Podcast 44 – Engine Oil system

Hello all and welcome to another talk episode. We're getting technical again this week as I'm sure you've missed the ins and outs of a good old system refresher for a few weeks now!

On this podcast we'll discuss the 737NG Engine Oil system in more detail. Engine oil lubricates, cools and cleans engine bearings and gears. There is some form of oil storage capacity as well as a distribution network and indications given to us on the flight deck.

That storage system comes in the form on the engine oil tank which holds approximately 21 US quarts, or 20.2 litres. We say approximately because the oil tank for engine 2 can actually hold slightly more than engine 1 due to wing dihedral.

We have an oil tank access door located on the side of the right fan cowl where you can check oil level using a sight gauge and fill if necessary. As well as storing sufficient oil for a continuous supply to the distribution circuit, and allowing us a visual contents check, the oil tank also removes air from the scavenge oil.

The oil distribution system consists of a supply system, a scavenge system and a vent system.

The supply system lubricates and cools internal components in the engine. From the tank the oil passes through an anti-leak valve, which is a pressure-actuated valve. When the engine does not operate, a spring closes the valve thus preventing oil leakage during the removal of a component of the oil distribution system.

From here the oil heads into the lubrication unit where it is pressurised by the supply pump and passed through the supply oil filter. Oil then flows in three separate lines to the Forward sump and transfer gearbox, the Rear sump, and the Accessory gearbox. The lubrication unit also takes the oil that collects in the sumps and the gearboxes and sends it back to the oil tank.

The accessory gearbox turns the oil supply pump and the three scavenge pumps in the lubrication unit, which are on a common shaft. The oil supply pump, however, does not control the output pressure and when the engine speed changes, the oil pressure changes.

The supply oil filter is a paper cartridge type which can be discarded after use. It removes and holds contaminants and when it clogs, the supply oil filter by-pass valve opens.

The scavenge system takes the oil that collects at the lowest points of the forward sump, the rear sump, the accessory gearbox and the transfer gearbox. Through three lines the oil then flows through three chip detectors, or on some models three debris monitoring system detectors. Both variants essentially alert us to mechanical failure of an engine bearing or gear through the use of magnets and engineering inspections of these detectors.

Downstream of these detectors there are three scavenge oil pumps, one for each scavenge line sending the oil into the scavenge oil filter assembly which contains the scavenge oil filter and the scavenge oil filter clogging transmitter. In the body, an oil filter bypass valve opens

when debris causes the scavenge oil filter to clog. This filter is another discardable paper filter cartridge which removes debris from the three scavenge circuits.

Oil heads from the scavenge oil filter, through the servo fuel heater, on its journey to the main oil/fuel heat exchanger, as well as the HMU. Here the oil cools as it heats the fuel and then heads back to the oil tank. The main oil/fuel heat exchanger also has an oil bypass valve. The oil bypass valve opens when the exchanger core is clogged. This permits the oil to flow around the core exchanger causing the oil temperature to increase but the oil continues to flow.

Vent wise, a line connects the oil tank with the forward sump. Internally, the accessory gearbox and the transfer gearbox also connect with the forward sump. Both the forward sump and the rear sump vent out through the turbine exhaust plug at the rear of the engine.

Oil consumption runs at approximately 2, up to around 4 quarts an hour and at certain phases of flight you may notice deviations from initial levels. At ground idle this may be around 4 quarts or 20%, take-off 6 quarts or 30%, in the climb, cruise and descent 4-5 quarts or 20-25% and after landing around 4 quarts or again 20%.

So, onto the indications. Oil system data is provided through transmitters to our display units or DEUs to use their correct acronym, with our primary and secondary engine displays giving us data on oil quantity, temperature, pressure, and scavenge filter condition. The primary display shows us the Oil filter Bypass light which is related to the scavenge filter condition.

The oil quantity transmitter, located on the oil tank, sends signals directly to the DEUs where the quantity is shown on the lower display unit. Depending on the model this quantity may be shown in quarts, litres or as a percentage of full. Refer to your company procedures for minimum dispatch requirements.

A LOW message shows when the oil quantity is less than 4 quarts for 35 seconds, less than 4 litres for 35 seconds, or less than 18.8 percent full for 35 seconds depending on your displayed units. The oil quantity shows in reverse video when the low quantity exceedance is active.

Oil pressure is considered the most significant of the oil system indicators, but you can recognise a deteriorating system through monitoring all the parameters. While the engine operation is governed by both oil pressure and temperature limits, there is no minimum oil quantity limit and so we have no QRH for this condition. You will more than likely start to see exceedances in the other parameters should your quantity drop so low but until you get those other indications you may operate the engine normally but would of course be keeping a very close eye on it.

Moving on to those other parameters then. We have an oil pressure transmitter that measures the oil pressure at the outlet of the lubrication unit. The oil pressure transmitter sends the oil pressure data to the DEUs through the EEC.

Oil pressure shows on two vertical indicators and two digital displays. A pointer shows the oil pressure in psi differential on each vertical indicator. The indicator has two index markers. The amber index marker shows the oil pressure amber limit. The red index marker shows the oil pressure redline limit. If the oil pressure shows between the amber limit and the redline

limit, the digital display and the box around the digital display are amber. This is the caution range. If the oil pressure shows under the redline limit, the digital display and box around the digital display are red. This is the out-of-limit range.

The low oil pressure amber limit set pressure increases based with an increase in engine speed.

As an example, a normal range at 85% N2 is between 18-65 psi whereas at 95% N2 it would be between 24-80psi. The red band is less than 13psi with the amber ranging from 13-26psi.

When the oil pressure is less than the red line limit, the EEC sends a signal to the DEUs. This causes the DU to show the amber LOW OIL PRESSURE message on the primary engine display for the affected engine. All 3 message of the crew alerts flash for 10 seconds then the LOW OIL PRESSURE alert shows continuously when the low oil pressure is less than the red line limit.

Blinking is inhibited on take-off from 80kts to 400ft RA, or 30 seconds after reaching 80kts, whichever occurs first and on landing below 200ft RA until 30 seconds after touchdown. During these periods the alert will illuminate steady. During start, the EEC prevents the indicator and pointer from a change to amber or red.

Having seen this alert or noticed the lower display amber alert we would reference the QRH. On the ground, with take-off thrust set and oil pressure in the amber band we would not take-off. If oil pressure is at or below redline, either on the ground or airborne, then we told to reference the Engine failure or Shutdown checklist.

Temperature now. An oil temperature sensor measures the oil temperature at the outlet of the lubrication unit. The temperature sensor transmits the oil temperature data to the DEUs through the EEC.

Some limitations on oil temperature include minimum for starting of -40°C for type 2 oil, with that dropping to -54°C for type 1. During those cold weather starts, oil pressure may temporarily exceed the green band or may not show any increase until the oil temperature rises, but we must see an oil pressure indication by idle RPM or an immediate shutdown is required. We must also see a rise in oil temperature prior to take-off which you may well have company SOPs to check on the taxi out.

The oil temperature, like the pressure, shows on two vertical indicators and two digital displays on the lower DU. A pointer shows the oil temperature in degrees Celsius on each indicator. The vertical indicator has two index markers. The amber index marker shows the oil temperature amber limit. The red index marker shows the oil temperature redline limit.

Maximum continuous temperatures are 150°C at idle, 140°C above idle with a 45-minute max limit of 160°C idle and 155°C above idle.

If the oil temperature is between the amber limit and the redline limit, the digital display and the box around the digital display are amber. This is the caution range. If the oil temperature

is more than the redline limit, the digital display and the box around the digital display are red with this being the out-of-limit range.

Referencing the QRH for Engine High Oil Temperature we start with a couple of choices. Firstly, if we are at or above redline, we are straight away redirected to the Engine Failure or Shutdown Checklist.

The amber band however gives us different options. Here we can disconnect the autothrottle and, after confirming the correct lever, retard it slowly to get the temperature back within normal operating range or completely closing the lever if necessary. Now we are into a waiting game of 45minutes to determine our next course of action. Should we be in that amber band for 45mins or less then we can run the engine at a setting to maintain normal operation temperatures, but our FMC performance indications are now wrong, and we must operate in TA mode on the transponder as we may be unable to comply with climb commands.

If, however, oil temperature is in the amber band for more than 45 mins we are back to our old friend the Engine Failure and Shutdown checklist.

Finally, onto the oil filter bypass warning system. The oil filter bypass warning system shows the scavenge oil filter condition data on a common display system display unit which receives the signal from the clogging transmitter via the EEC. The scavenge oil filter clogging transmitter monitors the oil pressure difference between the inlet and the outlet of the scavenge oil filter and closes before the oil filter bypass valve opens.

The DUs shows the message OIL FILTER BYPASS and the oil filter bypass message flashes for 10 seconds, and then shows continuously.

All three crew alert boxes flash for 10 seconds and the applicable OIL FILTER BYPASS alert message then shows continuously.

Back into the QRH which tells you the alert indicates oil filter contamination can cause oil to bypass the filter. You are then into the checklist where you'll again disengage the autothrottle and see if thrust reduction will remedy the problem. If it doesn't, we're again directed to the Engine Failure or Shutdown checklist. If the light goes out, we operate the engine at a level that keeps it that way again disregarding FMC performance predictions and again we put our TCAS into TA mode.

Now to lubricate those brain cells or Ian's case cell and have a…

Q1 Which oil filter is associated with the OIL FILTER BYPASS light?

Q2: How is engine fuel heated

Q3: What is the minimum engine oil pressure?

Q4: What is the minimum oil temperature for start using type 2 oil?

Q5: This is a bit of a tough engineery one but here goes. Is there an indication if the oil supply filter becomes blocked?

Q6: Is soft alternate mode on the EEC selectable?

Q7: Will redline exceedance protection for N1 and N2 be provided in normal and alternate EEC modes?

Q8: What is the maximum speed for lowering the flaps using the alternate system?

Q9: How many flight spoilers are on each wing?

Q10: For landing what does the white bug on the speed tape indicate?

That just about wraps up a more in-depth look at the engine oil system and how the various indications we get on flight deck link up with it and the actions we need to take should we receive them. It highlights the importance of the system to us with a lot of those malfunctions leading us in to shutting down an engine. We'll be back again soon with more 737 related information be it technical, procedural, or investigative. Thanks again for taking the time to spend with us and we hope that's cleared up some burning questions. If not, you can contact us over on b737talk.com with any enquires. Until next time though, fly well and be safe.