing agent and flushing fluid are sent through the charging port, flushing and cleaning the tank and lines. The T-handle is then turned to the right and pushed in to close the drain valve. The tank is then filled with precharge flushing fluid until the fluid level light on the service panel illuminates.

The toilet requires a precharge of 2.3 US gallons (8.7 liters) of flushing fluid.





NOTE

Access panel can not be closed unless waste valve and precharge port covers are closed and locked and drain valve T handle is locked.

Lavatory Waste System – Lavatory Service Panel
Figure 21–30–1

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Lavatory Waste System	Toilet	TOILET	AC SERVICE	2	D5	
	Waste	WASTE SYST	DC SERVICE		M9	
		WATER CONT			M10	

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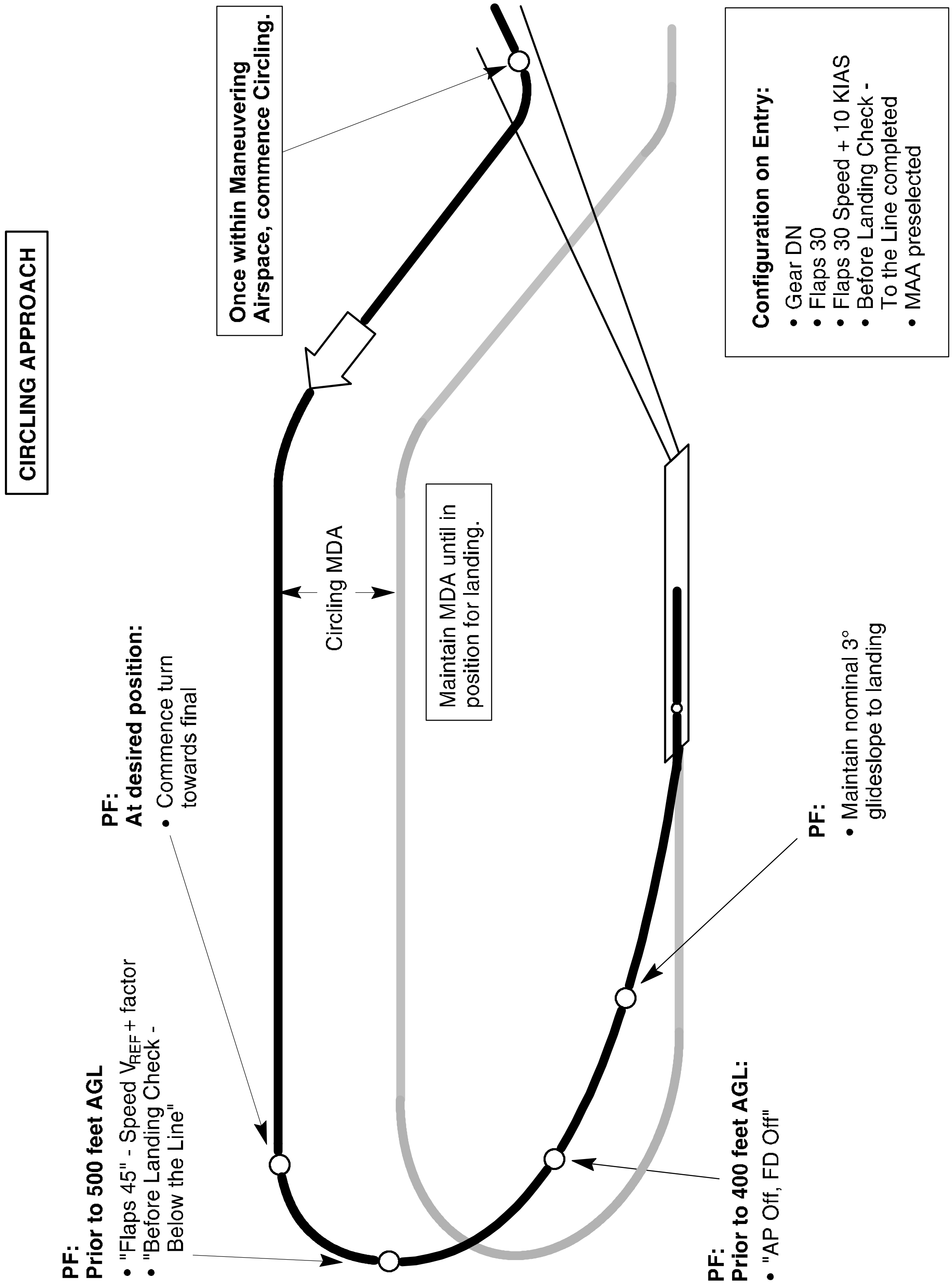
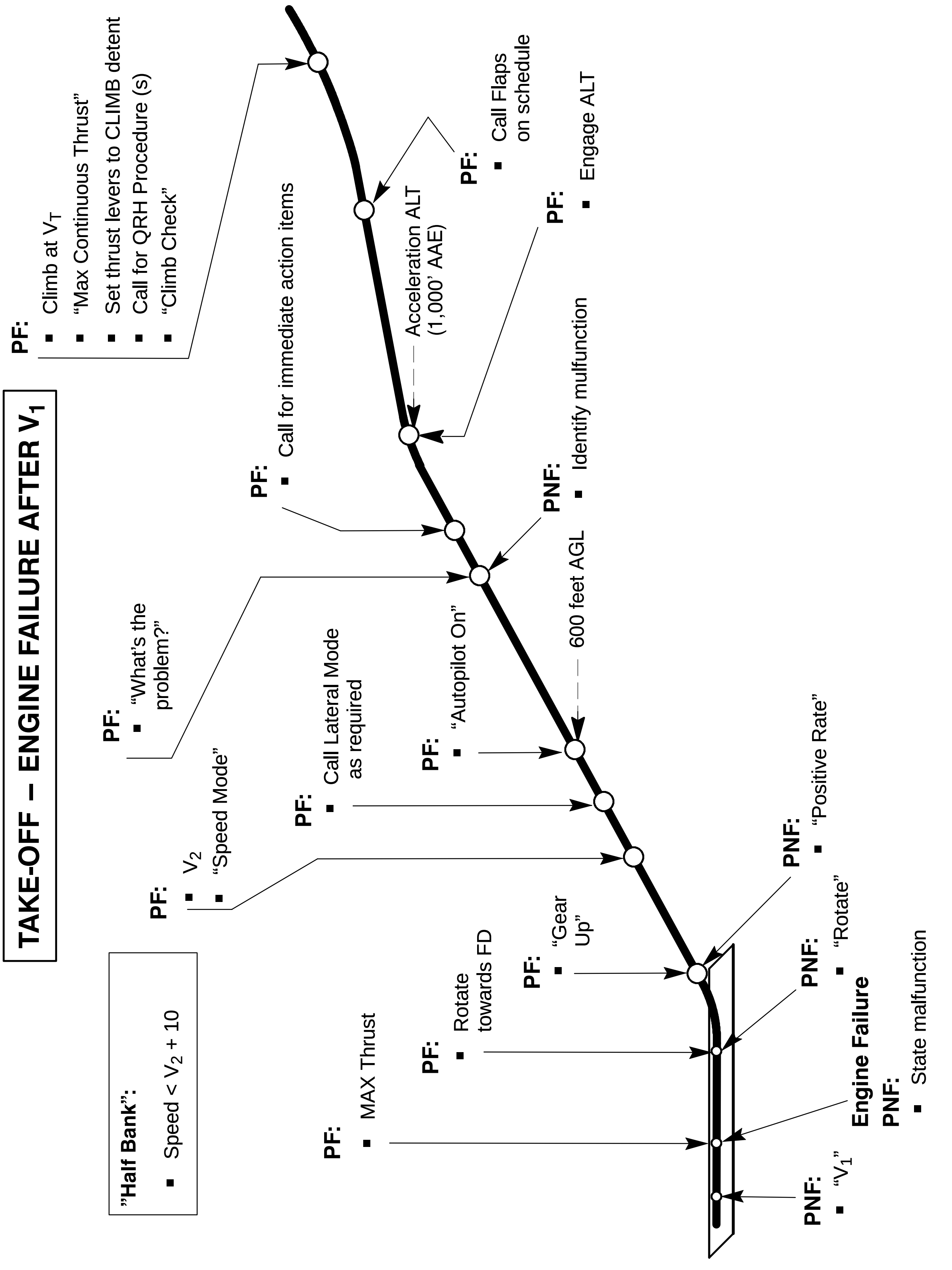
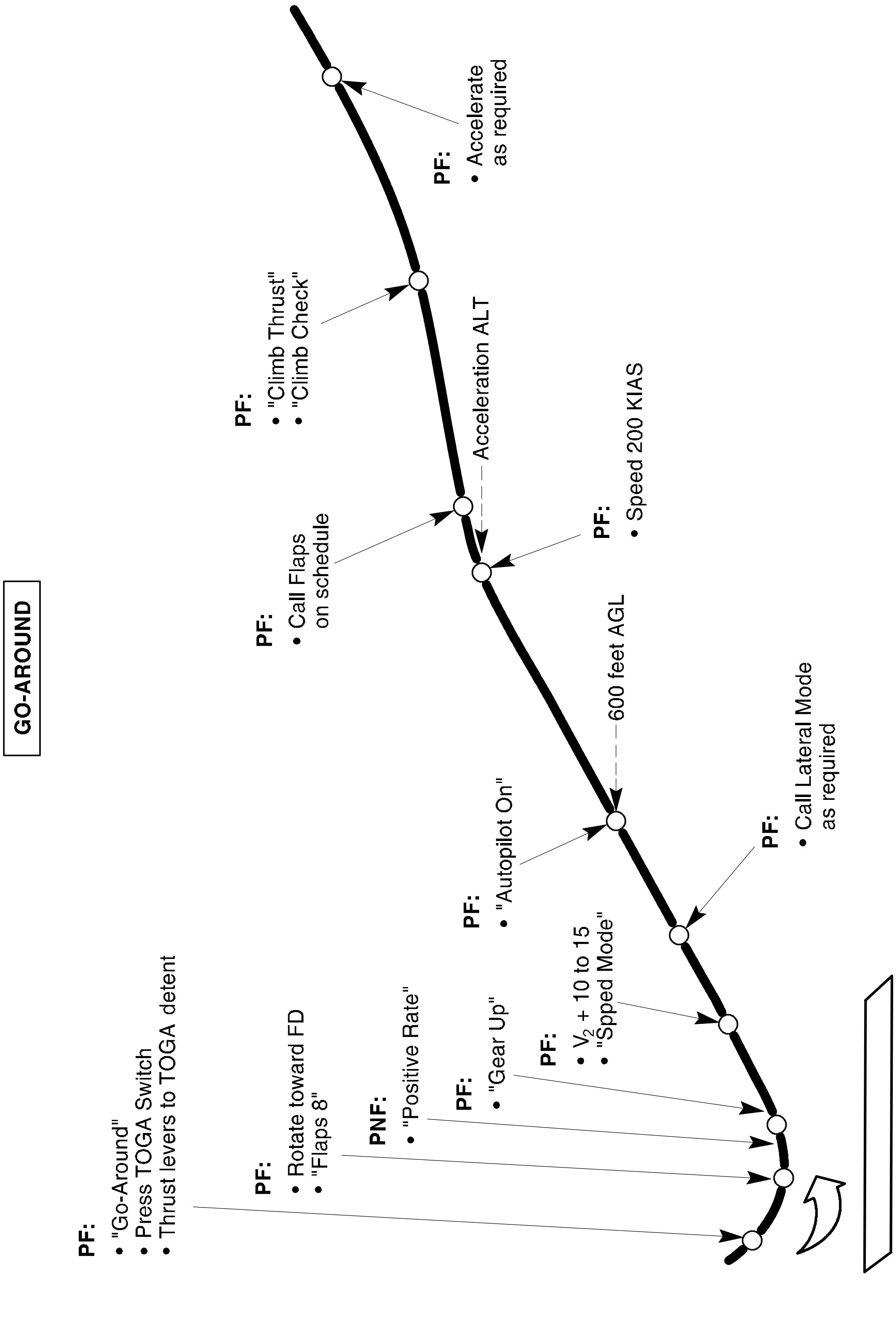
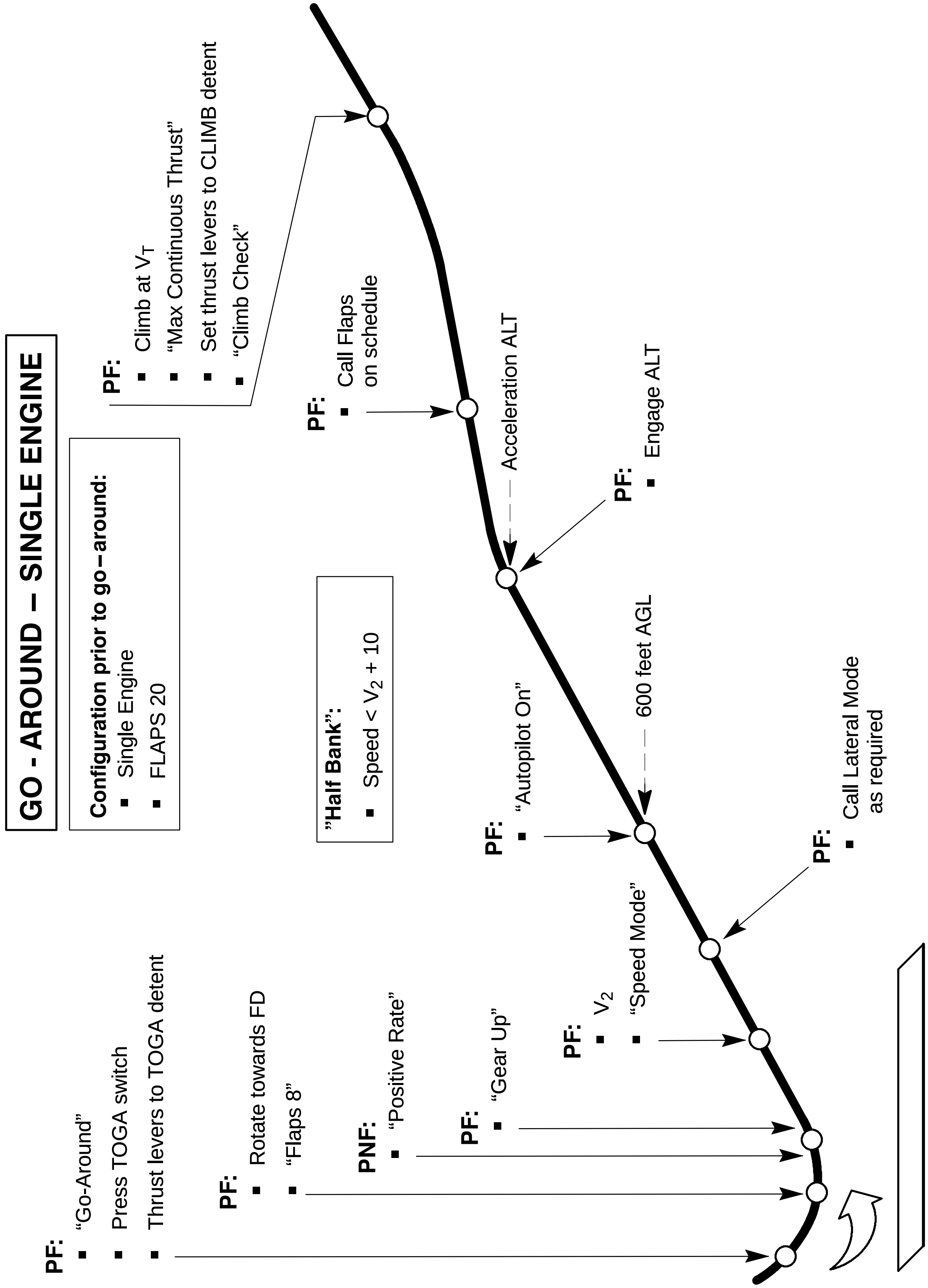
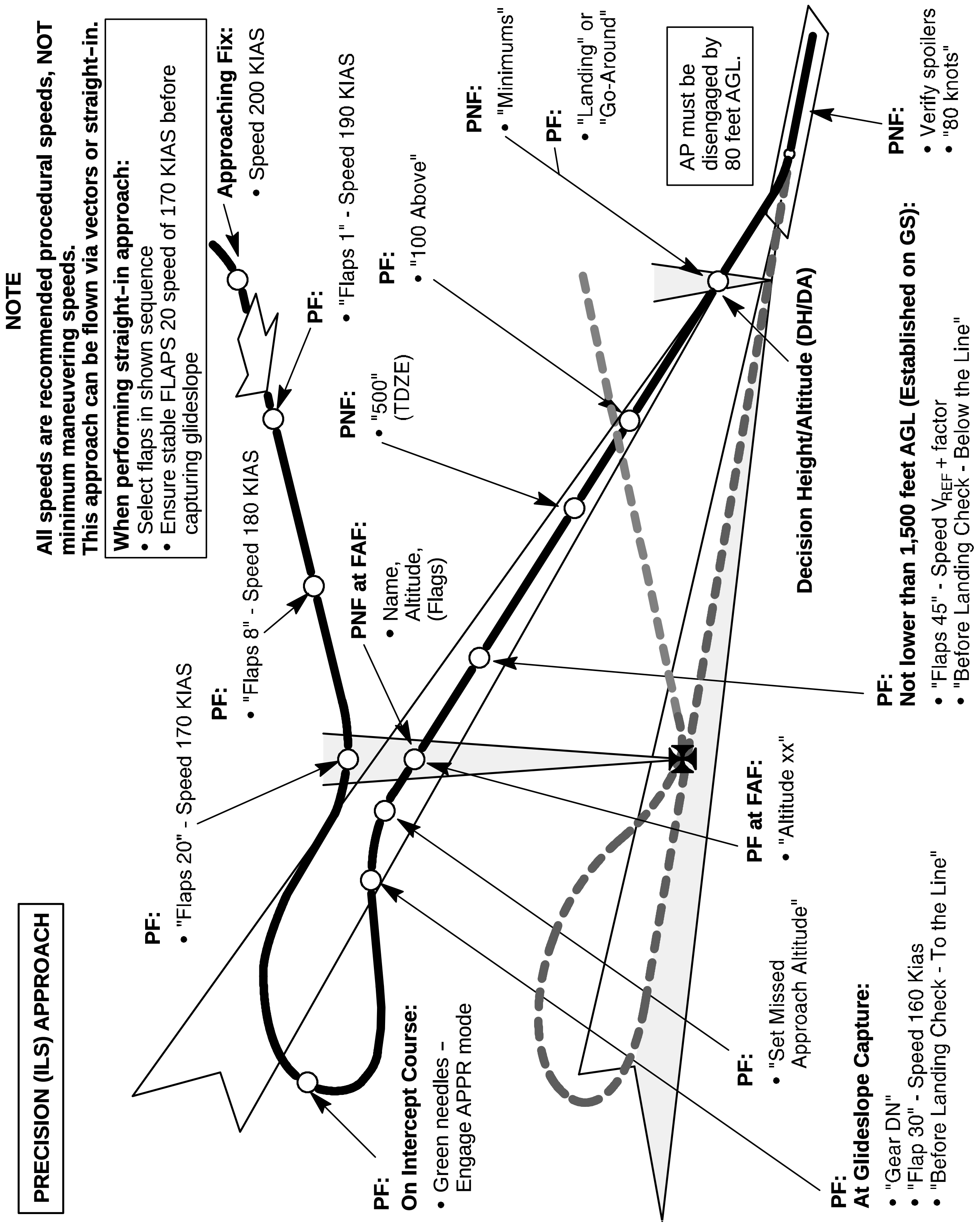

CIRCLING APPROACH
Once within Maneuvering Airspace, commence Circling.
Configuration on Entry:
• Gear DN
• Flaps 30
• Flaps 30 Speed + 10 KIAS
• Before Landing Check - To the Line completed
• MAA preselected
Circling MDA
Maintain MDA until in position for landing.
PF:
At desired position:
• Commence turn towards final
PF:
• Maintain nominal 3° glideslope to landing
PF:
Prior to 500 feet AGL
• "Flaps 45" - Speed V_{REF} + factor
• "Before Landing Check - Below the Line"
PF:
Prior to 400 feet AGL:
• "AP Off, FD Off"


TAKE-OFF – ENGINE FAILURE AFTER V1
PF:
Climb at VT
"Max Continuous Thrust"
Set thrust levers to CLIMB detent
Call for QRH Procedure (s)
"Climb Check"
PF:
Call Flaps on schedule
PF:
Engage ALT
Acceleration ALT (1,000' AAE)
PF:
Call for immediate action items
PNF:
Identify mulfunction
PF:
"What's the problem?"
600 feet AGL
PF:
"Autopilot On"
PF:
Call Lateral Mode as required
PF:
V2
"Speed Mode"
PNF:
"Positive Rate"
"Half Bank":
Speed < V2 + 10
PF:
"Gear Up"
PNF:
"Rotate"
PF:
Rotate towards FD
PF:
MAX Thrust
Engine Failure
PNF:
State malfunction
PNF:
"V1"

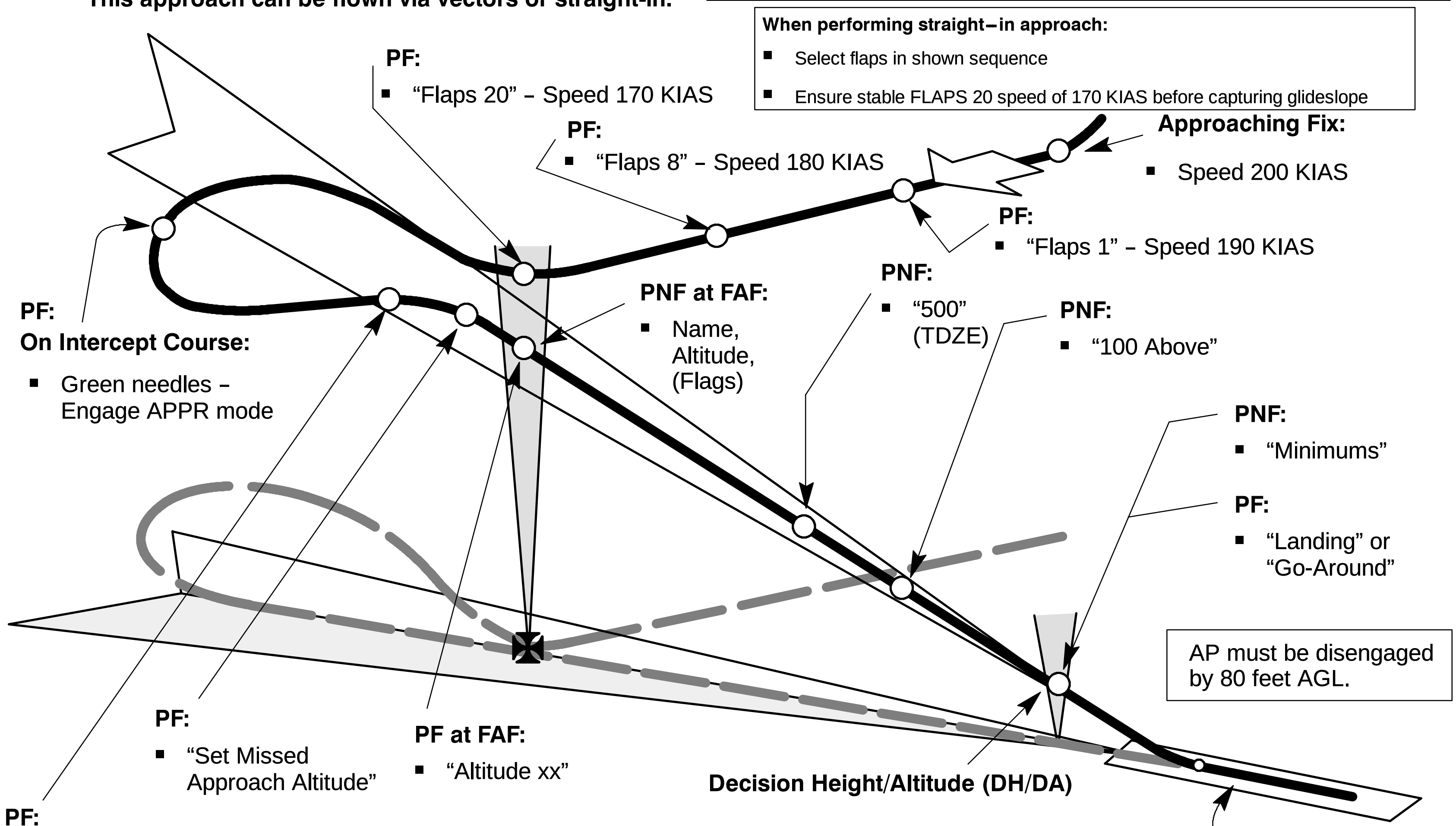

GO-AROUND
PF:
• "Go-Around"
• Press TOGA Switch
• Thrust levers to TOGA detent
PF:
• Rotate toward FD
• "Flaps 8"
PNF:
• "Positive Rate"
PF:
• "Gear Up"
PF:
• V_2 + 10 to 15
• "Spped Mode"
PF:
• "Autopilot On"
PF:
• Call Lateral Mode
as required
600 feet AGL
PF:
• Call Flaps
on schedule
PF:
• Speed 200 KIAS
Acceleration ALT
PF:
• "Climb Thrust"
• "Climb Check"
PF:
• Accelerate
as required


GO - AROUND – SINGLE ENGINE
Configuration prior to go–around:
Single Engine
FLAPS 20
"Half Bank":
Speed < V2 + 10
PF:
"Go-Around"
Press TOGA switch
Thrust levers to TOGA detent
PF:
Rotate towards FD
"Flaps 8"
PNF:
"Positive Rate"
PF:
"Gear Up"
PF:
V2
"Speed Mode"
PF:
Call Lateral Mode as required
PF:
"Autopilot On"
600 feet AGL
PF:
Engage ALT
Acceleration ALT
PF:
Call Flaps on schedule
PF:
Climb at VT
"Max Continuous Thrust"
Set thrust levers to CLIMB detent
"Climb Check"


PRECISION (ILS) APPROACH
NOTE
All speeds are recommended procedural speeds, NOT minimum maneuvering speeds.
This approach can be flown via vectors or straight–in.
When performing straight–in approach:
• Select flaps in shown sequence
• Ensure stable FLAPS 20 speed of 170 KIAS before capturing glideslope
Approaching Fix:
• Speed 200 KIAS
PF:
• "Flaps 1" - Speed 190 KIAS
PF:
• "Flaps 8" - Speed 180 KIAS
PF:
• "Flaps 20" - Speed 170 KIAS
PF:
On Intercept Course:
• Green needles -
Engage APPR mode
PNF at FAF:
• Name,
Altitude,
(Flags)
PNF:
• "500"
(TDZE)
PF:
• "100 Above"
PNF:
• "Minimums"
PF:
• "Landing" or
"Go-Around"
AP must be disengaged by 80 feet AGL.
PNF:
• Verify spoilers
• "80 knots"
Decision Height/Altitude (DH/DA)
Not lower than 1,500 feet AGL (Established on GS):
• "Flaps 45" - Speed V_{REF} + factor
• "Before Landing Check - Below the Line"
PF:
PF at FAF:
• "Altitude xx"
PF:
• "Set Missed
Approach Altitude"
PF:
At Glideslope Capture:
• "Gear DN"
• "Flap 30" - Speed 160 Kias
• "Before Landing Check - To the Line"

**NOTE: All speeds are recommended procedural speeds, NOT minimum maneuvering speeds.
This approach can be flown via vectors or straight-in.**

PRECISION (ILS) APPROACH, SINGLE ENGINE



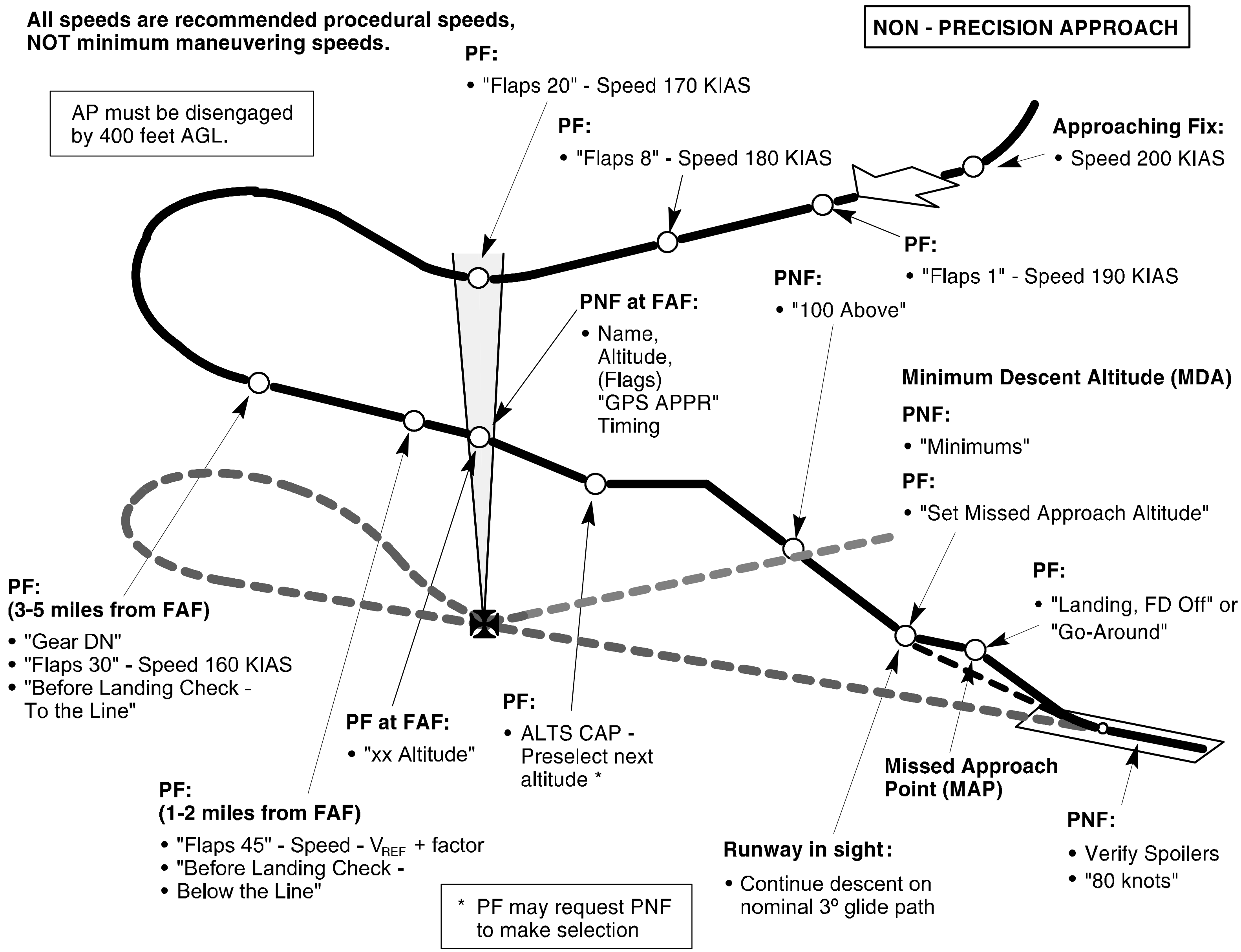
PF:
At Glideslope Capture:

- "Gear DN"
- Speed V_{REF} + 12 + factor
- "Before Landing Check"

Factor – 1/2 GUST
MIN – 5 knots
MAX – 10 knots

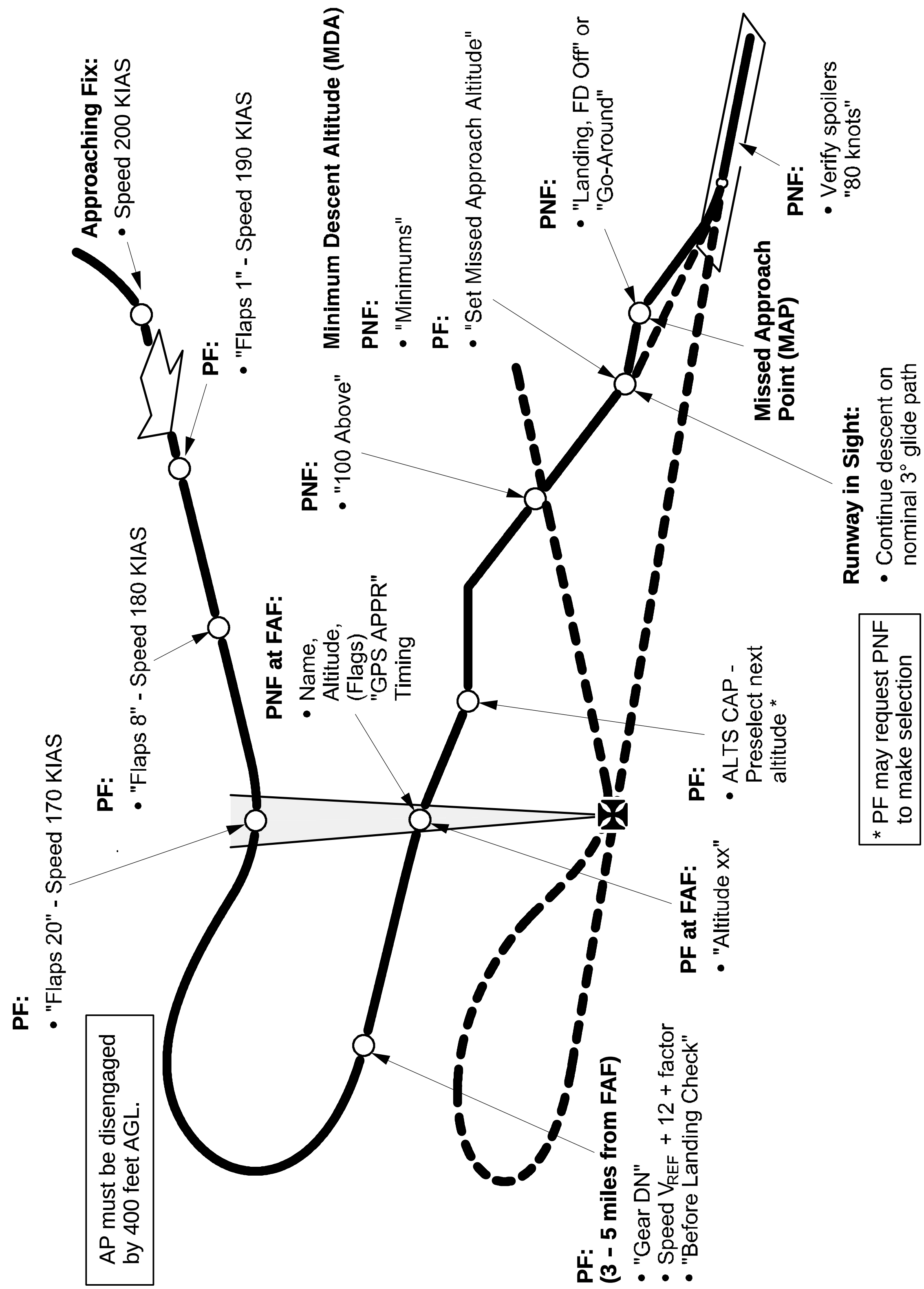
NOTE

All speeds are recommended procedural speeds, NOT minimum maneuvering speeds.

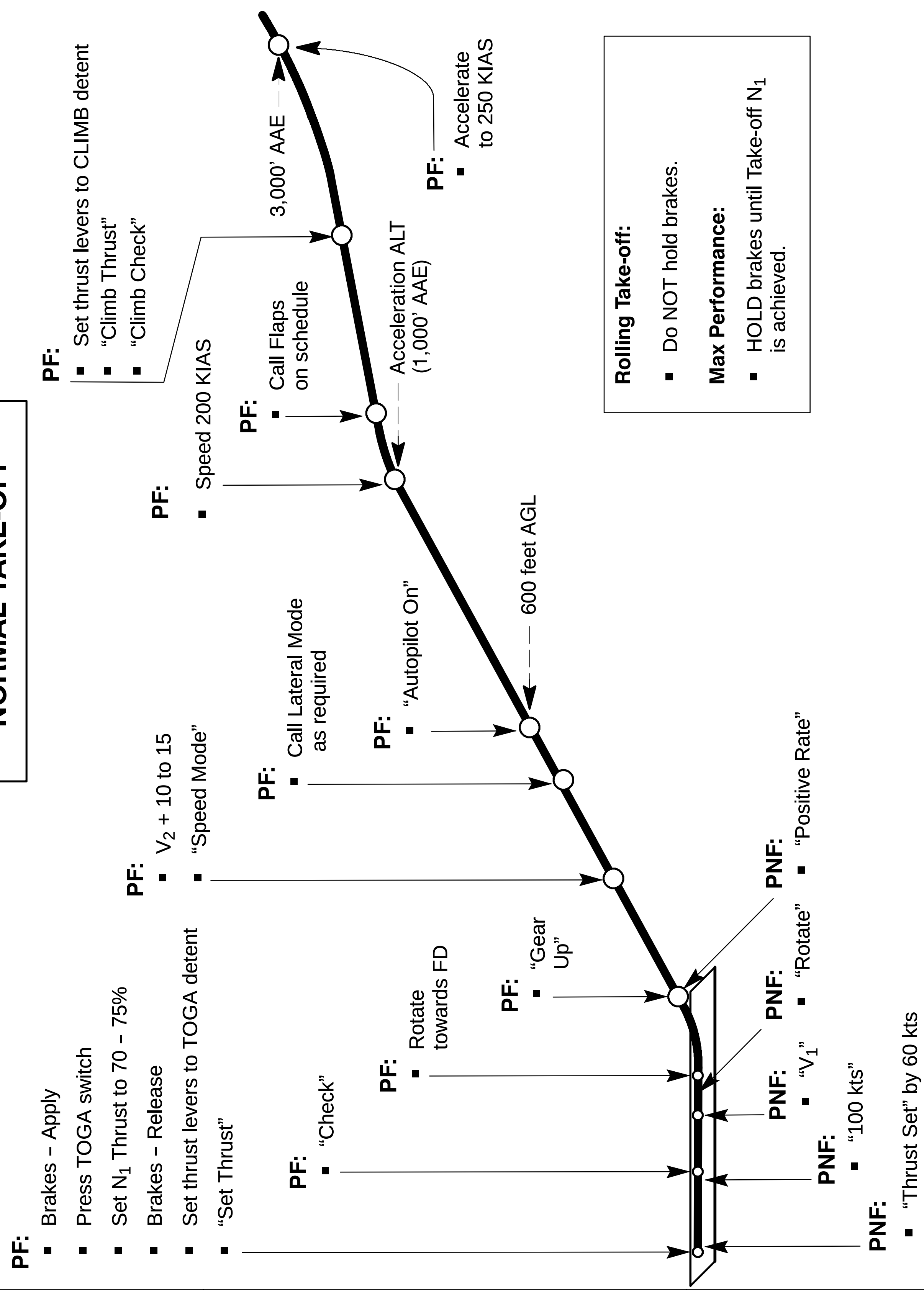


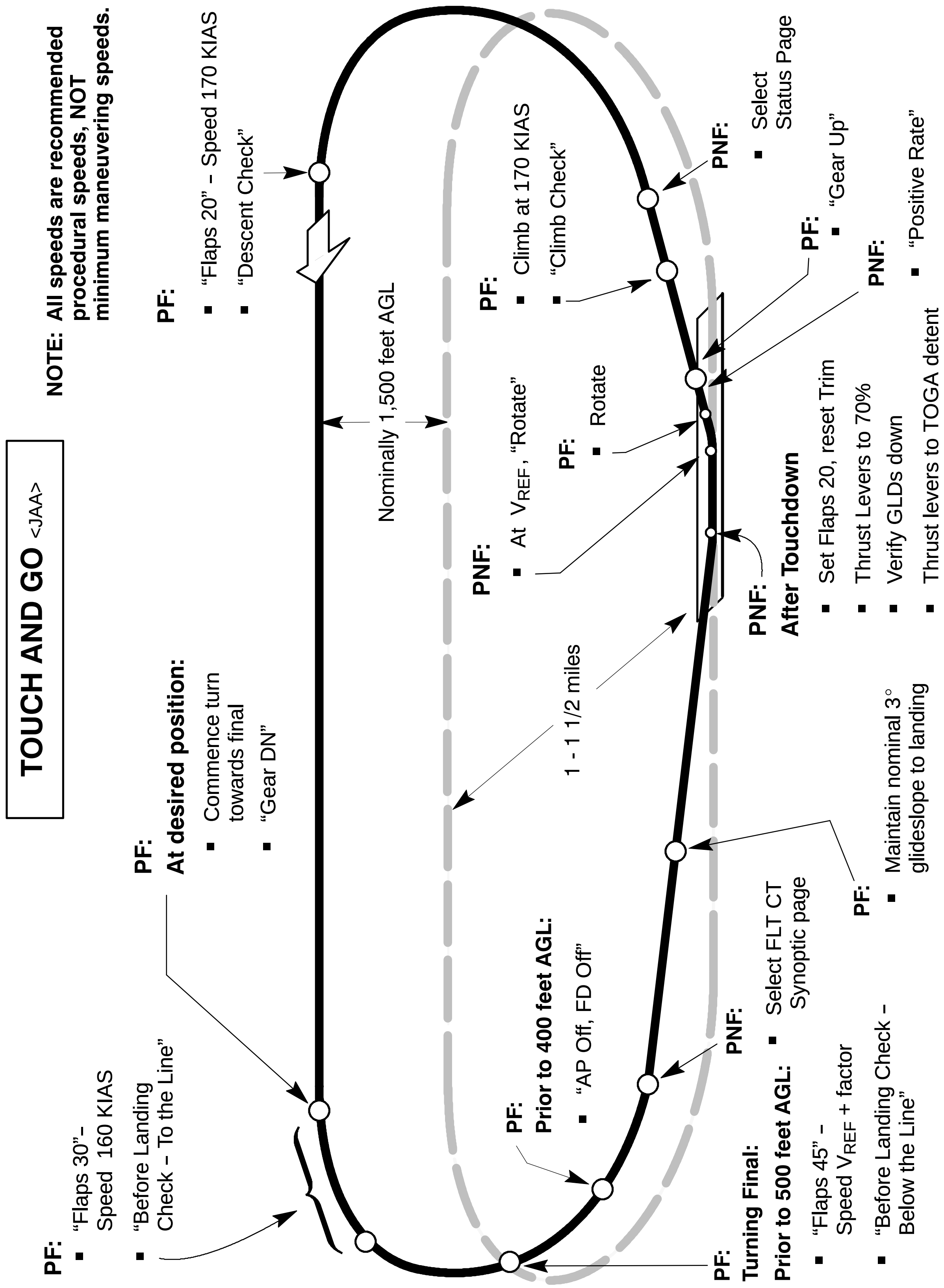
NOTE

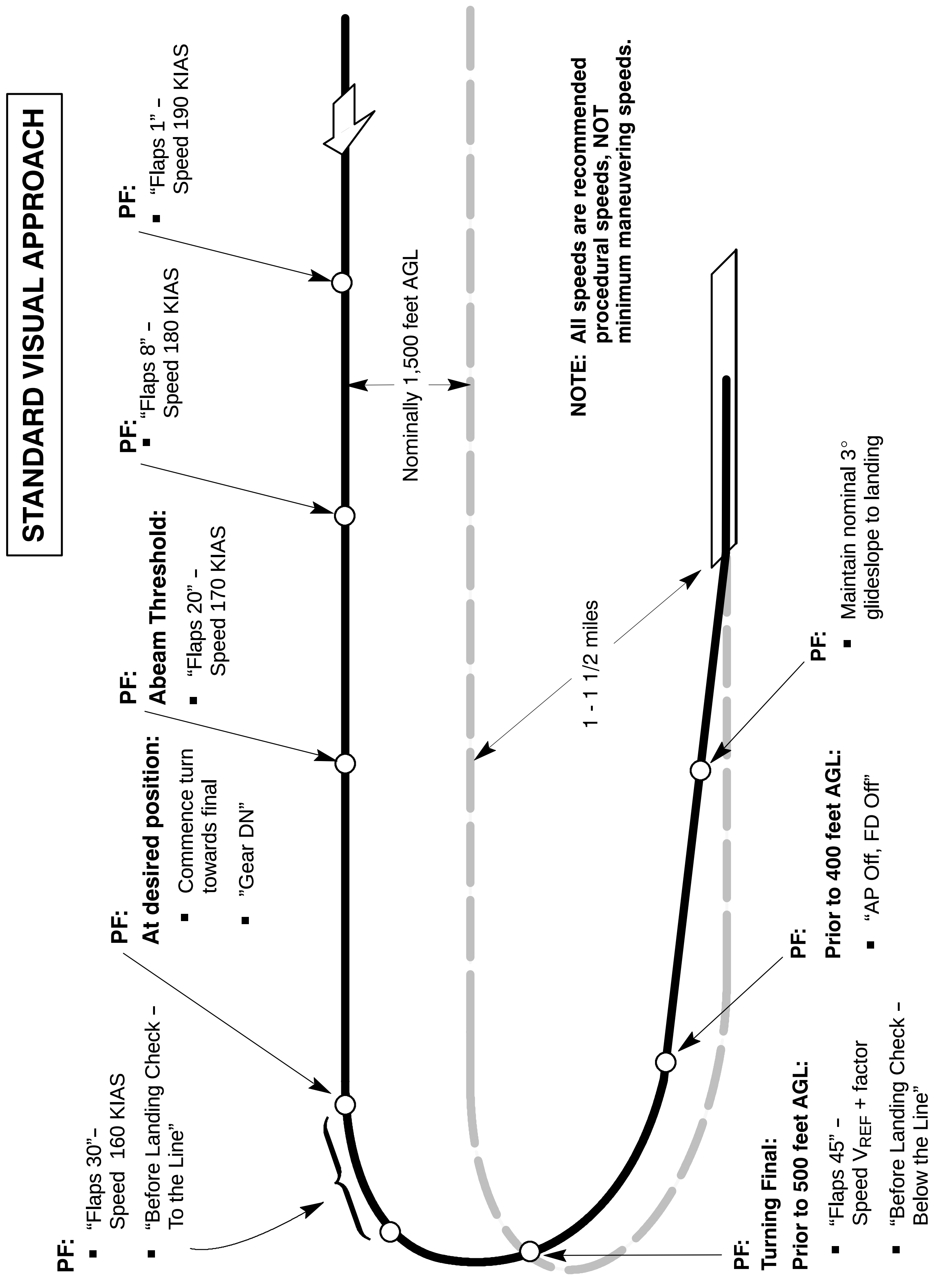
All speeds are recommended procedural speeds, NOT minimum maneuvering speeds.



NORMAL TAKE-OFF




TOUCH AND GO <JAA>
NOTE: All speeds are recommended procedural speeds, NOT minimum maneuvering speeds.
PF:
▪ "Flaps 20" – Speed 170 KIAS
▪ "Descent Check"
Nominally 1,500 feet AGL
PF:
At desired position:
▪ Commence turn towards final
▪ "Gear DN"
1 - 1 1/2 miles
PF:
▪ "Flaps 30"– Speed 160 KIAS
▪ "Before Landing Check – To the Line"
PF:
Prior to 400 feet AGL:
▪ "AP Off, FD Off"
PNF:
▪ Select FLT CT Synoptic page
PF:
Turning Final:
Prior to 500 feet AGL:
▪ "Flaps 45" – Speed V_{REF} + factor
▪ "Before Landing Check – Below the Line"
PF:
▪ Maintain nominal 3° glideslope to landing
PNF:
After Touchdown
▪ Set Flaps 20, reset Trim
▪ Thrust Levers to 70%
▪ Verify GLDs down
▪ Thrust levers to TOGA detent
PNF:
▪ At V_{REF}, "Rotate"
PF:
▪ Rotate
PF:
▪ Climb at 170 KIAS
▪ "Climb Check"
PNF:
▪ Select Status Page
PF:
▪ "Gear Up"
PNF:
▪ "Positive Rate"


STANDARD VISUAL APPROACH
PF:
■ "Flaps 1" – Speed 190 KIAS
PF:
■ "Flaps 8" – Speed 180 KIAS
PF:
Abeam Threshold:
■ "Flaps 20" – Speed 170 KIAS
PF:
At desired position:
■ Commence turn towards final
■ "Gear DN"
PF:
■ "Flaps 30"– Speed 160 KIAS
■ "Before Landing Check – To the Line"
Nominally 1,500 feet AGL
NOTE: All speeds are recommended procedural speeds, NOT minimum maneuvering speeds.
1 - 1 1/2 miles
PF:
■ Maintain nominal 3° glideslope to landing
PF:
Prior to 400 feet AGL:
■ "AP Off, FD Off"
PF:
Turning Final:
Prior to 500 feet AGL:
■ "Flaps 45" – Speed V_{REF} + factor
■ "Before Landing Check – Below the Line"