



## Embraer Bandeirante Strikes Mountain Ridge During Trans-island Flight in Fiji

*Investigators could not determine the circumstances of the collision, but their accident report included findings of inadequate surveillance by the regulator and inadequate check-and-training procedures, standard operating procedures and record keeping by the operator. The report also said that the captain had insufficient rest before the flight and had consumed an 'above-therapeutic level' of antihistamine.*

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FSF Editorial Staff

Shortly after 0530 local time on July 24, 1999, an Air Fiji Embraer Bandeirante 110P1 (EMB-110) struck a mountain ridge during a planned 25-minute domestic flight in Fiji. The airplane was destroyed, and the two-member flight crew and 15 passengers were killed.

The Australian Transport Safety Bureau (ATSB), which conducted the investigation on behalf of the Civil Aviation Authority of the Fiji Islands (CAAF), said in its final report that although “the circumstances of the collision could not be established,” they were “consistent with an in-flight collision with solid objects.”

Nevertheless, the report said, “The investigation identified a number of factors that influenced the organizational environment, that is, the regulatory and company systems, and the operational environment in which the flight was conducted. These factors included inadequate surveillance by the regulator [and] inadequate check-and-training procedures, standard operating procedures and record keeping by the operator.”

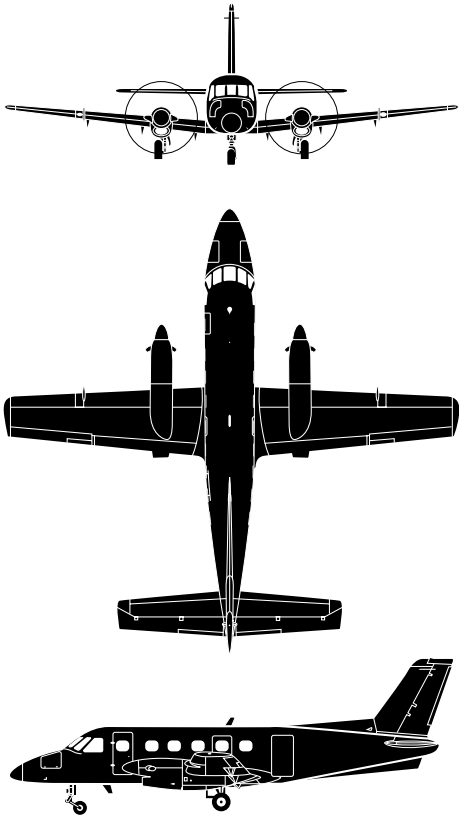
In addition, the report said that the captain “had insufficient rest prior to the flight” and that he “had consumed an



above-therapeutic level of antihistamine prior to the flight, which would have degraded his ability to safely pilot the aircraft.”

Other findings in the report said that:

- “Training records indicate that the co-pilot may not have asserted himself if he recognized that the pilot-in-command was having difficulties”;
- Neither the pilot nor the co-pilot had received training in crew resource management (CRM);
- Air Fiji’s company operations manual, last amended in 1995, “did not reflect the company structure or procedures at the time of the accident”;
- Air Fiji’s published standard operating procedures for the Bandeirante were “inadequate”;
- Air Fiji did not keep “records of personnel having completed weight-and-balance training or comprehensive records of [crews’] check and training, currency and recency reports and instrument renewals”;



### Embraer Bandeirante 110

The Embraer Bandeirante 110 (EMB-110) is a twin-turboprop light transport airplane developed during the late 1960s as a general-purpose aircraft to be used in air transport, navigation training and aeromedical evacuation flights. The first prototype was flown in 1968, and the first production Bandeirante was flown in 1972. The Bandeirante was certified by the Aerospace Technical Centre of the Brazilian Ministry of Aeronautics, and the first three were delivered to the Brazilian Air Force in 1973. More than one dozen other models have been manufactured since then.

The EMB-110P1, a quick-change version of the EMB-110P2 designed for passenger and cargo operations, has seats for up to 18 people, a crew/passenger door at the front of the cabin and a passenger/baggage door at the rear.

The wing span is 15.33 meters (50 feet 3 1/2 inches). Length is 15.10 meters (49 feet 6 1/2 inches). Height is 4.92 meters (16 feet 1 3/4 inches).

The Bandeirante has two 559 kilowatt (750 shaft horsepower) Pratt & Whitney Aircraft of Canada PT6A-34 turboprop engines with Hartzell HC-B3TN-3C/T10178H-8R constant-speed, three-blade metal propellers. Maximum fuel capacity is 1,720 liters (454 gallons).

Maximum takeoff and landing weight is 5,670 kilograms (12,500 pounds). Maximum cruise speed at 8,000 feet and 5,760 kilograms is 223 knots (413 kilometers per hour [kph]). Maximum rate of climb at sea level is 545 meters (1,788 feet) per minute. Maximum single-engine rate of climb at sea level is 131 meters (430 feet) per minute. Stall speed at 5,670 kilograms is 69 knots (128 kph).

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

- Air traffic control (ATC) “did not adhere to procedures as published in their *Manual of Air Traffic Services*, specifically with regard to search and rescue”; and,
- Before mid-1999, the CAAF flying operations department “had not conducted adequate surveillance of the industry.”

The accident airplane departed in darkness from Nausori on the east coast of the island of Viti Levu at 0525 local time on a flight to Nadi, located on the other side of a number of mountain ranges on the west coast, 124 kilometers (77 miles) away. Visibility at Nausori 25 minutes before departure was 40 kilometers (25 miles), with scattered clouds at 2,200 feet, but a pilot who left Nausori 10 minutes after the accident airplane said that, after takeoff, his airplane climbed through broken clouds up to 5,500 feet. The clouds extended for 55 kilometers (34 miles) along the route of flight. A witness at the Nausori airport said that, immediately after departure, the accident airplane was flown to the right of the direct track to Nadi but that a correction apparently was made.

At 0526, Nausori ATC told Nadi ATC of the airplane’s departure and said that Nadi ATC should expect the crew to contact them at 0535.

At 0532, the crew told Nausori ATC that the airplane was 14 nautical miles (25.9 kilometers) from Nausori and climbing through 5,500 feet.

At 0533, the crew told Nausori ATC that the airplane was maintaining 6,000 feet on a direct track to Nadi. (The published minimum safe altitude for the route is 5,400 feet.) ATC responded and instructed the crew to contact Nadi ATC at 0535.

(In 1995, ATC in Fiji had begun using the global positioning system [GPS] Harris Aries system, an aircraft-based and ground-based ATC system that used the GPS unit in an aircraft to transmit to ATC positional data derived from GPS satellites. The system allowed ATC to monitor aircraft positions without a radar infrastructure. When the accident occurred, the system was out of service.)

Shortly after 0530, a resident of the village of Delailasakau, said that she heard “an aircraft that sounded closer than normal, with an unusual engine sound. The resident then went outside and observed an aircraft until it disappeared from her field of view. Several seconds later, she observed a bright flash and heard the sound of an explosion. The resident began to wake people in the village and ran to the next village to wake the radio operator to report the aircraft accident.”

When the crew did not contact Nadi ATC at 0535, controllers contacted Nausori ATC and were told that controllers in Nausori had had no further contact with the crew.

At 0543, Nadi ATC tried to contact the crew. There was no answer from the accident airplane's crew, but the crew of another Air Fiji airplane that had departed from Nausori for Nadi at 0535 responded and then attempted unsuccessfully to contact the crew of the accident airplane. Nadi ATC then asked the crew of the second airplane to monitor the emergency frequency, which would have received transmissions from an emergency locator transmitter (ELT). No transmission was heard.

The ATC staff at Nausori later said that, because they received no ELT transmission, they assumed that the aircraft may have experienced a radio equipment failure and either was continuing to Nadi or returning to Nausori, the report said.

At 0700, Nadi ATC received a telephone call from a controller in Nausori, who said that a witness had reported, by radio telephone, that an aircraft had struck terrain about three kilometers (1.9 miles) from Delailasakau. Police records said that an airport security guard had told police about the accident report at 0731. At 0758, an Air Fiji pilot began a search for the airplane and reported at 0816 that the wreckage had been located.

The main wreckage, including most of the fuselage, the left wing, the left-main landing-gear assembly, the left engine and propeller and the nose landing-gear assembly, was found on the southeastern slope of a ridge 41 kilometers (25.5 miles) west of Nausori and about three kilometers south of the direct track from Nausori to Nadi. The horizontal stabilizer was found on the southeastern side of a higher peak 300 meters (984 feet) southwest of the main wreckage, with the rudder about 50 meters (164 feet) away. Parts of the right wing, the right-main landing-gear assembly and the right engine and propeller were found 200 meters (656 feet) from the horizontal stabilizer.

The airplane's final flight path was in a northeastern direction, descending at a 40-degree angle.

"The locations in which the components were found suggested that the aircraft began to break up and separate shortly before impacting the trees and ridge," the report said.

Damage to the leading edge of the right wing was significant, and about one meter (3.3 feet) of the leading edge had been torn away. The right-wing main spar had fractured 2.2 meters (7.2 feet) inboard from the wingtip and was deformed at the fracture point for about 10 centimeters (3.9 inches) back. The deformation was "consistent with a collision with a solid object," the report said. The main spar and rear spar also had fractured in three locations; the fractures exhibited rearward and upward bending that is characteristic of a wing exposed to stresses that exceeded its structural strength.

In-flight stresses resulting from the loss of the right wing caused the empennage to separate from the fuselage immediately before the final impact. The right engine and propeller also separated from the airplane before the final impact, and during the final impact sequence, most of the aircraft collided with trees before striking the ground "inverted on its right side."

"Examination of the engines and propellers indicated that both engines had been operating under power during a collision with one or more objects," the report said. "Although the witnesses reported an unusual engine sound while observing the aircraft, no evidence of a pre-existing defect with the aircraft or its systems, that may have influenced the circumstances of the accident, was found."

There was no evidence of an explosion or fire. The "bright flash" in the sky reported by the Delailasakau witness could have resulted from "a possible air burst of fuel vapor as sections of the right wing, incorporating fuel tanks and electrical cables, separated from the fuselage," the report said.

The airplane, which was manufactured in 1983, was maintained in accordance with the manufacturer's procedures, and there was no evidence of any fault in the airplane that might have contributed to the accident. In 1985, the manufacturer had issued an airworthiness directive (AD) calling for deactivation of the autopilot system and the electric-elevator-trim system on Bandeirante aircraft. The AD was withdrawn in 1988, but aircraft maintenance logbooks did not indicate that either system was reinstated on the accident airplane. Air Fiji advised pilots not to use the autopilot

because it was unserviceable, but investigators could not determine whether the systems had been isolated properly or placarded as "unserviceable." There was no indication that the trim system had contributed to the accident.

Weight-and-balance documents indicated that the airplane was within weight-and-balance limitations.

The airplane was not equipped with a flight data recorder or a cockpit voice recorder, and regulations did not require them.

Investigators found no record that ATC staff implemented the procedures in their *Manual of Air Traffic Services*, which required them to declare an "uncertainty phase" if a pilot failed to report within 15 minutes of a pre-arranged frequency change and an "alert phase" if subsequent communication checks and other inquiries "fail to reveal any news of the aircraft" or if the uncertainty phase exceeded 30 minutes.

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“The delay of two hours and 20 minutes from the time at which the aircraft became overdue to the declaration of a distress phase by ATC directly resulted from staff not adhering to procedures,” the report said. “The reason for this non-adherence could not be positively established. However, ATC officers apparently relied on the activation of the emergency locator transmitter (ELT) to prompt them to initiate a search-and-rescue (SAR) phase. The ELT was not recovered, as it is probable that it was destroyed during the impact sequence or buried beneath wreckage, which would have prevented it from operating satisfactorily due to shielding.”

Without radar service, ATC could monitor aircraft positions only by flight crew position reports. If the GPS Harris Aries system or a similar system had been working, ATC would have known “almost immediately that a significant event had occurred to [the accident airplane],” the report said. “Such an alert would have enabled a rapid response which would be critical in the circumstances of a survivable accident.”

Air Fiji employees were concerned when the airplane did not arrive at Nadi as scheduled, but no action was taken until a company pilot returning from a scheduled flight decided at 0758 to search for the missing airplane.

The report said that if the airline had implemented an appropriate company flight-following system, “with clearly defined procedures to be adhered to in the event of an aircraft encountering difficulties or becoming overdue,” Air Fiji would have been able to initiate SAR activities sooner.

Fiji had been included in a 1992–93 project by the International Civil Aviation Organization (ICAO) to help nations in the Pacific region develop more efficient SAR services. The project recommended that each nation establish a national SAR plan. When the accident occurred, Fiji’s national SAR plan had not been implemented. If the plan had been in place, the report said, a national SAR coordinator “would or should have coordinated SAR resources on receipt of a report from the villager, ATC or police.”

The 26-year-old captain had a commercial pilot license and 4,500 flight hours, including 1,000 hours in Bandeirantes. He completed captain training in the Bandeirante in May 1998 and was approved to conduct line training of other pilots in Bandeirantes in June 1999.

The day before the accident, the captain had driven to Nadi and rested at a relative’s house from 1600 until 2000, when he met a friend arriving at the airport on an international flight. The two then drove three hours to Suva and spent time together until 0200 on the morning of the accident. Shortly after 0430,

a colleague drove the captain to work. Later, he said that the captain had appeared quieter than usual.

After he arrived at the airport, the captain went directly to the aircraft without engaging in flight planning.

Relatives said that the captain appeared to have been in good health. A toxicology test, however, revealed “above therapeutic levels” of chlorpheniramine, which medical specialists described as “a sedating antihistamine which may exacerbate fatigue and affect concentration, alertness, vision, decision making and psychomotor skills.”

The report said, “The advice [from the medical specialists] reported that the pilot would have been significantly sedated and probably suffered visual disturbances and a decreased mental alertness which may have affected his judgment.”

If the captain had consumed antihistamine because of a respiratory ailment, he also may have experienced pain in his sinuses or ears because of air pressure changes during the flight, the report said.

“The pilot-in-command’s apparently out-of-character behavior immediately prior to the flight, and the report of the aircraft initially turning right after takeoff, suggest that the pilot was experiencing difficulty,” the report said. “This apparent difficulty may have been the result of fatigue, compounded by the medication or an illness. As the co-pilot was making all of the recorded radio transmissions, it is likely that the pilot-in-command was the handling pilot for that sector. If he was experiencing difficulty controlling the aircraft under instrument meteorological conditions, he

may have become [disoriented].”

The 25-year-old first officer had a commercial pilot license and 1,616 flight hours, including 400 hours in Bandeirantes. He was described as enthusiastic about having achieved captain’s status in another aircraft type earlier in July 1999 but had not assumed those duties. Training records included comments about his “shyness and lack of confidence,” and a check-and-training captain had written: “Still has problem in communicating. Must overcome this.”

The first officer was reportedly in good health and was taking no medication. He had two days off and slept late the morning before the accident flight. The night before the accident, he had about five hours of sleep and arose at 0300. The toxicology report revealed no abnormalities.

Neither pilot had received CRM training. (Air Fiji had offered CRM courses until about two years before the accident and

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planned to reintroduce them later in 1999.) The report said that, because effective CRM requires the first officer to be assertive under specific circumstances and because the first officer had been described as shy, “it is likely that due to a lack of CRM training, the co-pilot would not have responded in an adequately assertive manner had the need arisen. In the circumstances of this accident, it is possible that early intervention by the co-pilot may have prevented the accident.”

Flight crew records showed that both pilots had received perfect scores at every line check during their years at Air Fiji. The most recent instrument renewals, currency and recency records and base check reports contained no comments indicating that there were concerns about the pilots’ abilities.

Nevertheless, one Air Fiji staff member told accident investigators, “When commencing employment with the company, a staff member encountered poor procedures, such as line pilots being promoted to checking and training responsibilities and management positions without formal assessment. He commented that no one has ever failed a check ride, as the examiner doesn’t want to embarrass the candidate with a fail ... .”

The report said that the airline’s operational management was “deficient in that pilots had been cleared to current positions or promoted to positions of higher responsibility, including check and training, without appropriate assessment of their ability to perform at that level. Consequently, some check-and-training pilots did not possess the required skills to properly assess flight-crew competencies but instead applied superficial procedures to provide an apparent compliance with the regulations.”

The report also said that an accurate assessment of the skills of the accident airplane’s crew was impossible because of inadequate records, “particularly the absence of substantiating comments” in their training records.

During the investigation, other Air Fiji employees said that the airline had no standard operating procedures for Bandeirantes and that there were no records of personnel who had completed weight-and-balance training and no centralized record of the aircraft types on which pilots were endorsed or current.

The lack of standard operating procedures “led the pilots to improvise their own procedures,” the report said. “This was evident in the lack of adherence to standardized speed and power settings for Bandeirante aircraft for the climb sequence. It was also evident in a lack of professionalism by the crews (e.g., smoking in the vicinity of aircraft, inappropriate procedures for the loading of passengers with an engine operating and inadequate fuel-checking practices).

One pilot told accident investigators that he had received no training in multi-crew procedures and that he was not aware of his responsibilities as captain or of his first-officer’s responsibilities.

“When questioned regarding [CRM] training, the pilot was unfamiliar with the concept and practice of CRM,” the report said. “He commented that he had not yet sighted a company operations manual. The pilot stated that other pilots with the rank of captain had warned him to watch his co-pilots closely, as they do not cope with high workloads or unusual situations.”

A check of several company operations manuals showed that they had not been amended to include changes in the structure of the company since 1995.

A representative of the airline said that, during the 18 months before the accident, 16 new pilots were hired, increasing the pilot roster by more than 40 percent.

The report said, “This meant that an additional 40 percent of pilots over the preceding 18 months would have required training and supervision, with many of them requiring aircraft type-endorsement training as well as routine checks.”

Without adequate records or standard operating procedures, however, check-and-training pilots and airline management would have had difficulty monitoring the progress of the new pilots, the report said.

CAAF regulates civil aviation, including the issuance of licenses and certificates for airlines conducting commercial air service. CAAF has given airline check-and-training pilots the authority to renew instrument ratings and conduct recurrent flight reviews. CAAF is required to conduct surveillance checks “to ensure the maintenance of aviation standards and regulations.”

A CAAF officer said that surveillance checks had been conducted since the beginning of 1999, but before the accident, there had been only one inspector available to conduct the checks. He said that, at one time, CAAF had conducted “industry information days,” but they were ended because of a shortage of resources. When the accident occurred, no formal mechanism existed to allow confidential reporting of air safety incidents by aviation personnel.

The report said that CAAF’s operational surveillance was “ineffective” because of “inadequate allocation of qualified resources.” Creation of a safe environment depends on allocation of resources to allow for scheduled visits and unannounced visits to airlines, including line-flying with crews, the report said.

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“This would have served to promote a working relationship with the industry, ensured that the industry was fully complying with the regulations and highlighted deficiencies in the regulations and their interpretation by the industry,” the report said.

A CAAF officer cited several aviation safety issues, including:

- “Selection and promotion of aircrew based on ethnic origins, rather than ability and experience”;
- “Generally low standard of flying skills and airmanship”;
- “Lack of communication between multinational crews while in the cockpit”;
- “Lack of a responsible attitude by aviation personnel across the industry, including pilots, ground staff and engineers, towards their work”;
- “Reticence of pilots to seek assistance or clarification from senior management or the government authorities.”

Legislation says that CAAF also is responsible for investigating aviation accidents that occur in Fiji. The report said, however, that during the accident investigation, “it was found that the legislation ... made no provision for complying with investigation requests submitted by the investigation team. Additionally, there was no power available to the inspector to delegate authority to nominated individuals to assist with an investigation.”

When investigators first arrived at the accident scene, police officers prevented them from beginning their investigation; consultations with local authorities were required. Two days later, villagers denied investigators access to the site; more consultations were required before the investigative team gained full access to the site — five days after arriving in Fiji. By then, heavy rains hampered access and retrieval activities and may have contributed to a loss of evidence.

After a number of aviation accidents and serious incidents in Fiji during the 1980s, the government asked the New Zealand Office of Air Accidents to review aviation safety in Fiji. The resulting report, *The Safety of Air Transport Within Fiji*, cited “inadequate supervision, standard operating procedures and training of flight crews” and “inadequate resources and consequently [inadequate] surveillance of the industry by CAAF.”

A subsequent investigation by CAAF of a series of aviation accidents in Fiji during the 1990s yielded findings of “inadequate supervision, standard operating procedures, and inexperience of flight crew” and “the need for CAAF to increase surveillance of the aviation industry.”

The report said that, despite those recommendations, surveillance had been ineffective in addressing problems

involving standard operating procedures, flight-crew inexperience and training and regulatory oversight.

“The environment in which Air Fiji operated should have been strongly influenced by an effective regulatory oversight,” the report said. “However, the environment was characterized by infrequent and superficial surveillance visits by CAAF, which resulted in Air Fiji determining their own responses to safety issues within the company. This is evidenced by inadequate management of operational documentation and standard operating procedures.”

The report also said that the crew operated in an environment that was influenced “by the cultures of the company, the regulator and the Fijian community” and that the environment helped determine the pilots’ attitudes about adhering to standard operating procedures; referring to company documents, including the company operations manual, for guidance; complying with regulations; and assessing their own fitness to fly.

As a result of the accident investigation, ATSB recommended that:

- The Fiji government ensure that CAAF “is adequately resourced with well-qualified and experienced personnel to ... conduct frequent comprehensive scheduled and unscheduled audits of all commercial aircraft operators ... and conduct regular regional operational safety education meetings for line pilots and aircraft maintenance engineers. These meetings should target current safety concerns, such as adherence to standard operating procedures and [CRM] practices”;
- CAAF and the operator “ensure that the company operations manual properly reflects the organizational structure and operational function of the company. This should include the requirement that no personnel management changes likely to affect the operational safety and integrity of the company be implemented prior to approved amendment of the operations manual”;
- CAAF and commercial aircraft operators develop “appropriate recurrent [CRM] training programs ... [that] take account of the various cultural influences that may otherwise mitigate against successful implementation of such training”;
- The Fiji government “engage the services of an internationally recognized emergency-response specialist. The specialist should examine all aspects of the response capability of government and non-government agencies. The review should include an assessment of the adequacy of communication resources and procedures”;

- The Fiji government “ensure that there are appropriate procedures in place to enable timely and accurate toxicological information to be obtained”;
- CAAF “ensure that procedures contained in the *Manual of Air Traffic Services* for the alerting of emergency-response agencies adequately meet their intended purpose. Particular reference should be made to establishing appropriate time frames for the various response phases”;
- Operators “ensure that the position of chief pilot is accorded executive authority and support to enable full accountability for the safe operation of aircraft in accordance with the company operations manual”;
- Operators review flight-following procedures “to ensure that aircraft flight progress is adequately monitored and that emergency-response agencies are promptly advised when uncertainty exists as to the safety of an aircraft”;
- The Fiji government “implement an [ATC] aircraft-monitoring system using appropriate technology”;
- The Fiji government and CAAF “examine the feasibility of requiring operators to fit and carry operative flight data [recorders] and cockpit voice recorders on commercial aircraft of 15 or more passengers”;
- The Fiji government implement specific recommendations from the ICAO report on *Pacific Search and Rescue Special Implementation Project*;
- The Fiji government “consider putting in place arrangements with countries that are able to assist with aircraft accident investigations”; and,
- CAAF “consider setting up a confidential reporting program.”

The report said that, during the investigation, CAAF wrote to the investigators to outline actions that had been initiated after the accident, including an increase in surveillance of the industry, a review of CAAF resources and structure, the appointment of a new controller of air safety, the recruiting of

new staff members for the flight safety unit, the training and placement of Fijian nationals in substantive positions, and the reactivation of regular regional operational safety education meetings with aircraft operators and pilots. Other actions included notifying the industry of specialists available for CRM training, seeking approval for publication of mandatory occurrence reports to “show general trends in aviation safety and highlight lapses in safety standards,” developing a confidential incident-reporting system, reviewing rules on the use of alcohol and other substances by flight crews, developing minimum-requirement documents that are specific for local environments, and meeting with the airport operator to discuss reinstatement of the GPS Harris Aries system.

During the investigation, Air Fiji wrote to the investigators to outline actions initiated after the accident, including reviews of pilot flight times and duty times, including allowances for taxi time, and reviews of record keeping for flight times and duty times; limiting pilots to eight flight sectors a day and eight hours of flight time; requiring a minimum of 10 hours of rest, “which must include the hours 2300–2400 and extended rest periods if the duty times exceed 11 hours”; requiring pilots to live within a 45-minute drive of Nausori airport; and imposing financial penalties against company pilots who do not adhere to procedures.

During the investigation, Strategic Air Services, which provides ATC services in Fiji, wrote to investigators to outline actions initiated after the accident, including requiring controllers to “‘transfer/release’ aircraft at a specific time, position or level and to discontinue the practice of ‘transfer on contact’ or ‘release to be advised’”; producing a flow chart that includes notification procedures for internal and external agencies; amending the operations manual to include activation of the appropriate SAR phase in situations of en route communications failure; introducing a safety management system that includes a manual, handbooks, software and staff training; and providing refresher training in “emergency procedures and timely activation of SAR phases” for controllers, supervisors and managers. ♦

[FSF editorial note: This article, except where specifically noted, is based on *Investigation Report: Embraer EMB-110-P1 Bandeirante DQ-AFN, 24 July 1999, Delailasakau, Republic of Fiji Island*. The 25-page report includes maps and a photograph.]

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