Accidents and Incidents Involving Air Traffic Control Error

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Chapter 1

2001 Japan Airlines Mid-Air Incident

2001 Japan Airlines mid-air incident
(JAL 907 and JAL 958)

Artist's conception of JA8904 (below) diving under JA8546 (above). The planes were less than 100 meters from each other at the moment of the near miss.

Accident summary	
Date	January 31, 2001
Type	Near miss, ATC error
Site	near Yaizu, Shizuoka, Japan
Total injuries	99 (9 serious)
Total fatalities	0
Total survivors	677 (all)
First aircraft	
Type	Boeing 747-446D
Operator	Japan Airlines
Tail number	JA8904

Flight origin	Tokyo Int'l Airport
Destination	Naha Int'l Airport, Okinawa
Passengers	411
Crew	16
Injuries	99 (9 serious)
Survivors	427 (all)
Second aircraft	
Type	Douglas DC-10-40D
Operator	Japan Airlines
Tail number	JA8546
Flight origin	Gimhae International Airport Busan, South Korea
Destination	Narita International Airport
Passengers	237
Crew	13
Injuries	0
Survivors	250 (all)

A Japan Airlines 747-400, similar to this Japan Airlines that nearly collided with JA8546.

A Japan Airlines Douglas DC-10-40, similar to this Japan Airlines Douglas DC-10-40D, nearly collided with JA8904.

On Wednesday, January 31, 2001, **Japan Airlines Flight 907**, using a Boeing 747-446 Domestic bound from Tokyo International Airport (Haneda Airport) in Ōta, Tokyo, Japan to Naha International Airport in Naha, Okinawa, Japan and **Japan Airlines Flight 958**, using a Douglas DC-10-40D bound from Gimhae International Airport in Busan, South Korea to Narita International Airport in Narita, Chiba Prefecture, Japan, nearly collided over the Suruga Bay near Yaizu, Shizuoka Prefecture due to human error.

Flight information

Japan Airlines Flight 907, registration JA8904, was a 747-446 Domestic with 411 passengers and 16 crew making a domestic flight from Tokyo Haneda International Airport to Naha Airport. Japan Airlines Flight 958, registration JA8546, was a McDonnell Douglas DC-10-40 with 237 passengers and 13 crew bound from Gimhae International Airport to Narita International Airport. Flight 907, using an aircraft registered as "JA8904," left Haneda at 3:36 PM.

According to the flight plan, JAL907 and JAL958 would pass each other while 2,000 feet apart.

Mid-air incident

JA8904's TCAS sounded 20 minutes after its departure as the jet climbed towards 39,000 feet. The DC-10, JA8546, cruised at 37,000 feet.

The mid-air incident occurred as flight attendants began to serve drinks onboard Flight 907.

The two planes were on a collision course towards each other. The pilots of both planes had received conflicting instructions from their RJAA and the flight controller at the Tokyo Area Control Center in Tokorozawa, Saitama Prefecture. Flight 907, headed by 40-year-old pilot Makoto Watanabe (渡辺 誠 *Watanabe Makoto*?), followed an order to descend issued by the flight controller while Flight 958, headed by pilot Tatsuyuki Akazawa (赤沢 達幸 *Akazawa Tatsuyuki*?), descended as instructed by the TCAS, meaning that both planes remained on a collision course. The trainee for the aerospace sector, 26-year-old Hideki Hachitani (蜂谷 秀樹 *Hachitani Hideki*?), handled ten other flights at the time of the near miss. Hachitani intended to tell Flight 958 to descend. Instead, at 3:54 p.m, he told Flight 907 to descend. When the trainee noticed that JAL 958 cruised at a level altitude instead of descending, the trainee asked JAL 958 to turn right; the message did not get through to the JAL 958 pilot. The trainee's supervisor, Yasuko Momii (籾井 康子 *Momii Yasuko*?), ordered "JAL 957" to climb, intending to tell JAL 907 to climb. There was no "JAL 957" in the sky.

Watanabe avoided disaster when he abruptly forced the aircraft to dive based on a visual judgment, saving a total of 677 people on the two aircraft. If the collision had occurred, it would have been the deadliest civil aviation accident in history in terms of passenger

lives, surpassing the Tenerife disaster in which two Boeing 747s collided on a runway and killed 583 people in 1977. It also would have been the deadliest mid-air collision, surpassing the 1996 Charkhi Dadri mid-air collision in which 349 people were killed. The aircraft missed each other by less than 100 meters. Watanabe said that the aircraft were 35 feet apart. An unidentified passenger told NHK "I have never seen a plane fly so close. I thought we were going to crash." Alex Turner, a passenger on Flight 907 and a student at Kadena High School, a school for children with parents stationed at Kadena Air Base in Okinawa Prefecture, estimated that the avoidance maneuver lasted for two seconds.

Seven passengers and two crew members of the 747 sustained serious injuries; additionally, 81 passengers and 10 crew members reported minor injuries. Some unbelted passengers, flight attendants, and drink carts hit the ceiling, dislodging some ceiling tiles. The maneuver threw one boy across four rows of seats. Most of the injuries to occupants consisted of bruising. The maneuvers broke the leg of a 54-year-old woman. In addition, a drink cart spilled, scalding some passengers. No passengers on the DC-10 sustained injuries. Flight 907, with the 747's cabin bearing minor damage, returned to Haneda, landing at 4:45 PM.

Thirteen students at Kadena High School had boarded Flight 907 after returning from a school-sanctioned ROTC competition. Two students from Michigan, United States, 15-year-old Meggan Wesche and 14-year-old Allison Ambrose, sustained some minor injuries and became hospitalized for a short time. Wesche, who had slipped out of her seat during the descent and became disoriented from the incident, received an X-ray and other examinations at Toho University Hospital. She said that her body felt like "the plane is going down again" even though she was on land. The following day the students left on another Japan Airlines flight and arrived in Okinawa.

American Airlines Flight 157, traveling from Dallas-Fort Worth International Airport to Kansai International Airport near Osaka, Japan, communicated with the air traffic controller and flew in close proximity to the Japan Airlines planes around the time of the near miss.

Aftermath

By 18:00 on February 1 eight Flight 907 passengers remained hospitalized while 22 injured passengers had been released. Two passengers remained hospitalized at Kamata General Hospital (蒲田総合病院 *Kamata Sōgō Byōin*?). Two passengers remained hospitalized at Ichikawa No. 2 Hospital (市川第2病院 *Ichikawa Daini Byōin*?). In addition the following hospitals each had one passenger remaining: Takano Hospital (タカノ病院 *Takano Byōin*?), Kitasato University, Horinaka Hospital (堀中病院 *Horinaka Byōin*?), and Tokyo Rosai Hospital (東京労災病院 *Tōkyō Rōsai Byōin*?). All injured passengers recovered.

JAL sent apology letters to the passengers on the 747; injured passengers directly received messages, and uninjured passengers received messages via the mail.

The International Civil Aviation Organization (ICAO) did not take action based on the occurrence of the near-miss. Japanese authorities called for measures that would prevent similar accidents from happening, but ICAO did not further investigate the incident until after the 2002 Überlingen mid-air collision. The ICAO decided to fulfill Japan's request 18 months after the Japan Airlines incident.

Criminal investigation and trial

Tokyo Metropolitan Police Department and the Ministry of Land, Infrastructure and Transport investigated the incident.

In May 2003 Tokyo police filed an investigative report concerning Hideki Hachitani, Yasuko Momii, and Makoto Watanabe, suspecting them of professional negligence. In March 2004 prosecutors indicted Hachitani and Momii for professional negligence.

Hachitani, then 30 years old, and Momii, then 35 years old, pleaded not guilty to the charges at Tokyo District Court in 2004. During the same year the lawyer for Hachitani and Momii said that the pilots of the aircraft bore the responsibility for the near miss.

By November 16, 2005, 12 trials had been held since the initial hearing on September 9, 2004. The prosecution argued that the two defendants neglected to provide proper separation for the two aircraft, the instructions issued were inappropriate, and that the supervisor failed to correct the trainee. The defense argued that the lack of separation would not immediately have led to a near miss, that the instructions issued were appropriate, that the TCAS procedure was not proper, and that the Computer Navigation Fix (CNF) had faulty data.

In 2006 prosecutors asked for Hachitani, then 31, to be sentenced to one year in prison and for Momii, then 37, to be sentenced to one and one half years. On March 20, 2006 the court ruled that Hachitani and Momii were not guilty of the charge. The court stated that Hachitani could not have foreseen the accident and that the mixup of the flight numbers did not have a causal relationship with the accident. Hisaharu Yasui, the presiding judge, said that prosecuting controllers and pilots would be "unsuitable" in this case. The Tokyo District Public Prosecutor's Office filed an appeal with the Tokyo High Court on March 31. During the same year the Japanese government agreed to pay Japan Airlines and Tokio Marine & Nichido Fire Insurance a total of 82.4 million yen to compensate for the near miss.

On April 11, 2008, on appeal, a higher court overturned the decision and found Hachitani and Momii guilty. The presiding judge, Masaru Suda (須田賢 *Suda Masaharu*?), sentenced Hachitani, then 33, to confinement for one year, and Momii, then 39, for one year and six months. Both were placed on probation. Each of the two sentences was suspended for three years. Suda described the mixing of the flight numbers as a "rudimentary error." The lawyers representing the controllers planned to file appeals.

Chapter 2

2002 Uberlingen Mid-Air Collision

Bashkirian Airlines Flight 2937 DHL Flight 611	
Accident summary	
Date	1 July 2002
Type	Mid-air collision involving ATC/crew/training error
Site	Überlingen, Germany 47°46′42″N 9°10′26″E / 47.77833°N 9.17389°ECoordinates: 47°46′42″N 9°10′26″E / 47.77833°N 9.17389°E
Total fatalities	71
Total survivors	0
First aircraft	
Type	Tupolev Tu-154M
Operator	Bashkirian Airlines
Tail number	RA-85816
Flight origin	Domodedovo Int Airport Moscow, Russia
Destination	Barcelona Int'l Airport Barcelona, Spain

Passengers	60
Crew	9
Second aircraft	
Type	Boeing 757-23APF
Operator	DHL
Tail number	A9C-DHL
Flight origin	Bahrain Int'l Airport
Stopover	Orio al Serio Airport Bergamo, Italy
Destination	Brussels Airport, Belgium
Passengers	0
Crew	2

Site of the crash
The crash occurred at approximately 47° 46′ 42″ N, 9° 10′ 26″ E

Bashkirian Airlines Flight 2937 was a Tupolev Tu-154M passenger jet en route from Moscow to Barcelona. **DHL Flight 611**, registration A9C-DHL, was a Boeing 757-23APF cargo jet flying from Bergamo, Italy, to Brussels, Belgium. The two aircraft collided in mid-air on 1 July 2002, at 21:35 (UTC) over the towns of Owingen and Überlingen in Germany, (near Lake Constance), killing all 71 aboard both aircraft. The German Federal Bureau of Aircraft Accidents Investigation (BFU) determined on 19 May 2004, that the accident had been caused by problems within the air traffic control system and problems with the use of the collision warning system. On 24 February 2004, Peter Nielsen, the controller who was on duty at the time of the accident, was stabbed to death by Vitaly Kaloyev who had lost his wife and two children in the accident.

Flights involved

Flight 2937 was a chartered flight carrying 60 passengers and 9 crew. Forty-five passengers were Bashkortostan schoolchildren on a school trip organized by the local UNESCO committee to the Costa Daurada area of Spain. Most of the parents of the children were high-ranking officials in Bashkortostan. The aircraft, a Tupolev Tu-154M with the registration RA-85816, was piloted by a Russian crew. The captain, Alexander Mihailovich Gross, and first officer Oleg Pavlovich Grigoriev, flew the Tupolev. Grigoriev, the chief pilot of Bashkirian Airlines, used the trip to evaluate Gross's performance. Murat Ahatovich Itkulov, normally the first officer, did not officially serve on duty because of this. The crew valued the opinions and guidance of Itkulov, who was slated to be promoted to captain. Sergei Kharlov, a navigator, and a flight engineer joined the three pilots.

Flight 611 of DHL International Aviation ME was carrying a load of air freight and had two Bahrain-based crew members aboard, British Captain Paul Phillips and Canadian First Officer Brant Campioni.

Notable passengers on Flight 2937

Fourteen-year old Kirill Degtyarev created paintings from age 4 to his death and had held two public exhibitions. After his death, Ufa hosted one exhibition and Überlingen hosted another exhibition. The family of future deputy North Ossetian housing minister Vitaly Kaloyev all died. Kaloyev would later go on to murder Neilsen.

Accident

The two aircraft were flying at flight level 360 (approximately 36,000 feet (11,000 m) above Mean Sea Level) on a collision course. Despite being over Germany, the airspace was controlled from Zürich, Switzerland by the private Swiss airspace control company Skyguide. The only air traffic controller handling the airspace, Peter Nielsen, was working two workstations at the same time. He did not realise the problem in time and thus failed to keep the aircraft at a safe distance from each other. Only less than a minute before the accident did he realize the danger and contacted Flight 2937, instructing the pilot to descend by a thousand feet to avoid collision with crossing traffic (Flight 611). Seconds after the Russian crew initiated the descent, however, their Traffic Collision Avoidance System (TCAS) instructed them to climb, while at about the same time the TCAS on Flight 611 instructed the pilots of that aircraft to descend. Had both aircraft followed those automated instructions, it is likely that the collision would not have occurred.

Flight 611's pilots on the Boeing jet initially followed the TCAS instructions and initiated a descent, but could not immediately inform the controller due to the fact that he was dealing with Flight 2937. About eight seconds before the collision, Flight 611's descent rate was about 2,400 feet per minute (12 m/s), not as rapid as the 2,500 to 3,000 ft/min (13 to 15 m/s) range advised by TCAS. The Russian pilot on the Tupolev disregarded the

TCAS instruction to climb and instead began to descend, as instructed by the controller, thus both planes were now descending.

Unaware of the TCAS-issued alerts, Nielsen repeated his instruction to Flight 2937 to descend, giving the Tupolev crew incorrect information as to the position of the DHL plane. Maintenance work was being carried out on the main radar system, which meant that the controllers were forced to use a slower system.

The aircraft collided at almost a right angle at an altitude of 34,890 feet (10,630 m), with the Boeing's vertical stabilizer slicing completely through Flight 2937's fuselage just ahead of the Tupolev's wings. The Tupolev exploded and broke into several pieces, scattering wreckage over a wide area. The nose section of the aircraft fell vertically, while the tail section with the engines continued, stalled, and fell. As the nose section of the Tupolev fell at such speed, the flight deck crew soon lose consciousness. The crippled Boeing, now with 80% of its vertical stabilizer lost, struggled for a further seven kilometres (four miles) before crashing into a wooded area close to the village of Taisersdorf at a 70 degree downward angle. Each engine ended up several hundred metres away from the main wreckage, and the tail section was torn from the fuselage by trees just before impact. All 69 people on the Tupolev, and the two on board the Boeing, died.

Other factors in the crash

Only one air traffic controller, Peter Nielsen of ACC Zurich, was controlling the airspace through which the aircraft were transitioning. The other controller on duty was resting in another room for the night. This was against the regulations, but had been a common practice for years and was known and tolerated by management. Due to maintenance work, Nielsen had a stand-by controller and system manager on call. Nielsen was either unaware of this or he chose not to use either of the two additional air traffic controllers available to him. When Nielsen realised that the situation had subtly increased beyond his span of control, it was too late to summon assistance.

In the minutes before the accident, Nielsen was occupied with an Airbus on a delayed Aero Lloyd Flight 1135 approaching Friedrichshafen Airport. Handling two workstations at once, Nielsen struggled with the malfunctioning phone system that he was trying to use to call the Friedrichshafen airport to announce the approaching Aero Lloyd. The main phone lines at Skyguide were down due to maintenance work, and the backup line was defective. This caused Nielsen to spend more time than he anticipated coordinating the Airbus late arrival into Friedrichshafen, and to miss several calls from aircraft. The faulty phone lines also prevented adjacent air traffic controllers at Karlsruhe from phoning in a warning. Due to these distractions he did not spot the danger until about a minute before impact. Had he been aware of the dangerous situation earlier, he could have kept the aircraft at a safe distance from each other. They would have been separated and their collision avoidance systems would not have issued instructions.

Additionally, after Nielsen instructed the Russian crew to descend, he returned to the situation with the Airbus bound for Friedrichshafen, and did not hear the DHL aircraft TCAS report of its descent.

Another factor was that the ground-based optical collision warning system, which would have alerted the controller to imminent collisions early, had been switched off for maintenance; Nielsen was unaware of this. There still was an aural STCA warning system, which released a warning addressed to workstation RE SUED at 21:35:00 (32 seconds before the collision); this warning was not heard by anyone present at that time, although no error in this system could be found in a subsequent technical audit; whether this audible warning is turned on or not, is not logged technically. Even if Nielsen had heard this warning, he might have misinterpreted it until the next radar update 12 seconds later became visible or until the TCAS descent notice by the DHL crew came in; at that time finding a useful resolution order by the air traffic controller is difficult to impossible.

Deviating statements in the official report

All countries involved could add additional "deviating" statements to the official report. The Kingdom of Bahrain, Switzerland and the Russian Federation did submit positions that were published with the official report. The USA did not submit deviating positions. The comments were published as an appendix to the report but were not commented upon by the German federal investigators.

The statement by the *Kingdom of Bahrain*, the home country of the DHL plane, mostly agrees with the findings of the report. It says that the report should have put less emphasis on the actions of individuals and stressed the problems with the organisation and management more. Bahrain's statement also mentions the lack of crew resource management in the Tupolev's cockpit as a factor in the crash.

The *Russian Federation* states that the Russian pilots were unable to obey the TCAS advisory to climb; the advisory was given when they were already at 35500 feet while the controller wrongly stated there was conflicting traffic above them at 36000 feet. Also, the controller gave the wrong position of the DHL plane (2 o'clock instead of the actual 10 o'clock). Russia asserts that the DHL crew had a "real possibility" to avoid a collision since they were able to hear the conversation between the Russian crew and the controller.

Switzerland notes that the Tupolev was about 33 metres below the flight level ordered by the Swiss controller, and still descending at 1900 feet per minute. The Swiss say that this was also a cause of the accident. The Swiss position also states that in spite of the false information given (position and phraseology) by the Swiss controller the TCAS advisories would have been useful if obeyed immediately.

The change in magnetic bearing of the Russian aircraft by cumulatively 20 degrees (from 254 to 274) during the upcoming conflict is not assessed in the official report.

Consequences

Skyguide memorial to the aviation accident and murder of Peter Nielsen.

Nielsen needed medical attention due to traumatic stress caused by the accident. At Skyguide, his former colleagues maintained a vase with a white rose over Nielsen's former workstation. Skyguide, after initially having blamed the Russian pilot for the accident, accepted its share of the responsibility and has paid compensation to some of the Russian families.

On 19 May 2004, the official investigators found that managerial incompetence and systems failures were the main cause for the accident, so that Nielsen was surely not the

only one to be blamed for the disaster. As explained above, a series of coincidences of which Kaloyev and Nielsen were unaware precipitated the accident.

On 27 July 2006, a court in Konstanz decided that the Federal Republic of Germany should pay compensation to Bashkirian Airlines. The court found that it was illegal for the state to allow a foreign private company to provide air traffic control in German airspace. The government appealed the ruling, and a final decision is still pending as of 2008.

In another case before the court in Konstanz, Skyguide's liability insurance is suing Bashkirian Airlines for 2.5 million euro in damages. The case was opened in March 2008; the legal questions are expected to be difficult, as the airline has filed for bankruptcy under Russian law.

A criminal investigation of Skyguide began as of May 2004. On 7 August 2006, a Swiss prosecutor filed manslaughter charges against eight employees of Skyguide. The Winterthur prosecutor called for jail terms of 6 to 15 months, alleging "homicide by negligence". The verdict was announced in September 2007. Three of the four managers convicted were given suspended prison terms and the fourth was ordered to pay a fine. Another four employees of the Skyguide firm were cleared of any wrongdoing.

Murder of Peter Nielsen

Grieved by the loss of his family, Vitaly Kaloyev held Peter Nielsen responsible for their deaths. He killed Nielsen at his Kloten home, near Zürich, on 24 February 2004. Police arrested Kaloyev at a local motel not long after the murder, and he was subsequently convicted of the crime in 2005. He was released on 8 November 2007 because his mental condition was not sufficiently considered in the initial sentence. After his release, Kaloyev was infamously dubbed a "hero" in North Ossetia. In January 2008, he was appointed deputy construction minister of North Ossetia.

TCAS and conflicting orders

The accident raised questions on how pilots must react when they receive conflicting orders from the TCAS and from air traffic control (ATC). The TCAS is programmed to assume that both crews will promptly follow the system's instructions. The operations manual clearly states that TCAS should always take precedence over any ATC commands: *If an instruction to manoeuvre is received simultaneously from an RA (resolution advisory, the command issued by the TCAS) and from ATC, the advice given by RA should be followed.*

It is not required to notify the ATC prior to responding to an RA. This manoeuvre does not require any ATC clearance since TCAS takes into account the position of all other aircraft with transponders in the surrounding area.

Prior incidents

About a year before the Bashkirian-DHL collision there had already been another incident involving confusion conflicting TCAS and ATC commands. During the 2001 Japan Airlines mid-air incident, two Japanese airliners nearly collided with each other in Japanese skies. Both aircraft had received conflicting orders from the TCAS and ATC; one pilot followed the instructions of the TCAS while the other did not. Disaster was only averted because one of the pilots made evasive manoeuvres based on a visual judgement. The aircraft missed each other by less than 100 metres (330 ft), and the abrupt manoeuvre necessary to avert disaster left about 100 occupants hurt on one aircraft, some seriously. As a consequence Japan called for measures to prevent similar incidents. However, the International Civil Aviation Organization (ICAO) did not take action until after the crash over Germany. In addition four near misses in Europe occurred before the German disaster, because one set of pilots obeyed the air traffic controllers while the other obeyed TCAS. The ICAO decided to fulfill Japan's request 18 months after the Japan Airlines incident.

Unclear instructions for the Bashkirian crew

The Bashkirian pilots were using the Tu-154 Flight Operations Manual, which contained a section that emphasizes the role of the ATC and describes the TCAS as an additional aid:

> “ *For the avoidance of in-flight collisions is the visual control of the situation in the airspace by the crew and the correct execution of all instructions issued by the Air Traffic Controller to be viewed as the most important tool. TCAS is an additional instrument which ensures the timely determination of oncoming traffic, the classification of the risk and, if necessary, planning of an advice for a vertical avoidance manoeuvre.* ”
>
> —TU154M Flight Operations Manual

The same flight manual, on a different page, also contains a passage that strictly forbids manoeuvers contrary to the TCAS under any circumstances. Nevertheless, the official investigation found that the pilots seemed unaware that the TCAS RA should take precedence.

Technical solutions

Before this accident a change proposal (CP 112) for the TCAS II system had been issued. This proposal would have created a "reversal" of the original warning - asking the DHL plane to climb and the Tupolev crew to descend. According to an analysis by Eurocontrol this would have avoided the collision if the DHL crew had followed the new instructions and the Tupolev had continued to descend.

Additionally, an automatic downlink for the TCAS - which would have alerted the air traffic controller - had not been deployed worldwide at the time of the accident.

Recommendations after the accident

The investigation report contains a number of recommendations concerning TCAS, calling for upgrades and for better training and clearer instructions to the pilots.

Dramatization

The Discovery Channel Canada documentary series *Mayday* featured this accident in the episode titled *Deadly Crossroads*, which was released in 2004.

"Flug in die Nacht - Das Unglück von Überlingen" (2009), *("Flight into the night - the accident at Überlingen")* produced by German and Swiss TV stations SWR and SF, is a motion picture based on the crash and the subsequent killing of the air traffic controller.

Chapter 3

2007 San Francisco International Airport Runway Incursion

2007 San Francisco International Airport runway incursion	
Incident summary	
Date	May 26, 2007
Type	Runway incursion
Site	San Francisco Int'l Airport California, USA
Total injuries	0
Total survivors	27 (all)
First aircraft	

An Embraer 170 Regional Jet similar to that involved in the incursion.

Type	Embraer 170 Regional Jet
Operator	Republic Airlines (o/a Frontier Airlines)
Tail number	N872RW

Passengers	11
Crew	4

Second aircraft

An Embraer EMB 120 Brasilia turboprop aircraft similar to that involved in the incursion.

Type	Embraer EMB 120 Brasilia
Operator	SkyWest Airlines (o/a United Express)
Tail number	N232SW
Passengers	9
Crew	3

The **2007 San Francisco International Airport runway incursion** occurred around 1:30 pm PST on May 26, 2007 when SkyWest Airlines (operating as United Express) Flight 5741 (SKW5741), an Embraer EMB 120 Brasilia turboprop aircraft, nearly collided with Republic Airlines (operating as Frontier Airlines) Flight 4912, an Embraer 170 Regional Jet, at the intersection of runways 1L and 28R at San Francisco International Airport (SFO), South San Francisco, California.

There were no reported injuries to occupants and no reported damage to either aircraft. Federal Aviation Administration (FAA) officials described the runway incursion as the most serious incident of its kind in at least a decade, and the National Transportation Safety Board (NTSB) initiated an investigation into the incident.

Incident

Visual representation of the runway configuration at SFO. The takeoff path of the jet is shown in red, and the landing path of the turboprop is shown in blue.

The SkyWest aircraft was arriving at SFO after a flight from Modesto, California, and was cleared for a visual approach to runway 28R by NorCal approach control. After being switched over to the tower controller, SkyWest was cleared to land on runway 28R. At the same time, the Republic Airlines aircraft, bound for Los Angeles, California was instructed to taxi into position and hold on the intersecting runway 1L. As the landing SkyWest aircraft passed the runway threshold the Republic Airlines aircraft was cleared for takeoff. Local procedures and FAA Order 7110.65 require the local controller to wait until the landing aircraft has passed through the intersection before clearing an aircraft for takeoff on one of the intersecting runways.

Approximately 27 seconds later the Airport Movement Area Safety System (AMASS) issued an aural warning of an imminent collision, and the local controller attempted to instruct the SkyWest aircraft to stop, transmitting, "uh, Skywest HOLD HOLD HOLD".

The SkyWest aircraft came to a stop in the intersection of runways 1L and 28R, while Republic Airlines flight lifted off and overflew it. The initial FAA tower report estimated the aircraft missed colliding by 300 feet; however the Skywest crew estimated the distance as 30 to 50 feet.

Investigation

Runway safety has been a priority concern for both the FAA and NTSB. In a March 23, 2007 press conference on runway safety the FAA Administrator Marion C. Blakey described the Tenerife disaster 30 years earlier as a "wake-up" call. Runway safety has been on the NTSB's annual list of "Most Wanted Improvements" continuously since 1990, and the NTSB held a one-day forum on runway incursions just two months earlier, on March 27, 2007.

In this case, the FAA categorized the incident's severity as "Category A", the most severe; Category A is defined as when "separation decreases and participants take extreme action to narrowly avoid a collision, or the event results in a collision." Of the previous 15 runway incursions at SFO between 2001 and 2007, none of them were more serious than Category C, defined as the situation where "separation decreases but there is ample time and distance to avoid a potential collision".

Commenting on the seriousness of the incident, NTSB spokesman Ted Lopatkiewicz noted that "We investigate probably just a handful (of incursions) a year." The NTSB officials have stated that the investigation could be completed by Fall. However, FAA spokesman Ian Gregor was quoted as saying "This wasn't a procedural issue, this was caused by a good controller with a lot of experience making a mistake", adding that since the incursion the controller had to be recertified for their job. The controller had over 20 years' experience.

SFO and AMASS

SFO was initially selected for the first test installation of the AMASS ground radar system in 1992. AMASS, which can detect and alert controllers to potential runway conflicts, was intended by the FAA to be eventually installed in 40 airports around the country. However much criticism was directed at the project for cost overruns and lengthy delays. The SFO AMASS was finally declared operational on June 18, 2001. According to AMASS technical support personnel, in a scenario such as this conflict, AMASS is designed to provide an alert 15 seconds before the aircraft reach the conflict point, and the system performed as designed.

Chapter 4

Aeroflot Flight 3352

Aeroflot Flight 3352	
Accident summary	
Date	11 October 1984
Type	Runway incursion
Site	Omsk, Russia
Passengers	170
Crew	9
Injuries	5
Fatalities	178 (4 on ground)
Survivors	5
Operator	Aeroflot
Tail number	SSSR-85243
Flight origin	Krasnodar International Airport
Stopover	Omsk Airport
Destination	Novosibirsk Tolmachevo Airport

Aeroflot Flight 3352 was a Tupolev Tu-154 airliner flight on a domestic route in Russia from Krasnodar to Novosibirsk, with an intermediate landing in Omsk. While landing at Omsk Airport on 11 October 1984, the aircraft crashed into maintenance vehicles on the runway killing 174 people on board and 4 on the ground. While a chain of mistakes in the airport operation contributed to the accident, its major cause was a ground controller falling asleep on duty. As of April 2010, this remains the deadliest airplane crash on Russian territory.

The accident

At 5:00 am local time (UTC/GMT + 7 hours), flight 3352 was preparing for its planned intermediate landing in the airport of Omsk, a key Russian city in southwestern Siberia, which has a population of over 1 million and is the administrative center of Omsk Oblast. This was the only aircraft approaching Omsk and was cleared for landing when it contacted the airport.

Tupolev Tu-154M

At 5:20 am, worried that the continuing rain would make landing slippery for the flights of the day, the airport ground maintenance crew requested permission to dry the runway. The ground controller on duty gave the permission and fell asleep right after, forgetting to switch on the "runway occupied" warning. By the airport regulations, such permission should not be given without approval by the Head of the Flights, but he was absent from the airport at the time. The maintenance crew operated following the airport's normal routine, namely three vehicles moved to the runway: a UAZ-469 4×4 with an attached trailer, driver and the crew manager in front, followed by KrAZ and Ural trucks. The latter were equipped with dry air compressors and loaded with fuel, and weighed 16–20 tons each. During the entire time on a runway, the maintenance vehicles should have their top flickering lights on. The lights irritated the eyes of maintenance workers though, so the local practice was to have only the UAZ lights on while moving to and from the runway and switch the lights off during the work.

UAZ-469

Around 5:36 am, the flight requested permission for landing from the approach controller. The request was sent twice because the pilots noticed vague contours on the runway and wanted to double check for obstacles. The controller verified the runway status, which remained unoccupied, contacted the ground controller and received no response, contacted the flight controller on internal radio and received an inaudible reply, which sounded like "..ree" (original, Russian: ..бодна) and was taken as "free" (Russian: свободна; communications were being taped and were analyzed later). The approach controller cleared the landing, unable to see the runway, though the regulations instructed him to keep the flight in the air and double check the runway condition. The ground controller and secondary control post could see the runway, but the former was asleep and the latter was unmanned because of lack of staff. The ground maintenance crew on the runway saw landing lights switch on, contacted the ground controller three times, received no response and ignored the lights thinking they are being tested.

At 5:38 am, the flight passed the lowest height at which the flight crew could abort the landing. The aircraft landed moving at 240 km/h on the runway. The flight crew saw the vehicles and attempted to turn the aircraft, but was unable to avoid the collision. The plane crashed into the Ural truck and then 200 m farther down the runway crashed into the KrAZ, igniting the 7 tons of fuel in each truck and the aircraft fuel tank. The plane overturned and broke into pieces, some of which crashed into the UAZ-469. A catastrophic fracture of the fuel tanks caused burning fuel to leak inside the passenger area, killing all but one passenger. The cockpit section detached and flew past the burning

vehicles. It suffered no major damage and none of the windows were broken. As a result, all four crew members in the cockpit survived and suffered only minor injuries. They escaped from the cabin and ran to the crash site attempting to help the passengers. Four ground maintenance crew were killed instantly inside the vehicles. One person in the passenger seat of the UAZ caught on fire; this was extinguished by the firefighters.

Investigation

The State investigation concluded that the accident was caused by a chain of mistakes made by negligence of the air traffic control and airport maintenance regulations. The ground controller was found directly responsible as he fell asleep on the job and thus did not respond to emergency queries; he also allowed the service trucks to move on the runway and did not mark the runway as occupied. At the hearing, he could not recollect his actions during the flight landing. He did not deny the charges, was sentenced to 15 years and committed suicide in jail.

Investigation also found that the operators of the Omsk airport neglected the essential safety regulations. The head of the airport flights was sentenced to 15 years in prison, the approach controller to 13 years and the head of the airport maintenance to 12 years. All three appealed the decision with negative outcome. The follow-up airport checks found numerous violations of safety regulations which resulted in dismissal of officials at several major airports across the Soviet Union.

No mistake was found in the aircraft operation. The flight mass and centering were within the norms. Because of poor visibility, the crew could not detect the obstruction on the runway. They had reasonable doubts as to whether or not the runways were occupied, but those were dispersed by the approach controller. The crew had only a few seconds to avoid the collision on the ground; they took evasive action, but could not possibly save the aircraft.

The flight controller and approach controller were experienced professionals with at least 10 years of service. The ground controller on duty was a newcomer of 23 years old. He was supposedly having sleep deprivation because of two young children. The hearing of the case occurred as early as 3 months after the accident, supposedly because of the obvious circumstances; most of that time was spent on identifying the victims and locating their relatives. All the prosecuted and their attorneys received threats and were moved to the court hearings under heavy security.

Technical data and statistics

The aircraft Tupolev Tu-154B-1, registration number CCCP-85243, was operated by Aeroflot (later becoming East Siberia). It was equipped with 3 Kuznetsov NK-8-2U engines and had its first flight in 1977. The flight carried 170 passengers, including 8 teenagers and 16 young children; 2700 kg of luggage, 306 kg of post and 1600 kg of cargo. The flight had an experienced crew of 9, the captain was a first-class pilot with 16365 hours in the air including 4303 hours of night flights. The flight was approaching

Omsk in poor weather: light rain, visibility 2 miles, 300 feet ceiling. The crash killed 169 passengers and 5 attendance crew members, as well as 4 airfield service workers. One passenger and 4 pilots survived. This was the deadliest airplane crash in the Russian history, 18th loss of a Tupolev 154, and the highest death toll of any accident involving a Tupolev Tu-154 at that time. It was only surpassed by a Tu-154 flying Aeroflot Flight 7425, which crashed in Uzbekistan on 10 July 1985 with 200 fatalities.

Chapter 5

Avianca Flight 52

Avianca Flight 52

An Avianca Boeing 707 similar to the one involved in the accident

Accident summary	
Date	January 25, 1990
Type	Controlled flight into terrain because of fuel exhaustion
Site	Cove Neck, New York 40°52′48″N 73°29′43″W / 40.88°N 73.49528°WCoordinates: 40°52′48″N 73°29′43″W / 40.88°N 73.49528°W
Passengers	149
Crew	9
Injuries	85

Fatalities	73
Survivors	85
Operator	Avianca
Flight origin	El Dorado International Airport
Stopover	José María Córdova International Airport
Destination	John F. Kennedy International Airport

Avianca Flight 52 was a regularly scheduled flight from Bogotá to New York via Medellín, Colombia. On Thursday, January 25, 1990, the aircraft performing this flight, a Boeing 707-321B registered as HK-2016, crashed into the village of Cove Neck, Long Island, New York after running out of fuel. Eight of the nine crew members and 65 of the 149 passengers on board were killed.

History

The 23-year-old Boeing 707 started its journey in Bogotá, stopping in Medellin at 2:04 pm after flying for half an hour. It then took off at 3:08 pm, a few minutes later than planned.

The flight crew included pilot Laureano Caviedes, first officer Mauricio Klotz and flight engineer Matias Moyano. The flight crew did not change at Medellin.

Flight history

On January 25, 1990, Avianca Flight 52 was much delayed in approaching its destination due to congestion and bad weather. It had been in a holding pattern off the coast near New York for over one hour due to fog and wind interfering with smooth arrivals and departures into John F. Kennedy International Airport. During this hold the aircraft was exhausting its reserve fuel supply, which would have allowed it to divert to its alternate, Boston, in case of an emergency or other critical situation.

When first put on hold, the crew of Flight 52 thought that they would be landing soon, after a few aircraft also on hold in front of them had landed. The bad weather, wind shear and other factors caused the pilots of these aircraft to abort their landings, and the hold time increased.

Seventy-seven minutes after entering the hold, New York air traffic control (ATC) asked the crew how long they could continue to hold, to which the first officer replied, "[A]bout five minutes." The first officer then stated that their alternate was Boston, but since they had been holding for so long they would not be able to make it there anymore. Even though Flight 52 had fuel issues, ATC passed the flight to another person, presumably

unaware there was any urgency to landing this airplane. The delay of the handover may have increased the pilots' stress and fear response, which may have led to less than optimal piloting. The new controller then cleared the aircraft for an approach to runway 22L and informed the flight of wind shear at 1,500 feet (460 m).

As Flight 52 flew the ILS approach, they encountered wind shear at an altitude of less than 500 feet (150 m). As a result, the plane descended below the planned glideslope and almost crashed into the ground short of the runway. The pilots were forced to abandon the landing, even though they knew the plane did not have enough fuel to turn around for another attempt. The crew alerted the controller that they were low on fuel, and in a subsequent transmission stated, "We're running out of fuel, sir." The controller then asked the crew to climb, to which the first officer replied, "No, sir, we're running out of fuel."

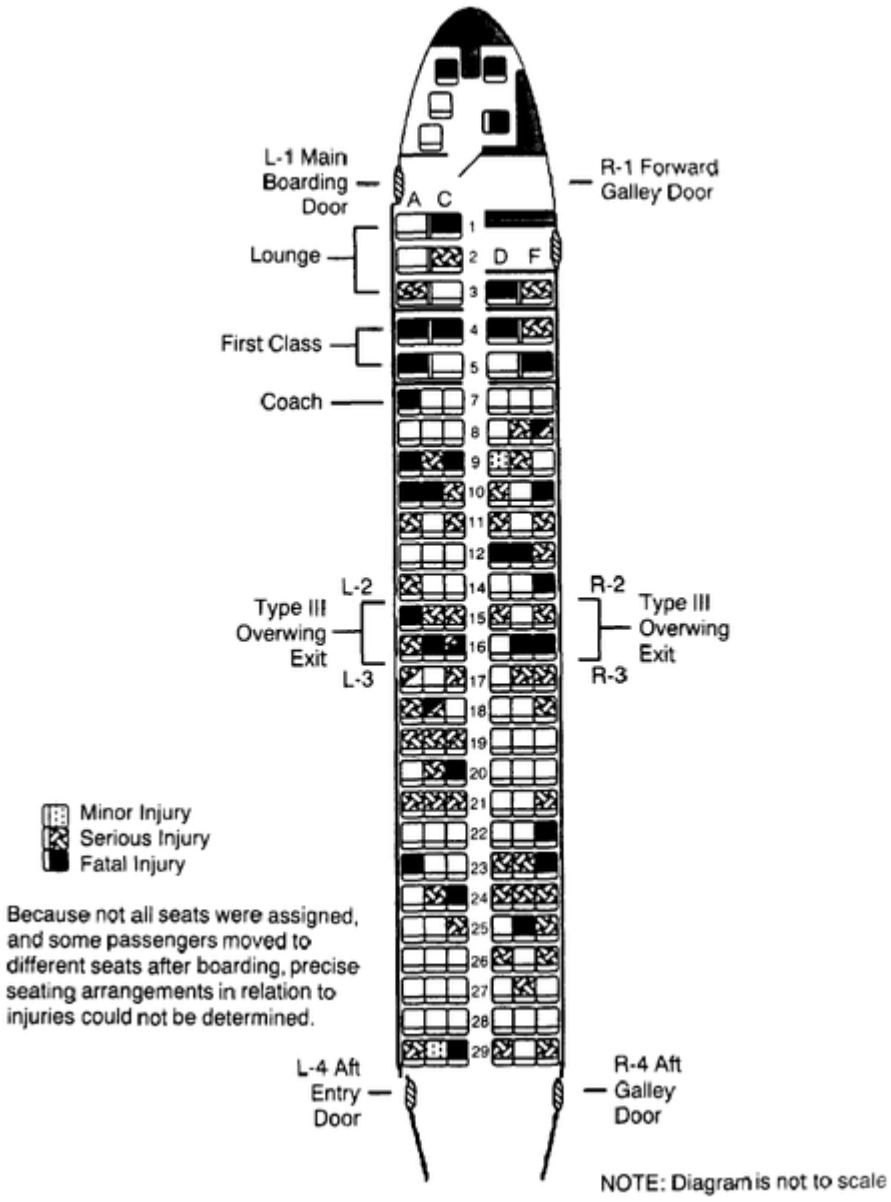
Moments later, with the airplane still very close to the ground, the number four engine flamed out, shortly followed by the other three. With the aircraft's main source of electrical power - generators driven off its engines - now gone, automatic load shedding would have caused many nonessential electrical systems to lose power. The cabin thus would have been plunged into darkness. With no engine thrust, the plane lost height. It plunged into the small village of Cove Neck on northern Long Island in Oyster Bay, 15 miles (24 km) from the airport.

The aircraft struck the ground and slid down a hill in the town, splitting into two pieces as it reached the bottom. The impact snapped off the cockpit, which landed over 100 feet (30 m) away in the side of an unoccupied house. Eighty-five people survived the crash with injuries, while 73 passengers and crew died.

Emergency response

The recovery efforts for Flight 52 proved to be difficult since the aircraft had crashed into the hilly, sparsely populated North Shore, making it difficult for emergency crews to reach. This was compounded by the narrow, winding roads that lead into the hamlet. Rescue squads from all over Long Island responded to the crash. The weather conditions and the darkness of night made the search crews' task even more challenging. The first ambulances to arrive performed triage, selecting the most critically injured passengers for transport to area hospitals. But so many other ambulances had arrived that a traffic jam developed, and some rigs were unable to leave the site immediately. Ambulatory passengers walked to other ambulances and arrived at hospitals sooner than critically injured ones.

Passengers and injuries



The seat map of HK2016, the Boeing 707. The National Transportation Safety Board (NTSB) could not determine a relationship between the locations of passengers and the severity of injuries because some passengers were not assigned seats and because some passengers changed seats.

The senior flight attendant, who sustained serious injuries, was the sole surviving crew member of the disaster.

The adult passengers on the Medellin-New York segment consisted of 61 males and 61 females. Sixteen children between 3 and 15 years of age, including 8 males and 8 females, flew on this segment.

Of the 11 babies (8 males and 3 females, ages ranging from 4 months to 27 months) on the Medellin-New York flight, 10 survived.

Of the surviving passengers, 80 suffered serious injuries and 4 sustained minor injuries. Of the passengers indicated by the NTSB map to have been assigned to first class (Rows 4 and 5), one survived. The NTSB stated that as the airline did not assign all of the filled seats and that some passengers relocated to other seats after boarding, the NTSB could not determine the injuries in relation to precise seating arrangements.

Cause and investigation

The NTSB's report on the accident determined the cause as pilot error due to the crew never declaring a fuel emergency to air traffic control as per International Air Transport Association (IATA) guidelines. The crew asked for a "priority" landing which, because of language differences between English and Spanish, can be interpreted as an emergency to Spanish-speaking pilots but not to English-speaking air traffic controllers. This may have caused some confusion amongst the pilots when ATC confirmed their priority status. Some NTSB board members felt that ATC was negligent in not providing arriving aircraft with the latest wind shear information, which could alert the crew to possible difficulties in landing. Avianca Airlines threatened to sue the Federal Aviation Administration (FAA) for the actions of the air traffic controllers, whom they felt were negligent in misunderstanding the pilots' reports. The FAA countered, stating that the crew never declared a fuel emergency until the final minutes before the crash and had never reported the amount of fuel they had left when asking for a priority landing, making it impossible for air traffic controllers to give them correct priority status.

Further from the NTSB report: "There was no flight following or interaction with the Avianca Airlines dispatcher for AVA052 following takeoff from Medellin ...Contributing to the accident was the flight crew's failure to use an airline operational control dispatch system to assist them during the international flight into a high-density airport in poor weather." This accident, along with Hapag-Lloyd Airlines Flight 3378, has been used as an example of why airlines in different countries should always have proactive flight following by flight dispatchers, as required in the U.S. by Federal Aviation Regulations (FAR) Part 121.

Many passengers were upset when the FAA stated that it had no responsibility in covering the crash.

Aftermath

After some deliberations, a settlement was reached in which the United States paid for around 40% of the settlements with the passengers and their families; the rest was paid by Avianca.

Following Flight 52, air traffic controllers were more conservative in determining if Avianca flights were running low on fuel and required priority landing. On June 22,

1990, a Boeing 727 was immediately cleared to land when the pilot declared a **minimum fuel situation**. In another instance, on August 4, 1990, controllers declared a fuel emergency for the pilot due to confusion over the remaining fuel. The jet landed with 2 more flying hours to spare.

Dramatization

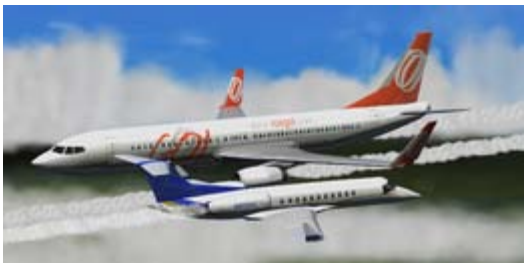
The story of the disaster was featured on the eighth season of Canadian National Geographic Channel show *Mayday* (known as *Air Emergency* in the US, Mayday in Ireland and *Air Crash Investigation* in the UK and the rest of world). The episode is entitled "*System Breakdown*".

In Malcolm Gladwell's book Outliers, the crash of Flight 52 was discussed in a section on different ethnic groups responses to authority figures.

Chapter 6

Gol Transportes Aereos Flight 1907

Gol Transportes Aéreos Flight 1907



Computer-generated image of Flight 1907 and N600XL about to collide. The Legacy's left winglet sliced off nearly half of the Boeing's left wing.

Accident summary	
Date	September 29, 2006
Type	Mid-air collision
Site	200 km (120 mi) east of Peixoto de Azevedo, Mato Grosso, Brazil 10°29′S 53°15′W / 10.483°S 53.25°W
Total fatalities	154
Total survivors	7
First aircraft	
Type	Boeing 737-8EH
Operator	Gol Transportes Aéreos

Tail number	PR-GTD
Flight origin	Eduardo Gomes Int'l Airport Manaus, Brazil
Stopover	Brasília International Airport
Destination	Galeão Int'l Airport Rio de Janeiro, Brazil
Passengers	148
Crew	6
Fatalities	154 (all)
Second aircraft	
Type	Embraer Legacy 600
Operator	ExcelAire (delivery flight)
Tail number	N600XL
Flight origin	São José dos Campos Regional Airport
Destination	Eduardo Gomes International Airport
Passengers	5
Crew	2
Survivors	7 (all)

Gol Transportes Aéreos Flight 1907 (ICAO: **GLO 1907**) was a Boeing 737-8EH, registration PR-GTD, on a scheduled passenger flight from Manaus, Brazil to Rio de Janeiro. On September 29, 2006, just before 17:00 BST, it collided in mid-air with an Embraer Legacy business jet over the Brazilian state of Mato Grosso. All 154 passengers and crew aboard the Boeing 737 were killed when the aircraft broke up in midair and crashed into an area of dense rainforest, while the Embraer Legacy, despite sustaining serious damage to its left wing and tail, landed safely with its seven occupants uninjured.

The accident, which triggered a crisis in Brazilian civil aviation, was the deadliest in that country's aviation history at the time, surpassing VASP Flight 168, which crashed in 1982 with 137 fatalities near Fortaleza. It was subsequently surpassed by TAM Airlines Flight 3054, which crashed on July 17, 2007 with 199 fatalities.On the other hand, it was also the deadliest aviation accident involving a Boeing 737 (all series) aircraft at that time. It was subsequently surpassed by Air India Express Flight 812, which crashed at Mangalore, India on 22 May 2010 with 158 fatalities.

The accident was investigated by both the Brazilian Air Force *Centro de Investigação e Prevenção de Acidentes Aeronáuticos* (CENIPA) and the U.S. National Transportation Safety Board (NTSB), with a final report issued on December 10, 2008. CENIPA concluded that the accident was caused by errors committed both by air traffic controllers and by the American pilots, while the NTSB determined that all pilots acted properly and were placed on a collision course by a variety of "individual and institutional" air traffic control errors.

Boeing aircraft and crew

A similar model of the Gol aircraft

The Gol Transportes Aéreos twin turbofan Boeing 737-8EH aircraft, a new Short Field Performance variant, had been delivered to Gol on September 12, 2006, seventeen days and 234 hours of operation prior to the accident flight. Gol Flight 1907 (ICAO code "GLO 1907") departed Eduardo Gomes International Airport in Manaus on September 29, 2006, at 15:35 Brazil Standard Time (BST), en route to Rio de Janeiro-Galeão International Airport, with a planned intermediate stop at Brasília International Airport.

There were 148 passengers and six crew members on board the Boeing airliner. The crew consisted of Captain Decio Chaves Jr., 44, First Officer Thiago Jordão Cruso, 29, and four flight attendants. The captain, who had also been serving as a Boeing 737 flight instructor for Gol, had 15,498 total flight hours, with 13,521 in Boeing 737 aircraft. The first officer had 3,981 total flight hours, with 3,081 in Boeing 737 aircraft.

Embraer aircraft and crew

The Embraer Legacy at Cachimbo Air Base

The twin turbofan Embraer Legacy 600 business jet, serial number 965 and registration N600XL, newly built by Embraer and purchased by ExcelAire Service Inc. of Ronkonkoma, New York, was on a delivery flight by ExcelAire from the Embraer factory to the U.S.. It departed from São José dos Campos Regional Airport (SJK), near São Paulo, at 14:51 BST, and was on its way to Eduardo Gomes International Airport (MAO) in Manaus as a planned en route stop.

The ExcelAire flight crew consisted of Captain Joseph Lepore, 42, and First Officer Jan Paul Paladino, 34, both U.S. citizens. Lepore had been a commercial pilot for more than 20 years and had logged 9,388 total flight hours, but only 5.5 hours in the Legacy 600. Paladino had been a commercial pilot for a decade and had accumulated more than 6,400 flight hours, including 317 hours flying as captain of Embraer ERJ-145 and ERJ-135 jet aircraft for American Eagle Airlines. Paladino had also served as first officer for American Airlines, flying MD-82 and MD-83 jet aircraft between the U.S. and Canada. Both pilots were legally qualified to fly the Embraer Legacy as captain.

The five passengers consisted of two Embraer employees, two ExcelAire executives, and *The New York Times* business travel columnist Joe Sharkey, who was writing a special report for *Business Jet Traveler*.

Collision

Approximate flight paths from flight origins to crash site Boeing southeast bound Embraer northwest bound

Just before 17:00 BST, the Boeing airliner and the Embraer business jet collided in mid-air at 37,000 feet (11,000 m), approximately midway between Brasilia and Manaus, near the town of Matupá, 750 kilometers (470 mi) southeast of Manaus.

The Boeing suffered major structural damage, losing nearly half of its left wing. This caused it to nosedive and enter an uncontrollable spin, which quickly led to an in-flight breakup and crash into an area of dense rainforest, 200 kilometres (120 mi) east of the municipality of Peixoto de Azevedo. All 154 passengers and crew on board were killed and the aircraft was destroyed, with the wreckage scattered in pieces around the crash site.

The Embraer jet, despite serious damage to the left horizontal stabilizer and left winglet, was able to continue flying, though its autopilot disengaged and it required an unusual amount of force on the yoke to keep the wings level.

With radio relay assistance from Polar Air Cargo Flight 71, a Boeing 747 cargo aircraft flying in the area at the time, the Embraer's crew successfully landed the crippled jet at the Cachimbo Air Base (Campo de Provas Brigadeiro Velloso), a Brazilian Air Force (BAF) base about 160 kilometers (100 mi) from the collision point.

Passenger and journalist Joe Sharkey described his experience aboard the Embraer in an article for *The New York Times*, titled "Colliding With Death at 37,000 Feet, and Living", filed on October 1, 2006:

And it had been a nice ride. Minutes before we were hit, I had wandered up to the cockpit to chat with the pilots, who said the plane was flying beautifully. I saw the readout that showed our altitude: 37,000 feet. I returned to my seat. Minutes later came the strike (it sheared off part of the plane's tail, too, we later learned).

Detention and charging of Embraer crew

Damage to the Legacy's left side

The undamaged right side of the Legacy, for comparison

Immediately after the Embraer's emergency landing at the Cachimbo air base, BAF and Agência Nacional de Aviação Civil (ANAC) officials detained and interviewed its flight crew. The officials also removed the two "black boxes"—Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR)—from the Embraer, and sent them to São José dos Campos, São Paulo, and from there to Ottawa, Canada for analysis.

In an initial deposition, the Embraer flight crew testified that they were cleared to flight level 370, approximately 37,000 feet (11,000 m) above mean sea level, by Brasilia ATC, and were level at that assigned altitude when the collision occurred. They also asserted that at the time of the collision they had lost contact with Brasilia ATC, and their anti-collision system did not alert them to any oncoming traffic.

On October 2, the Embraer's captain and first officer were ordered by the Mato Grosso Justice Tribunal to surrender their passports pending further investigation. The request, made by the Peixoto de Azevedo prosecutor, was granted by judge Tiago Sousa Nogueira e Abreu, who stated that the possibility of pilot error on the part of the Embraer crew could not be ruled out. The Embraer crew were forced to remain in Brazil until their passports were released to them on December 5, 2006, more than two months after the accident, after federal judge Candido Ribeiro ruled there were no legal grounds for "restricting the freedom of motion of the foreigners."

Prior to their scheduled departure to the United States, the crew were formally charged by Brazilian Federal Police with "endangering an aircraft", which carries a penalty of up to twelve years in prison. Former Justice Minister Jose Carlos Dias, who was acting as a lawyer for the Embraer's crew, criticized the charges against them as being "biased" and "discriminatory". The two pilots were allowed to leave the country after signing a document promising to return to Brazil for their trial or when required by Brazilian authorities. They picked up their passports and flew back to the United States.

Search and recovery operation

The Boeing's Flight Data Recorder

The Brazilian Air Force sent five fixed-wing aircraft and three helicopters to the region for an extensive search and rescue (SAR) operation. As many as 200 personnel were reported to be involved in the operation, among them a group of Kayapo people familiar with the forest. The crash site of Gol Flight 1907 was spotted on September 30 by the BAF, at coordinates 10°29′S 53°15′W / 10.483°S 53.25°WCoordinates: 10°29′S 53°15′W / 10.483°S 53.25°W, 200 km (120 mi) east of Peixoto de Azevedo, near Fazenda Jarinã, a cattle ranch. It was reported that rescue personnel had difficulty reaching the crash site due to the dense forest. The Brazilian airport administrator Infraero at first indicated the possibility of five survivors, but a later statement from the Brazilian Air Force, based on data collected by BAF personnel who rappelled (abseiled) to the crash site and local police who assisted in the SAR effort, confirmed that there were no survivors. Brazilian President Luiz Inácio Lula da Silva declared three days of national mourning.

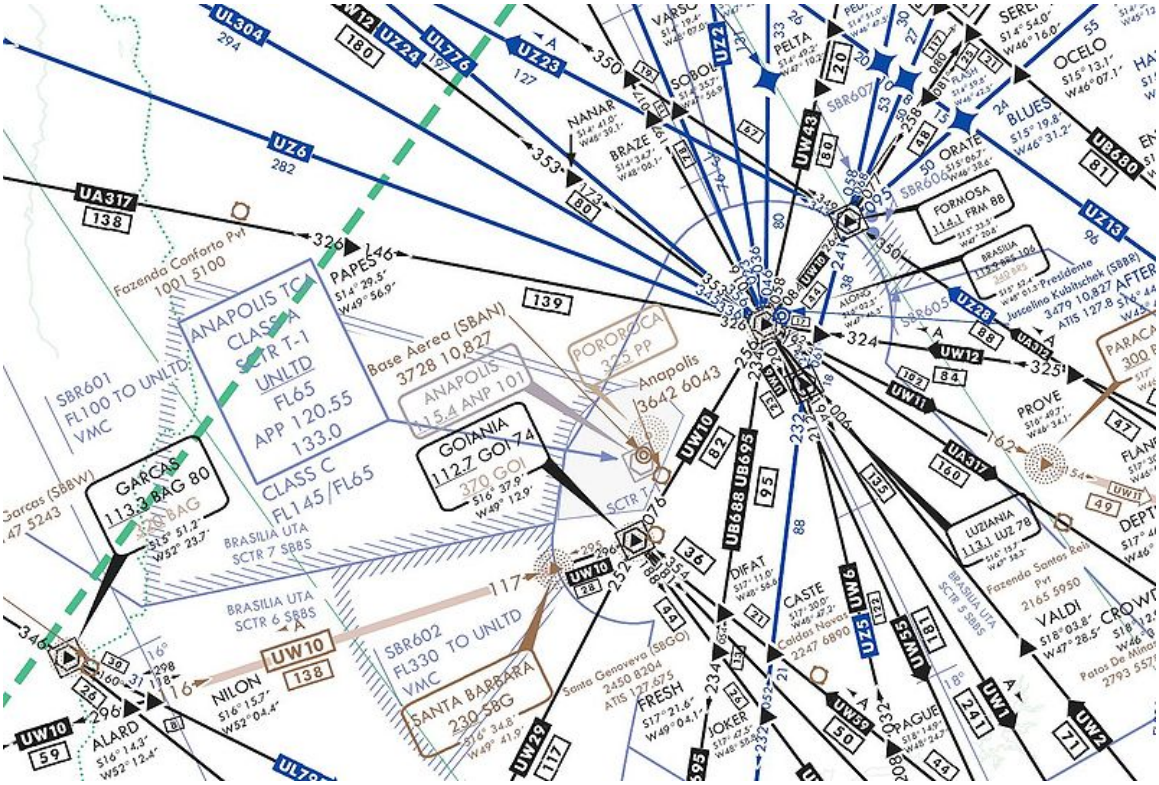
The Boeing's CVR memory module was found embedded in the soil, after four weeks of intensive searching by 200 Army troops.

The Flight Data Recorder and a non-data part of the Cockpit Voice Recorder from the Boeing 737 were found on October 2, 2006 and handed over to the investigators, who sent them to the Transportation Safety Board of Canada (TSB) in Gatineau, Quebec, Canada for analysis. On October 25, 2006, after nearly four weeks of intensive searching in the jungle by about 200 Brazilian Army troops equipped with metal detectors, the memory module of the Boeing's Cockpit Voice Recorder was finally found. The module was discovered intact, separated from other wreckage pieces, embedded in about 20 centimetres (8 in) of soil, and was also sent for analysis by the TSB in Canada.

On October 4, the recovery crews began moving the bodies to the temporary base established at the nearby Jarinã ranch. The BAF deployed a C-115 Buffalo aircraft to transport the bodies to Brasília for identification.

The recovery teams worked intensively for nearly seven weeks in a dense jungle environment, searching for and identifying the victims' remains. The final victim was recovered and identified by DNA testing by November 22, 2006.

Investigation



IFR high altitude en route chart section of Brasilia area, depicting UW2, UZ6 airways

The accident was investigated by the Brazilian Air Force CENIPA and the U.S. NTSB. The NTSB, in accordance with the provisions of ICAO Annex 13, participated in the investigation representing the state of manufacture of the Boeing, state of registry and operator of the Embraer, and state of manufacture of the Honeywell avionics equipment installed in both planes.

Once the black boxes and communication transcripts were obtained, the investigators interviewed the Embraer's flight crew and the air traffic controllers, trying to piece together the scenario which allowed two modern jet aircraft, equipped with the latest anti-collision gear, to collide with each other while on instrument flights in positive control airspace.

The Embraer's flight plan consisted of flying at FL370 up to Brasilia, on airway UW2, followed by a planned descent at Brasilia to FL360, proceeding outbound from Brasilia northwest-bound along airway UZ6 to the Teres fix, an aeronautical waypoint located 282 nm (324 mi, 522 km) northwest of Brasilia, where a climb to FL380 was planned. According to the filed flight plan, the Embraer was scheduled to have been level at FL380, proceeding towards Manaus, while passing the eventual collision point, which was about 307 kilometres (191 mi) northwest of Teres.

The Embraer's crew asserted in their depositions and subsequent interviews that they were cleared by air traffic control (ATC) to FL370 for the entire trip, all the way to Manaus. The actual transcript of the clearance given to the Embraer's crew prior to takeoff at São José dos Campos at 14:41:57 BST, as later released by CENIPA, was:

November Six Zero Zero X-ray Lima, ATC clearance to Eduardo Gomes, flight level three seven zero direct Poços de Caldas, squawk transponder code four five seven four, after take-off perform Oren departure.

The Embraer's crew's altitude clearance to FL370 was further confirmed after their handoff to Brasilia, during which they had the following radio exchange with ATC at 15:51 BST:

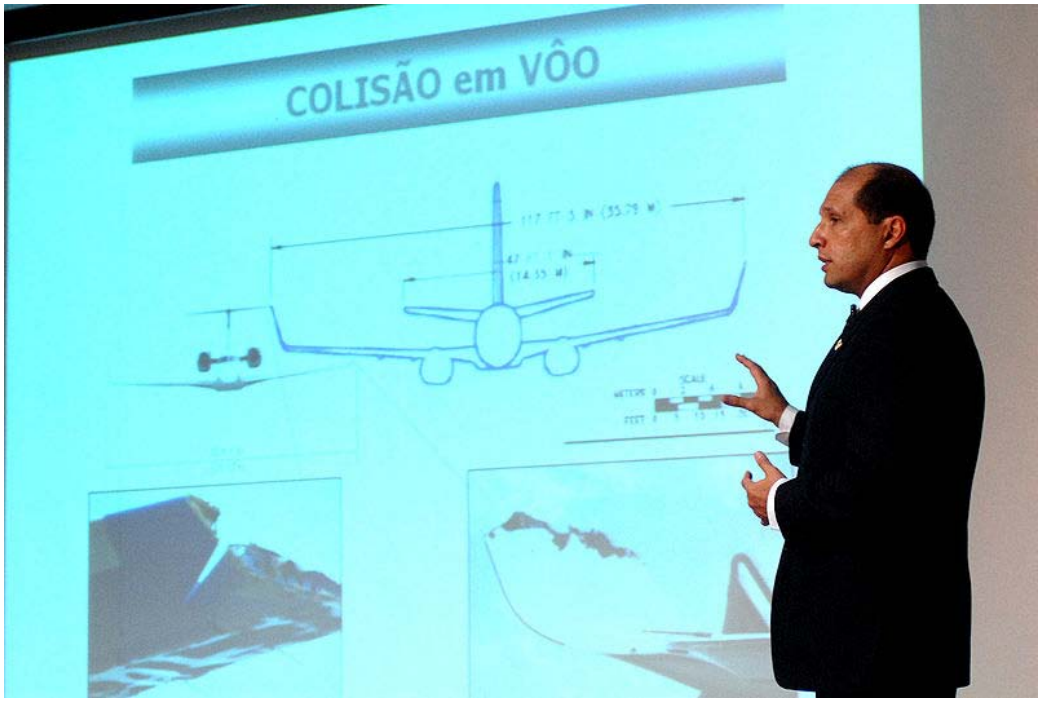
N600XL: *Brasilia, November six hundred X-ray Lima, level... flight level three seven zero, good afternoon.*

ATC: *November six zero zero X-ray Lima, squawk ident, radar surveillance.*

N600XL: *Roger.*

This was the last two-way radio communication between the Embraer's crew and ATC prior to the collision.

Embraer flight and communication sequence



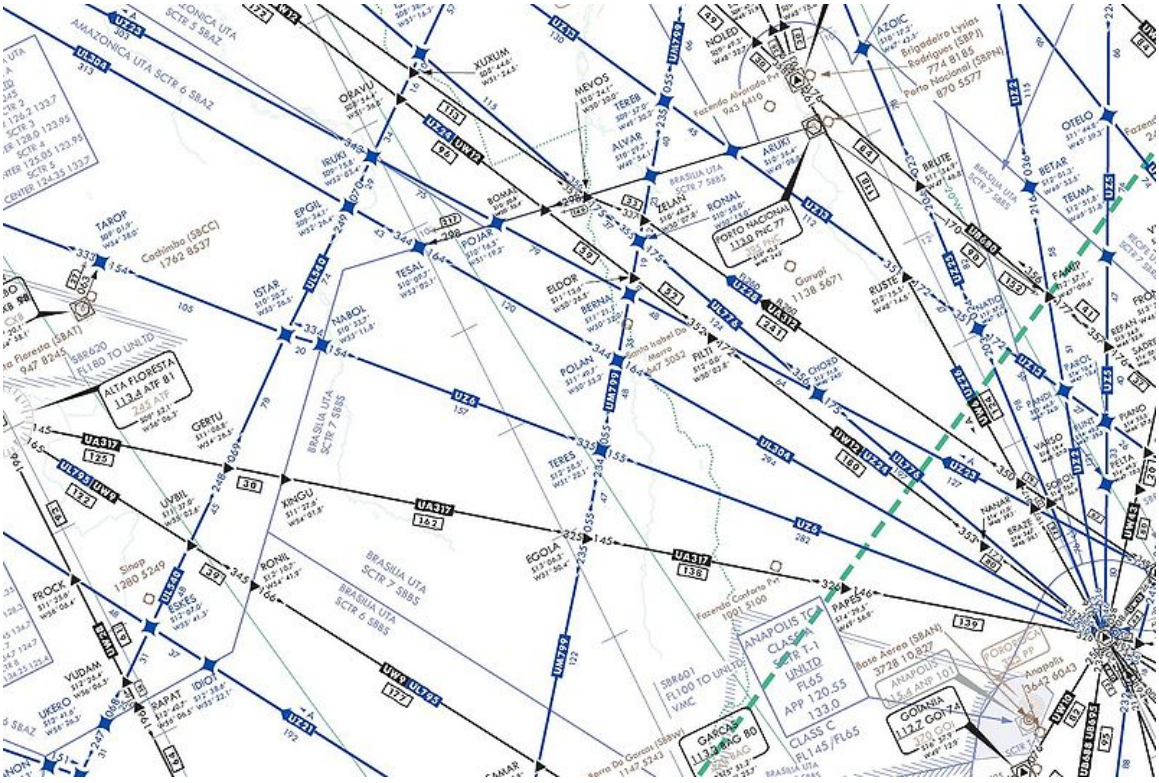
Investigation committee president Col. Rufino Antônio da Silva Ferreira presents the preliminary findings on November 16, 2006.

The Embraer took off from São José dos Campos at 14:51, reaching FL370 at 15:33, 42 minutes later, where it remained until the collision.

ATC maintained normal two-way radio contact with the Embraer up until 15:51, when the last successful radio exchange with the Embraer was made on VHF frequency 125.05 MHz with Brasilia Center. At that point the Embraer was just approaching the Brasilia VOR. The Embraer overflew the Brasilia VOR at 15:55, four minutes later, and proceeded northwest-bound along UZ6. At 16:02, seven minutes after crossing the Brasilia VOR, secondary radar contact was lost with the Embraer, thus stopping the display of the Embraer's reported altitude (Mode C) on the controller's radar screen.

No attempt was made by either the Embraer or Brasilia Center to contact each other from 15:51 until 16:26 when, 24 minutes after the loss of secondary radar contact, Brasilia Center called the Embraer and received no reply.

Brasilia Center then unsuccessfully attempted to contact the Embraer six more times, between 16:30 and 16:34. At 16:30 the Embraer's primary radar target became intermittent, and disappeared completely from the radar screen by 16:38, eight minutes later. Brasilia Center unsuccessfully attempted to effect a handoff of the Embraer to Amazonic Center at 16:53, by calling the Embraer in the blind.



IFR high altitude en route chart section of Teres fix area, depicting UZ6 airway and Cachimbo airbase; crash site is between Nabol and Istar fixes on UZ6

The Embraer, on the other hand, started calling Brasilia Center, also unsuccessfully, from 16:48 and continued with twelve more unsuccessful attempts until 16:53. Some limited contact was made at that point, but the Embraer was unable to copy the Amazonic Center frequencies. The Embraer then continued its attempts to reach Brasilia Center, seven more times until the collision.

The collision occurred at 16:56:54 BST at FL370, and it was confirmed that neither Traffic Collision Avoidance System (TCAS) system had activated or alerted its respective crew, nor did any crew see the oncoming traffic visually or initiate any evasive action prior to the collision. While both planes were equipped with TCAS, it was later determined that the Embraer's transponder had ceased operating almost an hour earlier, at 16:02, rendering both planes unable to automatically detect each other.

At 16:59:50, about three minutes after the collision, Amazonic Center started to receive the Embraer's secondary radar reply, with its correct altitude and last assigned code. At 17:00:30 Amazonic Center unsuccessfully attempted to contact the Embraer by radio.

Polar 71, a Boeing 747 cargo aircraft similar to the one depicted, provided radio relay and translation assistance to the crippled Embraer jet.

The Embraer started calling on the emergency frequency, 121.5 MHz, immediately after the collision, but as it was later determined in the CENIPA report, the emergency

transceivers in the area were not operational and thus the crew was unable to reach ATC on that frequency.

At 17:01:06 the Embraer established contact on the emergency frequency with a Boeing 747 cargo aircraft, Polar 71, which attempted to relay to ATC their request for an emergency landing, and continued to provide relay and translation assistance to the Embraer until its eventual landing.

At 17:18:03 the Embraer contacted the Cachimbo air base (SBCC) tower directly to coordinate its emergency landing there, and landed safely at Cachimbo at 17:23:00.

Gol 1907 flight and communication sequence

Gol 1907 took off from Manaus at 15:35, flying southeast-bound along UZ6 and reaching FL370 at 15:58, 23 minutes later, where it remained until the collision. There were no radio or radar contact problems with the flight until its handoff to Brasilia Center. There were no known attempts by ATC to warn Flight 1907 of the conflicting traffic.

NTSB Safety Recommendation

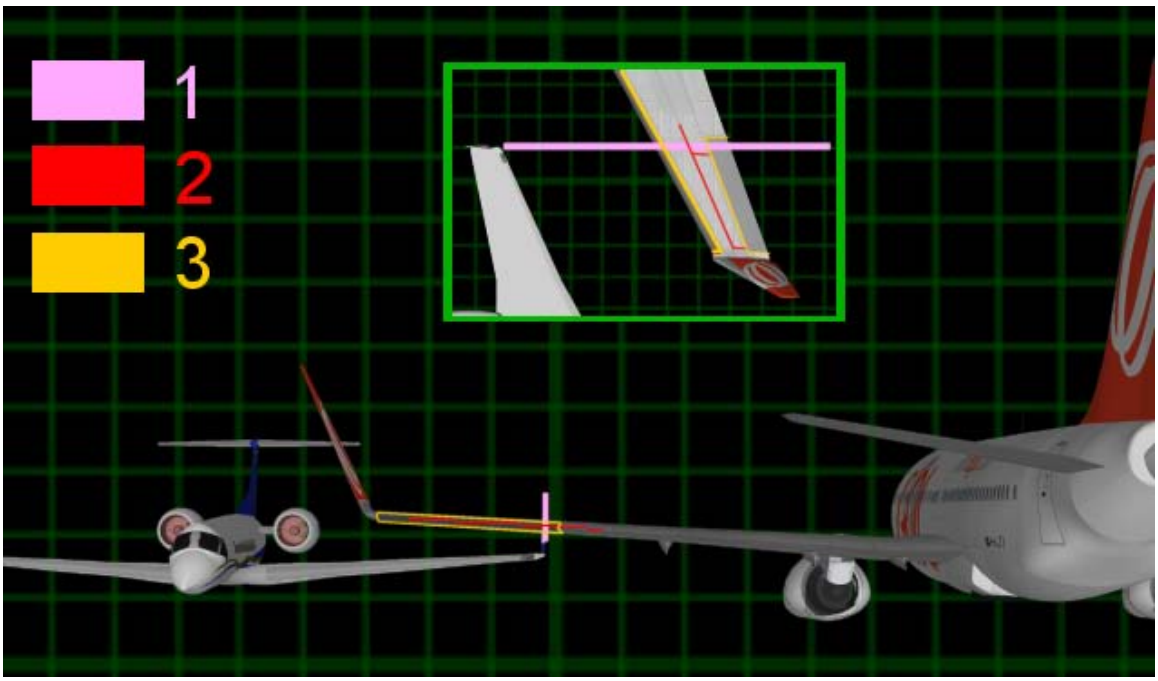


Diagram of impact. 1. Impact, 2. Hydraulic lines, 3. Control surfaces

On May 2, 2007 the National Transportation Safety Board (NTSB) issued a Safety Recommendation document that included an interim summary of the investigation to date, as well as some immediate safety recommendations that the NTSB believes should be implemented by the U.S. Federal Aviation Authority (FAA) to enhance flight safety. The NTSB reported that the Embraer apparently experienced a Traffic Collision

Avoidance System (TCAS) outage, unbeknownst to its flight crew prior to the collision, according to the Cockpit Voice Recorder (CVR):

Preliminary findings in the ongoing investigation indicate that, for reasons yet to be determined, the collision avoidance system in the Legacy airplane was not functioning at the time of the accident, thereby disabling the system's ability to detect and be detected by conflicting traffic. In addition, CVR data indicate that the flight crew was unaware that the collision avoidance system was not functioning until after the accident.

The NTSB added that the design of the Embraer's avionics is such that the non-functioning of the TCAS that apparently occurred is annunciated by a small static white text message, which may not be noticeable by the flight crew. The NTSB noted:

Using only static text messages to indicate a loss of collision avoidance system functionality is not a reliable means to capture pilots' attention because these visual warnings can be easily overlooked if pilots' attention is directed elsewhere in the flight environment.

Based on its observations, the NTSB recommended to the FAA that design changes be implemented to improve the noticeability of TCAS annunciation, and that the FAA advise pilots of all aircraft to become more familiar with the details of this accident, potential loss of transponder and/or TCAS function, and how to recognize them.

Final reports

CENIPA

Relatives of Gol 1907 victims react to presentation of CENIPA's final report in Brasilia.

On December 10, 2008, more than two years after the accident, Centro de Investigação e Prevenção de Acidentes Aeronáuticos (CENIPA) issued its final report, describing its investigation, findings, conclusions and recommendations. The CENIPA report includes a "Conclusions" section that summarizes the known facts and lists a variety of contributing factors relating to both air traffic controllers and the Embraer's flight crew. According to CENIPA, the air traffic controllers contributed to the accident by originally issuing an improper clearance to the Embraer, and not catching or correcting the mistake during the subsequent handoff to Brasilia Center or later on. CENIPA also found errors in the way the controllers handled the loss of radar and radio contact with the Embraer.

CENIPA concluded that the Embraer pilots also contributed to the accident with, among others, their failure to recognize that their transponder was inadvertently switched off, thereby disabling the collision avoidance system on both aircraft, as well as their overall insufficient training and preparation.

NTSB

The U.S. NTSB issued its own report on the accident, which was also appended to the CENIPA report with the following Probable Cause statement:

The evidence collected during this investigation strongly supports the conclusion that this accident was caused by N600XL and GLO1907 following ATC clearances which directed them to operate in opposite directions on the same airway at the same altitude resulting in a midair collision. The loss of effective air traffic control was not the result of a single error, but of a combination of numerous individual and institutional ATC factors, which reflected systemic shortcomings in emphasis on positive air traffic control concepts.

The NTSB further added the following contributing factors:

Contributing to this accident was the undetected loss of functionality of the airborne collision avoidance system technology as a result of the inadvertent inactivation of the transponder on board N600XL. Further contributing to the accident was inadequate communication between ATC and the N600XL flight crew.

Conflicting CENIPA and NTSB conclusions

While agreeing on most basic facts and findings, CENIPA and NTSB, which collaborated in the accident investigation, arrived at disagreeing interpretations and conclusions. The CENIPA report concludes the accident was caused by mistakes made both by air traffic controllers and by the Embraer pilots, whereas the NTSB focuses on the controllers and the ATC system, concluding that both flight crews acted properly but were placed on a collision course by the air traffic controllers.

According to *Aviation Week*, "the U.S. National Transportation Safety Board (NTSB) strongly disagreed with the Brazilian conclusions regarding the Legacy pilots' actions as a causal factor, noting, 'The crew flew the route precisely as cleared and complied with all ATC instructions,' as did the GOL airlines crew." *Aviation Week* adds that "the Brazilian military operates that country's air traffic control system, conducted the investigation and authored the report."

Aftermath

Aviation crisis

Passengers at Brasília International Airport inquiring about delayed flights.

The crash of Flight 1907 precipitated a major crisis of Brazil's civil aviation system, which included massive flight delays and cancellations, air traffic controller work-to-rule slowdowns and strikes, and public safety concerns about Brazil's airport and air traffic infrastructure.

Historically, Brazil was ruled by its armed forces from 1964 until 1985. Since then, a civilian government has taken over, but the country's airways are still (as of 2009) controlled and operated by the Brazilian Air Force (BAF) and run by generals, overseen by a civilian defense minister. Most of Brazil's air traffic controllers are military non-commissioned officers, and all Area Control Centers are run by the BAF.

In October 2006, as details surrounding the crash of Flight 1907 began to emerge, the investigation seemed to be at least partly focused on possible air traffic control errors. This led to increasing resentment by the controllers and exacerbated their already poor labor relations with their military superiors. The controllers complained about being overworked, underpaid, overstressed, and forced to work with outdated equipment. Many have poor English skills, limiting their ability to communicate with foreign pilots, which played a role in crash of Flight 1907. In addition, the military's complete control of the country's aviation was criticized for its lack of public accountability.

Amid rising tensions, the air traffic controllers began staging a series of work actions, including slowdowns, walkouts, and even a hunger strike. This led to chaos in Brazil's aviation industry: major delays and disruptions in domestic and international air service, stranded passengers, canceled flights, and public demonstrations. Those who blamed various civilian and military officials for the growing crisis called for their resignation.

On July 26, 2007, after an even deadlier crash in Brazil—TAM Airlines Flight 3054—claimed the lives of 199 people, President Luiz Inácio Lula da Silva fired his defense minister, Waldir Pires, who had been in charge of the country's aviation infrastructure and safety since March 2006, and was widely criticized for their failures. On the same day, Lula appointed former Supreme Court president Nelson Jobim to replace Pires, and has vowed to improve Brazil's air traffic control system.

Legal action

Civil litigation

On November 6, 2006, the families of ten of the deceased filed a lawsuit for negligence against ExcelAire and Honeywell, alleging that the Embraer pilots were flying at an "incorrect altitude" and that the Honeywell transponder was not functioning at the time of the collision. Other suits were subsequently filed on behalf of other victims, with similar allegations against ExcelAire and Honeywell. The victims' families also filed suits against other U.S. based defendants, including the two Embraer pilots, as well as Raytheon, Lockheed Martin and Amazon Tech (manufacturers of Brazil's air traffic control equipment), and ACSS (manufacturer of the Embraer's TCAS).

The attorney representing the Embraer crew, Miami-based Robert Torricella, responded to the allegation that the crew was flying at an "incorrect altitude" by stating that according to international regulations, clearances and directives issued by ATC supersede a previously filed flight plan, and in this case:

... the flight plan cleared by air traffic control at the time of departure required the Embraer to fly all the way to Manaus at 37,000 feet and, absent contrary directives from air traffic control, the Embraer was obligated to follow its cleared flight plan. As the findings of the investigation are made public, we are confident that ExcelAire's pilots will be exonerated.

A Honeywell spokesperson stated that "Honeywell is not aware of any evidence that indicates that its transponder on the Embraer Legacy was not functioning as designed or that Honeywell was responsible for the accident."

On July 2, 2008, U.S. District Court judge Brian Cogan of the Eastern District of New York dismissed the families' suits against all the U.S. based defendants under the premise of *forum non conveniens*. Without ruling on the merits of the cases, and while allowing discovery to continue, Cogan recommended the Brazilian court system as a more appropriate jurisdiction for the dispute.

Criminal proceedings

On June 1, 2007, Brazilian federal judge Murilo Mendes indicted the two Embraer pilots and four Brasilia-based air traffic controllers for their alleged roles in the accident. Mendes, a judge in the small city of Sinop, Mato Grosso, near the crash site of the Boeing, ruled that the two pilots and four controllers should be charged with "exposing an aircraft to danger."

On December 8, 2008, Mendes dismissed charges of negligence against the pilots, but left in place a charge of "imprudence". He also dismissed all charges against two of the four Brasilia-based controllers and reduced the charges against the other two, but supported bringing new charges against a fifth controller, based in São José dos Campos, the Embraer's departure point.

On January 12, 2010, Mendes's ruling was overturned by judge Candido Ribeiro in a federal court in Brasilia, reinstating the negligence charges against the pilots. The pilots may appeal this latest ruling.

Dramatization

Discovery Channel Brazil aired *A Tragédia do Vôo 1907* ("The Tragedy of Flight 1907"), a documentary about the disaster. In 2007 some family members of the Gol 1907 victims stated that they believed the documentary exhibited bias.

The crash was the subject of a Season 5 Episode of *Mayday* (also known as *Air Crash Investigation*) entitled *Phantom Strike* (also titled *Death Over the Amazon* and *Radio Silence*).

Chapter 7

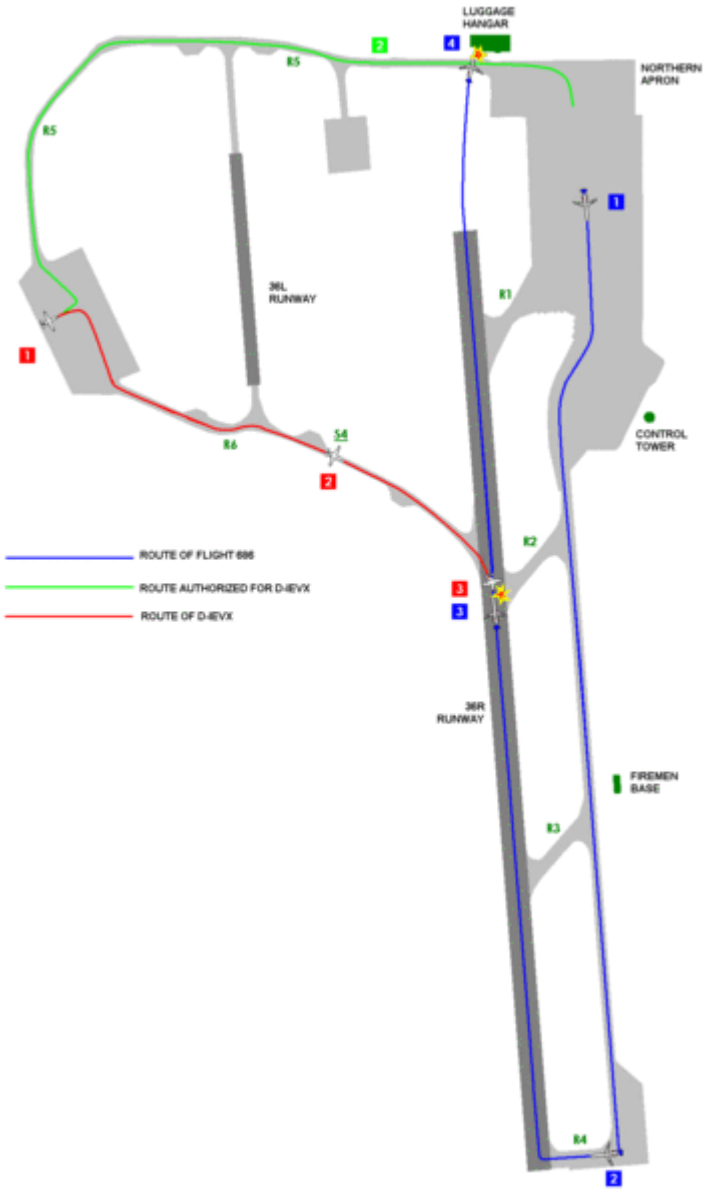
Linate Airport Disaster

Linate Airport disaster	
Accident summary	
Date	8 October 2001
Type	Runway collision
Site	Linate Airport Milan, Italy
Total injuries	4 (all on ground)
Total fatalities	118 (including 4 on ground)
First aircraft	
Type	McDonnell-Douglas MD-87
Name	*Lage Viking*
Operator	SAS
Tail number	SE-DMA
Passengers	104
Crew	6
Survivors	0
Second aircraft	
Type	Cessna Citation II
Operator	Private
Tail number	D-IEVX
Passengers	2
Crew	2

Survivors 0

The **Linate Airport disaster** occurred on 8 October 2001 at Linate Airport in Milan, Italy, when **Scandinavian Airlines Flight 686**, a McDonnell Douglas MD-87 airliner carrying 110 people bound for Copenhagen, Denmark, collided on take-off with a Cessna Citation II business jet carrying four people bound for Paris, France. All 114 people on board the two aircraft were killed, as were four on the ground. A further four people on the ground were injured.

Accident



Reconstruction of the disaster

An SAS MD-87 similar to SE-DMA *Lage Viking*

A Cessna Citation

The accident occurred in thick fog, with visibility reduced to less than 200 metres (656 ft).

The Cessna Citation was instructed to taxi from the western apron along the northern taxiway (taxiway R5), and then via the northern apron to the main taxiway which runs parallel to the main runway, a route that would have kept it clear of the main runway. Instead, the pilot taxied along the ***southern*** taxi route (taxiway R6), crossing the main runway toward the main taxiway which lay beyond it.

At 08:09:28, the SAS MD-87 was given clearance by a different controller to take off from runway 36R. 53 seconds later, the SAS aircraft, traveling at about 270 kilometres

per hour (150 kn; 170 mph), collided with the Cessna. All four in the Cessna were killed on impact. The MD-87 lost its right engine; the pilot, Joakim Gustafsson from Sweden, attempted to take off, reaching an altitude of approximately 12 metres (39 ft). The remaining engine lost some thrust due to debris ingestion, and the plane, having lost the starboard landing gear, came down. Gustafsson applied thrust reverser and brakes, and tried to guide the plane through its control surfaces. The maneuver was judged so skillful that it is now incorporated into SAS technical manuals. All this was, however, insufficient to halt the jet's momentum, and it crashed into a luggage hangar located near the runway's end, at a speed of approximately 251 kilometres per hour (136 kn; 156 mph). In the impact, all the MD-87's crew and passengers were killed. The crash and subsequent fire killed four Italian ground personnel in the hangar, and injured four more.

Of the occupants of the SAS aircraft, 54 (46%), mainly in the back of the aircraft, suffered severe burns; their bodies were identified using Forensic dentistry or DNA records. Those in the front of the aircraft suffered severe blunt trauma.

Causes

The accident occurred less than a month after the 11 September 2001 attacks and the day after the U.S. invasion of Afghanistan began, but SAS was quick to rule out a terrorist attack as the cause. This was subsequently confirmed by the investigations that followed.

The accident was investigated by the Agenzia Nazionale per la Sicurezza del Volo (ANSV, the italian equivalent of american NTSB). Its final report was published on January 20, 2004, and concluded that the "immediate cause" of the accident was the incursion of the Cessna aircraft on to the active runway. However, the ANSV stopped short of placing the blame unequivocally on the Cessna pilots, its report having identified a number of deficiencies in the airport layout and procedures.

Linate Airport was operating without a functioning ground radar system at the time, despite having had a system delivered some years beforehand, which had not been fully installed. The new system finally came online a few months later. Guidance signs along the taxiways were later found not to meet regulations; after mistakenly turning onto the R6 taxiway that led to the runway, there were no signs by which the Cessna pilots could recognize where they were. When they stopped at a taxiway stop-marking and correctly reported its identifier (S4), the ground controller disregarded this identification because it was not on his maps and was unknown to him. Furthermore, neither pilot of D-IEVX was certified for landings with visibility less than 550 metres (1,804 ft), but had landed at the airport anyway a few minutes before the disaster.

On 16 April 2004, a Milan court found four persons guilty for the disaster. Airport director Vincenzo Fusco and air-traffic controller Paolo Zacchetti were both sentenced to eight years in prison; sentences of six and a half years were given to Sandro Gualano, former head of the air traffic controllers' agency, and Francesco Federico, former head of the airport. In the appeal trial (July 7, 2006), Fusco and Federico were discharged. Another four people were sentenced. The pardon law issued by the Italian Parliament on

July 29, 2006 reduced all convictions by three years. On 20 February 2007 the Corte di Cassazione upheld the decision of the Appeal Court.

Victims

Nationality	SAS 686		Cessna		Ground	Total
	Passengers	Crew	Passengers	Crew		
Denmark	16	3	—	—	—	19
Finland	6	–	—	—	—	6
Germany	—	—	—	2	—	2
Italy	58	—	2	—	4	64
Norway	3	—	—	—	—	3
Romania	1	—	—	—	—	1
South Africa	1	—	—	—	—	1
Sweden	17	3	—	—	—	20
United Kingdom	2	—	—	—	—	2
Total	**104**	**6**	**2**	**2**	**4**	**118**

The victims included nationals of nine different countries. Most of the victims were Italian and Scandinavian. One passenger listed as a Briton by SAS held United Kingdom and United States citizenships.

The *Bosco dei Faggi*.

Four memorial services were held in honor of the SAS victims. On 12 October 2001 three separate ceremonies were held, with one in Denmark, one in Norway, and one in Sweden. On 13 October 2001 a fourth ceremony was held in Italy.

In March 2002 a forest containing 118 beeches called *Bosco dei Faggi* was inaugurated as a memorial to the victims in the Forlanini Park near the airport. A sculpture by the Swedish artist Christer Bording donated by SAS, called *Infinity Pain*, was placed in the centre of the forest.

The disaster devastated the Swedish go-kart community as some of the country's most promising young drivers were on the flight after having attended an event in Milan. After the disaster, the Swedish national motorsports club started a memorial fund together with some of the relatives. The fund awards annual stipends to promising Swedish youth in go-kart.

Chapter 8

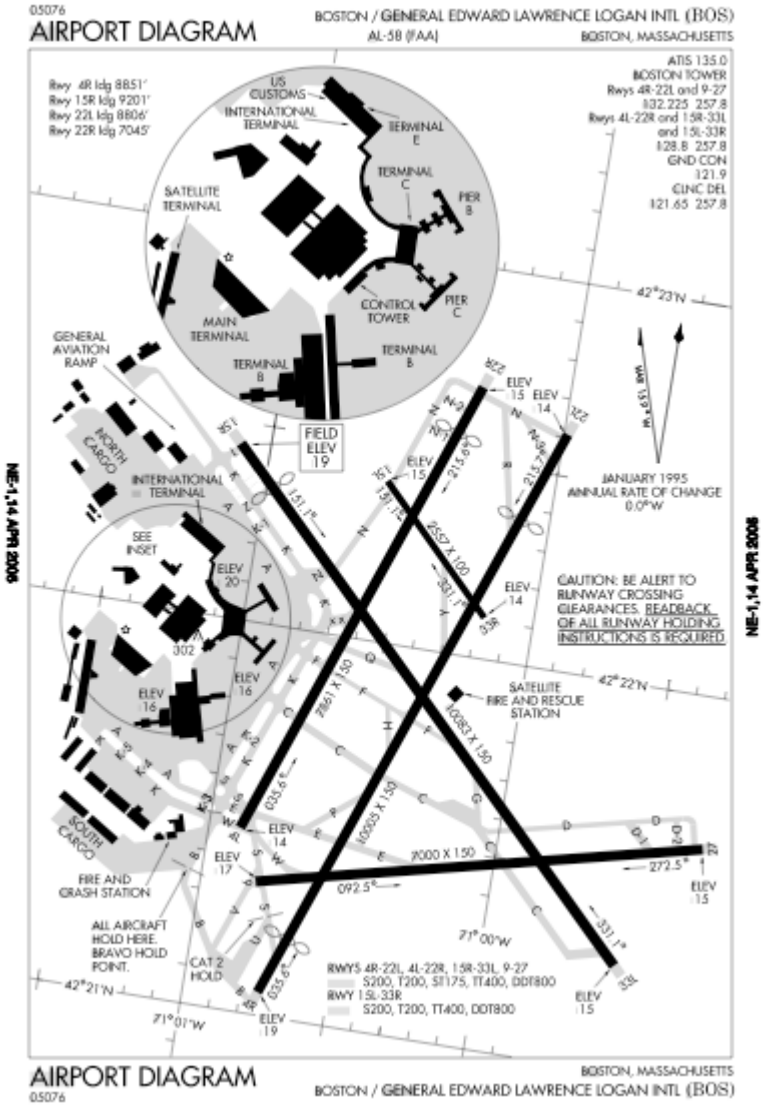
2005 Logan Airport Runway Incursion

2005 Logan Airport runway incursion	
Incident summary	
Date	June 9, 2005
Type	ATC error, near miss
Site	Logan International Airport Boston, Massachusetts, USA
Total injuries	0
Total fatalities	0
First aircraft	
Type	Airbus A330-300
Name	*St Maeve*
Operator	Aer Lingus
Tail number	EI-ORD
Destination	Shannon Airport Shannon, Ireland
Passengers	260
Crew	12
Second aircraft	
Type	Boeing 737-300
Operator	US Airways
Tail number	N394US

Destination	Philadelphia Int'l Airport Philadelphia, Pennsylvania
Passengers	103
Crew	6

The **2005 Logan Airport runway incursion** was a near runway collision that occurred at approximately 7:40 p.m. Eastern Daylight Time on 9 June 2005 between **US Airways Flight 1170** (US1170) and **Aer Lingus Flight 132** (EI132). EI132 was an Airbus A330-300 aircraft, owned and operated by the Irish airline Aer Lingus, destined for Shannon, Ireland and carrying 12 crew members and 260 passengers. US1170 was a Boeing 737-300 aircraft owned and operated by US Airways, destined for Philadelphia, Pennsylvania and carrying 6 crew members and 103 passengers. The near collision took place on the runway at General Edward Lawrence Logan International Airport (BOS), in Boston, Massachusetts. Collectively, there were a total of 381 people on board the two aircraft.

Incident



Runway layout at Logan Airport at the time of the incident. Runway 15R runs from top left to bottom right, whilst runway 9 runs from lower center to mid-right

To reduce radio congestion and consequences resulting from pilot or controller error, airports with a large number of operations will typically split the tower (local) controller into two or more positions. This was the case that evening when each of the incident flights were the responsibility of different controllers. The local control west controller was responsible for Aer Lingus flight 132 and the local control east controller was responsible for US Airways flight 1170.

At 19:39:10, Aer Lingus flight 132 was cleared for takeoff from runway 15R by local control west. Five seconds later, local control east cleared US Airways flight 1170 for

takeoff from runway 9 which intersects with runway 15R; the aircraft had essentially been sent on a collision course. With the airport terminals between the two aircraft as the takeoffs began, the flight crews could not initially see each other.

An Aer Lingus Airbus A330 similar to the one involved in the incident.

A US Airways Boeing 737-300 similar to the one involved.

During the take-off roll, the US Airways first officer noticed the other plane and realized that they could collide. He realized that at the runway intersection both aircraft would be slightly airborne. Asking the Captain to "Keep it down", he pushed the control column forward. In this way he was able to keep US Airways 1170 from lifting off the runway, allowing it to reach the intersection and pass under the other aircraft as it took off. The two planes passed within an estimated 170 feet (52 m) of each other, with the Aer Lingus aircraft flying over the US Airways aircraft. Since (according to the NTSB report) the US Airways flight had already achieved its V_1 speed and could no longer safely abort takeoff, the flight crew continued down the runway and lifted off after passing through the intersection.

Superior Airmanship Award

US Airways Captain Henry Jones and First Officer Jim Dannahower were later awarded a Superior Airmanship Award from the Air Line Pilots Association (ALPA) for their quick reactions and expert adjustment of their takeoff maneuver.

Probable cause

The NTSB completed its investigation and found that the east tower controller had given the west tower controller permission for the Aer Lingus to depart on 15R. While coordinating other traffic, he forgot about releasing that aircraft and cleared the US

Airways for takeoff. Local procedures required the east controller to wait until the departure on 15R had passed through the intersection before clearing the aircraft on runway 9 for takeoff. The NTSB reported that the probable cause of the incident was that the east local controller failed to follow FAA Order 7110.65 and local procedures which resulted in a runway incursion.

After the incident, the Boston tower changed its procedures so that only the west local controller may initiate a departure on the crossing runway 15R, and that once the east controllers accepts the release the aircraft must be cleared for takeoff within five seconds. Further, to reduce the chance of this type of incident happening again, aircraft must not be held on runway 9 waiting for their takeoff clearance while there is a departure on 15R. Once the departure has cleared the intersection, local west must inform the east controller that the intersection has been cleared.

Chapter 9

Tenerife Airport Disaster

Tenerife disaster
(KLM Flight 4805 and Pan Am Flight 1736)

CGI rendering of KLM Flight 4805 immediately before it collided with Pan Am Flight 1736. Some fog has been removed to give a clearer image of the two aircraft.

Accident summary	
Date	March 27, 1977
Type	Runway incursion, pilot error, ATC error and technical limitations
Site	Los Rodeos Airport (now Tenerife North Airport) Tenerife, Canary Islands
Total fatalities	583
Total survivors	61
First aircraft	

Type	Boeing 747–121
Name	*Clipper Victor*
Operator	Pan American World Airways
Tail number	N736PA
Flight origin	Los Angeles International Airport
Stopover	John F. Kennedy International Airport, New York City, United States
Destination	Gran Canaria Airport,
Passengers	380
Crew	16
Fatalities	335 (326 passengers, 9 crew members)
Survivors	61
Second aircraft	
Type	Boeing 747-206B
Name	*Rijn* ("Rhine")
Operator	KLM
Tail number	PH-BUF
Flight origin	Schiphol Airport, Amsterdam, Netherlands
Destination	Gran Canaria Airport
Passengers	234
Crew	14
Fatalities	248 (all)
Survivors	0 (none)

The **Tenerife airport disaster** in 1977 was a collision involving two Boeing 747 passenger aircraft on the runway of Los Rodeos Airport (now known as Tenerife North Airport) on the Spanish island of Tenerife, one of the Canary Islands. With 583 fatalities, the crash remains the deadliest accident in aviation history. All 248 aboard the fully-fuelled KLM Flight 4805 were killed. There were also 335 fatalities and 61 survivors

from Pan Am Flight 1736, which was struck along its spine by the KLM's landing gear, under-belly and four engines. Rescue crews were unaware for over 20 minutes that the Pan Am aircraft was also involved in the accident, because of the heavy fog and the separation of the crippled aircraft following the collision.

The collision took place on March 27, 1977, at 17:06:56 local time. The aircraft were operating as Pan Am Flight 1736 (the *Clipper Victor*) under the command of Captain Victor Grubbs, and KLM Flight 4805 (the *Rijn*) under the command of Captain Jacob Veldhuyzen van Zanten. Taking off in heavy fog on the airport's only runway, the KLM flight crashed into the top of the Pan Am aircraft backtaxiing in the opposite direction. The Pan Am had followed the backtaxiing of the KLM aircraft, under the direction of air traffic control, and the KLM's flight crew had been aware of Pan Am backtaxiing behind them on the same runway. Despite lack of visual confirmation due to the fog the KLM captain thought that Pan Am had cleared the runway and so attempted to take off without further clearance to do so. Several other key factors contributed to the accident.

Flight history

For both planes, Tenerife was an unscheduled stop. Their destination was Gran Canaria International Airport (also known as Las Palmas Airport), serving Las Palmas on the nearby island of Gran Canaria. Both are in the Canary Islands, an autonomous community of Spain located in the Atlantic Ocean off the west coast of Morocco.

Pan Am Flight 1736 had taken off from Los Angeles International Airport with an intermediate stop at New York's John F. Kennedy International Airport. The aircraft was a Boeing 747–121, registration N736PA. Of the 380 passengers, 14 had boarded in New York, where the crew was also changed. The new crew consisted of Captain Victor Grubbs, First Officer Robert Bragg, and Flight Engineer George Warns; there were 14 other crew members. The same aircraft had operated the inaugural 747 commercial flight on January 22, 1970.

KLM Flight 4805, a charter flight for Holland International Travel Group from the Netherlands, had taken off four hours before from Amsterdam Airport Schiphol. Its captain was Jacob Veldhuyzen van Zanten and the first officer was Klaas Meurs. The aircraft was a Boeing 747-206B, registration PH-BUF. The KLM jet had 14 crew members and 235 passengers, including 48 children and three infants. Most of the KLM passengers were Dutch; four Germans, two Austrians, and two Americans were also on the plane. After the aircraft landed at Tenerife, a Dutch tour guide named Robina van Lanschot, who lived on the island in Puerto de la Cruz and wanted to see her boyfriend that night, chose not to re-board the 747, leaving 234 passengers on board.

Disaster

Bombing at Las Palmas

Events on both planes had been routine until they approached the islands. Then, at 1:15 pm, a terrorist bomb (planted by separatist Fuerzas Armadas Guanches) exploded in the terminal of Gran Canaria International Airport. It had been preceded by a phone call warning of the bomb. The civil aviation authorities closed that airport after the bomb detonated and diverted all of its incoming flights to Los Rodeos, including the two Boeing 747 aircraft involved in the disaster. Upon contacting Gran Canaria airport, the Pan Am flight was informed of the temporary closure. Although the Pan Am crew indicated that they would prefer to circle in a holding pattern until landing clearance was given, the plane was ordered to divert to Los Rodeos, along with the KLM flight. This led to the critical cramped aircraft conditions within the smaller airport.

Congestion at Los Rodeos

In all, at least five large aircraft were diverted to Los Rodeos, a regional airport that could not easily accommodate them. The airport consisted of one runway and one major taxiway parallel to it, as well as several small taxiways connecting the main taxiway and the runway. While waiting for Gran Canaria airport to reopen, the diverted aircraft took up so much space that they were parked on the long taxiway, meaning that it could not be used for taxiing. Instead, departing aircraft would have to taxi along the runway to position themselves for takeoff, a procedure known as a runway backtaxi.

Refuelling

After the threat at Gran Canaria International Airport had been contained, authorities reopened the airport. The Pan Am aircraft was ready to depart, but the KLM plane and a refuelling vehicle obstructed the way to the active runway. The Pan Am aircraft was unable to maneuver around the fueling KLM, reach the runway and depart due to a lack of just 12 ft (3.7 m) of clearance. Captain Van Zanten had decided to fully refuel at Los Rodeos instead of Las Palmas, apparently to save time, but by doing so he added extra weight, greatly retarding liftoff (and accident escape) ability, which proved fatal. The refuelling took about 35 minutes.

Taxiing and weather conditions

Following the tower's instructions, the KLM aircraft was cleared to backtaxi the full length of runway 30 and make a 180° turn to put the aircraft in takeoff position — a difficult maneuver to perform with a 747 on a 45 m (150 ft) wide runway. While KLM 4805 was backtaxiing on runway 30, the controller asked the flight crew to report when it was ready to copy the ATC clearance. Because the flight crew was performing the checklist, copying this clearance was postponed until the aircraft was in takeoff position on Runway 30. During taxiing, the weather deteriorated and low-lying clouds now limited the visual range to about 300 m (1,000 ft). Legal or stipulated threshold for

takeoff was 700 m (2,300 ft) visibility, as noted in the NOVA documentary and relayed by surviving Pan Am co-pilot Robert Bragg.

Shortly afterward, Pan Am 1736 was instructed to also backtaxi, to follow the KLM aircraft down the same runway, to exit the runway by taking the "third exit" on their left and then using the parallel taxiway. Initially the crew was unclear as to whether the controller had told them to take the first or third exit. The crew asked for clarification and the controller responded emphatically by replying: "The third one, sir; one, two, three; third, third one". The crew began the taxi and proceeded to identify the unmarked taxiways using an airport diagram as they reached them.

Based on the chronology of the cockpit voice recorder (CVR) and the distances between the taxiways (and the location of the aircraft at the time of the collision), the crew successfully identified the first two taxiways (C-1 and C-2), but their discussion in the cockpit never indicated that they had sighted the third taxiway (C-3), which they had been instructed to use. There were no markings or signs to identify the runway exits. The Pan Am crew appeared to remain unsure of their position on the runway until the collision, which occurred near the intersection with the fourth taxiway (C-4). Pan Am's lack of visibility and runway exiting confusion probably contributed to its slow taxiing speed, another key factor in the accident.

The angle of the third taxiway would have required the plane to perform a turn of approximately 145°, which would lead counter-productively back toward the still-crowded main apron. At the end of C-3 another 145° turn would have to be made to continue taxiing towards the start of the runway. Taxiway C-4 would have required just two 35° turns. A study carried out by the Air Line Pilots Association after the accident concluded that making the second 145° turn at the end of taxiway C-3 would have been "a practical impossibility", although the Dutch report stated that such a maneuver "could reasonably be performed". The official report from the Spanish authorities did not explain why the controller had instructed the Pan Am aircraft to use the third taxiway, rather than the sensible and easier fourth taxiway.

Communication misunderstandings

Immediately after lining up, the KLM captain advanced the throttles (a standard procedure known as "spin-up", to verify that the engines are operating properly for takeoff) and co-pilot Meurs, surprised by the maneuver, quickly advised the captain that ATC clearance had not yet been given. Captain Van Zanten responded, "I know that. Go ahead, ask." Meurs then radioed the tower that they were "ready for takeoff" and "waiting for our ATC clearance". The KLM crew then received instructions which specified the route that the aircraft was to follow after takeoff. The instructions used the word "takeoff," but did not include an explicit statement that they were cleared for takeoff.

Meurs read the flight clearance back to the controller, completing the readback with the statement "we're now at takeoff" or "we're now, uh, taking off" (the exact wording of his statement was not clear), indicating to the controller that they were beginning their

takeoff roll. Captain Van Zanten interrupted the co-pilot's readback with the comment "We're going". As noted in the NOVA documentary, Meurs chose not to embarrass his superior a second time by stating that they still did not have the proper clearance to take off.

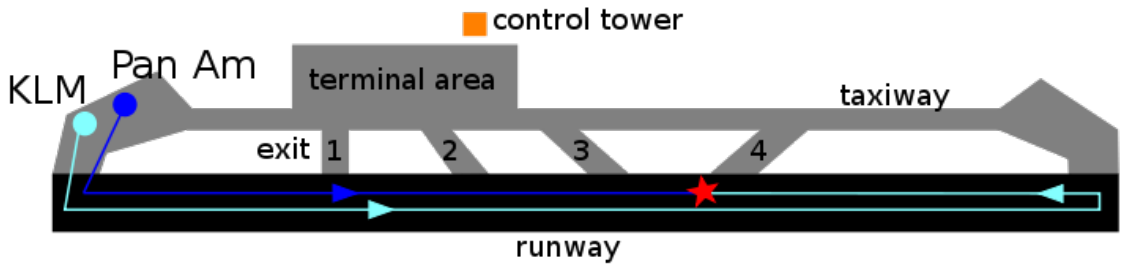
The Spanish controller, who could not see the runway due to the fog, initially responded with "OK" (terminology which is nonstandard), which reinforced the KLM captain's misinterpretation that they had takeoff clearance. The controller's response of "OK" to the co-pilot's nonstandard statement that they were "now at takeoff" was likely due to his misinterpretation that they were in takeoff position and ready to begin the roll when takeoff clearance was received, but not actually in the process of taking off. The controller then immediately added "stand by for takeoff, I will call you", indicating that he had not intended the clearance to be interpreted as a takeoff clearance. He probably had not heard the captain's announcement that they were "going," since Van Zanten had said this to his fellow crew members and not transmitted it on the radio himself.

A simultaneous radio call from the Pan Am crew caused mutual interference on the radio frequency, which was audible in the KLM cockpit as a whistling sound (or heterodyne). This made the crucial latter portion of the tower's response audible only with difficulty by the KLM crew. The Pan Am crew's transmission, which was also critical, was reporting that "We're still taxiing down the runway, the Clipper 1736!" This message was also blocked by the heterodyne and inaudible to the KLM crew. Either message, if heard in the KLM cockpit, would have given the KLM crew time to abort its second takeoff attempt.

Due to the fog, neither crew was able to see the other plane on the runway ahead of them. In addition, neither of the aircraft could be seen from the control tower, and the airport was not equipped with ground radar.

After the KLM plane had started its takeoff roll, the tower instructed the Pan Am crew to "report when runway clear." The crew replied: "OK, we'll report when we're clear." On hearing this, flight engineer Willem Schreuder expressed his concern about the Pan Am not being clear of the runway by asking the pilots, "Is he not clear, that Pan American?" Van Zanten emphatically replied "Oh, yes" and continued with the takeoff.

Collision



Simplified map of runway, taxiways, and aircraft. The red star indicates the location of impact.

According to the CVR, Captain Grubbs, captain of the Pan Am plane, spotted the KLM's landing lights just as the plane approached exit C-4, exclaiming, "Goddamn, that son-of-a-bitch is coming straight at us!" with the co-pilot Robert Bragg yelling, "Get off! Get off! Get off!". The Pan Am crew applied full power and took a sharp left turn towards the exit to avoid a collision. KLM Captain Van Zanten attempted to avoid a collision by climbing away, scraping the tail of the plane along the runway for 20 m (66 ft). As the KLM left the ground its steep angle of attack allowed the nose gear to clear the Pan Am but the lower fuselage and aft landing gears struck the upper right side of the Pan Am's fuselage at approximately 140 knots (260 km/h; 160 mph), ripping apart the center of the Pan Am jet almost directly above the wing, and its right engines crashed through Pan Am's upper-deck passenger cabin, immediately behind the cockpit.

The KLM plane was briefly airborne, but the impact with the Pan Am had sheared off the #1 (outer left) engine, and the #2 (inner left) engine had ingested significant amounts of shredded materials from the Pan Am. The KLM pilot quickly lost control, and the 747 went into a stall, rolled sharply, slammed into the ground at a point 150 m (500 ft) past the collision and slid a further 300 m down the runway. As the jet was fully fuelled, a deadly fuel-air explosion ensued.

A survivor of the Pan Am flight, John Coombs of Haleiwa, Hawaii, said that sitting in the nose of the plane probably saved his life: "We all settled back, and the next thing an explosion took place and the whole port side, left side of the plane, was just torn wide open."

Both airplanes were destroyed. All 234 passengers and 14 crew members in the KLM plane died, while 326 passengers and 9 crew members aboard the Pan Am flight were also killed, primarily due to the fire and explosions resulting from the fuel spilled and ignited in the impact. The other 56 passengers and 5 crew members aboard the Pan Am aircraft survived, including the captain, first officer, and flight engineer. Most of the survivors on the Pan Am aircraft walked out onto the left wing, the side away from the collision, through holes in the fuselage structure. The Pan Am's engines were still running at takeoff power for a few minutes after the accident despite First Officer Bragg's intention to turn them off. The top part of the cockpit, where the engine switches were located, had been destroyed in the collision. After a short time running at full power the Pan-Am's engines began to disintegrate, throwing engine parts at high speed that killed a flight attendant who had escaped the burning plane. Survivors waited for rescue, but it did not come promptly as the firefighters were initially unaware that there were two aircraft involved and were concentrating on the KLM wreck some distance away in the thick fog. Eventually, most of the survivors on the wings dropped to the ground below.

Captain Veldhuyzen van Zanten was KLM's chief of flight training and the airline's preferred pilot for publicity such as magazine advertisements. As such, KLM attempted to contact him to give public statements regarding the disaster, before learning that he was the captain involved. Veldhuyzen van Zanten had given Klaas Meurs, the first officer on the ill-fated flight, his Boeing 747 qualification check about two months before the accident.

Investigation

About 70 crash investigators from Spain, the Netherlands, the United States, and the two airline companies were involved in the investigation. Facts showed that there had been misinterpretations and false assumptions. Analysis of the CVR transcript showed that the KLM pilot was convinced that he had been cleared for takeoff, while the Tenerife control tower was certain that the KLM 747 was stationary at the end of the runway and awaiting takeoff clearance. It appears KLM's co-pilot was not as certain about take-off clearance as the captain.

Subsequent to the crash, first officer Robert Bragg, who was responsible for handling the Pan Am's radio communications, made public statements which conflict with statements made by the Pan Am crew in the official transcript of the CVR. In the documentary *Crash of the Century* (produced by the makers of *Mayday*), he stated he was convinced the tower controller had intended they take the fourth exit C-4 because the controller delivered the message to take "the third one, sir, one; two, three; third, third one" after the Pan Am's had already passed C-1 (making C-4 the third exit counting from there). The CVR shows unequivocally that they received this message before they identified C-1, with the position of the aircraft somewhere between the entrance and C-1. Also, in a *Time* article, Bragg stated that he made the statement "What's he doing? He'll kill us all!" which does not appear in the CVR transcript.

Probable cause

The investigation concluded that the fundamental cause of the accident was that Captain Van Zanten took off without takeoff clearance. The investigators suggested the reason for his mistake might have been a desire to leave as soon as possible in order to comply with KLM's duty-time regulations, and before the weather deteriorated further.

Other major factors contributing to the accident were:

- The sudden fog greatly limited visibility. The control tower and the crews of both planes were unable to see one another.
- Simultaneous radio transmissions, with the result that neither message could be heard.

The following factors were considered contributing but not critical:

- Use of ambiguous non-standard phrases by the KLM co-pilot ("We're at take off") and the Tenerife control tower ("OK").
- Pan Am mistakenly continued to exit C-4 instead of exiting at C-3 as directed.
- The airport was (due to rerouting from the bomb threat) forced to accommodate a great number of large aircraft, resulting in disruption of the normal use of taxiways.

Dutch response

The Dutch authorities were reluctant to accept the Spanish report blaming the KLM captain for the accident. The Netherlands Department of Civil Aviation published a response that, whilst accepting that the KLM aircraft had taken off "prematurely", argued that he alone should not be blamed for the "mutual misunderstanding" that occurred between the controller and the KLM crew, and that limitations of using radio as a means of communication should have been given greater consideration.

In particular, the Dutch response pointed out that

- the crowded airport had placed additional pressure on all parties, KLM, Pan Am, and the controller;
- sounds on the CVR suggested that during the incident the Spanish control tower crew had been listening to a football game on the radio and may have been distracted.
- the transmission from the tower in which the controller passed KLM their ATC clearance was ambiguous and could have been interpreted as also giving take-off clearance. In support of this part of their response, the Dutch investigators pointed out that Pan Am's messages "No! Eh?" and "We are still taxiing down the runway, the Clipper 1736!" indicated that Captain Grubbs and First Officer Bragg had recognised the ambiguity;
- if the Pan Am aircraft had not taxied beyond the third exit, the collision would not have occurred.

Speculations

Speculation regarding other contributing factors includes:

- Captain Van Zanten's failure to confirm instructions from the tower. The flight was one of his first after spending six months training new pilots on a flight simulator, where he had been in charge of everything (including simulated ATC), and having been away from the real world of flying for extended periods.
- The flight engineer's apparent hesitation to challenge Van Zanten further, possibly because Captain Van Zanten was not only senior in rank, but also one of the most able and experienced pilots working for the airline.
    - A study group put together by the Air Line Pilots Association found that not only the captain, but the first officer as well dismissed the flight engineer's question. In that case, the flight engineer might have been either reassured or even less inclined to press the question further.
- The reason only the flight engineer reacted to the radio transmission "Alpha one seven three six report when runway clear" might lie in the fact that this was the first and only time the Pan Am was referred to by that name. Before that, the plane was called "Clipper one seven three six". The flight engineer, having completed his pre-flight checks, might have recognized the numbers but his

colleagues, preparing themselves for take-off, might have subconsciously been tuned in to "Clipper".

- The extra fuel the KLM plane took on added several factors:
  - it delayed takeoff an extra 35 minutes, which gave time for the fog to settle in;
  - it added over forty tons of weight to the plane, which made it more difficult to clear the Pan Am when taking off;
  - it increased the size of the fire from the crash that ultimately killed everyone on board.
- Captain Van Zanten's reaction, once he spotted the Pan Am plane, was to attempt to take off. Although the plane had exceeded its V1 speed, it did not yet have adequate airspeed. The sharp lifting angle caused the KLM jet to drag its tail on the runway, thereby reducing its speed even further.

Responsibility

Although the Dutch authorities were initially reluctant to blame Captain Van Zanten and his crew, the airline ultimately accepted responsibility for the accident. KLM paid the victims or their families compensation ranging between $58,000 and $600,000. As reported in a March 25, 1980, Washington Post article the sum of settlements for property and damages was $110 million (an average of $189,000 per victim, due to limitations imposed by European Compensation Conventions in effect at the time).

Safety response

As a consequence of the accident, sweeping changes were made to international airline regulations and to aircraft. Aviation authorities around the world introduced requirements for standard phrases and a greater emphasis on English as a common working language. For example, ICAO calls for the phrase "line up and wait" as an instruction to an aircraft moving into position but not cleared for takeoff. The FAA equivalent at the time was "position and hold" (though as of September 30, 2010, this has been changed to "line up and wait" to comply with ICAO standards.). Also several national air safety boards began penalizing pilots for disobeying air traffic controller's orders. Air traffic instruction should not be acknowledged solely with a colloquial phrase such as "OK" or even "Roger", but with a readback of the key parts of the instruction, to show mutual understanding. Additionally, the phrase "takeoff" is only spoken when the actual takeoff clearance is given. Up until that point, both aircrew and controllers should use the phrase "departure" in its place (e.g. "ready for departure"). Cockpit procedures were also changed. Hierarchical relations among crew members were played down. More emphasis was placed on team decision-making by mutual agreement. This is known in the industry as Crew Resource Management.

In 1978 a second airport was inaugurated on the island: the new Tenerife South Airport (TFS). This airport now serves the majority of international tourist flights. Los Rodeos, renamed to Tenerife North Airport (TFN), was then used only for domestic and inter-island flights, but in 2002 a new terminal was opened and it carries international traffic

once again, including budget airlines. The Spanish authorities installed a ground radar at Tenerife North following the accident.

Memorials

Monument in Westgaarde Cemetery, Amsterdam

International Tenerife Memorial, Mount Mesa Mota, Tenerife, Canary Islands

A Dutch national memorial and final resting place for the victims of the KLM plane is located in Amsterdam, at Westgaarde cemetery. There is also a memorial at the Westminster Memorial Park and Mortuary in Westminster, California.

The 30th anniversary marked the first time that Dutch and American next of kin, and aid helpers from Tenerife, joined in international commemoration service held at the Auditorio de Tenerife in Santa Cruz; the **International Tenerife Memorial** was inaugurated at the Mesa Mota March 27, 2007. The monument was designed by Dutch sculptor Rudi van de Wint. A special 50-page commemorative booklet including a DVD in English, Dutch, and Spanish was published a year later, on March 27, 2008.

Notable victims

- Eve Meyer, a pin-up model, film actress and producer and former wife of Russ Meyer.
- A. P. Hamann, the former city manager of San Jose, California, and his wife Frances Hamann.

Documentaries

The disaster has featured in many TV shows and documentaries. These include *Crash of the Century*, the *Survival in the Sky* episode *Blaming the Pilot*, the *Seconds From Disaster* episode *Collision on the Runway*, PBS's NOVA episode "The Deadliest Plane Crash" in 2006, and the Discovery Channel TV series *Most Deadly* and *Destroyed In Seconds*.

Chapter 10

USAir Flight 1493

USAir 1493 collision	
Accident summary	
Date	February 1, 1991
Type	Runway collision caused by ATC error
Site	Los Angeles Int'l Airport
Total injuries	30
Total fatalities	34
Total survivors	67
First aircraft	
Type	Boeing 737-300
Operator	USAir
Tail number	N388US
Flight origin	Syracuse Hancock International Airport
1st stopover	Ronald Reagan Washington National Airport
2nd stopover	Port Columbus International Airport
Last stopover	Los Angeles Int'l Airport California, USA

Destination	San Francisco International Airport California, USA
Passengers	83
Crew	6
Injuries	13 serious, 17 minor
Fatalities	22
Survivors	67
Second aircraft	
Type	Fairchild Swearingen Metroliner
Operator	SkyWest Airlines
Tail number	N683AV
Flight origin	Los Angeles Int'l Airport California, USA
Destination	LA/Palmdale Regional Airport, USA
Passengers	10
Crew	2
Fatalities	12
Survivors	0

USAir Flight 1493 was a scheduled United States (US) domestic passenger flight from Syracuse Hancock International Airport, New York to San Francisco International Airport, California that collided with **SkyWest Flight 5569** upon landing at a scheduled stopover at Los Angeles International Airport (LAX). The evening of February 1, 1991, saw slow to moderate air traffic at LAX, but as the USAir 737 was on final approach, there were a series of abnormalities that occurred to distract the local controller, including an aircraft that inadvertently switched off the tower frequency and a misplaced flight progress strip which resulted in the SkyWest Metroliner being told to taxi into takeoff position while the USAir flight was landing on the same runway without the Metroliner ever being given a takeoff clearance.

Upon landing, the 737 collided with the twin-engine turboprop, continued down the runway with the turboprop crushed beneath it, exited the runway, and caught fire. Twenty-two of 89 people aboard the landing 737 and all 12 aboard the turboprop died. Rescue workers were on the scene of the fire within minutes and began the evacuation of the plane. Because of the intense fire three of the 737's six exits could not be used. Neither of the front exits were usable, which caused the front passengers to try to use the

overwing exits. However, only one of the overwing exits was usable, which caused a backlog to form. Most of those aboard the 737 who died in the accident did so from asphyxiation in the post-crash fire.

The National Transportation Safety Board (NTSB) found that the probable cause of the accident to be the procedures in use at the Los Angeles International Airport control tower provided inadequate redundancy that led to a loss of situational awareness by the local controller. The crash led directly to the use of the NTSB's recommendation of using different runways for takeoffs and landings at LAX.

Accident details

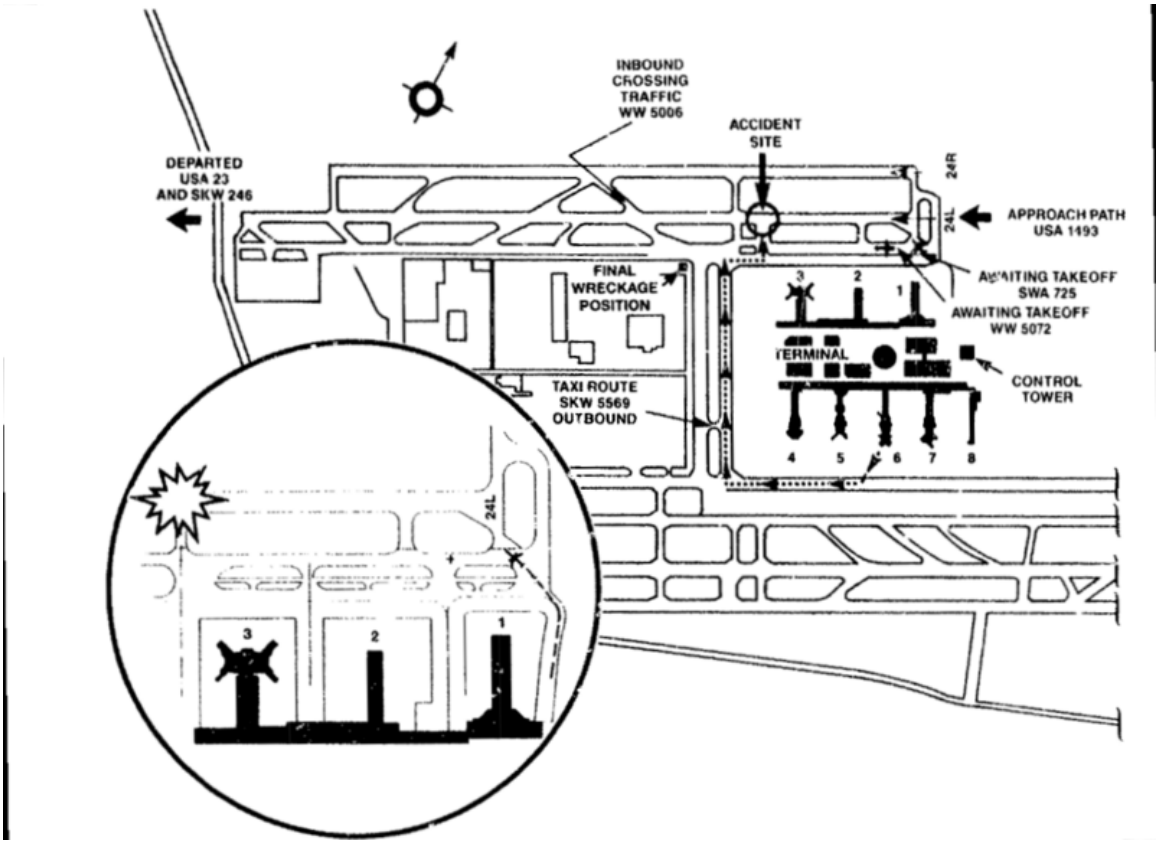


Diagram showing the movement of aircraft related to the accident.

On 1 February 1991, USAir flight 1493, under the command of Captain Colin Shaw, 48 and First Officer David Kelly, 32, departed Syracuse, making stops at Washington, D.C. and Columbus, Ohio before continuing to Los Angeles (LAX). On its second to last scheduled leg, but ultimately its last fatal leg, the aircraft carried 83 passengers and a crew of six. Until impact with the smaller plane, this had been a routine flight.

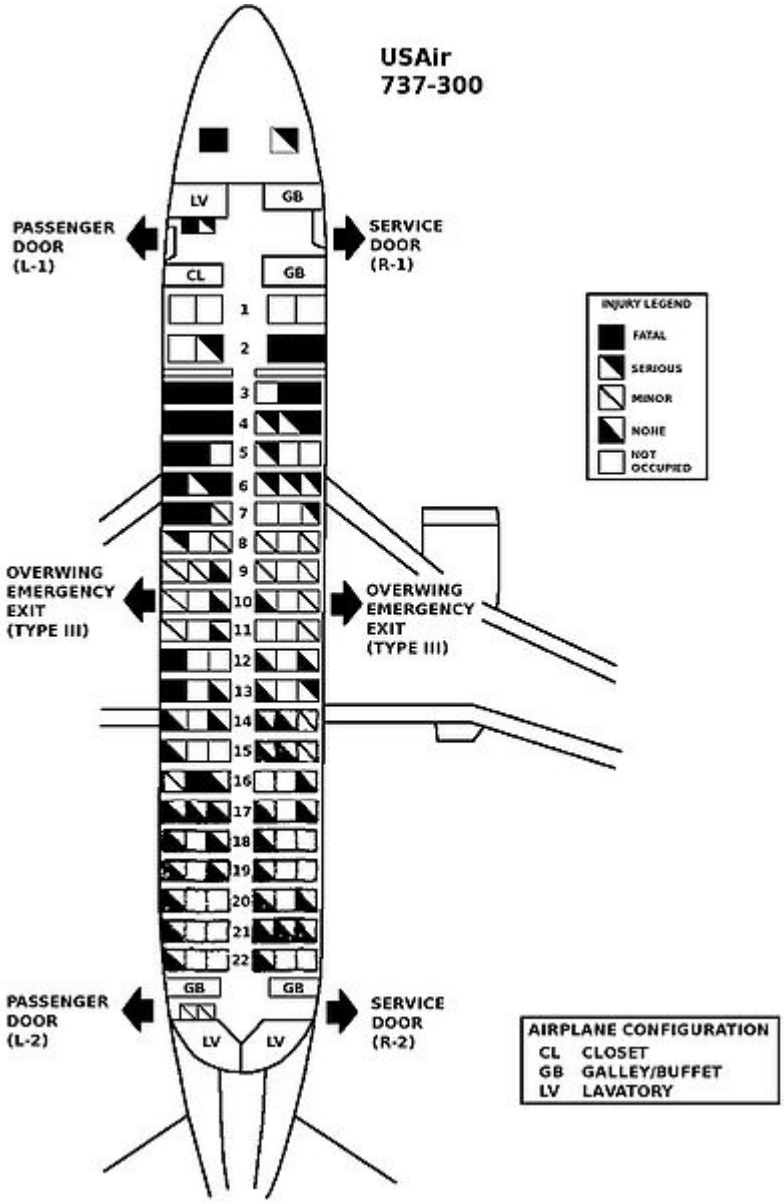
The Los Angeles Airport consisted of four parallel runways. There were two runways north of the terminal and a set of runways south of the terminal. The runways and taxiways to the north of the terminal were called the *North Complex* and contained the

northernmost runway 24R along with 24L which was closest runway to the terminal on the north side. There was no parallel taxiway between the runways, but there were several taxiways that let aircraft that landed on 24R to cross the inboard runway. Runways 25L and 25R were in the *South Complex*. To reduce taxi time, flights typically would try to depart from whichever complex was closest. Due to their northerly route of flight, Skywest 5569 was cleared to taxi to Runway 24L instead of the closer Runway 25R. The departure from the gate and taxi were normal and uneventful. They taxied from gate 32 to the runway via taxiways Kilo, 48, Tango, and 45 on a predetermined route called the *north route*. The taxiways have since been re-designated Charlie, Quebec, Delta, and Delta10 respectively. The flight was briefly not visible from the tower on taxiway 48 between Kilo and Tango in the area known as *no mans land*.

Immediately prior to SkyWest reaching runway 24L, a Wings West aircraft had landed on 24R and was holding short of 24L. The local controller attempted to cross the Wings West aircraft downfield but the crew had changed frequencies and did not answer, distracting the controller in her attempt to reestablish communications. Shortly after 6 PM local time, as USAir 1493 was making its final approach to LAX, SkyWest Airlines Flight 5569, a twin-engine Fairchild Metroliner (N683AV), a commuter flight bound for Palmdale with 10 passengers and two crew members on board, was cleared by LAX air traffic control (ATC) to taxi into its takeoff position at the intersection of taxiway 45, some 2,200 feet (670 m) from the runway threshold. After four attempts by the controller, the Wings West aircraft finally responded to the tower and apologized for switching frequencies. The local controller cleared them to cross runway 24L downfield. The same local controller cleared US1493 to land on the same runway with SkyWest still holding in position. Another Wings West aircraft called the tower reporting they were ready for takeoff. The tower controller queried this aircraft, another Metroliner, about their position, and they stated they were holding short of 24L behind a Southwest 737. The flight progress strip for this flight was still with the clearance delivery controller (another position in the control tower), and the local controller mistakenly thought this Metroliner was SkyWest 5569 and that the runway was clear of all aircraft. The first officer of USAir 1493 recalled hearing this conversation, but did not remember anyone being cleared to hold on the runway.

USAir 1493 touched down near the runway threshold and as the nose was being lowered, the first officer noticed the SkyWest plane on the runway and applied maximum braking. USAir 1493 shortly thereafter slammed into the Skywest aircraft. Both aircraft skidded down the runway with the Metroliner crushed beneath the 737's fuselage. The aircraft veered off the left side of the runway between the extended centerlines of taxiways 48 and 49 and the wreckage came to rest on the far side of the taxiway against a closed fire station building where it caught fire. Large debris from the Metroliner including its tail, wings, and right engine were found on the runway and between the runway and the abandoned fire station.

Fatalities and injuries



Seating chart of US Airways Flight 1493 from the NTSB, revealing locations of passengers, lack of injury, severity of injuries, and deaths.

All 12 people (10 passengers and 2 pilots, Captain Andrew J. Lucas, and First Officer Frank C. Prentice III, both based in San Luis Obispo.) on Skywest 5569 were killed, and 22 of the 89 aboard the 737 aircraft perished (20 passengers and 2 crew members-Captain Shaw and a flight attendant). Of the remaining passengers and crew aboard the USAir aircraft, two crew members and 11 passengers sustained serious injuries, 2 crew members and 15 passengers sustained minor injuries and 37 passengers received no injuries. American multi-billionaire David H. Koch was among the survivors.

The majority of fatalities aboard the USAir 737 occurred to those seated in the front of the plane. Everyone seated in row 6 or forward was either killed or sustained major injuries. Everyone aft of row 17 escaped unharmed or with minor injuries. There were 22 rows of seats in the accident 737. One reason for the higher fatality rate in the forward section of the aircraft is that the post crash fire originated in the forward cargo hold under the forward cabin, fed by a combination of fuel from the wreckage of the Metroliner and gaseous oxygen from the 737's damaged crew oxygen system. Only 2 passengers and one crew member managed to escape from the forward service (R1) door, while the main cabin (L1) door was inoperable due to damage. Only two passengers used the left over wing exit before the fire became too intense outside the aircraft. The majority of the survivors exited via the right over wing exit, with the rest of the surviving cabin occupants escaping through the rear service (R2) door. The rear passenger (L2) door was briefly opened during the course of the accident, but was quickly closed due to the spreading fire on that side of the aircraft. Multiple issues slowed the evacuation from the right over wing door including a passenger seated in the exit row who could not open the door, a brief scuffle between two men at the exit, and the seat back of the exit window seat being folded forward, partially obstructing the exit.

From the location of the bodies, authorities believed that 17 of those who died on the 737 had actually unbuckled their seat belts and died from smoke inhalation while making their way to the exits. Only two victims were found in their seats. According to James Burnett, who headed the National Transportation Safety Board (NTSB) investigation team, "I can't think of a recent accident where this many people have been up and out of their seats and didn't make it out." The captain was one of the few people who died of blunt force trauma. He received a fatal blow to the head when the bulkhead collapsed as the aircraft collided with the firehouse. The first officer was rescued through the cockpit windows by some of the first fire fighters to arrive on the accident scene.

One person who evacuated USAir 1493 died from thermal burns a few days after the accident. One of the 13 seriously injured passengers succumbed to multiple traumatic injuries 31 days after the crash. However, he was not listed as a fatality, due to language in the Code of Federal Regulations (49CFR830.2) that defines a fatality as taking place within 30 days of the accident.

Among the dead on the Skywest Metroliner were Skywest's Palmdale station manager as well as the husband of a Skywest employee in Palmdale, and an FAA Air Traffic controller who worked in Palmdale. Immediately after the crash, the Monterey California station manager, Terry Lewis, was brought in temporarily to keep the station running.

Aftermath

The first officer, who was the pilot flying the 737 during the accident leg, reported that he did not see the Skywest Metroliner until he lowered the nose of the aircraft onto the runway after landing. He also said that he applied the brakes, but did not have enough time for evasive action. Statements made by passengers who survived the crash were consistent with this testimony.

The Local Controller who cleared both aircraft to use the same runway testified before the NTSB and accepted blame for causing the crash. She said she originally thought the landing USAir plane had been hit by a bomb, then "realized something went wrong... I went to the supervisor and I said, 'I think this (the SkyWest plane) is what USAir hit.'" She testified that rooftop lights in her line of sight caused glare in the tower, making it difficult to see small planes at the intersection where the SkyWest plane was positioned. Just before the accident, she confused the Skywest plane with another commuter airliner that was on a taxiway near the end of the runway. Making matters more difficult, the ground radar at LAX was not working on the day of the accident.

The NTSB's investigation of the crash revealed that the cockpit crew of the landing USAir jet could not see the commuter plane, which blended in with other airport lights. The NTSB cited LAX's handling of the runways which placed much of the responsibility for the runways on the local controllers which directly led to the loss of situational awareness by the local controller. The NTSB also noted that during the previous performance review a supervisor had noted four deficiencies in the controller who ultimately worked the accident aircraft. These deficiencies were not addressed prior to the accident, and two of the deficiencies were apparent in the accident sequence—loss of situational awareness and aircraft misidentification.

At the time of the accident, air traffic controllers at LAX used all four runways for takeoffs and landings. One of the NTSB recommendations was that the runways be segregated with only landings or departures taking place on an individual runway. This recommendation was implemented, but not until after another incident, when on 19 Aug 2004 a B747 landing on 24L came within 200 ft vertically of a B737 holding on the same runway before executing a go around. LAX now uses the outboard runways (24R and 25L) for landings and the inboard runways (24L and 25R) for departures.

Before this accident, the Federal Aviation Administration (FAA) issued a ruling that required airlines to upgrade the flammability standards of materials on board, but the USAir plane had been built before the effective date of those requirements and had not yet been modernized. It was scheduled to be upgraded within the next year. By 2009, all aircraft operating in the United States were compliant.

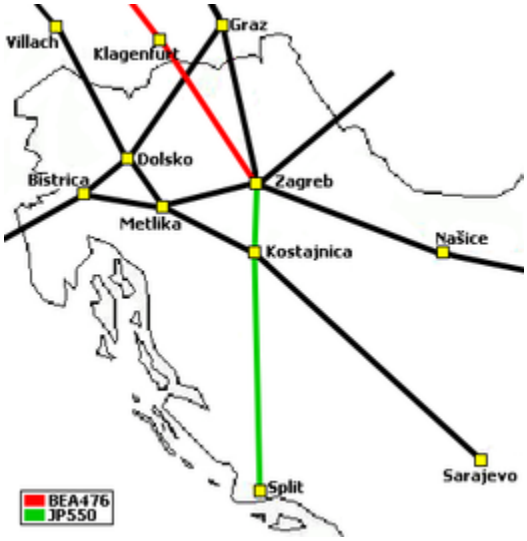
Dramatization

The Canadian television series *Mayday*, which examines aerial incidents, their causes and results, created a documentary episode, titled *Cleared For Disaster*, about the accident.

Chapter 11

1976 Zagreb Mid-Air Collision

British Airways Flight 476
Inex-Adria Aviopromet Flight 550



Zagreb FIR in 1976, showing route of BA476 (red) and JP550 (green). Not to scale.

Accident summary	
Date	10 September 1976
Type	Mid-air collision
Site	over Vrbovec, Zagreb County, Yugoslavia 45°53′33″N 16°18′38″E / 45.8925°N

	16.31056°ECoordinates: 45°53′33″N 16°18′38″E / 45.8925°N 16.31056°E
Total fatalities	176
Total survivors	0
First aircraft	
Type	Hawker Siddeley Trident 3B
Operator	British Airways
Tail number	G-AWZT
Flight origin	London Heathrow Airport London, UK
Destination	Yeşilköy Int'l Airport Istanbul, Turkey
Passengers	54
Crew	9
Survivors	0
Second aircraft	
Type	Douglas DC-9
Operator	Inex-Adria Aviopromet
Tail number	YU-AJR
Flight origin	Split Airport Split, Yugoslavia
Destination	Cologne Bonn Airport Cologne, West Germany
Passengers	108
Crew	5
Survivors	0

The **1976 Zagreb mid-air collision** occurred on 10 September 1976 when **British Airways Flight 476**, a Hawker Siddeley Trident 3B en route from London Heathrow Airport to Yeşilköy International Airport, Istanbul, collided in mid-air with **Inex-Adria Aviopromet Flight 550**, a Douglas DC-9 en route from Split Kaštela/Resnik Airport, Yugoslavia, to Cologne Bonn Airport, West Germany, at 11:15am local time (10:15 UTC).

All 176 people aboard both flights were killed making it, at the time, the world's deadliest mid-air collision; it had a death toll higher than that of All Nippon Airways Flight 58. It was, and remains, the only fatal accident to befall an aircraft operated by British Airways, not counting BA's ancestors.

Flights

British Airways Flight 476 departed Heathrow at 08:32 UTC as flight BEA476 with 54 passengers on board. At the controls of the Trident 3B was experienced captain Dennis Tann (born 21 June 1932), who by the time of the accident had accumulated 10,781 flying hours. He was assisted by first officer Brian Helm and acting first officer Martin Flint.

Inex-Adria Flight 550 departed Split, Yugoslavia at 09:48 UTC bound for Cologne, West Germany as flight JP550. It carried 108 passengers, mostly German holiday-makers returning home at the end of a holiday on the Dalmatian coast. At the controls sat captain Jože Krumpak and first officer Dušan Ivanuš. Inex-Adria was a charter airline based in Slovenia, the northern-most of the constituent republics making up the federation of Yugoslavia.

Both flights proceeded uneventfully until they reached the Zagreb VOR.

Air traffic control

In the mid-1970s, the Zagreb air traffic control region was one of the busiest in Europe despite being seriously undermanned and poorly equipped. The Zagreb VOR was a reporting point for a number of congested airways between northern Europe and southeastern Europe, the Middle East, and beyond. The airspace was divided into three sectors by altitude: the lower sector below 25,000 feet, the middle sector from 25,000 to 31,000 feet, and the upper sector above 31,000 feet.

At the time of the accident, staff on duty at the Zagreb Area Control Center included:

- Julio Dajčić, chief of shift (born 17 December 1932)
- Gradimir Tasić (born 29 April 1949), upper sector controller (at the time of the accident)
- Nenad Tepeš (born 2 September 1943), upper sector controller
- Mladen Hochberger (born 13 October 1946), upper sector controller
- Bojan Erjavec (born 15 June 1947), middle sector controller
- Gradimir Pelin (born 18 April 1948), middle sector controller

Accident

On entering Yugoslav airspace from Austria, flight 476 established radio contact with the Zagreb ACC upper-sector controller Gradimir Tasić at 10:04:12 UTC, informing him that they were at flight level 330 and expected to reach the Zagreb VOR at 10:14. The controller responded by instructing them to select transponder code 2312, and to call again on reaching the VOR.

10:04:12	BEA476	Zagreb, Bealine 476, good morning.
	Zagreb Upp	Bealine 476, good morning, go ahead.
10:04:19	BEA476	Er, 476, is Klagenfurt at 02, 330 and estimating Zagreb at One Four.
10:04:27	Zagreb Upp	Bealine 476, roger, call me passing Zagreb, flight level 330, Squawk Alpha 2312.
10:04:38	BEA476	2312 is coming.

This was the last communication with the Trident aircraft before the accident.

At around the same time, JP550 contacted middle-sector controller Bojan Erjavec asking for a higher flight level; the aircraft was at flight level 260, or 26,000 feet. FL280 and FL310 were unavailable, so Erjavec informed JP550 of the situation and offered FL350, which the pilots accepted. To get clearance for a higher level, it was necessary to obtain the permission of the upper-sector controller. Erjavec waved his hand to get Tasić's attention, but Tasić (who was working the upper sector on his own, as Hochberger had gone to search for Tepeš) was far too busy to be interrupted. Pelin was then instructed to co-ordinate the climbout for the DC-9 with Tasić.

According to Pelin, he walked to the upper sector console holding JP550's flight progress strip. He asked Tasić if the DC-9 could climb to FL350. Tasić took the strip from Pelin and looked at it, then asked where the aircraft was at the moment. Pelin then pointed to a blip on the screen approaching Kostajnica. Tasić's response was 'yes, it could climb'. Pelin then noticed an aircraft on the screen coming from the direction of Metlika and asked Tasić about it, who said 'wait until they cross'. Pelin referred to the middle-sector screen to make sure that he had identified the DC-9 positively on the upper-sector screen. He then returned to Tasić and they both watched the targets pass each other, at which point Tasić authorized JP550 to climb. Pelin then called out to Erjavec and said 'yes, climb it'. Upon Erjevec receiving the OK from Pelin, he instructed the DC-9 to climb to FL350. That was at 10:07:40.

Memorial to some of the dead

At 10:12:03, JP550 called the Zagreb middle-sector controller to inform them that the aircraft was out of flight level 310. The last instructions given by Erjavec to JP550 were to call the upper-sector controller on 134.45MHz and to stop squawking the assigned squawk code. By instructing JP550 to squawk Standby, Erjavec simply released a code allocated for the middle sector. The data tag for the DC-9 would now disappear from his screen and the aircraft would become merely a point among many others. If everything about this handover had been normal, the DC-9 would have been given a new code on initial contact with the upper sector controller and would have been positively identified on the upper sector screen with its flight number and altitude readout. But this had not been a normal handover because of the ill-handled coordination for the climb. Also, Tasić was busy with other traffic and JP550 did not immediately contact the upper-sector controller. This could have been because the frequency was busy, but the pilots might also have delayed the call for some unknown reason.

By the time JP550 contacted the upper-sector controller at 10:14:04 it had reached the Zagreb VOR and was already climbing through flight level 325. The controller immediately asked for confirmation of the aircraft's level:

10:14:04	JP550	Dobar dan ["Good day"] Zagreb, Adria 550.
10:14:07	Zagreb Upp	Adria 550, Zagreb, dobar dan, go ahead.
10:14:10	JP550	325 crossing Zagreb at One Four.
10:14:14	Zagreb Upp	What is your present level?
10:14:17	JP550	327.

Realising the imminent danger of collision, Tasić instructed the JP550 to stop climbing. In doing so, he reverted to his native Croatian language. The controller's last moment attempt to avert catastrophe turned what would have been a near miss into the collision he was trying to prevent. For, by the time JP550 had leveled off it was at flight level 330, exactly the same level as BE476:

10:14:22	Zagreb Upp	[stammering] ... e... zadržite se na toj visini i javite prolazak Zagreba ["uh... hold yourself at your height and report passing Zagreb"].
10:14:27	JP550	Kojoj visini? ["What height?"]
10:14:29	Zagreb Upp	Na kojoj ste sada u penjanju jer... e... imate avion pred vama na... [not coherent] 335 sa leva na desno. ["The height you are climbing through because... uh... you have an aircraft in front of you at... [not coherent] 335 from left to right."]
10:14:38	JP550	OK, ostajemo točno 330. ["OK, we'll remain precisely at 330."]

Half a minute later, Tasić called BEA476 and instructed it to report passing the next waypoint at Našice:

10:15:06	Zagreb Upp	Bealine 476, Zagreb... report passing Nasice.
10:15:12	BE778	Beatours 778, were you calling...?
10:15:14	Zagreb Upp	Negative.

Tasić continued to call BE476 and JP550, ignoring calls from other aircraft, but to no avail:

10:15:50	Zagreb Upp	Adria 550, Zagreb...
10:16:00	Zagreb Upp	Adria 550, Zagreb...
10:16:14	Zagreb Upp	Adria 550, Zagreb...
10:16:32	Zagreb Upp	Adria 550, Zagreb...
10:16:42	Zagreb Upp	Adria 550, Zagreb...
10:16:50	Zagreb Upp	Bealine 476, Zagreb...
10:16:58	Zagreb Upp	Bealine 476, Zagreb...

A Lufthansa Boeing 737 travelling eastbound on UB5 at level 290 towards Zagreb, was positioned only 15 miles behind the Trident. The co-pilot saw the collision as a flash of lightning and afterwards, out of a ball of smoke, two aircraft falling towards the ground. The Boeing 737 commander, Captain Josef Kröse, reported the sighting to Erjavec, the middle-sector controller.

10:15:40	Capt Kröse R/T	....e Zagreb! It is possible we have a mid-air collision in sight. We have two aircraft going down, well, almost below our position now.

This was spoken in such an agitated voice that Erjavec was unable to understand what was being said. (Later, on hearing the recording of this call, Captain Kröse had difficulty in understanding his own words). The Lufthansa captain had to repeat his message several times.

10:18:12	Capt Kröse R/T	It is possible that the other aircraft ahead of us had a mid-air collision....er...just overhead Zagreb. We had two aircraft going down with a rapid rate of descent...and there was also smoke coming out.

When the implications of what was being said dawned on Erjavec he glanced across to the upper-sector controller. At his station sat a stunned Tasić, white-faced with shock. Slowly he lifted the headset from his ears and placed it on the console in front of him.

Airplane remains

The two aircraft had collided over the town of Vrbovec. The last 5 meters of the DC-9's left wing sliced through the Trident's cockpit section. The DC-9 went into an immediate nose dive; the Trident remained in flight for a short while before going down. All 63 people aboard flight 476 and 113 people aboard flight 550 were killed.

Police officer Garo Tomaevic reported that a baby on the ground was "still giving feeble signs of life near the [British] plane, but even if the ambulances had arrived before me, it would have been too late to save it."

Trial

By noon that day, all controllers were in custody for interrogation. Later, all were released except Tasić, who remained in custody until the trial.

The trial opened on 11 April 1977 in Zagreb District Court. All the controllers were indicted under the Penal Code of Yugoslavia, Articles 271-72 as "persons who by endangering railway, sea or air traffic, threaten the lives of men or property".

Tasić was the only one to be found guilty; he was sentenced to seven years' imprisonment. After a petition by air traffic controllers, it was determined that Tasić had been used as a scapegoat, and he was released on 29 November 1978. He had served nearly two years and three months in prison.