Podcast 006 - Max Differences

Hello everybody and welcome to todays podcast. We thought that having looked at the Max recertification and the Lion Air accident we'd bring you a podcast based on the differences you will come across between the Max and NG. There are quite a few so we'll do our best to summarise them in a digestible manner.

We'll start with the most major change which is the engine redesign that comes in the form of the LEAP 1B being the main component for a 15% improved fuel consumption. The engines have more composite materials than before, resulting in a weight saving of over 200kg per engine even though overall the LEAP engine is 385kg heavier, and the new design allows them to operate at a higher pressure with a bypass ratio of 9:1. The fan diameter has increased by 20cm and there are fewer blades at 18 compared to the 24 of the NG. Ground clearance is maintained through a 20.3cm extension to the nosewheel. Another obvious physical difference are the chevrons at the rear which reduce noise through the improved mixing of ambient and engine air.

The N1 compressor in the LEAP has 3 stages compared to the CFM56-7 of 4 with the N2 compressor of the Max switching to 10 stages compared with 9 on the CFM56.

There are a few new indications on the primary engine displays. There are two new crew alerts. One saying Thrust and the other Fuel flow. The Thrust alert appears steady amber when thrust is more or less than commanded and is displayed in conjunction with the amber N1 command sector for the affected engine. More on that in a minute. The Thrust Alert blinks along with the entire block for 10 seconds and then remains steady until the condition no longer exists.

The fuel flow alert illuminates steady when engine fuel flow is abnormally high compared with FMC expected and blinks with the same parameters as just mentioned.

The blinking for both these alerts is inhibited during takeoff to 400ft RA or 30 seconds after reaching 80kts, whichever occurs first and during landing below 200ft RA until 30 seconds after touchdown. During these periods the alerts will illuminate steady.

Back to that amber N1 command sector. We're used to seeing it in white but on the max it will also turn amber when thrust is more or less than commanded for a longer period working in conjunction with that Thrust Alert.

A slight change to the Amber Eng Fail parameter on the EGT dial comes with the max, in that it will show when N2 is less than 63% with the start lever in Idle. Another familiar feature but with a difference is the red start limit line on the EGT dial. On the max you get a higher limit of 753 degrees C and the line will remain until approximately 66% N2 after which the engines are stabilised. Also of note is that your max operating EGT limit on the Max increases to 1038 degrees C and you also get a significantly higher N2 operating limit of 117.5%.

On the N2 dial we also have a new indication. On the LEAP the N1 and N2 rotor shafts bow due to thermal build up after engine shutdown. Motoring in white will appear after engine

start switch selection to GND and N2 is greater than 18%. Bowed rotor motoring or BRM logic is now active during engine start on the ground. N2 is held at approximately 23% while BRM is taking place. The amount of time this takes is variable between 6 to 85 seconds depending on the temperature of the engine, the hotter the longer. This function straightens both rotor shafts.

We are treated to two new EEC features on the LEAP engine. Thrust Control Malfunction Accommodation TCMA and Electronic Overspeed System EOS.

The TCMA provides protection against unacceptable high asymmetric thrust on the ground including an RTO or Landing. If the EEC detects this condition, it shuts off fuel flow to the affected engine.

The EOS provides protection against structural design limit exceedances. If an uncontrollable N2 overspeed condition is detected fuel flow will again be shut off. N1 overspeed is also protected as the EEC will open variable stator vanes to trigger an N2 overspeed with the EOS then triggering.

Both these functions are tested during engine start and during this the fuel shutoff valve repeatedly opens and closes. This will be indicated to you by the steady bright ENG VALVE CLOSED light with 0 fuel flow for a couple of seconds when the start lever is moved to idle.

Engine starting parameters are slightly different as I'm sure you'd expect. Start takes approximately 90 seconds mainly due to BRM and starter cut out occurs at 63% N2 with stabilisation at 66%. Normal start cycle limit is 3 minutes. Extra EEC start protections include Hung start on the ground, and Hot start and stall during start when in flight.

Reverse thrust on the leap is more effective due to the higher bypass ration. There are new warnings on the aft overhead associated with the Reverser system including the Reverser Command light which indicates one of the reversers is not in the stowed position in flight.

You also get a Reverser Air/GRD light showing a failure of that logic meaning selection inflight will allow reverser deployment and the final pair of lights indicate Reverser Limited on associated side. If they are on it means the associated reverser will either not deploy or be limited to idle.

Ok that's enough of the big engines let's look at the little one at the back. The Max comes with an updated APU with improved start reliability. The main changes are an APU door with three different positions, Closed, Flight open at 17 degrees and ground open at 45 degrees and the removal of the APU MAINT light and EGT indicator. Added is an APU DOOR light which illuminates after 165 seconds when either the APU door is not in the commanded position or when the APU door remains open after APU shutdown.

One of the first things you'll notice when stepping into the flight deck are the lovely new big screen displays in front of you. These are 4 new 15.1inch displays putting your iPad to shame! This required the moving down of what used to occupy the central part between the screens

such as the autobrake selector, brake pressure display and so on. The flap position indicator moves to these screens with the engine instruments.

The outboard display can show a combination of PFD along with either Aux, Engine Display, MFD or ND. The inboard display can show PFD along with Engine display MFD or ND as well as Engine Display and ND together or ND and MFD together.

You also get an Auxiliary Display on the outboard side of the PFD which will include data such as Flight number, Transponder code, SELCAL, and a clock whose elapsed time starts automatically on lift off and stops 30 seconds after touchdown.

On the engine display control panel, you have two new buttons INFO and ENG TFR. The INFO button shows N1/SPD Ref page which allows crews to manually set N1 targets and V speed bugs with inoperative FMC's. The ENG TFR button simply transfers the engine instruments between the inner DU's.

Another difference to the pilot display is the landing gear lever. This has shrunk down and now only has two positions UP and DOWN. The PSEU automatically sends signal to remove the retract hydraulic pressure from the system 10 seconds after gear is up and locked. There is also no trigger on the gear lever anymore as the lock override is now a button next to the lever. Next to this button you will find the Nose wheel Steer Alt switch which has migrated over on the max.

We just mentioned the PSEU which the Max retains. However, the light that says PSEU on the NG has changed to an amber MAINT light instead.

There is also an optional TIRE PRESSURE light available which will illuminate when any tire pressure falls below 100psi or if there is a 25% pressure difference between pairs of main wheels or 12% difference between the nose wheel tires.

In regard to fuel, you now get a new progress page, page 5 which shows you APU fuel used, a Fuel Quantity Totalizer as calculated by the Fuel Quantity Indication System the FQIS and a Fuel Quantity Calculated which is calculated by the FMC. The FMC takes data from the FQIS and then updates it with EEC fuel flow data.

You can line select either of these Fuel quantity sources to be used by the FMC for fuel predictions.

FUEL DISAGREE USING RSV FUEL and INSUFFICIENT FUEL now appear as scratchpad messages and as amber alerts below the fuel quantity indication with associated QRH checklists with an emphasis on leak detection.

As we've gone into the MCAS in more depth in another Podcast we won't cover it too much here other than to say it is now a much-improved system with 2 AoA sensor inputs and limitations on its interventions. It is still there to protect the aircraft from high angles of attack when the autopilot is disengaged, and the flaps are up.

Further flight control differences involve a rename of the Stabiliser Trim Cut out switches to PR (Primary) and B/U (Backup) and either switch will now cutout both the main electric and autopilot trim. We also have new fly-by wire spoilers. These new spoilers reduce weight and improve stopping distance as well as some other features.

Due to the structural changes to accommodate the LEAP an MLA or Maneuver Load Alleviation function was added as an automatic function to reduce wing loads during high load manoeuvres. It activates above 1.3g and below 0.3g partially retracting the spoilers and then returning them to commanded position when out of the condition.

The extension of the Max nose gear meant the chances of a nose gear first landing increased. The LAM or Landing Attitude Modifier was installed to mitigate this and uses symmetric spoilers to adjust the deck angle and maintain acceptable clearance. The system performs two functions. Firstly, when flaps are 15 to 30 and thrust levers are near idle LAM extends spoilers to catch and maintain the glide path similar to the NG. Secondly, in Flaps 30 to 40 LAM deploys spoilers to reduce lift and force a higher angle of attack. The spoiler deflection is variable with speed and begins at approximately Vref plus 10. In either of these cases the speedbrake lever itself does not move.

The max also brings with it an Elevator Jam landing Assist system designed for jammed or restriced pitch control. To activate it the switch needs to go to on when the flaps are at 1 or greater with autopilot disengaged. When active pushing the control column causes the spoilers to extend from a neutral position while pulling causes them to retract.

The new spoiler system has an EDS or Emergency Decent Speedbrakes function too which allows the spoilers to extend further than normal maximum flight deflection when the Cabin Altitude warning is operative, altitude is above 30,000ft and the speedbrake lever is in flight detent. EDS will remain in operation until the Cabin Altitude warning is no longer active or the Speedbrake lever is stowed.

The flight control panel now has a SPOILERS light which will illuminate with spoiler system faults and the Speedbrake extended light has the added functions of illuminating when speedbrakes are extended and the thrust levers are greater than idle for 15 seconds and when GA thurst is set for more than 3 seconds with speedbrakes extended.

As you can see, we are running up a hefty list of differences here and we're not quite finished yet, nor will we cover every single one, but I hope this certainly goes a large amount of the way to help towards a deeper understanding of the Max. I'll take a quick look at the air systems and the Ian will look at general differences before we all have a well-deserved rest!

The overhead air conditioning panel remains almost the same but there are some system differences including the fact that bleed air now comes from 4th and 10th compressor stage and the max can run both packs off one engine bleed on the ground and in flight.

The Pack Light takes on some new roles. It will illuminate after landing along with the MAINT, MASTER CAUTION and OVERHEAD system annunciator if there is a primary or secondary pack

control failure and both PACK lights will illuminate if both pack switches are off 45 seconds after flaps up after take-off.

The new BLEED light replaces the BLEED TRIP OFF light. A single light will illuminate for over pressure, over temperature, under pressure or a failure within the bleed air system rendering it potentially non-resettable. Both lights will illuminate if both bleed air switches are off 45 seconds after flaps are up after takeoff.

We get added smoke detectors to the equipment cooling system with an associated EQUIP SMOKE light which illuminates along with the Master Caution and OVERHEAD system annunciator on smoke detection. Both packs will automatically switch to high flow, the Electronic and equipment cooling supply fans turn off for approximately 5mins, the overboard exhaust valve opens to the smoke position and the recirc fans turn off. The supply fan light does not illuminate under these conditions.

Associated with the air system goes the anti-ice system. The LEAP introduces an engine core anti-ice which is controlled automatically by the EEC directing 7th stage bleed air to the core based on engine parameters and atmospheric conditions.

In addition to flight and approach idle the max has an icing idle which will be active on selection of anti-ice when flaps are up.

Engine Cowl anti-ice uses 4th and 10th stage bleed air using the same system operation as the NG. You do however have a different display on the overhead panel. The ENG ANTI-ICE lights indicate the system is inhibited due failure or the engine core anti-ice valve has failed closed. The COWL ANTI-ICE lights indicate an overpressure in the duct downstream of the engine cowl anti-ice valve and the amber COWL VALVE light indicates a disagree with the switch position hence you get a momentary illumination on anti-ice selection. This light replaces the Blue “COWL VALVE OPEN” light.

Wing anti-ice operation is also the same as the NG but with different overhead lights. Amber L or R VALVE lights replace the BLUE L/R VALVE OPEN lights. Illumination of these lights signifies a disagree between switch and valve position. They are inhibited on the ground.

Thanks Mark lets wrap this up with some General differences. We have a slightly longer wingspan on the Max of 35.92meters or 117ft 10 which keeps it Cat C for ground movements. Main wheel span also increases a little to 5.8m or 18ft 9 with it’s minimum 180n degree turn radius also bumping up a smidge to 24.4 meters or 80 inches.

The Max-8 is about 3 Tonnes heavier than the 737-800 but ups its max take-off weight by just over 3 tonnes and it’s max landing by just under 3 tonnes. Its approach category is operator dependant but will be either CAT C or D.

And finally, impressive new winglets called Max AT or Advanced technology adorn the wing tips which alone help to improve the fuel efficiency by approximately 1.5% with special materials and coatings apparently used to create laminar flow over the winglet.

I really hope you found that one useful for your transition to the Max as although it's largely the same aircraft you can see just how many differences there are and as I alluded to earlier we haven't even covered them all. Again, please head over to our socials to continue the talk where I'm sure even more differences will arise.