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Improper Control Inputs Cited In ATR 72 Bounced Landing

The captain took control from the first officer after the airplane 'skipped' on touchdown but did not take appropriate recovery action or conduct a go-around, the report said. Injuries and substantial damage resulted when the airplane bounced twice and veered off the runway.

FSF Editorial Staff

About 1450 local time May 9, 2004, an Avions de Transport Regional ATR 72 operated by Executive Airlines as American Eagle Flight 5401 skipped when it touched down on a runway at Luis Muñoz Marin International Airport in San Juan, Puerto Rico, U.S., bounced twice and veered off the runway.[1] The captain received serious injuries; the first officer, both flight attendants and 16 passengers received minor injuries; six passengers received no injuries. The airplane was substantially damaged.

In its final report, the U.S. National Transportation Safety Board (NTSB) said that the probable causes of the accident were "the captain's failure to execute proper techniques to recover from the bounced landings and his subsequent failure to execute a go-around."

At the time of the accident, Executive Airlines operated a fleet of 41 ATR 72s and eight ATR 42s from its major hubs in San Juan and Miami, Florida, U.S. The company provided scheduled passenger service under U.S. Federal Aviation Regulations (FARs) Part 121 to 40 airports in the Caribbean region.

The accident airplane had departed about 1415 from Mayagüez, Puerto Rico, for a scheduled flight to San Juan.

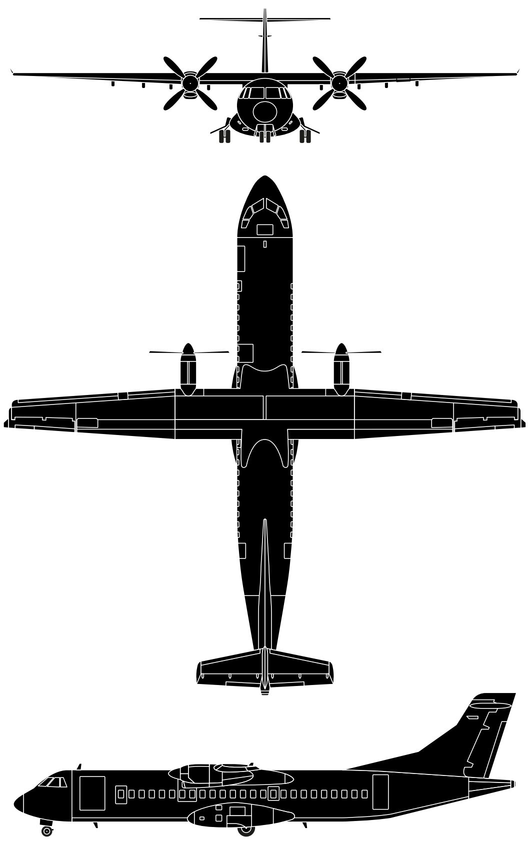
The captain, 33, held an airline transport pilot certificate and an ATR 42/72 type rating. He was a charter pilot and a regional airline pilot before being hired by Executive Airlines on Jan. 11, 1999. Company records indicated that he had 6,071 flight hours, including about 1,120 flight hours as pilot-in-command of ATR 42s and ATR 72s.

The first officer, 26, held a commercial pilot certificate. He was a flight instructor in Cessna 172s and Beech Barons before being hired by Executive Airlines on March 15, 2004. Company records indicated that he had about 2,000 flight hours, including 20 flight hours as second-in-command of ATR 42s and ATR 72s. The first officer had conducted eight landings in ATR 72s during his initial operating experience (IOE). The accident flight was his first scheduled flight after completing IOE.

The report said that the first officer's three most recent applications for an airman medical certificate did not indicate that he was being treated by a psychiatrist for anxiety.

"In July 2001, he began seeing the psychiatrist for treatment of various anxiety-related symptoms," the report said. "The psychiatrist prescribed alprazolam to treat the first officer's condition. Common side effects of alprazolam include drowsiness and light-headedness."

A form completed by the pilot when he began treatment for anxiety indicated that he was employed as a part-time flight instructor and that he aspired to become an airline pilot. In March 2004, the psychiatrist noted in the first officer's medical records that they had discussed "heightened anxieties surrounding … his intensive 'wind-down' training for full commercial jet pilot licensure" and that "we looked at creative as needed manipulation of alprazolam being mindful of … the need to stay alert."



Avions de Transport Regional ATR 72-210

Avions de Transport Regional (ATR) was formed from an agreement in 1981 between Aerospatiale (now part of EADS) and Aeritalia (now Alenia Aeronautica) to merge their individual efforts to design a twin-turboprop regional airplane. Deliveries of the first model, the ATR 42, began in 1984.

A stretched version, the ATR 72-200, was introduced in 1986. Its fuselage is 14.8 feet (4.5 meters) longer than the ATR 42's fuselage. The airplane is powered by Pratt & Whitney Canada PW124B engines, each rated at 2,160 shaft horsepower (1,611 kilowatts). The ATR 72-210, introduced in 1992, has PW127 engines, each rated at 2,480 shaft horsepower (1,850 kilowatts).

The ATR 72-210 accommodates as many as 74 passengers. Maximum takeoff weight is 48,501 pounds (22,000 kilograms). Maximum landing weight is 47,068 pounds (21,350 kilograms). Maximum operating altitude is 25,000 feet. Economy cruising speed at 23,000 feet is 248 knots. Maximum cruising speed is 284 knots at 15,000 feet.♦

Source: *Jane's All the World's Aircraft*

The first officer told investigators that he had taken alprazolam about 2000 the evening before the accident and that he had not taken alprazolam the day of the accident.

The accident airplane was manufactured in 1995 and delivered to AMR Leasing Corp. (Executive Airlines and AMR Leasing Corp. were owned by AMR Eagle Holding Corp.) At the time of the accident, the airplane had 19,276 flight hours and 18,086 cycles (takeoffs and landings).

Gross weight was about 36,590 pounds (16,597 kilograms) when the airplane departed from Mayagüez; maximum takeoff weight is 48,501 pounds (22,000 kilograms).

The first officer was the pilot flying. The airplane was in cruise flight at 7,000 feet at 1434, when the approach controller told the crew to descend to 6,000 feet and to expect clearance to conduct the instrument landing system (ILS) approach to Runway 10.

Visual meteorological conditions prevailed in San Juan. Weather conditions recorded by the airport's automated surface observing system included 10 statute miles (16 kilometers) visibility, scattered clouds at 2,300 feet, a broken ceiling at 3,400 feet and winds from 050 degrees at 15 knots, gusting to 23 knots.

At 1437, the approach controller told the crew to descend to 4,000 feet. The captain acknowledged the instruction and told the first officer that they probably would be cleared to circle to land on Runway 08.

"Ninety-nine percent of the time, approaches you do in San Juan are visual approaches," he said.

At 1441, the approach controller told the crew to turn left to a heading of 300 degrees to intercept the localizer and to reduce airspeed to 180 knots. The controller then told the crew to maintain 2,000 feet until established on the localizer and cleared them to conduct the ILS approach.

At 1443:03, the approach controller said, "You're four miles [seven kilometers] behind a Boeing seven twenty-seven; caution, wake turbulence."

The captain [who apparently believed that the controller had called the preceding traffic as a Boeing 757] told the first officer, "Get your speed back. You do not want to take wake turbulence from a seven five."

Analysis of recorded air traffic control (ATC) radar data indicated that, during the approach, the accident airplane and the B-727 were no closer than 4.3 nautical miles (8.0 kilometers) laterally, "which is greater than the minimum lateral separation specified in federal requirements," the report said.[2]

At 1443:44, the approach controller told the crew to reduce airspeed to 160 knots and to establish radio communication with the airport control tower. The cockpit voice recorder (CVR) transcript included in the report indicates that the captain acknowledged the instructions but did not immediately establish radio communication with the airport control tower.

At 1444:24, the captain told the first officer, "Get slowed down. I don't [want to] get too close to this thing."

The first officer said, "They said one sixty though, I thought."

"Yeah," the captain said. "Slow it down even more though. … You ever been rolled by a seven five seven? … I've had the [expletive] thing roll it like fifty-five degrees in an ATR. Scares the [expletive] out of the passengers."

"Oh, I'm sure it does," the first officer said.

"Yeah," the captain said. "All right. Just go about one forty."

At 1446:17, the captain told the tower controller that the airplane was established on the ILS approach to Runway 10 and that Runway 08 was in sight.

The controller cleared the crew to land on Runway 10. The controller said that there would be one departure before their arrival and that the crew of the B-727, which was one nautical mile (two kilometers) from Runway 10, had just reported a 10-knot decrease in indicated airspeed.

The captain asked the controller if Runway 08 was available for landing. After confirming that the crew had the runway in sight, he cleared them to conduct a visual approach and landing on Runway 08, which was 10,000 feet (3,050 meters) long and 200 feet (61 meters) wide.

The first officer turned the airplane left toward Runway 08 and used the visual approach slope indicator (VASI) to establish the airplane on glide path.

At 1448:06, the captain called out 1,000 feet. The first officer said, "All right. I'll wait till five hundred and I'll bring the autopilot off. … Little fast, correcting."

"All right," the captain said. "You're fine. Actually, it's better [that] you keep the speed up on this long runway, and you got traffic behind you doing about a hundred and fifty knots."

"OK," the first officer said. "Autopilot's coming off."

At 1448:57, the first officer said that the VASI indicated that the airplane was on the proper glide path.

"Looking OK," he said. "I'm just going to square it off here. Winds were … what?"

"Out of the east," the captain said. "But you better keep that nose down or get some power up, because you're going to balloon like [expletive]. Bring the power back to seventeen [percent torque]."[3]

At 1449:17, the airplane's terrain awareness and warning system (TAWS) issued a "minimums, minimums" aural advisory.[4]

The captain said, "Get your nose up."

At 1449:19, the TAWS issued a "glideslope" aural advisory.

The captain said, "Below the glideslope."

"Correcting," the first officer said.

At 1449:22, the captain said, "Power. You're going to balloon." A few seconds later, he said, "Power in a little bit."

Flight data recorder (FDR) data indicated that the airplane was about 45 feet above ground level (AGL) and that indicated airspeed was 110 knots — 15 knots higher than the landing reference speed (V_{REF}) — when the airplane crossed the runway threshold at 1449:30.

"Power in a little bit," the captain said. "Don't pull the nose up. Don't pull the nose up. … You're ballooning."

FDR data indicated that the airplane touched down 1,600 feet (488 meters) beyond the runway threshold at 1449:41 (Figure 1, page 4). Vertical acceleration (load) on the first touchdown was 1.3 g (i.e., 1.3 times standard gravitational acceleration), and the airplane skipped to four feet AGL.

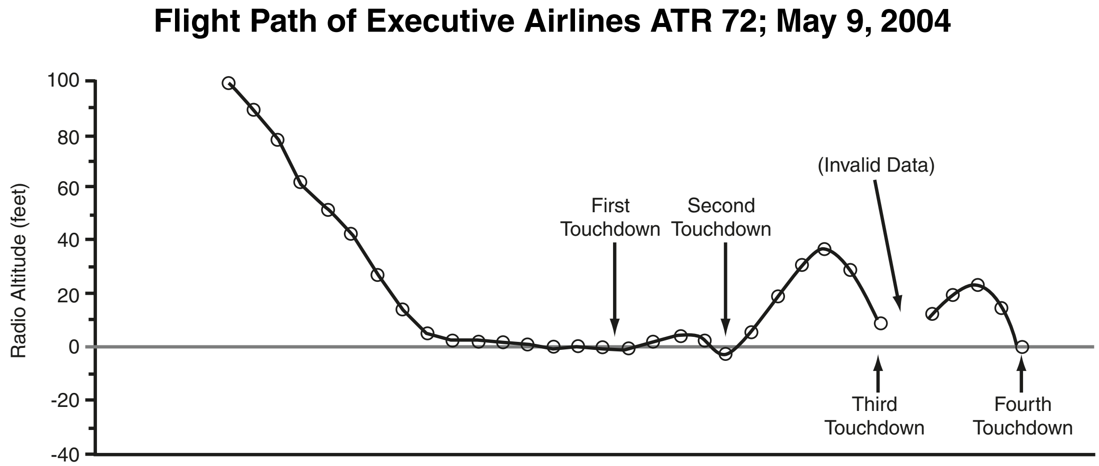
The report said that the flight crew could have conducted a successful landing after the airplane skipped.

"Only minor flight control inputs and/or slight power adjustments would most likely have been necessary to regain the proper landing attitude and settle the airplane back on the runway," the report said.

The captain said, "My airplane." The first officer acknowledged the transfer of control.

FDR data indicated that the captain "then made several abrupt changes in pitch and power," the report said.

At 1449:45, the CVR recorded the sound of a thump and one of the crewmembers saying, "God," as the airplane touched down again about 2,200 feet (671 meters) from the runway threshold. Pitch attitude increased to nine degrees nose-up, and engine torque increased from 10 percent to 43 percent as the airplane bounced to 37 feet AGL. Pitch attitude then



Source: U.S. National Transportation Safety Board

Figure 1

decreased to 10 degrees nose-down, and engine torque decreased to 20 percent.

The report said that these pitch corrections and power corrections were not appropriate and that the captain should have conducted a go-around.

Bank angle was seven degrees left-wing-down when the airplane touched down the third time about 3,300 feet (1,007 meters) from the runway threshold at 1449:51. When the left main landing gear struck the runway, its vertical velocity was between 19 feet per second and 32 feet per second. The left main landing gear, which was designed to absorb energy equivalent to a maximum vertical velocity of 10 feet per second at maximum landing weight [47,068 pounds (21,350 kilograms)], failed from overload.

Vertical acceleration recorded by the FDR during the third touchdown was 5 g.

"It is possible that the vertical loads experienced in the cockpit during the third touchdown were more than 12 g; however, this value could not be calculated because of the low FDR sampling rate," the report said.

Pitch attitude increased to 11 degrees nose-up as the airplane bounced to 24 feet AGL. Pitch attitude was seven degrees nose-down at 1449:56, when the airplane touched down the fourth time about 4,000 feet (1,220 meters) from the runway threshold.

"During the last touchdown, when the most substantial damage to the airplane most likely occurred (especially to the left side of the cockpit), the left bank angle recorded by the FDR was 29 degrees left-wing-down," the report said. "The average vertical loads experienced in the cockpit during the last touchdown could not be determined because the FDR data became unreliable at this point."

The airplane came to a stop on a grassy area about 217 feet (66 meters) left of the runway centerline and about 4,317 feet (1,317 meters) from the runway threshold.

The flight attendant in the forward section of the cabin decided not to open either of the emergency exits because she observed accident debris on the left side of the airplane and believed that the right emergency exit was too far above the ground. The passengers and crew exited through the main (aft, left) door.

An aircraft rescue and fire fighting (ARFF) specialist told investigators that he had been in an ARFF vehicle while observing the airplane's landing and that, when the airplane pitched up 'sharply' after the second bounce, he alerted the airport's ARFF stations.

"He then turned on the vehicle's beacon and siren, and visually tracked the airplane until it came to a complete stop," the report said. "He drove to the location where the airplane had stopped, [and] because he saw 'black and white' smoke coming from near the left engine, he 'hosed (it) down.'"

By 1500, several other ARFF vehicles, as well as several ambulances and fire trucks, had arrived at the accident site.

The report said that post-accident toxicological tests of the captain and first officer were negative for alcohol and illegal drugs.

"Company drug-and-alcohol testing also tested negative for alcohol and a wider range of drugs, including alprazolam," the report said.

The captain sustained a compression fracture of the first lumbar vertebrae. The report said that "at some point during the accident sequence, the captain's cockpit seat failed when it was subjected to vertical loads that exceeded those required for certification."

After the accident, the U.S. Federal Aviation Administration (FAA) revoked the first officer's medical certificate for allegedly falsifying his applications. The report said that insufficient information was available to "determine whether, or to what extent, the first officer's medical condition and prescription drug use contributed to the accident."

The manager of training and standards for Executive Airlines told investigators that no training on bounced-landing-recovery techniques had been provided to company pilots and that none of the company's manuals contained information on such procedures.

"The manager stated that he would not want to conduct bounced-landing-recovery techniques in a [flight] simulator because it is very difficult to demonstrate a bounce," the report said. "The manager stated that bounced-landing-recovery techniques could be addressed during pilot briefings [and] that, after the accident, Executive Airlines' president and vice president of operations asked him to look into the feasibility of conducting bounced-landing-recovery training and incorporating bounced-landing-recovery techniques in the company manuals."

During interviews by investigators, company simulator instructors and line check airmen cited various bounced-landing-recovery techniques.

"One simulator instructor stated that, if the airplane landed hard enough to bounce, the pilot should execute a go-around," the report said. "Another simulator instructor stated that a pilot should add power to recover from a bounce. A third simulator instructor stated that, if sufficient runway existed, the pilot should add power and land, and, if sufficient runway did not exist, the pilot should execute a go-around.

"A company line check airman stated that, if a first officer were to bounce the airplane on landing, he would take control of the airplane, apply power and go around. Another company line check airman stated that, if a bounced landing could be corrected safely, the pilot should proceed with the landing, and, if a bounced landing could not be corrected safely, the pilot should execute a go-around."

The report said that Executive Airlines in September 2004 revised its airplane operating manual to incorporate the following information:

> In the event the aircraft should bounce after landing, hold or re-establish a normal landing attitude and immediately add power as necessary to control the rate of descent. When using this recovery technique, exercise extreme caution not to increase the pitch attitude above normal as this will only increase the height of the bounce and may cause entry into stall warning. *Do not* push over, as this will only cause another bounce and damage the nose gear. If there is any doubt as to a safe recovery, the captain will call for and conduct an immediate go-around. Apply go-around power and fly the missed approach/rejected landing profile. *Do not* retract the landing gear until a positive rate of climb is established, because a second touchdown may occur during the recovery.

The report said that an informal survey of six airlines, an airplane manufacturer and a pilot-training facility "revealed that only some of the companies included bounced-landing-recovery techniques in their flight manuals and discussed these techniques during training. Most of the companies indicated that bounces commonly occurred during IOE check rides and that, when a bounce did occur, the check airman would provide verbal guidance to the pilot on how to recover the airplane."

Investigators found that left-aileron-position data recorded by the accident airplane's FDR were invalid. Aileron-position sensors and associated hardware had been installed in the airplane on Aug. 7, 2001, in accordance with Supplemental Type Certificate (STC) ST01310NY.[5]

"Executive Airlines stated that it added aileron-surface-position sensors to its 41 ATR 72 airplanes (two sensors per airplane, for a total of 82 sensors) in accordance with [the STC] and that, in the last 3.5 years, the company has replaced 47 of these sensors, which is a 57 percent failure rate," the report said. "The company also indicated that the sensors do not incorporate a warning [system] or an indication system [and that] sensor failures were typically caused by wear or weather-related damage."

The company had conducted functional checks of the FDRs in its airplanes every 3,000 flight cycles. The last functional check of the accident airplane's FDR had been conducted Jan. 3, 2003. After the accident, the company began conducting FDR functional checks every 1,000 flight cycles.

Based on these findings, NTSB made the following recommendations to FAA:

- "Require all [FARs] Part 121 and [Part] 135 air carriers to incorporate bounced-landing-recovery techniques in their flight manuals and to teach these techniques during initial [training] and recurrent training;
- "Require the replacement of aileron-surface-position sensors installed in accordance with [STC] ST01310NY with more reliable aileron-surface-position sensors within one year or at the next heavy-maintenance check, whichever comes first, after the issuance of an approved STC. Until reliable aileron-surface-position sensors have been installed, require flight data recorder

functional checks every six months and replacement of faulty sensors, as necessary; [and,]

- "Conduct a review of all flight data recorder systems that have been modified by [an STC] to determine the reliability of all sensors used as flight control surface-position sensors. If the review determines that a sensor does not provide reliable flight control surface-position data, require that the sensor be replaced with a more reliable sensor."

  [FAA had not responded to the recommendations as of Oct. 31, 2005.]♦

[FSF editorial note: This article, except where noted, is based on U.S. National Transportation Safety Board Aircraft Accident Report NTSB/AAR-05/02, *Crash During Landing, Executive Airlines (Doing Business as American Eagle) Flight 5401, Avions de Transport Regional 72-212, N438AT, San Juan, Puerto Rico, May 9, 2004*. The 118-page report contains illustrations and appendixes.]

Notes

1. The accident report said, "For the purposes of this report, the term *skip* refers to a landing airplane that momentarily becomes airborne after contact with the runway. A bounce is similar to a skip; however, the airplane reaches a higher altitude after contact with the runway. A skip or a bounce is typically caused by excessive airspeed or excessive back pressure being applied to the flight controls by the pilot."

2. The accident report said that U.S. Federal Aviation Administration (FAA) Order 7110.65, *Air Traffic Control*, required a minimum of 3.0 nautical miles (5.6 kilometers) lateral separation between the airplanes.

3. The accident report said, "The term *balloon* refers to a landing airplane that rises slightly before touching down. Ballooning is typically caused by excessive airspeed or excessive back pressure being applied to the flight controls by the pilot during the landing flare."

4. *Terrain awareness and warning system* (*TAWS*) is the term used by the European Joint Aviation Authorities and the FAA to describe equipment meeting International Civil Aviation Organization standards and recommendations for ground-proximity warning system (GPWS) equipment that provides predictive terrain-hazard warnings; *enhanced GPWS* and *ground collision avoidance system* are other terms used to describe TAWS equipment.

5. "Primary lateral control-surface position" is among the parameters that are required, by U.S. Federal Aviation Regulations Part 121.344, to be recorded by digital flight data recorders in turbine-powered transport category airplanes.

Further Reading From FSF Publications

FSF Editorial Staff. "Hard Landing Results in Destruction of Freighter." *Accident Prevention* Volume 62 (September 2005).

FSF Editorial Staff. "Stabilized Approach and Flare Are Keys to Avoiding Hard Landings." *Flight Safety Digest* Volume 23 (August 2004).

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