

United Airlines Flight 232

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(Redirected from United 232)

United Airlines Flight 232 was a scheduled flight operated by United Airlines between Denver and Philadelphia via Chicago. On July 19, 1989, the Douglas DC-10 (Registration N1819U) being operated for this flight suffered an uncontained failure of its number 2 engine (mounted in the tail), which destroyed all three of the aircraft's hydraulic systems. With no controls working except the power levers for the two remaining engines, it broke up during an emergency landing on the runway at Sioux City, Iowa killing 110 of its 285 passengers and one of the 11 crew members.

Owing to the skill of the crew and a DC-10 instructor pilot, 175 passengers and 10 crew members survived the crash, which is considered a textbook example of successful Crew Resource Management, due to the effective use of all the resources available aboard the plane for help during the emergency.^[1]

Contents

- 1 Chronology of the flight
- 2 Causes
- 3 Lessons learned
- 4 Factors contributing to survival
- 5 Notable survivors
- 6 In popular culture
- 7 See also
- 8 References
- 9 External links

Chronology of the flight

The flight took off at 14:09 (CDT) from Stapleton International Airport, Denver, Colorado and was due to fly to Philadelphia International Airport in Philadelphia, Pennsylvania via O'Hare International Airport in Chicago, Illinois. At 15:16, while the plane was in a shallow right turn at 37,000 feet, the N1 stage fan disk of its tail-mounted General Electric CF6-6 engine broke in two. The fan cowling was blown off and pieces of the engine penetrated the aircraft tail section in numerous places, including both horizontal stabilizers. Pieces of shrapnel

United Airlines Flight 232



N1819U on its final descent. Note damage on the horizontal stabilizer and fuselage tailcone.

Summary

Date	July 19, 1989
Type	Uncontained engine failure, complete loss of flight controls
Site	Sioux City, Iowa, United States
Fatalities	111
Injuries	172
Aircraft	
Aircraft type	McDonnell Douglas DC-10-10
Operator	United Airlines
Tail number	N1819U
Passengers	285
Crew	11
Survivors	185

which went through the right horizontal stabilizer severed the lines of all three hydraulic systems, allowing the fluid to drain away.^[2]

Captain Alfred C. Haynes and his flight crew (First Officer William Records, who was flying, and Second Officer Dudley Dvorak, flight engineer) felt a jolt going through the aircraft, and warning lights showed that the autopilot had disengaged, and the tail-mounted number two engine was malfunctioning. The co-pilot noticed that the airliner was off course, and moved his control column to correct this, but the plane did not respond. The flight crew discovered that the pressure gauges for each of the three hydraulic systems was registering zero, and they realized that the initial failure had left all control surfaces immovable. The three hydraulic systems were separated such that a single event in one system would not disable the other systems, but beyond that there was no backup system, a fact which the NTSB later recommended be remedied.^[3]

The plane had a continual tendency to turn right, and was difficult to maintain on a stable course. It began to slowly oscillate vertically in a phugoid cycle, which is characteristic of planes in which hydraulic power is lost. With each iteration of the cycle the aircraft lost approximately 1500 feet of altitude. Dennis E. Fitch, a DC-10 flight instructor, was deadheading as a passenger on the plane and offered his assistance. After entering the cockpit, Fitch discovered that the only available method of controlling the aircraft was through adjusting the throttles of the remaining two engines; running one engine faster than the other to turn the plane (differential thrust), and accelerating or decelerating in order to gain or lose altitude. Using this method, it was possible to mitigate the phugoid cycle and make rough steering adjustments. At one point Fitch manually lowered the landing gear in flight, hoping that this would force trapped hydraulic fluid back into the lines allowing some movement of control surfaces. Although the gear lowered successfully, there was no improvement in control response as all the fluid had been lost through the punctured lines.

Air traffic control (ATC) was contacted and an emergency landing at nearby Sioux Gateway Airport was organized.

Haynes kept his sense of humor during the emergency, as recorded on the plane's CVR:

Fitch: *I'll tell you what, we'll have a beer when this is all done.*

Haynes: *Well I don't drink, but I'll sure as hell have one.*

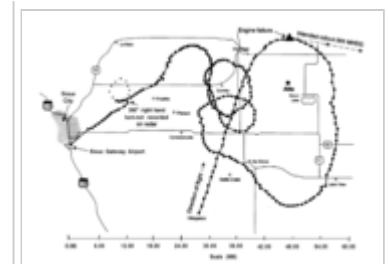
and later:

Sioux City Approach: *United Two Thirty-Two Heavy, the wind's currently three six zero at one one; three sixty at eleven. You're cleared to land on any runway.*

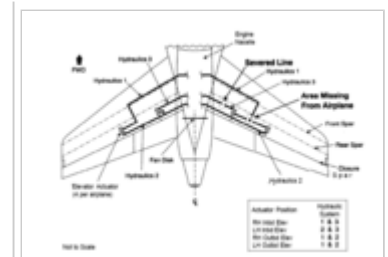
Haynes: *[laughter] Roger. [laughter] You want to be particular and make it a runway, huh?*^[4]

A more serious remark often quoted from Haynes was made when ATC asked the crew to make a left turn to keep them clear of the city:

Haynes: *Whatever you do, keep us away from the city.*^[5]



Radar plot of the plane's last minutes, from the NTSB report.



Damage to the rear of the plane, from the NTSB report.

Landing was originally planned on the 9,000 foot (2743 m) Runway 31. The difficulties in controlling the aircraft made lining up almost impossible. While dumping excess fuel, the plane executed a series of mostly right-hand turns (it was easier to turn the plane in this direction) with the intention of coming out at the end lined up with runway 31. When they came out they were instead left with an approach on the shorter Runway 22 of 6,600 feet (2012 m), with little capacity to maneuver.^[3]

Fire trucks had been placed on runway 22,^[6] anticipating a landing on runway 31, and there was a scramble as the trucks rushed out of the way. Fortunately, all the vehicles parked there got out of the way before the plane touched down.

Fitch continued to control the aircraft's descent by adjusting engine thrust. With the loss of all hydraulics, the crew were unable to control airspeed independent from sink rate. On final descent, the aircraft was going 240 knots and sinking at 1850 feet per minute, while a safe landing would require 140 knots and 300 feet per minute. The aircraft began to sink faster while on final approach and veer to the right. The tip of the right wing hit the runway first, spilling fuel which ignited immediately. The tail section broke off from the force of the impact and the rest of the aircraft bounced several times, shedding the landing gear and engine nacelles and breaking the fuselage into several main pieces. On the final impact the right wing was sheared off and the main part of the aircraft skidded sideways, rolled over on to its back, and slid to a stop upside down on the right side of runway 22. A misconception that the aircraft "cartwheeled" wingtip-over-wingtip arose from the poor quality of the video and news reporters' initial interpretation of it.

111 people died in the crash. Most were killed by injuries sustained in the multiple impacts, but many in the middle fuselage section directly above the fuel tanks died from smoke inhalation in the post-crash fire, which burned for longer than it might due to delays in the firefighting efforts. 185 people survived the accident, the majority of them from the second-class seating ahead of the wings (one of the crash survivors died a month later of his injuries).^[5] Many passengers were able to walk out through the ruptures to the structure, and in many cases got lost in the high field of corn adjacent to the runway. As with the Eastern Air Lines Flight 401 crash of a similarly-sized Lockheed L-1011 in 1972, the inherent crashworthiness of newer wide-bodied air transports played a part in the relatively high survival rate, as well as the shallow angle of descent.



The plane landed askew, causing the explosion and fire seen in this still from an amateur video.

Causes

Investigation attributed the cause of the fracture of the fan disk to a failure of United Airlines maintenance processes to detect an existing fatigue crack.^[3] Post-crash analysis of the crack surfaces showed the presence of the penetrating fluorescent dye used to detect cracks during maintenance, indicating that the crack was present and should have been detected at a prior inspection. The detection failure arose from poor attention to human factors in United Airlines' specification of maintenance processes.

The crack in the fan disk was traced back to the Alcoa foundry from



Part of the DC-10's fuselage after the crash.

which the engine part was sourced. It turned out that there was a defect in elimination of gaseous anomalies during the purifying of the titanium disk ingot. An excess amount of nitrogen was in the material, causing a 'hard alpha inclusion' which did not melt at the same temperature as the rest of the titanium but passed through to the mold unmelted, resulting in a structure with nonuniform properties. During the engine's normal running cycle, this inclusion would expand at a different rate than the rest of the material, causing a tiny stress crack that grew slowly each time the engine was powered up and brought to operating temperature.^[3] Newer batches used much higher melting temperatures and a 'triple vacuum' process to eliminate these impurities.

The subsequent investigation and airworthiness directive also revealed several other fan disks already in service from the same batch of ingots which had started to exhibit the initial cracking symptoms of part failure.

Some portions of the aircraft that had broken away when the fan disk failed were later found in farm fields along the flight path.

Lessons learned

The National Transportation Safety Board investigation reported that after subsequent reconstructions of the accident in flight simulators, it was deemed that training for such an event involved too many factors to be practical. While some level of control was possible, no precision could be achieved and a landing under these conditions was stated to be "a highly random event". The NTSB further noted that "under the circumstances the UAL flightcrew performance was highly commendable and greatly exceeded reasonable expectations."^[3]

Because this type of aircraft control is difficult for humans to achieve, some researchers have attempted to integrate this control ability into the computers of fly-by-wire aircraft. Early attempts to add the ability to real planes were not very successful, the software having been based on experiments conducted in flight simulators where jet engines are usually modeled as "perfect" devices with exactly the same thrust on each engine. Later, programming was updated to compensate for the problem, and planes have been successfully flown with this software installed.^[7] However, it remains a rarity on commercial aircraft.

The odds against all three hydraulic systems failing simultaneously had previously been calculated as high as a billion to one, but a similar failure had occurred just four years previously when Japan Airlines flight 123 suffered a structural failure that left it without any hydraulic controls.

Newer aircraft designs such as the MD-11 have incorporated hydraulic fuses to isolate a punctured section and prevent a total loss of hydraulic fluid; this was also partially implemented on DC-10 models after the accident.^[5]

Of the four children deemed too young to have seats of their own (so called 'lap children'), one died from smoke inhalation. Despite the survival rate for the lap children being much higher than that of the passengers (75% versus 62.5%), the NTSB added a safety recommendation to the FAA on its "List of Most Wanted Safety Improvements," the response to which was flagged on NTSB's website as an "acceptable response, progressing slowly." It also sparked a campaign, led by United Flight 232's senior flight attendant, Jan Brown Lohr, for all children to have seats on aircraft.^[8]

Factors contributing to survival

Of the 296 people aboard, 111 were killed in the crash, while 185 survived. Captain Haynes later

told of three contributing factors regarding the actual time of day that allowed for a better chance of survival:

1. The incident occurred during daylight hours;
2. The incident occurred as a shift change was occurring at both a regional trauma center and a regional burn center in Sioux City, allowing for more medical personnel to treat the injured; and
3. The incident occurred when the Iowa Air National Guard was on duty at Sioux Gateway Airport, allowing for 285 trained personnel to assist with triage and evacuation of the wounded.

"Had any of those things not been there," Haynes said later, "I'm sure the fatality rate would have been a lot higher."^[9]

Notable survivors

- Spencer Bailey - Subject of a famous photograph showing Lt. Colonel Dennis Nielsen carrying the three-year-old survivor to safety. A statue in part of Sioux City's riverfront development is based on the picture. The 1994 memorial commemorates the rescue efforts by the Sioux City community following the crash, featuring contemplative areas and a tree-lined approach with plaques describing the incident.
- Jerry Schemmel - Radio announcer for the Denver Nuggets, an NBA basketball team. Also wrote a book about United Airlines Flight 232 titled *Chosen to Live*, and was credited with saving the life of a child in the crash.
- Michael Matz - Trainer of the 2006 Kentucky Derby favorite and winner, Barbaro. Also credited with saving the lives of four children in the crash, three of whom were in the same family.
- Dennis E. Fitch - A safety consultant to NASA as a member of the Aerospace Safety Advisory Panel and has been inducted into the Aviation Hall of Fame at the Smithsonian National Air and Space Museum. Also a DC-10 pilot and instructor, he helped Captain Al Haynes fly United Airlines Flight 232. "For the thirty minutes I was up there," Fitch said later, "I was the most alive I've ever been. That is the only way I can describe it to you."^[9]
- Joseph Trombello - Wrote a book about United Airlines Flight 232 titled *Miracle in the Cornfield*.
- Pete Wernick - Prominent banjo player with the Hot Rize group and instructor, was on his way to a festival in the Albany, NY area. Walked away with his banjo and took the next flight to make the gig.
- Jan Brown Lohr - United 232's Senior Flight Attendant. She was forced by regulation to ask parents with "lap babies" (children without seats) aboard flight 232 to place their children on the cabin floor during the flight's final moments before impact. Upon impact one of four children was killed. The deceased child's mother came to her at the crash site and stated "You



Spencer Bailey, a young survivor, being carried to safety by Lt. Colonel Dennis Nielsen after the crash.

told me to put my baby on the floor and now he's gone." Since then, Lohr has tirelessly lobbied in Washington D.C. to promote the safety of children on all civilian aircraft and airlines, asking that federal regulations require all children to have a seatbelt on every flight.^[8]

- Ron May - Legal Associate at Winston and Strawn who went on to be an Assistant U.S Attorney for the Northern District of Illinois and then became a Teaching Pastor at Park Community Church. He gave a very interesting, first person message about this experience and how he and others dealt with the last 20 minutes here.

In popular culture

The incident was the subject of the 1992 television movie, *Crash Landing: The Rescue of Flight 232*,^[10] (also known as *A Thousand Heroes*) and was also featured in an episode of *Seconds From Disaster* on the National Geographic Channel and *MSNBC Investigates* on the MSNBC news channel. It was one of the inspirations for Peter Weir's 1993 film version of *Fearless*, adapted from a novel by Rafael Yglesias.

In 1992 an album by Leather Strip titled *Solitary Confinement* was released by Zoth Ommog Records, including a track titled "Crash of Flight 232/93" which was inspired by this accident.

Survivor and musician, Pete Wernick gave his personal account of the days events in the song, "A Day in '89 (You Never Know)"; Wernick has yet to release a recording of the song, but has published the lyrics on his website.^[11]

The DC-10 crash in the 1991 Dean Koontz novel *Cold Fire* is based on this accident.

See also

- Japan Airlines Flight 123, a Boeing 747, lost all hydraulic systems due to a structural failure on August 12, 1985. The resulting crash killed 520 of the 524 people on board. Fitch stated he had been interested enough on reading of the earlier Japanese disaster to practice on flight simulators controlling the DC-10 using throttles only.
- ValuJet Flight 592, a McDonnell Douglas DC-9, lost all hydraulics due to a fire in the cargo hold on May 11, 1996. The pilots attempted to fly the plane using the engine throttles only, but the plane ultimately crashed at full speed into the Everglades.
- The DHL shutdown incident in Baghdad was the first and only in-service jet airliner to land safely without any hydraulics.
- Flying an airplane without control surfaces

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10. [^] Crash Landing: The Rescue of Flight 232. IMDB. Retrieved on 2006 September 15.
11. [^] Lyrics to Pete Wernick's "A Day in '89 (You Never Know)" from drbanjo.com (Wernick's official site)

External links

- Aviation-safety.net entry on UA 232
- Cockpit voice-recorder transcript (pdf) (NB contains error)
- A talk given by the pilot, describing the crash, at NASA Dryden in 1991
- Flight 232 Memorial depicting Lt. Colonel Dennis Nielsen carrying Spencer Bailey
- "Crash Landing: The Rescue of Flight 232" - TV movie
- "17th Anniversary Tribute of Flight 232"
- Google Video film of the crash landing

Warning: The following links contain strobing pop-up ads:

- Cockpit voice-recorder recording at time of impact
- Accident photos
- A detailed description of the accident

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