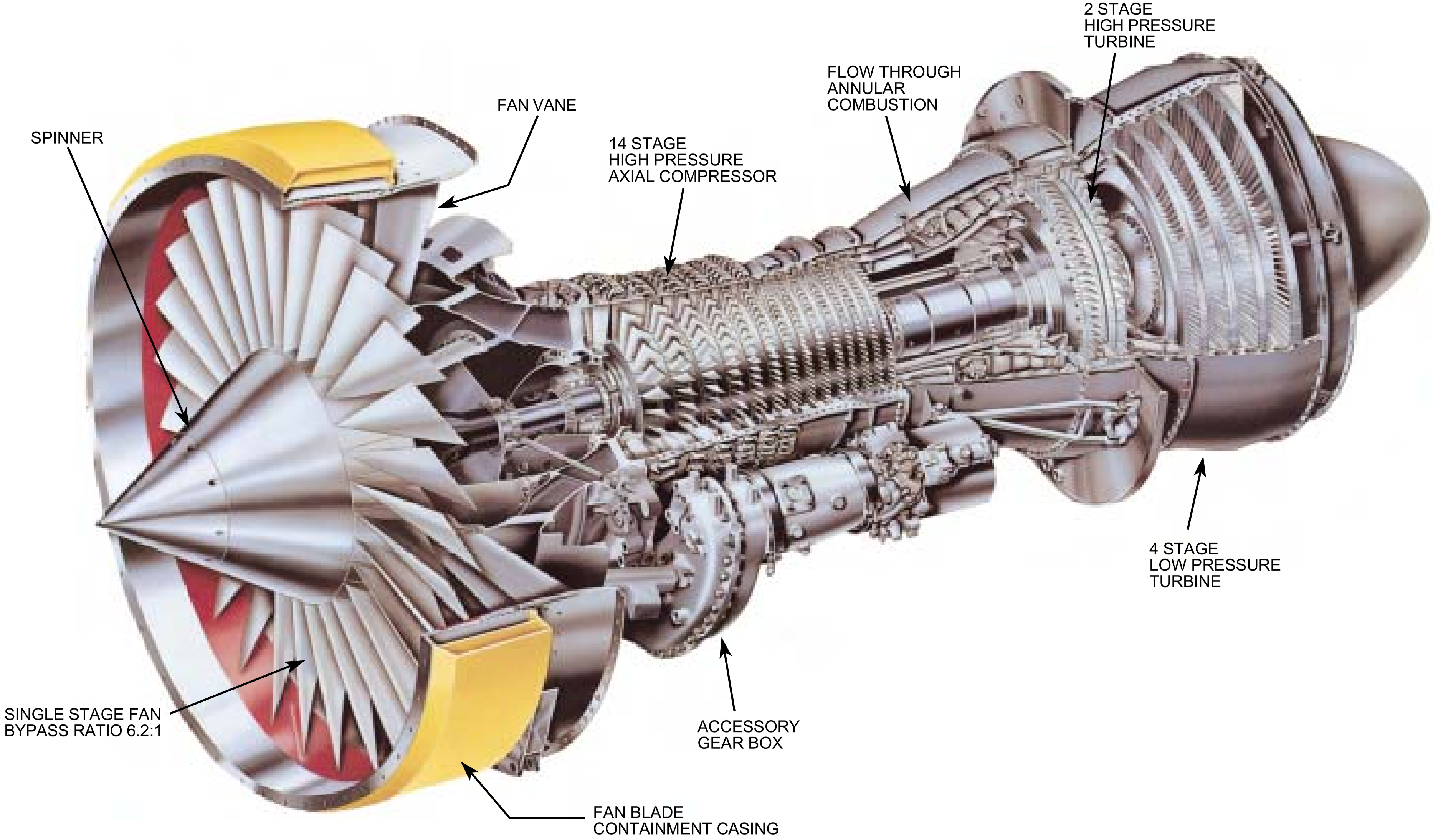
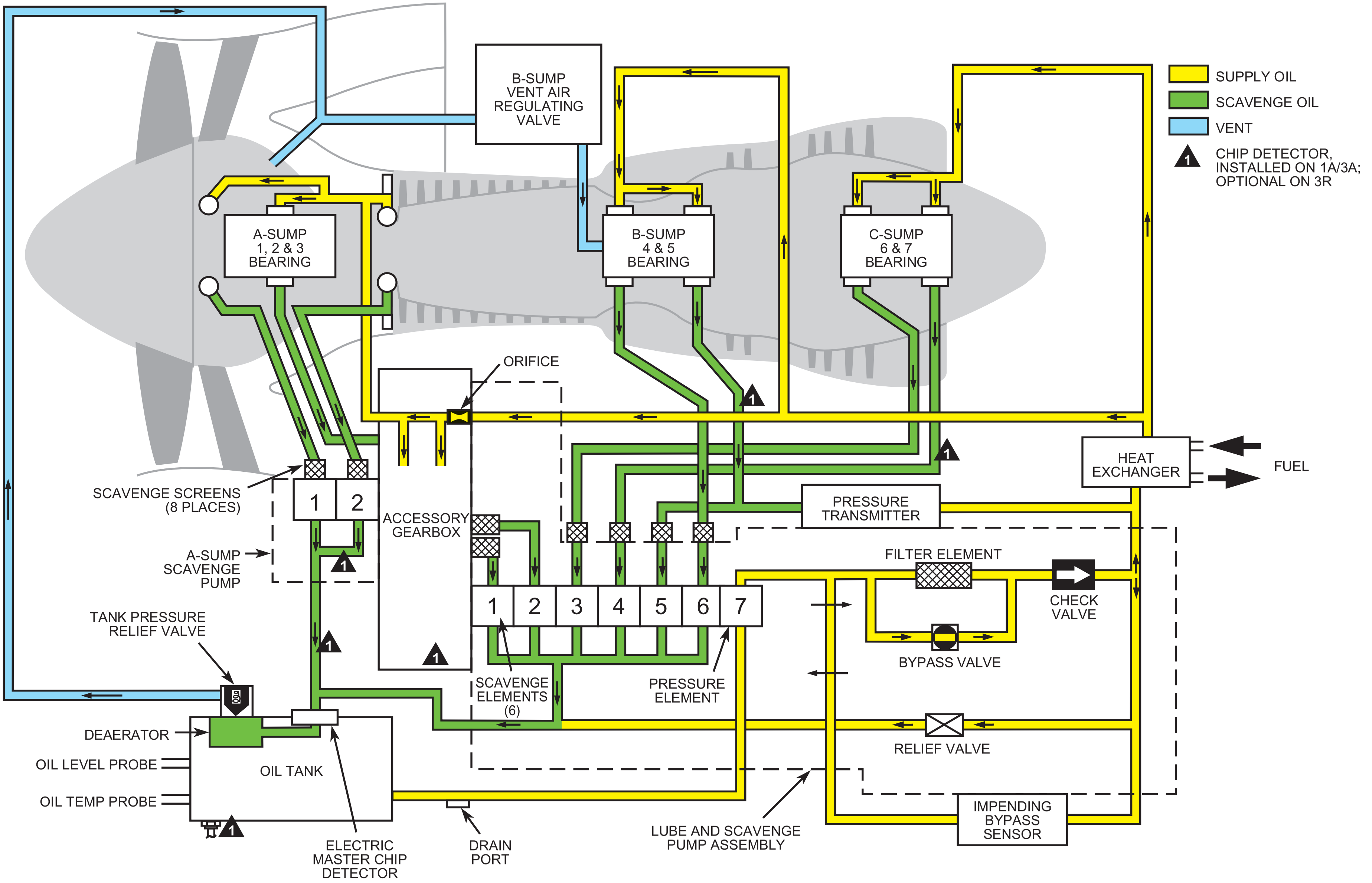
General Electric CF34 Engine

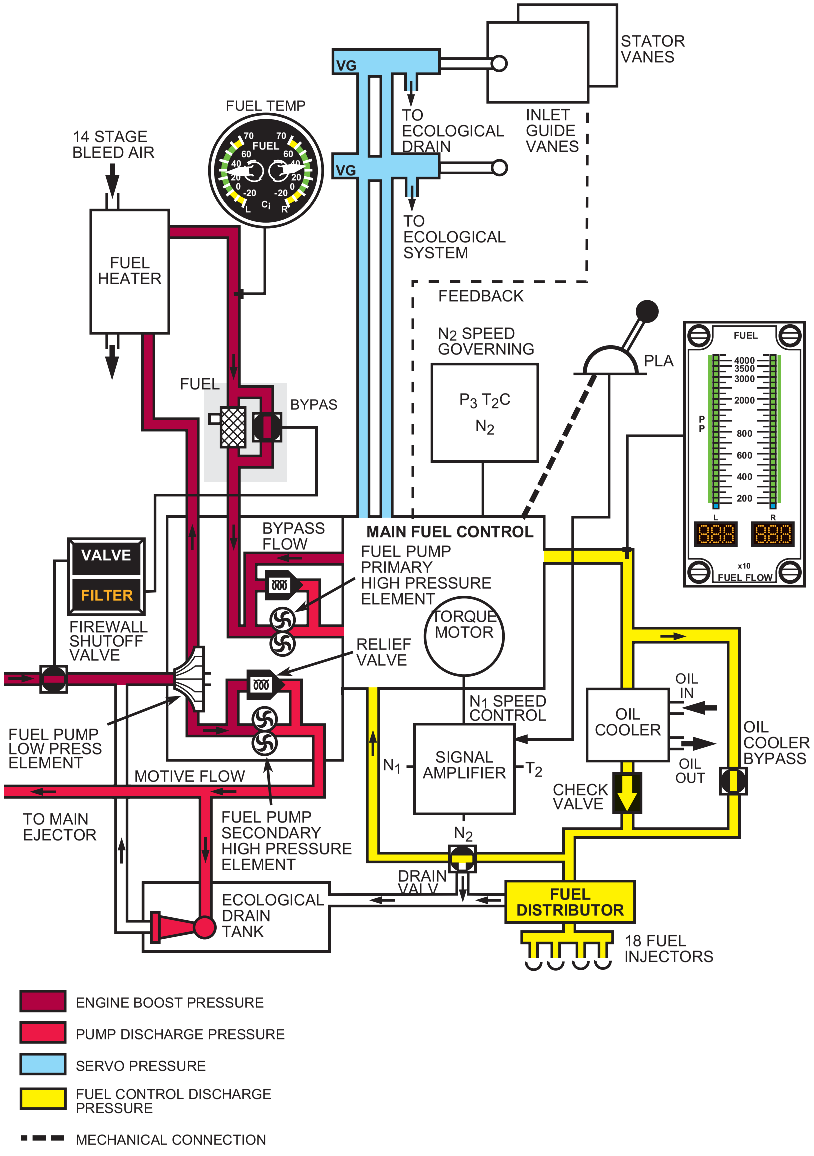


Engine Oil System



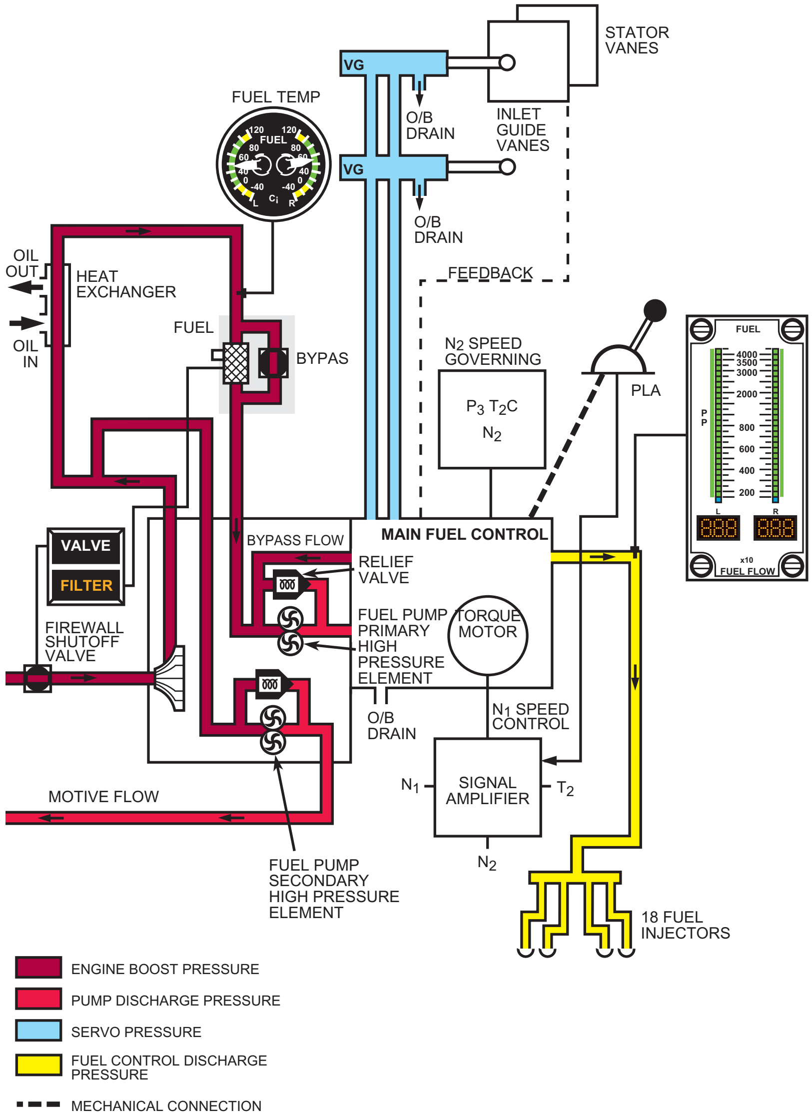
Engine Fuel System

GE CF34-1A/-3A



Engine Fuel System

GE CF34-3A1



Powerplant

Two General Electric CF34 turbofan engines power the Canadair Challenger CL-601-1A/-3A/3R aircraft (see **Table 4-N**).

Model	Standard	Optional
CL-601-1A	CF34-1A	CF34-3A/-3A2
CL-601-3A	CF34-3A	CF34-3A2
CL-601-3R	CF34-3A1	N/A

Table 4-N; Engine Installation

The GE CF34 turbofan, developed from the GE TF34 used on the Republic A-10 and Lockheed S-3, is an efficient and quiet engine that has a 6.2:1 bypass ratio.

The CF34-1A engine produces approximately 8,650 lbs of static takeoff thrust. An automatic performance reserve (APR) system provides 9,140 lbs of static takeoff thrust, an addition of 490 lbs, from the operating engine, if the other engine loses power or fails.

The CF34-3A/-3A2/-3A1 engines produce approximately 8,729 lbs of static takeoff thrust. These engines' APR systems provide 9,220 lbs of static thrust, an addition of 490 lbs from the operating engine, if the other engine loses power or fails.

Modular engine construction consists of six major sections to ease field maintenance and component replacement or repair. These six sections include:

- fan
- accessory
- compressor
- combustion
- high pressure (HP) turbine
- low pressure (LP) turbine.

The engine's two-stage HP turbine (N_2 spool) drives the 14-stage axial compressor; the four-stage LP turbine (N_1 spool) drives the single-stage front fan. Variable geometry inlet guide vanes (IGVs) behind the front fan control engine core air flow to prevent compressor stalling and surging.

As air enters the engine inlet, the front fan accelerates air rearward toward the fan nozzle axial compressor. Approximately 85% of the air bypasses the engine core and exhausts overboard as thrust through the fan nozzle. The remaining 15% enters the engine core. Essentially, the fan provides most of the thrust produced by the engine.

Before entering the compressor, air passes through the variable geometry IGVs. Controlled by two hydraulic (fuel) actuators, the IGV and five additional stages of variable geometry stator vanes open and close as a unit to regulate air flow into the 14-stage compressor.

As air flows through the compressor, it is progressively compressed and heated as its volume decreases. The compressed and heated air then enters the combustion section where it mixes with fuel. During engine start, two igniter plugs ignite the fuel/air mixture. After the engine is running, the combustion process is self-sustaining.

The hot, high velocity gas stream exiting the combustion section first flows through the two-stage HP turbine. The turbine extracts energy from the gas stream as it rotates to drive the axial compressor. The gas stream then passes through the four-stage LP turbine to drive the forward fan.

Finally, the combustion by-products exit through the core exhaust nozzle.

Powerplant Systems

Powerplant systems include:

- lubrication
- ignition
- starting
- fuel and fuel control
- engine control.

Lubrication

The oil pump's single pressure element draws oil from the oil tank to provide it under pressure through a filter. If the filter begins clogging, a bypass valve routes oil past the filter. If the filter begins clogging and differential pressure between the filter inlet and outlet reaches 21 to 26 PSID, the impending bypass sensor illuminates an indicator on the aft circuit breaker distribution box.

From the filter, oil flows through a check valve to the oil/fuel heat exchanger. As it flows through the heat exchanger, the oil gives up heat to the relatively cooler fuel. After passing through the heat exchanger, the oil flow splits into a low and high pressure circuit. The low pressure circuit supplies the No. 1, 2, and 3 bearings (A sump) and the accessory gearbox. The high pressure circuit supplies the No. 4 and 5 bearings (B sump) and the No. 6 and 7 bearings (C sump).

After lubricating, cleaning, and cooling the engine, the oil pump's scavenge elements draw oil from the accessory gearbox and B and C sumps. Oil from the A sump normally gravity flows to the accessory gearbox. During climbs and descents, the A sump scavenge pump draws oil from the A sump and then returns it to the oil tank. A cyclone-type de-aerator removes entrapped air from the oil. **On the CF34-3A1 engine**, the oil tank has a sight gage.

Downstream of the fuel/oil heat exchanger, a tapping provides pressurized oil to the oil pressure transmitter and low oil pressure switch. If oil pressure drops to 28 ±3 PSI (**CF34-1A/-3A/-3A2**) or 35 PSI (**CF34-3A1**), the pressure switch illuminates the appropriate OIL PRESS gage LOP (low oil pressure) light. A temperature bulb in the oil tank drives the OIL TEMP indicator.

Chip detectors at strategic points in the oil scavenge lines and tank monitor engine wear. If sufficient ferrous particles accumulate on a chip detector, the particles bridge the detector's contacts. During routine maintenance, a continuity check of each detector provides an indication of engine wear and possible mechanical failure.

An oil replenishment system allows engine oil tank refilling without opening the engine cowls. The system consists of an oil replenishment tank, electric oil pump, two oil level probes and signal conditioner, oil level control panel, and a selector valve. All but the oil level probes are in the rear equipment bay.

Placing the power switch in the ON position illuminates the ON light and supplies 28V DC to the selector valve. Selecting either L or R energizes the oil pump and directs oil from the replenishment tank to the selected engine's oil tank. When engine oil tank level reaches full, the associated LH or RH switchlight illuminates. Placing the selector valve in the OFF position de-energizes the electric oil pump. Selecting the power switch to OFF cuts power to the selector valve.

Ignition

The **CF34-1A and -3A engines** have a dual-circuit ignition exciter while the **CF34-3A2 and -3A1 engines** have two single-circuit ignition exciters.

Pressing the IGN A/ON and/or IGN B/ON switchlight arms the ignition system; the switchlight illuminates green. The A ignition system receives 115V AC directly from the AC electrical system. The B system receives 115V AC from a DC-powered static inverter.

Pressing a START button begins the engine start sequence by supplying power through the STOP switch contacts to the start latch and bleed air relays. The green START light illuminates. When the start latch relay closes, the ignition system relay closes to supply power to the ignition exciter(s). The ignition switchlight's ON capsule illuminates white. The capacitance-type ignition exciter(s) supplies low-voltage discharges to the igniter plugs.

When the engine reaches idle speed, the air turbine switch opens to de-energize the ignition system relay and de-activate the ignition system.

Pressing the CONT IGN switchlight, if necessary, energizes the continuous ignition slave relay. The relay closes to supply power to the IGN B/ON switchlight through the IGN A/ON switchlight. The IGN B/ON switchlight illuminates green. Pressing the IGN A/ON and/or IGN B/ON switchlight closes the ignition control relay to supply power to both engine's ignition exciters. The white ON capsule illuminates and the selected system(s) igniter plugs fire continuously until deselecting the CONT IGN switchlight.

Continuous ignition is normally only used in icing conditions, heavy precipitation, or on contaminated runways. It is also used during heavy turbulence or lightning.

Auto ignition is activated by the stall warning computer. It employs the same power supplies and ignition components as the normal system but uses separate relays. Both ignition systems on each engine energize when auto ignition is activated.

Starting

Pressing the IGN A/ON and/or IGN B/ON switchlight arms the ignition system. The associated green light illuminates. The A ignition system receives 115V AC directly from the AC Essential bus; the B system receives 115V AC from a static inverter powered by the Battery bus.

Pressing the START button begins the engine's start sequence. Power flows through the STOP switch contacts to the start latch and start bleed air relays. The green START light illuminates and the armed ignition switchlight's bottom half illuminates white (ON). After 60 seconds, the amber STOP light illuminates.

When the start bleed air relay closes, the bleed air shutoff and isolation valves open so bleed air from the APU, air cart, or opposite engine can supply the manifold. The start latch relay then closes to supply power to the opposite engine's start valve solenoid. When the start valve solenoid opens, it supplies bleed air from the manifold to the engine's air turbine starter (ATS) and energizes the ignition system relay. When the ignition exciter(s) receive power, the white ignition ON light illuminates. The ignition exciter(s) then supply the two igniter plugs.

As the ATS turns, it rotates the engine up to its starting speed of approximately 3,800 to 4,000 RPM. At this speed, the air turbine start switch opens. This de-energizes the start bleed air and start latch relays. The ignition system then de-energizes, and the bleed air shutoff, isolation, and air start shutoff valves close. The green START switchlight extinguishes; the stop indicator time-delay relay is deenergized. Because the combustion process is now self-sustaining, the engine accelerates to idle speed.

Fuel and Fuel Control

From the airframe fuel system, fuel under pressure enters through the normally open firewall shutoff valve and flows to the engine-driven fuel pump's low pressure element. The low pressure element boosts fuel pressure approximately 80 PSI before supplying it to the pump's two high pressure elements.

On CF34-1A, -3A, and -3A2 engines, the fuel flow splits within the fuel pump after passing through the low pressure element. One flow continues directly to one of the pump's high pressure elements to supply motive flow fuel for the fuel tank ejectors. The other flow continues through an AIR/FUEL heat exchanger that uses 14th stage bleed air to warm the fuel. A thermal sensor maintains fuel between 4 to 10°C (40 to 50°F) with an air modulating valve that regulates bleed air flow through the fuel heater. If pressure drop across the fuel heater exceeds 29 PSI, a bypass valve opens to pass fuel around the heater core.

On CF34-3A1 engines, the fuel flow continues toward the fuel/oil heat exchanger after passing through the low pressure element. Prior to the heat exchanger, the fuel flow splits at an external pipe that supplies one of the fuel pump's high-pressure elements for motive flow fuel. The other flow continues to a heat exchanger that cools engine oil while warming fuel.

After passing through the heat exchanger, fuel flows through a filter before it reaches the fuel pump's other high pressure element. If the filter begins clogging and differential pressure exceeds 16 to 19 PSI, a bypass pressure switch closes to illuminate the FILTER light. When the differential pressure reaches 22 to 27 PSI, a red indicator protrudes on the top of the filter housing.

The high pressure element boosts fuel pressure before delivering it to the hydromechanical fuel control unit (FCU). The FCU and the other fuel control system components meter fuel to the fuel injectors to obtain the desired power setting. The fuel control system also provides engine overspeed and overtemperature protection by regulating fuel flow.

The complete fuel control system includes:

- fuel control unit
- variable geometry actuators and feedback cable
- fan speed control amplifier
- N_1 speed control amplifier
- N_2 speed control alternator
- compressor inlet temperature sensor.

The fuel control system receives inputs from:

- power lever angle (PLA)
- fan (N_1) and compressor (N_2) speed
- fan inlet temperature (T_2)
- compressor inlet temperature (T_{2C})
- compressor discharge pressure (P_3)
- ambient static pressure (P_O)
- variable inlet guide vane (IGV) position
- automatic power reserve (APR) status.

With the ENG. SPEED CONTROL switches in the ON position, throttle lever position indirectly controls power setting through the FCU computer section. The computer section, along with PLA and the other inputs, controls a metering valve to regulate fuel flow.

With the ENG. SPEED CONTROL switches in the OFF position, throttle lever position directly controls the FCU.

On CF34-1A/-3A/-3A2 engines, metered fuel from the FCU passes through an oil cooler prior to the fuel distributor. A bypass valve opens to allow oil temperature to go to normal operating temperature before it is cooled by the oil cooler. After flowing through the oil cooler, metered fuel flows through the fuel flow distributor assembly, then to the 18 fuel injectors.

During engine start when fuel pressure exceeds 40 to 60 PSI, the distributor assembly's check and drain valves supply fuel to the injectors. During shutdown, the check and drain valves stop fuel flow to the distributor. Excess fuel in the injectors flows to the ecological drain system.

ON CF34-3A1 engines, fuel flows from the FCU directly to the 18 fuel injectors.

Radially arranged around the engine's combustion chamber frame, the fuel injectors project into the combustion chamber. Supplied with fuel, the injectors deliver a fine, cone-shaped mist of atomized fuel into the combustion chamber swirlers.

Engine Control

Moving a throttle lever from the SHUT OFF to IDLE position after releasing the stop release latch mechanically opens the FCU shutoff valve. With the respective ENG. SPEED CONTROL switch in the ON position, throttle lever movement between the IDLE and MAX POWER positions indirectly controls engine power through the FCU's computer. The computer processes information based on power level angle (PLA), fan and compressor speeds, fan, compressor, compressor discharge temperatures, and ambient pressure to control the FCU's metering valve. This provides the desired power setting.

During thrust reverser deployment and stowing, an auto-throttle retarder system (ATR) mechanically moves the throttle levers to the IDLE position.

With the APR switch in the ARM position and the engines at takeoff power, the APR controller monitors engine N_1 speeds; the APR READY light illuminates. If one engine's N_1 speed drops below 67.5% RPM, the APR controller signals both engines' fan speed control amplifiers. The operating engine's ON light illuminates, the READY light extinguishes, and the fan speed control amplifiers signal both engines to increase N_1 by approximately 2.3% RPM.

Auxiliary Power Unit

An Allied Signal GTCP36-100 (E) auxiliary power unit (APU) provides AC power for ground operation and, within the APU's operating limitations, emergency AC power in flight. Additionally, the APU provides high pressure bleed air for engine starting and the air conditioning system on the ground and, within its operating envelope, in flight.

The APU is a self-contained power source that has its own fire protection, starting, lubrication, and control systems. It only requires a fuel supply, aircraft electrical power (i.e. battery or external power), and stop and start commands from the cockpit.

The APU's electronic control unit (ECU) monitors all phases of APU operation from start to shutdown. If the ECU detects a system fault, it automatically performs an APU shutdown by closing its fuel shutoff valve. Automatic shutdown occurs with:

- overspeed (109 ±1% RPM)
- high exhaust gas temperature (704 to 732°C at 100% RPM)
- high oil temperature (>141°C)
- low oil pressure (<31 PSIG for 10 ±2 seconds at 95% RPM)
- high generator adapter oil temperature (>154°C)
- low generator adapter oil pressure (<140PSI)
- open or disconnected EGT thermocouple
- loss of APU RPM signal
- APU fire.

An APU fault panel in the aft fuselage contains an APU STOP switch and magnetic fault indicators. Pressing the APU STOP switch simulates an overspeed condition and automatic APU shutdown through its ECU 114% RPM overspeed test circuit.

The magnetic fault indicators trip and display the fault causing the automatic shutdown. Pressing the reset button resets the indicators if they trip because of a fault. A tripped magnetic indicator does not prevent APU starting; it only provides fault identification.

APU Starting

With DC power available, pressing the PWR-FUEL ON/OFF switchlight supplies power to the START/STOP switch and the APU fuel pump. Pressing the START/STOP switch begins the APU start cycle by energizing the APU start control and time delay relays. When the start control relay closes, 28V DC from the Battery Direct bus closes the APU start relay. Closing of this relay, in turn, closes the APU start and start protection contactors. The STARTER light illuminates; the APU starter begins turning.

As the APU accelerates to 10% RPM, the ECU opens the fuel shutoff valve to energize the ignition system. Fuel flows through the open shutoff valve to enter the APU's fuel control unit (FCU). The FCU meters and schedules the required fuel for efficient APU starting, operation, and shutdown. From the FCU, fuel continues through a fuel shutoff valve to the fuel nozzle assembly. The fuel nozzle, assisted by compressor delivery air, delivers a fine spray of fuel into the APU's combustor. With the igniter operating, the fuel ignites. The FCU then controls APU acceleration by metering more fuel through the nozzle into the combustor.

At 60% RPM, the ECU de-energizes the time delay relay. This opens the start control relays and the start and start protection contactors. The starter stops turning, the STARTER light extinguishes, and APU acceleration toward 100% RPM is self-sustaining. As the APU accelerates toward normal operating speed, the APU OIL and ADPTR OIL LO PRESS lights extinguish when oil pressure in the APU and generator adapter exceeds 31 and 140 PSI respectively.

When APU RPM reaches 95%, the ECU illuminates the APU READY light and the BLEED AIR switchlight. The ECU then regulates APU speed under varying load conditions through the FCU.

Pressing the BLEED AIR switchlight opens the pneumatically operated butterfly valve to supply APU bleed air for aircraft services. The OPEN light illuminates.

Placing the APU generator switch in the ON position energizes the generator control relay (GCR) and the generator line control relay (GLCR); the APU's GEN OFF light extinguishes. When the GLCR energizes, the APU power relay (APU PR) opens. AC power from the APU generator then flows through the closed auxiliary power contactor (APC), generator transfer contactors, and generator line contactors (GLCs) to the main AC buses.

APU Shutdown

When the APU is no longer required, placing the APU generator switch in the OFF position takes the APU generator off-line and illuminates the GEN OFF light.

Pressing the START/STOP switchlight begins the automatic APU shutdown sequence by generating a false overspeed signal. The ECU closes the fuel shutoff valve; the APU shuts down.

Pressing the BLEED AIR switchlight closes the butterfly valve and extinguishes the OPEN light. After the APU has stopped, pressing the PWR-FUEL ON/OFF switchlight cuts power to the START/STOP switch and shuts off the APU fuel pump.