



# Aviation Investigation Final Report

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<b>Location:</b>	MALAD CITY, Idaho	<b>Accident Number:</b>	SEA96MA043
<b>Date &amp; Time:</b>	January 15, 1996, 06:18 Local	<b>Registration:</b>	N693PA
<b>Aircraft:</b>	Mitsubishi MU-2B-36	<b>Aircraft Damage:</b>	Destroyed
<b>Defining Event:</b>		<b>Injuries:</b>	8 Fatal
<b>Flight Conducted Under:</b>	Part 91: General aviation - Executive/Corporate		

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## Analysis

A Mitsubishi MU-2 departed Salt Lake City, Utah, and climbed to 16,000 feet MS on an IFR flight to Pocatello, Idaho. While in cruise flight, the MU-2 encountered structural icing conditions. According to radar data, the MU-2 began slowing from a cruise speed of about 190 knots with slight deviations from heading and altitude. The airspeed decreased to about 100 knots, and the flight crew declared an unspecified emergency, then radio contact was lost. The MU-2 began a right turn, then it entered a steep descent and crashed. The pilot of a Beech 1900 (about 12 minutes in trail of the MU-2), stated that he encountered moderate rime icing at 16,000 feet. The Beech pilot activated his deice boots (3 times) and descended to 12,000 feet to exit the icing conditions. The MU-2 flight manual warned that during flight in icing conditions, stall warning devices may not be accurate and should not be relied upon; and to minimize ice accumulation, maintain a minimum cruise speed of 180 knots or exit the icing conditions. An investigation determined that the captain of the MU-2 was aware of deficiencies in the timer for the deice boots, as well as other maintenance deficiencies. The captain's medical certificate was dated 11/17/94; he was providing executive transportation for compensation under an agreement for "contractual flights," under 14 CFR 91. Although icing conditions were forecast in the destination area, no icing was forecast for the en route portion of the flight.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: continued flight by the flightcrew into icing conditions with known faulty deice equipment; structural (airframe) ice; and failure of the flight crew to maintain adequate airspeed, which resulted in the loss of aircraft control and collision with terrain. A factor relating to the accident was: the en route weather (icing) condition, which was not forecast (inaccurate

forecast).

## Findings

Occurrence #1: IN FLIGHT ENCOUNTER WITH WEATHER

Phase of Operation: CRUISE - NORMAL

Findings

1. (F) ANTI-ICE/DEICE SYSTEM, WING - INOPERATIVE
  2. (F) OPERATION WITH KNOWN DEFICIENCIES IN EQUIPMENT - PERFORMED - PILOT IN COMMAND
  3. WEATHER FORECAST - INACCURATE
  4. (F) WEATHER CONDITION - ICING CONDITIONS
  5. (C) FLIGHT INTO ADVERSE WEATHER - CONTINUED - FLIGHTCREW
  6. (C) AIRFRAME - ICE
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Occurrence #2: LOSS OF CONTROL - IN FLIGHT

Phase of Operation: CRUISE

Findings

7. (C) AIRSPEED - NOT MAINTAINED - FLIGHTCREW
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Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER

Phase of Operation: DESCENT - UNCONTROLLED

## Factual Information

### HISTORY OF FLIGHT

On January 15, 1996, at 0618 mountain standard time (MST), a Mitsubishi MU-2B-36, N693PA, was destroyed when it impacted terrain in a near-vertical attitude approximately eight miles northwest of Malad City, Idaho. The crew had declared an unspecified emergency moments before while in cruise flight at 15,700 feet MSL (mean sea level). The airline transport pilot and commercial pilot crew members, and the six passengers on board, were fatally injured. The aircraft, owned by Pro Air Services of Utah, LLC (a Utah limited liability company), was being operated by Pro Air Services of Salt Lake, LLC, for the purpose of transporting Swire Coca Cola, USA, executives from Salt Lake City, Utah, the departure point, to Pocatello, Idaho. The flight was one of a series of demonstration flights for which Pro Air Services of Salt Lake received compensation exceeding that stipulated in 14 CFR Part 91. An instrument flight rules (IFR) flight plan was filed for the flight, which had departed Salt Lake City International airport at 0548:40.

After departure from Salt Lake City, the aircraft had climbed to and leveled off at approximately 16,100 feet MSL and maintained about 190 knots indicated airspeed (KIAS) for close to twelve minutes. The aircraft then performed a heading change of approximately 20 degrees to the east and a subsequent correction back to the original heading. An oscillatory descent to 15,700 feet MSL and a slow decrease in indicated airspeed to approximately 150 KIAS was noted from radar data over the next two minutes of flight following the initial change of heading. About 15 minutes after leveling off, at 0617, the crew advised Air Traffic Control (ATC) that they had an unspecified emergency. No further communications were made by the crew. Soon after that point, radar contact was lost. Radar data also showed the aircraft's indicated airspeed decreasing from about 190 knots indicated airspeed (KIAS) to about 100 knots (KIAS) in the six minutes immediately preceding the uncontrolled descent from 15,700 feet MSL. The wreckage was found in open hilly terrain, approximately 5240 feet MSL. There was no report of an ELT actuating. There was a post-crash fire.

Before this flight, the MU-2's captain (who was a registered agent and officer of both Pro Air Service of Utah and Pro Air Services of Salt Lake) had previously provided at least 14 "executive demonstration" flights in N693PA to executives of Swire Coca-Cola, USA, while doing business as Pro Air Services of Salt Lake, LLC. The flight was conducted under 14 CFR 91, and was described as a series of flights for a "road show" marketing program for Swire Coca-Cola, USA, which is a large regional bottler of Coca-Cola products. Passengers on board the aircraft included four upper-level Swire executives, and two executives of Scopes Garcie Carlisle, Swire Coca Cola's advertising agency. No evidence was found that either Pro Air Services of Utah, LLC, or Pro Air Services of Salt Lake, LLC, held a 14 CFR 135 air carrier certificate. (The airplane was, however, on 14 CFR 135 operating specifications for D and D

Aviation, LC, of Salt Lake City, which had an approved minimum equipment list for the aircraft.)

A "flight management & consulting service agreement" existed between Swire Coca-Cola and Pro Air Services of Salt Lake, wherein a monthly stipend was paid by Swire Coca-Cola to Pro Air Services of Salt Lake, which would provide pilot services and management services, including making aircraft available which could be used for executive transportation. This agreement was signed August 1, 1995, and was to be valid for six months. A second agreement, also signed August 1, 1995, provided Swire Coca Cola with a list of aircraft "available for demonstration," with a price schedule based upon price per hour of utilization.

On the morning of the accident, at 0516, the Cedar City (Utah) Automated Flight Service Station (AFSS), received a telephone call from the pilot of N693PA requesting a weather briefing and expressing a desire to file an IFR flight plan. That person stated that he planned on departing Salt Lake for Pocatello, Idaho, in about 20 minutes. The FSS specialist asked if the pilot wanted just current reports or a standard briefing. The pilot stated that current reports were okay, " 'cause it doesn't take very long to get up there."

The FSS specialist provided current Salt Lake City weather as "twenty thousand overcast, visibility ten, temperature thirty-one, dew point twenty-nine, winds calm. Pocatello is showing measured ceiling nine thousand overcast, visibility twenty, temperature forty-five, dew point twenty-one and the wind two-one zero at one three. [I] don't see any pilot reports and just to the northwest of Pocatello there is an airmet for occasional mountain obscuration right in the Pocatello area. To the north-northwest, northeast all the way around to the southwest, [an] airmet [exists] for occasional moderate rime icing from about six or ten thousand...somewhere between six and ten thousand feet all the way up to twenty thousand and then an airmet over Idaho for occasional moderate turbulence below sixteen thousand."

The pilot requested winds aloft at 18,000 feet MSL, which the FSS specialist provided for Salt Lake City, from 260 degrees at 44 knots, and Pocatello, from 270 degrees at 49 knots. The pilot then filed an IFR flight plan, specifying that the aircraft had "slant romeo" equipment available (meaning that the aircraft was equipped with RNAV, or area navigation, with transponder and altitude reporting encoder), 260 knots cruise speed, departure time 1235 Zulu [0535 MST], 17,000 feet MSL cruising altitude, fifty minutes time en route direct from Salt Lake City to Pocatello. He stated that he had four hours of fuel on board, eight persons on board, and a black, silver and white aircraft. The conversation with the FSS specialist was terminated at 0519. The pilot did not file an alternate destination.

According to IFR low altitude en route charts, the minimum en route altitude (MEA) for V-21, the airway that approximately underlies the proposed route of flight, was 10,000 feet MSL. Total distance was about 152 nautical miles. Pocatello VOR (a VHF omnigational range navigation facility) is 41 nautical miles from Malad City VOR; the crash site was approximately five miles north-northeast of Malad City VOR.

Hudson General, an aircraft fueling facility at Salt Lake City International airport, fueled the

airplane prior to the flight. Their invoice for Jet-A fuel, dated January 15, 1996, indicated that the four wing tanks were to be topped, and 45 gallons were to be pumped in each tip tank. Total fuel delivered to the aircraft was 138 gallons. Refueling personnel observed the passengers and crew boarding the flight, and provided a ground-power unit (GPU) start for the airplane.

At 0542:33, the crew called Salt Lake City ATCT (Air Traffic Control Tower) ground control east by radio, advising that N693PA was at Hudson South and ready to taxi, and stated that they would "get their clearance on the way." At 0542:39, N693PA was cleared to taxi to runway 17.

At 0542:56, Salt Lake City ATCT (Air Traffic Control Tower) clearance delivery was contacted by the crew of N693PA, who requested their IFR clearance to Pocatello.

Clearance delivery provided an amended clearance to Pocatello, changing the pilots' filed routing to instead fly a heading of 160 degrees for a radar vector to V-21 to Malad, then direct to Pocatello; to climb and maintain eight thousand feet, and to expect 17,000 feet [MSL], ten minutes after departure. Departure control frequency of 135.5 Mhz (megahertz) and a transponder code of 4311 were also issued.

The crew read back their clearance. Their altitude restrictions were clarified by clearance delivery. At 0543:56, the crew acknowledged the correct clearance to expect a climb to 17,000 feet [MSL] ten minutes after departure.

At 0544:16, the crew of N693PA advised that they were back on ground control [frequency] after receiving their clearance. Ground control acknowledged.

At 0548:28, the crew of N693PA contacted the control tower (Salt Lake City ATCT local control center) and advised that they were "ready to go" on runway 17. N693PA was cleared for takeoff at 0548:33.

After departure, N693PA was given a right turn to a heading of 280 degrees and was told to contact departure control. The crew acknowledged at 0550:01.

At 0550:06, the crew of N693PA contacted departure control (Salt Lake City TRACON). The controller advised that the airplane was in radar contact, and cleared N693PA to climb to and maintain 16,000 feet [MSL]. At 0551:34, departure control provided a right turn to 330 degrees, which was acknowledged.

At 0552:30, departure control cleared N693PA to proceed direct to Pocatello, and advised the crew to resume their own navigation. This clearance was acknowledged. N693PA was then given a frequency change and hand-off to Salt Lake Center (Salt Lake City Air Route Traffic Control Center). The hand-off was acknowledged at 0554:36.

At 0554:44, the crew of N693PA contacted Salt Lake Center and said they were "with you [at] ten-thousand five-hundred [feet MSL] for one-six thousand [feet MSL]."

At 0554:52, Salt Lake Center acknowledged and cleared N693PA to continue climb to maintain [level off at] 17,000 feet MSL. The crew of N693PA requested a final altitude of 16,000 feet MSL, which was approved and acknowledged at 0555:07.

According to radar data, N693PA continued climbing until it reached 16,000 feet at 0602:30. After some slight altitude and velocity variations while leveling off, N693PA maintained a steady altitude and flight path for approximately eight minutes. During this time, aircraft airspeed slightly varied, deviating about an approximate value of 190 knots (KIAS) and pitch remained essentially steady.

From transponder radar data, a flight path heading deviation of about 20 degrees nose right occurred at approximately 0614:00, with a subsequent correction to the previous heading. This time also denotes the beginning of oscillations in altitude between 16,000 feet and 15,800 feet, which occur for the next two minutes. Calculated aircraft performance parameters during these oscillations show corresponding variations in airspeed, pitch attitude, and angle-of-attack.

At 0615:51, the Salt Lake Center controller requested that the crew of N693PA change to his frequency of 128.35 Mhz.

The crew of N693PA acknowledged the frequency change at 0615:56. Forty seconds later, at 0616:36, the crew of N693PA responded on the new frequency (with the same controller), stating that they were "with you [at] one-six thousand [feet MSL]." Altitude at that time, according to the altitude encoder radar data, was 15,800 feet MSL.

The ATC controller acknowledged and provided the Pocatello barometric pressure of 30.06. At 0616:45, the crew of N693PA repeated the altimeter setting, stating "three zero zero six, thanks."

Based upon radar transponder data, a decrease in airspeed of approximately 40 knots was observed between 0616:30 and 0617:30, along with analogous increases in pitch attitude and angle of attack. During this time, N693PA's altitude dropped to 15,700 feet MSL as the aircraft decelerated to about 150 knots (KIAS). A further reduction in airspeed is noted over the next 40 seconds to approximately 120 knots (KIAS), as the airplane varied its altitude first to 15,900 feet, then down to 15,700 feet MSL.

About 0617:40, the final radar transponder altitude transmission was received, and a further decrease in airspeed to about 100 knots (KIAS) was observed; subsequent radar returns up to the end of the flight were primary radar returns only.

At 0617:51, the crew of N693PA stated "center, uh Mitsubishi six niner three Papa Alpha we got an emergency." There were no further communications from N693PA, despite repeated attempts by Salt Lake Center to reestablish communications.

Remaining primary radar returns indicate a rolling right turn as the aircraft further decelerated, followed by a rapid increase in airspeed as the aircraft pitch abruptly shifted to a steep nose-down attitude. The calculated parameters indicate a change in pitch attitude occurred near, or shortly after, the time the crew declared an emergency. The final radar returns are indicative of the airplane experiencing an uncontrolled high-speed descent in a steep nose-down attitude. The aircraft impacted hilly terrain at about 5240 feet MSL, in an attitude of approximately 105 degrees nose down.

There were no eye-witnesses to the crash, however two ice fishermen heard the airplane prior to the crash. The ice fishermen, who were in a portable ice hut on St. John's Reservoir approximately 5.5 miles east of the crash site, heard the aircraft before and during its descent. After the impact, they looked outside and saw the glow of a fire, which they presumed to be the crash site. One fisherman described the conditions as dark night with a heavy cloud cover and no fog. He said that he heard the airplane about 0615, and noted that at about 0715 it started snowing. He said the noise came from the south for about a minute. Near the end, he said it went totally quiet, then the engines revved up. Then he heard the impact.

The pilot of AMF624, a Beech 1900, which was approximately 12 minutes in trail of N693PA on the same route of flight, stated that he had encountered moderate rime icing while in cruise flight at 16,000 feet MSL about 20 miles east of Malad VOR. The rate of ice accumulation was about 1/4 to 1/2 inch per minute. Total ice accumulation on unprotected areas of the airframe was about one inch, and the aircraft remained in the icing environment for about five minutes. The pilot described the ice as appearing similar to "refrigerator ice with little fingers 1/2 to 1 inch long." The ice accumulated about five inches aft on the propeller spinner. AMF624's pilot also noted that the airplane experienced an approximate 10 to 15 knots loss of airspeed. Outside air temperature at 16,000 feet was about -12 degrees C. In the icing environment there was rain and snow mixed, with cloud bases about 12,000 feet and cloud tops about 18,000 feet. The pilot stated that he activated the deice boots three times, determined that he was in moderate rime ice and diverted to 12,000 feet, where most of the ice sublimated before reaching his Idaho Falls, Idaho, destination, northeast of Pocatello. Radar data indicates that AMF624 requested and initiated a descent from 16,000 feet MSL about 0629 (when about two miles west of the crash site).

## PERSONNEL INFORMATION

The captain, male, age 48, listed his occupation as "aircraft sales" on his most recent airman's medical certificate application of November 17, 1994. He was self-employed, as manager and registered agent of Pro Air Services of Salt Lake, LLC (a Utah limited liability company formed April 12, 1993), and president and registered agent of Pro Air Services of Utah, LLC (which was also formed April 12, 1993). According to the Articles of Organization for both limited liability companies, the purpose of both companies was to be able to engage in any lawful business for which a company may be organized under the Utah Limited Liability Act, including but not limited to: Aircraft sales, servicing, leasing, consigning, purchasing and consulting; and to

provide any and all services relating to the aircraft industry including sales, servicing, leasing, consigning, purchasing and consulting.

The captain was issued a private pilot's certificate for single-engine land airplanes on February 28, 1971. On August 30, 1975, according to FAA records, he added a multi-engine land airplane rating, and had a total of 990 hours pilot-in-command flight time. On September 20, 1975, he added an instrument rating, with a total pilot-in-command flight time of 1006 hours. On January 23, 1977, he acquired a commercial pilot's certificate with single-engine land airplane rating and private pilot privileges in multi-engine land airplanes, before adding multi-engine land airplanes to his commercial certificate on February 4, 1977.

The captain received a Cessna 500 type rating in October 10, 1988, followed by an Airline Transport Pilot certificate on January 20, 1990. He added a Learjet type rating August 25, 1991. There were no further changes or additions to his airman's file.

The captain had previously been employed as a salesperson for Mitsubishi Aircraft International, Inc., which held the type certificate for the MU-2B at that time, starting February 23, 1981, with a termination date of January 31, 1986. The captain's logbook records show that he received 16 hours of MU-2B-60 simulator training from Flight Safety International in March, 1981. After that date, he began logging MU-2B demonstration flights as pilot-in-command time.

On a pilot summary provided to his insurer, signed July 11, 1995, the captain reported that he had attended Flight Safety International MU-2 initial ground and flight training in 1981, and Flight Safety MU-300 initial ground and flight training in 1982. Additionally, he noted on the pilot summary that he had received recurrent training every six months until 1986 at Flight Safety International, alternating between the MU-2 and the MU-300 turbo jet. In 1986, he received Beechcraft/Flight Safety King Air 200 and 300 initial ground and flight training.

On the pilot summary, the captain declared his flight time as 2635 hours single-engine land, 5590 multi-engine land, 2553 turboprop, 1127 jet, 665 IFR, 7065 pilot-in-command, and 8925 hours total flight time. He noted that he had "1200+" hours in long-body MU-2s, and "150+" hours in short-body MU-2s. He stated that his last flight check in a MU-2 was in April, 1995, at Scottsdale, Arizona. According to FAA information, no one at Scottsdale was qualified to provide a proficiency check in the MU-2, and investigators were unable to locate anyone who was able to verify that the captain had completed a MU-2 check ride during April, 1995. No log books were found that reflected 1995 or 1996 entries. A log book was found that covered flight time in 1993 and 1994. No records were found to satisfy the IFR recency of experience requirements of 14 CFR 61.57, of completion of an instrument competency check (as defined by 14 CFR 61.57(e) (2)) in the category of aircraft involved. A log entry for July 13, 1994 recorded a 1.0 hour dual flight in a Swearingen Merlin IIB, N480BC, from SLC to RET [return] with two landings, and remarks as a "check flight." There was no flight instructor entry in the remarks section. A check with the Utah Valley State College, registered owners of N480BC, revealed that the captain had undergone a checkout in their aircraft, with ground school



provided by ATC Group, Inc. This training was confirmed by ATC Group, Inc., and they also stated that upon completion of the training, the captain was provided with a certificate and an adhesive sticker to be placed in his log book which would certify that the training met the requirements of a 14 CFR 61.56 flight review, and an instrument competency check.

The captain's most recent airman's medical was for a second class medical certificate, issued November 17, 1994. He had no waivers or limitations on his medical certificate. At that time, he reported 9200 hours total flight time, with 125 hours in the preceding six months, and reported his weight as 203 pounds. He reported using Seldane for hay fever on an as-needed basis.

Attendance records of Mitsubishi Heavy Industries America, Inc. (MHIA), which-in conjunction with FlightSafety International-conducts PROP seminars for pilots, owners and operators of MU-2 airplanes, did not reflect that either crew member had attended any of the PROP seminars. Records did, however, reflect that the captain attended a one day MU-2 operator's conference in Las Vegas, Nevada in September, 1995. According to MHIA representatives, the stated objective of the conference was marketing and product support, rather than pilot training. The one-day conference included short sessions (of 30-75 minutes) on turbine aircraft accident review, MU-2 operating tips and techniques, icing certification developments, and FlightSafety International MU-2 training programs. There is no evidence available of the captain's attendance at any of the sessions.

The captain, doing business as Pro Air Services of Salt Lake, had entered into the aforementioned contractual agreement with Swire Coca-Cola, USA, on August 1, 1995, whereupon he would receive a monthly salary and then provide (or gain) access to various airplanes and demonstrate them to the bottling company executives. The stated intent of the contractual agreement was that the bottling company would evaluate aircraft for possible acquisition for executive transportation.

The copilot, male, age 27, was used on an occasional basis, by the day, by Pro Air Services of Salt Lake. had received a private pilot certificate for single-engine-land airplanes on August 15, 1990, with a total of 41 hours. He received a commercial pilot single-engine land certificate with instrument-airplane rating, on June 4, 1992, with 170 hours total time. He became a certified flight instructor (airplane single-engine) on February 8, 1993. On August 24, 1994, with 224 hours total time, he received a multi-engine rating on his commercial pilot's certificate. There was no record of his having received simulator or ground training in the MU-2 at Flight Safety, the sole domestic provider for simulator flight training in the MU-2B.

In his flight logbooks, the copilot recorded 1193.7 hours total flight time, 1152.8 hours pilot-in-command, 231.9 hours multi-engine, 59.7 hours instrument, 80.1 hours night, and 22.5 hours turboprop (which was recorded as pilot in command). The last entry in the logbook was dated January 7, 1996. On an undated resume, he listed as work experience corporate pilot services for officers and management of Swire Coca Cola from "August 1995 to present." Additionally, he listed experience as a flight instructor and as a traffic-watch pilot in Salt Lake City, from

"November 1994 to the present." He noted that 80 to 100 hours were flown each month.

The copilot's most recent airman's medical was a first class certificate without limitations or waivers, dated August 1, 1995. He listed his weight as 190 pounds, and listed his total pilot time as 800 hours, with 450 hours accumulated in the preceding six months. According to his wife, he had been flying with the captain in the MU-2 since August, 1995, and he had told her that he was "there for a learning experience." She stated that he rarely manipulated the controls on the MU-2, but that he had been flying a Beech Baron for the captain on a more frequent basis. She stated that he had taken the weekend off (the two days previous to the accident), except that he had given about one hour of flight instruction.

## AIRCRAFT INFORMATION

703 Mitsubishi MU-2B airplanes were assembled in the US between 1967 and 1986. Two variants, known colloquially as the long-body and short-body versions, were built during the production run. All models were manufactured using two AirResearch (or Garrett) TPE 331 series turboprop engines. Horsepower of the TPE 331 engines, as installed on MU-2B airplanes, progressively increased to an airframe limit of 715 shaft horsepower (shp) through the various TPE 331 "dash" models installed on the airplanes. The TPE 331 engine exhaust also produces approximately 148 pounds of jet thrust, the total engine output-as installed on MU-2B's-is often expressed as equivalent shaft horsepower (eshp), which varied from 605 eshp to a maximum of 778 eshp on the MU-2B fleet.

The long-body version has increased cabin area and seating capacity, the result of a fuselage redesign which increases the overall length of the aircraft from 33 feet 3 inches to 39 feet 5 inches. Wing span and area remained unchanged over the production life of the airplane. During the production period, maximum gross takeoff weights increased from the original MU-2B-10's 8,930 pounds to the MU-2B-60's 11,575 pounds. Seating arrangements varied from nine occupants, including crew seats, on the short-body aircraft up to 10 or 11 seats, including crew, for long-body aircraft. All versions were certificated for single-pilot operation, and did not require a copilot.

FAA certification of the Mitsubishi MU-2B was originally accomplished under the provisions of the Bilateral Airworthiness Agreement between the US and Japan, dated February 1, 1963. In accordance with Part 10 of the Civil Air Regulations (currently 14 CFR 21.29), FAA Type Certificate A2PC was issued for the MU-2B on November 4, 1965. The airplanes were initially shipped to the US as completed airframe kits; engines and other accessories were then added and the airplanes were test flown and released. Interior furnishings, additional avionics, and instruments were usually added after the airplane was released by Mitsubishi's US representative, which was originally Mooney Aircraft Corporation.

On September 12, 1973, Mitsubishi Aircraft International, Inc. (MAI) submitted an application for type certification of the MU-2B under the provisions of 14 CFR 21.21. The stated intent was

to place control of the type design data with MAI at San Angelo, Texas, and to place direct responsibility for specific approval of type design, and changes thereto, with the FAA, rather than through JCAB and bilateral agreements. Exemption number 1951 was granted on February 4, 1974, to permit use of the same certificating regulations as were used for airplanes manufactured under TC A2PC. On January 20, 1976, FAA type certificate approval A10SW was granted for the MU-2B-25 and -35 models. Subsequent approval was granted for -26, -26A, -36, -36A, -40, and -60 models, as part of TC A10SW. At the time of the accident, Raytheon (formerly Beech Aircraft Corporation) was licensed by Mitsubishi Heavy Industries to act on behalf of MHIA as holder of the type certificate and to provide product and spare parts support for the MU-2B series aircraft. MAI filed articles of dissolution on August 25, 1987.

The accident airplane, a long-body MU-2B-36, was manufactured by Mitsubishi Heavy Industries on November 20, 1975, and was assigned serial number 693. Certification basis for manufacture of this airplane was Civil Air Regulation (CAR) 10 and CAR 3. The airplane was originally configured with 724 eshp Garrett TPE 331-6-252M engines, and three-blade Hartzell propellers. According to FAA records, the aircraft was modified by STC (Supplemental Type Certificate) SA2413SW on February 18, 1977. The modification included a change from three-blade to four-blade propellers (Hartzell HC-B4TN-5DL/LT 10282B-5.3R) and a powerplant change to 776 eshp TPE 331-5-252M engines. This change was documented on an FAA Form 337, and approved on the basis of STC SA2413SW. This modification made N693PA essentially identical to a MU-2B-36A. Maximum certificated gross weight remained unchanged at 11,575 pounds, and seating capacity was 10 seats, including two crew member seats. According to MHIA, a block of aircraft, including serial numbers 689 through 696, were modified at the factory under that STC. 33 MU-2B-36 aircraft were produced; 27 remained active as of April 1, 1996. 39 MU-2B-36A aircraft were produced; 30 remained active as of the same date. Of the 703 aircraft built or assembled in the US, 478 were still considered active April 1, 1996.

The airplane was operated under US registration as N853MA, N693FB, and N87WW. On July 26, 1984, as N693FB, the airplane was carried by the FAA registry as a MU-2B-36. On April 24, 1987, a bill of sale reflected that it was sold as a MU-2B-36A. The airplane was deregistered by the FAA December 29, 1987, and flown to France as N693SA, on January 4, 1988. No documents were recorded reflecting the assignment of N693SA as a registration number after deregistration as N87WW. The airplane had accumulated 3653.7 hours total time as of January 4, 1988. As of February 6, 1995, the aircraft had accumulated 5506.1 hours total time and was registered in France as F-GHDS. The French registration number was assigned on or before February 11, 1988, and appears to have remained unchanged throughout the aircraft's service life in Europe.

On February 21, 1995, an FAA Bill of Sale for the airplane as a MU-2B-36A was signed by the seller, with the purchaser listed as Pro Air Services of Utah. An FAA Temporary Registration Certificate conveyance was recorded by the FAA on March 6, 1995, that listed the owner as Pro Air Services of Utah, LLC, signed on February 10, 1994 by Richard Shipman, member. Additionally, on March 6, 1995, an Aircraft Security Agreement conveyance was recorded by

the FAA upon Pro Air Services of Utah, LLC, TIN870508682, Richard Shipman, member. Those documents showed that the airplane's new US registration was N693PA.

The airplane returned to the US in March 1995, flying from Europe to Reykjavik, Iceland, on March 8, 1995, and from Reykjavik to Goose Bay, Newfoundland, on March 9, 1995. The aircraft reentered the continental US on March 10, 1995, clearing customs at Bangor, Maine. An FAA Standard Airworthiness Certificate, dated March 16, 1995, was issued for N693PA, Mitsubishi MU-2B-36A, by a Designated Airworthiness Representative (DAR). At a later date, a replacement FAA Standard Airworthiness Certificate signed by an FAA Inspector was issued for N693PA, correcting the model to Mitsubishi MU-2B-36.

According to MHIA, N693PA, as converted by Supplemental Type Certificate with TPE 331-5-252M engines and four-blade propellers, had identical performance and was otherwise identical to MU-2B-36A-configuration airplanes.

## AIRCRAFT EQUIPMENT

According to FAA records for the accident airplane for the period of time prior to its export to France, the aircraft equipment included-in addition to basic flight instruments-two heated windshields, weather radar, radar altimeter, area navigation (RNAV), flight director and autopilot, encoding altimeter, and Loran C. A marketing document negotiated with a Sarasota, Florida aircraft brokerage in early December, 1995, for a sales listing of the airplane, indicated that the aircraft's equipment remained similar to its original installation at the time of export to France, including Foster 612 RNAV and Garmin Skynav 5000 Loran C. The avionics installation included dual King KTR-905S communications transceivers, dual King KNR-630 VOR/LOC/GS receivers, King KDF-805 ADF, King KMR 675 marker beacon and King KDM-705A DME. Additionally, the equipment list included dual Sperry RD44NAV HSI indicators, dual Collins RMI-130 RMI, RCA Primus 44 WXD radar, and King KRA-405 radar altimeter. The autopilot was listed as a King [Bendix] M4-D. The seating configuration was noted at that time to include seven lateral-tracking passenger seats with two tables, and one belted lavatory seat. The equipment list did not include an ice detection system.

## MAINTENANCE HISTORY

Because of ICAO bilateral agreements, the aircraft's annual inspection, completed in France on January 2, 1995, would have remained valid until January 31, 1996, after the airplane was reimported into the US. Besides annual inspections, the manufacturer's maintenance program required 100-hour inspections, and six-month inspections of the Ni-Cad battery system. As the aircraft was equipped with Ni-Cad batteries at the time, a six-month inspection was due by the end of July. As the January 2, 1995, annual inspection was completed at 5506 hours total time in service, another 100-hour inspection was not due until 5606 hours total time in service.

After the accident, partial maintenance records of N693PA were recovered, including the original logbooks when the aircraft was registered in the United States, and French carnet de route (journey logs) which covered the period from February 11, 1988 to a period after the aircraft was reimported to the United States. The last logbook entries in the carnet de route were on July 19, 1995, with a sign off for a six-month inspection, and July 28, 1995, for a replacement of brake assemblies and gear strut servicing. The FAA inspector who reissued the Airworthiness Certificate correcting the model number, and who inspected the airplane prior to its being placed on D and D Aviation, LC, operating specifications, recalled that there were additional logbooks started some time after the aircraft's reimportation date. No evidence of those logbooks and no evidence of a current listing of Airworthiness Directives was found during the course of the investigation.

The periodic pitot/static system tests required by 14 CFR 91.411 were performed in France on January 6, 1994, and were due again on February 1, 1996. Additionally, according to records received from a French maintenance facility, other maintenance salient to the accident investigation was performed in the months before the aircraft's sale and return to the US. The deice system distributor valve and timer were checked by the French maintenance facility on November 11, 1994. The deice timer (part number 3D1472, serial number G534) was removed and replaced with deice timer part number 3D1472, serial number G0115, and the system was tested. The replacement timer had been overhauled by Precision Electronics, Inc., Atlanta, Georgia, on February 2, 1993. That timer was imported from the US by Aviation Business International, Senlis, France. When the timer was exported to France by Professional Aviation Associates, Inc., of Atlanta, Georgia, it was accompanied by an FAA Form 8130-3 Airworthiness Approval Tag and conformity documents signed by a Designated Airworthiness Representative, and dated November 11, 1994.

Shortly after the airplane returned to the US, its propellers were replaced, it was weighed, and it underwent other maintenance. Some of the maintenance was recorded in the airplane's journey logs (carnet de route).

On March 16, 1995, the propellers were removed and overhauled propellers were installed by Hartzell Service Center Repair Station, Piqua, Ohio. According to the Hartzell service center, the aircraft had been flown to Piqua for the propeller exchange and overhaul. The hour-meter time at that date was recorded as 2789.2.

According to an invoice stapled into the journey logs, on March 17, 1995, at Autopilots Central, Tulsa, Oklahoma, the autopilot computer was removed and repaired and an autopilot trim adapter was removed and exchanged.

Also on March 17, 1995, Intercontinental Jet, Inc., Tulsa, Oklahoma, work order number 2302-2 described four maintenance discrepancies. This work order was not referenced in the journey logs. "Discrepancy 1" on that work order noted that the "[deice] boots are not inflating." Remarks indicated that the mechanic "troubleshoot system...found timer to be bad, will inflate not cycle." Action taken was to "notify owner." Additionally, the radar did not "paint" (the

owner was notified that the indicator was suspect), the oxygen was serviced, and the beta lights were switched.

The Intercontinental Jet mechanic who performed the deice boot system troubleshooting stated during a telephone interview that he had applied a nominal 15 psi shop air source to the deice boot system, tapping into the system downstream of the engine. He then energized the electrical system, and actuated the deice boot switch on the overhead switch panel in the cockpit. He said that the deice boots inflated, but would not deflate until he turned off the switch. He determined that the deice system timer was not functioning properly and he told the aircraft's owner that it was possible to inflate and deflate the boots manually, using the switch as described, but the automatic cycling timer mode did not function. The mechanic stated that the aircraft's owner told him that he never used the automatic timer when operating deice boots, and he could cycle the boots manually.

According to the journey logs, on April 4, 1995, the replacement propellers were rebalanced at Desert Aviation, Scottsdale, Arizona. The hour-meter reading recorded in the journey logs at that time remained 2789.2, the same as it had been at Piqua, Ohio. No explanation for the failure of the hour-meter to record en route time between Piqua and Scottsdale was found.

The radar indicator unit was removed and repaired by an avionics facility in Scottsdale, Arizona. The work order was written on April 3, 1995. The indicator was reinstalled at a later date, and then the R/T unit magnetron failed, and the R/T unit was replaced with a spare unit. A journey log entry, dated May 25, 1995, reflected this exchange and repair.

According to a journey log entry, the airplane was weighed on April 25, 1995. Its empty weight was 7918 pounds. Center of gravity was 198.43 inches from datum, moment was 1571232.3, and center-of-gravity was 33.45% of mean aerodynamic chord. The log book entry for weighing was signed by a mechanic; the location was not identified.

On July 19, 1995, according to the journey logs, a six-month inspection was conducted. Total time on the aircraft at that time was recorded as 5537.1 hours. The nickel-cadmium (Ni-Cad) main batteries were removed at that date and replaced with lead-acid batteries, in accordance with an STC. The last maintenance recorded in the journey logs was on July 28, 1995, when a main gear tire was replaced, the landing gear struts were serviced, and the brakes were overhauled.

The airplane was placed on a lease agreement with D and D Aviation, LC, of Salt Lake City, Utah, by the owner. D and D Aviation obtained 14 CFR Part 135 operations specifications for the airplane, and used it for non-scheduled air carrier (air taxi) flights under that Part. D and D Aviation also had a "fleet" FAA approved Minimum Equipment List (MEL) for MU-2B aircraft. After the accident, the president of D and D Aviation stated that he had told the owner late in 1995 that he could no longer use the airplane on his air taxi certificate as the owner's use of the airplane created inadequate availability. FAA records showed that the aircraft still remained on D and D Aviation's FAA approved operations specifications at the time of the

accident.

On September 19, 1995, while operating on a 14 CFR 135 air taxi flight, a D and D Aviation pilot encountered hail during takeoff from Fanning Field, Idaho Falls, Idaho. The pilot continued his departure, and flew to Salt Lake City, his destination. D and D Aviation flight log sheets show that the aircraft was used by that company on at least three occasions in October, 1995, with the hail damage unrepaired.

Hail damage:

Intercontinental Jet provided Pro Air Services with a estimate dated December 7, 1995, estimating the costs of repair and replacement of the hail-damaged skins, although they had not physically inspected the aircraft. They predicated their quote upon removing the wing section from the fuselage and placing it in repair jigs, removing hail-damaged skins from LH Wing Section Station 5450 to LH Wing Section Station 580 and from RH Wing Station 580 to RH Wing Station 5450, placing the aircraft fuselage in cradle fixtures and removing damaged skins from F Station 180 to F Station 10245, removing horizontal stabilizer hail-damaged skins from LH HS 2320 to RH HS 2320, reassembling the aircraft, flight checking, and replacing all aforementioned skins with factory replacement items. The bid also included the replacement of the copilot's windshield, and replacement of all deice boots.

An aircraft broker, who had been instrumental in the reimportation of the airplane, stated that he observed the hail damage to the aircraft at Scottsdale, Arizona, on January 12, 1995, and discussed it at length with the captain. He stated that he had used a ladder with the specific purpose of looking at the damage on the top of the wings and fuselage. He was able to observe the damage to the upper nose cone as well as the upper surface of the horizontal stabilizer. He stated that "although the pock marks were noticeable, there was no skin penetration in any area and the damage appeared to be substantially cosmetic (as opposed to very insignificant)." He estimated that the depth of each hail strike was approximately from 1/32 to 1/16 of an inch, with approximately four dings per square foot.

MHIA engineers evaluated photographs illustrating the hail damage and observed that there were several dents on the upper surface of the leading edge of the elevator, there were many dents on the upper surface of the trailing edge of the elevator, there were projections like pain on the upper surface of the horizontal tail, and several dents on the upper surface of the trailing edge and leading edge of the wing flap. MHIA stated that those dents described appeared to be in excess of the aerodynamic smoothness requirements as specified in the Structural Repair Manual for the MU-2 aircraft. However, MHIA did not believe that those dents would have a substantial effect on flight characteristics.

Windshield:

The airplane was equipped with heated pilot and copilot windshields manufactured for Mitsubishi by PPG Industries.

The president of D and D Aviation stated that he observed the windshields of N693PA about the first week of January. He stated that there were no cracks in either the pilot's or copilot's windshields at that time, but that they appeared milky or delaminated at their edges. D and D Aviation filled out a work order on January 2, 1996, for an annual inspection. Airframe total time was 5602 at that date, and they noted that the inspection was due at 5606, four hours later. On the second page of that work order were notes that "windshields won't pass inspection?", "copilots heat inop", "pilot[s windshield] getting milky around border." Additional notes stated that the owner "will take to have replaced or inspected or repaired."

D and D Aviation's president stated in an interview that his maintenance facility's internal schedule was quite active at the time, and he had told the captain that his facility did not have the capability to do a windshield replacement, so the captain had elected to take the aircraft elsewhere for that work.

The Scottsdale aircraft broker stated that he had observed the copilot's windshield closely on January 12, 1996, and was informed by the captain that the heating elements on that side (the entire copilot main windshield) did not function. The broker observed two to three cracks running from the structure along the lower edge of the copilot windshield towards the trailing part, upwards toward and through the heating-element lower tape. He stated that he pointed out this discrepancy to both crew members. He stated that the captain told him that his insurance was going to pay for a windshield replacement. The broker also stated that, to the best of his knowledge, windshield replacement had not been accomplished as of the date of the accident.

In a Pro Air Services letter of January 5, 1995, to an insurance adjuster, and signed by the captain, the captain stated that both windshields would need to be replaced immediately, as they would not pass an inspection.

PPG representatives noted that the windshield design was tested to 12.2 psi, which is twice maximum cabin differential pressure (6.1 psi), with the outer pane of the glass/vinyl/glass laminate windshield failed. MU-2B maintenance manuals specifically prohibit further flight with cracked windshields.

Airframe deice components and timer:

The captain's widow stated that she believed the deice boots had been replaced shortly before the accident, however no work order substantiating this statement was found. Intercontinental Jet's December 7, 1995, quotation for work to repair the hail damage included a quotation to replace all the pneumatic deice boots, which they stated would need to be accomplished after replacement of the aircraft skins.



On March 21, 1995, the deice boots were reconditioned at Herb Carson Aircraft Services, Tulsa, Oklahoma, according to work order 645. This maintenance was not referenced in the journey logs. The proprietor of that business was interviewed. He stated that he provided boot patching and cosmetic services only, which entailed extensive cleaning of the deice boots, cosmetic polishing, and functional testing. During the telephone interview, he stated that he had functionally tested the deice boots on N693PA. He did not recall if the timer functioned.

## METEOROLOGICAL INFORMATION

The 0552 surface weather observation from Malad City, Idaho, indicated a cloud ceiling at 12,000 feet overcast with a visibility of 10 miles. At 0658, the ceiling and visibility decreased to 9,000 feet overcast and 6 miles respectively. At this time, snow pellets, fog and smoke were reported. Snow pellets are precipitation consisting of white opaque, approximately round (sometimes conical) ice particles having a snow-like structure, and are about 2 to 5 millimeters in diameter. Snow pellets form as a result of accretion of supercooled droplets collected on what is initially a falling ice crystal.

Sunrise at Malad City on January 15, 1996, occurred at 0756. At the time of the accident, the moon was at an azimuth of about 154 degrees at an altitude of about 29 degrees. The moon was about 32% illuminated.

Review of 0500 upper air data on the Safety Board's McIDAS workstation showed a freezing level in the area of the Malad City VOR of about 10,000 feet. The temperature at 16,000 feet was about -13 degrees C, and winds were westerly at approximately 35 knots.

Doppler Weather Radar data from Salt Lake City, Utah, and Pocatello, Idaho, for the approximate time period from 0600 to 0620 were reviewed on a Hewlett Packard Workstation using Motif Interactive Radar Analysis Software (Motif-IRAS). These data showed weather echoes in the area of the Malad City VOR at the Flight Level of N693PA. The presence of these echoes is consistent with the likely existence of cloud, drizzle, and rain drops in the Malad City VOR area. Geostationary Operational Environmental Satellite (GOES) 8 Data, reviewed on the Safety Board's McIDAS Workstation, indicated the likely presence of liquid water drops in the area where the accident occurred.

The Liquid Water Content (LWC) along the flight path of N693PA was not observed or measured. Therefore, estimates of the LWC were made using a formula developed by the USAF, computer programs developed by the NTSB, and Doppler Weather Radar data from Salt Lake City, Utah and Pocatello, Idaho. These estimates ranged from less than 0.1 gram per cubic meter to .68 gram per cubic meter. Using an NTSB developed computer program to calculate the rate of ice accumulation given a LWC of .7 gram per cubic meter and an aircraft True Airspeed of about 200 knots results in a value of about .2 inch of ice accumulation per minute.

The following Pilot Reports (PIREPs) were pertinent to the investigation:

270 degrees at 10 nautical miles from BYI [Burley, Idaho]/ Time 1304Z / Flight Level (FL) 12,000 feet / Type Aircraft BE99 / Icing light to moderate mixed. (BYI is located about 62 nautical miles west-northwest of the Malad City VOR.)

Over MLD [Malad City, Idaho]/ Time 1329Z / FL 16,000 feet / Type Aircraft BE02 / Icing moderate rime.

120 degrees at 30 nautical miles from BYI / Time 1337Z / FL 14,000 feet / Type Aircraft SW3 / Icing light to moderate rime .

The terminal forecast for Pocatello, Idaho, issued by the National Weather Service valid for the time period 0300 to 0600 was for a cloud ceiling at 20,000 feet broken. For the time period 0600 to 1200, the forecast was for a cloud ceiling at 10,000 feet overcast; winds 200 degrees at 10 knots; occasional cloud ceiling at 5,000 feet broken.

The following AIRMET (AIRMET Zulu Update 1) was issued by the National Weather Service Aviation Weather Center in Kansas City, Missouri, at 0145 and was valid until 0800:

Occasional moderate rime icing in cloud above the freezing level to 20,000 feet. Freezing level surface Eastern Montana / Northeastern Wyoming sloping to 6,000 to 10,000 feet remainder of the area. The area encompassed by this AIRMET was about 42 nautical miles north and 62 nautical miles west of the accident location. Pocatello, Idaho (PIH), N693PA's destination, was located in the icing area.

According to the meteorologist at the Aviation Weather Center who issued AIRMET Zulu Update 1 for icing at 0145, the AIRMET did not cover extreme southeast Idaho because, "based on the meteorological information I had on hand to analyze and interpret in regards to assessing significant icing potential, I forecast the threat of icing to be to the north and west of the Malad City region through the forecast period 0200 to 0800." The meteorologist was on duty from 2200 January 14 to 0600 on January 15, 1996. He was the on duty meteorologist responsible for the western one-third of the contiguous United States.

The meteorologist at the Aviation Weather Center who came on duty at 0600 did not recall why the previously uncovered area of southeast Idaho was added by him to the subsequent icing AIRMET (AIRMET Zulu Update 2) issued at 0745. He could only speculate that, based on daily experience: 1) he may have received a Pilot Report of icing over the area that, coupled with other objective and subjective interpretation, indicated that the area should now be covered; 2) if there was an icing PIREP he may have considered that it was an isolated situation but that changes during the next six hours would require that the area should be covered by an AIRMET Zulu; 3) the latest numerical model fields combined with current data may have indicated that the area be covered.

The Center Weather Service Unit meteorologist at the Salt Lake City Air Route Traffic Control Center did not issue a Center Weather Advisory for icing. According to the meteorologist, an AIRMET (AIRMET Zulu Update 1) was in effect for occasional moderate rime icing from the freezing level to 20,000 feet for a portion of Southern Idaho but not Northern Utah. The southern extent of this area was to the north of Malad City. According to the meteorologist, within the first half hour of operation he received only one pilot report, for light to moderate icing 10 miles west of Burley, Idaho. The report was within the area covered by the AIRMET, so in the absence of any additional information, the meteorologist decided that the AIRMET covered the area of icing adequately. The existing meteorological conditions, based on surface observations and radar data plus the absence of pilot reports for icing indicated to the meteorologist that any reconfiguration of the AIRMET was unwarranted. The meteorologist also noted that since no moderate to severe icing reports were received or expected "it would seem" the issuance of a SIGMET or Center Weather Advisory was not justified.

According to information received from the National Center for Atmospheric Research (NCAR) and the National Weather Service (NWS), icing forecast techniques are currently predicated on relative humidity and temperature fields. This method enables a forecaster to determine the potential for icing conditions and typically covers large areas. However, these forecasts do not include Supercooled Liquid Water Content or provide explicit water drop sizes. According to an NCAR scientist it is not possible, using temperature and humidity data, to accurately determine the severity of the icing conditions that may exist. The scientist also noted that with continuing deployment of Radar Wind Profilers, the use of Doppler Weather Radar, multispectral satellite data, aircraft-transmitted atmospheric reports, and the sophisticated mesoscale atmospheric models, it is possible to refine current icing forecasts.

#### AIDS TO NAVIGATION

There were no reported anomalies or equipment outages regarding aids to navigation.

#### COMMUNICATIONS

There were no known communications difficulties. A salient extract of communications transcripts between N693PA and ATC (Air Traffic Control) has been provided in the History of flight chapter of this report; complete ATC transcripts are appended.

#### WRECKAGE AND IMPACT INFORMATION

The airplane impacted the ground in a slightly inverted nose-down attitude at an angle of approximately 105 degrees, determined from crush angles on the airplane's tip tanks relative to ground level. The coordinates of the accident site were plotted using Global Positioning System (GPS) as 42 degrees 14.66 minutes north latitude and 112 degrees 23.87 minutes

west longitude, at an elevation of 5240 feet MSL. The terrain at the accident site consisted of a grassy canyon surrounded by moderate inclines and rolling hills. There were no trees or tall vegetation surrounding the accident site and no evidence of the airplane colliding with any other terrain prior to the main impact area. There were large patches of burned grass surrounding the wreckage.

The wreckage distribution path began at four parallel craters with a main impact area in the center of the craters. The main impact area measured 6 feet wide by 4 feet deep and contained pieces of the nose landing gear, rudder pedals, yoke assembly, sections of a cockpit seat, cockpit pieces, parts of the instrument panel, and pieces of 1/2 inch thick clear acrylic plastic and aqua-colored acrylic plastic similar to the side window materials of the MU-2B-36. Two 4-foot deep craters on either side of the main impact crater were found to contain the left and right engine gearboxes. All eight propeller blades were separated from their hubs and were found in the vicinity of the gearboxes.

Two additional craters, of about one foot depth, were found on either side of the engine gearbox craters. These two craters contained pieces of the wing tip fuel tanks, and were approximately 40 feet apart, consistent with the span between the MU-2B-36 wing tip fuel tanks.

The wreckage distribution path was perpendicular to the axis between the two small craters containing wing tip fuel tank pieces, at 88 degrees magnetic from the center crater. Pieces of the fuselage, left and right wings, control surfaces, right and left engine power sections, and the main cabin door were located along that distribution path. All of the flight control surfaces were found throughout the wreckage path. The tail assembly, including the rudder, vertical stabilizer, and horizontal stabilizer, was located 90 feet from the main impact area and exhibited severe post-impact fire damage. The farthest wreckage-pieces of the landing gear structure-was found 360 feet from the main impact area, and exhibited no fire damage.

The fuselage structure, from the nose at fuselage station -170 to the wing at fuselage station (FS) 4285, was predominantly destroyed by impact damage and post-impact fire. The main cabin door at FS 6495 remained intact and exhibited impact damage to the exterior surface. Examination of the main cabin door revealed that the handle and latches were in the extended and locked position. The aft section of the tail cone was found separated from the fuselage at FS 9195 and exhibited severe post-impact fire and heat damage. The horizontal stabilizer and the lower portion of the vertical stabilizer remained attached to the tail cone and exhibited severe post-impact fire damage.

The main, outer, and wing tip fuel tanks were all ruptured and no fuel residue was found. The major portion of the left wing leading edge was destroyed by impact and post-impact fire. Examination of portions of the left wing flaps, spoilers, and trim ailerons revealed severe fire and heat damage. The flap jackscrews were found in the retracted position. The left inboard and outboard flaps separated from the wing structure, but remained integral to the flap tracks.

The remaining portions of the right wing also exhibited severe impact damage and post-impact fire damage. Examination of the right wing flap tracks revealed that the flaps were in the retracted position. The right inboard and outboard spoilers separated from the wing and exhibited impact and soot damage.

Wing spoiler positions could not be determined. Examination of the aileron roll trim rigging pins revealed alignment of the rigging holes consistent with both left and right roll trim actuators in the neutral position. Both elevator trim actuators revealed alignment of the rigging pin holes consistent with the elevators in the neutral pitch trim positions. Examination of the rudder trim actuator revealed that the extension rod was extended 5 1/2 inches from the base of the actuator to the jam nut, corresponding to 5 degrees of nose left trim.

All of the flight control surfaces were located in the wreckage debris. The continuity of the control systems could not be determined, although the rudder and elevator control cables were traced from the mid-cabin area to the empennage, and the spoiler cables were traced from the nose to the mixer control. Trim control cable continuity could not be established due to fire and impact damage.

From the fully extended jack screws, it was determined that the main and nose landing gear were in the up position at the time of impact.

The pilot's and copilot's gyro synchronizers were located and removed for examination. The pilot's and copilot's altimeters were recovered; both had sustained impact damage. Examination of the copilot's altimeter face showed a barometric setting of 30.18. No other flight instruments were found that could provide any useful information. The right engine tachometer was found, exhibiting severe impact and post-impact fire damage. All other engine instruments were destroyed by impact forces and fire damage. The accident site was revisited May 7, 1996. An additional search of the accident site was conducted, including extensive excavating. One prop pitch link, one igniter box, and a multitude of small airframe pieces were recovered. No pieces of the windshield or of an ice detection system were found. MHIA posted an award for parties who might locate the windshield, and also conducted an unsuccessful independent search of the vicinity for the windshield or windshield components in July, 1996.

## MEDICAL AND PATHOLOGICAL INFORMATION

The medical examiner determined that the cause of death for all occupants of the airplane was multiple traumatic injuries. Insufficient samples were available for toxicological testing. The medical examiner noted in a telephone interview that no glass fragments were observed during the course of conducting autopsies of the occupants.

## FIRE

There was no evidence of in-flight fire. Post-crash fire created a fire ring of about 200 feet diameter, with many airframe components partially consumed by fire.

## SURVIVAL ASPECTS

The wreckage was discovered about 1030 on the morning of the accident by a search aircraft.

All occupants were ejected from the wreckage or embedded in the impact crater. All were separated from their seats. The accident was considered non-survivable; all occupants sustained blunt force trauma.

## TESTS AND RESEARCH

Both the pilot's and copilot's gyro synchronizers were removed from the empennage and examined at Honeywell, in Phoenix, Arizona. Both revealed gyro rotors that were scored on the outer diameters from contacting the gimbal balance screws, consistent with rotation at impact. Both gyro slip-ring bushings were also burned at the tips, consistent with electrical continuity at impact.

Deicing of the MU-2B-36 wing and empennage leading edges is accomplished by inflating and deflating rubber boots attached to the leading edges. Regulated engine bleed air is used to inflate the boots. The deice system consists of a pressure regulator and relief valve, ejector, distribution valve, timer, and a pressure switch. When the pilot activates the "WING DE-ICE" switch (on the upper left cockpit switch panel), the deice timer is energized and the pressurizing port of the distribution valve opens in response to a signal from the timer. The pressure regulator and relief valve regulates air pressure and supplies air to inflate or deflate the deice boots. When the pressurizing port is closed in response to a signal from the timer, the negative pressure port opens and air in the boots is evacuated by the ejector, keeping the boots under negative pressure so the boots are not inflated during flight in non-icing conditions. During automatic operation, the inflation and deflation cycles are carried out every three minutes, but manual control can shorten the cycle to 16-18 seconds. When the boots are operating normally, the indicator light on the switch panel illuminates.

The deice timer sends a signal to actuate the distribution valve, cycling inflation and deflation of the deice boots. During automatic operation, when the pilot activates the wing deice switch, the timer sends a cycle signal of about six seconds that repeats every 180 seconds (about six seconds on, and 174 seconds off). When the switch is turned off, the timer returns to the starting position in less than one second. The deice system can also be operated in a manual mode at the pilot's command; i.e. the switch is turned on and the deice boots cycle. After ten seconds, the switch can be released and turned on again for another cycle. If the deice timer stepper motor becomes inoperative, both the automatic and manual deice modes will not function.

The deice boot timer, deice distribution valve, deice boot pressure regulator, and relief valve removed from the wreckage were examined at the BF Goodrich facility in Uniontown, Ohio.

The BF Goodrich timer, part number 3D1472, serial number G0115, exhibited impact damage to the casing and the casing lid had separated from the casing on one side. A gold-colored identification plate affixed to the lid of the timer revealed that the timer had been overhauled by Precision Electronics, Inc., on February 22, 1993. The timer decks A through D were crushed, and deck A was found in the home position (power off). Decks B through D were also found in the home position aligned with deck A. The two sets of interrupt contacts mounted on the stepping switch that controls the sequencing action of the timer exhibited normal wear, with no discoloration of the contacts. The electrical plug exhibited burned and broken wires three inches from the plug. Continuity was established from the end of the burned wire to each respective receptacle pin in the plug. Electrical power applied directly to the stepper motor energized the motor. The normal power routing through the timer's power plug was damaged by the impact. A continuity check of the relay that runs the stepper motor revealed that both sets of contacts operated normally. Two capacitors normally mounted on the circuit board were separated from the board and were found within the timer case.

Review of Precision Electronics' work order EF03520 revealed that the Q2 transistor and the R1 and R8 resistors had been replaced. The work order did not reflect rework or replacement of any other circuit components on the circuit board. Examination of the damaged circuit board, however, revealed areas of reflowed solder and areas of flux at Q1, Q2 and Q3 transistors, R1 and R2 resistors, and C2 capacitor positive lead. The R4, R6 and R7 resistors were determined to be wire-wound resistors, instead of the manufacturer's approved carbon composition resistors. BF Goodrich technicians stated that the use of wire-wound resistors does not adversely affect the conductivity of the resistors. The source of the rework at Q1, Q2, Q3, R2, and C2; and replacement of R4, R6, and R7 was not determined during the investigation.

Further examination of the circuit board found heavy flux accumulations on the bottom surface of the trace pad corresponding to the C2 capacitor positive lead. An optical inspection of the C2 capacitor positive lead by the NTSB materials laboratory found that the lead extended less than .0003 inch through the circuit board when the solder was applied.

An open circuit at the C2 positive lead was established on an identical functional deice timer. When power was applied to the timer with the open circuit, the stepping motor would not step out of the home position, subsequently rendering the timer inoperative in both the manual and automatic modes.

BF Goodrich technicians determined that the deice timer, and subsequently, the deice boots, would not function with an open circuit at the C2 capacitor. With continuity through the C2 capacitor circuit, and with various secondary failures on the circuit board, it would be possible for the stepping motor to move from the home position, which would energize the distribution valve and permit inflation of the deice boots. Depending upon the nature of the secondary failures, the boots could remain inflated until the deice boot switch was turned off, at which

time the timer stepping motor would be powered to the home position and the deice boots would deflate. This sequence of events is consistent with that described by the Intercontinental Jet mechanic who functionally tested the deice system March 17, 1995.

Recordings of communications between ATC and N693PA were analyzed by Safety Board investigators. It was determined that the recordings' background noise precluded determination of engine rpm, igniter firing, or other parameters that would provide meaningful information to the investigation.

#### Simulator tests:

Motion-based flight simulator tests were performed to examine several flight scenarios and determine if these simulated conditions produced flight profiles similar to the accident flight profile.

#### Single engine reduction to flight idle:

Simulator tests were performed to determine the deceleration rate in the situation of a single engine reduced to flight idle while auto-pilot is engaged and in cruise configuration. The initial flight conditions, altitude, and airspeed before N693PA experienced decay of airspeed was used as the initial conditions for the simulator tests. This test situation generated a drop in airspeed of 40 knots within 48 seconds, clearly a much faster deceleration than was experienced by N693PA in the final portion of the flight before the loss of transponder radar data.

#### Both engines reduction to flight idle:

Similar initial test conditions as described above were utilized, with both engines in this test reduced to flight idle. A 40 knot reduction in airspeed was observed within 38 seconds, exhibiting a much faster rate of deceleration than observed in the flight of N693PA.

#### Increase in drag:

A slow increase in drag was simulated through a weight increase and forward movement of the center of gravity (CG) of the aircraft from approximately 25% of the mean aerodynamic chord (MAC) to 22.5% of MAC. The flight simulation was performed at the same initial cruise altitude, configuration, and airspeed as N693PA. With auto-pilot engaged, the increased weight and change in position of CG simulated the accretion of ice on the wing surfaces. A slow decrease in airspeed of 40 knots occurred over a period of 7.5 minutes, similar in magnitude to that observed in the accident flight. During this deceleration, a slow increase in pitch attitude and angle of attack was noted until the airspeed was reduced to the approximate stall speed of approximately 110 knots (KIAS), when the simulation was terminated. Of the scenarios examined, this case most closely matched the flight characteristics of N693PA prior to the upset and rapid descent.



## ADDITIONAL INFORMATION

The captain, who was the principal member or officer of Pro Air Services of Salt Lake, LLC, was also president of Pro Air Services of Utah, LLC, and was considered to be the owner of both entities, and of N693PA. On August 1, 1995, the captain had signed a "flight management and consulting service agreement" between Pro Air Services of Salt Lake LLC, with Swire Coca-Cola, USA, of Salt Lake City. The agreement, to remain in effect for an initial term of six months, bound the consultant to provide aircraft and comprehensive analysis for various aircraft during the evaluation period, and to make monthly reports to the client. In part, the consultant agreed to do a monthly evaluation, flight load manifests, review of aircraft flight times, weather summary review and other flight-related or requested data. The consultant would provide five pilot service days per month at no charge as part of the agreement. A "pilot service day" was defined as any six hour or more period away from an interim base or initial departure from an interim base on multiple day trips. Additional pilot service days were to be billed at an additional daily rate, differentiated between turbine-powered and pressurized aircraft, and non-pressurized aircraft. One paragraph in the agreement stated that "qualified pilots will be available for all company flights. Pilots will use conservative guidelines when evaluating weather, fatigue, aircraft status and all other factors that impinge upon safe flight operations. The safety of the aircraft and its occupants will always be the first priority. Two pilots will be used on all 'turbine' aircraft flights in which 'IFR' (instrument flight rules) weather is anticipated."

Swire Coca-Cola, USA, was provided with an inventory of aircraft "available for demonstration." This list included two single-engine airplanes, plus a 7-passenger Navajo, 5-passenger Cessna 340, 3-passenger Baron B55, and 8-passenger MU2. Each of these was listed with a schedule of price per hour of utilization. According to a separate agreement independent of the "flight management and consulting service agreement," "Swire will be allowed to fly and operate the...aircraft at double the cost of fuel plus engine reserves or their respective direct cost which[ever] is less."

During August, 1995, Pro Air Services billed Swire Coca Cola for 3.1 hours in a MU-2, and 21.3 hours in a Beech B-55, and included compensation for a sixth "pilot service day." September, 1995, billing was for 10.1 hours MU-2, and 7.5 hours B-55. October billing was for 10.8 hours MU-2 and 5.3 hours Cessna Turbo 210. November billing was for 4.4 hours in a Cessna 340. December 1995, included two MU-2 flights totalling 5.3 hours, and 1.3 hours in a B-55.

A "Roadshow Flight Schedule," as provided by Swire Coca Cola, itemized five flights between January 8, 1996 and January 12. Four flights, including the accident flight, were scheduled for the second week of January, 1996. Departure time from Salt Lake City was proposed as 0530, with proposed arrival in Pocatello at 0615. The proposed itinerary for January 15 included additional stops in Twin Falls and Boise, Idaho, with a return to Salt Lake City scheduled for 0030 on the morning of January 16. Total duty day, exclusive of travel to and from the

departure airport and preflight inspection and weather briefing, was scheduled as 19 hours on the day of the accident. Two other flights on the itinerary were scheduled for 14:40 and 16 hour duty days.

Pro Air Service had provided other services to Swire Coca Cola prior to signing the flight management agreement of August 1, 1995. Swire paid an invoice date December 1994 for "Demo" for several thousand dollars. Swire paid an invoice for three "Aerostar Demo Flights" in January 1995. Swire was billed for two "Executive Demonstration Flights" in July 1995, in a MU-2, specified as N693PA on the invoice, with an additional \$200 billing for pilot services; also one flight on July 20, 1995 was billed in Baron N1010X. N1010X, a Beech B-55, was registered to Pro Air Services of Utah.

Besides negotiating with Pro Air Services, Swire Coca Cola was actively soliciting information from aircraft brokers concerning other aircraft, receiving multiple fax messages and brokers' responses on December 6, 1994. A number of other fax messages from brokers offering aircraft were dated July 31, 1995.

#### MU-2B-36 Airplane Flight Manual:

The Airplane Flight Manual (AFM) for the airplane provides the pilot with information concerning flight in icing conditions. A warning, in bold-face type, states (in part) the following:

**DUE TO DISTORTION OF AIRFOILS, STALLING SPEEDS SHOULD BE EXPECTED TO INCREASE AS ICE ACCUMULATES ON THE AIRPLANE. STALL WARNING DEVICES MAY NOT BE ACCURATE AND SHOULD NOT BE RELIED UPON.**

**IN ORDER TO MINIMIZE ICE ACCUMULATIONS ON UNPROTECTED LOWER SURFACES, MAINTAIN A MINIMUM CRUISE SPEED OF 180 KIAS DURING OPERATIONS IN SUSTAINED CRUISE IN ICING CONDITIONS. THIS WILL PROVIDE AN ANGLE OF ATTACK THAT REDUCES EXPOSURE (FRONTAL AREA) OF THE LOWER SURFACES TO ICE ACCUMULATION. IF UNABLE TO MAINTAIN 180 KIAS AT MAXIMUM CONTINUOUS POWER, A CHANGE OF ALTITUDE AND/OR COURSE MAY BE NECESSARY TO MAINTAIN MINIMUM AIRSPEED AND/OR EXIT ICING CONDITIONS.**

#### D and D Aviation Minimum Equipment List (MEL):

The MEL approved for D and D Aviation permits temporary deferral of maintenance to the deice timer. The automatic surface deicing system to be inoperative provided the manual system is operative or it may be inoperative provided that the aircraft is not operated in known or forecast icing conditions. The manual deicing system may be inoperative provided the aircraft is not operated in known or forecast icing conditions. In either instance, the MEL requires that the inoperative timer shall be repaired within ten (10) consecutive calendar days (240 hours), excluding the day the malfunction was recorded in the aircraft maintenance record/logbook.

## FAA Testing:

After this accident, the FAA, with the cooperation of MHIA, conducted extensive tests of the long-body MU-2B, including flying the airplane behind the USAF tanker, where water droplets of various selected diameters are sprayed from the tanker in below freezing temperatures at altitude to accumulate on the airframe. Using data derived from that testing, a variety of selected aerodynamic shapes were attached to the lifting surfaces and stabilizing surfaces of the airframe, and the airplane was test-flown again. Based upon the testing, the FAA determined that the airplane met certification criteria in effect at the time of type certification..

The wreckage was released to the insurance adjuster on November 14, 1996. It remained in storage at Specialty Aircraft Co., Redmond, Oregon.

### Pilot Information

<b>Certificate:</b>	Airline transport	<b>Age:</b>	48, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>		<b>Restraint Used:</b>	
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	No
<b>Medical Certification:</b>	Class 2 Invalid Medical for flight	<b>Last FAA Medical Exam:</b>	November 17, 1994
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	8925 hours (Total, all aircraft), 1200 hours (Total, this make and model), 7065 hours (Pilot In Command, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Mitsubishi	<b>Registration:</b>	N693PA
<b>Model/Series:</b>	MU-2B-36 MU-2B-36	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Normal	<b>Serial Number:</b>	693
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	11
<b>Date/Type of Last Inspection:</b>	January 2, 1995 Annual	<b>Certified Max Gross Wt.:</b>	11575 lbs
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	2 Turbo prop
<b>Airframe Total Time:</b>		<b>Engine Manufacturer:</b>	Garrett
<b>ELT:</b>	Installed, not activated	<b>Engine Model/Series:</b>	TPE-331-5-252
<b>Registered Owner:</b>	PRO AIR SERVICES OF UTAH	<b>Rated Power:</b>	776 Horsepower
<b>Operator:</b>	PRO AIR SERVICES OF SALT LAKE	<b>Operating Certificate(s) Held:</b>	None
<b>Operator Does Business As:</b>		<b>Operator Designator Code:</b>	

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Night/bright
<b>Observation Facility, Elevation:</b>	MLD	<b>Distance from Accident Site:</b>	
<b>Observation Time:</b>	05:52 Local	<b>Direction from Accident Site:</b>	
<b>Lowest Cloud Condition:</b>	Unknown	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	Overcast / 12000 ft AGL	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	4 knots /	<b>Turbulence Type Forecast/Actual:</b>	/
<b>Wind Direction:</b>	310°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	30 inches Hg	<b>Temperature/Dew Point:</b>	28°C / 25°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	SALT LAKE CITY , UT (SLC )	<b>Type of Flight Plan Filed:</b>	IFR
<b>Destination:</b>	POCATELLO , ID (PIH )	<b>Type of Clearance:</b>	IFR
<b>Departure Time:</b>	05:49 Local	<b>Type of Airspace:</b>	Class E

## Airport Information

<b>Airport:</b>		<b>Runway Surface Type:</b>	
<b>Airport Elevation:</b>		<b>Runway Surface Condition:</b>	
<b>Runway Used:</b>	0	<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>		<b>VFR Approach/Landing:</b>	None

## Wreckage and Impact Information

<b>Crew Injuries:</b>	2 Fatal	<b>Aircraft Damage:</b>	Destroyed
<b>Passenger Injuries:</b>	6 Fatal	<b>Aircraft Fire:</b>	On-ground
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	8 Fatal	<b>Latitude, Longitude:</b>	42.239139,-112.300422(est)

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Stockhill, Michael
<b>Additional Participating Persons:</b>	TIM MASON; SALT LAKE CITY , UT JOSEPH F MANNO; WASHINGTON , DC PETER B BAKER; PHOENIX , AZ RALPH SORRELLS; SAN ANGELO , TX
<b>Original Publish Date:</b>	April 29, 1997
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	
<b>Investigation Docket:</b>	<a href="https://data.nts.gov/Docket?ProjectID=42471">https://data.nts.gov/Docket?ProjectID=42471</a>

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).