National Transportation Safety Board
Aviation Accident Final Report

Location:	La Alianza, PR	**Accident Number:**	ERA14MA060
Date & Time:	12/02/2013, 2010 AST	**Registration:**	N831BC
Aircraft:	FAIRCHILD SA227-AC	**Aircraft Damage:**	Destroyed
Defining Event:	Aircraft structural failure	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled		

Analysis

The captain and first officer were conducting an international cargo flight in the twin-engine turboprop airplane. After about 40 minutes of flight during night visual meteorological conditions, an air traffic controller cleared the airplane for a descent to 7,000 ft and then another controller further cleared the airplane for a descent to 3,000 ft and told the flight crew to expect an ILS (instrument landing system) approach. During the descent, about 7,300 ft and about 290 kts, the airplane entered a shallow left turn, followed by a 45-degree right turn and a rapid, uncontrolled descent, during which the airplane broke up about 1,500 ft over uneven terrain.

The moderately loaded cargo airplane was not equipped with a flight data recorder or cockpit voice recorder (CVR) (although it previously had a CVR in its passenger configuration) nor was it required by Federal Aviation Administration (FAA) regulations. There were also no avionics on board with downloadable or nonvolatile memory. As a result, there was limited information available to determine what led to the uncontrolled descent or what occurred as the flight crew attempted to regain control of the airplane. Also, although the first officer was identified in FAA-recorded radio transmissions several minutes before the loss of control and it was company policy that the pilot not flying make those transmissions, it could not be determined who was at the controls when either the loss of control occurred or when the airplane broke up.

There was no evidence of any in-flight mechanical failures that would have resulted in the loss of control, and the airplane was loaded within limits. Evidence of all flight control surfaces was confirmed, and, to the extent possible, flight control continuity was also confirmed. Evidence also indicated that both engines were operating at the time of the accident, and, although one of the four propeller blades from the right propeller was not located after separating from the fractured hub, there was no evidence of any preexisting propeller anomalies. The electrically controlled pitch trim actuator did not exhibit any evidence of runaway pitch, and measurements of the actuator rods indicated that the airplane was trimmed slightly nose low, consistent for the phase of flight. Due to the separation of the wings and tail, the in-flight positions of the manually operated aileron and rudder trim wheels could not be determined.

Other similarly documented accidents and incidents generally involved unequal fuel burns, which resulted in wing drops or airplane rolls. In one case, the flight crew intentionally induced an excessive slide slip to balance fuel between the wings, which resulted in an uncontrolled roll. However, in the current investigation, the fuel cross feed valve was found in the closed position, indicating that a fuel imbalance was likely not a concern of the flight crew.

In at least two other events, unequal fuel loads also involved autopilots that reached their maximum hold limits, snapped off, and rolled the airplane. Although the airplane in this accident did not have an autopilot, historical examples indicate that a sudden yawing or rolling motion, regardless of the source, could result in a roll, nose tuck, and loss of control. The roll may have been recoverable, and in one documented case, a pilot was able to recover the airplane, but after it lost almost 11,000 ft of altitude.

During this accident flight, it was likely that, during the descent, the flight crew did regain control of the airplane to the extent that the flight control surfaces were effective. With darkness and the rapid descent at a relatively low altitude, one or both crewmembers likely pulled hard on the yoke to arrest the downward trajectory, and, in doing so, placed the wings broadside against the force of the relative wind, which resulted in both wings failing upward. As the wings failed, the propellers simultaneously chopped through the fuselage behind the cockpit. At the same time, the horizontal stabilizers were also positioned broadside against the relative wind, and they also failed upward. Evidence also revealed that, at some point, the flight crew lowered the landing gear. Although it could not be determined when they lowered the gear, it could have been in an attempt to slow or regain control of the airplane during the descent.

Although reasons for the loss of control could not be definitively determined, the lack of any preexisting mechanical anomalies indicates a likelihood of flight crew involvement. Then, during the recovery attempt, the flight crew's actions, while operating under the difficult circumstances of darkness and rapidly decreasing altitude, resulted in the overstress of the airplane.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The flight crew's excessive elevator input during a rapid descent under night lighting conditions, which resulted in the overstress and breakup of the airplane. Contributing to the accident was an initial loss of airplane control for reasons that could not be determined because postaccident examination revealed no mechanical anomalies that would have precluded normal operation.

Findings

Aircraft	Lateral/bank control - Not specified (Factor) Spar (on wing) - Capability exceeded
Personnel issues	Use of equip/system - Flight crew (Cause)
Environmental issues	Dark - Not specified

Factual Information

HISTORY OF FLIGHT

On December 2, 2013, at 2010 Atlantic standard time, a Fairchild SA227-AC, N831BC, operating as IBC Airways flight 405 ("Chasqui 405"), was destroyed during a rapid descent and subsequent inflight breakup near La Alianza, Puerto Rico. The captain and the first officer were fatally injured. Night visual meteorological conditions prevailed. The international cargo flight was operating on an instrument flight rules flight plan between Las Americas International Airport (MDSD), Santo Domingo, Dominican Republic, and San Juan International Airport (TJSJ), San Juan, Puerto Rico, under the provisions of 14 Code of Federal Regulations Part 135.

According to operator records, the accident flight occurred during the return leg of a round trip between TJSJ and MDSD. Prior to the outbound flight, "normal dispatch requirements were met," and the airplane took on fuel at TJSJ for both legs. The airplane departed MDSD on the accident flight at 1936.

A review of radio transmission transcripts indicated that the crew first contacted the San Juan Combined En route Approach Control (CERAP) facility at 1948, 13 nautical miles west of "MELLA" intersection at 11,000 feet. At 2001, the crew was told to descend to 7,000 feet at "pilot's discretion," and at 2007, the crew was advised to change frequency to the next CERAP sector controller. The crew subsequently contacted the next controller, "leaving one one thousand, descending to seven thousand." The controller then advised the crew to maintain 3,000 feet, expect the ILS (instrument landing system) approach, proceed direct to the "TNNER" fix, and that information "Tango" was in effect. After a crewmember read back the information at 2007:46, there were no further transmissions from the airplane. At 2011:52, the controller advised that radar contact was lost.

According to a Federal Aviation Administration (FAA) inspector interview (the inspector conducted the interview in Spanish and translated it into English), a witness stated that he heard some engine noise, and when he looked outside, he saw the airplane with the right wing down, "turning in a spiral form." He also noticed a red light "spinning." After that, he heard an "impact noise" and 5 seconds later, "another solid impact noise."

Radar data revealed that after crossing MELLA, the airplane proceeded toward TJSJ along a heading of about 085 degrees true, crossing the west coast of Puerto Rico just south of the town of Stella. The airplane maintained 11,000 feet until 2007, and had descended to 8,300 feet by 2010:08. The radar track then indicated a 20-degree turn to the left, and a descent to 7,300 feet by 2010:13. The radar track subsequently indicated about a 45-degree turn to the right, and a descent to 5,500 feet by 2010:18. There were no additional verifiable altitude positions.

Descent calculations between 2010:08 and 2010:13 indicated a rate of descent of about 12,000 feet per minute (fpm), and between 2010:13 and 2010:18, over 21,000 fpm. Groundspeed calculations indicated a fairly constant average of about 260 knots (provided in 10-knot increments) until the airplane initiated a descent. The last two calculations, 1 minute apart and just prior to the rapid descent, were 280 and 290 knots.

AIRPLANE INFORMATION

Description

Airframe

An Airworthiness Group Chairman's Factual Report is located in the public docket for this accident, including airplane structural diagrams in Attachment 1. From the report, the following airframe description is provided:

The airplane was an all metal, twin engine, propeller driven, low wing, pressurized airplane originally equipped to carry 19 passengers. It had a cruciform tail and retractable tricycle landing gear. The airplane was powered by two turboprop engines and was configured to only carry cargo at the time of the accident.

The fuselage was a semi-monocoque structure composed primarily of aluminum alloy frames, skins, stringers, and bulkheads. The fuselage had three major sections that joined together at production splices. The forebody structure included the cockpit, the mid-section structure included the entry door, emergency exits, passenger windows, cargo door and wing attach points. The aftbody structure included the attach points for the vertical stabilizer. The fuselage could be pressurized between the forward pressure bulkhead and the aft pressure bulkhead.

The wing was attached to the lower portion of the fuselage at four points, two on the main spar and two on the rear spar. The wing was a one-piece design with continuous main and rear spars, integral fuel tanks and removable flaps and ailerons. The spars were built-up I-beam structures constructed of aluminum alloy with titanium alloy and steel alloy reinforcements on the upper and lower spar caps. The height of both the main and rear spars decreased where they passed under the fuselage. The main spar transitioned from about 13 inches tall to about 9 inches tall and the rear spar transitioned from about 10 inches tall to about 9 inches tall. Five-foot wing extensions were attached to the outboard end of each wing to increase the span to 57 feet.

The airplane also included conventional horizontal and vertical stabilizers composed primarily of aluminum alloy components. The vertical stabilizer was a cantilever design with two spars attached to bulkheads in the aft fuselage. A cable-driven rudder and trim tab were attached to the aft spar of the vertical stabilizer. The horizontal stabilizers were of cantilever design fastened together at the fuselage centerline and attached to the vertical stabilizer with a trunnion bolt. The stabilizer could pivot around the trunnion bolt, changing the angle of incidence of the stabilizer and providing pitch trim for the airplane.

All-aluminum cable-driven elevators were attached to the horizontal stabilizers and fastened together at the center splice plate hinge point. The pitch trim was controlled electrically by switches on the control yokes that actuated two motor-operated jackscrews mounted to the top of the fuselage.

The ailerons, elevators, and rudder were manually controlled from either the pilot or copilot station in the cockpit by a conventional yoke and rudder pedals. Aileron control cables, 1/8 inch in diameter, interconnected the yokes and ran through several pulleys aft under the floor to an aileron drum in the center wing area. The aileron drum was connected to a series of push-pull tubes that ran along the aft side of the rear spar on each wing to bellcranks mounted near the aileron inboard hinges. Push-pull tubes connected the ailerons to the bellcranks for aileron control.

Elevator control cables, 1/8 inch in diameter, ran from the elevator walking beam immediately aft of the columns through several pulleys aft under the floor to the elevator quadrant in the vertical stabilizer. Push-pull tubes connected the elevators to the quadrant for elevator control.

Rudder cables, 1/8 inch in diameter, ran through several pulleys aft under the floor to the rudder bellcrank in the aft fuselage. A rudder bellcrank drove the rudder torque tube for rudder control. Aileron and rudder trim were manually set via control wheels on the center pedestal in the cockpit. The aileron and rudder trim cables, 1/16 inch in diameter, ran through several pulleys to their respective tabs. The flaps were electrically controlled and hydraulically actuated.

Fuel System

According to the SA227 Maintenance Manuel, the fuel system had a usable capacity of 648 U.S. gallons. Fuel was contained in integral left and right wing fuel tanks.

Each engine was supplied fuel by an independent system that included the tanks, boost pumps and check valves. An interconnecting cross flow line was installed for balancing the fuel quantity between the left and right wing tanks, and for supplying either engine with all available fuel. A 2-inch cross flow line was located in the center wing section, aft of the main spar. Fuel cross flow was via gravity, controlled by a shut off valve in the 2-inch cross flow line. When the valve was opened, a center light on the fluid annunciator panel should have illuminated.

According to the manufacturer's pilot checklist, the cross flow valve should have been closed on engine start, taxi, and descent.

A representative of the manufacturer indicated that upon removal of electrical power, the cross flow valve would be in the last position selected.

Fuel cross flow procedures included:

In flight, "Check aircraft is in coordinated flight. Open the cross flow valve and observe proper annunciation. In level, unaccelerated flight, fuel will flow in the desired direction (heavy to light) due to gravity.

To expedite process, use aileron control and place the wing with less fuel to a lower position (no more than 5 degrees is needed) than the wing with more fuel. Use rudder to maintain assigned heading. Maintain a safe margin of airspeed during this 'slip' condition.

When fuel balance approaches desired indications, close the cross flow valve, check for proper annunciation, and return aircraft to trimmed condition."

According to the flight manual, maximum allowable fuel imbalance was 500 pounds.

The IBC Airways weight and balance sheet found at the accident site stated, from "SDQ" to "SJU," that there were 1,800 pounds of fuel onboard.

Engines

The airplane was powered by two Honeywell (Garrett) TPE331-11U single shaft engines, each producing 1,100 horsepower and driving a four-bladed metal McCauley propeller.

The engines did not have a full auto-feathering capability. Instead, each had a negative torque sensing (NTS) system which, if a negative torque was sensed (such as during an engine failure) it would automatically drive the propeller to a coarser pitch. Full feathering would then be accomplished via manual activation.

Loading

The airplane was loaded mostly with letters and small boxes. Weight and Balance calculations indicated that the airplane was about 2,800 pounds under maximum gross takeoff weight, and would have been about 3,100 pounds under maximum landing weight.

Additional Equipment

The airplane was not equipped with an autopilot or yaw damper.

There were no cockpit or flight data recorders onboard the airplane, nor were any required by the FAA with the airplane in a cargo configuration. The airplane had been equipped with a cockpit voice recorder previously, when it was in a passenger configuration.

There was no non-volatile memory available for download.

Maintenance Records

According to the Maintenance Records Review located in the public docket for this accident, the airplane was originally manufactured in 1985. IBC Airways, Inc. acquired the airplane on March 29, 1999.

The airplane had 33,883.4 total hours with 35,698 total cycles as of November 29, 2013.

The airplane was maintained per a Continuous Airworthiness Maintenance Program (CAMP). All the required regulatory requirements and recurring inspections were incorporated into the CAMP.

The CAMP utilized a phased inspection interval by zones as well as an 85-hour repetitive service check. The phased inspection check intervals were every 150 hours and numbered one through six. In addition to the phased inspections, there were supplemental inspections that were tracked individually.

As part of the maintenance records review, attention was focused on the airplane's pitch control. The CAMP included a light inspection of the tail (zone 8) at the phase two interval and a heavy inspection at phase 5.

A review of all daily flight logs from January 2012 through November 29, 2013, was completed. Particular attention was also given to flight controls, engines, and flight instruments, unusual flight characteristics such as airframe vibration, pitch, roll, and yaw attitude. Additional areas of review included the environmental control system and any systemic issues. No significant or unusual findings were noted with the flight logs.

All major alterations and repairs were reviewed. There were 14 major alterations and 21 major repairs on the airplane. Of note, one of the major repairs was accomplished in June 2008 due to right wing damage. Repairs were made to the wing skins, ribs and main spar. In addition, 18 of the 21 major repairs were accomplished on the wings, elevators, fuselage and doors in June of 1991.

The maintenance records also included an item for the pitch trim warning box being overhauled on September 4, 2008, and subsequently installed on the airplane on December 22, 2009. There was also an item for the left elevator outboard attach hinge being replaced due to corrosion on October 18, 2011.

More detailed information can be found in the Maintenance Records Review contained in the public docket for this investigation.

Previous Flights

According to the captain who had flown the airplane with the accident first officer on December 1, 2013, the day before the accident flight, they flew four legs, "with no indications of any mechanical irregularities. The aircraft performed well and showed no problems."

Another captain, who had flown the airplane on November 25, 26, and 28, 2013, the last two flights being with the accident first officer, stated, "there were no discrepancies noted during the [time the] aircraft was assigned to me."

PILOT INFORMATION

The captain, age 35, held a commercial certificate with airplane single-engine land and sea, multiengine land and sea, and instrument-airplane ratings. He also held an airplane single engine flight instructor certificate. His latest FAA first class medical certificate was dated April 16, 2013. According to company records, the captain was assigned a captain's position on June 5, 2013, after completing his FAA proficiency checkride on June 3, 2013, and his line checkride on June 5, 2013.

Company records also indicated that as of November 30, 2013, the captain had 1,740 total flight hours, 686 hours in type, 239 hours as pilot-in-command, and 121 hours in the previous 90 days. Night flight hours could not be ascertained.

The first officer, age 28, held a commercial pilot certificate, with airplane single- engine land, multiengine land, and instrument-airplane ratings. His latest FAA first class medical certificate was dated September 9, 2013. At the time, he indicated 1,850 hours of flight time. The first officer was a relatively recent hire; according to company records, he was assigned a first officer position on October 3, 2013 after completing his FAA proficiency checkride on October 2, 2013.

Company records also indicated that as of November 30, 2013, the first officer had 1,954 total flight hours, 92 hours in type, and 92 hours in the previous 90 days. Night flight hours could not be ascertained.

According the company Director of Operations (DO), after arrival in Santo Domingo, the crew would typically have been transported to a local hotel where they would have spent the next 10 hours at rest, typically arriving at the hotel at 0800 and then being picked up at 1800 for transport back to the airport for the flight back to San Juan. "The day was typically spent, resting, eating, lounging by the pool and/or taking a nap; each pilot had their own agenda."

The DO also noted that the company's standard operating procedure was for the non-flying pilot to be responsible for all radio communications. However, it would not necessarily always be the case.

The DO, who had flown with both pilots previously, listened to the radio transmissions recorded by the FAA and recognized the first officer's voice.

METEOROLOGICAL INFORMATION

Weather, recorded at TJSJ, 33 nm to the east, at 1956, included wind from 170 degrees true at 5 knots, visibility 10 miles, a few clouds at 7,000 feet, and scattered clouds at 10,000 feet. A review of weather radar images at the time of the accident revealed no precipitation in the area.

U.S. Naval Observatory data indicated that sunset occurred at 1749 and that the end of civil

twilight occurred at 1813.

The accident occurred near the Arecibo Radio Telescope. According to a staff astronomer, a passive project (receive data and observations) was ongoing at the time with no radars transmitting.

WRECKAGE AND IMPACT INFORMATION

On Scene

Wreckage was scattered over a large area that included a pasture and the hillsides that partially surrounded it. General dimensions of the wreckage field were about 1,900 feet in length and 600 feet in width at its widest point, oriented toward 178 degrees true.

The wreckage field commenced in the vicinity of 18 degrees, 23.07 minutes north latitude, 066 degrees, 35.30 minutes west longitude, with lighter materials, including the airplane's radome. The field narrowed toward its end, with the heavier materials such as the airplane's two engines located close to each other in the vicinity of 18 degrees, 22.77 minutes north latitude, 066 degrees, 35.29 minutes west longitude. Terrain elevation varied throughout the wreckage field, with the beginning about 625 feet above sea level the middle, in a valley about 575 feet, and the end, where the engines were found, about 675 feet.

There was no impact crater; only airplane remnants scattered throughout the wreckage field. Significant remnants included, from north to south: the upper right cockpit area, and to the left and further south of that, the outboard portion of the left wing. Farther south was the left side of the cockpit, and near that, toward the center of the wreckage field, was the empennage. To the right of the empennage was the right wing, and farther to the south, on the left side of the wreckage field, was the remainder of the left wing. Beyond that, but before the engines, was the airplane's nose section, which included many of the cockpit controls.

There was no evidence of an inflight fire or explosion.

All three landing gear remained with their respective housings. The right wing was found upside down, with the landing gear extended and the drag brace assemblies locked over center. The right flap was flush with the wing. The main part of the left wing was also found upside down, but with the landing gear retracted and loose in the wheel well. Extending the landing gear by hand revealed housing deformations and tire marks consistent with the gear having been extended in flight. The nose landing gear was found partially extended in the airplane's nose section, which came to rest on its side. When the nose section was rolled upside down, the landing gear fell back into the wheel well. However, when the landing gear was extended by hand, housing deformation and tire marks found were consistent with the landing gear having been extended in flight. The cockpit landing gear handle, which could only be pulled upward, but not moved forward or aft, was found in the "gear down" position.

There was residual fuel in both wings, but quantity at the time of the accident could not be determined.

As found, the pilot's electric altimeter indicated 2,080 feet, with an altimeter setting just under 29.84 inches. The copilot's altimeter indicated 2,040 feet, with an altimeter setting of 29.94 inches.

With the breakup of the airplane, the inflight positions of the center-pedestal, manually-operated aileron and rudder trim wheels could not be determined. In addition, the position of

the electro-mechanical pitch trim could not be determined at the accident site.

A cell phone found at the accident site was later determined to contain no information pertaining to the accident.

Although extensive on-site photographs were taken, the size of the wreckage field, as well as the muddy terrain and wet weather precluded complete documentation of the wreckage at the accident site. The wreckage was recovered and containerized by a contractor for the insurance company, and shipped to a storage facility in Houston, Texas.

Follow-Up Examinations

The wreckage was further examined at a Port of Houston warehouse February 4-6, 2014. More specific airframe information, including photographs and diagrams can be found in the Airworthiness Group Chairman's Factual Report located in the public docket. From the report:

For reference purposes, wing and fuselage positions may be referred to as distances from datum. Fuselage distances would be inches aft of datum line (FS0-693) while wing distances would be inches from airplane centerline outboard from datum (WS0-266).

Fuselage

The forebody section of the fuselage, including the cockpit, was mostly complete from the forward bulkhead at fuselage station (FS) 0 aft to FS 126 but sustained heavy crushing damage. It contained the cockpit floor, center pedestal, control columns, rudder pedals, both forward baggage door cutouts, and the nose landing gear.

The center portion of the fuselage was subsequently laid out at the storage facility. Most of the upper fuselage structure was identified from the forward end of the pilot compartment windows at FS 69 to the aft cargo door at FS 438. There was an area of structure from the right side of the fuselage where the "IBC" logo was painted that was not recovered between about FS 160 and FS 250. There was a distinct cut through the fuselage near FS 165 (about 5 inches aft of the main entry door) that ran from the lower edge of the entry door on the left side to the top of the stripe on the right side. The edges of the cut exhibited mechanical damage, paint and metal smearing, and multi-directional curling and folding of the structure that was markedly different from the tearing of the skin and structure evident elsewhere.

The aft fuselage was mostly complete from the forward edge of the cargo door at FS 438 to the end of the tail cone but sustained some crushing damage laterally.

Empennage

The vertical stabilizer, rudder and right horizontal stabilizer that were attached to the aft fuselage at the wreckage site had been cut from the fuselage for transport. There was a distinct impact impression with paint and metal smearing on the right side of the fuselage from FS 438 to FS 474 that was about 4 feet high.

The vertical stabilizer, rudder and right horizontal stabilizer, which had been cut from the fuselage during recovery, were mostly complete.

The right horizontal stabilizer was folded up against the vertical stabilizer. There was dark blue paint transfer on the upper surface of the right horizontal stabilizer. The right elevator was separated from the stabilizer and recovered mostly complete. The tip and counterweight were separated and not recovered.

The left horizontal stabilizer was recovered separated at the impact site near the aft fuselage. The inboard 21 inches of left horizontal stabilizer forward spar and 18 inches of aft spar remained attached to the vertical stabilizer. Both spars exhibited upward deformation at the outboard ends where they were fractured. The left horizontal stabilizer had dark blue paint transfer on the upper surface.

Two pieces of the left elevator were recovered. The inboard piece spanned from the control horn at the inboard end out about 42 inches. The outboard piece was about 22 inches long and contained the elevator counterweight. The center portion of the left elevator was not recovered.

The electrically-actuated pitch trim actuator remained installed at the base of the vertical stabilizer but sustained several areas of damage from the cutting of the structure during recovery. The two actuator rods were cut from the actuator during recovery but remained attached to the horizontal stabilizer fittings at the upper end. The two fittings were fractured from the horizontal stabilizer.

The aft ends of the elevator cables remained attached to the quadrant in the vertical stabilizer. The rudder counterweight was missing.

Wings

The left wing was mostly complete from the inboard edge to the outboard end of the flap, with significantly more damage than the right wing. The spar fractures at the inboard end matched the fractures on the right wing. The upper cap members on both the main and rear spars exhibited upward deformation and curling at the fracture locations. The lower cap members on both the forward and aft spars did not have any noticeable deformation.

Both spars and the structure between them were deformed forward between the fracture locations and about wing station (WS) 27. Dirt and rocks were embedded in the structure at the fracture location.

A large section of the outboard left wing from about WS 174 to WS 337 was recovered separately. The fiberglass wing tip was not attached to this section. Additionally, two smaller pieces of wing skin structure from the area of the break were recovered separately. There was significant impact damage, scratching, and scoring on the lower wing surface at the location of the break.

The outboard 18 inches of the left aileron with the balance weight attached was recovered separately from the wing with mechanical damage at the outboard hinge location. The remainder of the left aileron was not recovered. The outboard aileron hinge was intact on the left wing and included the hinge clevis from the left aileron. The hinge clevis was pulled from the left aileron and the attachment bolts were not present. The fracture features on the outboard left aileron at the outboard hinge location were consistent with overstress separation.

The left flap remained attached to the wing but could not be moved due to the damage. There was some light blue paint transfer on the upper surface of the flap from about WS 50 to WS 68.

The right wing was mostly complete. The main spar and rear spar upper cap members were fractured near the centerline. The upper cap members on both the main and rear spars exhibited upward deformation and curling at the fracture locations. The lower cap members on both the main and rear spars did not have any noticeable deformation.

There was light blue paint transfer on the upper surface of the right wing between about WS 32

and WS 81.

The right flap remained attached to the wing and was free to move. The inboard half of the right aileron remained attached to the wing between the inboard edge and the center hinge point. The outboard half was not recovered. The outboard aileron hinge was intact on the right wing and included the hinge clevis from the right aileron. The hinge clevis was pulled from the right aileron with the attachment bolts intact. There was a small piece of torn aileron structure remaining at the lower attach bolt with fracture features consistent with overstress separation.

Control Continuity

The control yokes were disassembled to assess the condition of the aileron sprockets and chains at the upper end of the yokes. The sprockets and chains were intact with no evidence of binding. The flap handle was lodged in place between 0 and ¼, with deformation of the control stand.

Control continuity was established from the control columns and rudder pedals through the floor to the aft end of the section.

Left wing control continuity was established from the wing break at WS 174 to the rear spar fracture location. The left aileron trim tab actuator appeared to be in the fully extended position.

There was a small section of aileron trim cable lodged in a pulley at the wing root. The aileron trim cable was missing from the trim actuator to the wing root and not recovered. The guides, pulleys, and fair leads for the left aileron trim cable appeared undamaged.

Right wing control continuity was established for the push-pull tubes from the aileron to the rear spar fracture location. The right aileron trim tab remained attached to the right aileron and control continuity was established from the tab to the wing fracture location at the rear spar. The right aileron trim tab actuator was dislodged from its mount and appeared to be fully retracted. The chain was not installed on the sprocket of the actuator but was found adjacent to the actuator.

Several flight control cables extended from the forward end of the aft fuselage. All of the cable lengths were measured from the forward edge of the cargo door forward. The rudder control cables were identified and continuity was established to the rudder control horn at the base of the vertical stabilizer. All of the forward fractured ends of the cables exhibited a splayed appearance consistent with tension overstress separation.

Landing Gear

The nose landing gear was fully extended. The drag brace trunnions had been pulled out and both the up and down locks were intact with no obvious damage. There was a distinct tire impression on the forward exterior surface of the right nose landing gear door. A portion of the outer bead area on the right nose wheel was fractured and separated.

The left main landing gear remained attached to the wing, which was upside down, in the retracted position. The inboard side of the wheel well was deformed such that the inboard drag brace trunnion was not fully engaged. The landing gear could be extended by hand but would not engage the down locks due to the deformation at the drag brace trunnion. The up and down locks were intact with no abnormal damage.

The right main landing gear was in the extended position. The down locks were intact and

engaged. The up lock was intact with no abnormal damage. The drag brace was fractured between the trunnions.

Propellers

All four blades of the left propeller were recovered, but were found completely separated from the hub. Leading and trailing edge damage was noted on all of the blades, and all four were missing significant amounts of material from their outboard ends.

The propeller hub was fractured and separated. Only the mounting portion of the propeller hub remained attached to the engine propeller shaft. The propeller piston and dome assembly were not recovered.

Only two of the four propeller blades remained attached to the right propeller hub. A third blade was recovered completely separated from the fractured hub, and the fourth blade was not recovered, but also was completely missing from the fractured hub. Leading and trailing edge damage was noted on all three blades, and all three were missing significant amounts of material from their outboard ends.

The spinner was impact-damaged and crushed on one side.

Engines

The left engine, which was impact-damaged, remained within the truss and airplane mounting structure. The engine cowling was not attached to the engine. White paint transfer was noted on the upper aft and slightly inboard area of the upper engine cowling

The reduction gearbox was fractured into approximately four pieces. The air inlet portion of the gear case was fractured and crushed. The propeller governor was fractured at the mounting flange. The fuel control unit (FCU) was fragmented, but most of the components were present. The fuel pump mount inserts were pulled out and remained attached to the fuel pump mount flange. The fuel pump drive shaft was fractured. The fuel pump side was not located.

No metallic debris was noted on the chip detector, and the oil filter bypass indicator was in the retracted (no bypass) position.

The engine power section was fractured and would not rotate.

Metal spray was noted on the suction side of the third stage turbine stator vanes.

The right engine was generally intact, but impact-damaged. The cowling, truss and airplane mounting structure remained attached to the engine. Blue paint transfer was noted on the inboard side of the engine nacelle.

The engine power section was not free to rotate.

No metallic debris was noted on the chip detector, and the oil filter bypass indicator was in the retracted (no bypass) position.

Metal spray was noted on the suction side of the third stage turbine stator vanes.

The right engine FCU was forwarded to the manufacturer where it was examined under FAA oversight. The unit was impact-damaged and several parts had to be replaced. As-received testing also found out-of- tolerance conditions that were attributed to impact damage.

Annunciator Panel

Filament examinations did not result in any additional information pertinent to the loss of control.

Additional Wreckage Examination

Portions of the wreckage were again examined on March 22, 2016, with an FAA inspector providing government oversight. At that time, the fuel cross flow valve was observed to be in the closed position. The fuel cross flow valve switch and the fuel gauges were not found. Additional items were documented in context to a possible inflight engine shut down in progress by the crew, but the observations were noted as incomplete and deemed unreliable because items could have moved during airplane breakup and ground impact. Discussions at that time also noted that the easiest way to shut down an engine, if needed, was to pull the engine stop and feather knob, which was not pulled.

TESTS AND RESEARCH

Pitch Trim Actuator

The linear electro-mechanical actuator was taken to the manufacturer for further examination under NTSB oversight. Examination revealed no evidence of preexisting mechanical anomalies that would have precluded normal operation.

Pitch Trim Setting

The pitch trim actuator rods had been cut during the wreckage recovery process. Remnants of the actuating rods and the saw cuts were subsequently measured, and together indicated a pitch trim actuator extension of 19.25 inches. Interpolated results yielded a stabilizer incidence of 0.62º-1.02º leading edge up, or airplane slightly nose down trim, consistent with the phase of flight.

Aileron Controls

In September 2014, M7 Aerospace, the type certificate holder of the airplane, issued two service bulletins instructing operators to inspect the aileron bellcranks, link rods, hinge brackets, and rod end bearings for damage and tightness. On September 19, 2014, M7 Aerospace issued a revised service bulletin instructing operators to inspect the outboard aileron hinge attachments for cracking.

The left and right aileron bellcranks and attached link rods were retrieved from the wreckage for examination.

The left aileron bellcrank was recovered separated from the left wing but with the aileron link rod and a control tube attached. The bellcrank pivot bolt and both rod end bolts were found installed with the cotter pins intact. There was some wood debris embedded in the head of the cotter pin on the control tube attachment bolt. There was also some mechanical damage on the upper and lower surfaces of the bellcrank adjacent to the pivot bolt. The control tube was removed to facilitate shipping of the bellcrank. The control tube rod end bearing moved freely. The threaded portion of the male rod end on the aileron link rod was deformed and the banjo body on the female rod end (normally attached to the aileron) was fractured and deformed. The spherical bearing from the female rod end was not recovered. The fracture faces on the banjo body were examined under a microscope and had features consistent with overstress separation. The bolt attaching the aileron link rod male rod end was disassembled. The male rod end was examined under a microscope and no evidence of cracking was observed in the

banjo body. The spherical bearing on the male rod end was clean and free to rotate with no binding evident.

The right aileron bellcrank remained attached to the right wing at its mounting location. The control tube and aileron link rod were attached and the aileron link rod was attached to the right aileron portion that remained. The bellcrank pivot bolt and both rod end bolts were installed with the cotter pins intact. The control tube bolt, pivot bolt, and aileron attach bolt were disassembled in order to remove the bell crank and aileron link rod. The control tube rod end bearing moved freely.

The threaded portion of the male rod end on the aileron link rod was deformed. The bolt attaching the aileron link rod male rod end was disassembled. The male and female rod ends were examined under a microscope and no evidence of cracking was observed in the banjo bodies.

MEDICAL AND PATHOLOGICAL INFORMATION

Autopsies were performed on both pilots at the Instituto de Ciencias Forenses de Puerto Rico, San Juan, Puerto Rico, where the cause of death for both pilots was determined to be (translated) "severe body trauma."

Toxicological testing was performed at the Instituto de Ciencias Forenses, with further testing performed at the FAA's Civil Aeromedical Institute (CAMI), Oklahoma City, Oklahoma.

Due to the severity of the captain's injuries, no blood, urine, or vitreous was available for testing. Toxicological testing performed on a specimen of the pilot's liver by the Instituto de Ciencias Forenses was unsuitable for the identification of volatiles and negative for evidence of cocaine or opiates.

Toxicological testing performed at CAMI's Bioaeronautical Research Laboratory revealed ethanol in muscle (0.036 gm/dl), kidney (0.019 gm/dl), and heart (0.013 gm/dl) tissues, but did not detect any ethanol in his liver specimen. No other tested-for substance was found in the captain's specimens.

Toxicological testing performed by the Instituto De Ciencias Forenses De Puerto Rico, Division de Laboratorio de Criminalistica on the first officer identified ethanol in vitreous (0.07 mg/dl) and brain tissue (0.17 mg/dl).

Testing performed the FAA's Bioaeronautical Research Laboratory at CAMI identified ethanol in first officer's muscle (0.150 mg/dl), brain (0.133 mg/dl), heart (0.095 mg/dl), and liver (0.082 mg/dl). No other specimens were available and no other tested-for substance was identified in the first officer's specimens.

According to the NTSB Medical Factual Report for this accident, ethanol is an intoxicant commonly found in beer, wine, and liquor. "After absorption, ethanol is quickly distributed throughout the body's tissues and fluids fairly uniformly. Ethanol may also be produced in the body after death by microbial activity and when this is the cause of identified ethanol, the measured levels may vary widely."

ADDITIONAL INFORMATION

According to DOT/FAA/AR-00/18, "Development of Supplemental Inspection Report for the Fairchild Metro SA226 and SA227 Airplane," 1.2 Aircraft Description, "Structurally there is little difference between the SA226 and SA227. The primary difference is that the SA227 wing

is longer by 10 ft to support higher takeoff weights."

Prior SA226/SA227 Accidents/Incidents

A search of prior SA226/SA226 accidents and incidents involving an inflight loss of control, included:

On August 30, 2004, near Bankstown, New South Wales, Australia: an SA226 with one pilot with seven passengers onboard. With a balanced fuel load noted before takeoff, the airplane was manually climbed in instrument meteorological conditions, leveling off at 16,000 feet, when the pilot noticed that the right wing was "slightly low." The pilot applied left rudder trim and engaged the autopilot; about 2 ½ minutes later the autopilot suddenly disengaged, and the airplane rolled right and entered a steep spiral descent. The pilot was able to recover the airplane at 5,200 feet, and when he did, he noticed that the airplane was "very heavy on the right side," and the right fuel tank was reading 350 kg greater than the left. The investigative report noted that that the outcome suggested that the fuel flow cross flow valve had been open during the flight. When the autopilot could no longer trim against increasing fuel load in the right wing, it disengaged without warning. The airplane was not equipped with a CVR or FDR. (Australia Safety Transport Bureau (ASTB) report 200403209)

On May 23, 2005, near Stratford, Taranaki, New Zealand: an SA227 with two pilots onboard during a night cargo flight. The airplane was en route at 22,000 feet, and "the night was dark, with no moon, and the aircraft was probably flying above cloud which would have obscured any ground lights." The crew was balancing fuel between tanks, with the rudder input trimmed to an excessive sideslip, and with the autopilot engaged. Data indicated that autopilot capability was exceeded; it then disengaged, precipitating an upset. During descent, the airplane was overstressed and came apart in flight. The airplane had an operating CVR and FDR onboard. (New Zealand Transport Accident Investigation Commission (TAIC) report 05-0006),

On February 8, 2007, over Paris, Tennessee: an SA226, with a single pilot was on a night cargo flight. The airplane was en route at 16,000 feet in visual meteorological conditions. The pilot requested from air traffic control (ATC), a 360-degeee turn to the left, and shortly thereafter, requested a 360-degree turn to the right. He then requested vectors to the closest airport, and advised ATC that he had an asymmetric fuel condition. About a minute later, the pilot transmitted six Maydays, and witnesses saw the airplane descend into the ground in a vertical attitude. The impact crater was about 25 feet deep, the airplane was severely fragmented, and the fuel crossflow valve could not be located. The presence/non-presence of a CVR, FDR or autopilot were not noted in the report. (NTSB Report ATL06FA045)

On August 28, 2013, Bankstown, New South Wales, Australia, an SA227, with a single pilot on a night cargo flight. During the initial climb from the departure airport, the pilot reported that the right wing dropped "markedly." The pilot raised the wing and opened the fuel cross flow valve to rebalance the airplane. After the airplane was in trim, he closed the cross flow valve. In cruise, the airplane appeared to be in trim and the pilot engaged the autopilot. About 1 hour later, the pilot disengaged the autopilot and ensured the airplane was still in trim. During the approach, the airplane handled "normally" until about 400 feet above ground level, when the right wing dropped again when the final stage of flap was selected. The pilot raised the right wing and landed without further incident. Subsequent ground checks determined that there was a fuel tank imbalance of about 210 liters (about 55 gallons). (Australian Transport Safety Bureau report AO-2013-196)

On April 13, 2015, near North Vancouver, British Columbia, an SA226, with two pilots onboard during day cargo flight. The airplane was about 15 nm north of the departure airport, above a cloud layer, over mountainous terrain, about 2,400 meters (about 8,000 feet) above sea level, when it lost altitude rapidly and experienced an inflight breakup. As the State of Design and Manufacture, the U.S. sent a team to assist in the examination the wreckage; however, the investigation is under the jurisdiction of the government of Canada and is ongoing at the time of publication of this report. (Transportation Safety Board of Canada investigation A15P0081)

History of Flight

Enroute-descent	Loss of control in flight Aircraft structural failure (Defining event)

Pilot Information

Certificate:	Flight Instructor; Commercial	**Age:**	35, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Without Waivers/Limitations	**Last Medical Exam:**	04/16/2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	06/05/2013
Flight Time:	(Estimated) 1740 hours (Total, all aircraft), 686 hours (Total, this make and model), 121 hours (Last 90 days, all aircraft)		

Co-Pilot Information

Certificate:	Flight Instructor; Commercial	**Age:**	28, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With Waivers/Limitations	**Last Medical Exam:**	09/09/2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	10/02/2013
Flight Time:	(Estimated) 1954 hours (Total, all aircraft), 92 hours (Total, this make and model), 1642 hours (Pilot In Command, all aircraft), 92 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	FAIRCHILD	**Registration:**	N831BC
Model/Series:	SA227-AC	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	AC-654B
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	09/27/2013, Continuous Airworthiness	**Certified Max Gross Wt.:**	15697 lbs
Time Since Last Inspection:	70 Hours	**Engines:**	2 Turbo Prop
Airframe Total Time:	33888 Hours	**Engine Manufacturer:**	Honeywell
ELT:	C126 installed, not activated	**Engine Model/Series:**	TPE331-11
Registered Owner:	IBC AIRWAYS INC	**Rated Power:**	1100 hp
Operator:	IBC AIRWAYS INC	**Air Carrier Operating Certificate:**	Commuter Air Carrier (135); On-demand Air Taxi (135)
Operator Does Business As:		**Operator Designator Code:**	OZCA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night
Observation Facility, Elevation:	TJSJ, 9 ft msl	**Observation Time:**	1956 AST
Distance from Accident Site:	33 Nautical Miles	**Direction from Accident Site:**	85°
Lowest Cloud Condition:	Few / 70 ft agl	**Temperature/Dew Point:**	26°C / 22°C
Lowest Ceiling:	None	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	5 knots, 170°	**Visibility (RVR):**	
Altimeter Setting:	29.91 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Santo Domingo, CB (MDSD)	**Type of Flight Plan Filed:**	IFR
Destination:	San Juan, PR (TJSJ)	**Type of Clearance:**	IFR
Departure Time:	1936 AST	**Type of Airspace:**	Unknown

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	18.384444, -66.588333

Administrative Information

Investigator In Charge (IIC):	Paul R Cox	**Adopted Date:**	07/25/2016
Additional Participating Persons:	Ramon Ruiz; FAA/FSDO; San Juan, PR James Norton; Elbit Systems of America (M7 Aerospace); San Antonio, TX David Studtmann; Honeywell; Phoenix, AZ Hans Jonsson; IBC Airways; Fort Lauderdale, FL		
Publish Date:	07/25/2016		
Note:	The NTSB traveled to the scene of this accident.		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=88505		