Podcast 49 – Southwest flight 1380

Hello everyone and welcome to another Talk where this time we're back on the accident trail, technically speaking, with a look at a very well-known 737 event involving a Southwest Airlines 737 which took off from LaGuardia airport on April 17th, 2018. We know we talked to you about the safety 2 concept last time but there are still plenty of learning opportunities to take away from events that we perhaps can't foresee, such as this.

The crew were on the second day of a 4-day pairing together and had operated a 2hr 45 sector from Nashville to LaGuardia reporting at 0600 local previous to the accident flight. The captain was experienced with 24 years at Southwest having flown the 737 as a first officer before gaining her command in 2000, giving her over 10,000hrs on type. Before Southwest she flew the A-7 and F-18 in the US Navy.

The first officer had held the 737 rating with Southwest since 2007 accumulating close to 7000 hours on type. Previously he flew with the US air force.

The aircraft itself was delivered new to Southwest on July 7th 2000 being a 737-700 NG model. It had 63,521 hours total flight time with 37,021 total flight cycles. A flight cycle is one complete sequence from take-off to landing. There were no deferred defects for the accident flight.

Engine wise this NG was kitted out with CFM56-7B24 turbofans and if you want to hear more about those, please check out podcast 21. The left engine was born in December 1997 and had accumulated 67,040hrs with 40,569 cycles and had last been overhauled in November 2012.

Flight 1380 pushed back in LaGuardia at 1027 taking off at 1043. The first officer was PF and an uneventful taxi and take-off occurred as well as initial climb, until passing FL320 at 1103. Here the CVR picked up an increased level of background noise with the FDR then picking up a decrease in the left engine fan and core speed with increased vibrations. The flighcrew reported a loud bang was heard along with significant airframe vibration felt.

The aircraft began an uncommanded roll to the left and within 3.2 seconds of the fan blade failure the inlet and fan cowl were damaged structurally, the fan cowl halves separated, fan cowl portions departed the aircraft with some impacting the fuselage and a passenger window departed the aircraft. The aircraft immediately began to depressurise with the cabin altitude warning occurring 4.4 seconds after the fan blade failure with the cabin becoming totally depressurised within 5.5 seconds.

CVR recordings then became unintelligible for the next couple of minutes, but the FDR showed the left roll to reach a peak of 41.3° before the first offer brought the roll back under control. Around 8 seconds after this FDR data shows the right engine being brought to idle, as well as idle power being selected on the failed left engine, consistent with the start of an emergency descent. A further 9 seconds on and the left fuel cutoff parameter showed a transition to cutoff.

In all the initial startle ATC were unable to communicate with the crew, only hearing static. This was thought to be caused by some confusion about the position of the switch on the ACP which is understandable given the environment the crew must have been operating in at the time. Some 737s have automatic mask switching but others have a switch on the ACP which needs to be placed in mask for communications with ATC as well as the interphone and PA system.

From the initial action of the emergency descent until the crew communicated with ATC took approximately one minute with the aircraft passing 28,500ft. A request for a vector to the closest airport was made after the initial call reporting the fire warning and descent. The controller suggested Middletown, Pennsylvania, MDT, which was 29 miles away at that point. The first officer had looked at the map and had Philadelphia, PHL, in mind. He suggested this to the captain who negotiated it with ATC. It was a good team decision as PHL was only 57 miles away, has 3 extra runways, the longest providing an extra 2000ft over MDT and the firefighting category at PHL of E is the highest on the American index compared to compared to B at MDT which means a lot more fire trucks and water available.

While the captain negotiated with ATC the aircrafts rate of descent reached a peak of 5,228fpm down with airspeed between 280 and 300kts.

About 2.5 minutes after the engine failure the crew were cleared direct PHL with the captain stating she was "going to go through" the QRH. A PA was then made informing crew and passengers on the intended diversion which no doubt but both more at ease having heard from the captain that a plan was in place.

The controller asked the crew if they wanted "anything standing by on the ground" to which the captain replied, "tell em roll the trucks it's on the … engine number one captain's side". This is a very nice piece of clear communication leaving the controller in no doubt as to which side to brief the fire crew to attend. After a transfer of communications to the next sector the captain announced a mayday giving the flight top priority and ensuring the highest level of service on the ground.

In accordance with SWA single engine policy for landing captain Shults took control. This was done at an altitude of 13,600ft after which the first officer as PM began the engine fire or severe damage or separation checklist.

The first officer asked the captain "we're going to need a few minutes, right? To run a couple of checklists? Is that right?" To which the captain responded, "nope just keep going". In the SWA manuals at the time it was stated that "in all non-normal situations, flight crew members should take the following actions:

- Maintain aircraft control
- Analyse the problem
- Take appropriate action
- Maintain SA

Both crew members stated they were focussed on point one during the emergency descent which is understandable given what instigated it.

The way Southwest organise their QRH checklists involves immediate action items, which are those committed to memory, quick reference items, which are time-sensitive steps completed from a Quick reference Card or QRC and then reference items which are done while referencing the QRH.

Immediate action items are printed in both the QRH and the QRC with a dashed red line below, with quick reference items being on both the QRH and QRC too above a black dashed line. Reference items are in the QRH alone.

The situation flight 1380 was in called for 4 non-normal checklists. The Engine Fire or Severe Damage or Separation, the One Engine Inoperative Landing, the Cabin Altitude or Rapid depressurisation and the Emergency Descent.

The flight crew performed most of the Engine Fire or Severe Damage or Separation checklist but did not formally perform the others though several items from the Cabin Altitude or Rapid depressurisation and the Emergency Descent checklists were covered. The normal before landing checklist was also performed.

The captain decreased speed down to 232kts which she later explained was to try to reduce the severity of the airframe vibration which seems a good piece of logic, and the approach controller asked whether they planned to “go right in” or needed “extended final” to which the captain responded, “extended final”. The first officer further commented about having checklists to run but then 3 seconds later indicated he would like to speak to the cabin to find out the status. The noise in the cabin though, prevented the crew from hearing the first officer over the interphone.

The controller offered the crew free rein on when to turn in for a long final on runway 27L with the captain stating in the post-accident interview that she wanted a long final to accomplish checklists.

At 1115.04, approximately 11.5 minutes after the engine failure the first officer did manage to speak to a flight attendant who stated, “we got a window open and somebody is out the window” The crew were managing the fatally injured passenger in row 14 with CPR being administered by a paramedic and nurse who were passengers onboard.

During this discussion the first officer also communicated to the captain to slow down further to 210kts and after talking with ATC the flight was given speed at their discretion and any altitude above 3,000ft.

The first officer informed the captain of the injury, and the captain instructed the first officer to complete the severe damage checklist. This news from the cabin influenced the captain to expedite the approach in a call of judgement, as is the requirement on a PIC.

Another judgement call followed influenced by the aircraft controllability in the descent where the captain reported she was experiencing “lots of drag”. This call was to use flaps 5 for the landing adding 20kts to the flap 15 approach speed. This meant an approach speed of 180kts. This was outside of any SWA QRH guidance with flap 15 the recommended for single engine but was justified by the captain due to those controllability issues.

In SWA Operations manual it stated:

“In an emergency situation that requires immediate decision and action, the Captain may take any action necessary under the circumstances. In such a case, the Captain may deviate from Southwest Airlines’ operations procedures and methods, weather minimums, and regulations to the extent required in the interests of safety. “

The NTSB investigation concluded that the non-performance of the OEI checklist had no adverse effect on the outcome of the emergency. In fact, in the NTSB analysis the only omission from the checklists not done that could have had an effect, and I stress could, was missing the extension of speedbrakes on the emergency descent which could possibly have allowed for a quicker landing at MDT had the crew opted for this airport.

Anyway, the captain communicated her intention to turn in the ATC and asked for medical personal to meet the aircraft due to the injured passenger. The captain called the airport in sight and was cleared for the visual approach to runway 27L.

Surface wind was 280° at 19kts gusting 25 and flight 1380 was cleared to land. The captain called for the before landing checklist which was performed using the normal checklist. The CVR then picked up the cabin crew giving the command “heads down, stay down” to the passengers.

About 17 minutes after the failure had occurred the aircraft touched down at a speed of 171kts with reverse used on the remaining engine. A high-speed taxiway was utilised where the aircraft stopped near a fire truck. The captain made a PA to the passengers informing them of the approaching truck and that they should remain seated and follow the crews instructions.

Communications were established with Aircraft Rescue Firefighting (ARFF) who reported “no signs of any smoke or fire from the outside” and the status of injuries on board was passed emphasising the need for attention as soon as possible. The crew then completed the shutdown checklist and the captain went to check on the cabin.

Buses were said to be on the way at 11.25.20, 5 minutes later the crew again told the ARFF that a passenger need immediate medical attention. A further 12 minutes later the CVR picked up the sound of the first responder vehicle siren. The captain had pulled the CVR breaker in accordance with SWA procedures and preserved the audio thus assisting in the post flight investigation.

The passengers were deplaned initiating at 11.51.55 with the crew leaving the aircraft around 1236.

So, what actually happened to that engine? Fan blade 13 had fractured at its root due to a low cycle fatigue crack with the dovetail, part of the blade root, remaining within a slot of the fan disk. The separated part then impacted the engine fan case and fractured into multiple fragments. Some travelled forward and into the inlet, and portions on the inlet and the fan cowl departed the aircraft. Part of the fan cowl then impacted the fuselage by a cabin window causing the window to depart too leading to the rapid cabin depressurisation and the tragic fatal injury.

All 24 blades of the accident engine operated as a set and were overhauled in 2012 in accordance with set procedures. Tests showed no anomalies and the dovetails had been relubricated on the wing within the CFM recommendation of every 3,000 cycles or 5,000hrs, whichever came first. On this flight it had been 1,704 cycles since the relubrication procedure and in October 2018 CFM reduced their recommendations to 1,600 cycles.
As an indication to the level of damage sustained to the engine approximately 65% of the outboard fan cowl and 30% of the inboard were recovered separately from the aircraft.

Was this a black swan event? To unfold in the way it did specifically then perhaps, but this fan blade failure had occurred to SWA previously in August 2016. Flight 3472 experienced a left engine failure passing FL310 in the climb with an emergency declared and a successful diversion accomplished.

No one was injured in this one but the aircraft sustained substantial damage and the flight crew were on oxygen during part of the emergency descent. There was a 16 by 5 inch through-puncture on the left side fuselage just below the cabin windows by rows 11 and 12. The engine inlet was almost completely missing, with what was left severely damaged.

Blade 23 suffered a full-length blade separation as for our accident flight, again due to a fatigue crack.

As a result of flight 3472 CFM put procedures in place at overhaul for scans to both the concave and convex sides of the dovetail with the blade coating removed.

Various Service Bulletins and Airworthiness Directives followed from CFM, the FAA and EASA including from CFM on 20/06/17 one-time ultrasonic inspections of all fan blades installed in engines with more than 15,000 flight cycles since the last shop visit within 6 months and on 28/07/18 one-time ultrasonic inspections of fan blades that were modified from a specific part number as soon as possible but no later than the 31/12/18.

The FAA then issued a notice of proposed rulemaking on the 25/8/17 for One-time ultrasonic inspection of all fan blades on engines with more than 15,000 cycles since the last shop visit as well as 15,000 or fewer cycles since new.

EASAs AD on the 26/3/18 called for One-time ultrasonic inspection of engines with fan blades that had specific part numbers within 9 months and then post our accident flight CFM released an SB for initial and repetitive ultrasonic inspections for all engine fan blades based on an engine's cycles. After the accident flight numerous Emergency ADs and ADs and SBs

were then released to inspect fan blades at certain intervals culminating in a CFM SB on the 06/08/19 stating "Fan blade removal from service before 55,000 fan blade cycles". Our accident fan blade failed with 32,636 cycles since new.

As of June 18, 15 cracked fan blades were confirmed with 1 of these from our accident flight but a further 7 from flight 3472. Of the remaining 7, 3 were found between the two flights mentioned and a further 4 two months after our accident flight.

This led to the interval between lubrications lessening from 3,000 to 1,600 cycles when CFM discovered the dovetail area was experiencing higher peak stresses than originally predicted.

Up to August 19 a further 8 cracked fan blades were discovered.

Delving more into the NTSB analysis of our accident flight now. Some interesting points include ATC requiring 4 frequency changes over the 17-minute span adding to an already task-saturated crews' load. A further change was given even after the captain had requested a single channel.

The NTSB concluded that performing required checklists according to standard operating procedures is a critical part of safe flight operations. However, given the emergency aboard this flight, the flight crew's performance of most, but not all, of the items on the Engine Fire or Engine Severe Damage or Separation non-normal checklist and the non-performance of the three other relevant non-normal checklists allowed the crew to appropriately balance the procedural requirement of executing checklists with the high workload associated with maintaining airplane control and accomplishing a safe and timely descent and landing.

The recommendations from the NTSB after the investigation were given to the FAA, SWA and EASA.

To the FAA it was recommended:

- To require Boeing to determine the critical fan blade impact location(s) on the CFM56-7B engine fan case and redesign the fan cowl structure on all Boeing 737 next-generation-series airplanes to ensure the structural integrity of the fan cowl after a fan-blade-out event.

- Once the actions requested in that Safety Recommendation are completed, to require Boeing to install the redesigned fan cowl structure on new-production 737 next-generation-series airplanes and also require operators of Boeing 737 next-generation-series airplanes to retrofit their airplanes with the redesigned fan cowl structure.

- Expand the Title 14 Code of Federal Regulations Part 25 and 33 certification requirements to mandate that airplane and engine manufacturers work collaboratively to (1) analyze all critical fan blade impact locations for all engine

operating conditions, the resulting fan blade fragmentation, and the effects of the fan-blade-out-generated loads on the nacelle structure and (2) develop a method to ensure that the analysis findings are fully accounted for in the design of the nacelle structure and its components. and

- Develop and issue guidance on ways that air carriers can mitigate hazards to passengers affected by an in-flight loss of seating capacity.

South west were recommended to include the lessons learned from the accident involving Southwest Airlines flight 1380 in initial and recurrent flight attendant training, emphasizing the importance of being secured in a jumpseat during emergency landings.

To EASA the same recommendation on expanding the regulations as to the FAA was suggested.

Well that just about wraps up our look at flight 1380 and episode 49 but we do have something pretty special up our sleeve for episode 50 so make sure you tune in next time for that. Until then, from both of us, fly well and be safe.