2A-79-10: Engine Oil System

1. General:

A. Description:

Pressurized oil is supplied to the engine bearings and gears to provide lubrication and cooling. Each engine has an individual oil tank integral to the accessory gear box. The engine oil pump, mounted on and driven by the accessory gear box, pressurizes oil drawn from the tank and supplies the engine bearing compartments and the accessory gearbox through distribution lines. Scavenge pumps downstream of the bearings and gear box return oil back to the tank through a common return line. The oil supply lines are vented to the atmosphere to promote lubrication flow, with a breather separating the resulting air / oil mist, retaining oil in system lines and porting air into the engine exhaust section.

Integrated into the circulation of the engine oil system are a filter with a differential switch, pressure and temperature sensors and magnetic chip detectors. Sensors within the oil system report data to the Full Authority Digital Engine Control (FADEC) that in turn communicates with the Modular Avionics Units (MAUs) to provide information for cockpit displays.

The oil quantity in each engine tank may be determined during preflight by viewing a sight glass mounted within an access panel on the outboard side of the engine. Oil quantity indications are shown in the cockpit on the Ground Service 1/6 window, with the quantities determined through an interface with the Fuel Quantity Signal Conditioner (FQSC) software that interprets readings from probes mounted within the engine oil tanks. The FQSC supplies data to the MAUs for use in formatting the Ground Service window display oil quantity indications. The oil replenishing tank located in the tail compartment also contains a digital display of oil quantity derived from the FQSC. For all three (3) quantity indication sources, an accurate oil quantity reading is only available between five (5) and thirty (30) minutes after engine shutdown due to the distortions caused by foam normally generated during the oil circulation process.

NOTE:

In order to satisfy Rolls Royce / BMW engine warranty requirements, only readings taken from the sight glass on the outboard side of the engines within five (5) to thirty (30) minutes of engine shutdown are to be used to determine actual engine oil levels.

B. Operation:

Engine oil is drawn from the oil tank by the positive displacement oil pump. After pressurization by the pump, oil is filtered and then flows through the Fuel Cooled Oil Cooler (FCOC). The cooled oil is supplied to the front and rear bearing chambers and to the accessory gearbox. Oil pressure is sensed as a differential between oil entering and exiting the rear bearing chamber since this accurately measures the pressure within the rotating engine components. A scavenge pump with four (4) intakes removes oil from the front and rear bearing chambers, accessory gearbox and air / oil

breather. Magnetic chip detectors are fitted into the scavenge intakes to sample the circulating engine oil for metallic particles that may indicate engine deterioration. Oil temperature is measured in the return line from the scavenge pump to the engine oil tank.

The engine lubrication system includes the following components:

- Oil Tank
- Oil Quantity Transmitter
- Oil Pump
- Oil Filter Assembly
- Fuel Cooled Oil Cooler (FCOC)
- Oil Pressure Transducers
- Magnetic Chip Detectors
- Oil Temperature Transducers
- Engine Oil Replenishing System

2. Description Of Subsystems, Units And Components:

(See Figure 1.)

A. Oil Tank:

The oil tank is located on the Accessory Gearbox (AGB) as an integral component. Tank capacity is thirty-two point eight (32.8) U.S. pints or fifteen point five (15.5) liters, with twenty point five (20.5) pints or nine point seven (9.7) liters usable. An oil level sight glass installed on the tank at the outboard side of the engine permits direct observation of tank quantity. If the oil quantity requires servicing, oil can be added directly to the tank through a filler tube, a pressure fill connection for an external tank or through the engine oiler located in the tail compartment.

During engine operation the oil volume expands as it is heated and foam is formed within the system by the intake of ambient air that provides ventilation. (Ventilation air is necessary to prevent a vacuum lock in system lines and subsequent distortion of supply lines as the oil cools after engine shutdown.) A de-aerator in the tank separates oil from the foam mixture and vents excess air overboard through a breather mast that exits into the engine exhaust section.

B. Oil Quantity Transmitter:

An oil quantity capacitance probe in the tank provides data to the FQSC software. The capacitance of the probe varies with the amount of oil in the tank causing the voltage of a reference signal supplied by the FQSC to change accordingly. The voltage is translated by the software into a reading in pints supplied to the MAUs. The MAUs forward quantity information for cockpit display on the Ground Service 1/6 window.

C. Oil Pump:

The oil pump is located on and driven by the accessory gearbox. The pump is a positive displacement unit that operates whenever the engine begins to rotate, drawing oil from the engine tank and pressurizing the supply lines for distribution to engine components.

D. Oil Filter Assembly:

A filter installed on the oil pump removes any debris in the oil prior to delivery to engine components. The filter incorporates a differential pressure switch that monitors oil pressure at the filter inlet and pressure at the filter outlet. If debris collects within the filter restricting oil flow through the filter, a pressure differential will be detected by the switch. If a pressure drop reaches approximately fifty (50) psi, a differential pressure indicator on the filter assembly will extend to provide a visual indication of impending bypass due to contamination. At approximately sixty-four (64) psi differential, the oil will bypass the filter.

E. Fuel Cooled Oil Cooler (FCOC):

The FCOC is located between the oil filter outlet and the supply inlets to the engine bearings and accessory gearbox. The oil cooler is a heat exchanger that uses hot engine oil to warm fuel drawn from the wing tanks prior to entering the engine fuel metering unit. The lower fuel temperature is increased and the warm oil temperature reduced in the heat exchange process. During cold weather starting, a pressure relief valve on the heat exchanger bypasses oil around the cooler to prevent further increases in oil viscosity.

F. Oil Pressure Transducers:

Engine oil pressure is measured by two variable resistance transducers that sense the difference in oil pressure supplied to the engine bearings and oil pressure removed from the bearings by the oil scavenge pump. (Only one of the transducers is active at a time - the dual installation provides a transducer for each FADEC control channel.) The difference between the two pressures reflects the pressure of the oil as it actually performs lubrication of the bearings. Pressure is measured by the transducers as a change in resistance to a reference voltage supplied by the engine FADEC. Oil pressure reported to the FADEC is forwarded to the MAUs for formatting on cockpit engine displays.

G. Magnetic Chip Detectors:

Magnetic detectors are installed in the four (4) scavenge pump inlets to monitor the presence of metallic particles in the oil supply. The detectors are fitted into non-metallic screens and use magnetic force to attract any metallic debris onto the screens. The detector screens are periodically examined for evidence of particle accumulation that may indicate engine wear or deterioration.

H. Oil Temperature Transducers:

Dual oil temperature transducers are mounted in the oil return line to the tank. The temperature transducers are very similar to the pressure transducers, with only the transducer associated with the active FADEC channel operating to supply temperature data. The transducer measures a change in resistance to a reference voltage supplied by the FADEC caused by temperature variation. The voltage difference is interpreted by the FADEC as oil temperature and communicated to the MAUs for use on cockpit engine display windows.

I. Engine Oil Replenishing System:

An oil replenishing system, powered by the ground service bus, is located on the left side of the aircraft tail compartment. The system includes a reservoir and quantity gage that can be used to fill the engine oil tanks if servicing is required (the system is also used to service the APU oil tank). The reservoir holds fourteen (14) pints of engine oil when full and has a sight gage to indicate the amount of oil remaining in the reservoir. The reservoir may be filled through a removable cap on top of the reservoir tank. See the depiction of the system in Figure 2.

The control panel for the replenishing system contains a digital engine oil quantity gage and a manual selector valve that is used to direct the output of an electric pump that transfers oil from the reservoir to the designated engine oil tank. The digital quantity gage contains a display screen and a panel with two (2) switches: an ON / OFF switch and a FILL / TEST switch. Selecting the TEST position with the FILL / TEST switch initiates a built in test of system internal circuits and the information link to the FQSC. When the ON / OFF switch at the panel is selected ON, the display screen is powered to indicate current oil tank quantities for the engines (and APU). The quantity signal is provided by the FQSC interface that also supplies data to the Ground Service 1/6 window on the cockpit displays.

The quantity indications on the display screen show the engine oil tank levels (and APU oil state). If the tank is full, a digital text indication of FULL is shown; if the tank oil level is at or below the minimum usable level, a text indication of LO is displayed. Readings between FULL and LO are shown in pints below the full level, with a resolution to a tenth (0.1) of a pint (i.e. a reading of -2.5 indicates that two and a half pints of oil must be added to bring the engine tank up to the FULL level).

If the digital display indicates that an engine oil tank requires servicing, oil may be added to the tank from the reservoir by moving the manual selector valve to the low tank and holding the FILL / TEST switch below the digital screen to the FILL position. These actions will power the electric pump at the reservoir, transferring oil from the reservoir to the designated engine tank. The pump will automatically shut off when the FULL level is reached. At the completion of servicing, the FILL / TEST switch is released, the ON / OFF switch set to OFF, and the manual selector handle moved to the OFF position.

For engine oil servicing procedures, see Section 09-02-20: Engine Oil Servicing.

3. Controls And Indications:

NOTE:

See Section 2B-07-00 for a complete description of the Secondary Engine, Compacted Engine, Engine Start and Ground Service 1/6 window displays.

Digital indications of engine oil pressure are shown on the following window displays:

- Secondary Engine
- Compacted Engine

- Engine Start

Digital indications of engine oil temperature are shown on the following window displays:

- Secondary Engine
- Compacted Engine

Graphic indications of engine (and APU) oil quantity are shown on the Ground Service window display.

The color of the digital indications for oil temperature and oil pressure varies with operational limitations and corresponds to that of CAS messages displayed when limitations are exceeded. Digital presentations are summarized in the following table:

Color	Oil Temp	Oil Press
Red	T > +160°C T < - 30°C	P < 25 psi
Amber	-30°C ≤ T < +20°C	varies with HP rpm 25 psi ≤ P > 35 psi at 72.3% HP 35 psi ≤ P > 45 psi at 90.0% HP
White	+20°C ≤ T ≤ 160°C	varies with HP rpm 35 psi ≤ P at 72.3% HP 45 psi ≤ P at 90.0% HP

The Ground Service window contains graphic displays of oil quantity. Quantities are shown in bar graph format with indices on the right side. Each mark on the indices represents two (2) pints. The range of the bar graphics for engine oil is from zero (0) at the bottom to fourteen point four (14.4) pints at the top - the range corresponds to FULL at the top and minimum usable quantity at the bottom (LO). Quantities displayed on the Ground Service window are derived from data supplied by the FQSC.

A. Circuit Breaker (CB):

The following CB powers the engine oil replenishment system:

Circuit Breaker Name:	CB Panel:	Location:	Power Source:
OILER/HYD PUMPS	REER	C-9	Ground Service Bus

B. Crew Alerting System (CAS) Messages:

The following CAS messages are associated with the engine oil system:

Area Monitored:	CAS Message:	Message Color:
Oil Pressure Transducers	L-R Oil Pressure Low	Red
Oil Temperature Transducers	L-R Oil Temperature High	Red
Oil Temperature Transducers	L-R Oil Temperature Low	Red
Oil Pressure Transducers	L-R Oil Pressure Low	Amber
Oil Temperature Transducers	L-R Oil Temperature Low	Amber

4. Limitations:

A. Flight Manual Limitations:

(1) Oil Inlet Temperature:

(a) Minimum For Starting: -30°C

(b) Minimum For Takeoff Power: +20°C

(c) Maximum Temperature: +160°C

NOTE:

External heating will be required to raise oil temperature to -30°C for cold weather starting. At oil temperatures between -30°C to +20°C, only thrust required for taxi operations shall be used.

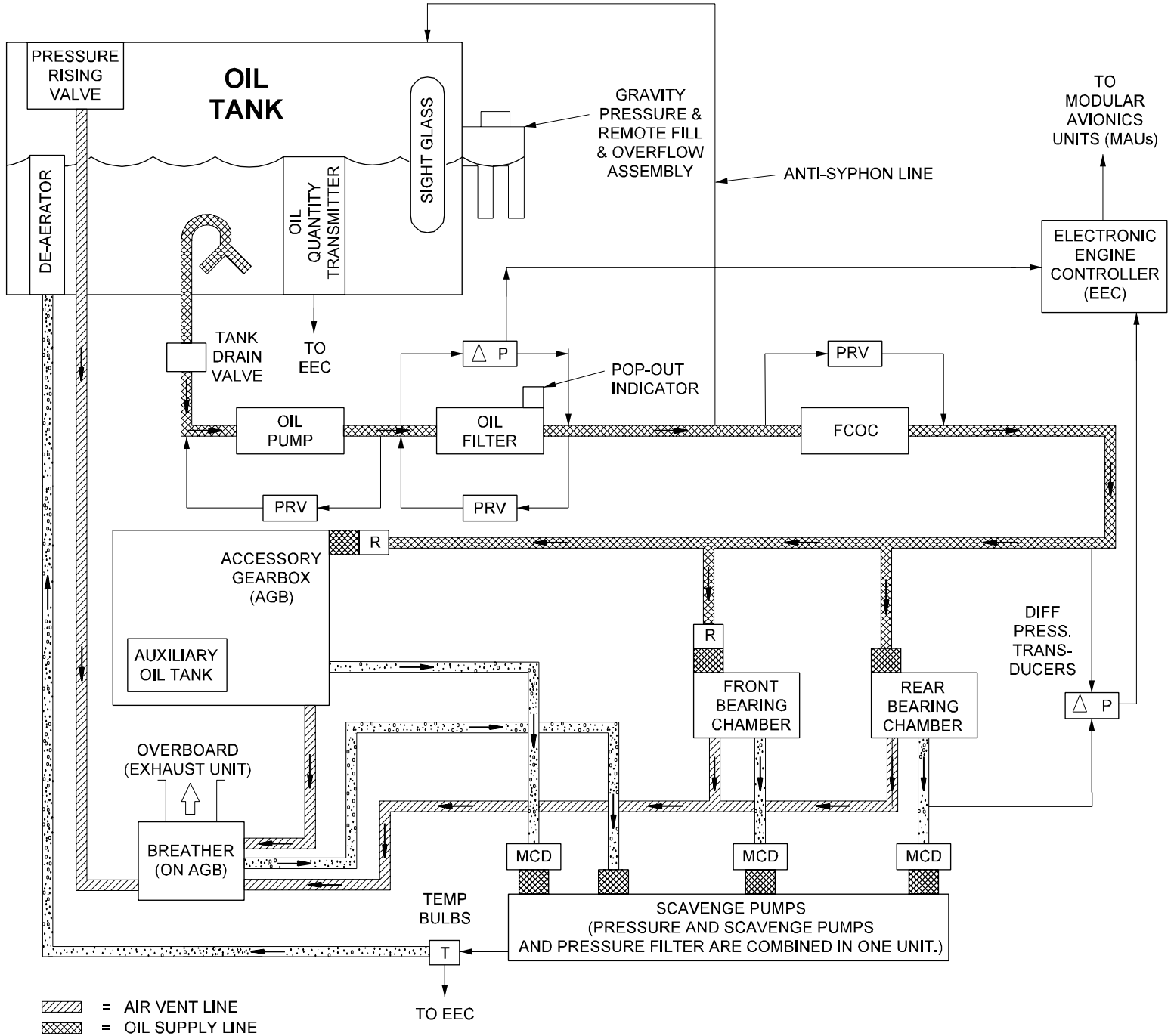
(2) Oil Pressure:

(a) Shutdown Oil Pressure:

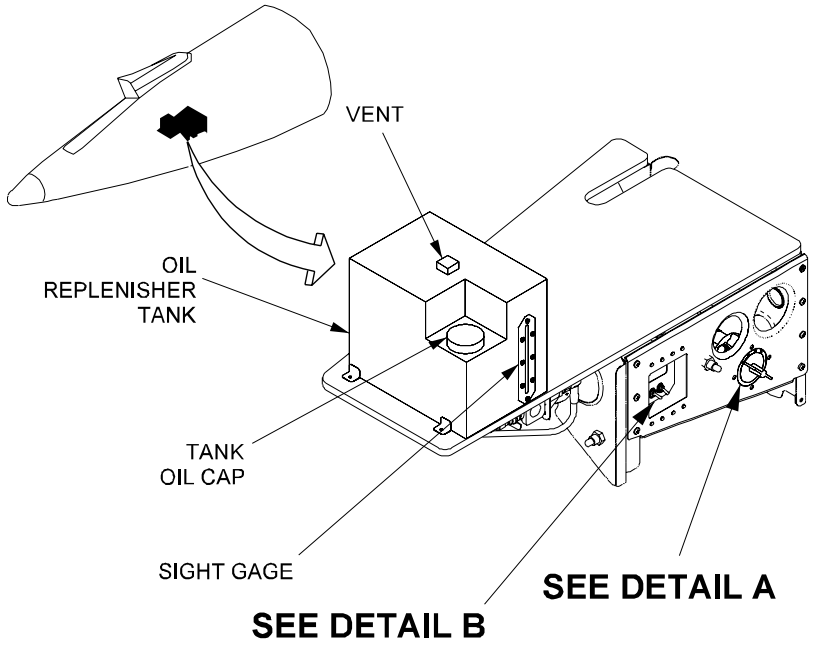
The engine must be shut down when oil pressure drops below 25 psi.

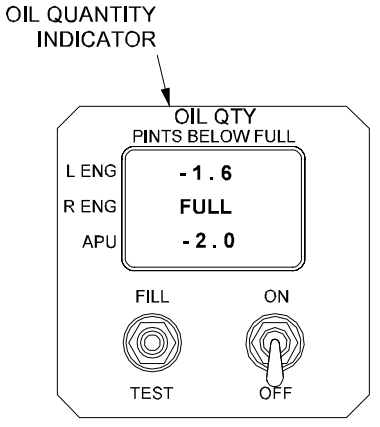
(b) Minimum Engine Oil Pressure:

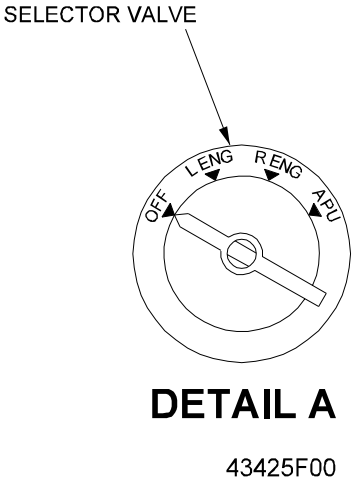
Power Setting:	For Takeoff:	To Complete Flight:
Below 72.3% HP	35 psi	25 psi
Above 90.0% HP	45 psi	35 psi



Engine Oil System
Simplified Block Diagram
Figure 1







43425F00

Engine Oil Replenisher
Figure 2

THIS PAGE IS INTENTIONALLY LEFT BLANK.