The japan airlines 123 flights

Environment, Air

This report documents the chain of events before, during and after the Japan Airlines 123 Flight, registered under JA8119. It evaluates the cause and effects of the factors before the fateful flight, and connects with the factors during the flight and after the flight, not forgetting, it also offers possible recommendations to improve the safety of the aviation industry.

The main cause of the flight's death, was very simple, just a very common tailstrike incident which was not repaired to specifications stated by the manufacturer themselves. It was further neglected after passing through a check by the maintenance engineer himself, which should have grounded the airplane. Instead, it went on to fly another 12319 cycles before its life ended on 12th August 1985. During the flights it has gone through, continous cycle loading had caused heavy metal fatigue on the repair and the pressure bulkhead itself. Time after time, it accumulated, the cracks finally nucleated together in the aft pressure bulkhead. It ruptured the tailfin, along with it the heart of the airplane, the Central Hydraulic Unit. It drained the plane of its blood which was the hydraulic fluids that control the primary systems. After losing control, and fighting with it for 32 minutes it crashed into two ridges of Mount Takamagahara in Ueno, Gunma Prefecture, 100 km from Tokyo.

Based on research and findings, the aviation industry has improved so far, with the new Boeing maintenance procedures which include more stringent checks on repair patches, with new installation of relief valves.

However, to us, it is not enough, we would recommend as well to include newer standards, such that to allow lesser temporary repairs to pass through inspection, filling up the empty space with more part replacements. It may take a longer time, but safety is maintained.

Introduction

Purpose

This report is to document and shed more light on the timeline, chain of events occurring before and after the tragic flight of JA8119. It also includes the revision of aviation standards, and the proposal of ways to increase consumer safety in aviation.

Background Information

15 years have passed, and many do not remember the tragic flight of JA8119 on Flight 123. It happened to be the most deadliest single-aircraft accident in aviation history. The final flight also occurred on 12th August 1985 which was the Obon holiday period where the Japanese return to their hometown for visiting their ancestor’s graves. The victim was a Boeing 747-SR46, which carried 524 passengers on board, for which only 4 survived. It suffered mechanical failures 12 minutes into the flight and 32 minutes later crashed into two ridges of Mount Takamagahara in Ueno, Gunma Prefecture, 100 kilometers from Tokyo. The crash site was on Osutaka Ridge near Mount Osutaka.

Up to today, it still remains as the most tragic incident, due to its high number of casualties and the coincidence of the type of tradition also occurring during the period.

Due to this, It raised worldwide awareness towards the dangers of aviation, causing the Flight Aviation Authority to revise its maintenance measures, and made the aircraft manufacturer Boeing, to revise its design on all of its infamous 747 platforms.

Method of Investigation

Information extracted from an episode from National Geographic's Air Crash Investigations/May Day Series, Episode 2 " Out of Control", reports on Aircraft Safety revisions, an actual blackbox recording of the actual incident, and various documents on the cause and effects of the crash.

Scope of Investigation.

It is broken down into 3 sections comprising generally the Pre-incident details, which would contain the tailstrike incident which occurred 7 years ago, leading to the analysis improper repairs done, followed by the lax attitude the ground crew took. The second section would the the Incident Details, which will document the chain of events which occurred in the rear pressure bulkhead, comprising of rivet failure, bulkhead failure, explosive decompression, leading to the hydraulic failure and the pilot faults. Followed on lastly by post incident details, documenting the refusal of US military base help from Tokyo, leading to the late rescue efforts which resulted in more deaths, and the lessons learnt from this incident. Lastly, Our own recommendation on what could be further done.

Pre Incident Details

2. 1 Tailstrike Incident

A Boeing 747SR was arriving on 2nd June 1978 at Osaka Airport. The weather in the area was not optimistic at all, with rain that just ended, resulting in extreme heavy fog. The pilot, was in the skies during that period had just been approved to land. Due to low visibility, he could hardly see what was in front, and relied on his instruments as guiding points. By the time, the altitude meter read 100 feet, he had realized that he was too close to the runway. It caused him to deploy the flares very aggressively. It touched down, but due to the extended flares, it gained altitude and increased the angle of attack, which resulted it to land on its empennage on its second touchdown. This is known as a tailstrike incident.

Figure 1 – Extent of damage on the tail of JA8119

2. 2 Botched Repair

The tailstrike incident suffered by JA8119, resulted in issues that were not appealing at all. The rear bulkhead had various scratches, but on a closer look, there were cracks, and it was already unacceptable to be approved for flight purposes. However, they had to do a temporary repair on the bulkhead still, and they were not following prescribed steps to do so. Boeing stated in their manual for these procedures:

A Continuous doubler plate on the bulkhead itself.

Followed on with 3 rows of rivets on each side.

This is to reinforce the bulkhead, such like what the objectives of a temporary repair should be. Instead, the licensed engineers of Boeing stationed at the airport did this:

Two doubler plates cut out from a huge splice plate

Two rows of rivets on one side, Single row of rivets on the other.

(Wikipedia, 31 August 2010)

Figure 2 – The Actual Repair(National Geographic, 2007, Air Crash Investigation[Online], Season 3 Episode 3 Part 4 , Available from: Youtube. com [Accessed 23rd May 2010])

All of this was done by the engineers so that It would fit nicely. Which would later carry a serious consequence of servere failure during flight.

2. 3 Metal Fatigue

Metal fatigue, described as structural failure caused by consistent cycle loading, which would mean as stressing on part throughout a prolonged continous time. This is inevitably caused by the improvised procedures done by the engineers in Osaka Airport, as stated, in the previous factor.

Figure 3 – Leftovers of the rear bulkhead after shearing off during flight. (National Geographic, 2007, Air Crash Investigation[Online], Season 3 Episode 3 Part 4 , Available from: Youtube. com [Accessed 23rd May 2010])

Due to the nature of aircraft parts to go through consistent cycle loading, the doubler plate which was done as a patch repair to the rear pressure bulkhead, if done in correctly would result in extreme fatigue. This was exactly what happened.

The loss of one row of rivets due to this procedure had caused them to take much higher stress than normal, such that having 2 rows with one row instead of 3 would distribute the load unevenly, causing the material to experience different rates of fatigue, as a result. This would be the main causing factor for the during flight incidents.

Negligence of Ground Crew

Usually, after a maintenance task has been completed, a senior engineer would do a check on it. This is where partly the fault had fell on. The senior engineer did a check on the splice plate repair on the rear bulkhead shortly after. In the beginning, the engineer did not approve of the repair due to the nature of the plate and the rivet placements, but looking at it as a temporary repair, he signed off declaring the plane of its worthiness. (JST Failure Knowledge Database, August 23, 2006)

This would be catastrophic as no matter how minor a repair is, it should be done up to the best standards to avoid accidents. This was not the case.

3 Incident Details

3. 1 Riveting Failure

The cause of this was via the botched repair that was not done up to manufacturer standards.

Figure 4 – L18 Stiffener Joint (Dr. Yotarou Hatamura, 2005, JST Failure Knowledge Database[Online], Crash of Japan Airlines B-747 at Mt. Osutaka, Available from: http://shippai. jst. go. jp/en/)

Refer to Figure 4, this diagram compares the actual repair with the directed repair specified by the manufacturer, Boeing. The first drawing, starting from the left, shows a full doubler plate with 3 rows of rivets intact along a full plate attached to the damaged portion, with a small smount of sealant near the L18 stiffener which do not penetrate the doubler plate. The second drawing, which is the actual repair done, was not up to standard in comparison with the first drawing. It shows a chopped splice plate, which was in two pieces, and riveted with 2 rows of rivets on the bottom, with 1 row on the top. The only major difference would be the higher amount of sealant near the L18 stiffener. Comparing it to the previous drawing, the sealant, penetrated through the splice repair. This increased the stresses taken by the fracture site and the rivets. As illustrated by the drawings, the arrows would mean stress concentration, which had reduced, from two arrows to one. This cause the stress to be highly concentrated there, multiple-site cracks started to form near the fastener holes. This cause the rivets to be overloaded and finally failed.

Aft Bulkhead Failure

Once a repair is signed off as complete, it will never be looked at again. Such was the case for the JA8119 after 12319 fight cycles. During flight, the whole plane goes through cycle loading due to the difference in air pressure surrounding it, it may seem insignificant at earlier parts, but the accumulated hard pressure could cause something to fail without maintenance. In this case it was a botched repair. According to the FAA, the one “ doubler plate” which was specified for the job (the FAA calls it a “ splice plate” – essentially a patch) was cut into two pieces parallel to the stress crack it was intended to reinforce, “ to make it fit. The unstable nature of this repair resulted in a 70% decrease in Fatigue Resistance. Due to that fact that it did not properly cover up the fracture of the aft bulkhead, did it worsen and let loose during flight.

Figure 5 – Aft Pressure Bulkhead of JA8119 on Display(Flight Global, 2010[Online], Available from http://www. flightglobal. com/assets/getAsset. aspx? ItemID= 12345)

Refer to Figure 5. The multiple-cracks that form on the bulkhead follows a similar pattern, which is that they started mostly from the fastener holes, as they tear considerably close to the rivets themselves. In the early years of the repair done, the cracks are small, but through 12300 cycles, they became bigger and eventually joined up. In the analysis report that was signed off, it was said that there were cracks from 30 of the 50 fastener holes of the area of repair, the total length of the cracks of the repair patch was 270mm. Only one reason could explain the huge extent of the cracks, majority of them had extended overtime and eventually joined together, causing catastrophic failures once they became concentrated. It would shatter the pressure bulkhead all together.

Explosive Decompression

Refer to Fig. 5, under high altitude conditions, the aircraft cabin is pressurized to keep the correct amount of oxygen. It is necessary when an airliner reaches high altitudes, because the atmospheric pressure is too low to allow people to absorb sufficient oxygen, causing altitude sickness and eventually hypoxia.(Wikipedia, 24 July 2010)

The air pressure difference in high altitudes can be very high, any decompression incident such as a small pinhole in the aircraft skin would produce a large hissing sound which could depressurized a whole cabin in five seconds. The lack of oxygen in the cabin will mean a 25% reduction in oxygen in our lungs, which will cause sluggish thinking, dimmed vision, loss of consciousness and ultimately death.

Figure 6 – Cabin Pressurisation Process(The Informer-Truth and Travel, 2010[Online], Available from: http://informer. truth. travel/media/images/CabinAirGraphic. gif)

The aft pressure bulkhead failure caused it to rip apart, allowing hypersonic air to rush into the tail fin which already caused explosive decompression. This eventually blew off a portion of the tail fin which further aggravated cabin decompression in the cabin, considering now that a huge hole had become a void.

Hydraulic Failure

Figure 7 – Cause of loss of tail fin during flight (Dr. Yotarou Hatamura, 2005, JST Failure Knowledge Database[Online], Crash of Japan Airlines B-747 at Mt.

Osutaka, Available from: http://shippai. jst. go. jp/en/Detail? fn= 2&id= CB1071008)

Hydraulic lines are like the blood vessels of a human being, one snap in any of them, would mean death. As illustrated in Fig. 6, the explosive decompression caused hypersonic air to rupture the tail fin and a part of the tail.

Severed Hydraulic Lines

It also shredded through one of the most important parts of the aircraft, the Central Hydraulic unit which controls the moving of hydraulic fluid to and fro the rudders on the vertical stabilizer and the horizontal stabilizer. Beside them were the important hydraulic lines which also went off along with the Central Hydraulic unit.

Loss of Primary Controls

Once the hydraulic lines were cut off, the fluid escaped through the openings, which within minutes, the pilot reported difficulties in handling moments before he lost full control, which would mean that the hydraulic lines are now empty. To salvage the situation, the pilots varied their thrust between the engines on the left and the right wing and also they tried putting down the landing gear and the flaps.

(National Geographic, 2007, Air Crash Investigation[Online], Season 3 Episode 3 Part 2, Available from: Youtube. com[Accessed 23rd May 2010])

3. 5 Human Error

Many were at fault, but we couldn't possibly absolve no one of all blame. They did not put on oxygen masks, no reason was stated why. There was a lot of chaos in the cabin as well. Due to this, they were probably in a state of Hypoxia as they did not do two things:

Report fully on the situation.

Tried to land in Nagoya Airport which is on a linear path. Refer to Fig 7.

Unknowingly, they also allowed the plane to stall in its path, which aggravated its out of control, rising and diving in the skies. This was also an accident that was the first of its kind, which would mean there was no training available for situations like these. Any precautions they had learnt was irrevelant to what they had encountered.

Figure 8 – Map of JA8119 Flight Path(Christopher Kilroy, 2008, Air Disasters[Online], Special Report: Japan Air Lines 123, Available from: Air Disasters. com)

Post Incident

4. 1 Late Rescue

Rescue efforts came only after 14 hours. This was justified when crash victim and survivor, Yumi Ochiai stated:" Many more survived the crash, as their screams died down through the night."

(National Geographic, 2007, Air Crash Investigation[Online], Season 3 Episode 3 Part 3, Available from: Youtube. com[Accessed 23rd May 2010])

4. 1. 1 Refusal of US Military Assistance

Yokota US Military Air Base had sent a C-130 to scout. Which they had reported back to have seen the crash site. Shortly after, a US helicopter was sent to the crash site to assist in the rescue effort. Meanwhile, rescue teams have been assembled and were on their way to the site.

4. 1. 2 Inaccessibility of area

As stated, it crashed into two ridges of Mount Takamagahara in Ueno, Gunma Prefecture, 100 kilometers from Tokyo. It was in a mountainous region where roads do not directly lead to the crash site itself at all, and most of the wreckage lay on a downhill slope which meant more caution was taken to access to the site, costing more and more time.

Figure 9 – Panel of JA8119 lying on a downslope.(Available from: http://otona. yomiuri. co. jp/history/anohi090812. htm)

Inclusion of new procedures in guidebook.

The FAA consequently issued the following airworthiness directives:

AD 85-22-12 which required a one-time visual inspection of the aft side of the aft pressure bulkhead for evidence of repairs or damage.

AD 86-08-02, requiring the addition of a structural cover for the opening within the empennage to provide access to the vertical fin of all B747 models. This is to prevent structural failure of the vertical fin in the event of failure of the aft pressure bulkhead.

AD 87-12-04 to require installation of a hydraulic fuse in the number 4 hydraulic system on Boeing Model 747 series airplanes.

AD 87-23-10 was effective December 10, 1987 and required inspection for damage and cracking of the aft pressure bulkhead on Boeing Model 747 airplanes. This AD was later superseded by AD 98-20-20 which added repetitive inspections AD 98-20-20 was, in turn, superseded by AD 2000-15-08, which requires that a one-time inspection to detect cracking of the upper segment of the bulkhead web be accomplished repetitively, and adds additional repetitive inspections to detect cracking of the upper and lower segments of the aft bulkhead web. (Aviation Safety Network, 11 October 2009)

Relief valves were also fitted into the Boeing 747, so that in the case of any dismemberment of the aircraft will not lose all of its hydraulic fluid, still having a high percentage of control of the aircraft.

Conclusion

Overall, we can see a pattern which in the events happened, ranging from the tailstrike incident in 12th August 1985, which led to a botched repair which sealed the fate of the plane to its imminent death. Lastly, the negligence of the ground crew who did passed the repair even though it wasn’t on specifications. Throughout the flight, the plane suffered mechanical difficulties 12 minutes into the flight due to the failing of the rivets, causing the rear pressure bulkhead to rupture, allowing hypersonic speed air into the tail of the plane, inevitably tearing off the top portion of its tail fin, along with it went the Central Hydraulic unit which was the heart of the airplane. They lost all control all together shortly after losing all the hydraulic fluid, and with the case of a depressurized cabin, they suffered from hypoxia which hampered their decision making. 32 minutes later it crashed into two ridges of Mount Takamagahara in Ueno, even though the pilots tried all sorts of manuveurs to salvage the plane from its fate. Rescue efforts were also hampered as the government rejected help from an US airbase for unknown reasons, even though they were already on site. The location also posed a problem, being inaccessible from any road, and being on a downhill slope slowed down emergency services.

From this, we can see how serious a molehill can become a mountain in a matter of years. From scratches, they became cracks and tore through an important component. Maintenance was an issue here, as it was slack, even though Boeing had released new inspection and repair procedures 2-3 years after the tragic accident which included 522 lives, have we learnt? Maybe. China Airlines flight 611, crashed on 25th May 2002, which killed all passengers and the crew, coincidently bearing the same few causes such as botch repair, metal fatigue, riveting failure & multiple-site damage. This happened 20 years after the procedures were implemented. In the world, there will always be a balance between evil and good, such like this case. It could have been them only the engineers not following procedures, the rest of the countries were. There is only one thing that we can do to prevent all these, is to learn from our mistakes and never to repeat them again. We can never stop these incidences, which is why prevention is more than enough to keep the industry going until today.

Recommendations

Looking into the above information collected, the recommendations are:

To include more stringent checks on the repair itself such as the creation of a small ultrasonic device to expose any gaps or cheating in the repair procedures

Replace parts if damage is far too severe to be repaired. Rather than to do temporary repairs that could put lives at a small risk.

Primary Controls to have failsafes as well, instead of having it in the hydraulic pipelines only.

One example would be on the 4th of December 1987, Boeing requested fuses to be installed as a secondary safety measure in the primary control hydraulic lines in the case of another prevention measure.