GENERAL

The Challenger 605 is equipped with two General Electric CF34-3B high-bypass ratio turbofan engines.

The dual-assembly engine consists of a fan rotor (N_1) and a compressor rotor (N_2). The N_1 rotor is comprised of a single-stage fan connected through a shaft to a four-stage low-pressure turbine. The N_2 rotor is a 14-stage axial flow compressor connected through a shaft to a two-stage high-pressure turbine. The accessory gearbox is mechanically driven by the N_2 compressor.

Normal takeoff thrust rating is 8,729 pounds per engine. During engine-out operation, the automatic performance reserve (APR) system increases thrust on the operable engine to 9,220 pounds.

FLAT-RATED THRUST

Outside air temperature and pressure altitude are determining factors in achieving takeoff and APR power. Increases in ambient temperature or pressure altitude adversely affect the engine's ability to produce rated thrust. The CF34-3B is flat-rated to ISA + 15°C at sea level.

ENGINE CONSTRUCTION

Description

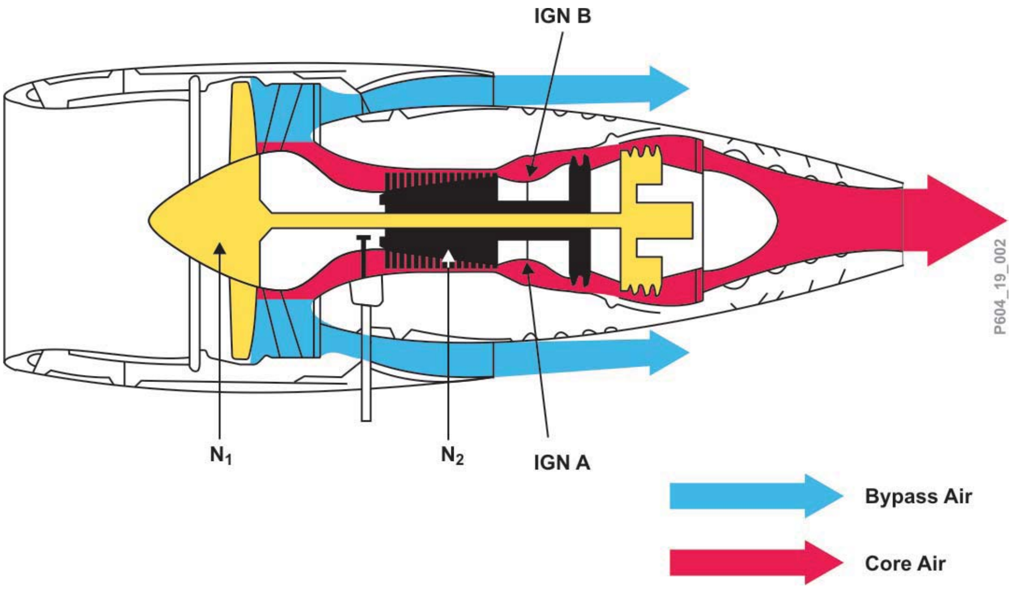
The CF34 power plant has two independently rotating major assemblies. The N_1 section consists of a fan rotor that is driven through a shaft by a four-stage low-pressure turbine. The N_2 section is comprised of a 14-stage axial flow compressor, a combustor, an accessory gearbox and a two-stage high-pressure turbine. The compressor is driven by the high-pressure turbine.

Flow Distribution

Engine airflow passes through the single-stage fan, and is divided into two airflow paths:

- Bypass air – Air is accelerated by the single-stage N_1 fan only, and is ducted around the engine nacelle. Bypass airflow produces approximately 80% of the thrust at takeoff. Thrust reversers are used to divert the bypass air forward to assist in airplane braking on the ground.
- Core air – Air that is accelerated by the N_1 fan enters the N_2 core where it is compressed, mixed with fuel, and ignited. The resulting combustion gases are exhausted through the high-pressure two-stage N_2 turbine, which drives the N_2 assembly. The exhaust gases are then discharged through the low-pressure four-stage N_1 turbine to drive the N_1 fan. Jet pipe thrust produces approximately 20% of the takeoff thrust.

ENGINE CONSTRUCTION (CONT'D)



Flow Distribution
Figure 19–10–1

Major Power Plant Components

N_1 Fan

The N_1 fan is a single-stage fan that consists of 28 titanium blades. A Kevlar blanket is wrapped around the inlet housing to contain damage from a failed fan blade. The N_1 fan rpm is displayed on the EICAS page.

Variable Geometry (VG) Compressor

The VG system regulates airflow across the compressor, by changing the position of the compressor inlet guide vanes and the first five stages of the stator vanes. Fuel metered by the fuel control unit (FCU) is used to hydraulically change the vane angle. The VG system optimizes the airflow's angle of attack at the compressor blades, and provides compressor stall and surge protection.

Accessory Gearbox

The engine-mounted accessory gearbox is driven by the N_2 compressor. The gearbox drives the:

- Engine lubrication pumps;
- Alternator that powers the N_1 control amplifier;
- Engine-driven hydraulic pump (hydraulic pump 1A or 2A);
- Engine-driven fuel pump; and
- Integral drive AC generator (IDG).

Mounted on the gearbox is the air turbine starter (ATS).

The N_2 rpm is displayed on the EICAS page.

ENGINE FUEL SYSTEM

Description

Fuel is delivered to the fuel injectors at pressures and flow rates required to maintain the desired engine thrust. The engine fuel system, in addition to providing fuel for combustion, is used for:

- Controlling and actuating the VG compressor linkage;
- Cooling the engine oil (heat exchange);
- Actuating and lubricating servos within the fuel control unit (FCU); and
- Providing motive flow for the main ejector and scavenge ejector pumps.

Combustion fuel can be interrupted by moving the thrust lever to SHUT OFF, or by selecting the engine FIRE PUSH switch/light. The SHUT OFF position shuts off the fuel at the FCU. The FIRE PUSH switch/light closes the fuel shutoff valve.

Components and Operation

Engine-Driven Fuel Pump

The accessory gearbox-mounted fuel pump is comprised of three separate pumps contained within a single housing. The engine-driven fuel pump provides high-pressure fuel at a flow rate that exceeds the requirements of the engine at any power setting. Fuel pump pressure is used to generate motive flow for the scavenge and main ejectors of the aircraft fuel system.

Fuel/Oil Heat Exchanger and Fuel Filter

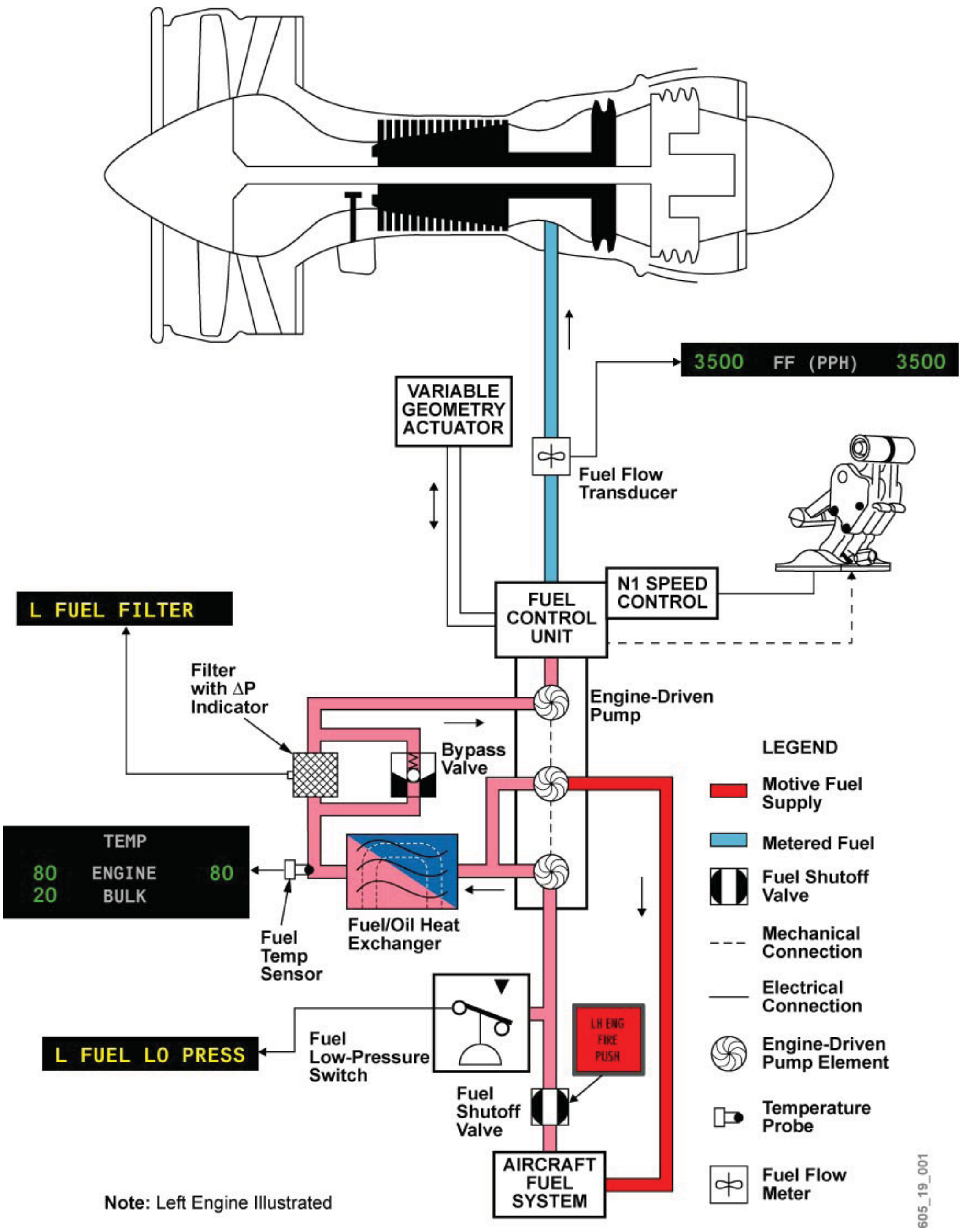
A fuel/oil heat exchanger is used to warm engine fuel and cool engine oil. The fuel temperature at the fuel filter is indicated on the SUMMARY page. A fuel filter is used to remove solid contaminants from the fuel. If the filter becomes clogged, the fuel bypasses the filter to ensure continued operation. A clogged filter is indicated by the **L (R) FUEL FILTER** caution EICAS message.

Fuel Control Unit (FCU)

The fuel control unit is a hydromechanical metering device that supplies fuel in response to mechanical inputs from the thrust levers. In addition, the FCU controls and actuates the VG inlet guide vanes and stator vanes of the engine compressor.

During start and at low power, the FCU hydromechanically schedules the fuel.

ENGINE FUEL SYSTEM (CONT'D)



Engine Fuel System – Schematic
Figure 19–10–2

ENGINE FUEL SYSTEM (CONT'D)

Electronic Control Unit (ECU)

When at high thrust settings, the engine is controlled by an electronic control unit (ECU), which works in tandem with the FCU. The ECU is also referred to as the N_1 control amplifier. The ECU (or N_1 control amplifier) trims the FCU fuel output to maintain a N_1 speed schedule for a given thrust lever setting.

Fuel System Operation

N_2 Speed Control (N_1 <79%)

At low power settings (N_1 below 79%), the FCU hydromechanically controls the N_2 speed. In N_2 mode, the FCU adjusts N_2 speed, so that matched movement of the thrust levers produces nearly matched N_2 rpm for the engines. N_1 speeds, fuel flows, or ITT indications may differ between engines.

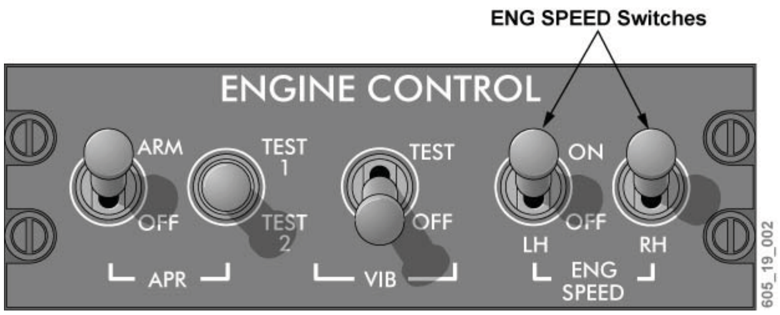
N_1 Speed Control (N_1 >79%)

At takeoff, climb and cruise power settings (N_1 above 79%), the N_1 control amplifier controls the engine N_1 rpm. The amplifier trims the FCU fuel output to achieve the desired N_1 rpm.

With the ENG SPEED switches selected to ON, automatic switchover from N_2 to N_1 speed governing occurs at 79% N_1. Matched movement of the thrust levers produces nearly matched N_1 rpm and nearly matched thrust between the engines.

NOTE

If an ENGINE SPEED switch is moved from ON to OFF at high power settings, the engine will revert to N_2 speed control. A rapid increase in engine acceleration will occur, and an overtemperature limit may be exceeded.



ENGINE CONTROL Panel
Figure 19–10–3

AUTOMATIC PERFORMANCE RESERVE SYSTEM

Description

During takeoff, the APR system monitors the N_1 rpm of both engines. If a significant loss of N_1 rpm is sensed on one engine, the APR system automatically increases the thrust of the remaining engine to the APR thrust rating.

AUTOMATIC PERFORMANCE RESERVE SYSTEM (CONT'D)

APR activation does not override thrust lever input to the FCU, nor does it restrict movement of the thrust lever.

Operation

The APR system is armed during takeoff when the APR switch is selected to ARM, and both engines' N_1 rpm is above 79% (N_1 speed mode). This is indicated by the **APR ARM** advisory EICAS message. During a normal takeoff, the advisory message is removed five minutes after APR arming.

During takeoff, the APR system monitors the N_1 rpm of both engines through the DCUs. If an N_1 rpm drop below 67.6% rpm is sensed at either engine, the system automatically commands both engines to increase N_1 speed. Only the normally operating engine can respond, which it does by increasing the N_1 fan speed by a minimum of 2%. This increase in rpm equates to an increase of approximately 500 pounds of thrust. No roll-back in N_1 rpm occurs when APR thrust has been commanded and the APR system times-out.

When the APR system is activated, a green APR icon appears in the center of the N_1 gauge of the operating engine.

APR Test

The APR TEST switches allow the system to be tested on the ground. The system can only be tested successfully with the engines operating. Normal system test operation results in the **APR TEST 1 (2) OK** advisory EICAS message. If the system fails, an **APR INOP** caution EICAS message is displayed.

ENGINE CONTROL Panel
Figure 19–10–4

ENGINE OIL SYSTEM

Description

Oil from each engine nacelle tank is circulated under pressure to lubricate the engine and accessory gearbox.

Components and Operation

The gearbox-driven main lubrication pump pressurizes the lubrication system. Oil flows from the pump through an oil filter, a fuel/oil heat exchanger, and continues through the engine sumps to the bearings and gearbox.

ENGINE OIL SYSTEM (CONT'D)

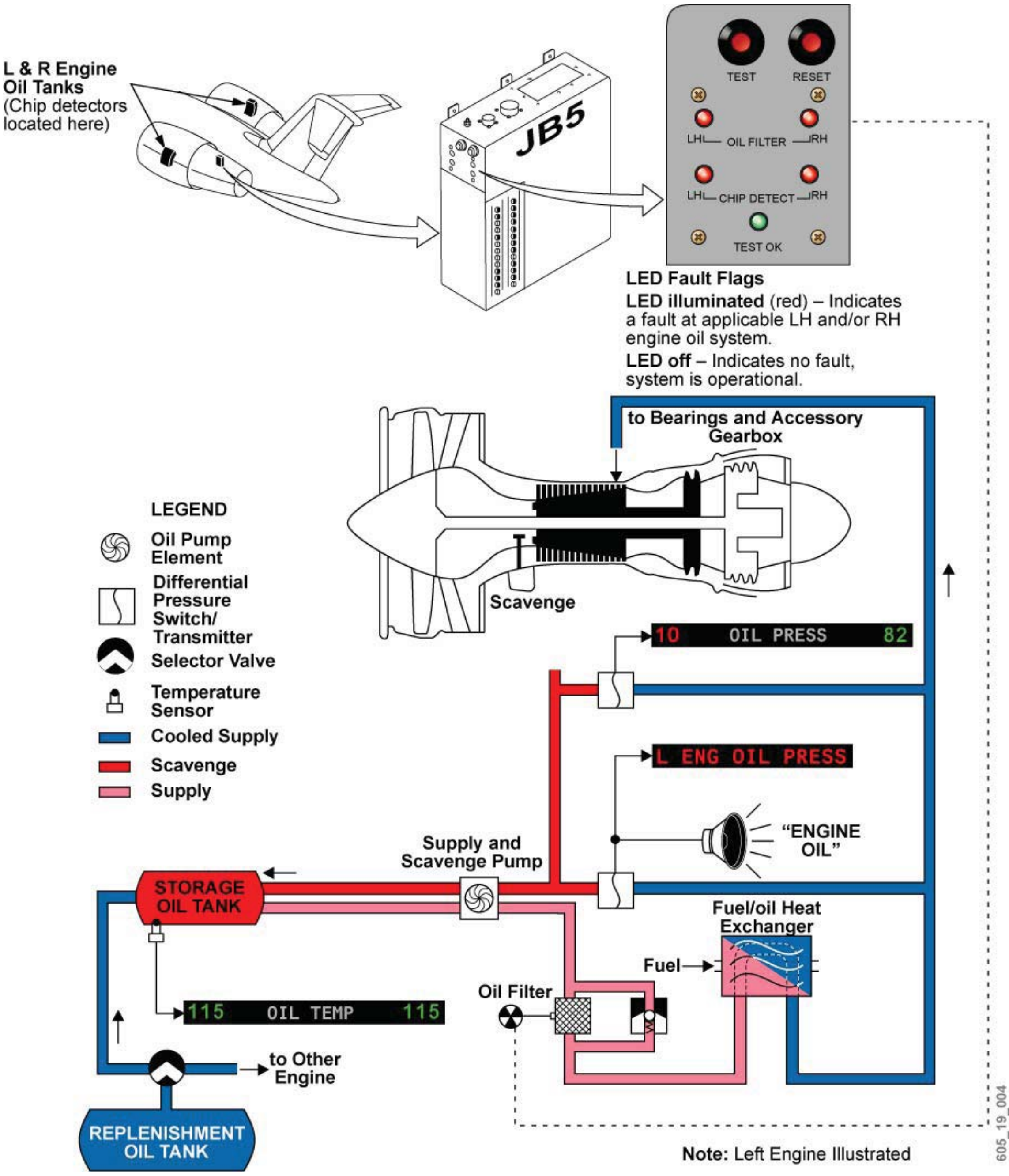
The oil is returned to the oil tank by the gearbox-driven main lubrication and scavenge pumps. The oil passes through scavenge screens for filtering prior to the oil pumps. The oil then flows through a chip detector and a deaerator to the tank. Maximum oil consumption is 6.4 ounces or 0.05 US gallons/hour.

Engine oil pressure and temperature indications are presented on the EICAS page. To provide system redundancy, a pressure switch and separate pressure transmitter are used to monitor the engine oil pressure. When low oil pressure is detected by the pressure switch, the **L (R) ENG OIL PRESS** warning EICAS message is presented. If the pressure transmitter detects low oil pressure, the EICAS digital oil pressure readout changes to red.

Chip detector and impending oil filter bypass indications are provided in the aft equipment bay on junction box 5 (JB5), but are not presented on EICAS.

Pressurized refilling of the engine oil tanks is provided by a replenishment tank system, located in the aft equipment bay. The system remotely gauges engine oil tank level, and is used to transfer oil to the engine-mounted tanks.

ENGINE OIL SYSTEM (CONT'D)



Oil System Schematic
Figure 19–10–5

Engine Oil Replenishment System

The Challenger 605 is equipped with an oil replenishment system, located in the aft equipment bay. The system consists of a replenishment tank, holding approximately 6.0 U.S. quarts of oil, a pump, selector valve, and control panel.

ENGINE OIL SYSTEM (CONT'D)

If a low oil tank quantity is indicated during the test, the nacelle oil tanks can be filled from the replenishment tank. Pump and selector valves, located next to the replenishment tank, are used to transfer oil from the replenishment tank to the applicable engine-mounted tank.

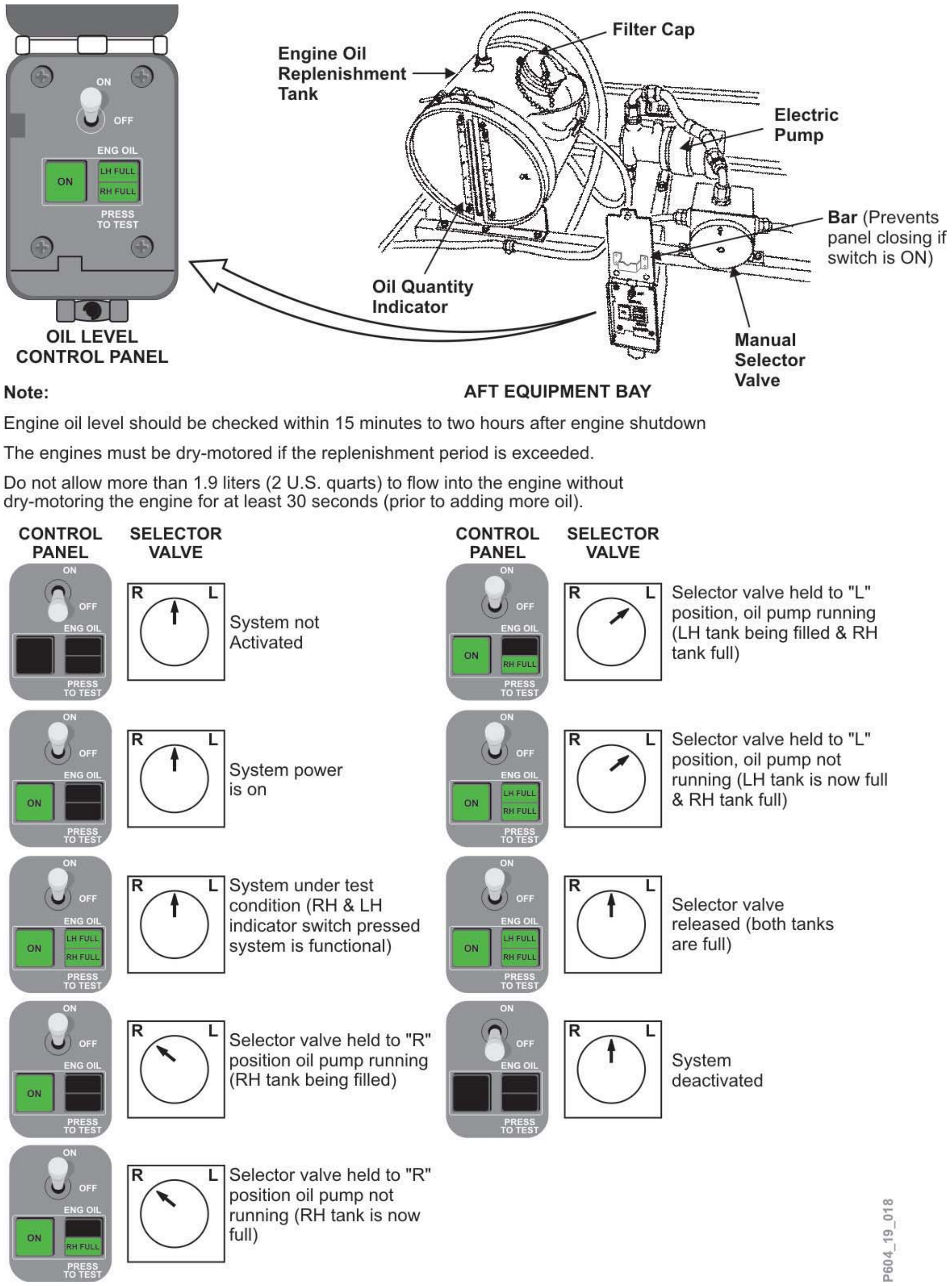
Engine Oil Replenishment Procedure

Oil levels should be checked between 15 minutes to two hours after engine shutdown. The engines must be motored if the replenishment period is exceeded. Maximum refill allowable is 2 U.S. quarts, then the engine must be dry-motored for at least 30 seconds prior to adding more oil.

Oil replenishment is accomplished as follows:

1. Note the oil quantity on the oil replenishment tank gauge.
2. The system power switch is selected ON, illuminating the green ON light.
3. The ENG OIL PRESS TO TEST switch/light is activated to illuminate (test) the green LH (RH)-FULL indications.
4. The selector valve is rotated to the L or R position, as required, to pump oil from the oil replenishment tank to the associated engine oil tank.
5. The selector valve is released when the pump automatically shuts off, and the LH (RH)-FULL legend illuminates. A full level is indicated by the illumination of the respective side green light (LH FULL or RH FULL).
6. The system power switch is selected OFF.
7. Oil quantity used for each engine is noted.

ENGINE OIL SYSTEM (CONT'D)



Oil Replenishment System
Figure 19–10–6

ENGINE BLEED AIR SYSTEM

Description

Engine bleed air is extracted from the 7th, 10th and 14th stages of the engine compressor, and used by the airplane systems below:

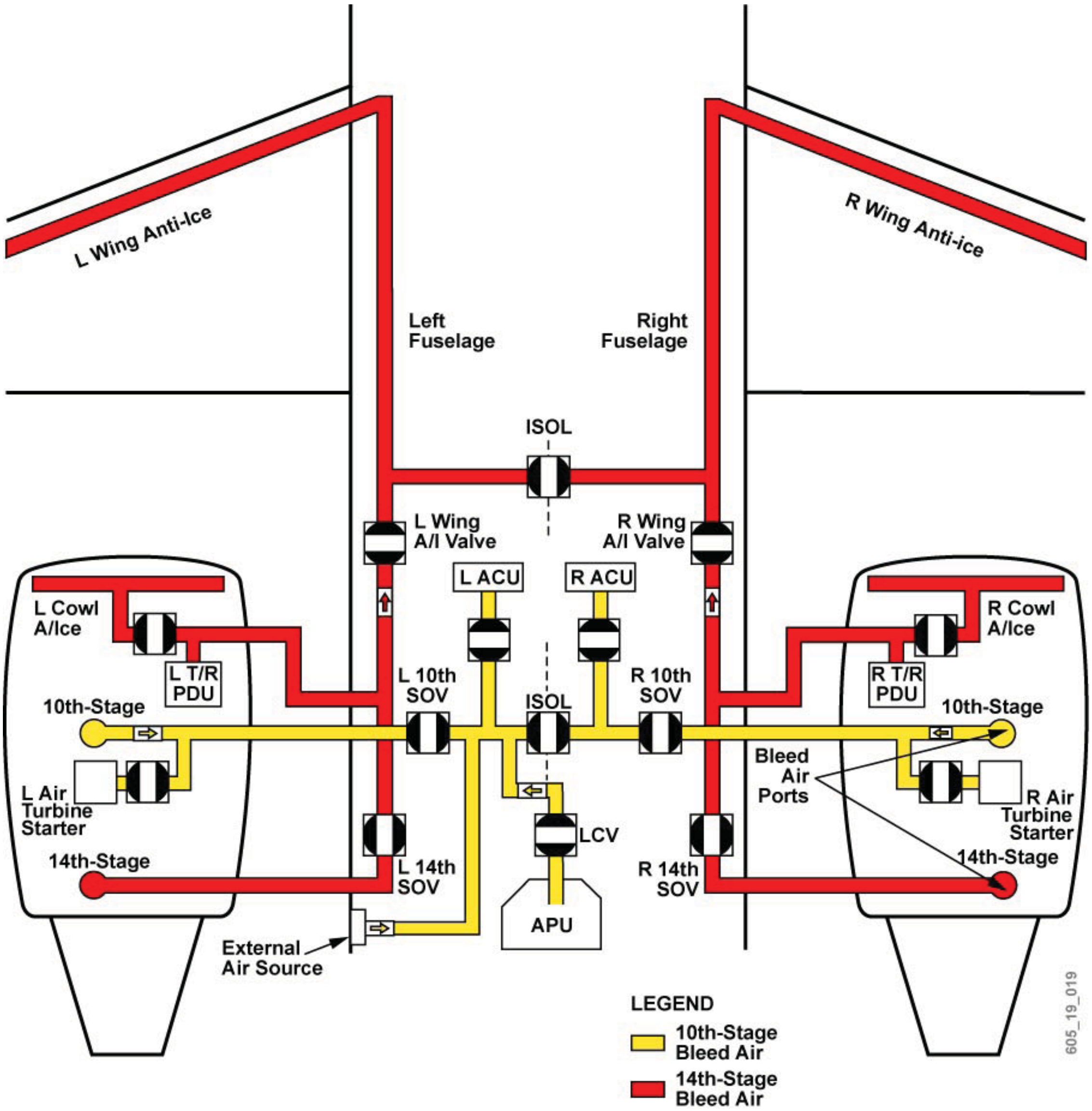
- 7th stage: Pressurization of oil seals, and the venting of engine sumps in the lubrication system.
- 10th stage: Pneumatic supply to the air conditioning and pressurization systems, and engine starting.
- 14th stage: Pneumatic supply to the engine cowl and wing anti-ice systems, or thrust reverser systems.

Components and Operation

Ducting and check valves are used to direct the flow of bleed air from the engine to the 10th- and 14th-stage bleed air manifolds. The nacelle and pylon ducts are monitored for bleed air leakage by the engine fire and jet pipe overheat detection systems.

For additional information, refer to Chapter 9, Fire Protection, and Chapter 18, Pneumatic System.

ENGINE BLEED AIR SYSTEM (CONT'D)



Engine Bleed Air System – Schematic
Figure 19–10–7

ENGINE STARTING SYSTEM

Description

The starting system consists of the starter control valve and the air turbine starter. The air turbine starter drives the accessory gearbox, which in turn drives the N_2 core section. DC electrical power and air from the 10th-stage bleed air manifold are required to open the starter control valve and engage the air turbine starter.

ENGINE STARTING SYSTEM (CONT'D)

The 10th-stage bleed air manifold can pressurized by the:

- APU;
- External air cart; or
- 10th-stage bleed air from the operating engine (crossbleed).

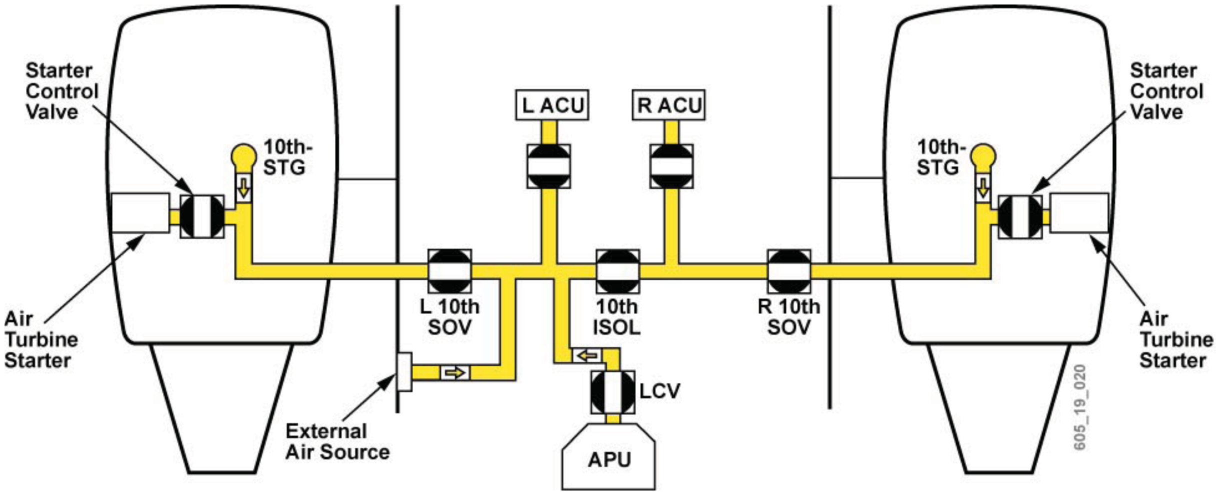
The following minimum bleed air pressures should be available for an engine start:

- APU – 40 psi;
- External air start cart – 45 psi; or
- Engine crossbleed – 60 psi (approximately 85% N_2).

L (R) 10th-stage bleed air manifold pressure is displayed on the SUMMARY page.

CAUTION

During an engine crossbleed air start, ensure that intake and exhaust areas of the operating engine are secure. When starting engines in close quarters, consideration should be given to the effects of jet blast.



Starting System – Schematic
Figure 19–10–8

Components and Operation

Starter Control Valve

The starter control valve is mounted next to the air turbine starter, inside the engine nacelle. It controls the initial rate of engine acceleration upon engagement of the starter, by regulating the amount of air supplied to the starter. The starter control valve is controlled by the START and STOP switches on the START/IGNITION panel.

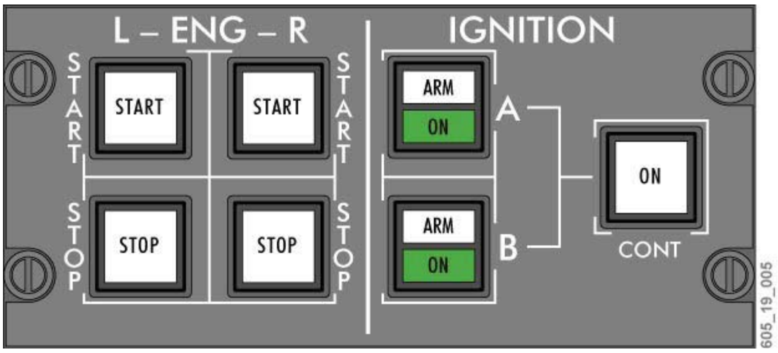
ENGINE STARTING SYSTEM (CONT'D)

Air Turbine Starter

The air turbine starter is mounted on the accessory gearbox. The air turbine starter converts pneumatic energy into mechanical motion. The starter mechanically engages the accessory gearbox through a clutch, and accelerates the N_2 section of the power plant. The starter is capable of dry-motoring the engine up to approximately 28% N_2 rpm. During a normal start, the starter remains engaged until 55% N_2, to assist the engine in accelerating to idle speed. At 55% N_2 rpm, the starter control valve closes and the air turbine starter disengages.

For subsequent starts or relights, the starter clutch does not require that engine rotation be completely stopped before engaging the starter. The air turbine starter may be engaged at any rpm up to 55% N_2 rpm (starter cutout speed).

Starter disengagement may be commanded at any time by pressing the engine STOP switch/light.



Engine Start/Ignition Panel
Figure 19–10–9

Start Sequence

Each engine has a set of START and STOP switch/lights on the ENGINE START/IGNITION panel. When the engine START switch/light is pressed, the following occurs:

- Left, right and isolation 10th-stage bleed air SOVs open;
- Starter control valve on the associated engine opens to allow pressure from the 10th-stage manifold to engage the air turbine starter;
- When the starter control valve opens, a white light illuminates in the associated START switch/light; and
- At 55% N_2 rpm, the start control valve is de-energized and the air turbine starter disengages.

The air turbine starter is subject to the following starter engagement limits:

STARTER ENGAGEMENT LIMITATIONS

START #	ENGAGEMENT TIME	COOLING PERIOD
1	30 seconds	none
2	30 seconds	none
3 & subsequent	30 seconds	5 minutes

ENGINE STARTING SYSTEM (CONT'D)

DRY MOTORING #	ENGAGEMENT TIME	COOLING PERIOD
1	90 seconds	5 minutes
2 & subsequent	30 seconds	5 minutes

Dry-Motoring

Dry-motoring is performed with ignition off and thrust levers at SHUT OFF.

Dry-motoring may be used for engine ground starts and engine airstarts.

IGNITION SYSTEM

Description

Two independent alternating current (AC) ignition systems are provided for each engine. Each ignition system consists of one ignition exciter and one igniter plug.

Ignition system A is powered by the AC essential bus. Ignition system B is powered by the battery bus through a static inverter.

Operation

There are three ignition system modes:

Normal – Prior to engine start, the ignition is armed by selecting either A or B ignition switch/light at the START/IGNITION panel. When an ignition system is armed, the corresponding white ARM light illuminates. Ignition is energized upon starter engagement, and is de-energized at starter cutout (55% N_2). While an ignition system is energized, the corresponding green ON light illuminates, and the **IGNITION A (B)** advisory EICAS message appears.

Continuous ignition – Continuous ignition may be selected by pressing the CONT ignition switch/light on the START/IGNITION panel. Both ignitions A and B are energized. When continuous ignition is selected, both green ON lights illuminate, and the **IGNITION A/B** advisory EICAS message appears.

Continuous ignition must be used during the following flight conditions:

- Takeoff and landings on contaminated runways;
- Takeoff with high crosswind components (greater than 10 knots);
- Flight through moderate or heavier intensity rain;
- Flight through moderate or heavier intensity turbulence; or
- Flight in the vicinity of thunderstorms.

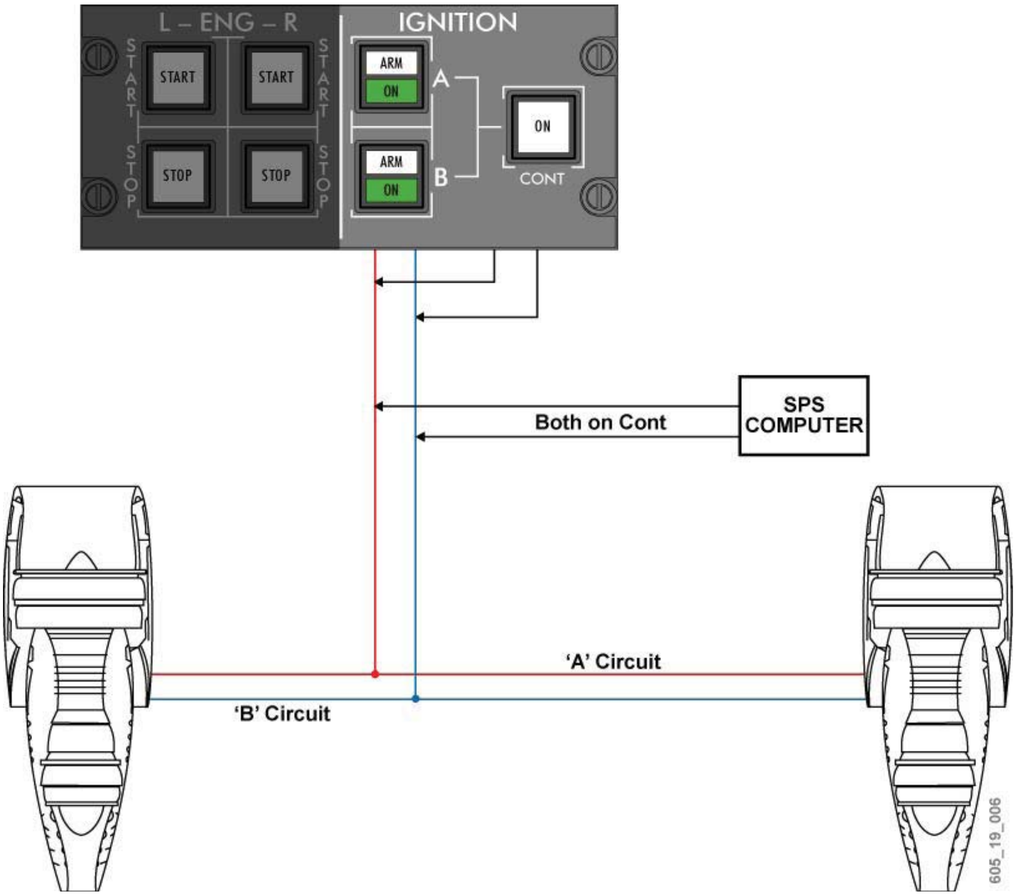
Autoignition (aerodynamic stall protection) – Automatic activation of continuous ignition is based upon angle-of-attack (AOA) data. Both systems A and B are energized by the stall warning computer, and remain on until the airplane flight attitude is corrected.

IGNITION SYSTEM (CONT'D)

CAUTION

Activation of the Stall Protection System Test will activate continuous ignition.

Both ignition systems A and B are disabled on the associated engine when the L (R) ENGINE FIRE PUSH switch/light is selected. If continuous ignition was in use, the white ON legend of the CONT switch/light will extinguish, but the green ON lights in the switch/lights remain illuminated, and the **IGNITION A/B** advisory EICAS message remains displayed (to advise the crew that continuous ignition is still active on the unaffected engine).



Ignition System
Figure 19–10–10

VIBRATION MONITORING SYSTEM

Description

The power plant consists of two major rotating assemblies, the N_1 fan and N_2 core sections. Each assembly is continuously monitored for vibration. Indications are displayed on the EICAS page.

VIBRATION MONITORING SYSTEM (CONT'D)

Operation

N_1 Fan

N_1 fan vibration is displayed as a numeric readout on the EICAS page as FAN VIB. When the N_1 vibration level is 2.7 mils or greater, the color of the readout changes to amber. There is no associated caution EICAS message.

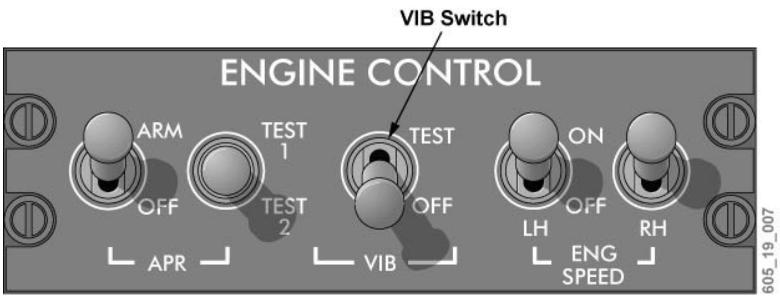
N_2 Core

N_2 core vibration levels are continuously monitored, but are presented only when vibration levels exceed a target value. An amber VIB icon appears in the middle of the N_2 gauge when the vibration target value is exceeded. There is no associated caution EICAS message.

Vibration Monitoring System Test

The system is tested by selecting the VIB switch on the ENGINE CONTROL panel to the TEST position. In the TEST position, high vibration levels are simulated in the electrical circuitry. The following indications appear on selection of the ENGINE VIB test switch:

- FAN VIB readouts increase to 3.6 mils, changing from green to amber, passing through 2.7 mils; and
- Amber VIB icons appear on the N_2 dials.



ENGINE CONTROL Panel
Figure 19–10–11

THRUST LEVERS

Description

The thrust lever quadrant contains the thrust levers, thrust reverse levers, microswitches, and internal locks and stops necessary to control the engines in forward and reverse thrust.

Operation

Thrust Levers

Most functions of the thrust levers are conventional in operation. Thrust lever quadrant settings are SHUT OFF, IDLE, and MAX POWER.

THRUST LEVERS (CONT'D)

Mechanical Stop

A mechanical stop prevents the thrust levers from inadvertent movement. When the thrust lever is at SHUT OFF, the thrust lever is mechanically locked in that position. When the thrust lever is at idle, the mechanical stop prevents the thrust lever from being accidentally moved to SHUT OFF. The mechanical stop is released by lifting the idle/shutoff release latch on the thrust lever.

Friction Knobs

A friction knob is set to a preset friction value for ATS operation, and is not adjustable by the pilot.

Thrust Lever Position Measurement

Actual thrust lever positions are electrically measured by rotary variable differential transformers (RVDTs), or sensed by microswitches that are housed within the thrust lever quadrant. The information is provided to the N_1 control amplifier, the flight control computers (FCCs), and the data concentrator units (DCUs). Other aircraft systems receive thrust lever position information, including:

- Landing gear warning system;
- Takeoff configuration warning system;
- Cabin pressurization; and
- Ground spoilers.

Takeoff/Go-Around (TOGA) Switches

A takeoff/go-around switch is mounted on each thrust lever. When pressed, the TOGA switch signals the flight control computers to activate flight director modes accordingly.

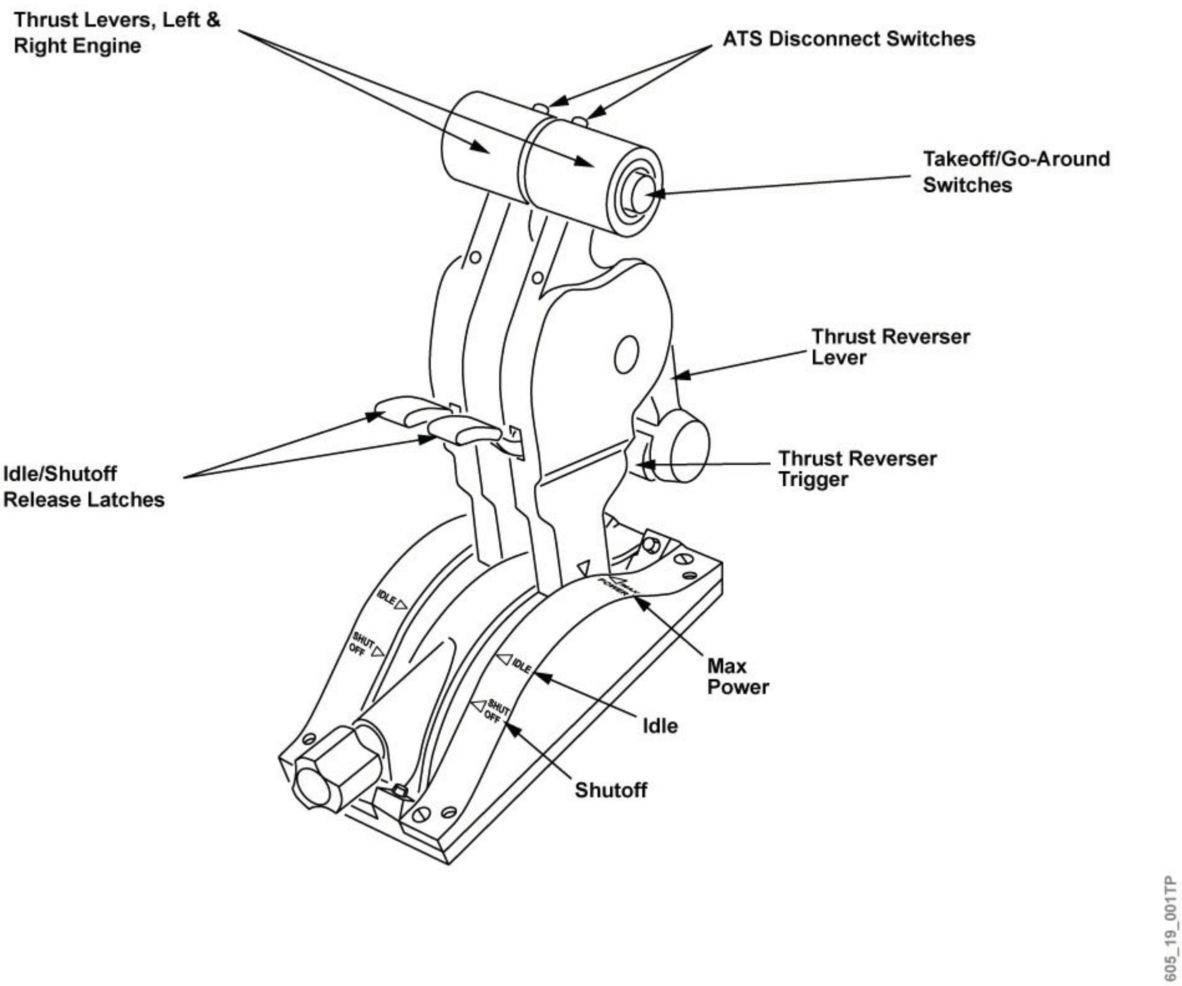
Autothrottle System (ATS) Disconnect Switches

These switches, on the forward face of each thrust lever (ATS DISC), are associated with the autothrottle system (ATS). In addition to control through the ATS control panel on the glareshield, ATS disengage is also provided by these disconnect pushbutton switches.

Thrust Reverse Levers

The thrust reverse levers control the operation of the thrust reverser system. See the thrust reverser description in this chapter for further details.

THRUST LEVERS (CONT'D)



Thrust Levers
Figure 19–10–12

THRUST REVERSER SYSTEM

Description

The thrust reverser system is used to assist in stopping the aircraft on landing and during a rejected takeoff (RTO). The system is operable on the ground only.

Operation

The thrust reversers are armed when the appropriate switches on the THRUST REVERSER panel are selected to ARM, and the respective 14th-stage bleed air shutoff valves are opened. When armed, a **L (R) REV ARMED** advisory EICAS message is displayed.

THRUST REVERSER SYSTEM (CONT'D)

Reverse thrust is generated by blocking fan bypass airflow, and redirecting it forward through a series of cascade vanes. Bleed air, from the 14th stage of the compressor, pneumatically activates a power drive unit (PDU), which mechanically moves the engine translating cowls rearward by means of a flexible driveshaft and ballscrew actuators. As the translating cowl moves rearward, blocker doors rotate to redirect fan airflow forward through the cascade vanes.

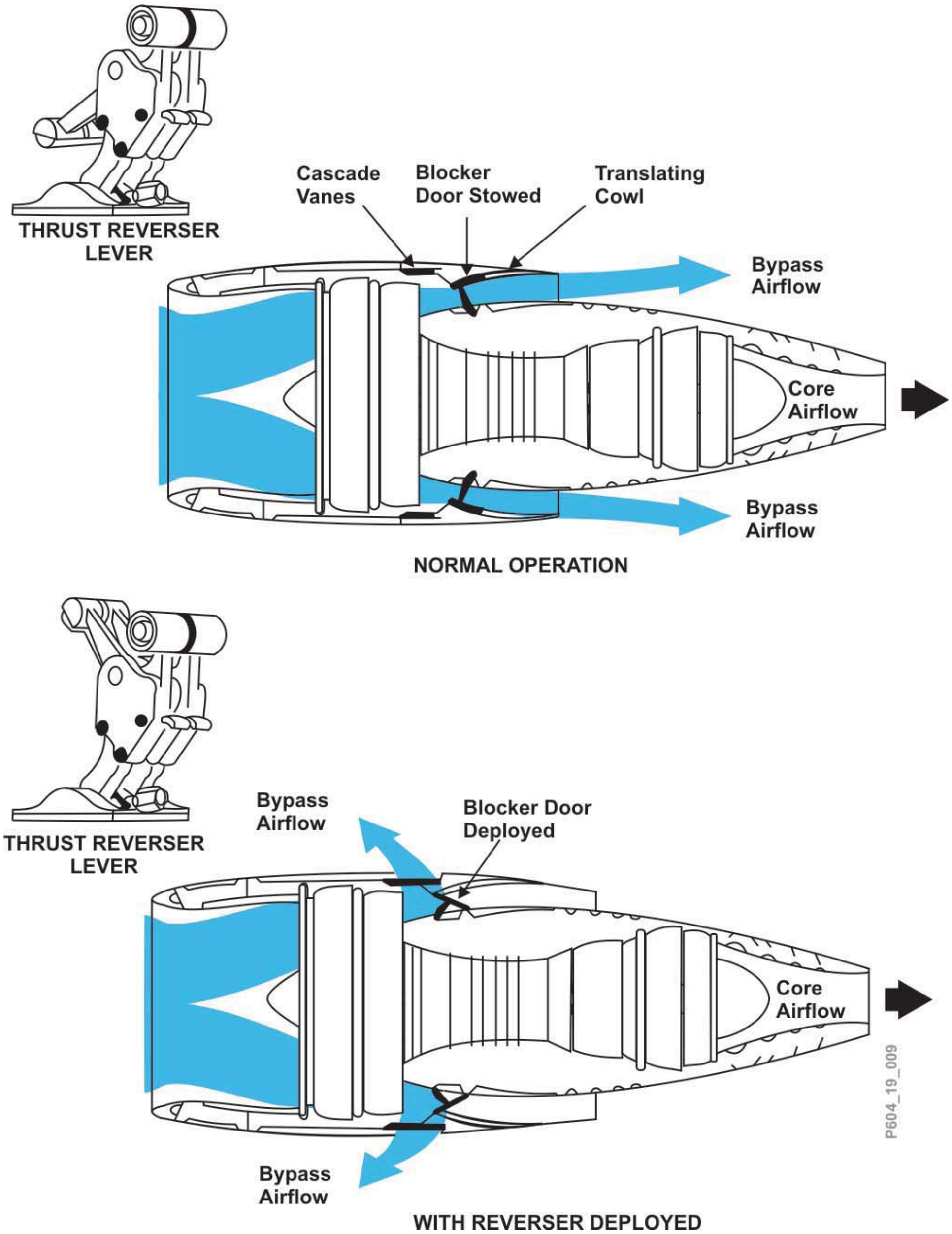
Reverser deployment is accomplished by squeezing the thrust reverser triggers and applying upward pressure on the thrust reverse levers. Thrust reverse lever movement is initially restricted to approximately 20 degrees by a solenoid stop and a reverse thrust lever lock. This locks the thrust lever in the IDLE position, and prevents thrust from being applied. When the translating cowl reaches full aft travel, the solenoid stop is released, allowing the reverse lever to be operated though its full range, and reverse thrust to be applied.

During normal thrust reverser deployment, an amber REV icon appears in the engine N_1 gauge while the reverser is in transit. When the reverser is fully deployed, the REV icon changes to green. Reverser deployment is achieved in approximately 5 seconds.

Anti-Ice Disable

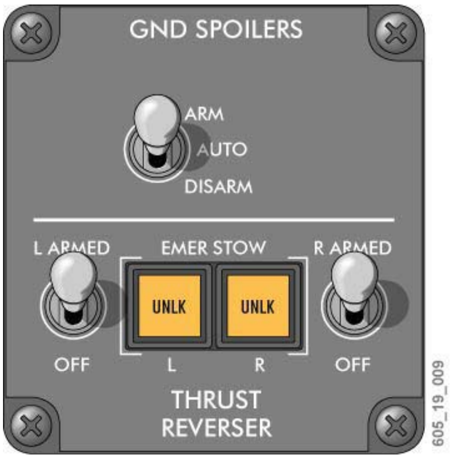
On touchdown, or during rejected takeoff with the wing and/or cowl anti-ice system on, the anti-ice systems are automatically disabled while the thrust reversers are activated. This disabling action redirects all 14th-stage bleed air to the thrust reverser PDU to ensure proper operation.

THRUST REVERSER SYSTEM (CONT'D)



Thrust Reverser Operation
Figure 19−10−13

THRUST REVERSER SYSTEM (CONT'D)



GND SPOILERS/THRUST REVERSER Panel
Figure 19–10–14

The thrust reverse system incorporates the following safety features:

- **In-flight protection** – The reversers are locked out in flight. WOW (weight-on-wheels) signals from the proximity sensing electronics unit (PSEU) or wheel spin-up (from the anti-skid control unit) must be sensed in order to energize the thrust reverser deploy relays.
- **Flexshaft lockpin and lock cam** – The reverse thrust PDU flexshaft is equipped with a lock pin and lock cam, as well as a brake, which act to prevent uncommanded travel of the reverser by more than 1/4 of an inch from the fully stowed position.
- **Auto stow** – In the event of flexshaft lock cam failure, resulting in uncommanded movement of the thrust reverser away from the fully stowed position, the stow solenoid will energize, and provided 14th-stage bleed air is available, the thrust reverser will be returned to the fully stowed position.
- **Automatic thrust lever retard system** – An auto-retarding thrust lever mechanism ensures that the thrust lever is at idle whenever the thrust reverser is in transit. In flight, should a thrust reverser inadvertently deploy, the affected thrust lever is automatically retarded to IDLE, and locked to minimize asymmetric thrust.
- **Emergency stow** – A thrust reverser emergency stow system is installed to stow an unlocked thrust reverser. Selecting the respective UNLK switch/light on the THRUST REVERSER panel directs 14th-stage bleed air to the PDU to stow the unlocked reverser.

NOTE

While the UNLK switch/light is selected, 14th-stage bleed air is continuously applied to the PDU, even if the reverser returns to the stowed position.

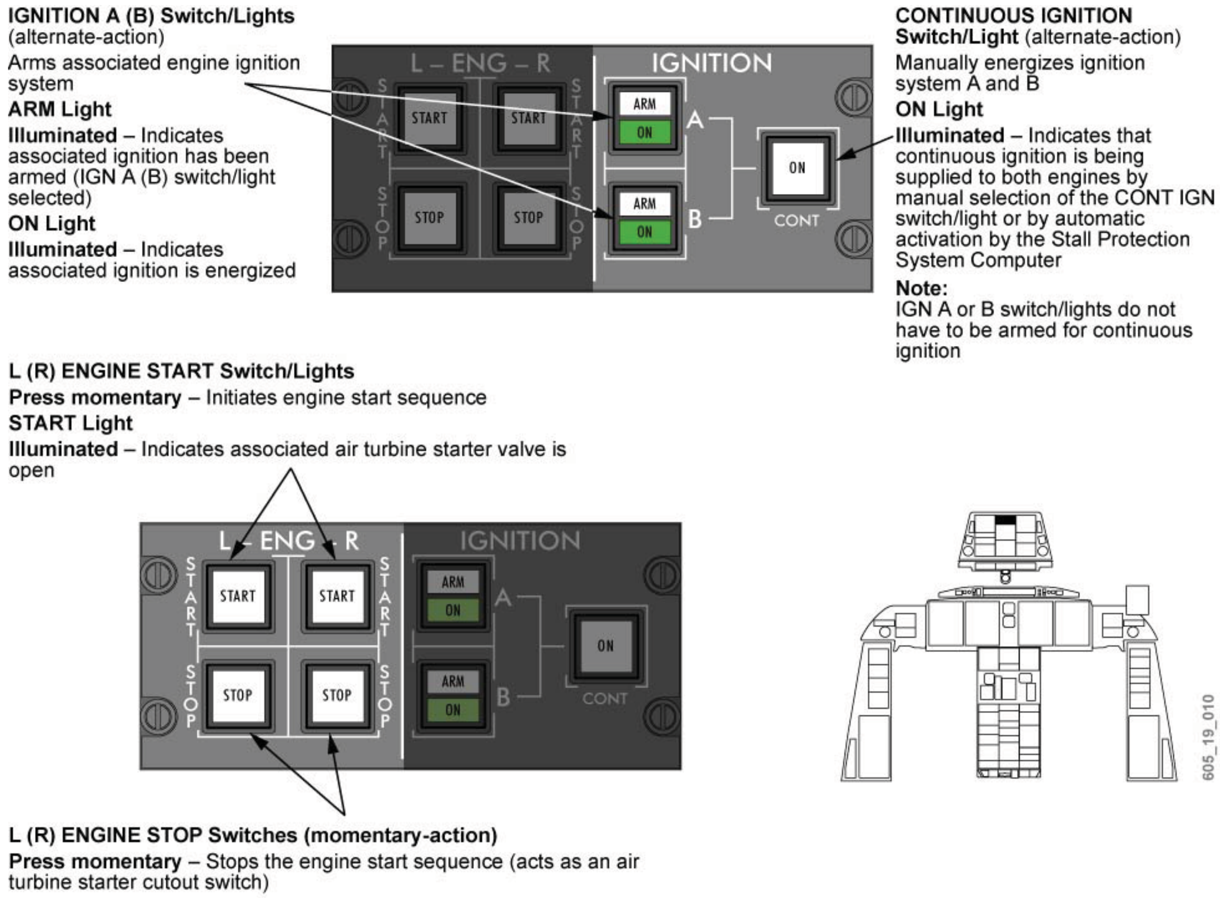
CONTROLS AND INDICATORS

The CF 34–3B engine controls consist of the following:

- Thrust levers
- Thrust reversers
- Engine start/ignition panel
- Engine control panel

The EICAS page and SUMMARY page provide analog and digital engine information, and system warning/caution and advisory messages.

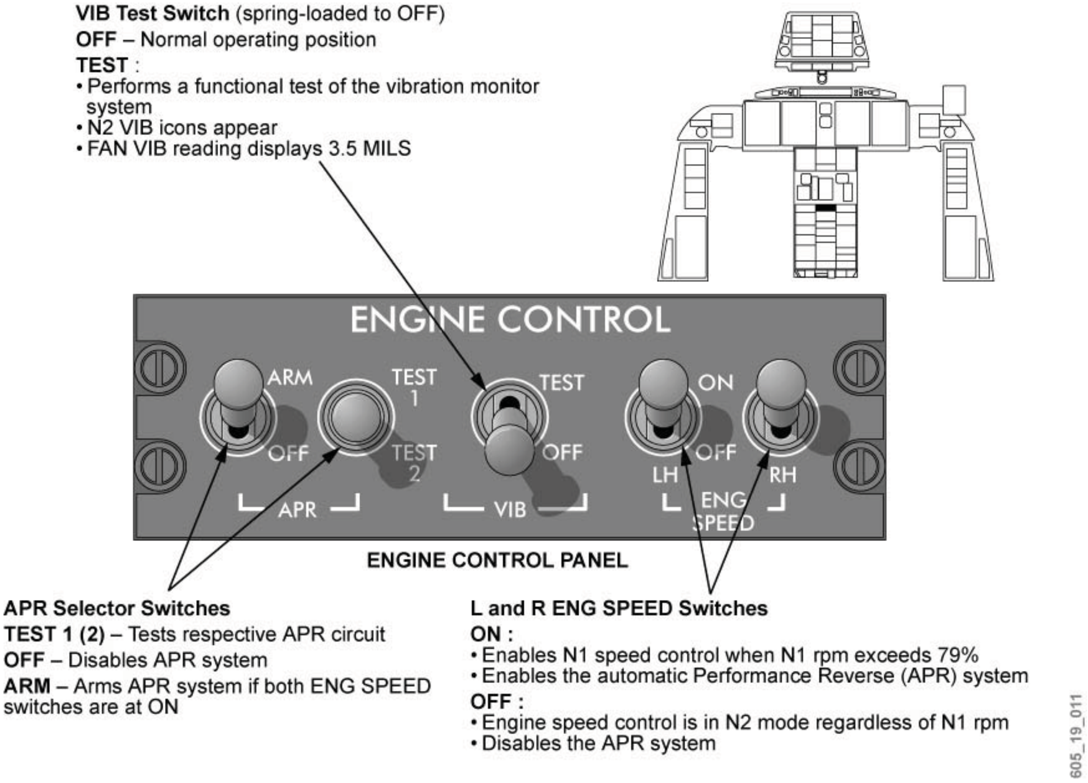
Engine Starting



Engine Start/Ignition Panel
Figure 19–10–15

CONTROLS AND INDICATORS (CONT'D)

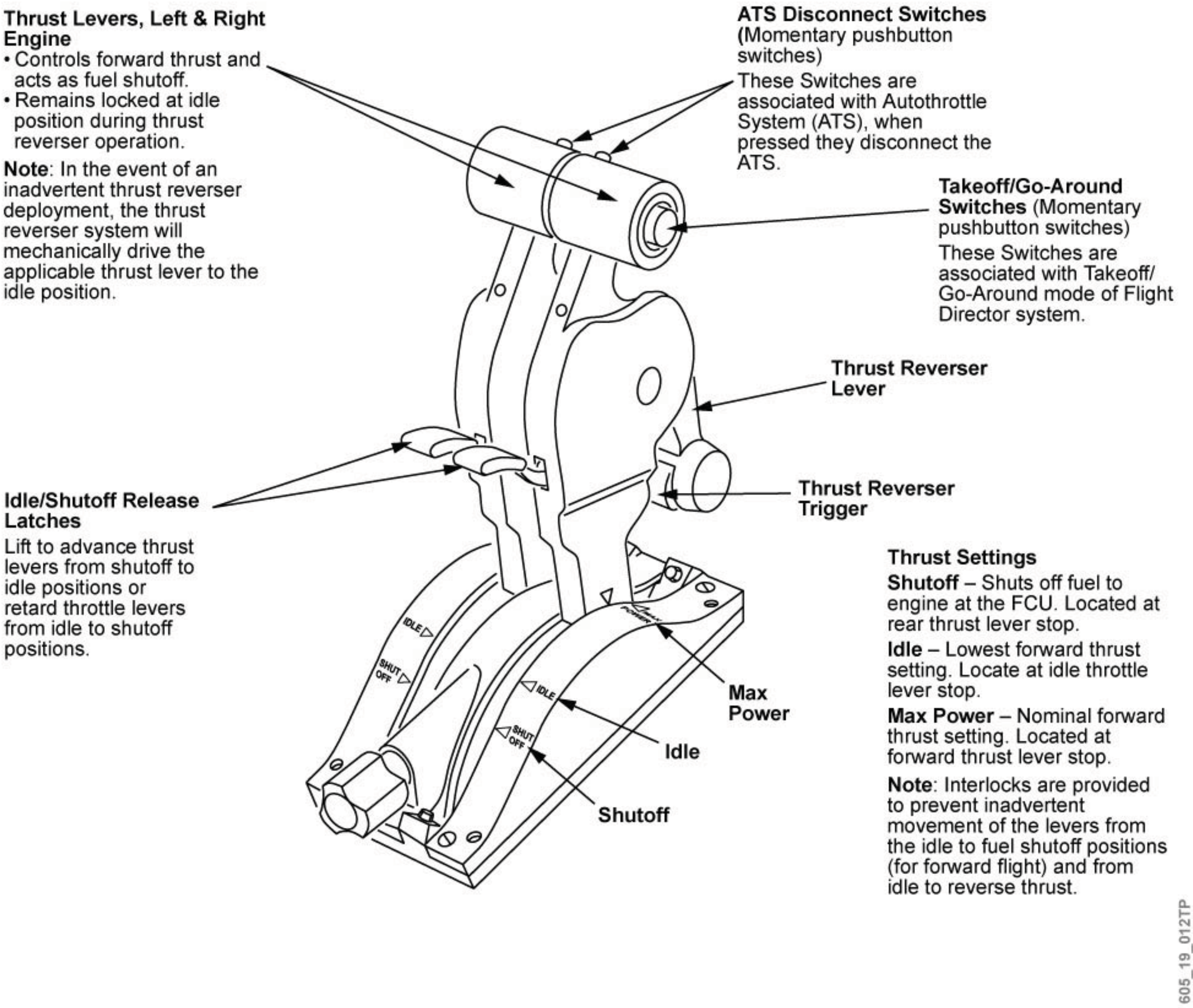
Engine Speed Controls



ENGINE CONTROL Panel
Figure 19–10–16

CONTROLS AND INDICATORS (CONT'D)

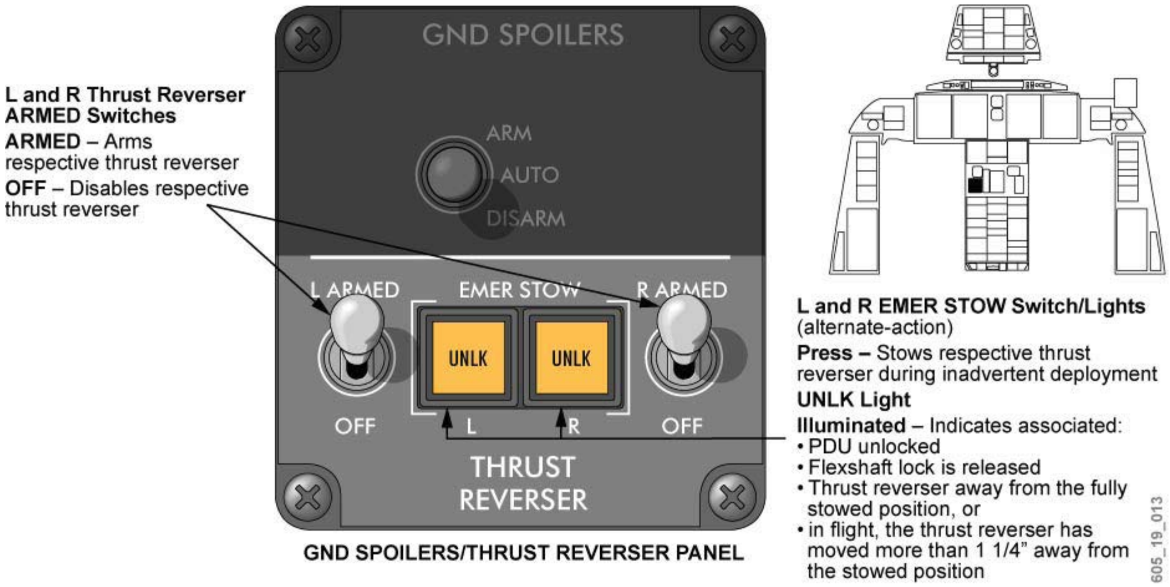
Thrust Levers



Thrust Levers
Figure 19–10–17

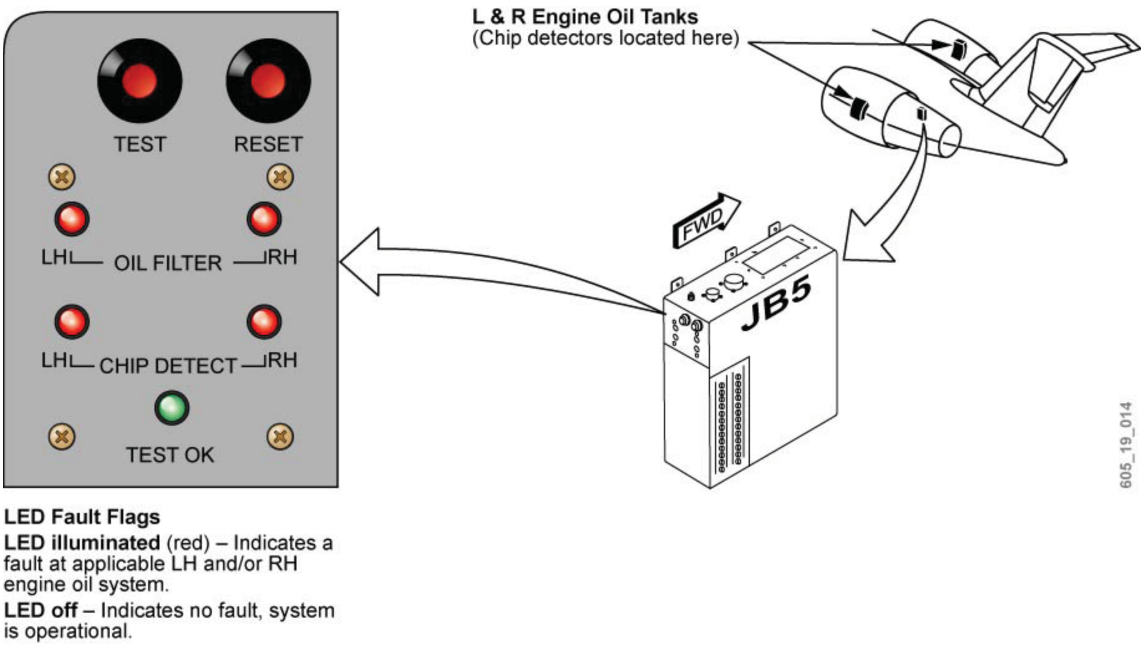
CONTROLS AND INDICATORS (CONT'D)

Reverse Thrust



GND SPOILERS/THRUST REVERSER Panel
Figure 19–10–18

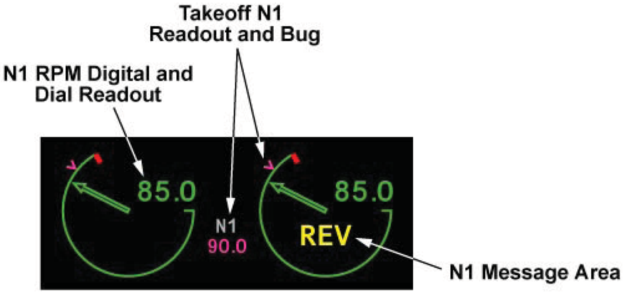
Oil System



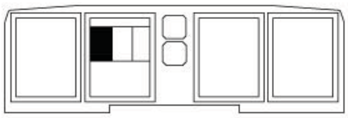
Impending Bypass and Chip Detector Annunciators (JB5)
Figure 19–10–19

CONTROLS AND INDICATORS (CONT'D)

EICAS Page



EICAS PAGE



Description	Symbol	Condition
N1 RPM Digital and Dial Readout.		Indicates fan speed in percent RPM and Takeoff N1 readout. Green – 0 to 98.5% Red – 98.6 Bug range – 76 to 98.5% N1 **Note:** Takeoff N1 readout removed automatically when airplane is at cruise altitude. Must be manually reset for go-around.
		N1 RPM is above 98.6%
N1 Limit Readout and Bug		Displays N1 limit for selected thrust setting
Thrust Setting Display	TO CLB CRZ MCT APR TGT	Indicates selected thrust setting TO – Maximum Takeoff CLB – Maximum Climb CRZ – Maximum Cruise MCT – Maximum Continuous Thrust APR – Automatic Performance Reserve TGT – Target (Pilot entered)
N1 Message Area	APR	APR thrust has been commanded and achieved
	REV	Thrust Reverser is in transit
	REV	Thrust Reverser is fully deployed

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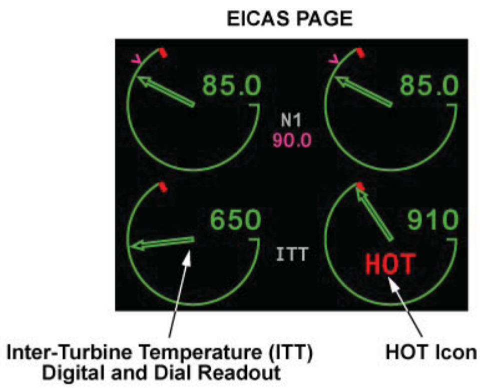
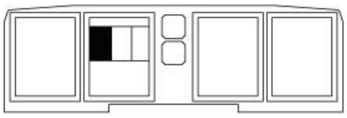
N_1 Indications
Figure 19–10–20

CONTROLS AND INDICATORS (CONT'D)





Description	Symbol	Condition
Inter-Turbine Temperature (ITT) Digital and Dial Readout		Indicates the temperature of the low pressure turbine exhaust in °C (APR not activated scale) Green – 0 to 899°C Red – 900°C
		Indicates the temperature of the low pressure turbine exhaust in °C (APR activated scale) Green – 0 to 927°C Red – 928°C
		Indicates that ITT is above the maximum limit (900°C)
HOT Icon		Indicates that engine has a hot start; remains displayed until engine is shut down and ITT reduces below 220°C

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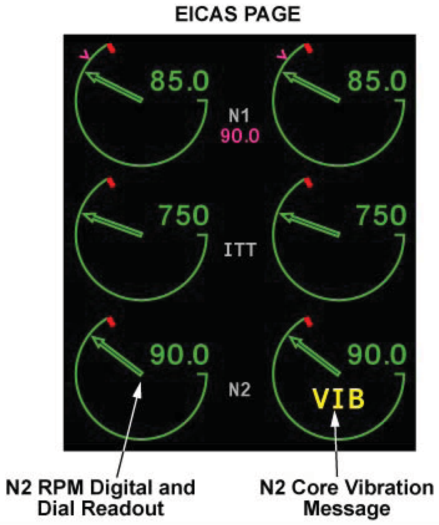
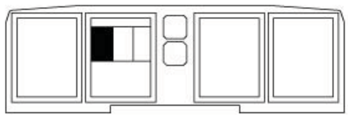
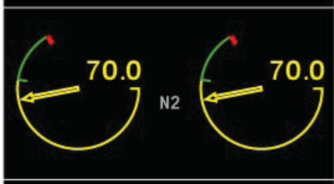
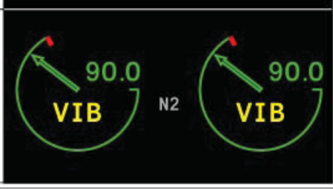
ITT Indications
Figure 19–10–21

CONTROLS AND INDICATORS (CONT'D)





Description	Symbol	Condition
N2 RPM Digital and Dial Readout		Indicates maximum allowable compressor speed in percent RPM Green – 0 to 99.2% Red – 99.3%
		N2 RPM is above 78% and Wing Anti-Ice is selected on. Amber band – 0 to 77.9%
		N2 RPM is less than 78% and Wing Anti-Ice is selected on.
		N2 RPM is above 99.3%.
N2 Core Vibration Message		Displayed when N2 vibration is greater than 1.7 MILS

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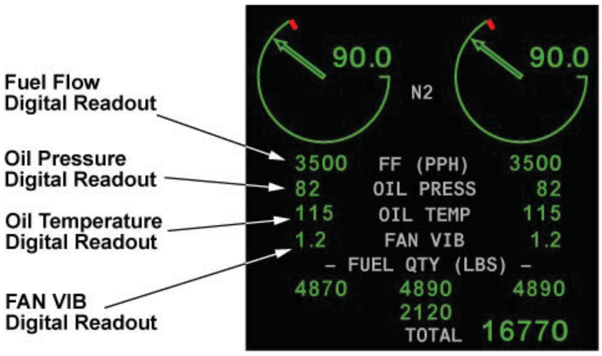
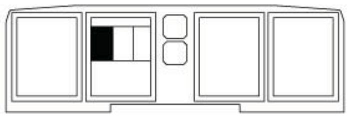
N_2 Indications
Figure 19–10–22

CONTROLS AND INDICATORS (CONT'D)

EICAS PAGE





Description	Symbol	Condition
Fuel Flow Digital Readout	3500 FF 3500	Indicates fuel flow in pounds per hour (PPH)
	---- FF ----	Invalid data or fuel flow exceeds 5000 lbs/hr
Fuel Flow Digital Readout	3500 FF(PPH) 3500 1590 FF(KGH) 1590	Indicates fuel flow in pounds per hour (PPH) or kilograms per hour (KGH)
	---- FF(PPH) ---- ---- FF(KGH) ----	Invalid data or fuel flow exceeds 5000 lbs/hr or 2222 kg/hr
Oil Pressure Digital Readout	82 OIL PRESS 82	Oil pressure greater than 25 psi and less than or equal to 115 psi
	120 OIL PRESS 120	Oil pressure greater than 116 psi and less than or equal to 155 psi
	10 OIL PRESS 10	Oil pressure is less than or equal to 25 psi
	--- OIL PRESS ---	Invalid data
Oil Temperature Digital Readout	115 OIL TEMP 115	Oil temperature greater than -40°C and less than or equal to 154°C
	158 OIL TEMP 158	Oil temperature greater than 155°C and less than or equal to 162°C
	169 OIL TEMP 169	Oil temperature is greater than 163°C
	--- OIL TEMP ---	Invalid data
FAN VIB Digital Readout	1.2 FAN VIB 1.2	Fan vibration is 0 to less than or equal to 2.6 MILS
	3.0 FAN VIB 3.0	Fan vibration is equal or greater than 2.7 MILS
	-.- FAN VIB -.-	Invalid data

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Engine Secondary Indications
Figure 19–10–23

EICAS MESSAGES

Message	Meaning	Aural Warning (If Any)
ENGINE	Left or right engine N_1 or N_2 or ITT above exceedance level.	WARNING (Triple Chime)
L ENG OIL PRESS R ENG OIL PRESS	Oil pressure in the respective engine is less than 25 psi.	"ENGINE OIL"
L ENG START SOV R ENG START SOV	The respective start shutoff valve is not closed with that engine running.	WARNING (Triple Chime)
APR INOP	Either the APR has failed or it is not armed (APR to arm and N_1 >79% and both eng speed switches on).	
APR CMD SET	APR has been inadvertently activated on both engines.	
L ENG MISCOMP R ENG MISCOMP	The engine comparator has sensed a discrepancy in the respective engine parameters (N_1, ITT or N_2).	
L FUEL FILTER R FUEL FILTER	Respective fuel filter is in impending bypass mode.	
L FUEL LO PRESS R FUEL LO PRESS	Insufficient pressure at the respective engine pump inlet.	
L REV UNLOCKED R REV UNLOCKED	Reverser moved away from fully stowed position without a deploy command.	
L REV UNSAFE R REV UNSAFE	Unarmed thrust reverser received a deploy command.	
APR ARM	Aircraft in takeoff configuration, dynamic test OK.	
APR TEST 1 OK APR TEST 2 OK	The respective APR circuit has passed the self-test.	
L ENG SOV CLSD R ENG SOV CLSD	Fuel shutoff valve is closed after activation of the respective ENG FIRE PUSH switch/light.	
IGNITION A	'A' igniters are activated, 'B' igniters off.	
IGNITION A/B	Both 'A' and B' igniters are activated.	
IGNITION B	'B' igniters are activated, 'A' igniters off.	
L REV ARMED R REV ARMED	The respective thrust reverser is armed.	
DCU 1 APR FAIL DCU 2 APR FAIL	The respective DCU has failed its APR test.	
L ENG ECU FAIL R ENG ECU FAIL	The respective engine ECU failed to respond to an APR test.	

POWER SUPPLY AND CIRCUIT BREAKER SUMMARY

SYSTEM	SUB–SYSTEM	CB NAME	BUS BAR	CB PANEL	CB LOCATION	NOTES
Power Plant	Ignition System	ENG IGN A	AC ESS	3	C7	
		ENG IGN A	DC BATT	1	L7	
		ENG IGN B	DC BATT	1	L8	
		ENG IGN B	BATT BUS	5	A1	
	Starter System	ENG START L	DC BATT	1	L10	
		ENG START R	DC BATT	1	L9	
	Oil Pressure Indications	L OIL PRESS TRANS	DC BATT	1	L6	
		R OIL PRESS TRANS	DC ESS	4	B6	
		OIL BYPASS IND	DC APU BATT DIRECT	5	B3	
		ENG OIL POWER	DC APU BATT DIRECT	5	B4	
	Vibration Monitor	ENG VIB MON	AC BUS 1	1	C7	
	Thrust Reversers	THRUST REV AUTO STOW 1	DC ESS	4	A4	
		THRUST REV AUTO STOW 2	DC ESS	4	A5	
		THRUST REV 1	DC ESS	4	A6	
		THRUST REV 2	DC ESS	4	A7	
	Automatic Performance Reserve	APR	DC BATT	5	A2	