CHAPTER 20 – POWER PLANT

LIST OF ILLUSTRATIONS

1. INTRODUCTION

The aircraft is equipped with two General Electric CF34–3A1 high bypass ratio turbofan engines which have a normal take-off thrust rating of 8,729 pounds flat rated at 21°C (70°F). In the event of an engine failure during takeoff, an automatic power reserve (APR) system, will increase the thrust on the remaining engine to 9,220 pounds.

The aircraft is equipped with two General Electric CF34–3B1 high bypass ratio turbofan engines which have a normal take-off thrust rating of 8,729 pounds flat rated at 30°C (86°F). In the event of an engine failure during takeoff, an automatic power reserve (APR) system, will increase the thrust on the remaining engine to 9,220 pounds.<0005>

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 14-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 approximately 85% of the engine thrust. On landing, thrust reversers are used to direct the bypass air forward to assist in braking.

- Core air – Air that enters the engine core section is compressed, mixed with fuel and ignited. The expanding hot 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 five 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 the fuel control unit (FCU) which uses high pressure fuel to hydraulically move two actuators which are mechanically linked to the VG system.

The engine fuel control system consists of a hydromechanical core engine speed (N2) governing system and an electrical fan speed (N1) governing system. The engine is on N2 governing at low power settings and on N1 governing at high power settings.

An accessory gearbox, mounted on the engine, is driven by the N2 rotor. The following components are mounted on and driven by accessory gearbox:

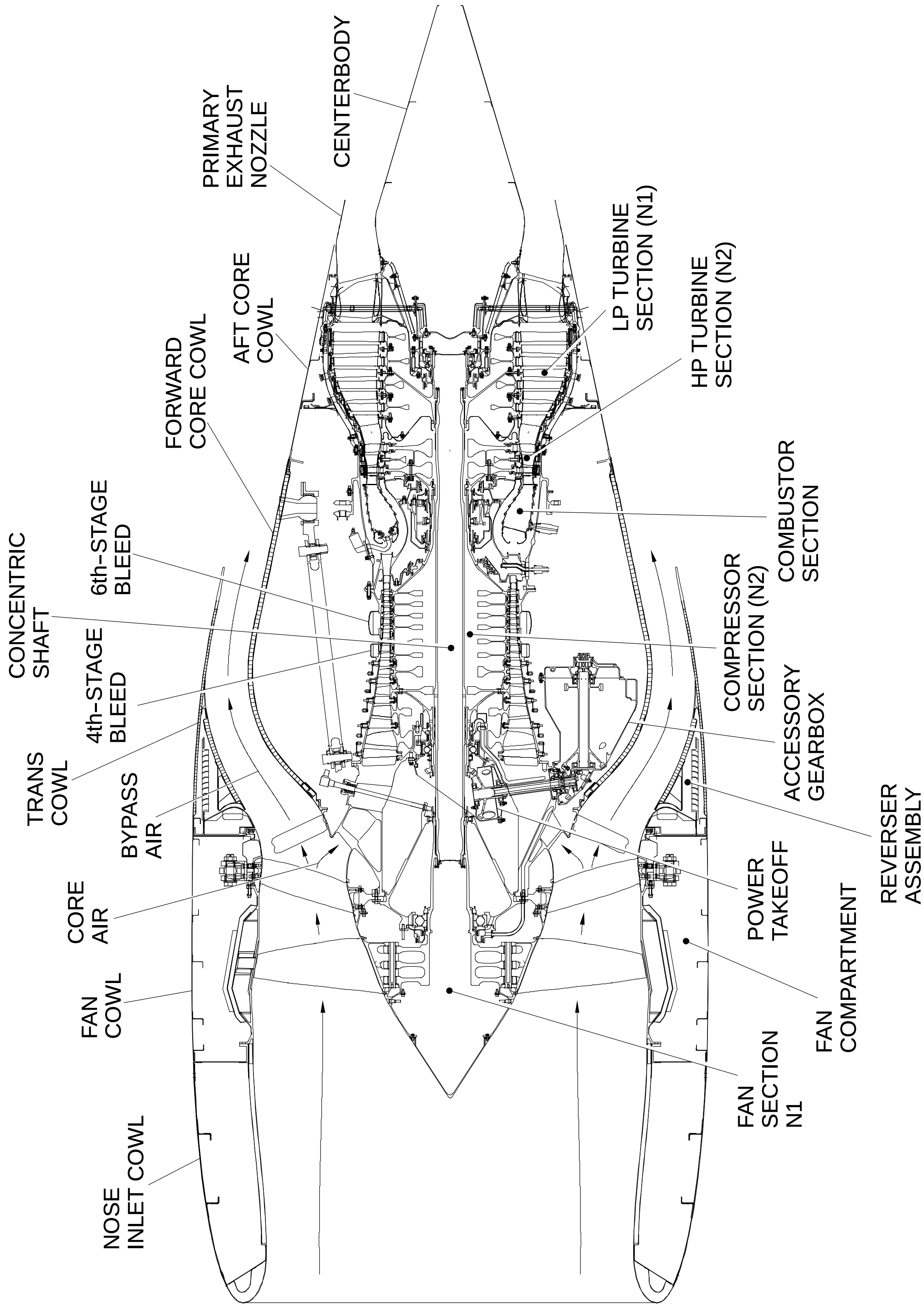
- Engine lubrication pump and integral oil reservoir

- Alternator (provides N2 speed indication and powers the fuel electronic control unit)

- Hydraulic pump

- Engine fuel pump assembly

- Integrated drive AC generator (IDG)
- Air turbine starter.



Power Plant – Cross Section
Figure 20-10-1

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1. THRUST CONTROL

The thrust control system supplies the control signals for engine operation. The flight compartment quadrant assembly consists of two thrust levers, two thrust reverser levers, friction knob and internal locks and stops to control the engines in the forward and reverse thrust ranges. (see section 20–70 of this chapter for the thrust reverser system).

The thrust levers control the application of power in the forward thrust range and have lever settings of SHUTOFF, IDLE AND MAX POWER. Release latches (painted red) are located behind each thrust lever. The release latches are used to remove the mechanical locks that guard against inadvertent movement of the thrust levers to SHUTOFF.

A mechanical interlock built into the thrust levers, prevents reverse selection by the thrust reverser levers until the throttles are at the idle position.

The thrust levers are connected by cable systems to the associated engine fuel control unit. The thrust levers mechanically control power from idle to takeoff and reverse.

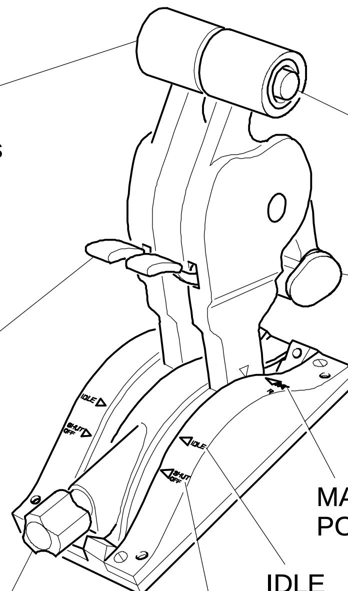
For electronic fuel contol, the thrust lever positions are monitored by transformers that are housed in the quadrant. The thrust lever position information is provided to an N1 amplifier. The amplifier uses the information to supply inputs to the fuel control unit to adjust the fuel schedule relative to throttle position and ambient conditions. Electronic fuel control is only effective at engine speeds greater than 79% N1, such as on takeoff, climb or in cruise.

An auto–retarding thrust mechanism ensures that the throttle lever is at IDLE whenever the thrust reverser is in transit. In flight, if a thrust reverser is inadvertently deployed, the affected throttle lever is automatically retarded to IDLE to minimize asymmetric thrust.

A switching unit, located below the quadrant, contains four switches for each thrust lever:

- Takeoff configuration switch – provides a warning when the thrust levers are advanced for takeoff and the spoilers are not in the takeoff configuration.
- Pressurization control switch – On the ground, when the thrust levers are advanced to approximately 80% N1, the pressurization system begins cabin pre–pressurization.
- Landing configuration switch – In flight, when the thrust levers are retarded towards IDLE, a warning is initiated if the landing gear is not extended.
- Thrust reverser deploy switch – Allows the thrust reversers to deploy through signals from the thrust levers at idle and wheel spin–up.

A take–off go–around (TOGA) button, located on each forward thrust lever, can be used by the flight crew to reset the flight director for go–around.



Thrust Control – Thrust Levers
Figure 20–20–1

1. STARTING AND IGNITION SYSTEMS

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 (APU) or from a ground air source. A minimum supply pressure of 40 psi is required for engine start. The engines can also be started using 10th stage cross bleed air from a running engine. For cross bleed starting, the running engine N2 must be above 85%. Pneumatic pressure indications are displayed on the EICAS ECS synoptic page.

Engine starting is initiated by the respective START switchlight 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 start control valve opens and allows pressure from the 10th stage manifold to rotate the air turbine starter. The starter drives the engine accessory gearbox, which in turn drives the engine N2 core section. When the engine has accelerated to 20% N2 rpm, the thrust levers are advanced to the IDLE position to turn on the fuel, resulting in engine light–off. As the engine accelerates to the on speed condition, the starter will cut-out at 55% N2 rpm.

B. Ignition System

The engine ignition system provides high–energy electrical sparking to ignite the fuel/air mixture in the combustion chamber during engine 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 form 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 engines are normally started using only one of the systems as selected by the flight crew (A on even days and B on odd days). The ignitors may be selected on one at a time (either IGN–A or IGN–B) or as a pair.

Continuous ignition can be activated manually by selecting the CONT switchlight on the Start/Ignition panel which will activate both ignition systems on both engines. Continuous ignition is used for the following flight conditions:

- Takeoff and landing on contaminated runways
- Takeoff with high cross wind components
- Flight through moderate to heavy intensity rain
- Flight through moderate to heavy intensity turbulence
- Flight in the vicinity of thunderstorms.

Continuous ignition is also activated automatically by the stall protection computer, when an impending stall is detected.

2. START SEQUENCE

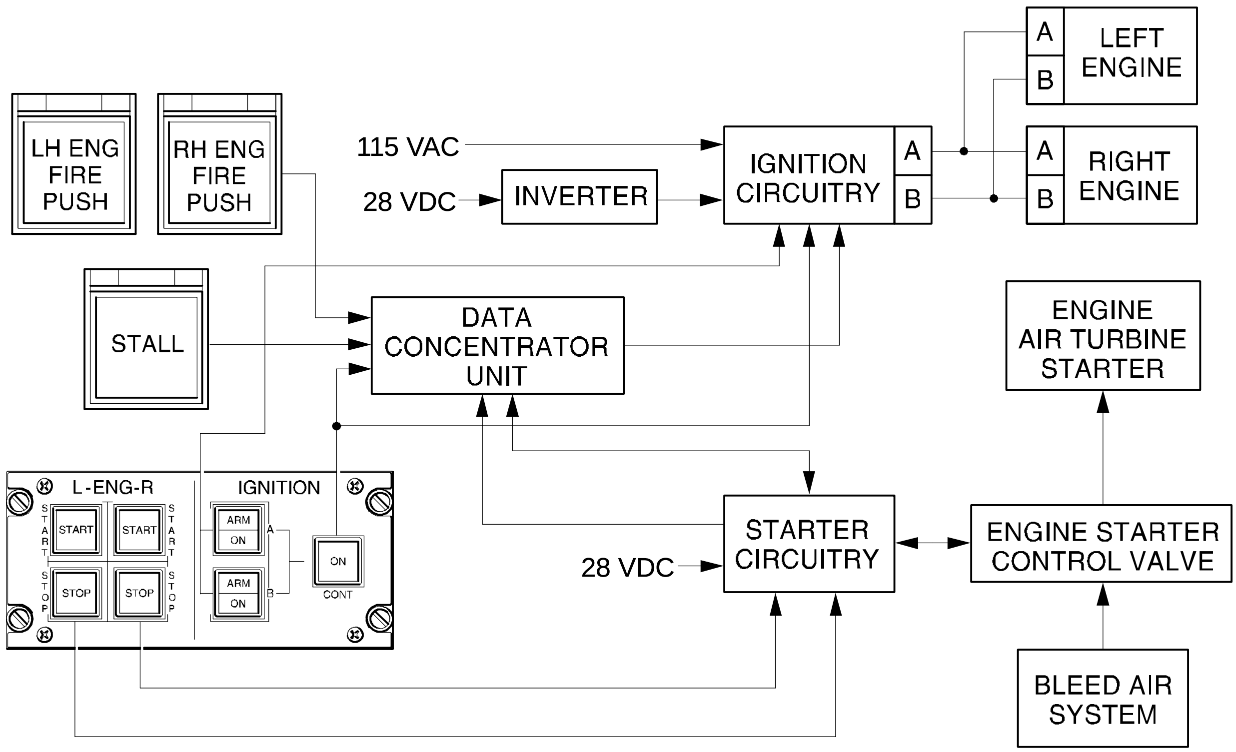
When the engine START switchlight is pushed:

- The 10th–stage bleed isolation valve and the left and right bleed shutoff valves open.
- The start valve on the associated engine opens to allow air pressure to the starter.
- When the start valve opens, the white START switchlight illuminates and the L or R ENGINE START status message is displayed on the EICAS status page.
- At 55% N2, power is removed from the start valve and the starter disengages. The white START switchlight goes out and the status message is removed.

A. Starter Limitations

START #	TIME ON	TIME OFF
1	60 seconds	10 seconds
2	60 seconds	10 seconds
3 and subsequent	60 seconds	5 minutes

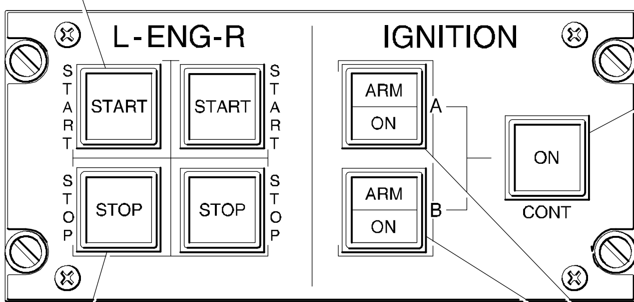
Dry Motoring	TIME ON	TIME OFF
1	90 seconds	5 minutes
2 and subsequent	30 seconds	5 minutes



Starting and Ignition Systems – Block Schematic
Figure 20–30–1

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.



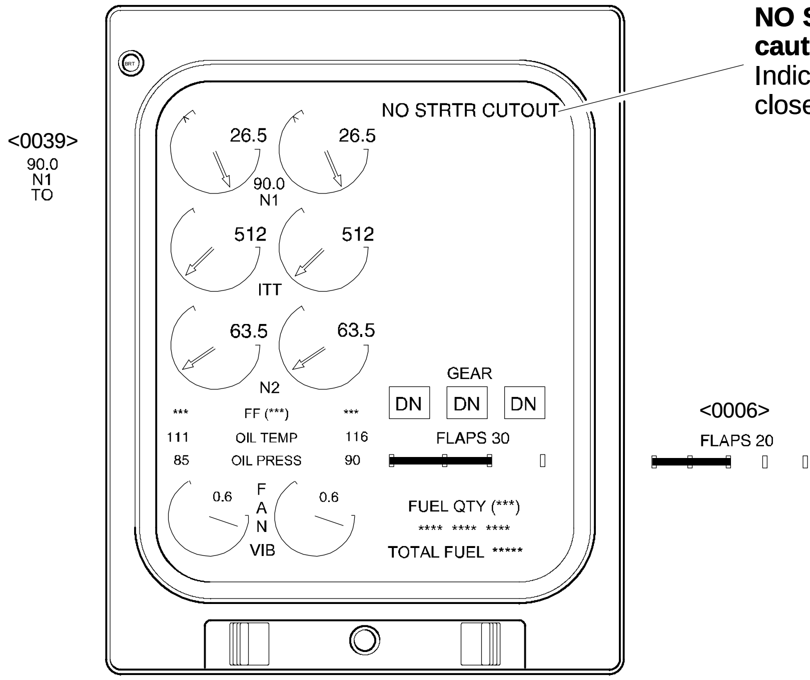
Engine Start/Ignition Panel
Overhead Panel

L ENG and R ENG STOP
Used to stop engine start sequence.
- STOP (white) light indicates stop is selected.

IGNITION
- ARM (green) – Arms respective ignition system on both engines.
- ON (white) – Indicates that the ignition system is activated.

Starting and Ignition Systems – Control Panel
Figure 20–30–2

NO STRTR CUTOUT caution (amber) <0039>
Indicates that the starter valve is not closed when engine running.



Primary Page

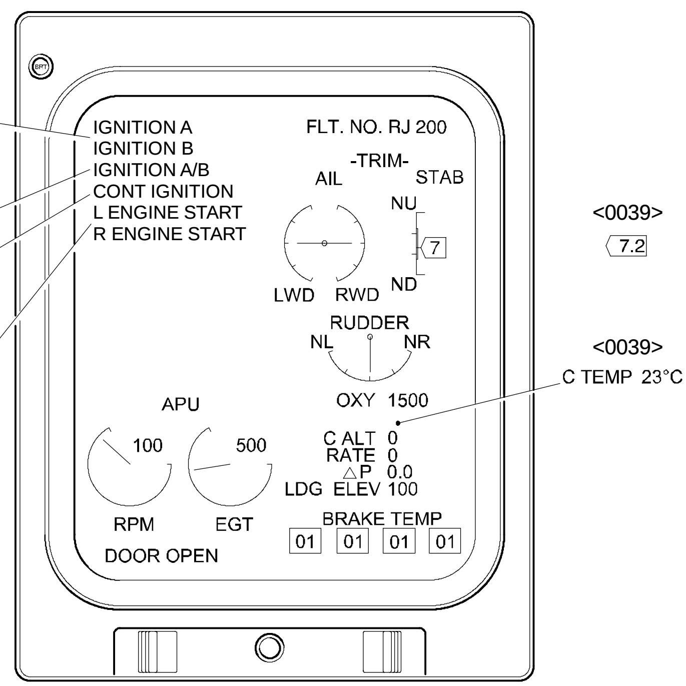
IGNITION A,B advisory (green)
Comes on to indicate that one ignitor is inoperative on one or both engines.

IGNITION A,B advisory (white) <0039>
Comes on to indicate that at least one ignitor is in use on each engine.

IGNITION A/B advisory (green)
Comes on to indicate that both ignitors are inoperative on one engine.

CONT IGNITION status (white)
Indicates that all ignitors have been selected on.

L or R ENGINE START status (white)
Indicates that engine start has been selected.



Status Page

Starting and Ignition Systems – L or R Start Abort Caution <MST>
Figure 20–30–3

B. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Power Plant	Ignition System	ENG IGN A	AC ESS BUS	3	B7	
			BATT BUS	1	M2	
		ENG IGN B			M3	
				5	B1	
	Starter System	ENG START L		1	M5	
		ENG START R			M4	

1. OIL SYSTEM

Each engine has an independent lubrication supply system consisting 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. The usable oil quantity is 7 U.S. quarts (6.6 liters).

The lubrication system is pressurized by the main lube pump. Oil flows from the main pump, passes through an oil filter and the oil/fuel heat exchanger. The oil then continues through the engine, for cooling and lubricating, then to the engine sumps. Scavenge pumps return the oil to the reservoir after passing through a chip detector and de-aerator.

Sensors for oil pressure and temperature indications are located on the forward side of the oil tank. A chip detector is also mounted on the accessory gearbox in the scavenge oil return line.

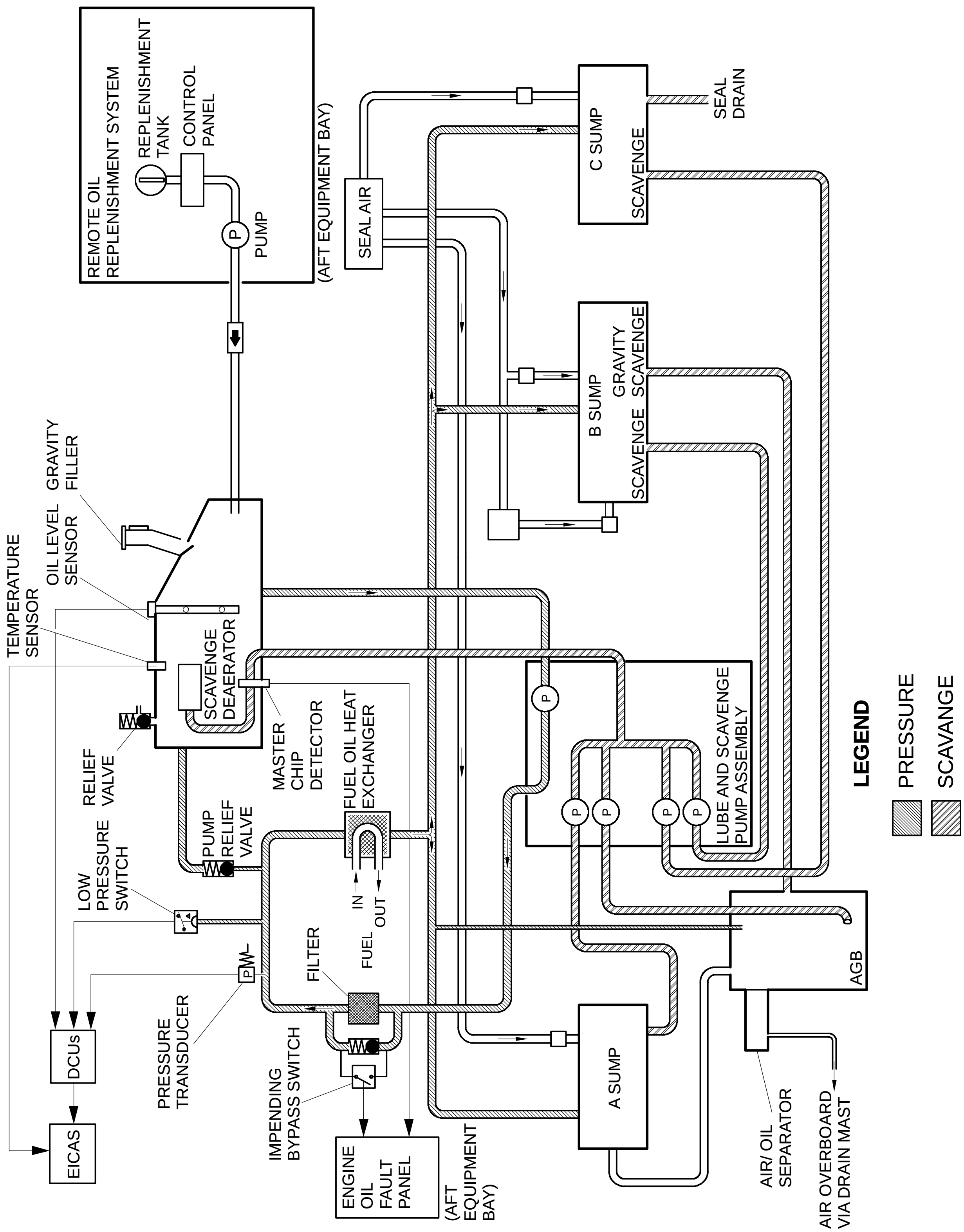
The engine oil system is monitored for oil temperature and oil pressure. The oil system indications include analog pressure gauges, temperature and pressure digital readouts and low oil pressure warning messages that are displayed on the EICAS primary page. Oil filter impending bypass and chip detector indications are provided on the engine fault panel in the aft equipment compartment.

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.

NOTE

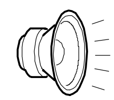
The ENGINE OIL aural is inhibited when the engine is shutdown on the ground. <0039>

Filling of the engine oil tanks is provided by a remote oil replenishment tank located in the aft equipment compartment.



Oil Distribution System – Schematic
Figure 20–40–1

L or G ENG OIL PRES warning (red)
Indicates oil pressure is less than 25 psi.



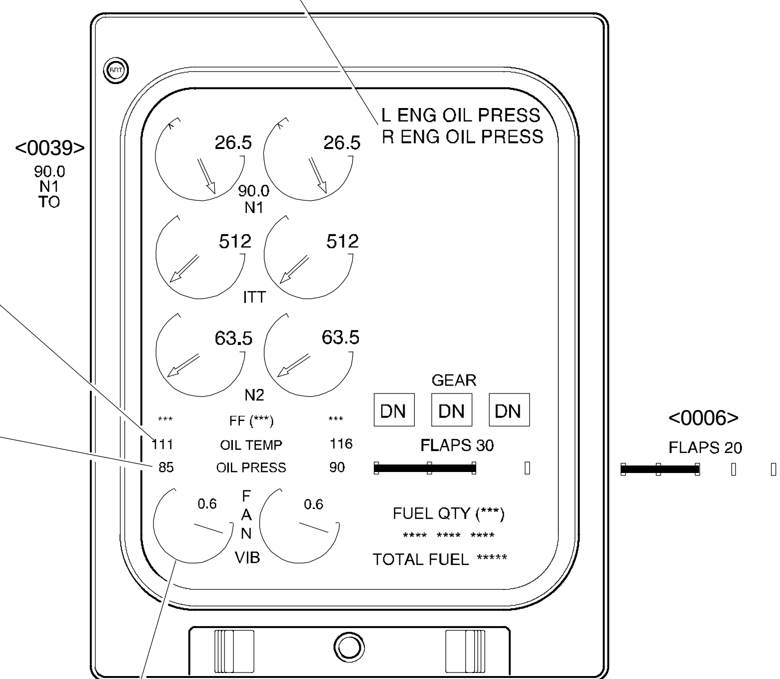
ENGINE OIL

OIL TEMP
Displays engine oil temperature (in 1 °C increments).

- Green, -40 to 149 °C
- Amber, 150 to 162 °C
- Red, greater than 163 °C
- Amber dashes - Invalid data.

OIL PRESS
Displays engine oil pressure (in 1 psi increments).

- Red, 0 to 25 psi
- Green, 26 to 115 psi
- Amber, >116 to 156 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 <MST>
Figure 20–40–2

A. Engine Oil Level Indication System

The engine oil level indication system provides a means of checking (from the flight compartment) if the engine oil tanks are full at engine shutdown after flight. The level indication system is operated on the ground as a post–shutdown checklist item. The engine oil level panel is located on the pilots side console and consists of:

- Two, split legend, FAIL/REFILL lights
- START/STOP, split legend, switchlight.

NOTE

1. The engine oil tank level is verified within three minutes and 2 hours after shutdown.
2. For aircraft operations in excess of 16 operating hours (without engine oil tank servicing), the engine oil level must be checked from the flight compartment ENGINE OIL LEVEL panel.

START/STOP Switch/Light

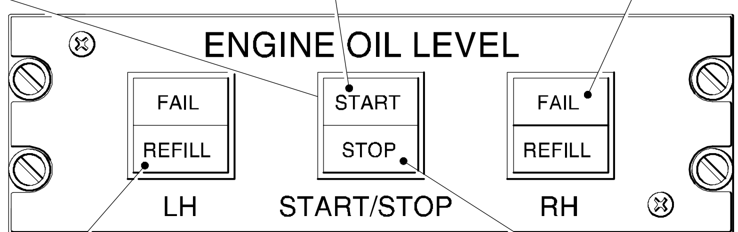
- Pressed–in – Engine oil level indication system self test and panel lamp test is activated.
  - START light comes on for 2 seconds.
  - All lights go out for 1 second.
  - All lights come on for 4 seconds.
  - START light remains on.

Upon successful completion of the self test, engine oil level check is automatically activated.

- Pressed–out – Engine oil level indication system is de–energized.

START Light (green)
Comes on to indicate that the engine oil level indication system self test is initialized. START light remains on until the engine oil level check is complete.

LH,RH FAIL Light (amber)
Comes on to indicate that, during the engine oil level indication system self check, the respective engine oil level sensor has failed.



Engine Oil Level Indicator Panel
Pilot's Side Console

LH,RH REFILL Light (amber)
Comes on to indicate that the respective engine oil level is low, 4543 cc (4.8 quarts US) or less.

STOP Light (white)
Comes on, after 5 seconds, to indicate that the engine oil level check is complete and both engine oil levels are normal.

Engine Oil Level Indicaton System
Figure 20–40–3

B. Oil Replenishing System

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 (manual) selector valve. The engine oil tank can also be refilled through a oil filler cap on the oil tank.

NOTE

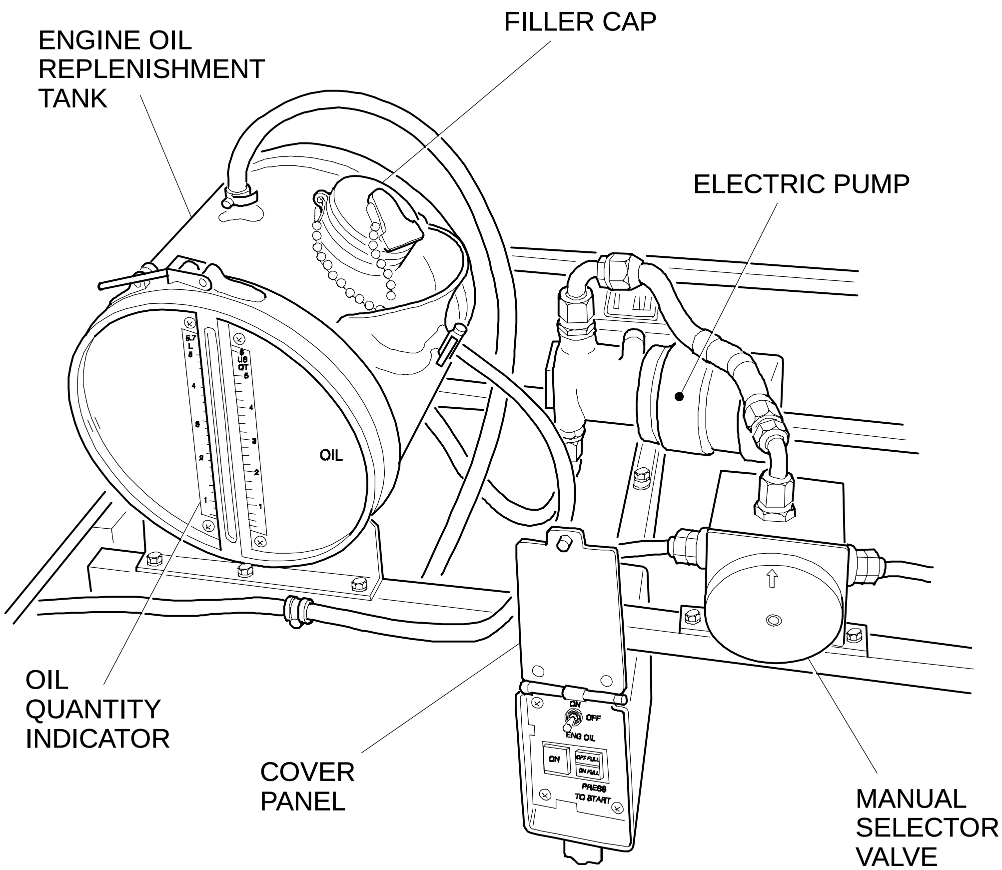
1. The maximum refill allowable is 1890 cubic centiliters (2 U.S. quarts) without dry motoring the engine.
2. If the oil system has been replenished to maximum capacity and the replenishment period has been exceeded, the engine(s) must be dry motored.
3. The instruction placard for filling the engine oil tanks is located below the replenishment oil tank.

C. Refilling Sequence

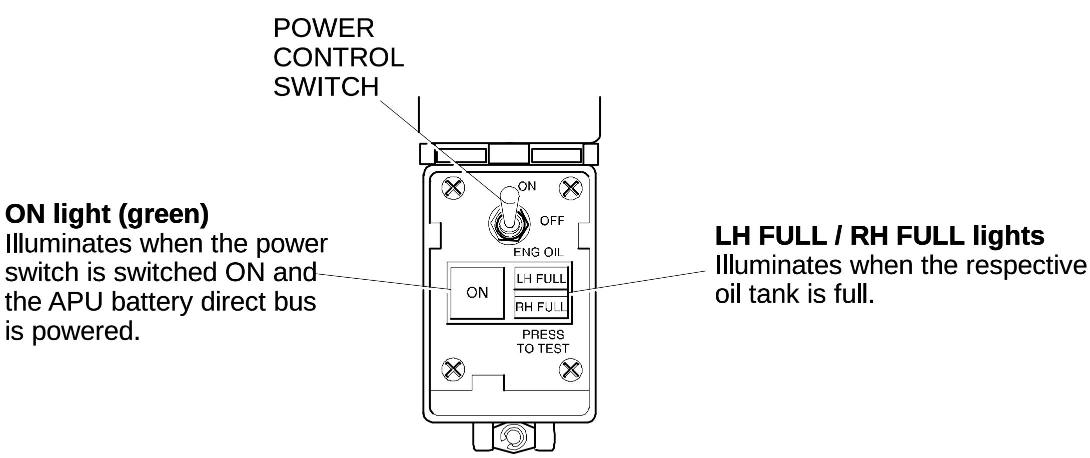
- Open the cover panel and select the power switch to ON (Check that the green ON light illuminates)
- If the engine tanks are full, the respective FULL lights will illuminate
- If an engine FULL light does not come on, turn the selector valve to the engine that requires oil until the FULL light illuminates
- Turn the power switch off.

NOTE

A bar installed on the cover panel will prevent the panel from closing if the power switch is left on.



Aft Equipment Bay



**Oil Level
Control Panel**

Oil Replenishment System
Figure 20–40–4

D. Engine Oil Filter Impending Bypass and Chip Detector Panel

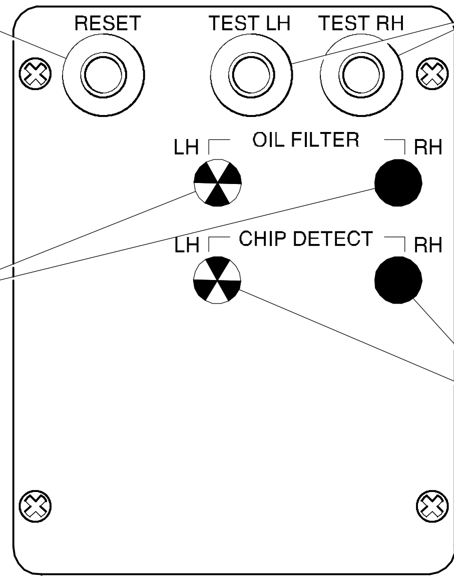
The panel is located in the aft equipment compartment on the left side. The panels OIL FILTER and CHIP DETECT indicators provide warnings of impending filter bypass and engine deterioration.

NOTE

Do not reset an OIL FILTER or CHIP DETECT indicator unless instructed to by maintenance or when conducting maintenance functional checks.

RESET switch
Resets the OIL FILTER and CHIP DETECT flags to normal indication.

TEST LH/RH switches
Pressed-in, respective oil filter impending bypass black and white flag and respective chip detector black and white flag are displayed, indicating that the system is operational. Flags remain latched until RESET switch is pressed.



LH/RH OIL FILTER flags
- All black - Respective oil filter operating normally.
- Black and white flag - Respective oil filter impending bypass is indicated.

LH/RH CHIP DETECT flags
- All black - Respective oil system operating normally.
- Black and white flag - Chip detection on the respective side is indicated.

- Normal

- Indicating oil filter impending bypass and/or chip detection

Engine Oil Filter Impending Bypass and Chip Detector Panel Ground Air Connector Access Panel

Effectivity:
Airplanes 7002 - 7158.

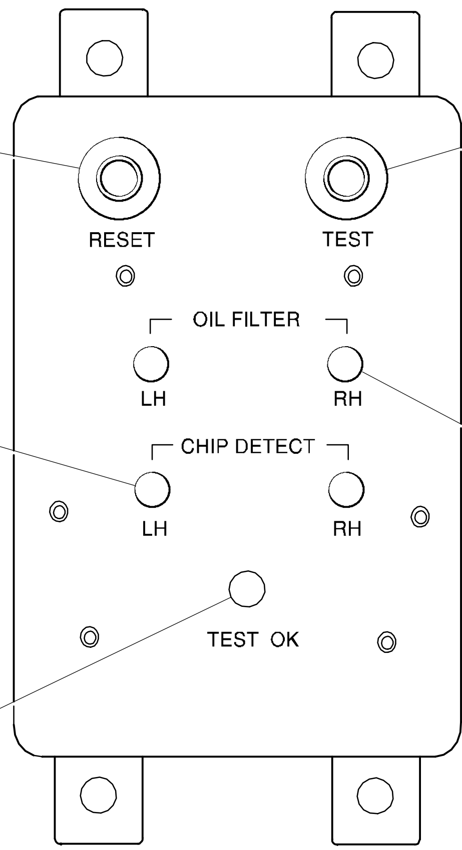
Engine Oil Impending Bypass and Chip Detector Panel
Airplanes 7002 to 7158
Figure 20–40–5

NOTE

If a fault is detected, the respective indicator light comes ON red and remains ON until the RESET switch is pressed.

RESET switch
Resets the OIL FILTER and CHIP DETECT indicator lights.

TEST switch
Press–in, TEST OK: indicator light comes ON green, indicating that the system is operational.



LH/RH CHIP DETECT indicators lights

- Lights OFF:
  Oil systems operating normally.
- Red light:
  Chip detection is indicated on respective side.

LH/RH OIL FILTER indicators lights

- Lights OFF:
  Oil filters operating normally.
- Red light:
  Impending oil filter bypass is indicated on respective side.

TEST OK indicator light
Green light:
Indicates systems operational.

Engine Oil Filter Impending Bypass and Chip Detector Panel

Effectivity:
Airplanes 7159 and subsequent.

Engine Oil Impending Bypass and Chip Detector Panel
Airplanes 7159 and Subsequent
Figure 20–40–5

E. System Circuit Breakers

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Oil System	Oil Pressure Indications	L ENG OIL PRESS	BATTERY BUS	1	M1	
		R ENG OIL PRESS	DC ESSENTIAL	4	B11	
		OIL BYPS IND	APU BATTERY DIRECT	5	B8	
		ENG OIL PWR			B9	

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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 electrical booster pump, through the engine fuel feed shutoff valve.

Engine fuel distribution is controlled by a gearbox-driven fuel pump unit and a mechanical fuel control unit (FCU). Pressurized fuel from the centrifugal pump goes through the heat exchanger and a filter then back to the fuel pump unit. The fuel/oil heat exchanger uses hot engine oil to heat the combustion fuel and cold fuel to cool the engine oil.

The supply fuel pressure is then increased by the primary pump and then sent to the FCU metering circuit and variable geometry (VG) actuator circuit. Fuel metered by the FCU is then supplied to the combustion chamber via the fuel flow transmitter.

The FCU is a hydromechanical metering unit that supplies fuel in response to mechanical commands from the thrust levers. During engine start and at low power settings the FCU hydromechanically schedules the fuel to control N2 speed. At high power settings, the N1 amplifier trims the MFC fuel schedule. The FCU has two metering schedules, N2 speed control and N1 speed control:

- N2 speed control – At low power settings, the FCU hydromechanically controls N2 speed relative to thrust lever position
- N1 speed control – At takeoff, climb and cruise power, (with the speed switches selected ON) the MFC electronically controls N1 above 79%.

NOTE

If N2 speed control is used to set takeoff thrust (engine speed switches OFF), APR thrust will be inhibited. Takeoff thrust will be obtained at a lower power lever angle than if N1 speed control is used. The thrust levers will not always be aligned when fans speeds are matched.

CAUTION

Do not set the speed switches on the engine control panel to the OFF position when the thrust lever is above 79% N1. This will cause a rapid increase of N2 speed and may cause the engine RPM and temperature to exceed normal limits.

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 spray fuel into the combustor.

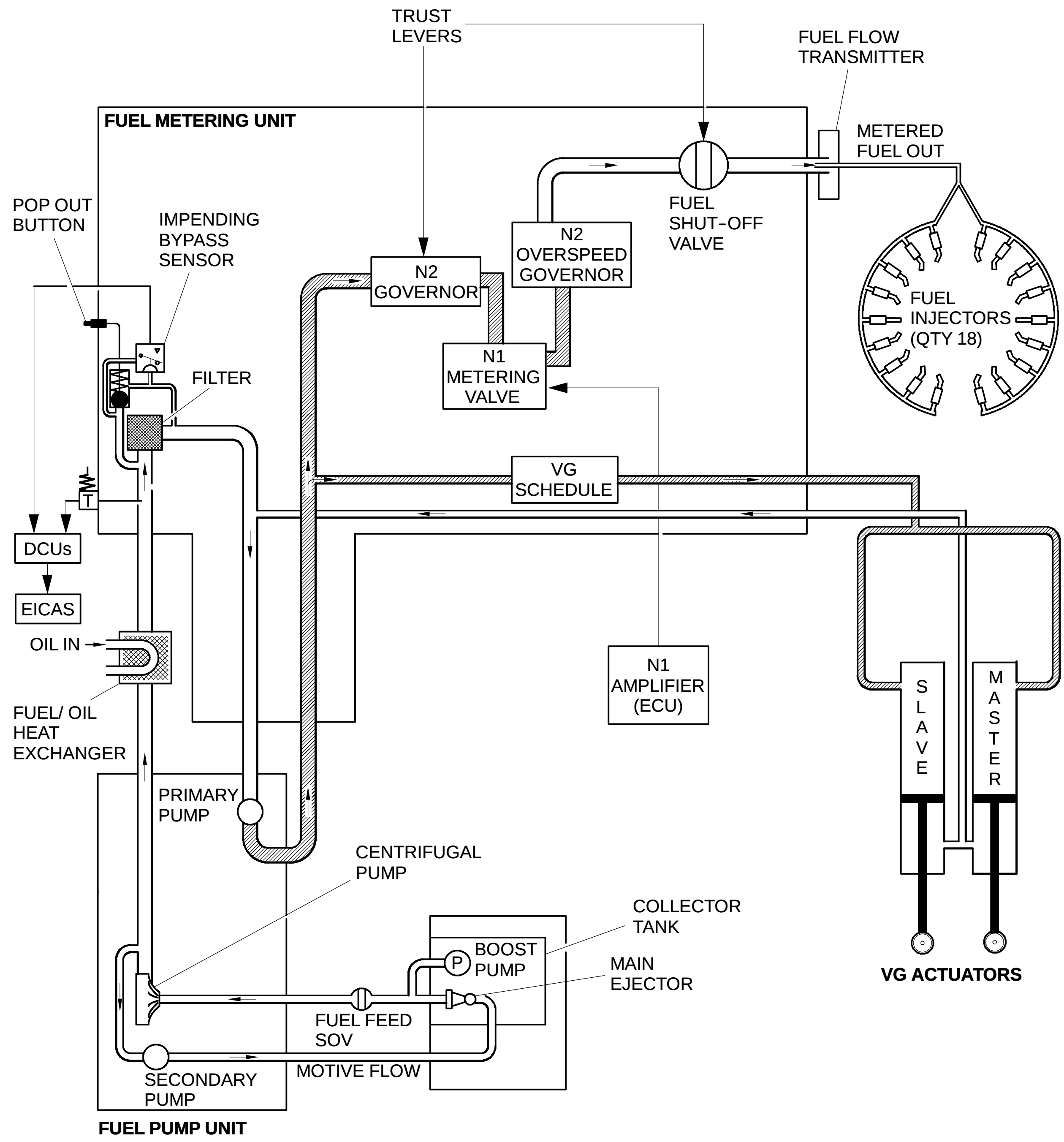
Combustion fuel can be shut off by moving the thrust lever to the shutoff position or by selecting the related engine fire push switchlight. Moving the thrust lever to the shutoff position closes the FCU shutoff valve. The engine fire push switchlight closes the engine fuel feed shutoff valve.

Fuel pressure is used to control and actuate the operability bleed valve and variable geometry linkages for engine compressor surge and stall protection.

The operability bleed valve vents excess air overboard and the VG system varies the position of the compressor inlet guide vanes and the first five stages of the stator vanes to regulate air through the engine. Fuel metered by the FCU drives the VG actuators which position the vanes open as engine speed increases and toward close as engine speed decreases.

Fuel is also used to actuate and lubricate components within the fuel system.

Fuel that is not used for combustion is returned to the fuel system to provide motive flow (venturi pressure) for the main and scavenge ejectors in the fuel tanks.



Fuel Distribution System Schematic
Figure 20-50-1

A. Engine Overspeed

An N2 overspeed governor in the MFC trims the fuel flow if the N2 speed exceeds 103%.

N1 speed is normally limited by the N1 amplifier. A red overspeed tick mark is on the analog scale at 98.6%. If the N1 exceeds 98.6%, the digital readout and pointer turn red and flash for 4 seconds.

2. Automatic Performance Reserve

The automatic performance reserve (APR) system (which is part of the DCU logic) provides automatic engine failure detection and subsequent thrust increase on the good engine during takeoff and climb. The APR feature is armed when:

- The APR ARM switch, on the ENGINE CONTROL panel, is set to ARM
- Both ENG SPEED switches (on the ENGINE CONTROL panel) are set to ON
- Aircraft has weight–on–wheels (WOW)
- Both engines N1 is greater than 79%
- Two DCU’s must be serviceable.

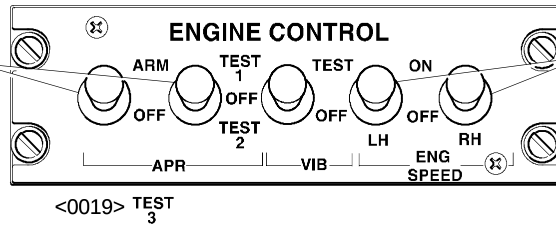
When all the above conditions are met, a green APR ARM advisory message is posted on the EICAS status page.

During takeoff or climb, if the N1 on either engine decreases below 67.6% for any reason, the DCU’s will supply a signal to the N1 amplifier which will then signal the FCU to increase the N1 speed 2.3% on the good engine for 5 minutes. The engine with the N1 drop will revert to N2 mechanical control and will not follow N1 commands An APR icon will also appear in the center of the N1 gauge of the good engine and the advisory message APR ARM will be removed. The EICAS will also reset the ITT scale red line on the good engine from 900 °C to 928°C.

NOTE

The APR does not affect or override thrust lever inputs to the FCU. It is possible to advance the thrust levers and obtain power settings higher than normal takeoff thrust. With higher than normal takeoff thrust settings, followed by a thrust loss on one engine, the good engine will respond to the APR commands to increase thrust which may result in the ITT limits being exceeded.

APR Selector switches
Used to arm, test and/or disable APR system.
- ARM – Arms APR system if both (L/R) ENG SPEED switches are at ON (both engines in N1 speed control mode).
- OFF – Disables APR system (APR will not trigger if one engine is throttled back).
- TEST 1, 2 – Tests APR circuits.
- TEST 1, 2, 3 – Tests <0019> APR circuits.



Engine Control Panel
Centre Pedestal

Engine Speed L/R Control Switches
Two–position switches used to set engine speed control via electronic or mechanical modes:
- ON – Engine speed control is in N1 mode when N1 rpm exceeds 79.1 per cent.
- OFF – Engine speed control is in N2 mode regardless of N1 rpm.

Engine Speed Control <MST>
Figure 20–50–2

3. N_1 THRUST SETTINGS <0039>

The FMS is capable of calculating the N1 thrust limits and displaying them on the EICAS primary page. The calculations are based on pressure altitude, static air temperature and indicated airspeed. Calculated N1 thrust limits are provided for:

- Takeoff (TO)
- Go–around (GA)
- Climb (CLB)
- Cruise (CRZ)
- Maximum continuous thrust (MTC)
- Flex thrust (FLX).

The FMS calculated N1 value is selected on the THRUST LIMIT page of the FMS CDU. and displayed on the primary page as:

- Digital reference
- Thrust mode annunciation
- Caret or doughnut.

The thrust mode annunciation defines the thrust limit that has been selected while the digital reference provides the value of the setting. Calculated TO, GA and MCT limits are displayed as a cyan caret. When CRZ is set, the N1 caret is replaced with a white doughnut to indicate that the setting does not represent the maximum N1 value.

On the ground, the FMS does not calculate the thrust settings until the OAT is entered on the THRUST LIMITS page. The OAT entered must be followed by a degrees C or F.

Flex power for TO is selected by entering an assumed temperature on the THRUST LIMITS page. Reduction in takeoff thrust is limited to ensure adequate aircraft performance in the event of an engine failure. If entering an assumed temperature results in the calculated N1 FLX value being less than the maximum N1 reduction allowed, a LOW TAKEOFF N1 is displayed on the THRUST LIMITS page and the FLX line remains blank. All FLX power indications are displayed in magenta to differentiate them from other thrust settings.

The N1 values are influenced by the amount of 10th and 14th bleed air that is used by their respective systems. The FMS monitors four different bleed air parameters to calculate the thrust limit:

- OFF: All engine bleed valves are CLOSED
- 10TH: The engines are supplying the 10th–stage manifold
- COWL: The cowl anti–ice is selected ON
- WG+COWL: The wing and cowl anti–ice is selected ON.

The ENG BLEED line key can be used to observe changes in N1 values for different bleed configurations. When the ENG BLEED line key selection does not agree with the BLEED AIR panel switch positions, the active bleed status value is displayed in amber and the N1 limit is not displayed on the primary page.

The EICAS transmits the displayed N1 value to the FMS. If the calculated FMS N1 reference value and the received N1 differs, the N1 reference is removed from the primary page and a FMS–EFD N1 DISAGREE message is displayed on the CDU.

The temperature from both ADC's is also compared by the FMS. If the temperature difference is more than 3 degrees, the N1 reference is removed from the primary page and a ADC TEMP DISAGREE message is displayed on the CDU.

Through cross–talk capability, the two FMS compare calculated N1 values, If the N1 reference values differ, the N1 reference is removed from the primary page and a FMS–FMS N1 DISAGREE message is displayed on the CDU. The EICAS also monitors the values from the two FMS, and if there is a difference, the N1 reference is removed from the primary page and a FMS–EFD N1 DISAGREE message is displayed on the CDU. <0024>

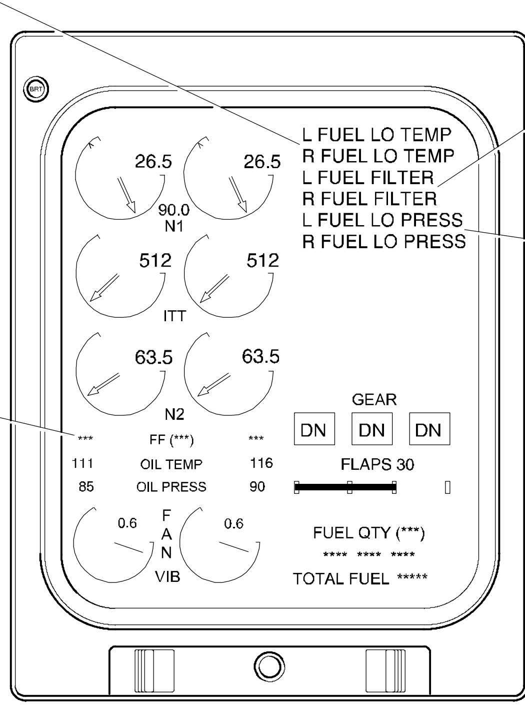
FUEL LO TEMP (L, R) Caution (amber)
Comes on to indicate fuel temperature is less than 5 °C.

FUEL FILTER (L, R) Caution (amber)
Comes on to indicate filter bypass when pressure drop is detected across associated main fuel filter.

<0039>
90.0
N1
TO

FUEL LO PRESS (L, R) Caution (amber)
Comes on at 5 psig to indicate that a low fuel pressure condition (at the engine inlet) has been detected.

FUEL FLOW L/R Readout
Indicates rate of fuel flow:
- Green – 0 to 5000 lb/hr. (0 to 2270 kilograms per hour.) <0001>
- Amber Dashes – flow greater than 5000 lb/hr. (2270 kilograms per hour.) <0001>



<0006>
FLAPS 20

Primary Page

Engine Indication (Fuel) <MST>
Figure 20–50–3

N1% RPM L/R Indicator/Readout
Indicates fan speed in percent rpm. Used as the primary thrust setting reference. Colours are:
- Green - 0 to 98.5%
- Red w 98.6%.

ENGINE OVERSPD Warning (red) <0039>
Comes on to indicate that an N1 / N2 limitation is being exceeded.

L(R) ENG MISCOMP Caution (amber
Comes on to indicate engine comparator disagreement at affected data concentrator unit:
- N1 by 5%, or
- N2 by 5%, or
- ITT by 40°.

Takeoff N1 Readout (cyan)
Indicates value set at MENU page (N1 REFERENCE Line), when airplane is in a take–off/configuration.

(Bug range is 76 to 98.5 % N1).

Displayed on ground and removed automatically when airplane is at cruise altitude.

NOTE

N1 bug must be manually reset for go–around.

N1 bug comes on during flap or gear extension.

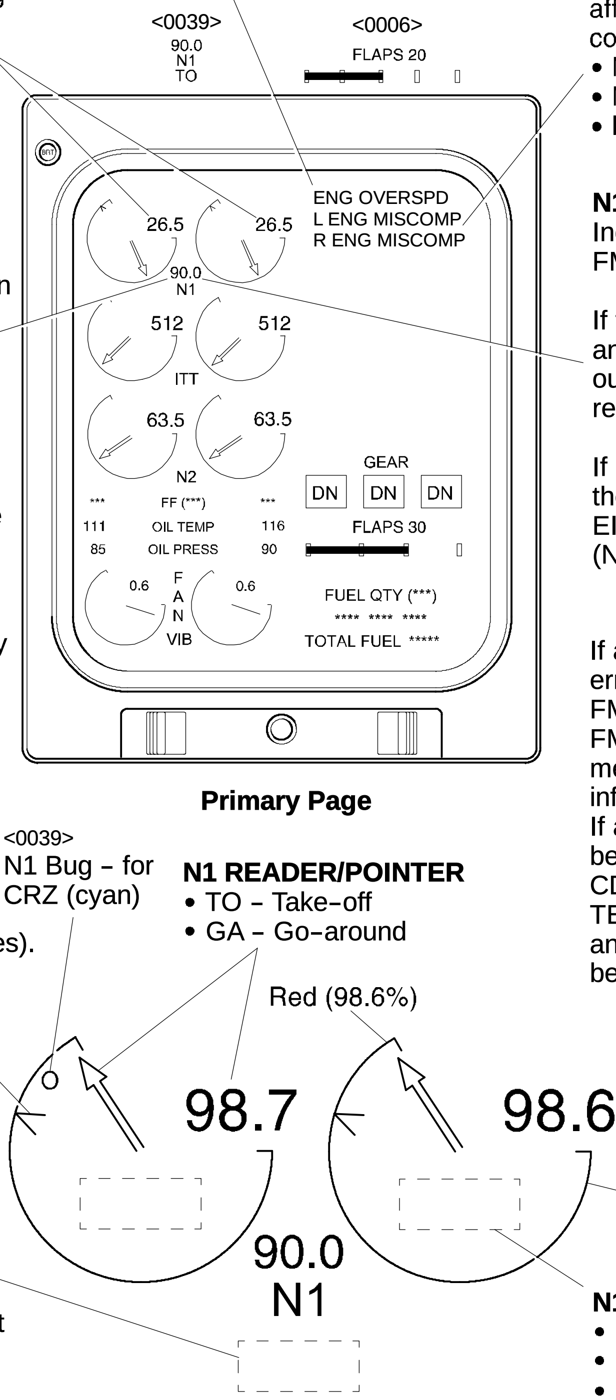
N1 Bug Readout <0039>
Indicates value set by the FMS (THRUST LIMIT page).

If the pilot–entered altitude and temperature values are out of range, then N1 bug readout will be blanked.

If FMS failed – readout then indicates value set on EICAS MENU page (N1 reference line).

NOTE <0039>

If a data comparator error is detected, the FMS CDU will display a FMS – EFD N1 DISAGREE message and N1 bug information will be blanked. If a temperature error has been detected, the FMS CDU will display an ADC TEMP DISAGREE message and N1 bug information will be blanked.



N1 Bug <0039>
(magenta – FLEX)
(cyan – all other phases).

<0039>
N1 Bug – for CRZ (cyan)

N1 READER/POINTER
- TO – Take–off
- GA – Go–around

Takeoff N1 Bug (cyan)

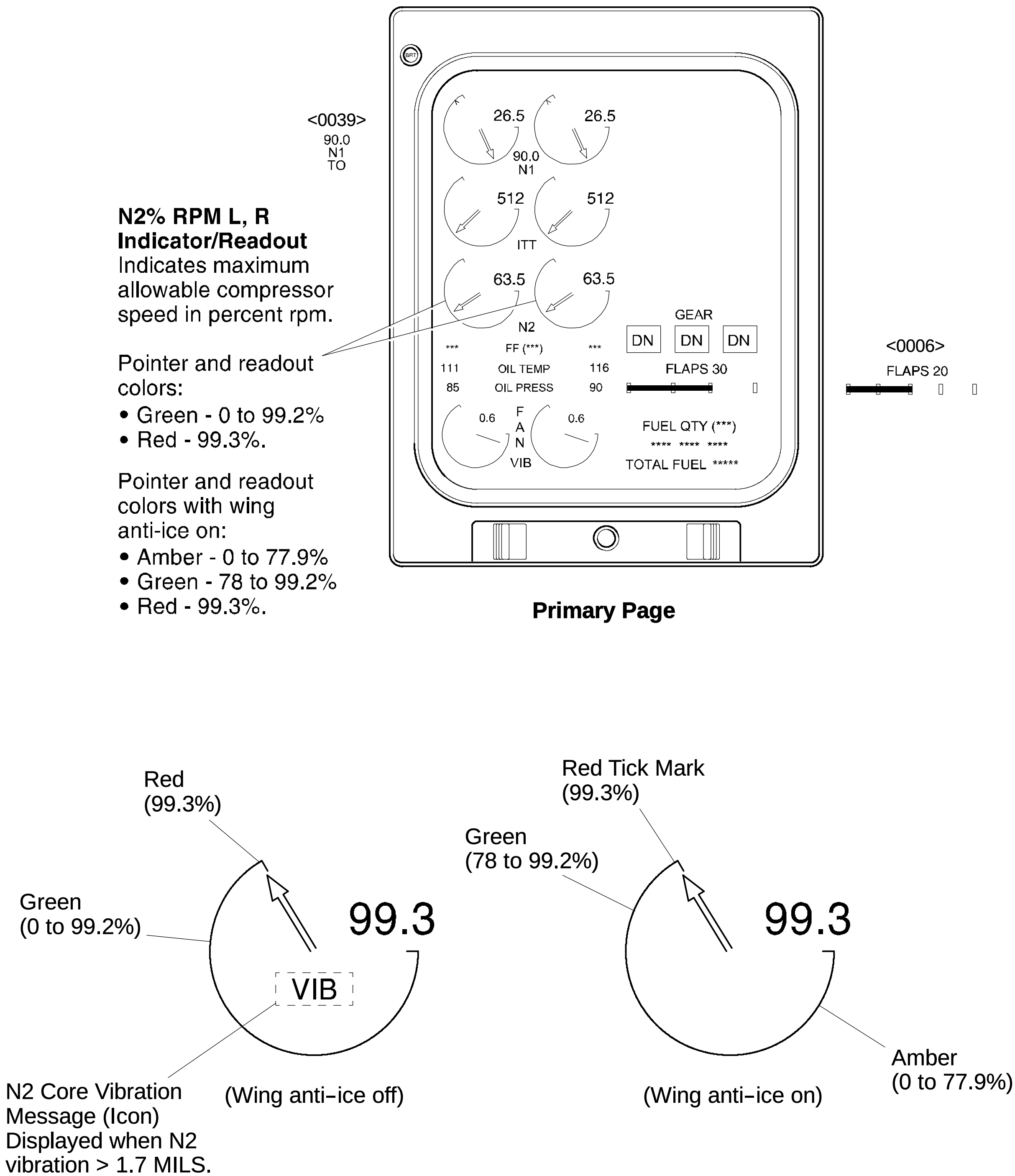
Red (98.6%)

<0039>
N1 REFERENCE
- TO – Take–off
- GA – Go–around
- FLEX – Reduced thrust take–off.
- CLB – Climb
- CRZ – Cruise
- MCT – Maximum continuous thrust
- TGT – Manual entry of target N1.

Green (0 to 98.5%)

N1 REFERENCE
- L/R APR (green)
- L/R REV (green)
- L/R REV (amber)

Engine Indication (N1) <MST>
Figure 20–50–4



Engine Indication (N2) <MST>
Figure 20-50-5

APR icon (L, R engine) (green)
Comes on when engine is in an APR condition.

APR ARM Advisory (green)
Comes on to indicate APR system has been armed (N1 > 79%).

APR TEST (1, 2) OK Advisory (green)
Comes on to indicate successful test of DCU and APR circuits.

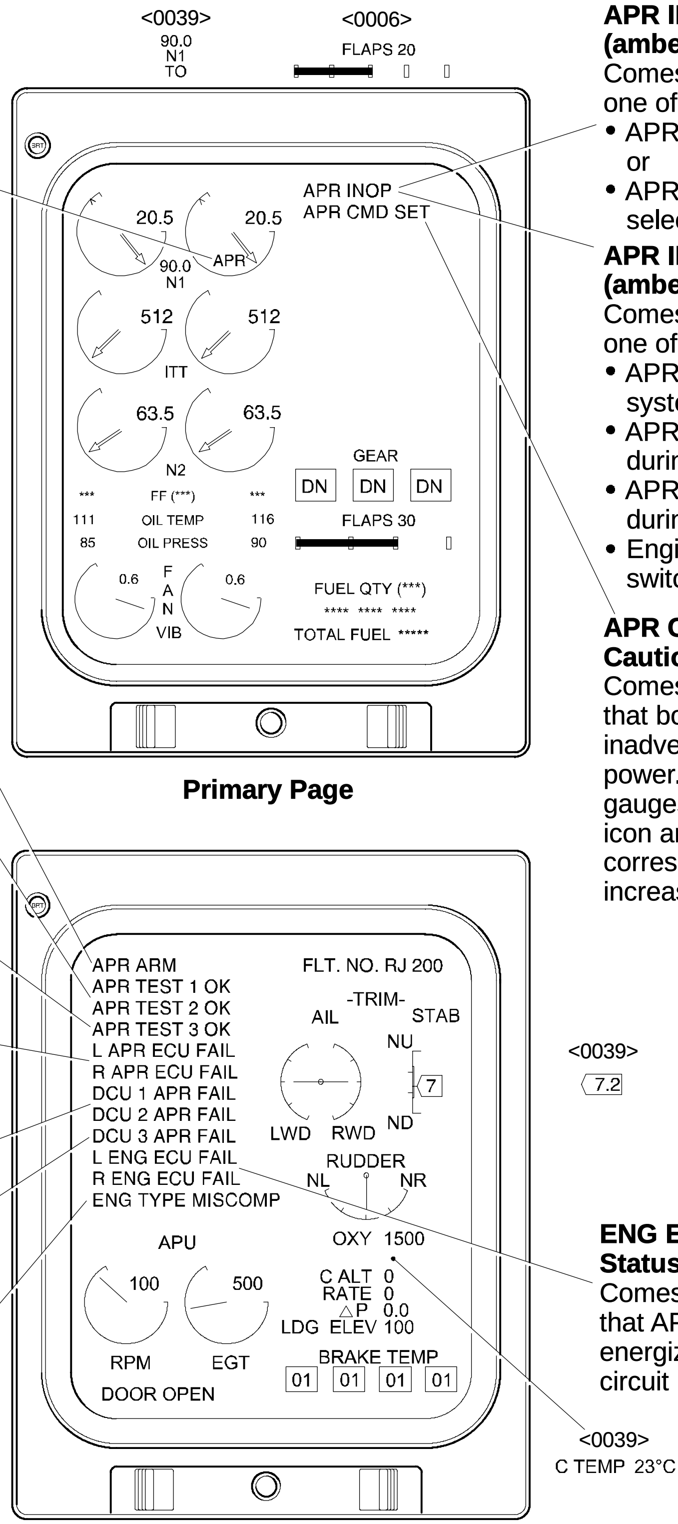
APR TEST (1, 2, 3) OK Advisory (green) <0019>
Comes on to indicate successful test of DCU and APR circuits.

APR ECU FAIL (L, R) Status (white) <0039>
Comes on to indicate that APR relay has energized but APR circuit is not triggered.

DCU APR (1, 2) FAIL Status (white)
Comes on to indicate that APR relay has not energized during test.

DCU APR (1, 2, 3) FAIL Status (white) <0019>
Comes on to indicate that APR relay has not energized during test.

ENG TYPE MISCOMP Status (white) <0005>
Comes on to indicate that there is a DCU miscompare.



Primary Page

Status Page

APR INOP Caution (amber) <0039>
Comes on to indicate one of the following:
- APR has failed, or
- APR switch is selected off.

APR INOP Caution (amber)
Comes on to indicate one of the following:
- APR has failed system tests, or
- APR has failed during flight, or
- APR is not armed during take–off or
- Engine speed switches are not on.

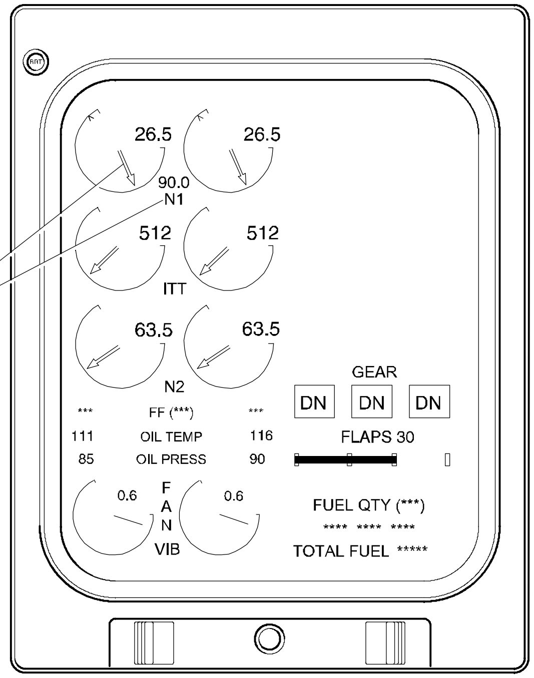
APR CMD SET Caution (amber)
Comes on to indicate that both engines are inadvertently at APR power. Both N1 gauges indicate APR icon and corresponding N1 increase.

ENG ECU (L, R) FAIL Status (white)
Comes on to indicate that APR relay has energized but APR circuit is not triggered.

Automatic Performance Reserve (APR) <MST>
Figure 20–50–6

TAKEOFF N1 POINTER AND READOUT (cyan)
- Comes on when the airplane is on the ground in a takeoff or landing configuration.
- Removed from the display when the airplane is at cruise altitude or when the airplane lands.
- Pointer and readout <PRE0039> values set at EICAS MENU page.

<0039>
90.0
N1
TO



Primary Page

NOTE <0039>

The N1 reference bugs and digital readout values are normally set by the FMS. If the FMS fails, the N1 reference bugs and digital readout values are set using the MENU page.

<0006>

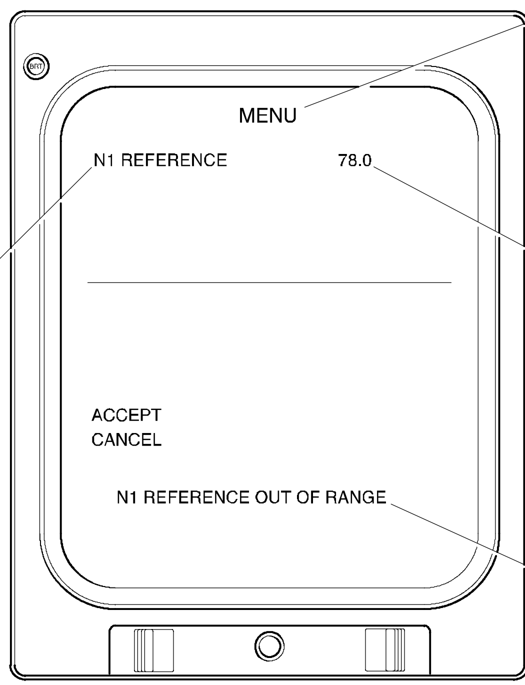
NOTE

N1 bug must be manually reset for go–around.

N1 bug comes on during flap or gear extension.

EICAS MENU PAGE
Displayed when MENU key on EICAS control panel is pressed.

N1 REFERENCE Line
- Accessed through UP/DN keys on EICAS control panel.
- Values set by slewing through digits (using UP/DN) and confirming each digit with SEL switch.
- Cursor will go to ACCEPT line and prompt message will appear if entry is not within 76 to 98.5. SEL switch used to confirm entry.
- CANCEL line used to cancel edit.
- Values entered will be displayed on primary page when conditions are met.

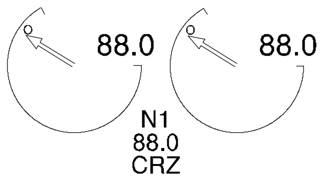


Menu Page

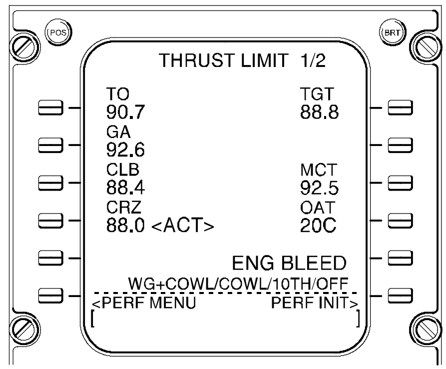
N1 REFERENCE READOUT
- Green – Active and/or preset data that may be displayed on primary page.
- Cyan – Data being edited.
- White – Inactive/ default data. Readout defaults to last entered data.

N1 REFERENCE OUT OF RANGE Error Message (white)
Comes on if pilot input is not within 76 to 98.5 % N1.

Engine Indication (N1 Bug) <MST>
Figure 20–50–7

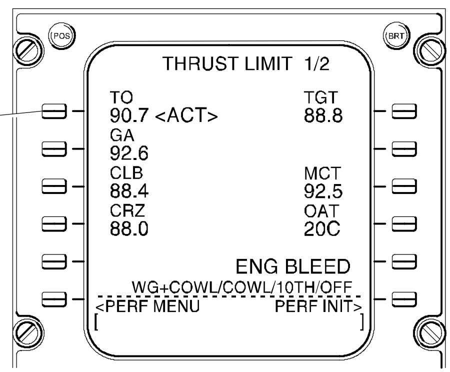


CRZ selected on the FMS and displayed as a doughnut on the primary page.



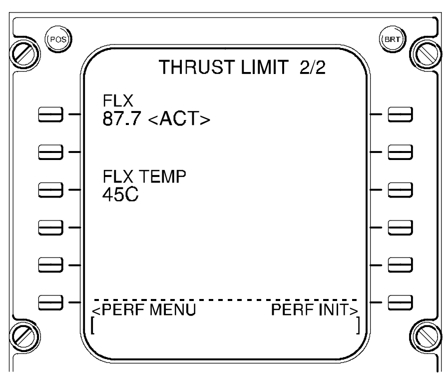
To make the <ACT> cursor move, press line select key opposite the desired thrust value.

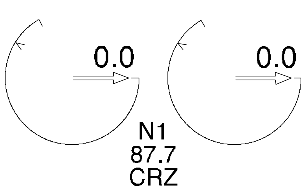
When selected, the white <ACT> changes to cyan, along with the thrust value. The value is now displayed on the primary page.



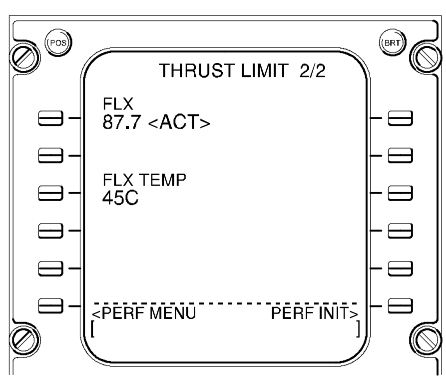
To display the FLX value on the FMS, first a FLX TEMP must be entered.

When FLX is selected, the white <ACT> changes to magenta, along with the thrust value. The thrust value is now displayed on the primary page.





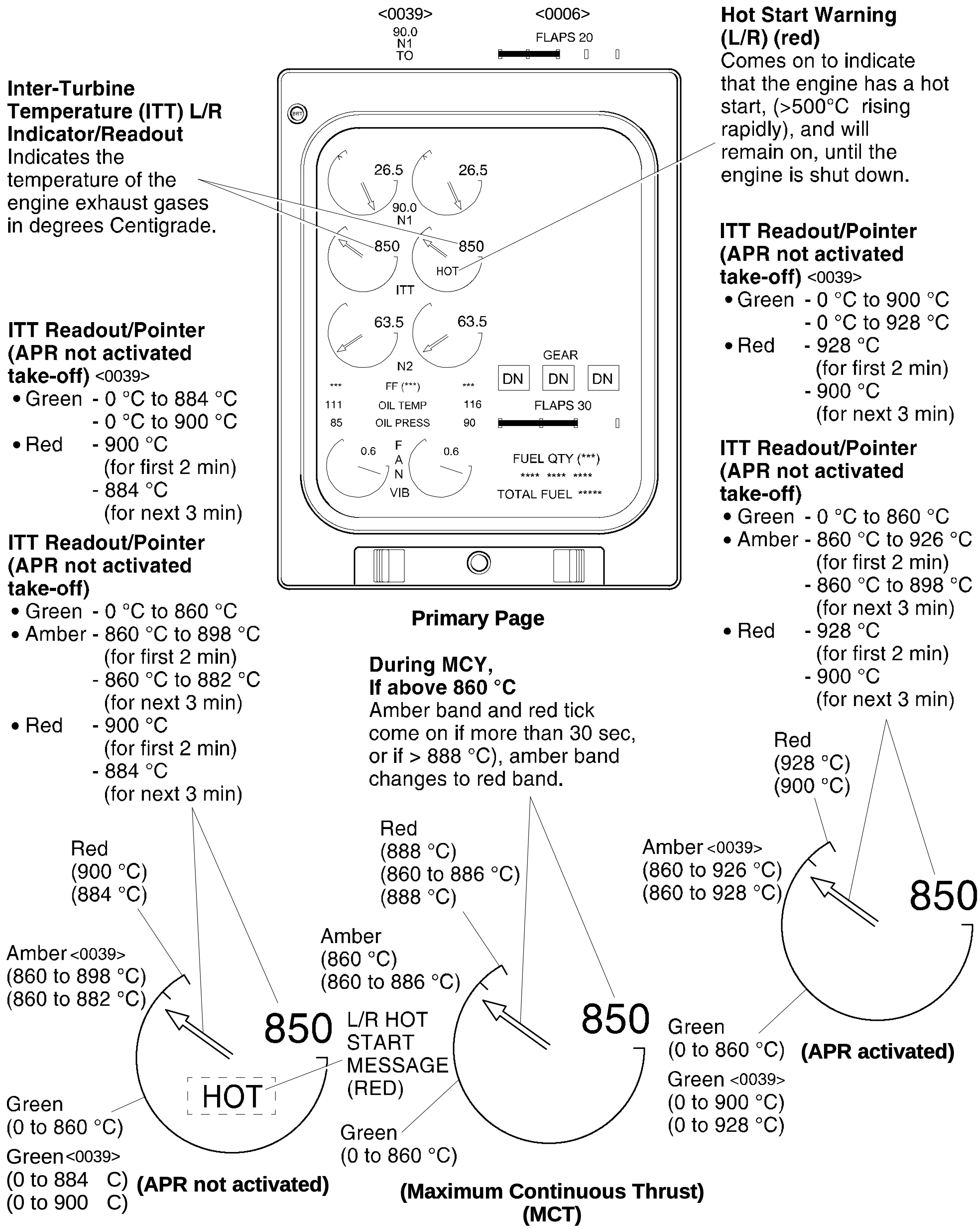
FLX selected on the FMS and displayed on the primary page. Once airborne FLX is removed from the FMS.



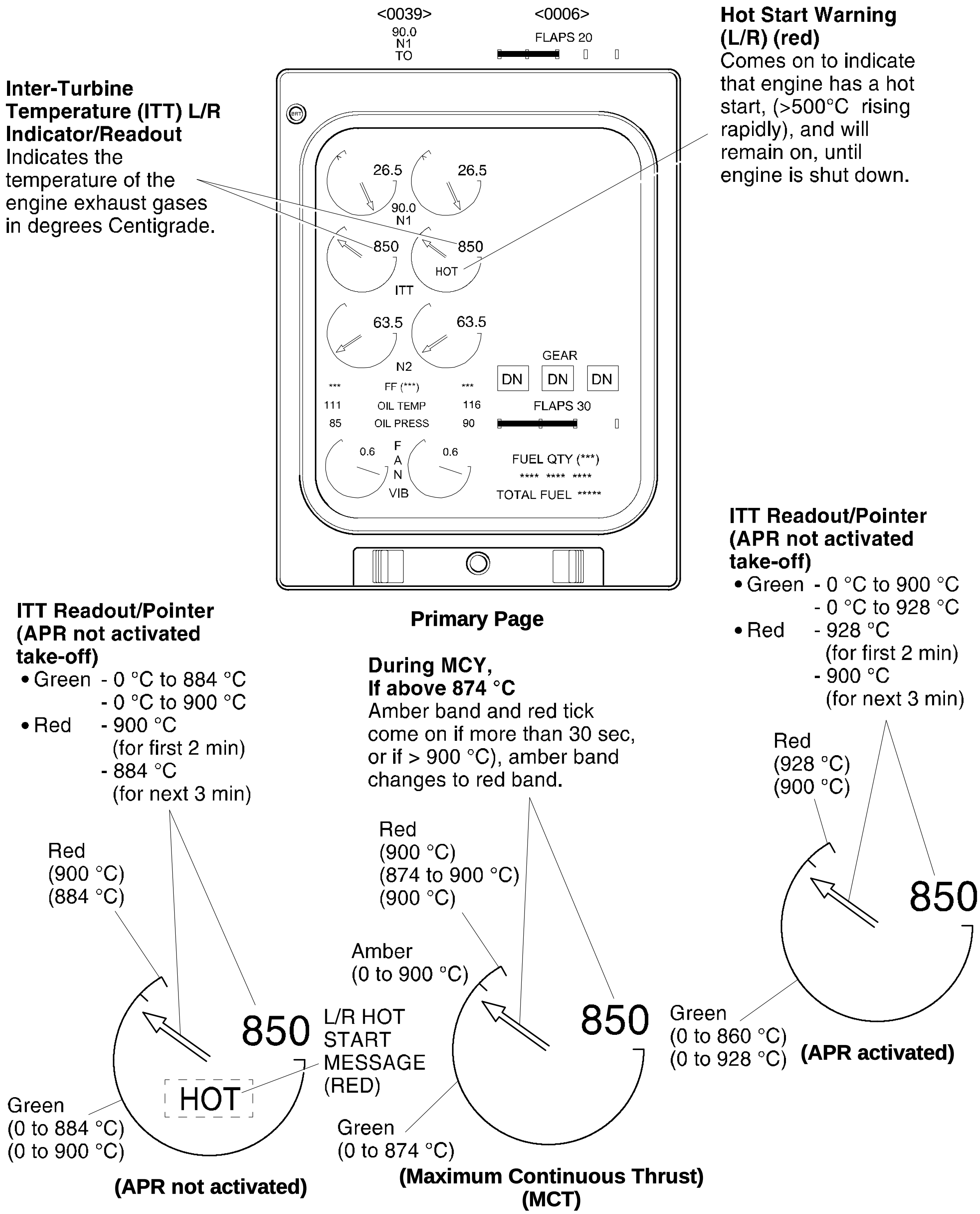
Flight Management System Thrust Limit <0039>
Figure 20–50–8

1. INTERTURBINE TEMPERATURE (ITT) MONITORING

The engine ITT is measured by ten probes mounted around the engine turbine section. The probes measure the average gas path temperature at the high pressure turbine (HPT) exit Each probe generates a millivolt signal which is sent to an engine mounted junction box where the signals are averaged and then sent to the DCU's for ITT indication on the EICAS primary page.



Engine Indication (ITT) for CF34–3A1 <MST>
Figure 20–55–1



Engine Indication (ITT) for CF34−3B1 <MST>
Figure 20−55−2

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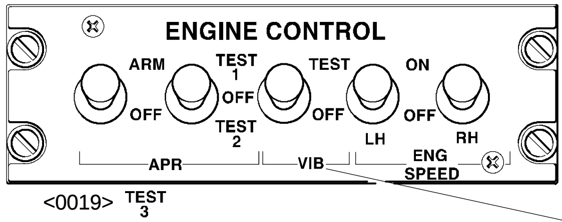
1. VIBRATION MONITORING

The N1 fan and the N2 core section are continuously monitored for vibration. A signal conditioner unit, mounted in the avionics compartment, monitors the vibration levels in each engine that it receives from N1 fan and N2 core speed sensors. The unit processes the signals and provides output signals to the DCU's for display on the EICAS primary page. The system can be tested using the VIB test switch on the ENGINE CONTROL panel.

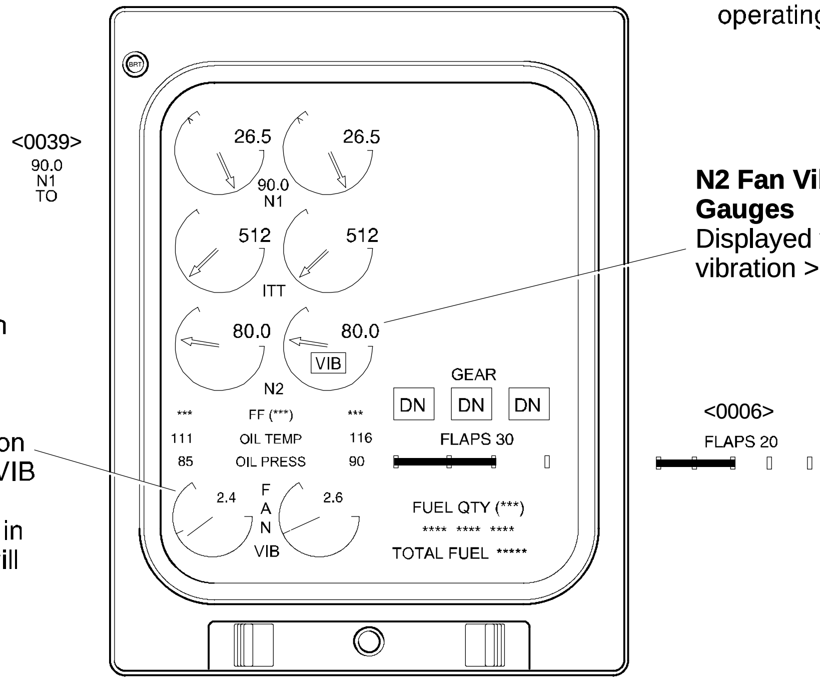
The N2 vibration level is only indicated as a VIB icon on the respective N2 gauge when the vibration level exceeds 1.7 mils.

The N1 fan vibration gauges are only displayed after engine start when both engines are at idle and the engine oil pressure is normal. When the N1 vibration level exceeds 2.7 mils, the gauge and pointer color change to amber. When either engine is shutdown or oil pressure is low, the N1 vibration gauges revert to oil pressure gauges.



Engine Control Panel
Center Pedestal

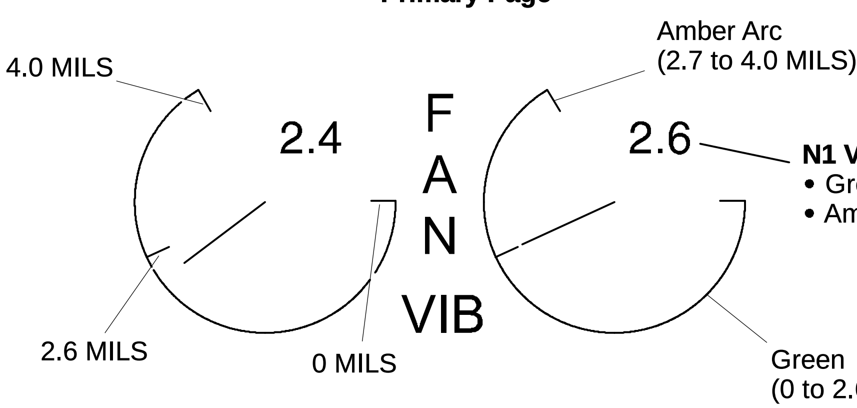
Vibration Monitor Switch
Used to test vibration monitor system.
- TEST - Functional test of display and control circuit. EICAS will show FAN VIB reading of 3.6 MILS and N2 VIB icon.
- OFF - Normal operating position.



N1 Fan Vibration Gauges
- Displayed after engines have both reached 55% N2 (+ 2 seconds).
- During single engine operation on the ground, FAN VIB reverts to oil pressure gauges, in the air FAN VIB will remain.

N2 Fan Vibration Gauges
Displayed when N2 vibration > 1.7 MILS.

Primary Page



N1 Vibration Readout
- Green 0 to 2.6 MILS
- Amber w 2.7 MILS

Engine Vibration Monitoring <MST>
Figure 20–60–1

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Power Plant	Vibration Monitor	ENG VIB MON	DC BAT	1	C7	

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1. THRUST REVERSER SYSTEM

The thrust reverser (TR) system is used to assist in stopping the aircraft during landing rollout or during a rejected/aborted take-off.

The TR system is installed at the discharge end of the fan duct and provides reverse thrust by redirecting fan bypass air in the forward direction through a series of blocker doors and cascade vanes. The TR actuating system uses pneumatic pressure from the 14th-stage bleed air system to deploy and stow the thrust reverser.

The TR system is armed using the thrust reverser LH and RH ARMED switches on the THRUST REVERSER panel on the center console. The TR system is controlled using the thrust reverser levers on the thrust lever quadrant.

Each thrust reverser lever is held down in the stow position by a lever lock which is released by pressing on the release trigger under the reverser handle. Raising the thrust reverser levers is only possible when the thrust levers are at IDLE. This action simultaneously locks the forward thrust levers in the IDLE position.

The thrust reverser levers can initially be raised approximately 20°, where they contact a solenoid stop. The solenoid stop prevents TR lever movement beyond deploy or reverse idle positions until the reverser assemblies are fully deployed.

NOTE

An autoretarding thrust lever mechanism makes sure that the thrust levers are at idle whenever the thrust reverser assemblies are in transit. In flight, should a thrust reverser inadvertently deploy, the autoretarding mechanism will automatically retard the affected engine thrust lever to IDLE to minimize asymmetric thrust.

Once the TR is fully deployed, the TR levers control reverse thrust from idle to maximum reverse power. Reverse operation shuts off the 14th-stage bleed air. Returning the TR levers to idle (full down) opens the 14th-stage bleed air and stows the reversers. Once the reversers are stowed, the thrust levers can be moved forward to increase engine thrust.

NOTE

Reverser deployment does not prevent the thrust levers from being selected to shutoff.

Emergency stow switches are provided on the TR panel to drive the thrust reverser to the stow position should the automatic stow system fail.

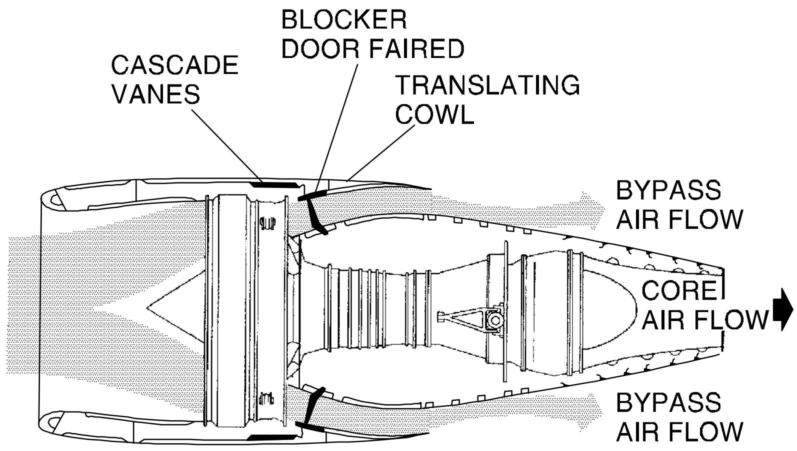
WARNING

< For aircraft not ***incorporating*** *SB 601R-27-012 Effectivity AC 7003, 7007 to 7030, 7033, 7035, 7038, 7078, 7081 to 7126>*,
Inadvertent actuation of the thrust reverser triggers, may result in thrust reverser lock at idle. If this occurs, stow the thrust reverser levers in the full forward position.

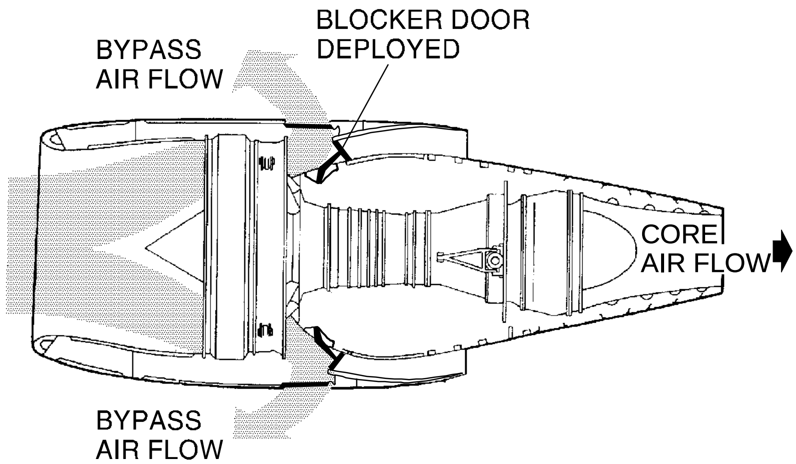
The 14th–stage bleed air does not supply sufficient air pressure to operate the anti–ice system and the TR system at the same time. Therefore, the anti–icing system is automatically disabled upon thrust reverser deployment and remains disabled until the TR has been stowed for 5 seconds.

CAUTION

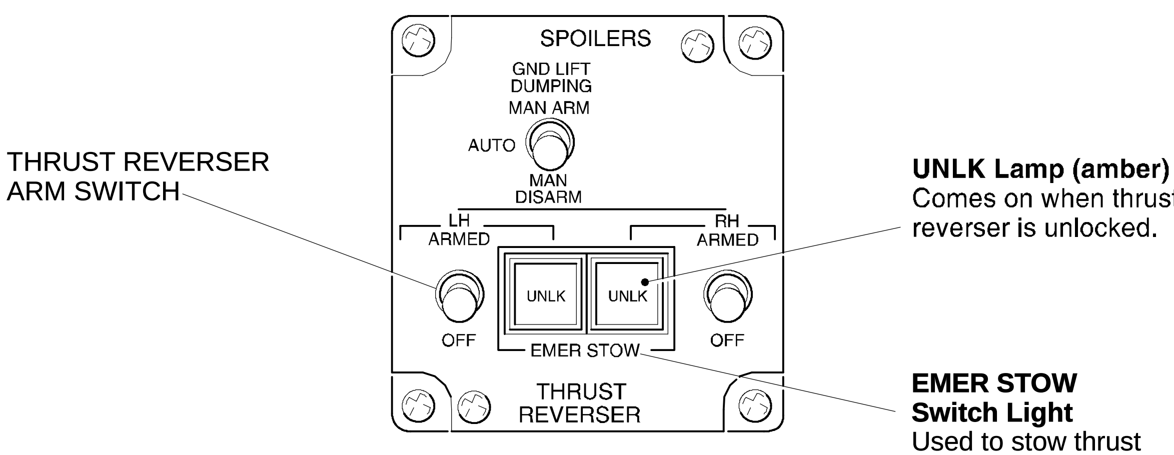
Wing overheat (WING OVHT) may occur if only one thrust reverser is deployed with both engines operating and the wing anti–ice selected on.



Normal Operation



With Reverser Deployed



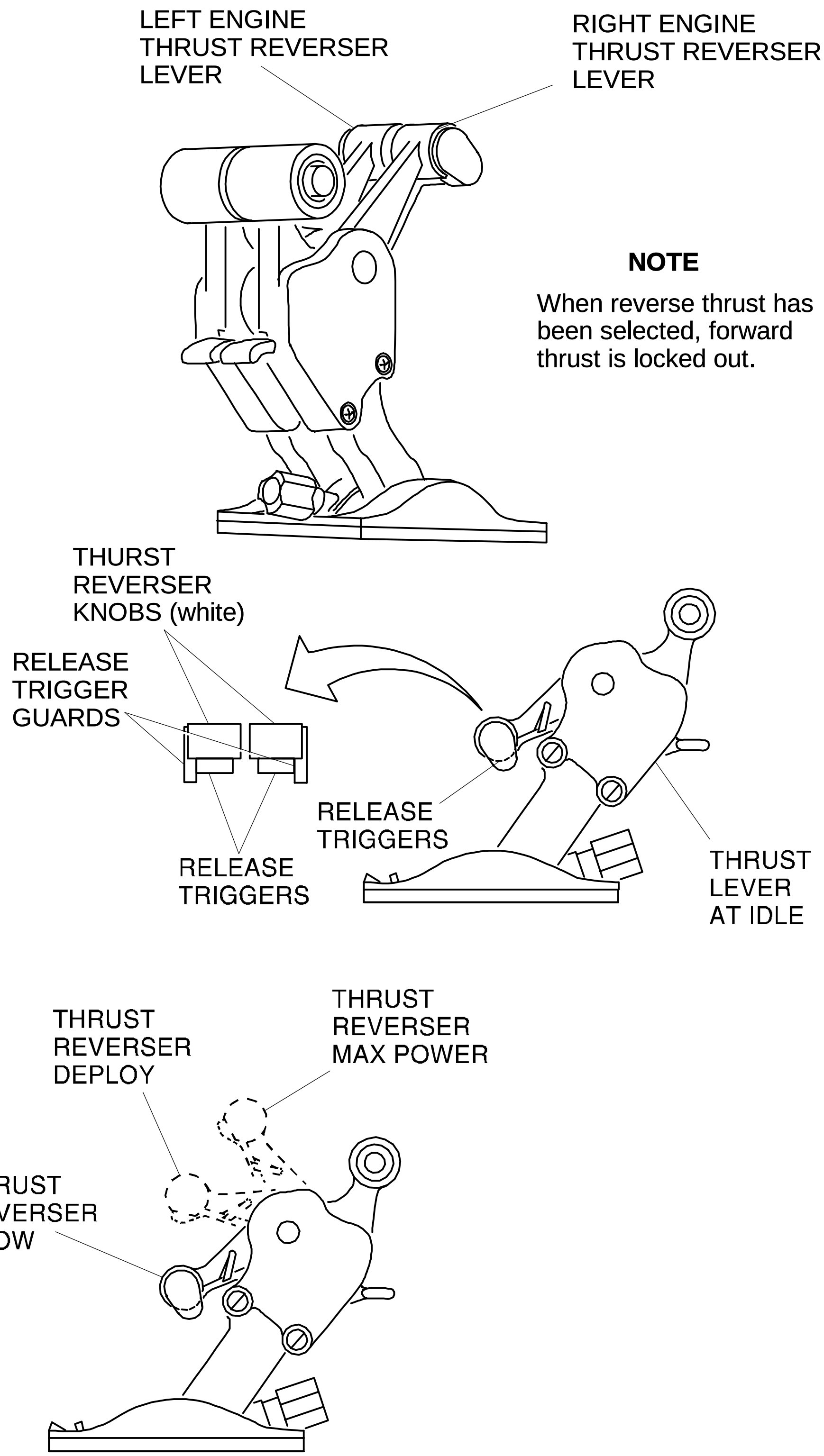
Spoilers/Thrust Reverser Panel
Center Pedestal

Thrust Reverser Operation
Figure 20–70–1

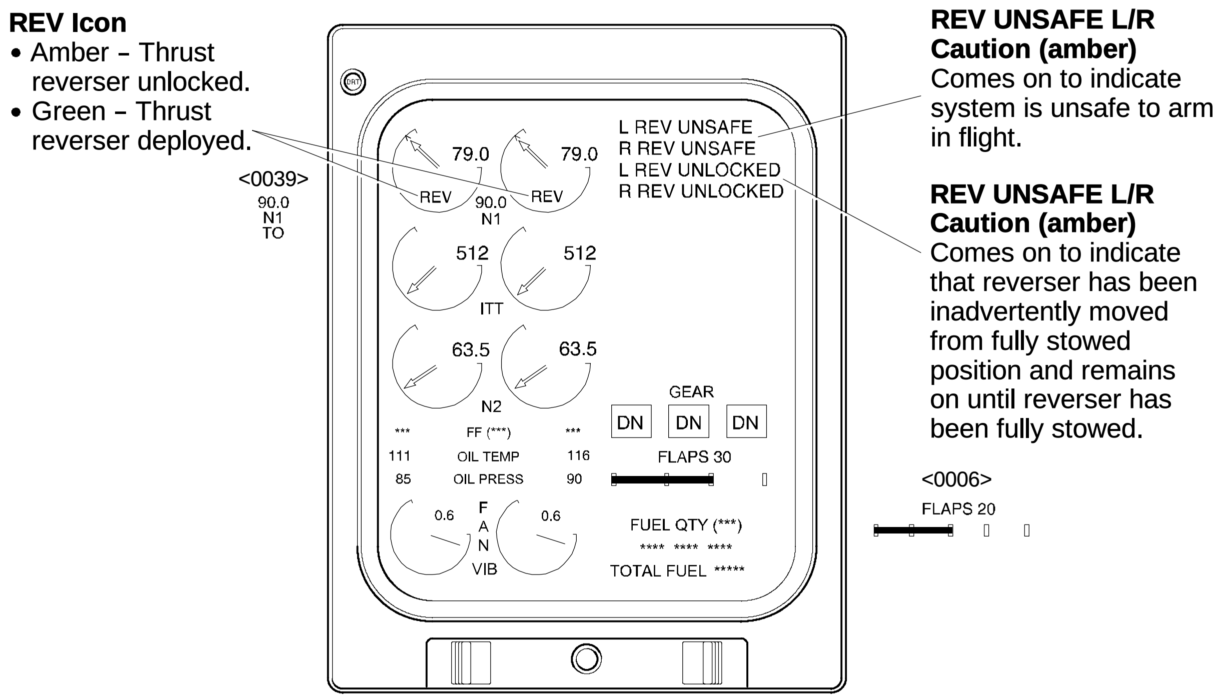
Thrust Reverser (TR) Levers
With thrust levers at IDLE, pulling on TR levers deploys thrust reversers if the following conditions are met:
- Thrust reverser system is armed (THRUST REVERSER switch at ARMED and EICAS acknowledgment messages L REV ARMED and R REV ARMED).
- Aircraft is on ground or wheel spin–up exceed 16 kt.

NOTE

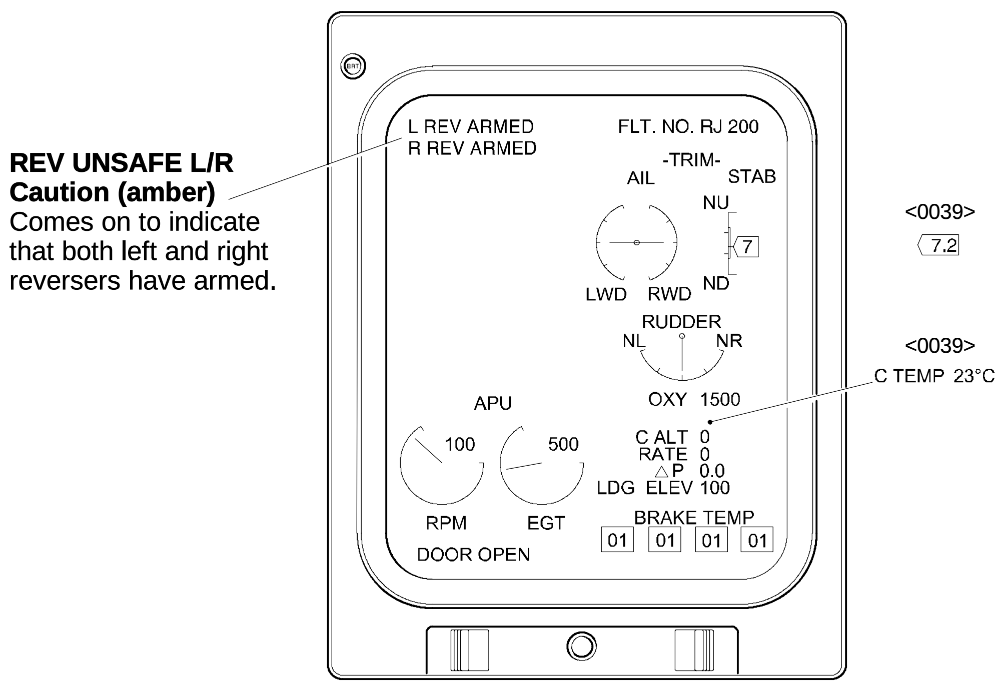
When reverse thrust has been selected, forward thrust is locked out.



Thrust Reverser
Figure 20–70–2



Primary Page



Status Page

Reverse Thrust – EICAS Indications <MST>
Figure 20–70–3

A. System Circuit Breakers

SYSTEM	SUB-SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Power Plant	Thrust Reversers	THRUST REV AUTO STOW 1	DC ESSENTIAL	4	B5	
		THRUST REV AUTO STOW 2			B6	
		THRUST REV 1			B7	
		THRUST REV 2			B8	