Podcast 35 – Hydraulic B failure

Hello all and welcome to another 737 Talk. This episode we'll be discussing a system failure with some failure management techniques for you to think about. We'll talk about a Hydraulic B total system loss in flight on arrival.

From our previous hydraulics episode, you may remember we thought of system B as the "airborne" system. Both system A and B input into our flight controls, in other words Aileron, Elevator and Rudder so we have sufficient back up there. We do however lose flight spoilers 3,5,8 and 10, with a small loss in associated roll rates, as well as the Yaw Damper. Something to bear in mind on the Yaw Damper is that although you have lost it the switch itself only kicks off via the SMYD when yaw damping is sensed as needed, but the yaw damper doesn't respond. This will lead to its own, perhaps separate master caution with a FLT CONT annunciator light. More significant is the loss of our primary extension and retraction means for the trailing and leading-edge devices as well as the auto slats. Other systems of note include Autopilot B, Normal brakes and Reverser number 2.

A quick mention of the PTU as it can get confusing in this situation. The PTU will automatically operate under the following conditions:

i) We are airborne
ii) The B EDP pressure drops below 2350psi for more than 0.5 sec
iii) On an SFP aircraft flaps are not up
iv) On a non SFP Flaps are less than 15° but not up

What we're getting at here is that the PTU will be used to aid the remaining B EMDP in a scenario such as a number 2 engine failure on Take-off, but in this situation here, we are looking at a total system loss ie both pumps or a total fluid loss. As soon as the standby hydraulic system is used to extend the LED, the PTU and autoslat systems become redundant.

So, on to the scenario. Let's say we're in the descent on our way into destination. Now unless you had an eye on that system the first attention grabber of the total system loss is likely to be the master caution along with the FLT CONT and HYD annunciator lights. If this was a sim scenario it's more than likely that the TRI or TRE will have engineered you to have Autopilot B in command which will then fairly quickly drop out.

So, what do you do first? The answer is not to jump straight into identifying the failure. We always like to consider the Aviate, Navigate, Communicate mantra to start with. For Aviate - A quick scan of the FMAs allows you to understand what the aircraft is trying to achieve and whether it matches what you want it to achieve. If the answer is the aircraft is doing what I want and I'm following the FD commands, you can then look at re-engaging the AP by selecting AP A. Remember as PM to monitor all this before you start trying to identify any failures.

Navigate here means taking into consideration where we are in space and where we want to be. Will we need to hold to give ourselves time to identify the failure and run the QRH? and are we vertically safe as we descend toward our cleared altitude?

Communicate then gets us to think about who we need to talk to with the first port of call each other. As PF a mini brief here can be useful to make sure the other pilot is thinking in the same manner as you. Something along the lines of "Ok Ian, Autopilot A is in command, we are in the descent into BHX heading toward point WELIN and our cleared Level is FL120 which is well above the highest area MSA of 2,500ft. If you're happy please Identify the failure". This shows your PM you've thought about the flight path management before they start looking eyes in.

Looking up at the overhead panel now, to the panels where the annunciator has guided us, we would see that on the hydraulic panel under the B Hydraulic pumps we would have two low pressure lights for ELEC pump 1 and ENG pump 2. We could confirm this by bringing up the system page for a look at the quantity and pressure. Going across now to the FLT CONT panel we would also see a low-pressure light associated with FLT CONT B and the FEEL DIFF PRESS light due to excessive differential hydraulic pressure sensed in the elevator feel computer.

As PM you can now make your analysis of the failure and say to PF something along the lines "The overhead panel is showing low pressure lights for both the system B pumps as well as a low-pressure light on the FLT CONT B side. Our system page shows 0 for both quantity and pressure for system B. To me this confirms a loss of system B hydraulics"

PF can then cast their eyes over the systems to make their own confirmation and verbalise agreement, or disagreement if that is the case. Once the agreement has occurred you can now cancel the master caution light thus resetting the system for any further alerts. Here is where the correct QRH will be called for which in this case is "Loss of system B".

As PF in this situation, you may think about asking the PM to put a call out to ATC and a useful structure for this call can be the NITS format. Something along the lines of Ian could you tell Air Traffic with a PAN call we have a technical issue (that's Nature) and wish to slow to 210kts and hold at point GROVE (that's Intention) to allow us some time to run our checklists (Time) and then we will advise them when we are ready for an approach (Special instruction). Doing this prior to running the QRH here allows for less distractions from ATC and for the FPM to be taken care of before running the QRH.

The QRH, in section 13, will instruct you to put the FLT CONT B system switch to STBY RUD. As a refresher for you this will activate the standby EMDP, shut off system B pressure to ailerons, elevators and rudder by closing the flight control shut off valve, open the stby rudder shut off valve, deactivate the B flight control low pressure light, allow the standby system to power the rudder and thrust reversers and illuminate the Stby Rud on light, master caution and FLT CONT annunciator. Although we have our Reverser 2 powered by the standby system just bear in mind the deployment rate may be slower leading to some asymmetric reverse.

We are directed to turn both B system pumps off, either to stop them running dry, or if they have both failed, just to confirm the failure. We are then to plan to do a flap 15 landing bearing in mind the associated VREF ICE if necessary.

We have lost hydraulic B pressure so we lose the ability to lower the TE flaps with the hydraulics. We do however have an alternate electric motor capable of lowering the TE flaps to 15. There is also a useful reminder for us to check landing distances using our company approved method.

On page 2 of the QRH we have a list of inoperative items and some further useful information such as the time to flaps 15 extension being approximately 2 mins, the fact the LE cannot be retracted, we will be utilising the alternate braking, which will be done manually using anti-skid on wheel pairs only and the potential asymmetric reverse thrust. Here you'll then find the line "Checklist complete Except Differed Items". You have completed that part of the QRH but a tip here would be a quick read ahead just so you know what to expect as the flight progresses.

Page 3 covers how to extend the TE flaps with our alternate electric motor including the limitation of 230kts maximum speed during alternate flap extension. There are a few important operational techniques to keep in mind.

-To arm the alternate flap selection, we need to make a selection on the overhead flight control panel. This is a red guarded switch and will need confirmation from your colleague.

-A Note states that the LE FLAPS TRANSIT light stays illuminated. This is because, as soon as you set flap 1 with the flap lever, the Standby hydraulic system will lower the LE flaps and slats straight away to full extend, and because they are not in agreement with the TE flap flaps co-ordination, we get the LE FLAPS TRANSIT light until such a time as they are. This would be F15 on the SFP and F10 on non SFP.

-Whilst using the electric motor to extend the TE flap to 15, on schedule, it is worth noting that the time taken to extend will be significantly more than normal operation. You must hold down and keep holding down the switch whilst monitoring the TE flap position on the flap position indicator. To move from flaps up to flap 15 is in the region of 2 minutes! With this in mind, care must be taken when managing your approach to ensure you have enough time to configure.

The QRH also mentions you no longer have asymmetry protection so a careful eye must be kept on the Flap position indicator to detect this at the earliest opportunity.

So, having completed the QRH and read ahead to know what to expect we can now come back together, again making sure we are happy with the aircraft flight path management, and start to think about putting a plan together using the company decision making model. Here is a good point to get any local weather to assist in your decision making and allowing you to make your performance calculations. This decision-making model could be GRADE, DODAR, FORDEC or many others which all bring us to the same point.

We'll use FORDEC today for no particular reason. What is always useful is to surround your acronym with the letter T for Time. In today's situation we are now almost entering our hold at GROVE which was on our original flight plan so only now are we about to go outside of the planned fuel. We need to look at what we have left and decide how best to use it bearing in

mind in this situation that we'll preferably want a long final to help with that extended configuration time. We also need to consider our inability to retract the leading edge meaning we are looking at a minimum of approximately 10% extra burn to get to our alternate which is not shown by the FMC.

That all said today we have enough to allow ourselves 10 minutes in the hold before making our approach and being confident we'd still have number 1 alternate fuel in the event of the go around.

Moving ahead with our FORDEC. A good way to start is using the line "The way I see it and please point out any differences when I'm finished is…" This allows your PM to know you are open to ideas but to let you have your full say for them to see your mental model before agreeing, or perhaps adding to it.

As PF I would then say something along the lines of… The Facts are we have a confirmed B system loss with Options around us of Destination, East Midlands, or Manchester. All have good enough weather and length of runways, and we have sufficient fuel for Manchester after 10 minutes of holding and East Midlands allows us 15mins. The Risks associated with the failure include increased landing performance which we have mitigated through our calculations, the time to configure which we will negotiate a 12-mile final to assist with, Float 15 awareness, please call me manual brakes, a potential for asymmetric reverse, the Go-around which we will brief shortly and diversion with leading edge extended which we have mitigated through the addition of fuel. Do you see any other risks? In that case my decision would be to stick with destination where the wind isn't an issue, and the weather allows us to fly the ILS runway 15 as we have already briefed and set up with a couple of differences we will cover due to the failure. To execute that we'll need a brief, to inform the crew and to let ATC know. At any point if you feel a change of plan is necessary, please voice it to me and we'll run a Check and use FORDEC as a continuous loop. We can then close the initial loop with another look at T. We have now just entered the hold so have 10mins to complete our preparations.

Here is a natural break and a time to think what is next? If you get stuck come back to your ANC. Is the aircraft doing what I want, where I want it? Is there anyone I need to Communicate with? ATC would be a good one here just to inform them you would like to commence the approach in 10 minutes time and require vectors for a 12-mile final with perhaps emergency services following you when thinking about hot brakes and hydraulic leaks. Do you want to talk to the Cabin on this? It is secure for landing given our phase of flight here but if time is available, it would be well spent giving a quick NITS brief with the special instruction of the crew perhaps noticing a higher-than-normal landing speed due to F15 and the emergency services following the aircraft.

Do you talk to the passengers? It is unlikely anything in this situation has been noticed and you are looking at a relatively normal landing. That is one for personal discretion and perhaps company guidance.

A nice framework for a succinct brief in a non-normal situation is the four Fs. Fly it, Flare it, Forget it, Fix it.

Fly it is how you will fly the approach. In this case it will be flown as a standard ILS using AP but with a long final and slow configuration. We will configure to F5 when we turn base carefully monitoring for asymmetry and I won't move the speed until I see the flaps are running. Then, on GS alive I will configure to Gear down Flap 15 calling for the deferred landing checklist.

Flare it covers any differences for the landing and ground roll. Here I would re-iterate the Float 15, please call me manual brakes and the potential for asymmetric reverse.

Forget it covers Go Around differences. An important one here as we are using the alternate system. How will we fly it? We can accelerate at normal acceleration or at MAA. Remember the flap lever position will drive your speed so when you call for F5 and PM sets the flap lever to 5 we will accelerate but the flaps won't move until you use the alternate system. If you choose to fly to MAA and then retract flaps be prepared that you may get the landing gear horn as thrust levers move back. Either way you're LE will not have retracted so make sure to limit your speed to 230kts and altitude to 20,000ft.

Fix it covers what will be done after the Go-around. What was the reason? Will we make another approach? What are the minimum fuel quantities for diversion?

Brief completed, with interaction encouraged from PM, and you are now ready to run the deferred Descent Checklist and make your approach. Remember that FORDEC, or your company model, is a continuous loop so keep making sure your plan is still relevant and be wary of confirmation bias. Read what is in front of you, not what you would like to be there. Perhaps we'll do a specific failure management podcast in the future, but we hope that this one has at least given a few things to try out in your arm chair and the simulator to see if any of them work for you. Always remember you are a team and by that I mean your colleagues, not only in the flight deck, but in the cabin and the control tower too.

You've worked hard today on that failure so why not let's go for something a little lighter and try a… (TALKS TECH TEN)

Q1: What is the maximum hydraulic system pressure?

Q2: How are system A and B hydraulic reservoirs pressurized?

Q3: How is the alternate brake system powered?

Q4: Why do we leave the engine driven hydraulic pump switches ON on shutdown?

Q5: When is the standby hydraulic system LOW PRESSURE light armed?

Q6: What will the standby pump supply pressure to?

Q7: What does an IMBAL light below one of the main fuel tank indicators represent?

Q8: Where is the manual defueling valve and what is its purpose?

Q9: What are the memory items for a runaway stabilizer?

Q10: When the window heat switches are ON, if fitted, why are the green ON lights not always illuminated?

Thanks again for taking the time to join us on today's Talk and we hope that one helps you out if you ever come across this failure in the Jet or the simulator. If you'd like to add anything from your experience, please do so on our socials @B737Talk or feel free to contact us through the website b737talk.com. This one is another one we take a good look at over on b737trainining.org where you'll find Sim videos of us exploring failures in more detail including briefs and debriefs. Until next time though from Mark and I fly well and be safe.