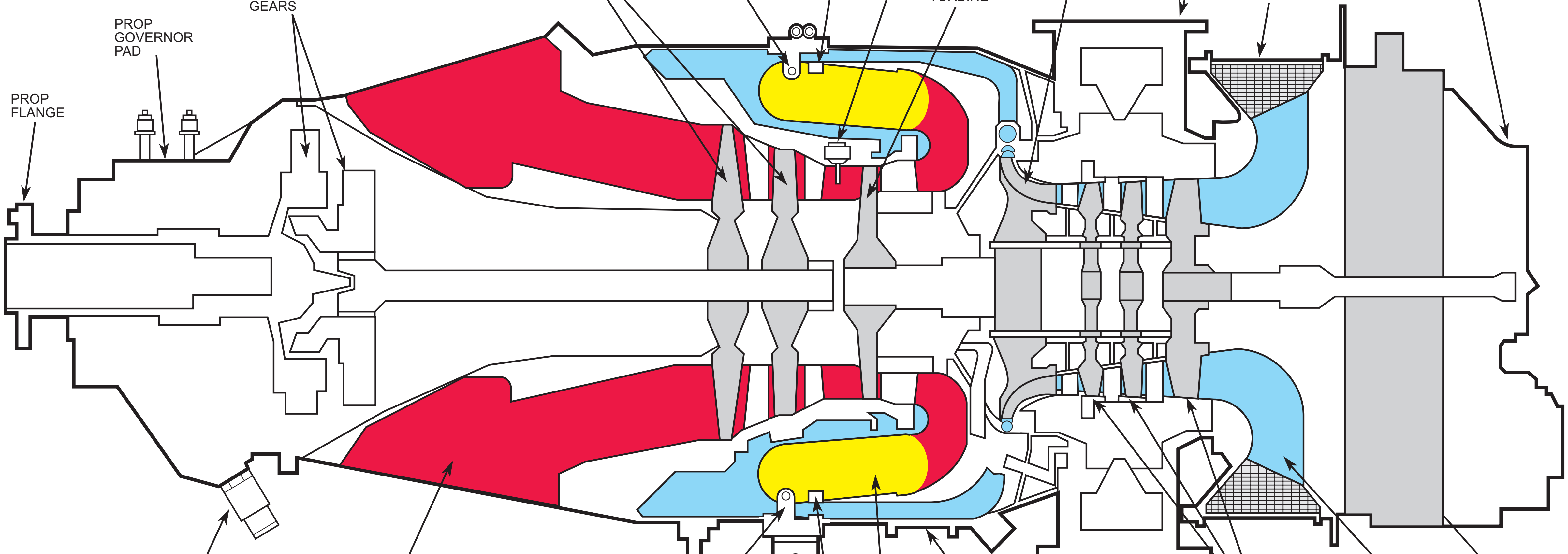
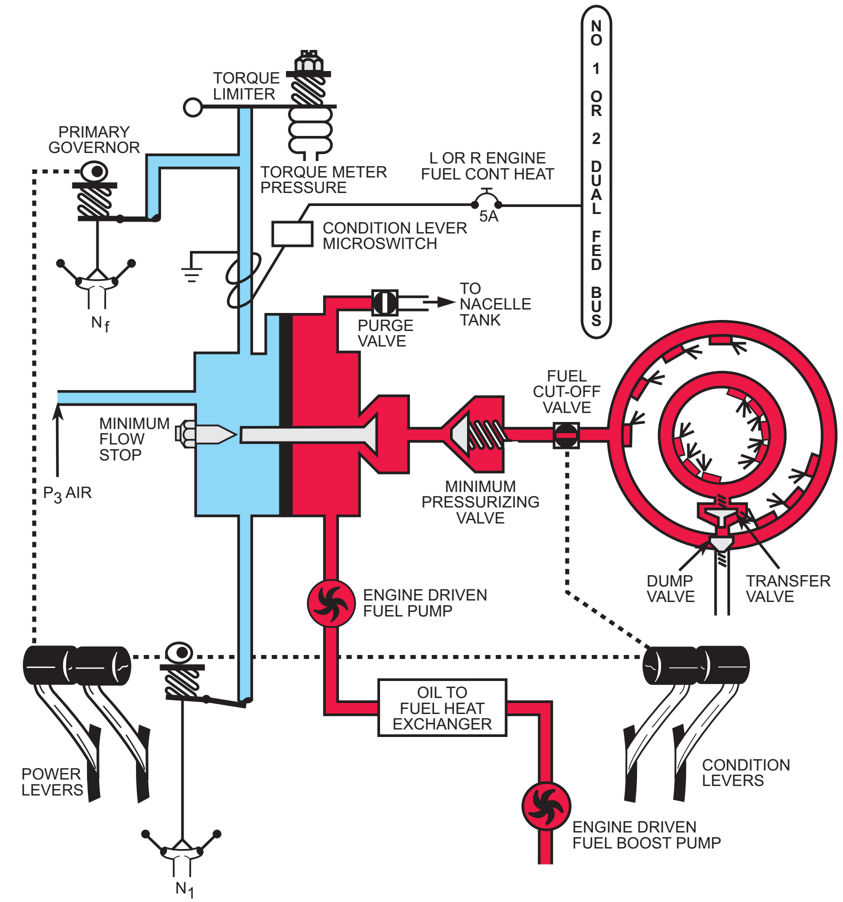
PT6A Engine

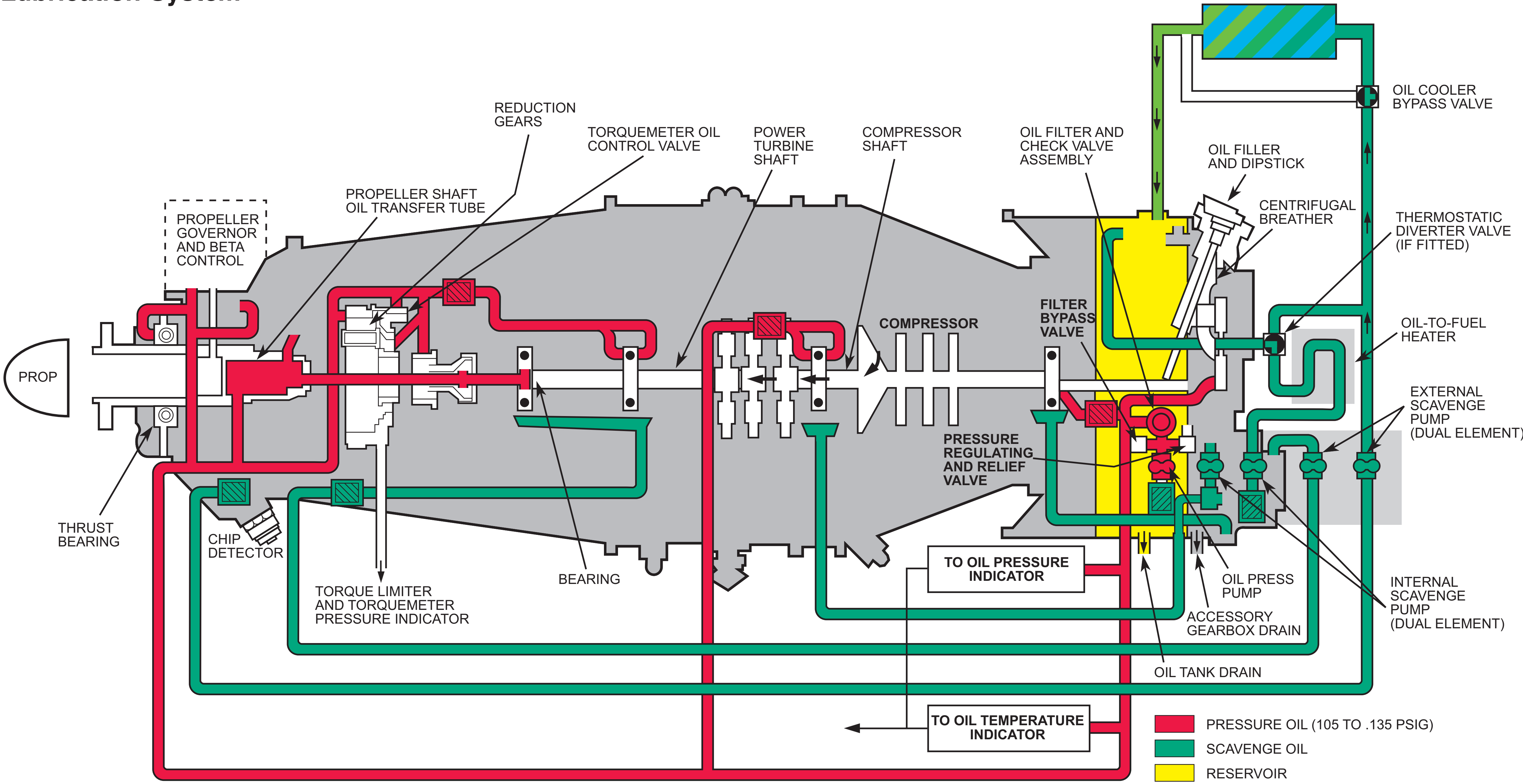


ACCESSORY SECTION
■ HIGH PRESSURE FUEL PUMP
■ BOOST PUMP
■ OIL PRESS PUMP
■ N1 GOVERNOR
■ A/C COMPRESSOR (RIGHT ENG)
■ OIL SCAVENGE PUMPS
■ STARTER GENERATOR
POWER TURBINES
INTERSTAGE TURBINE TEMPERATURE PROBE
CENTRIFUGAL COMPRESSOR
HIGH PRESSURE BLEED VALVE
FUEL NOZZLE
IGNITOR
COMPRESSOR TURBINE
AIR INLET SCREEN
REDUCTION GEARS
PROP GOVERNOR PAD
PROP FLANGE
CHIP DETECTOR
EXHAUST OUTLET
FUEL NOZZLE
TRANSFER VALVE
IGNITOR
ANULAR COMBUSTION CHAMBER
P3 BLEED AIR TAPOFF FOR:
■ ENVIRONMENTAL SYSTEM
■ PRESSURIZATION
■ PNEUMATICS
LOW PRESSURE BLEED VALVE
3 STAGE AXIAL COMPRESSOR
COMPRESSOR INLET
OIL RESEVOIR

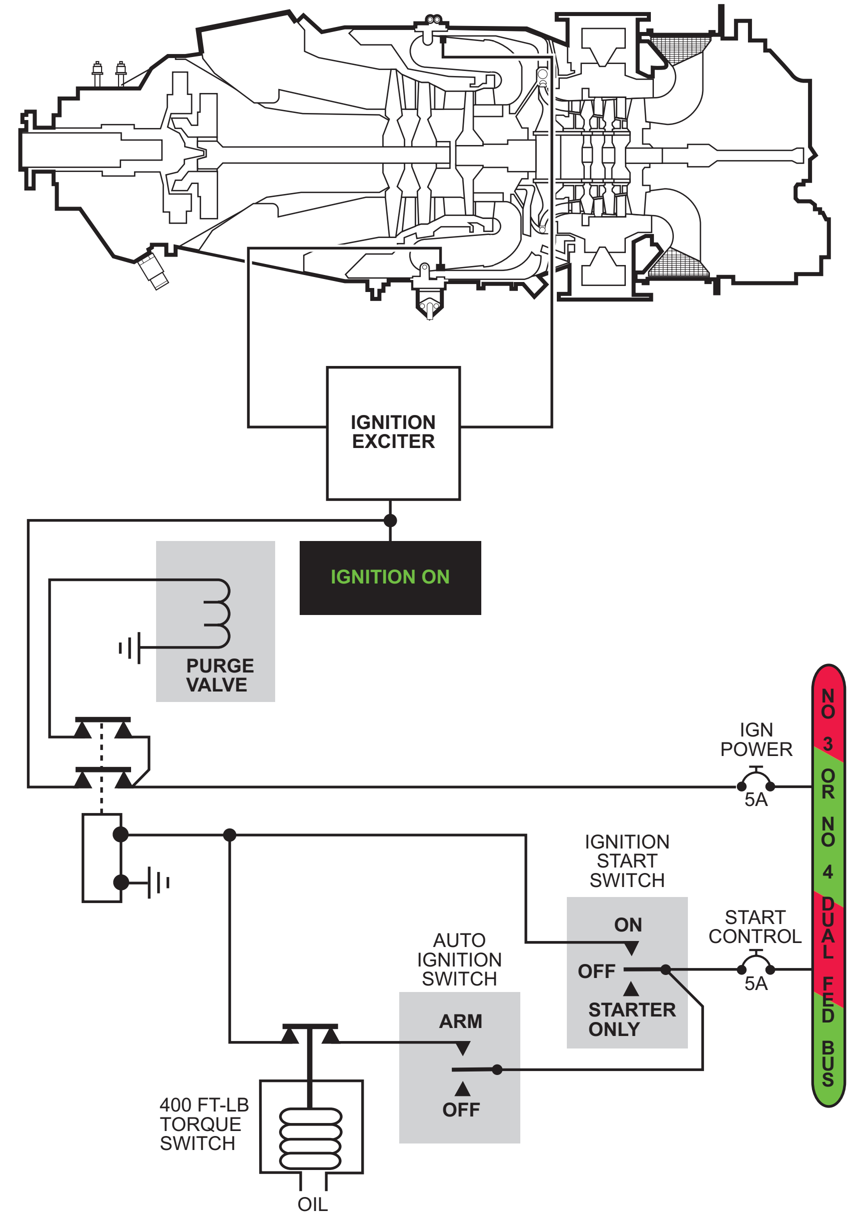
Fuel Control System



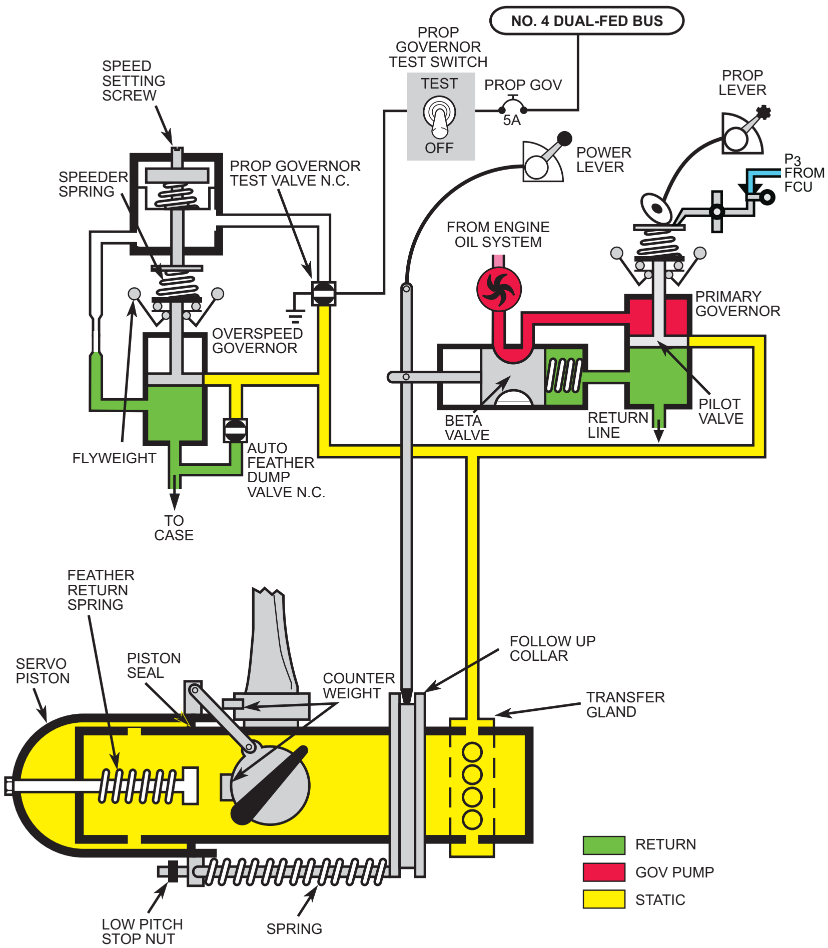
Lubrication System



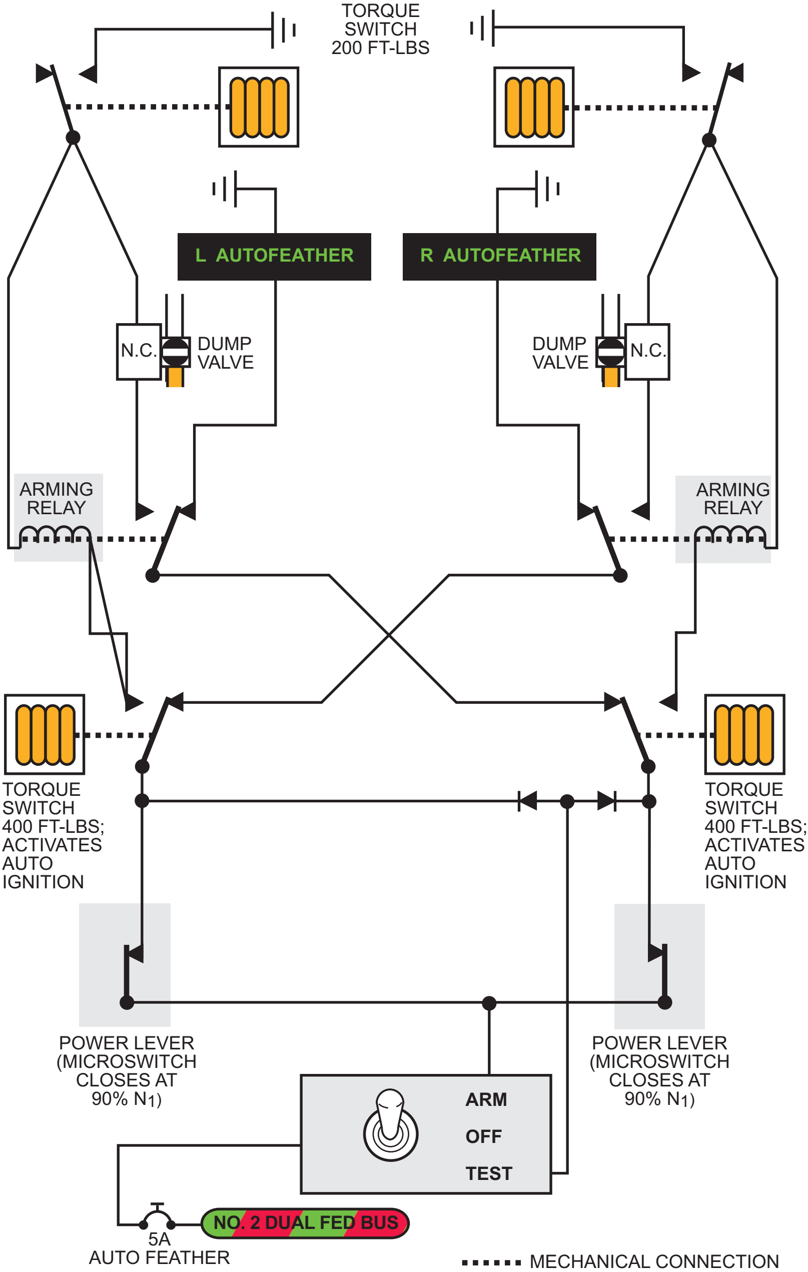
Ignition System



Propeller Systems



Autofeather System



Powerplant

Two Pratt & Whitney Canada (PWC) PT6A-41 or -42 turboprop engines power the aircraft. The PT6A is a lightweight, reverse-flow, free-turbine engine that drives a three or four-bladed constant-speed, full-feathering reversible propeller.

Each engine produces approximately 850 shaft-horsepower, 2,230 foot-pounds of torque, and approximately 135 lbs of jet thrust. The PT6A-41 and -42 engines are essentially the same except that the -42 engine's higher operating temperature provides better performance at high ambient temperatures.

Operation

The free-turbine turboprop engine compresses air, mixes it with fuel, and ignites the mixture to produce a high-temperature, high-speed gas.

The combustion cycle begins as air passes through an annular (ring- shaped) plenum chamber formed by the compressor inlet case. The air flows through the compressor where each successive compressor stage (stator and rotor pair) converts air velocity into increasing air pressure. After exiting the compressor section, vanes straighten the airflow before it reaches the combustion section.

As the high pressure air enters the annular combustion chamber, it changes direction 180° before mixing with fuel. A circular arrangement of 14 simplex atomizers spray fuel into the combustion chamber where air and fuel mix. Two igniters protruding into the combustion chamber spark to ignite the mixture. Once combustion is started, the igniters are no longer required because the combustion process is self-sustaining.

The rapidly expanding, high-temperature gases then reverse direction to travel through the exit zone. Inlet guide vanes straighten the gas flow before it reaches the single-stage compressor turbine. The turbine, in turn, drives the compressor through a shaft at the rear of the engine.

After passing through the compressor turbine, the gas flow drives the two-stage power turbine connected to the gearbox. The gearbox drives the propeller shaft. The exhaust gases exit the engine through the exhaust duct and stacks.

Powerplant Systems

Powerplant systems include:

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

Lubrication

The engine's integral lubrication system provides filtered oil under pressure to lubricate, cool, and clean engine bearings and gearboxes. This system includes:

- oil tank
- centrifugal breather
- chip detector
- pressure pump
- pressure relief/pressurizing valve
- filter
- oil cooler
- fuel heater
- scavenge pumps.

The accessory gearbox powers the oil pump as it draws oil from the tank and provides it under pressure to the oil filter. An external pressure regulating and relief valve maintains oil pump delivery pressure within a set operating range. If oil pressure exceeds a set value (i.e., cold viscous oil), the relief valve opens to prevent excess system pressure by directing oil back to the tank.

The oil filter removes contaminants from the oil supply before it reaches the engine's bearings and gearboxes. If sufficient contamination accumulates on the filter element to restrict oil flow, a bypass valve bypasses oil around the filter element.

Oil lubricates the No. 1 bearing first. This bearing, like Nos. 2 and 3 bearings, has a fine strainer that prevents extraneous matter from reaching the bearings. Nozzles direct oil to all of the bearing faces to ensure efficient lubrication.

A common oil supply line from the oil filter outlet supplies the rest of the engine bearings through a boss on the engine case. From this boss, the oil supply splits into three lines to supply the Nos. 2, 3, and 4 bearings and gearbox, front accessories, and propeller, respectively.

After lubricating the bearings and gearboxes, oil drains by gravity into sumps. The centrifugal breather removes entrapped air from the bearing and gearbox sumps and vents it to atmosphere. Oil is then directed back to the tank by one of the scavenge pump elements. When oil is above a set temperature, a thermostatic bypass/check valve directs oil moved by the external scavenge pump through an oil cooler. Oil then flows from the cooler to the oil tank.

A pressure sensor and temperature bulb in the common supply line downstream of the filter drive the oil pressure and temperature gages.

Fuel and Fuel Control

The fuel and control system regulates fuel flow from the aircraft fuel system to the engine using:

- engine-driven boost pump
- oil-to-fuel heater
- engine-driven fuel pump
- fuel control unit (FCU)
- torque limiter
- flow divider and dump valve
- fuel manifold and nozzles.

The engine's boost pump draws fuel from its nacelle tank and provides it under pressure to the oil-to-fuel heater where it is heated by warm engine oil. As fuel temperature increases toward 70°F (21°C), the heater's bypass valve admits less oil into the heater. Once fuel temperature reaches 90°F (32°C), the bypass valve closes completely.

Fuel flows from the heater to the engine-driven fuel pump. Before entering the pump, fuel flows through a strainer. If the strainer clogs, a bypass valve routes fuel around the strainer. The pump pressurizes the fuel to approximately 800 PSI before it flows through a filter. Like the strainer, the filter also has a bypass valve. A transmitter between the boost pump and engine-drive pump measures fuel flow to the engine and drives the fuel flow indicator in the cockpit.

The pressurized fuel then enters the fuel control unit (FCU). Based on throttle lever position, ambient air pressure, engine torque, and other inputs, the FCU regulates necessary fuel flow for engine starting, acceleration, constant speed operation, deceleration, and shut-down.

A torque limiter monitors torquemeter oil pressure to provide engine protection. If the engine produces excessive torque, the limiter bleeds off governing air pressure within the FCU to reduce fuel flow.

From the FCU, metered fuel flows to the fuel divider and dump valve. A minimum pressurizing valve in the output line to the fuel divider maintains sufficient pressure to maintain correct fuel metering. The divider controls fuel supplied to the primary and secondary fuel manifolds. In turn, the manifolds supply their primary and secondary fuel nozzles.

During engine start, the flow divider supplies the primary manifolds. As the engine accelerates and fuel pressure proportionately increases, the divider begins supplying the secondary manifolds.

During engine shutdown, the divider dumps fuel. Once the dump valve opens, fuel flows into an EPA collector tank (**BB-2 to 665**), or pressure in a purge tank (**BB-665 and subsequent**) forces fuel from the manifolds into the combustion chamber. In this chamber fuel manifolds distribute the fuel to primary and secondary fuel nozzles. Each nozzle provides a finely atomized mist of fuel into the combustion section.

Ignition System

An engine's ignition system consists of an ignition exciter, leads, two igniters, ignition switch, and auto-ignition system. Place the IGNITION AND ENGINE START switch in ON to close the associated ignition power relay and power the ignition exciter; the IGNITION ON annunciator illuminates.

The exciter converts the relatively low voltage DC input into a high voltage output. The exciter's capacitor continues to charge until the stored energy is sufficient to jump a spark gap. The exciter then discharges to supply the igniters.

Place the switch in STARTER ONLY to supply power to the engine's starter only; the ignition system is unpowered.

An automatic ignition system monitors engine torque to provide automatic system operation if torque drops below 400 ft-lbs. With the ENG AUTO IGNITION switch in ARM. If torque drops below approximately 400 ft-lbs, the pressure switch energizes the ignition power relay to power the ignition exciter. Once torque exceeds 400 ft-lbs, the system de-activates.

Engine Air

Compressor interstage ($P_{2.5}$) air provides bearing compartment sealing and turbine disk cooling. Compressor discharge (P3) air supplies airframe services such as air conditioning and pressurization, discussed in the environmental section.

The relationship between $P_{2.5}$ and P_3 air control compressor bleed valves that discharge $P_{2.5}$ air to atmosphere to prevent engine stalling at low engine RPM settings. As engine power increases and airflow smooths, the valves slowly close until at high power settings (>90% N_1), they are completely closed.

Propellers

The aircraft's three or four-bladed constant speed, full-feathering, reversible propellers are manufactured by Hartzell or McCauley.

The propeller blades are attached to a hub, which has a servo piston, low pitch stop rod(s), low pitch stop collar, feathering spring, and beta yoke. The servo piston moves the blades to change pitch in response to oil pressure supplied by a primary governor. Counterweights on each propeller blade assisted by the feathering spring move the blades to the feathered position with loss of controlling oil pressure.

In response to propeller lever setting, the constant-speed primary governor hydraulically controls propeller (N_2) RPM by changing the propeller's pitch. The primary governor range is from 2,000 to 1,600 RPM.

The primary governor maintains selected propeller speed by decreasing or increasing blade angle respectively. Decreasing blade angle speeds the propeller while increasing the angle slows it.

If the primary governor fails to limit propeller speed, the overspeed governor acts at approximately 2,080 RPM to reduce oil pressure to the servo piston. Reduced oil pressure reduces propeller speed by moving the blades to a higher blade angle.

A mechanically monitored hydraulic stop sets the propeller's low pitch stop to prevent inadvertent propeller reversing.

Raising the power lever aft past the normal idle stop allows the propellers to move toward the reverse thrust setting. Oil pressure to the servo piston then drives the propellers through the zero thrust angle (beta range) to the full reverse blade angle. Pulling the power levers further aft increases engine power to the maximum reverse thrust range. The primary governor's fuel topping mode reduces engine thrust to limit propeller RPM to 95%

of selected RPM (1,900 RPM when selected RPM is 2,000). Fuel restriction by the fuel topping function prevents propeller overspeed.

Place the AUTO FEATHER switch in ARM position with both power levers above approximately 85 to 90% N_1 setting arms the autofeathering system.

As engine torque increases, that engine's high pressure switch energizes the opposite engine's arming-light-out relay and illuminate its AUTOFEATHER light. This interlock between the two engines prevents system arming until both engines are above the mentioned power setting as well as both engines autofeathering if a malfunction occurs. If an engine fails and torque drops, the respective high pressure switch at 400 ft-lbs de-energizes the opposite engine's arming-light-out relay, de-activates its autofeather system, and extinguish its AUTOFEATHER light.

As torque continues to fall, the low pressure switch energizes its autofeather control relay at 200 ft-lbs to route power to the respective overspeed governor's solenoid dump valve. Oil pressure is dumped back to the gearbox case and the feathering spring and centrifugal weights rapidly move the propeller to the feathered position.

Holding the AUTO FEATHER switch in the TEST position with N_1 RPM below 90% bypasses the power lever switches to verify operation of the pressure switches, control relays, and solenoid dump valves.

Aircraft BB-2 to 934 and 991; BL-1 to 41 have a Type I propeller synchrophaser that adjusts right propeller RPM to match the left.

Aircraft BB-935 and 990, BB-992 and subsequent; BL-42 and subsequent have a Type II synchrophaser that adjusts the slower propeller to the faster propeller's RPM.

A propeller synchroscope provides a visual indication of the synchronization.

The Type I synchrophaser receives propeller RPM from a magnetic pickup on the propeller overspeed governor and a phase pickup on the propeller bulkhead. The system then compares right propeller RPM (slave) to the left's (master). Within system authority range of approximately s propeller governor to match the left propeller's RPM.

On the Type II system, magnetic pickups generate an AC current proportional to propeller RPM. The control box compares waveforms of the AC inputs from each propeller's pickups and attempts to superimpose the waveforms (match propeller RPM) by varying propeller RPM. With propeller RPM within the 25 ±2 RPM authority range, the control box sends correction signals to increase the slower prop.

An electrically powered single or dual-element deice boot warms each propeller blade to prevent ice formation (see Ice and Rain Protection). Slip rings and brush assemblies deliver DC power to the deice boots.

Powerplant System

Power Source	Reverse flow, free turbine engines Pratt and Whitney PT6A-41 (**200**) Pratt and Whitney PT6A-42 (**B200**)
Distribution	Air from inlet screen to: Axial-flow compressor Centrifugal-flow compressor section Annular combustion chamber Hot, high-pressure gas from combustion chamber to: Single-stage, axial-flow turbine (to drive compressor and accesory section) Two-stage, axial-flow turbine (to drive power turbine shaft) Power turbine shaft drives Propeller Reduction gearbox
Control	Levers Power Propeller Condition (fuel control unit) Switches IGNITION AND ENGINE START (ON/OFF/STARTER ONLY) (L/R) ENG AUTO IGNITION (ARM/OFF) (L/R) ICE VANE (EXTEND/RETRACT) (L/R) PROP GOV (TEST/OFF)

Monitor	Engine operation ITT Torque Prop RPM N_1 RPM Indicators FUEL FLOW OIL TEMP OIL PRESS Warning annunciators ENG FIRE L/R FUEL PRESS L/R OIL PRESS L/R CHIP DETECT L/R Caution/advisory/annunciators ICE VANE L/R (amber) ICE VANE EXT L/R (green) AUTOFEATHER L/R IGNITION ON L/R
Protection	Engine operating parameters (overspeed, overtemperature, overtorque) N_1 governor (overspeed) Torque limiter (overtorque) Magnetic chip detector (oil contamination warning Oil-to-fuel heat exchanger (fuel warming-see Ice and Rain Protection) Fuel shutoff valves