

GREAT DISASTERS

Air France Flight 358

After a long trans-Atlantic flight, most people are pretty keen to disembark. Those seats get a little cramped after the first couple of hours, even if the passenger in front of you doesn't recline. For the passengers of Air France Flight 358 to Toronto, there was more urgency than normal; buffeted by a heavy storm, their plane had just careened over a thousand feet past the end of the runway and into a ravine.

Despite the crash, the weather, the flames and the failure of two of the emergency escape chutes, all three hundred and nine people aboard escaped in under ninety seconds.

I'm Kari Fay, and this is Great Disasters.

While many disasters make the headlines because of their heavy death toll, every so often we can be thankful to say that everyone survived. This was one such occasion; despite everything that went wrong, only twelve people on the plane that day suffered serious injuries. With the flight at capacity, it was clear that it could have been much, much worse.

Air France Flight 358 took off from Paris, France on the 2nd August 2005 with 297 passengers headed for Toronto. Most of the passengers were either French or Canadian citizens, with various other nationalities making up about a third of the list.

The plane itself was an Airbus A340, designed to carry 295 passengers - three of those who boarded were given seats in crew designated areas. It had been in use since 1999, when it had been delivered, new, to Air France. At the time, there had never been a crash resulting in the loss of an Airbus A340, a clean record lasting fourteen years, so it was considered to be a pretty reliable aircraft.

The captain was 57 year old Alain Rosaye, a veteran pilot with over fifteen thousand hours total flight time. His co-pilot, First Officer Frédéric Naud, was 43 years old and had nearly five thousand hours' flight experience.

They had taken off from Charles de Gaulle Airport that morning, and enjoyed an uneventful flight until they approached Toronto.

Statistically, the two riskiest parts of any flight are the take-off and the landing. There's a lot for the pilots to do, even under perfect conditions, and when there's more to do, there's more risk of doing something wrong.

Unfortunately, the conditions they were going to land in were far from perfect. Thunderstorms and heavy rain in the area were disrupting air traffic considerably. 540 flights scheduled to either depart or arrive in Toronto during this time were cancelled completely; other arrivals were redirected to other airports, such as Montreal, Ottawa, or even New York.

GREAT DISASTERS

But the decision to land at an alternate airport is never taken lightly. Doing so means that the airline has to cover the cost of transferring all the passengers back to the city they expected to arrive in. The resulting inconvenience to the passengers can also create ill will - which is expensive in business terms. In addition, there's the inconvenience of having both plane and crew in the wrong place for return or onward flights, disrupting schedules drastically. For the pilot making the decision, knowing that their employer is going to want them to justify it, it's a heavy load.

In this case, the alternate airport for Flight 358 was originally Niagara Falls, New York, which is only about eighty miles away by road, but of course has the complication of being in a different country to the destination.

The pilots of Flight 358 received regular updates on the weather conditions; when they took off the forecast for their landing at Toronto Pearson International Airport indicated a 30 percent probability of thunderstorms. This was amended at noon, and the probability subsequently climbed each hour as the weather worsened. Just after three o'clock - about an hour before the flight was due to land - a significant meteorological forecast or SIGMET was issued, advising the pilots of an organised line of thunderstorms from Buffalo, New York, to Muskoka, Ontario. This affected their alternate airport as well as their destination, so they changed their alternate to Ottawa. That's 275 miles away from Toronto, so it was out of the weather, but the inconvenience factor was a lot higher. Changing to a more distant alternate also meant that the pilots had to factor their fuel load into the decision; at the end of an eight hour flight, were they still carrying enough fuel to reach a different airport?

Two hours before they were due to land, the weather at Toronto Pearson was bad enough to force a ground stop. This means that all activity on the ground, such as refuelling and servicing, is halted, and departures are cancelled. However, landings are still permitted, if the pilot chooses to do so.

Flight 358 continued towards Toronto, with First Officer Naud assigned the duty of actually landing the plane, while the captain monitored flight systems and communication. This is a standard separation of duties. The cockpit of a modern passenger aircraft is an overwhelming array of lights, dials and switches, so the pilot flying needs to be able to focus as much as possible on the controls, so they're not overloaded by the sheer amount of information coming in. It's not unusual for the less experienced pilot to be in control, though; it's often done so that they can gain that experience.

As they descended, they saw thunderstorm cells on their radar, and had to request permission from air traffic control to deviate from their course a couple of times so that they could avoid them. ATC gave permission, and they continued onwards.

GREAT DISASTERS

At 3:54, there was a lightning strike at the airport, which damaged the systems that give the control tower information about the wind direction and speed. However, the crew still had actual information relative to their position coming in constantly on their flight management system. The tower controller was also able to give them information from the flights landing ahead of them; two aircraft reported that braking action was poor, and one crew estimated the surface wind at 15 knots, gusting to 20 knots.

At 3:56, they were cleared to land on Runway 24 Left. They could see two areas of storm activity on their radar; one to the north and one to the southwest of the runway. Based on the information they received from the flights ahead of them, they changed their automatic brake setting from "low" to "medium"; rain reduces the friction on the runway, and makes it harder to stop.

Auto-pilot and auto-thrust systems were engaged until the plane was about 350 feet above the ground; from there the pilot handled the landing visually, in accordance with the standard operating procedures of the airline. They approached at a speed of 140 knots, which was correct for a plane of that size, but as they reached the threshold of the runway they were slightly higher than expected; a hundred feet instead of fifty. Around the same time, the plane's airspeed increased to 154 knots. They entered a heavy rain shower, which reduced their visibility at a crucial moment, and surface winds shifted.

They touched down about 3,800 feet along the runway, and hit the brakes as hard as they could. But it wasn't enough. They were still moving at a speed of around eighty knots when they reached the end of the runway, and they kept going.

There was no order to brace as they came down, but JoAnn Cordary Bundock, seated near the front of the plane, could tell that they were coming in too fast.

"We landed hard, and then it was like we were going a hundred and fifty miles an hour over a road that was filled with giant potholes. The plane skidded on its tummy. I could smell jet fuel as soon as we stopped."

The plane only halted when it fell into a ravine. Roel Bramar described the crash as "a hell of a roller coaster."

Philippe Lacaille, travelling with his wife and two children, looked over to see his daughter's face surrounded by an orange halo; the plane was on fire. He unbuckled his seat belt, grabbed his family, and made for the nearest exit.

"Nobody was telling us what to do. People were grabbing their belongings and taking pictures while the cabin was filling up with smoke. A flight attendant struggled to open the nearest exit. The chute deployed and we were almost the first ones out."

GREAT DISASTERS

There are eight exit doors on an Airbus A340, each with an inflatable emergency slide that deploys so that passengers can reach the ground safely. Because of the location of the fire, the two left rear exits couldn't be used. That left six exits. But the slide failed to deploy at all at one of the other left exits, so that couldn't be used, and at one of the right exits, the slide deflated because it got punctured by aircraft wreckage. So they were down to four. And at least one of those slides was damaged; still usable, but not as safe as it ought to be. Some of the passengers had to jump.

A student from Johannesburg called Eddie Ho was seated a few rows from the exit where the slide didn't deploy. He described reaching it, and finding a lady blocking the way, afraid to jump. "People were pushing from behind. I ran to a business class exit, but the slide was not inflated. With no other option, I leaped out about four to five metres and tumbled onto some people below me. It was a mess."

The passengers and crew found themselves in a ravine, in the pouring rain, next to a plane which was burning out of control fed by the fuel onboard. Some of the passengers scrambled up the ravine, and found they were on the side of Highway 401. This is one of the world's busiest highways, and it runs almost parallel to the runway. Passing motorists stopped to help; some picked up the injured, taking them directly to nearby hospitals. Others picked up people who weren't hurt, and took them round to the airport terminal. Meanwhile, others stopped or slowed down just to look, creating significant traffic problems. Footage of the fire shows just how terrifying it was, with huge clouds of heavy black smoke billowing out as flames consumed the fuselage.

Eddie Ho was one of the passengers taking pictures. He had a camera in his pocket, and he used it to document the crash. He took a picture before he even got out, showing passengers moving for the exits, then turned to take pictures of the burning plane once he was on the ground. One of those dramatic images shows the left side of the plane, with flames licking around the wing, passengers scrambling to get away, and somebody looking out of that exit without a slide, probably debating whether to jump.

It took less than a minute for emergency response vehicles to get to the crash site, but the fire burned for two hours. You might think that crashing in the rain would reduce the risk of fire, but it doesn't. You need a special foam designed to put out fires fed by aviation fuel, but the rain was so heavy that it diluted the foam as the firefighters sprayed it out. Even though they were on the scene straight away, the fire intensified quickly, and eventually destroyed most of the fuselage. In addition to the jet fuel, the fire was powered by oxygen tanks carried on the plane for therapeutic use and first aid; these tanks are thought to have exploded during the fire.

GREAT DISASTERS

Passengers were left in disarray. There was little organisation once they had scrambled away from the wreckage, and it took several hours to account for everyone on board, reunite with their families and make the astonishing announcement that everybody on board had escaped.

Once the fire was out, the investigation was able to begin. It was led by the Transportation Safety Board of Canada, or TSB, with assistance from the operator, Air France, and the airframe and engine manufacturers, Airbus and GE Aviation. In addition, Transport Canada represented the country where the crash occurred, the French Department of Transport represented the country where the operator and airframe manufacturer were based, and the American National Transportation Safety Board (NTSB) represented the country where the engine manufacturer was based. That may seem like a lot of people and organisations were involved, but that's actually fairly normal for an air crash investigation; there's a lot of cooperation required.

The flight data recorder and the cockpit voice recorder were retrieved from the wreckage and sent to France for analysis. Despite the intensity of the fire, they had survived to provide valuable information to the investigators.

They found no significant anomalies of the aircraft systems; no malfunctions, no problems with the flight controls, the spoilers, tires or brakes. However, selection of the thrust reversers was delayed. This is one of the systems used to slow the plane down on landing; it does exactly what it sounds like it does, reversing the thrust from the engines so that it slows the plane down instead of driving it forward. Most of the time, the thrust reversers are not absolutely necessary; the plane's brakes should be sufficient to bring it to a stop. However, they are usually deployed to reduce wear on the brakes and for safety purposes, and when landing in adverse conditions they're definitely needed to provide additional deceleration.

They also found that Captain Rosaye, who was the pilot not flying, had not made some of the standard callouts as they landed. As the pilot monitoring the systems, he should have been announcing the status of the spoilers and thrust reversers. Because he didn't do this, the pilot flying didn't select the thrust reversers straight away- it took at least twelve seconds. This delay contributed to the overrun.

The weather conditions had a lot to do with this incident, but the investigators discovered that Air France had no set procedures advising pilots of a required distance from thunderstorms during an approach and landing, and such procedures weren't required by regulations. In the absence of such guidelines, pilots were likely to continue to attempt landing even when faced with the same kind of weather Flight 358 had.

GREAT DISASTERS

Some pilots were under the impression that Air Traffic Control would close airports if the weather made it unsafe to land, but that wasn't true. ATC simply gave pilots the information they had, the pilots had to make the decision themselves, and investigators found that crews were relying too much on suggestions and directions from ATC as to whether to land or not in stormy weather. It has also been reported that the pilot had been told by controllers that the airport would reopen soon.

They had come in too high; this was attributed to two factors. Firstly, the pilot had increased thrust after the autopilot and autothrust systems disengaged; he was reacting to a decrease in airspeed and the perception that the aircraft was sinking. Secondly, the winds had shifted when they were about 300 feet above ground level; instead of a headwind, they now had a tailwind, and their flight path was effectively changed by this. The loss of the ground-based wind information made things worse - investigators found that this information was critical, and said the system should have redundancies built in, so that one lightning strike couldn't take it out in future.

The intensity of the rain that they came through reduced their visibility. Because they couldn't see, they didn't know exactly where they were in relation to the runway.

At this point, they still actually had the option of a go-around. This is basically an abandoned landing; up until a certain point in the process, the pilot is still able to pull the plane up, go back into the sky and go around for a second try, or decide to make for their alternate instead. Investigators noted that the plane would have needed 4,500 kg of fuel to reach their alternate airport, Ottawa. They landed with 7,500 kg.

As they approached the threshold of the runway, however, they committed to the landing; they believed that their go-around option no longer existed.

When they touched down, they were significantly further along the runway than they ought to have been; about 3800 feet along, which meant they only had about 5100 feet in which to stop. The crosswind at touchdown exceeded the landing limits of the aircraft, because the runway was contaminated by the rain. It had about a quarter inch of standing water at the time. That may not sound like a lot, but when you're bringing an aircraft weighing 185 tonnes down at a speed of something like a hundred and sixty miles an hour, you need a lot of friction to bring it to a stop. And if you don't have that friction, you need a lot of room.

The operational flight plan they were using didn't indicate landing distances for contaminated runways, and even though they had weather forecasts telling them about thunderstorms, the crew hadn't calculated the landing distance required for Runway 24 Left. That meant they didn't know what their margin for error was; they didn't know how far along the runway would be too far to be able to stop.

GREAT DISASTERS

They also didn't know that they lost that margin for error when they hit the tailwind. If they'd had this information, they may have realised that they weren't going to make it in time to take the go-around.

Making the decision to go around, to call a missed approach and pull up, is something that has to be done quickly. Past a certain point, it's not feasible, you don't have enough thrust to get back up into the sky. The investigators pointed out that a policy where only the captain can make that decision can increase the time it takes to initiate a missed approach, which increases the risk involved.

Once they touched down, the crew didn't have any choice. They had to stop, one way or another, and despite stamping down on the brakes and deploying the thrust reversers, they just didn't have enough runway to do it. There was simply nothing that they could do at that point to prevent the crash.

The first five hundred feet past the end of the runway complied with Aerodrome Standards and Recommended Practices. Past that, however, it got rough, and led down into a ravine where the Etobicoke Creek ran. This rough terrain contributed to the damage to the aircraft. The final report suggested changes to Canadian runway standards, either extending the runway safety area another five hundred feet, or providing a backup method of stopping aircraft where that's not possible.

There had actually been another crash at Toronto Pearson airport back in 1978, when an Air Canada DC-9 had also ended up in Etobicoke Creek after overrunning a different runway, killing two people on board. In the aftermath of that crash, there had been calls for the ravine to be filled or spanned by a bridge, and the coroner's inquest had made those same recommendations for extending the runway safety area. A lawsuit filed by Air France in June 2008 claimed that Transport Canada was "negligent" in failing to implement those recommendations.

The fact that everybody got out of Air France 358 alive is incredible. It took just ninety seconds for three hundred and nine people to get out of four exits. The plane was completely destroyed by the fire, but only nine people were seriously injured in the impact; three more sustained serious injuries leaving the plane, when they had to jump from exits where the slides weren't fully in place. Hospitals treated a handful of people for smoke inhalation, or minor injuries; twisted ankles, sore necks. These things are unpleasant, of course, but if you're looking back at a burning plane with just a few bruises, fortune has been on your side.

That's not to say that this was a textbook evacuation. Aside from the problems with the slides, there were other factors that got in the way. The flight attendants got their passengers out quickly, but a lot of passengers pointed out that they weren't told to leave their bags behind. Stopping for your luggage when the plane is on fire sounds like a bad idea when you consider it from a safe

GREAT DISASTERS

viewpoint, but people act on instinct. You got on with your bag, your bag probably has important things in it, you want to take it with you. Nearly half of the passengers on Flight 358 had their carry-on luggage with them when they escaped. They probably counted themselves lucky to have saved their stuff, but if fortune had swayed just a little, the time they took to grab their bag could have cost somebody their life.

Under ideal circumstances, flight attendants would also tell passengers to remove their shoes before an emergency evacuation. This sounds a bit counter-intuitive - you can stop to take off your shoes, but not to grab your bag - but when you're relying on an inflatable slide to get everyone safely on the ground, you don't want to risk it being punctured by somebody's heels. If, like me, you're the kind of person who habitually wears big laced-up boots, you might want to take this into account before you board your next flight and wear something you can kick off instead, just in case.

Eddie Ho sold the photographs he took to media syndicates, earning a fair bit of money. He won the Canadian Press Picture of the Year for one of them, and it was listed as one of the best photos of the year by Time Magazine. The investigators referred to the pictures in their report, and were able to draw some conclusions based on what they saw. Pictures can be valuable evidence. But alongside the acclaim, there was also criticism.

Mark Rosenker, acting chairman of the NTSB, said that the idea of taking pictures during an emergency evacuation was "irresponsible". "Your business is to get off the airplane. Your business is to help anybody who needs help."

In the same way that stopping for your bag can cause unwanted delays, trying to take a picture can slow down the evacuation, too, and in this sort of incident time is of the essence. Helen Muir, aerospace psychology professor at Cranfield University, pointed out that in most crashes, there's only two minutes from the first spark to the point at which conditions in the cabin are not survivable. It's not the kind of risk you want to take.

Great Disasters is written, researched and produced by me, Kari Fay. For more information, sources and further reading, check out the Great Disasters blog at greatdisasterspodcast.wordpress.com, or if you'd like to start a conversation, you can find the Great Disasters Podcast on Facebook and on Twitter @great_disasters. If you'd like to support the Great Disasters Podcast, you can become a patreon and earn unique rewards at patreon.com/greatdisasters.

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