



## B-737 Strikes Terrain After Power Loss Occurs on Takeoff

*The airplane was near gross weight during departure from an Algerian airport. The left engine failed but the crew did not retract the landing gear. Pitch attitude for a normal all-engine initial climb was maintained, and airspeed decreased to stall speed.*

FSF Editorial Staff

At 1515 local time March 6, 2003, a Boeing 737-200 Advanced operated by Air Algérie struck terrain after an engine failed on takeoff in visual meteorological conditions from Aguenar Airport in Tamanrasset, Algeria. The two pilots, four flight attendants and 96 passengers were killed; one passenger received serious injuries.

The Commission of Inquiry established by the Algerian Ministry of Transport said, in its final report, that the probable causes of the accident were “the loss of an engine during a critical phase of flight, the non-retraction of the landing gear after the engine failure and the captain, the PNF [pilot not flying], taking over control of the airplane before having clearly identified the problem.”

The report said that the following factors contributed to the accident:

- “The perfunctory flight preparation, which meant that the crew were not equipped to face the situation that occurred at a critical moment of the flight;
- “The coincidence between the moment the [engine] failure occurred and the request [by the pilot flying] to retract the landing gear;
- “The speed of the event that left the crew little time to recover the situation;
- “Maintaining an inappropriate rate of climb, taking into account the failure of one engine;



- “The absence of any teamwork after the engine failure, which led to a failure to detect and correct parameters related to the conduct of the flight (speed, rate of climb, configuration, etc.);
- “The takeoff weight being close to the maximum with a high aerodrome altitude and high temperature; [and,]
- “The rocky environment around the aerodrome [being] unsuitable for an emergency landing.”

The airplane was scheduled to fly from Tamanrasset to Ghardaïa and Algiers. The captain, 48, had a public transport pilot’s license and 10,760 flight hours, including 1,087 flight hours as a B-737 captain. He also served as a Boeing 767 copilot for Air Algérie.

The copilot, 44, had a professional pilot’s license and 5,219 flight hours, including 1,292 flight hours in type.

Air Algérie had operated the airplane since it was manufactured in 1983. The airplane had accumulated 41,472 airframe hours and 27,184 cycles.

“No technical exemptions or deferred maintenance items applied to the airplane,” the report said. “On departure from Algiers, it had been subject to routine maintenance for a minor technical problem, a hydraulic pump having been changed in the Circuit B landing gear bay.”

The airplane had Pratt & Whitney JT8D-17A turbofan engines. The left engine had accumulated 30,586 operating hours and

20,040 cycles, including 6,729 operating hours and 4,285 cycles since its last overhaul in February 1999. The engine was installed on the accident airplane in November 2002. It had accumulated 285 hours and 355 cycles since a hot-section inspection was conducted in July 2002.



### Boeing 737-200 Advanced

The Boeing 737 originally was designed as a short-range jet transport that would use many components already in production for the B-727. Deliveries of the B-737-100 began in 1967. Fewer than 30 of the 100-series airplanes were built before the model was replaced with the B-737-200, which had a 193-centimeter (76-inch) longer fuselage and accommodated 12 more passengers. The B-737-200 Advanced, introduced in 1971, has aerodynamic improvements, including modified wing-leading-edge slats, Krueger flaps and engine-nacelle fairings.

Standard accommodation is for two flight crewmembers and up to 120 passengers. Standard maximum ramp weight is 52,391 kilograms (115,500 pounds). Maximum landing weight is 46,721 kilograms (103,000 pounds).

Pratt & Whitney JT8D-9A engines, each producing 64.5 kilonewtons (14,500 pounds) thrust, were standard. More-powerful JT8D-15 and JT8D-17 engines were options.

Maximum operating speed is Mach 0.84. Maximum cruise speed with JT8D-17 engines is 562 knots. Stall speed at maximum landing weight with flaps extended is 102 knots.♦

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

The right engine had accumulated 22,884 operating hours and 15,316 cycles, including 10,652 operating hours and 7,879 cycles since its last overhaul in January 1994. The engine was installed on the accident airplane in May 2001. It had accumulated 4,649 hours and 3,353 cycles since a hot-section inspection was conducted in January 2000.

Before the airplane departed from Tamanrasset, it was refueled with 5,840 liters (1,543 gallons) of fuel, bringing total fuel quantity to 12,696 liters (3,354 gallons). The report said that the airplane was within weight-and-balance limits. Takeoff weight was 48,708 kilograms (107,381 pounds); maximum takeoff weight is 49,500 kilograms (109,128 pounds).

The captain was late in arriving for the flight; the copilot conducted the preparations for the flight. The copilot requested and received authorization from the captain to fly the first leg of the flight. The copilot began conducting the "Pre-takeoff" checklist by announcing the selected takeoff speeds:  $V_1$  (takeoff decision speed), 144 knots;  $V_R$  (rotation speed), 146 knots; and  $V_2$  (takeoff safety speed), 150 knots. She was then interrupted by the captain, who was talking with the chief flight attendant. The report said that the presence of the chief flight attendant in the cockpit contributed to discontinuation of the checklist.

"This lack of rigor in the preparation of the flight was also noticeable during taxiing," the report said. "The CVR [cockpit voice recorder] shows that at no time was there any dialogue or briefing related to a possible anomaly during takeoff, as required in the Air Algérie procedures. The crew was not apparently sufficiently psychologically prepared to face any possible problems that might occur."

The airline's published one-engine-out departure procedure for Runway 02 called for a climbing left turn to a heading of 239 degrees after crossing the Tamanrasset very-high-frequency omnidirectional radio (VOR). [The VOR was approximately 1,940 meters (6,365 feet) from the departure end of the runway.] Airport elevation was 4,518 feet; the one-engine-out departure procedure chart depicted higher terrain (e.g., at 5,394 feet and 6,106 feet) north of the airport.

Surface wind was from 330 degrees at 12 knots when the crew were cleared to taxi to Runway 02, which was 3,600 meters (11,812 feet) long and 45 meters (148 feet) wide. (The airport had another runway, 08-26, that was 3,100 meters [10,171 feet] long and 45 meters wide.) Temperature was 23 degrees Celsius (74 degrees Fahrenheit).

The crew began the takeoff at 1513. Maximum thrust was applied, and the crew made the standard callouts.

"Rotation was performed at about 150 knots, just above the planned speed," the report said.

Flight data recorder (FDR) data indicated that the rate of climb was between 1,400 feet per minute and 1,800 feet per minute

after rotation, and nose-up pitch angle was about 18 degrees, which were normal for an all-engine climb, the report said.

The crew communicated in Arabic, English and French. At 1514:55, about five seconds after rotation, the copilot said, "Gear up." At the same time, the CVR recorded a sharp thumping noise. The airplane was 78 feet above ground level (AGL); airspeed was 158 knots.

The airplane yawed 12 degrees left, and a left-engine low-oil-pressure warning occurred.

"The crew, which had been in a routine flight situation, was suddenly confronted with an emergency situation that required high levels of alertness, coordination and concentration, a situation for which, as previously noted, they were not specifically prepared," the report said. "In this context, the captain did not read back the order to retract the landing gear and did not retract it. There was no announcement of the [engine] failure, no mention of any possible visual warnings such as the one associated with the oil pressure. ... Even the callouts related to flying the airplane (speed, climb rate, trim, etc.) were not made."

Performance calculations made during the investigation indicated that a significant reduction of thrust from the right engine occurred a few seconds after the left engine failed. The report said that the loss of thrust from the right engine "greatly reduced the performance of the airplane during initial climb."

The copilot made several exclamations and said, "What's going on?"

The captain told the copilot that he was taking over the controls. The captain then repeatedly said, "Let go," and "Take your hands off."

After verbally confirming that she was relinquishing the controls, the copilot offered to retract the landing gear. The captain did not respond. The report said that the captain might not have heard the copilot's offer to retract the landing gear because of his "sudden excess workload."

The airline's procedure for initial single-engine climb included retracting the landing gear when a positive rate of climb is achieved and maintaining a minimum airspeed of  $V_2$ . The report said that under the existing conditions (e.g., airplane gross weight, airport elevation and high ambient temperature), maintaining a positive rate of climb would have been difficult. With the landing gear extended and the high nose-up pitch attitude maintained, the accident airplane's aerodynamic performance decreased rapidly.

At 1515:04, the copilot told the controller that they had "un petit problème" (a small problem). Two seconds later, the CVR recorded the sound of stick-shaker (stall-warning-system) activation for one second. The airplane was at its maximum height, 398 feet AGL; airspeed was 134 knots.

At 1515:08, the CVR recorded stick-shaker activation for a half second. Two seconds later, a ground-proximity warning system (GPWS) warning, "Don't sink," was recorded.

"From that moment on, the stick-shaker is heard continuously until the end of the recording," the report said. "At [1515:15], a second GPWS 'Don't sink' aural warning is heard. The two recorders stopped just after that."

The airplane was 335 feet AGL, magnetic heading was 005 degrees, and airspeed was 126 knots when the CVR and FDR stopped recording.

"The shutdown of the flight recorders before impact occurred while the airplane was in a stall situation," the report said. "The shutdown is related to a loss of electrical power. The [investigation] was unable to identify the precise cause of this loss of electrical power."

The airplane struck terrain in a nose-high, right-wing-low attitude about 1,645 meters (5,397 feet) from where it lifted off the runway and to the left of the extended runway centerline.

"The airplane slid along, losing various parts, struck and knocked over the airport-perimeter fence, then crossed a road before coming to a halt in flames," the report said.

Most of the wreckage was consumed by fire.

"The chief flight attendant was found collapsed over the center console inside the cockpit," the report said. "The other cabin attendants as well as the passengers were in their places with seat belts attached. The severe fire that broke out immediately after impact left them no chance of survival."

"Only one passenger, seated in the last row and with [his] seat belt unattached, according to his statement, was ejected from the plane by the impact and escaped from the accident."

The accident was observed by several witnesses. A ground technician who had worked on the accident airplane told investigators, "Just after the takeoff, the plane swerved slightly to the left, then righted itself on the [takeoff] track; and, at that moment, I noticed that the plane was losing speed and altitude, still with its landing gear down until the moment of the crash, when there was a total explosion."

An airport-tower controller said, "Just after the takeoff from Runway 02, a kind of explosion was heard. The alarm was immediately activated. The pilot said, 'We have a small problem.' ... The plane began to fall and crashed near the threshold of Runway 20."

Debris from the left engine was found on the runway near the point at which the airplane lifted off. The report said that disassembly and examination of the engines produced the following findings:

- “The two engines showed no [signs of] uncontained failures and no indication of any fire;
- “The rotating parts of the cold [compressor] section of both engines showed deformations, significant on the right engine, less so on the left engine. This means that at the moment of impact with the ground, the latter was rotating at low speed, not developing any thrust;
- “The hot [combustion] section of the left engine had damaged components, corresponding to those found on the runway;
- “The [left] engine was not damaged by a foreign object; [and,]
- “The hot section of the right engine had some damaged components.”

Further examinations of the left engine and of the debris found on the runway indicated that the high-pressure turbine had failed. The report said that the right engine was rotating on impact; the investigation did not determine the power setting selected by the crew.

Based on these findings, the Court of Inquiry made the following recommendations:

- “Air Algérie, along with other operators, [should] ensure that their CRM [crew resource management] training programs effectively heighten crew awareness of the strict respect required for handover procedures and task-sharing;
- “The [Algerian] Civil Aviation and Meteorology Directorate [should] set up an organization to inspect the application and conformity of the procedures in training programs for flight crews;
- “The Civil Aviation and Meteorology Directorate [should] ensure that Air Algérie and other operators set up a flight safety program that associates feedback and the systematic analysis of flight data; [and,]
- “The Ministry of Transport [should] set up a permanent organization for the investigation of civil aviation accidents and incidents.”♦

[FSF editorial note: This article, except where specifically noted, is based on the Algerian Ministry of Transport Commission of Inquiry report no. 7t-z030306a: *Report on the Accident on 6 March 2003 at Tamanrasset to the Boeing 737-200 Registered 7T-VEZ Operated by Air Algérie*. The 62-page report contains illustrations and appendixes.]

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