



## Absence of Aircraft Load Data Cited in Failed Takeoff in Benin

*No documents accurately showed the B-727's weight and balance. The airplane's takeoff weight likely was higher and its center of gravity likely was farther forward than the values calculated by the flight crew. High-density-altitude conditions prevailed during the attempted departure from a relatively short runway.*

FSF Editorial Staff

At 1459 local time Dec. 25, 2003, a Boeing 727-200 operated by Union des Transports Africains (UTA) of Guinea struck a concrete building containing electronic equipment for localizer-signal transmissions during takeoff in visual meteorological conditions from Cotonou (Benin) Cadjèhoun Airport. The airplane then descended onto a beach and came to rest in the Bight of Benin. Approximately five crewmembers and 136 passengers were killed, and five crewmembers, 18 passengers and a technician inside the building received serious injuries. The airplane was destroyed.

An accident-investigation commission established by the government of Benin delegated the technical investigation to the Bureau d'Enquêtes et d'Analyses Pour la Sécurité de l'Aviation Civile (BEA, the French aircraft-accident investigation bureau).

In its final report, BEA said that the direct cause of the accident was "the difficulty that the flight crew encountered in performing the rotation with an overloaded airplane whose forward center of gravity [CG] was unknown to them."

The report said that the following were causal factors:



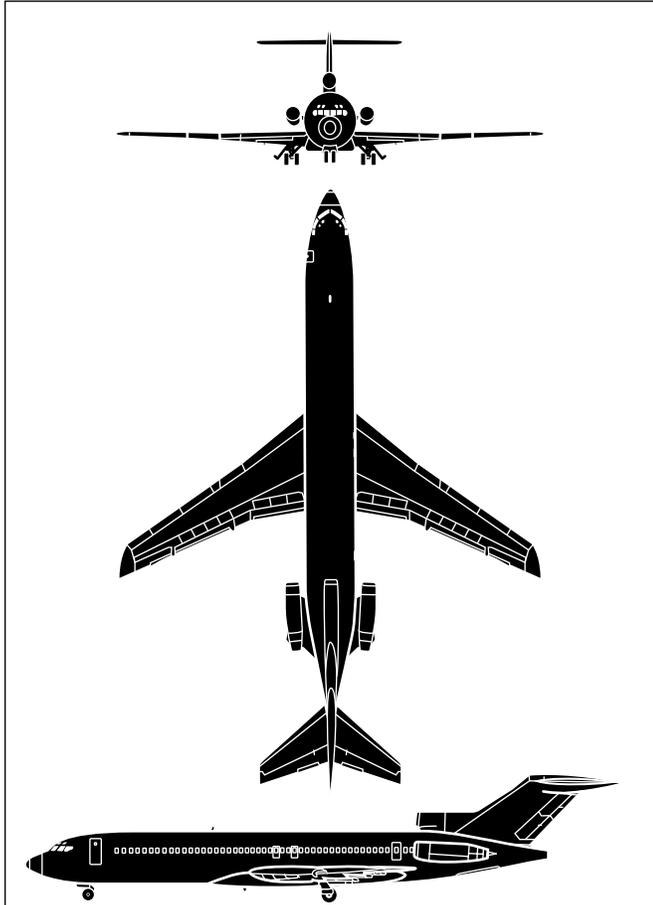
- "The operator's serious lack of competence, organization and regulatory documentation, which made it impossible for it both to organize the operation of the route correctly and to check the loading of the airplane; [and,]
- "The inadequacy of the supervision exercised by the Guinean civil aviation authorities and, previously, by the authorities in Swaziland, in the context of safety oversight."

The airplane was being operated on the second leg of a scheduled flight from Conakry, Guinea, to Cotonou; Kufra, Libya; Beirut, Lebanon; and Dubai, United Arab Emirates.

The captain, 49, held an airline transport pilot license (ATPL) issued by Libya in 1988. The report said that the captain's ATPL had not been validated by the Guinean Direction Nationale de l'Aviation Civile (DNAC, the Guinean civil aviation authority). The captain held a commercial pilot license issued by the United Kingdom in 1977 and validated by the DNAC in December 2003 for three months. He held type ratings in the B-727 and B-707, and had 11,000 flight hours, including 5,000 flight hours as a B-727 captain.

The copilot, 49, held an ATPL issued by Libya in March 2001 but not validated by the DNAC, and a commercial pilot license issued by the United Kingdom in 1979 and validated by the DNAC in December 2003 for three months. Investigators did not obtain information on the copilot's flight experience.

The flight engineer, 45, held a flight engineer license issued by Libya in 2002 and validated by the DNAC in December 2003 for three months. He had 14,000 flight hours.



### Boeing 727-200

The three-engine, short/medium-range B-727 was introduced into service in 1960. The B-727-200, introduced in 1967, is a "stretched" version, with three-meter (10-foot) fuselage extensions both forward and aft of the main landing gear wheel wells.

The airplane accommodates 163 passengers to 189 passengers (compared with 103 passengers in the B-727-100) and has a three-pilot flight deck. Maximum takeoff weight is 86,410 kilograms (190,500 pounds). Maximum landing weight is 72,576 kilograms (160,000 pounds).

Pratt & Whitney JT8D-9 turbofan engines, each flat-rated at 6,577 kilograms (14,500 pounds) thrust, were standard. JT8D-11 engines, flat-rated at 6,804 kilograms (15,000 pounds) thrust, and JT8D-15 engines, flat-rated at 7,031 kilograms (15,500 pounds) thrust, were options. ♦

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

The report said that the captain, copilot and flight engineer had flown as a crew for Libya Arab Airlines before joining Financial Advisory Group, which leased the B-727 to UTA.

Financial Advisory Group, which was based at the time of the accident in Miami, Florida, U.S., owned transport category aircraft that it leased to several operators. The accident airplane was managed by personnel in a Financial Advisory Group office in Sharjah, United Arab Emirates.

The airplane, manufactured in 1977, had accumulated 67,186 airframe hours and 40,452 cycles (takeoffs and landings). Flight hours accumulated by the three Pratt & Whitney JT8D-9A engines ranged from 66,503 to 81,485. The airplane had been operated by American Airlines from June 1977 to October 2001, when it was placed in storage. Financial Advisory Group purchased the airplane in January 2003. The airplane was operated by Ariana Afghan Airlines in Afghanistan and Alpha Omega Airways in Swaziland before it was registered in Guinea and leased to UTA in October 2003. As part of the lease agreement, Financial Advisory Group supplied UTA with flight crews and two aviation maintenance technicians, who accompanied the flight crew on the scheduled flights.

The flight crew had conducted their first flight for UTA on Dec. 8, 2003. During the 18 days preceding the accident, the captain, copilot and flight engineer had accumulated about 67 flight hours.

UTA had conducted flight operations in Sierra Leone from 1995 to 1997, when it established headquarters in Conakry.

"The majority of management posts at UTA, including that of director general, were filled by [people who did not have] any technical knowledge relating to air transport," the report said. "[The chief pilot's] area of competence was limited to the two low-capacity airplanes [an Antonov 24 and a Let 410 operated by UTA]. The chief pilot was not rated on [the B-727]."

UTA had been conducting local flights with the twin-turboprop Antonov 24 and Let 410 when it established a route from Conakry to Beirut and later extended the route to Dubai. The report said that company management likely "did not realize the extent of the leap forward in terms of means and organization that this development represented."

The report said that UTA set up "a regular route with just one aircraft and one crew, with no real technical support at the stopovers" and that "the extension of the route to Dubai ... was also done without analysis of the new operational implications of the decision. For example, it led the flight crew to systematically exceed the number of flying hours recommended by Guinea or set up by the operator."

DNAC had "supported and immediately passed on the request to open the route ... without obliging the operator to set up the

structure and generate the documentation required for these operations,” the report said.

The morning of the accident, the airplane departed from Conakry at 1107 with 86 passengers and 10 crewmembers, and arrived in Cotonou at 1325. Nine passengers disembarked. Investigators did not obtain an accurate count of the passengers who boarded the airplane for the flight to Kufra.

“Passenger boarding and baggage loading took place in a climate of great confusion,” the report said. “The airplane was full. In the cockpit, two UTA executives [one of whom was the director general] were occupying the jump seats. Faced with the particularly large number and size of the hand baggage, the chief flight attendant informed the captain of the situation.”

Ground-handling personnel began loading baggage into the aft hold but were told by an agent of the ground-handling company to load the forward hold, which already contained baggage.

“When the operation was finished, the [forward] hold was full,” the report said. “During this time, the crew prepared the airplane for the second flight segment. The copilot [discussed] his concerns [about weight and balance] with the UTA executives, reminding them of the importance of determining the precise weight of the loading of the airplane.”

The report said that cockpit voice recorder (CVR) data indicated that the copilot was angry and discontented.

“The sheets they gave us don’t have the load,” the copilot said. “The sheets they gave us don’t have the weight, only passengers. ... I tell you, it will be quite a performance if we manage to take off today.”

CVR data indicated that the flight crew decided to conduct the takeoff with 25 degrees of flap and with the air-conditioning units off. They planned to apply full power before releasing the wheel brakes, limit the initial nose-up pitch attitude to a maximum of three degrees to gain airspeed and conduct no turns until the airplane was over the water.

Weather conditions included surface winds variable from 130 degrees to 210 degrees at six knots, a few clouds at 1,500 feet, a broken ceiling at 2,500 feet, temperature 32 degrees Celsius (C; 90 degrees Fahrenheit [F]) and dew point 27 degrees C (81 degrees F).

As the airplane was being taxied to Runway 24, a flight attendant told the flight crew that “passengers who wanted to sit near their friends were still standing and did not want to sit down,” the report said. “The airline’s director general called the people in the cabin to order.”

At 1457:40, the airport tower controller cleared the flight crew for takeoff on Runway 24, which was 2,400 meters (7,874 feet) long and 45 meters (148 feet) wide, and had a 55-meter (180-foot) stopway.

CVR data indicate that the copilot (the pilot flying) called for takeoff thrust at 1458:01 and released the wheel brakes at 1458:15.

At 1458:24, the captain told the copilot to “push.” Flight data recorder (FDR) data indicate that this instruction was followed by forward movement of the control column.

The airplane had rolled about 480 meters (1,575 feet) at 1458:40, when the captain called “eighty.”

The airplane had rolled about 1,620 meters (5,315 feet) at 1459:00, when the captain called “V one, V R.” Airspeed was 137 knots.

The report said that although the copilot applied back pressure on the control column, the airplane’s angle-of-attack did not change. The airplane had rolled about 1,780 meters (5,840 feet) at 1459:03, when the captain said, “Rotate ... rotate ... more, more, more.” Airspeed was 140 knots.

The copilot increased back pressure on the control column, and the airplane lifted off the runway at 1459:07, after rolling about 2,100 meters (6,890 feet). Airspeed was 148 knots. Between 1459:09 and 1459:14, when the CVR recording ended, the captain said “pull” 11 times.

The report said that after the copilot had increased back pressure on the control column, angle-of-attack had increased slowly, and the airplane “had hardly left the ground” when it struck localizer antennas and the building 118 meters (387 feet) beyond the runway end. The building was on the extended runway centerline. The roof of the building was torn off by the airplane’s right main landing gear. Parts from the airplane’s tail and aft stairway later were found inside the building.

“The right main landing gear broke off and ripped off a part of the underwing flaps on the right wing,” the report said. “The airplane banked slightly to the right and crashed onto the beach. It broke into several pieces and ended up in the ocean.”

Some passengers had not fastened their seat belts. A surviving passenger told investigators that he saw people “fly around the cabin” after impact.

Breaking waves kept the wreckage near the shoreline, where water depth varied from three meters to 10 meters (10 feet to 33 feet). More than half of the airplane’s fuselage and the left engine were not found; the report said that they likely were covered with sand by strong water currents.

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When aircraft rescue and fire fighting (ARFF) personnel arrived at the accident site, they found survivors in the wreckage on the beach and in the water. The survivors — including the captain, flight engineer and the two UTA executives — were found seated in the forward section and the aft section of the airplane.

Fire fighters and emergency medical service personnel from Cotonou, and Red Cross personnel arrived soon after the ARFF personnel.

“After the accident, several thousand people went to the site, which interfered with the rescue operations, especially as the fire-service vehicles could not access the beach or became bogged down in the sand,” the report said. “There was no coordination between the staff of the various organizations concerned. The existing action plan was not put into effect. ... Fishermen helped to recover some victims.”

The report said that International Civil Aviation Organization (ICAO) standards and recommended procedures (SARPs) require that weight-and-balance sheets be prepared before a public transport flight to allow the captain to ensure that the airplane’s weight limitations and CG limits are not exceeded.<sup>1</sup>

“Two copies of the sheet are usually made, one to be kept on board and the other to be filed by the operator’s local agent,” the report said. “The weight-and-balance sheets for both flights on 25 December could not be provided to the investigators by the operator; [the operator could not provide] any of the general documents on the weight of the airplane or any loading plan for the departures from Conakry and Cotonou.”

The UTA agents who had provided information to the flight crew about the loading of the airplane had received no specific training, the report said. The company’s operations manual contained no detailed information on weight-and-balance calculations and limits.

“UTA was not able to produce [for investigators] any documents at all relating to the weight-and-balance calculation for any previous flight,” the report said. “It was incapable of indicating who was, in reality, responsible for supervising the loading of the holds and what such a person’s instructions or training might be.”

The report said that only the flight manifests were provided to investigators and that the flight manifests listed the passengers but not their seat assignments. The number of survivors and nonsurvivors accounted for at the accident site exceeded the number of passengers shown in the flight manifests.

“It is possible that there were some passengers on board who were not included on the manifests or that there were people on the beach at the time of the accident, even though the latter

seems less plausible since no disappearances were [reported],” the report said. “It is also likely that some errors were made in identifying the bodies.”

The report said that, based on the limited information that had been available on the airplane’s loading, the flight crew had calculated that the airplane’s takeoff weight was 78,000 kilograms (171,959 pounds) and that the CG was at 19 percent mean aerodynamic chord (MAC); these values were within the airplane’s weight-and-balance limits. The crew accordingly extended the flaps 25 degrees and used a horizontal stabilizer setting of 6 3/4 for takeoff.

Investigators calculated that the airplane’s takeoff weight was between 81,355 kilograms and 86,249 kilograms (179,355 pounds and 190,145 pounds). The calculated takeoff weight was lower than the maximum takeoff weight (86,410 kilograms [190,500 pounds]), but was “greater, by several tons, than the maximum acceptable value under the conditions of the day of the accident,” the report said.

Investigators conducted performance calculations based on a takeoff weight of 85,500 kilograms (188,493 pounds). The performance calculations indicated that the airplane’s CG was at 14 percent MAC, “a forward balance that would require a stabilizer setting of 7 3/4,” the report said. “Boeing specialists confirmed that such a center of gravity, if it were not taken into account in the elevator setting, would make the rotation slow and difficult at the speed selected [i.e., 137 knots for rotation].”

The building struck by the airplane was 2.45 meters (8.04 feet) high. The report said that because the building was constructed in the 1960s, it was not required by the ICAO

SARPs to be frangible [i.e., easily broken, to reduce aircraft damage in the event of a collision].<sup>2</sup>

The report said that ICAO SARPs require that before issuing an air operator certificate, an ICAO contracting state (nation) must ensure that the operator “has the organization and means available to guarantee the safety of operations, including a method for oversight of flights, a program of training for flight crew and satisfactory provisions in terms of maintenance, and that it diligently undertake any appropriate corrective measures, where necessary.”

In 1995, ICAO established a program to audit the safety oversight performed by contracting states: the program currently is called the Universal Safety Oversight Audit Program (USOAP).

“The audit reports are confidential and are handed over to the civil aviation authorities of the states concerned,” the report said. “ICAO makes available report summaries for other states

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that show any difficulties in the area of safety oversight that a state may have experienced at the time of the audit, along with the planned corrective measures. However, it does not provide an updated list of states that continue to present shortcomings in their obligations in this area.”

The report said that nearly one-third of the states audited through July 2004 had difficulty fulfilling their planned corrective measures, eight states did not submit a plan for corrective measures after their first audits and 12 states “could not be audited for various reasons.”

In January 2004, a follow-up to an audit of Guinea conducted in 2001 indicated that Guinea had not fulfilled planned corrective measures.

“At the time of the accident, Guinea had a civil aviation code and explicit references to international provisions but had not established the detailed regulations to put these into effect nor the necessary means and procedures,” the report said.

[During the 35th session of the ICAO Assembly in September 2004, ICAO introduced Working Paper (WP) 63, which proposed a strategy to assist states that are having difficulty resolving safety deficiencies identified by USOAP audits. The working paper recommended, in part, that states share critical safety information, establish regional partnerships to collaborate in the development of solutions to common problems, use the services of the ICAO Technical Cooperation Bureau to resolve deficiencies and use funding by the International Financial Facility for Aviation Safety to help finance measures necessary to correct deficiencies.<sup>3]</sup>

The report said, “The entire investigation and the analysis of the facts carried out by the BEA show the relevance of WP 63 and the importance of the voluntary application of its recommendations by the international community.”

Based on the findings of the investigation, BEA made the following recommendations to Guinea and other ICAO contracting states that issue air operator certificates:

- “Urgently draw up complete regulations in accordance with the recommended standards and practices relating to safety in aviation and ensure that they possess the structures and means necessary to enforce these regulations;
- “This complete set of national regulations requires the precise identification of the owner of aircraft operated and of the companies responsible for their maintenance, as well as the effective [establishment] of a flight safety program;
- “This complete set of national regulations [should] include a minimum time period for the examination of the statutory documents and ensure that no provisional

approval can be given, whether at the start of operations or when a new aircraft type enters service, if these documents are not complete and satisfactory from the point of view of operational safety;

- “The national civil aviation authorities [should] undertake a new and complete examination of the structures and capacities of a carrier each time that there is a significant change in its activity;
- “The national civil aviation authorities [should] undertake regular inspections of the various companies involved in the operation of an aircraft in commercial service;
- “The national civil aviation authorities [should] ensure that their aerodromes check the loading of aircraft and that a copy of the weight-and-balance sheet is filed with them; [and,]
- “The national civil aviation authorities [should] ensure that boarding cards are [seat-specific] and that they are checked on boarding.”

BEA made the following recommendations to ICAO:

- “The ICAO Council [should] vigorously follow up the actions to be taken as a result of the resolutions that the [ICAO] Assembly adopted in the area of safety by affirming its role as the lead actor and conductor where safety is concerned, and by endeavoring to ensure, where necessary, that states be made aware of their responsibilities in this area;
- “The ICAO Council [should] examine all of the provisions relating to safety oversight that are contained in the Chicago Convention and its various annexes, so as to identify any updates required — in particular, in relation to the role of the state of [the] operator and to the deletion of the distinctions made between scheduled flights and charter flights;
- “The ICAO Council [should] endeavor to clarify the notion of operator, given the various forms of aircraft leasing and agreements between carriers, in order to avoid the dispersal of responsibilities;
- “The ICAO Council, noting the inevitable complexity in regulations and documentation relating to safety oversight, [should] study the development of a guide, intended for those responsible at a national level for safety matters, that informs them in a structured manner of their responsibilities relating to safety and of the provisions for which they are responsible for ensuring compliance; [and,]
- “States that have a tradition of technical assistance, given the means at their disposal and their long and confident relations with other states, [should] study the relevance of

their current technical-assistance programs in the realm of safety and, where appropriate, reorganize them to support and complete ICAO's actions."

BEA made the following recommendations about autonomous systems for measuring the weight and balance of commercial airplanes:

- "The civil aviation authorities — particularly the FAA [U.S. Federal Aviation Administration] and EASA [European Aviation Safety Agency] — [should] modify the certification requirements so as to ensure the presence, on new-generation airplanes to be used for commercial flights, of on-board systems to determine weight and balance, as well as recording of the parameters supplied by these systems; [and,]
- "The civil aviation authorities [should] put in place the necessary regulatory measures to require, where technically possible, retrofitting on airplanes used for commercial flights of such systems and the recording of the parameters supplied."♦

[FSF editorial note: This article, except where noted, is based on the French Bureau d'Enquêtes et d'Analyses Pour la Sécurité de l'Aviation Civile (BEA) Report Translation 3x-o031225a, *Accident on 25 December 2003 at Cotonou Cadjehoun Aerodrome (Benin) to the Boeing 727-223 Registered 3X-GDO Operated by UTA (Union des Transports Africains)*. The

88-page report contains illustrations and appendixes. BEA said, "As accurate as the [English] translation may be, the original text in French should be considered as the work of reference."]

## Notes

1. International Civil Aviation Organization (ICAO) *Annex 6 to the Convention on International Civil Aviation: Operation of Aircraft, Part 1, International Commercial Air Transport — Aeroplanes*, paragraph 4.3, says, "A flight shall not be commenced until flight-preparation forms have been completed certifying that the pilot-in-command is satisfied that: ... (d) the [weight] of the aeroplane and the center-of-gravity location are such that the flight can be conducted safely, taking into account the flight conditions expected; [and] (e) any load carried is properly distributed and safely secured." Paragraph 4.3.2 says, "Completed flight-preparation forms shall be kept by an operator for a period of three months."
2. ICAO *Annex 14 to the Convention on International Civil Aviation: Aerodromes*, paragraph 9.9.2, says, "Any equipment or installation required for air navigation purposes which must be located ... on a runway end safety area ... shall be frangible and mounted as low as possible." Paragraph 9.9.3, says, "Existing nonvisual aids need not meet the requirement of 9.9.2 until 1 January 2010." ICAO defines *runway end safety area* as "an area symmetrical about the extended runway centerline and adjacent to the end of the strip [i.e., the runway and stopway, if provided] primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway."
3. ICAO Working Paper 63. Assembly—35th Session. Sept. 7, 2004.

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