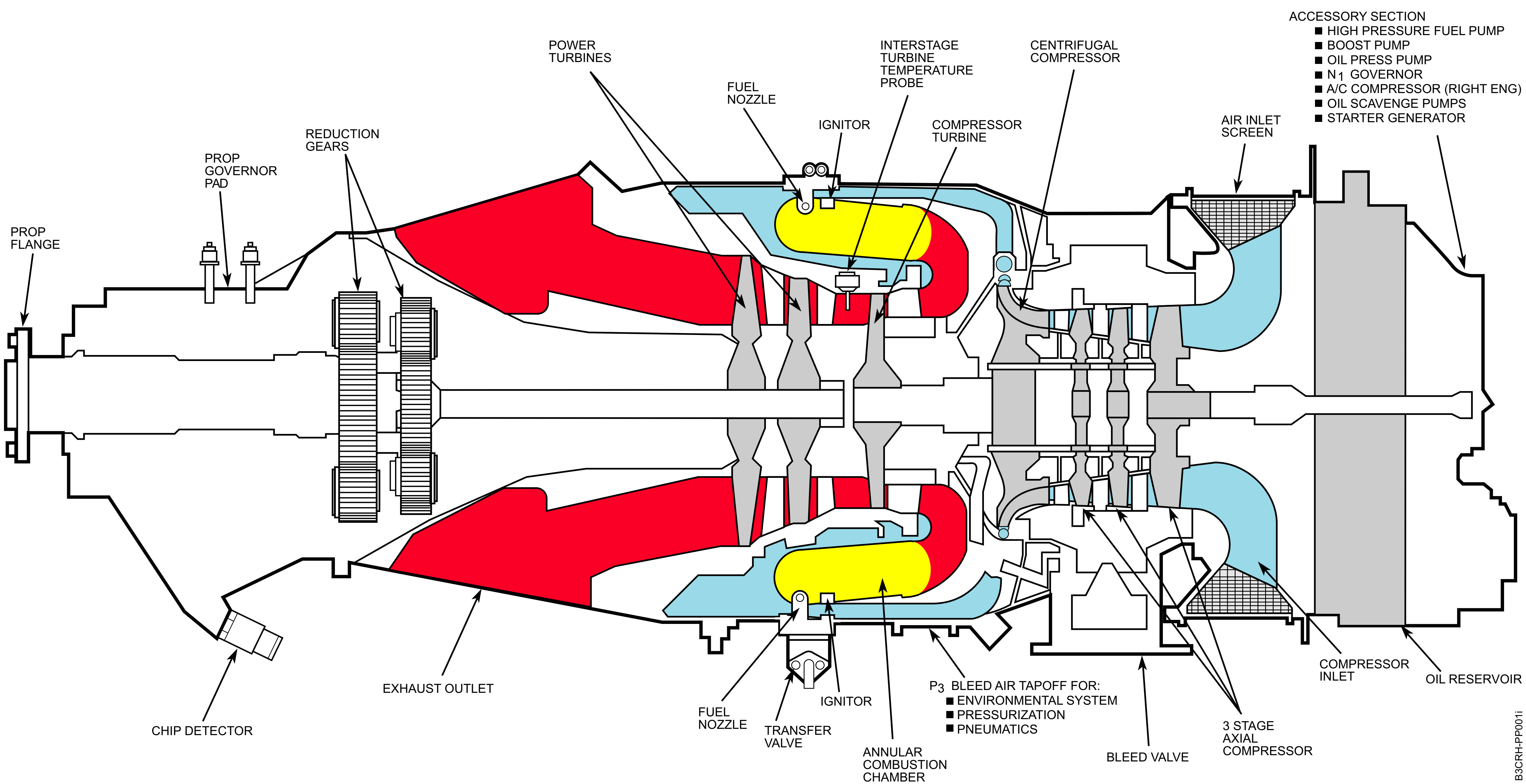
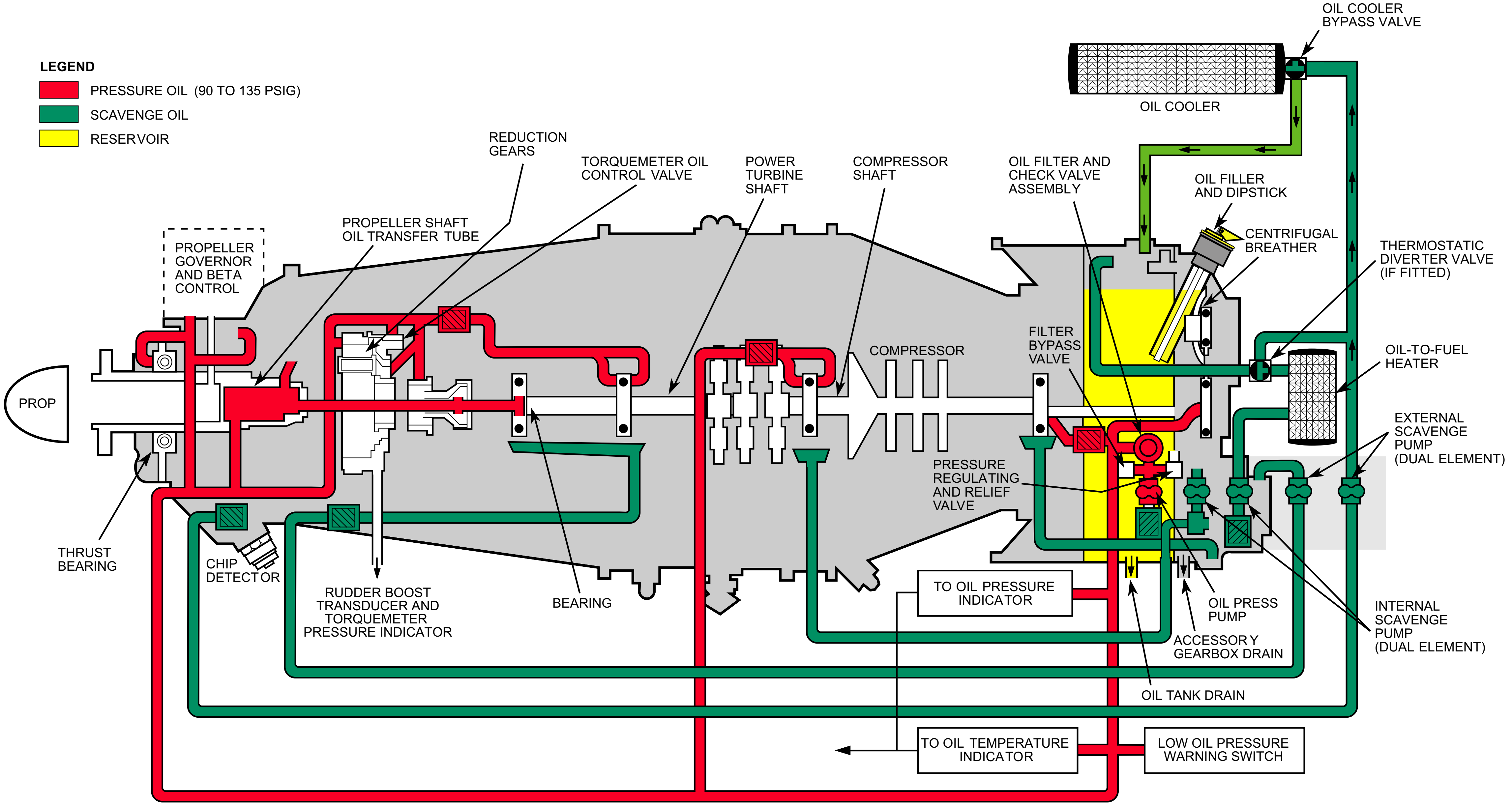
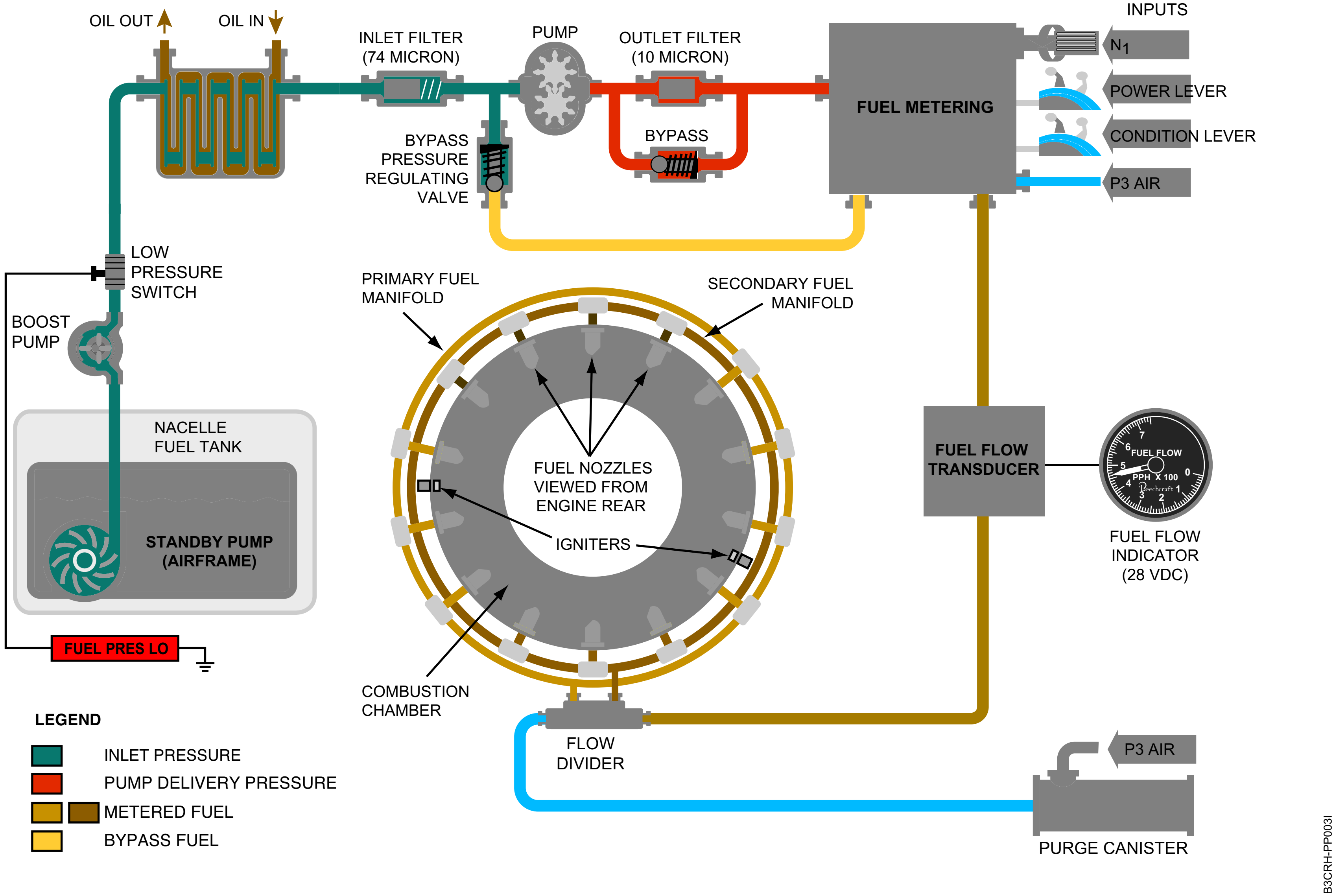
PT6A-60A Engine



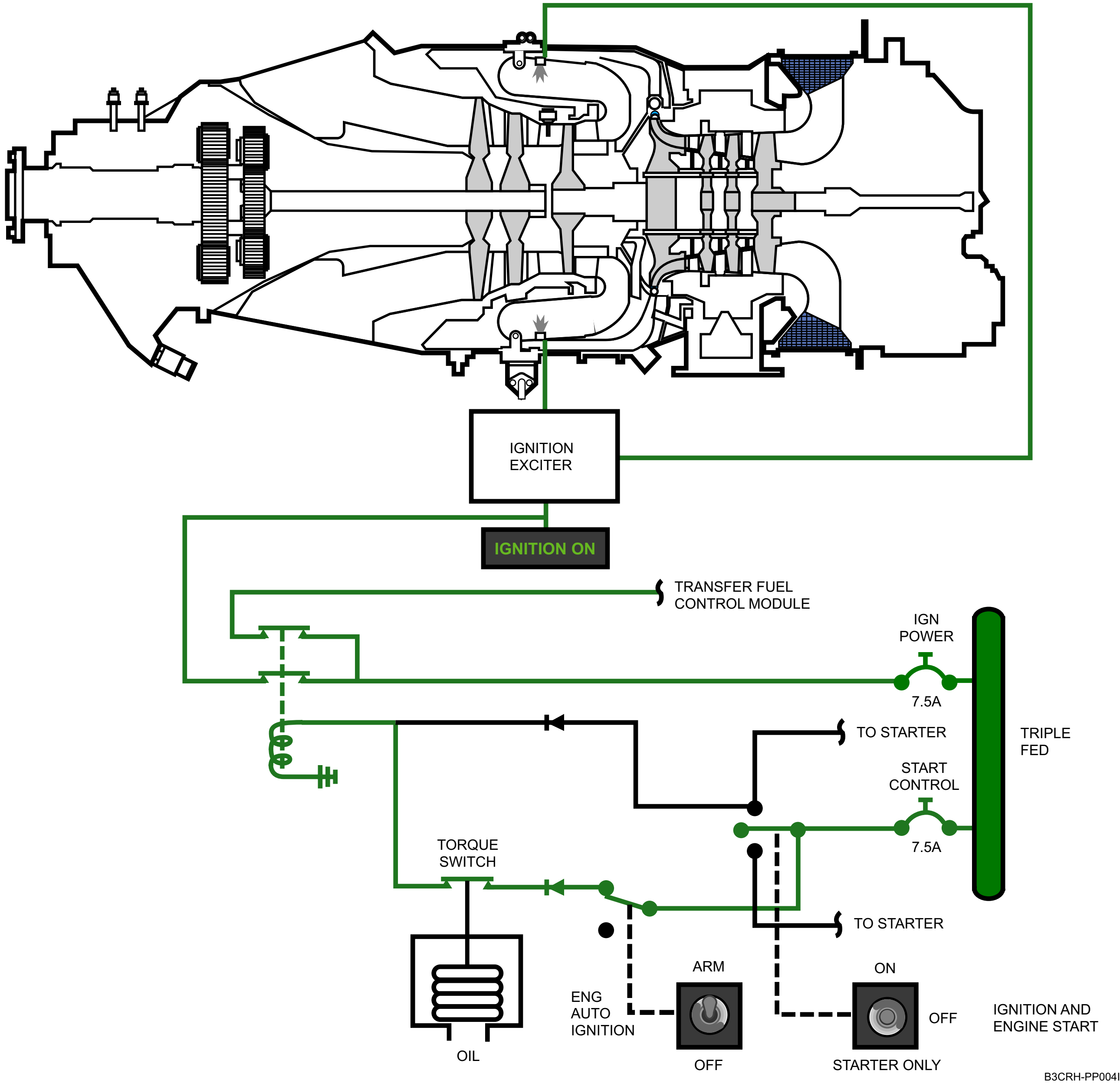
Lubrication System



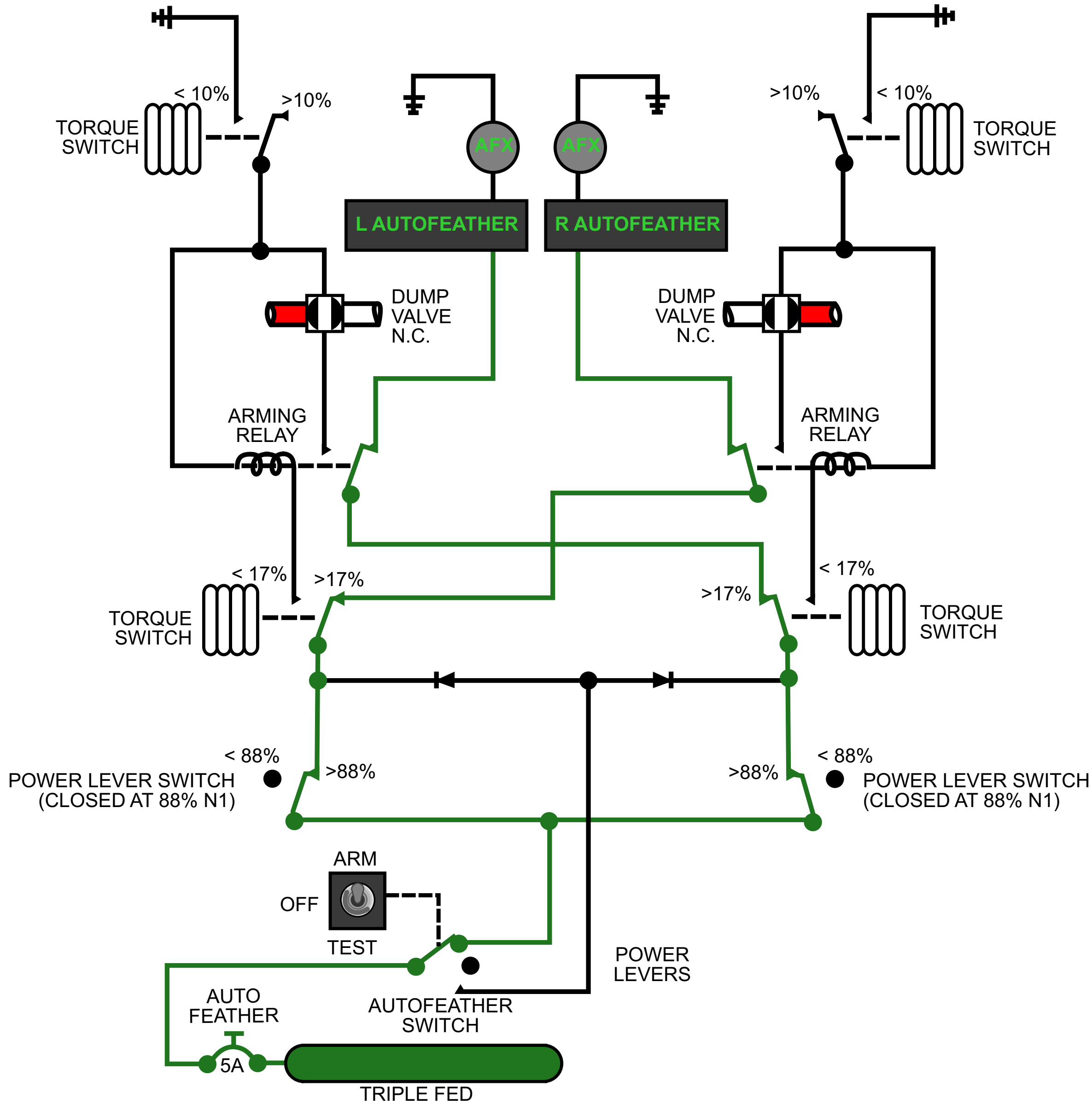
Engine Fuel System



Ignition System



Autofeather



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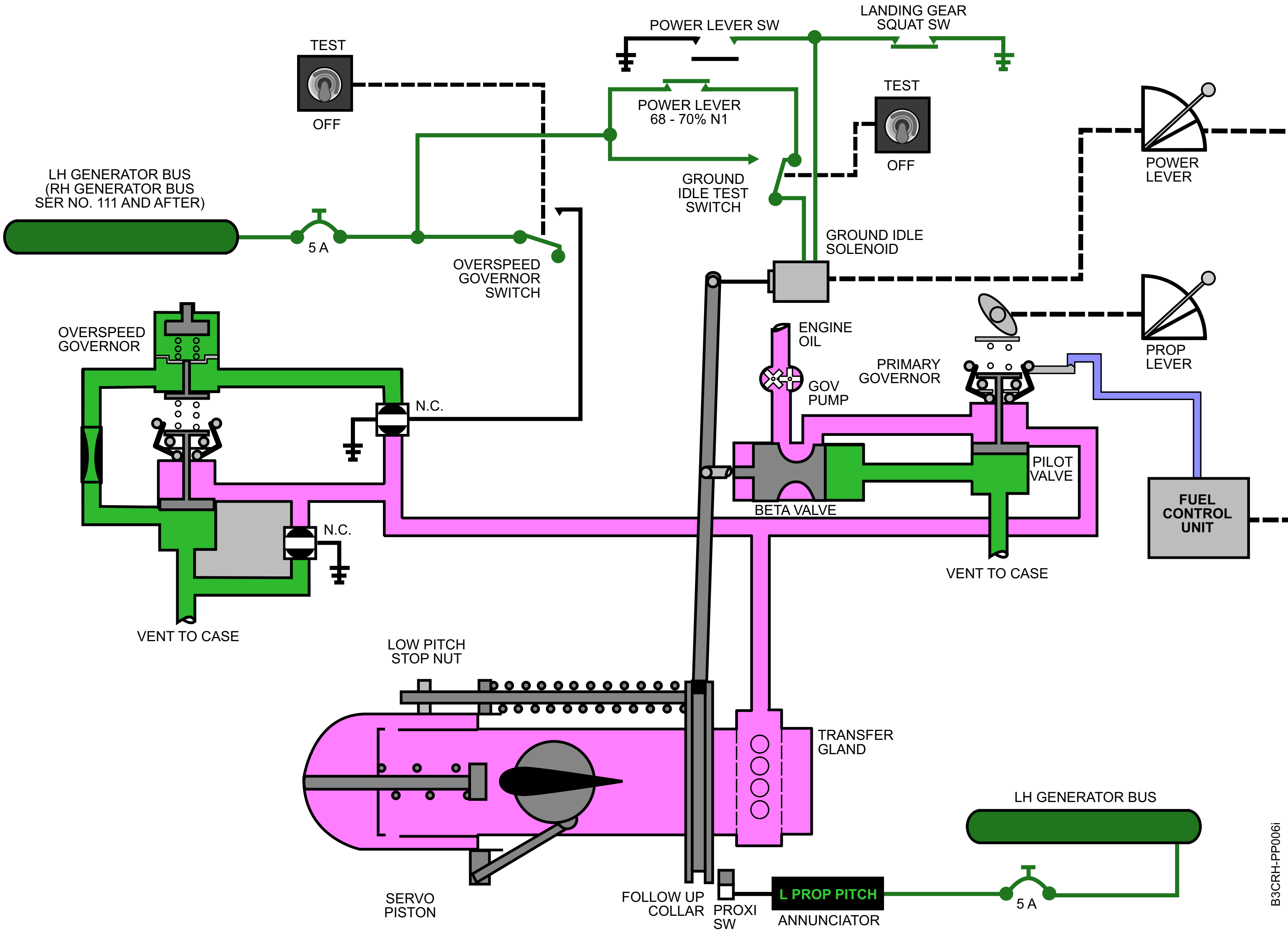
Propeller Control Systems



Powerplant

The King Air 350 is powered by two Pratt & Whitney Canada PT6A-60A turboprop engines with a Hartzell four-blade, full-feathering, constant speed, counter-weighted, reversing, variable-pitch propeller mounted on the output shaft of the reduction gearbox.

Operation

A row of stator vanes, located between each stage of compression, diffuses the air, raises its static pressure and directs it to the next stage of compression. The compressed air passes through diffuser tubes which turn the air through 90 degrees in direction and convert velocity to static pressure. The diffused air then passes through straightening vanes to the annulus surrounding the combustion chamber liner assembly.

The combustion chamber liner consists of two annular wrappers bolted together at the front dome-shaped end. The outer wrapper incorporates an integral large exit duct. The liner assembly has perforations of various sizes that allow entry of compressor delivery air. The flow of air changes direction 180 degrees as it enters and mixes with fuel.

The fuel/air mixture is ignited and the expanding gases are directed to the turbines. The fuel is then injected into the combustion chamber liner through 14 individual nozzles arranged in two sets of seven. The fuel/air mixture is ignited by two spark igniters which protrude into the liner. The resultant gases expand from the liner, reverse direction in the exit duct zone and pass through the compressor turbine inlet guide vanes to the single-stage compressor turbine. The guide vanes ensure that the expanding gases contact the turbine blades at the correct angle, with minimum loss of energy. The still expanding gases are then directed forward to drive the power turbine section.

The two-stage power turbine, consisting of the first-stage guide vane and turbine and the second-stage inlet guide vane and turbine, drives the propeller shaft through a reduction gearbox. The exhaust gas from the power turbine is collected, routed into the exhaust duct assembly and directed into the atmosphere by twin opposed exhaust stacks.

All engine-driven accessories, with the exception of the propeller governor, overspeed governor and tachometer generator, are driven by the compressor by means of a coupling shaft, which extends the drive through a tube at the center of the oil tank.

A single-acting engine-driven governor accomplishes propeller speed control. Backing up the engine-driven governor is an overspeed governor and a power turbine (N_2) governor, which is integral to the normal or primary governor. A servo-piston mounted on the front of the propeller spider hub moves the propeller blades through links connected to the trailing edges. Centrifugal counterweights on each blade, in conjunction with a feathering spring on the servo piston, increase pitch (decrease RPM) toward the feathered position as governor oil pressure is relieved. The feathering spring completes the feathering operation when centrifugal twisting moment is lost as the propeller stops rotating.

The autofeather system also provides a means of immediately dumping oil from the propeller governor. This enables the feathering springs to start feathering the propeller blades as soon as the engine torquemeter oil pressure drops below 4.7 PSI at power settings above 87 to 89% N_1.

Engine Systems

Engine 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 No. 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 No. 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 the 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 transmitter, oil pressure switch and temperature gages.

Fuel and Fuel Control

The fuel and fuel 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 fuel control unit and engine fuel manifold 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 shutdown.

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 integral cutoff valve in the FCU provides a positive means of shutting off fuel flow to the engine. Shutdown is accomplished by moving the fuel condition lever in the cockpit to FUEL CUT OFF. Fuel is then returned to the fuel pump inlet via the internal bypass passages and ports in the FCU and fuel pump. The flow divider and purge valve uses compressed air from an airframe-mounted accumulator to flush residual fuel from the manifolds into the combustion chamber where it is burned.

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 L or R 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 not powered.

An automatic ignition system monitors engine torque to provide automatic system operation if engine torque drops below 16%. With the ENG AUTO IGNITION switch in ARM position, if torque drops below approximately 16%, the pressure switch energizes the ignition power relay to power the ignition exciter. Once torque exceeds 16%, the system deactivates.

Engine Air

Compressor interstage (P2.5) 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 P2.5 and P3 air controls compressor bleed valves that discharge P2.5 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 (>97% N_1), they are completely closed.

Propeller System

Low Pitch Stops

The propeller control systems are equipped with flight idle and ground idle low pitch stops. The flight idle low pitch stop is a mechanically actuated hydraulic stop. The ground idle low pitch stop is an electrically actuated stop controlled by a solenoid, which resets the governor beta valve to produce the desired blade angle. Power is normally removed from the ground idle low pitch solenoid when the right squat switch is activated at liftoff. If a failure occurs in the system during flight, such that one or both of the ground idle low pitch solenoids are receiving 28 volts for more than 10 seconds, the yellow PROP GND SOL annunciator (FL-115 and after, FM-12 and after, FN-2 and after) will illuminate. With power supplied to a ground idle low pitch solenoid, the pitch of the associated propeller will continue to decrease from the flight idle stop to the ground idle stop when the propeller is no longer controlled by the governor, causing an increase in disking drag and a yawing moment if only one propeller is affected. Power can normally be removed from the solenoids by pulling the PROP GOV TEST circuit breaker. If this removes power from the solenoids, the PROP GND SOL annunciator (if installed) will extinguish.

The L or R PROP PITCH annunciators are provided to inform the pilot of a blade angle more than 8 degrees below the flight idle low pitch stop. The difference between the flight idle and ground idle blade angles is approximately 10 degrees. Therefore, in normal ground operation, these lights will be illuminated. The blade angles will be automatically reset from the ground idle low pitch stop to the flight idle low pitch stop as the power levers are advanced above 68-70% N_1 speed, and the L and R PROP PITCH annunciators will extinguish.

Propeller Governors

Two governors, a constant speed governor and an overspeed governor, control the propeller RPM. The constant speed governor controls the propeller through its entire range. The propeller control lever controls the RPM of the propeller by means of this governor. If the constant speed governor should malfunction and prop RPM exceed 1,700 RPM, the overspeed governor releases oil from the propeller to keep the RPM from exceeding approximately 1,768 RPM.

Autofeather System

The automatic feathering system provides a means of immediately dumping oil from the propeller servo to enable the feathering spring and counterweights to start the feathering action of the blades in the event of an engine failure. The system is primarily intended for use during takeoff and landing. It should be ARMED until the airplane has reached cruise altitude. The autofeathering system is controlled by a three-position switch ARM/OFF/TEST.

Two green annunciators, L AUTOFEATHER and R AUTOFEATHER, are located on the pilot's glareshield, inboard of the MASTER CAUTION annunciator; these indicate the status of the autofeather system. On aircraft FL120, and FL122 and after, the autofeather indication is provided by a set of circular indicators located near each torque gauge. Illumination of each annunciator indicates that the respective system is armed and that the power lever is advanced above 90% N_1.

A caution annunciator, placarded AUTOFTHER OFF, in the caution/advisory/status annunciator panel, will illuminate whenever the autofeather system is not armed and the landing gear is extended.

Propeller Synchrophaser

The propeller synchrophaser system is an electronic system certified for all operations including takeoff and landing. The system automatically matches the RPM of both propellers and positions them at a preset phase relationship in order to reduce cabin noise.

The system maintains propeller synchronization by increasing the RPM of the slower propeller to the RPM of the faster propeller. The system will never reduce RPM below that selected by the propeller control lever.

The synchrophaser system is controlled through a push switch placarded PROP SYNCH-ON-OFF. To operate the system, synchronize the propellers in the normal manner and turn the synchrophaser on. To change RPM, adjust both propellers at the same time. This will keep the setting within the holding range of the system. If the synchrophaser is on, but will not synchronize the propellers, the propeller speeds are not within the capture range (23 to 27 RPM between propeller) required for the system to assume control. Turn the synchrophaser off, synchronize the propellers manually, then turn the synchrophaser on.