National Transportation Safety Board
Aviation Accident Final Report

Location:	Payson, AZ	**Accident Number:**	WPR13FA072
Date & Time:	12/18/2012, 1825 MST	**Registration:**	N62959
Aircraft:	PIPER PA-31-350	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled		

Analysis

The pilot began flying the twin piston-engine airplane model for the cargo airline about 11 months before the accident. Although he had since upgraded to one of the airline's twin-turboprop airplane models, due to the airline's logistical needs, the pilot was transferred back to the piston-engine model about 1 week before the accident.

The flight originated at one of the airline's outlying destination airports and was planned to stop at an interim destination to the southwest before continuing to the airline's base as the final destination. The late afternoon departure meant that the flight would arrive at the interim destination about 10 minutes after sunset. That interim destination was situated in a sparsely populated geographic bowl just south of terrain that was significantly higher, and the ceilings there included multiple broken and overcast cloud layers near, or lower than, the surrounding terrain.

Although not required by Federal Aviation Administration (FAA) regulations, the airline employed dedicated personnel who performed partial dispatch-like activities, such as providing relevant flight information, including weather, to the pilots. Before takeoff on the accident flight, the pilot conferred briefly with the dispatch personnel by telephone, and, with little discussion, they agreed that the flight would proceed under visual flight rules to the interim destination. Information available at the time indicated that the cloud cover almost certainly precluded access to the airport without an instrument approach; however, the airplane was not equipped to conduct the only available instrument approach procedure for that airport. Additionally, the pilot did not have in-flight access to any GPS or terrain mapping/database information to readily assist him in either locating the airport or remaining safely clear of the local terrain.

Although the airplane was not being actively tracked or assisted by air traffic control (ATC) early in the flight, review of ground tracking radar data showed that the flight initially headed directly toward the interim destination but then began a series of turns, descents, and climbs. The airplane then disappeared from radar as the result of radar coverage floor limitations due to high terrain and radar antenna siting. The airplane reappeared on radar about 24 minutes after it disappeared and about 9 minutes after the FAA-defined beginning of night. Based on the flight track, it is likely that the pilot made a dedicated effort to access the airport, while concurrently remaining clear of the clouds and terrain, strictly by visual means. This task was made considerably more difficult and hazardous by attempting it in dusk conditions, and then darkness, instead of during daylight hours.

About 15 minutes after the airplane reappeared on radar, when it was at an altitude of about 13,500 ft, the pilot contacted ATC and requested and was granted an instrument flight rules clearance to his final destination. About 3 minutes later, the controller cleared the flight to descend to 10,000 ft, and the airplane leveled off at that altitude about 6 minutes later. However, upon reaching 10,000 ft, the pilot requested a lower altitude to escape "heavy" up- and down-drafts, but the controller was unable to comply because the ATC minimum vectoring altitude was 9,700 ft in that region. About 1 minute later, radar contact was lost. Shortly thereafter, the airplane impacted terrain in a steep nose-down attitude in a near-vertical trajectory.

Although examination of the wreckage did not reveal any preimpact mechanical deficiencies that would have prevented normal operation and continued flight, the extent of the damage precluded, except on a macro scale, any determination of the preimpact integrity or functionality of any systems, subsystems, or components, including the ice protection systems, autopilot, and nose baggage door.

Analysis of the radar data indicated that the airplane was above 10,000 ft for at least 41 minutes (possibly in two discontinuous periods) and above 12,000 ft (in two discontinuous periods) for at least 18 minutes. Although the airplane was reportedly equipped with supplemental oxygen, the investigation was unable to verify either its presence or its use by the pilot. Lack of supplemental oxygen at those altitudes for those periods could have contributed to a decrease in the pilot's mental acuity and his ability to safely conduct the flight.

Analysis of air mass data revealed that mountain-wave activity and up- and downdrafts with vertical velocities of about 1,000 ft per minute (fpm) were present near the accident site and that the largest and most rapid transitions from up- to down-drafts occurred near the accident site, which was also supported by the airplane's altitude data trace. The analysis also indicated that the last radar target from the airplane was located in a downdraft with a velocity of between 600 and 1,000 fpm. Other meteorological analysis indicated that the airplane encountered icing conditions, likely in the form of supercooled large droplets (SLD), several minutes before the accident. Aside from pilot reports from aircraft actually encountering SLD, no tools currently exist to detect airborne SLD. Further, the tools and processes to reliably forecast SLD do not exist. SLD is often associated with rapid ice accumulation, especially on portions of the airplane that are not served by ice protection systems. Airframe icing, whether due to accumulation rates or locations that exceed the airplane's deicing system capabilities, mechanical failure, or the pilot's failure to properly use the system, can impose significant adverse effects on airplane controllability and its ability to remain airborne.

Because of the pilot's recent transition from the Beechcraft BE-99, in which the pitot heat was always operating during flight, he may have forgotten that the accident airplane's pitot heat procedures were different and that the pitot heat had to be manually activated when the airplane encountered the icing conditions. If the pitot heat is not operating in icing conditions, the airspeed information becomes unreliable and likely erroneous. Erroneous airspeed indications, particularly in night instrument meteorological conditions when the pilot has no outside references, could result in a loss of control. The investigation was unable to determine whether the pitot heat was operating during the final portion of the flight.

The investigation was unable to determine whether the pilot used the autopilot during the last portion of the flight. If he was using the autopilot, it is possible that, at some point, he was forced to revert to flying the airplane manually due to the unit's inability and to a corresponding Pilot's Operating Handbook prohibition against using it to maintain altitude in the strong up- and downdrafts, which would increase the pilot's workload. Another possibility is that the autopilot was unable to maintain altitude, and, instead of disconnecting it, the pilot overpowered it via the control wheel. If that occurred and the pilot overrode the autopilot for more than 3 seconds, the pitch autotrim system would have activated in the direction opposite the pilot's input, and, when the pilot released the control wheel, the airplane could have been significantly out of trim, which could result in uncommanded pitch, altitude, and speed excursions and possible loss of control.

Whether the pilot was hand-flying the airplane or was using the autopilot, the encounter with the strong up- and downdrafts and consequent altitude loss likely prompted the pilot to input corrective actions to regain the lost altitude, specifically increasing pitch and possibly power. Such corrections typically result in airspeed losses; those losses can sometimes be significant as a function of downdraft strength and the airplane's climb capability. If that capability is compromised by the added weight, drag, and other adverse aerodynamic effects of ice, aerodynamic stall and a loss of control could result.

Radar tracking data and ATC communications revealed that another, similar-model airplane flew a very similar track about 6 minutes behind the accident airplane, except that that other airplane was at 12,000 ft not 10,000 ft. The 10,000-ft ATC-mandated altitude placed the accident airplane closer to the underlying high terrain and into the clouds with the icing conditions and the strong vertical air movements. In contrast, the pilot of the second airplane reported that he was in and out of the cloud tops and did not report any weather-induced difficulties.

The accident pilot did not have any efficient in-flight means for accurately determining the airborne meteorological conditions ahead, and the ATC controller did not advise him of any adverse conditions. Therefore, the pilot did not have any objective or immediate reason to refuse the ATC-assigned altitude of 10,000 ft. Ideally, based on both the AIRMET and the ambient temperatures, the pilot should have been aware of the likelihood of icing once he descended into clouds. That, particularly combined with his previously expressed lack of confidence in the airplane's capability in icing conditions, could have prompted him to request either an interim stepdown altitude of 12,000 ft or an outright delay in a direct descent to 10,000 ft, but, for undetermined reasons, the pilot did not make any such request of ATC.

Based on the available evidence, if the ATC controller had not descended the airplane to 10,000 ft when he did, either by delaying or by assigning an interim altitude of 12,000 ft, it is likely that the airplane would not have encountered the icing conditions and the strong up- and downdrafts. In addition, if the presence of SLD and/or strong up- and downdrafts had been known or explicitly forecast and then communicated to the pilot either via his weather briefing, his onboard equipment, or by ATC, it is likely that the pilot would have opted to avoid those phenomena to the maximum extent possible. The flight's encounter with airframe icing and strong up-and downdrafts placed the pilot and airplane in an environment that either exacerbated or directly caused a situation that resulted in the loss of airplane control.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:
The airplane's inadvertent encounter, in night instrument meteorological conditions, with unforecast strong up- and downdrafts and possibly severe airframe icing conditions (which likely included supercooled large droplets that the airplane was not certificated to fly in) that led to the pilot's loss of airplane control.

Findings

Personnel issues	Aircraft control - Pilot (Cause)
Environmental issues	Conducive to structural icing - Effect on operation (Cause) Turbulence - Effect on operation (Cause) Dark - Effect on personnel (Cause)

Factual Information

HISTORY OF FLIGHT

On December 18, 2012, about 1825 mountain standard time, a Piper PA-31-350, N62959, was lost from Federal Aviation Administration (FAA) radio and radar contact about 10 miles southwest of Payson, Arizona, during an instrument flight rules (IFR) flight to Phoenix Sky Harbor Airport (PHX), Phoenix, Arizona. The wreckage was located the following day; the pilot had received fatal injuries and the airplane was substantially damaged. The flight was being operated as Ameriflight 3853 (AMF3853) as a cargo flight for United Parcel Service (UPS), and was conducted under the provisions of Title 14 Code of Federal Regulations Part 135. Instrument meteorological conditions prevailed in the vicinity at the time contact with the airplane was lost.

According to information from representatives of the airline and UPS, the flight departed Holbrook Municipal Airport (P14), Holbrook, Arizona, about its scheduled time of 1700, with a scheduled arrival time of 1730 at Payson Airport (PAN), Payson. According to the driver of the UPS truck who was at PAN and was scheduled to meet the flight, he never saw or heard the airplane. The driver left PAN about 20 minutes after the flight was due.

According to FAA air traffic control (ATC) information, the flight's first ATC contact was with Albuquerque air route traffic control center (designated ZAB) about 1812, when the airplane was at an altitude of about 13,500 feet; the pilot requested a clearance to PHX. The flight was assigned a discrete transponder code, radar identified, and cleared direct to PHX, with an altitude crossing restriction that necessitated a descent. Shortly after the airplane reached the assigned altitude, the pilot requested a lower altitude; his request was denied due to ATC minimum vectoring altitude limitations. Shortly thereafter, radio and radar contact was lost.

Weather conditions in the area precluded an aerial search until the following day. About 0950 on December 19, 2012, the wreckage was located at the same approximate latitude/longitude as the last radar target associated with the airplane, at an approximate elevation of 7,000 feet. The accident site was located about 12.4 miles, on a true bearing of about 213 degrees, from PAN.

PERSONNEL INFORMATION

According to FAA information, the 28-year-old pilot held a commercial pilot certificate with airplane single- and multi-engine land, and instrument airplane ratings, as well as a flight instructor certificate with the same ratings. His most recent FAA first-class medical certificate was issued in August 2012.

The pilot was an employee of Ameriflight. According to information provided by the airline, the pilot had a total flight experience of about 1,908 hours, including about 346 hours in the accident airplane make and model. His most recent flight review was completed in September 2012, in the BE-99 airplane.

According to an airline representative, as of March 4, 2011 (which was prior to the pilot's employment by Ameriflight), the pilot had accumulated 1.4 actual and 84.4 simulated instrument hours. The airline did not track its pilots' actual or simulated instrument time, and the accident pilot's logbooks were not located, so no determination of his current instrument experience was able to be made.

The pilot was hired by the airline in January 2012, and was initially assigned to the PA-31 airplane. In September 2012, he completed training for, and was assigned to, the BE-99 twin turboprop airplane.

About a week before the accident, due to the airline's logistical requirements for the holiday season, the pilot was transferred back to the PA-31 airplane. When he became aware of that transfer, he told his father that he had received "some really bad news," and informed his father of the transfer back to the PA-31. The pilot told his father that the BE-99 is a "better" airplane, and that he did not "like or trust" the ice protection equipment on the PA-31. The pilot flew the PA-31 a total of about 11 hours between his transfer and the accident.

Ameriflight pilots, dispatchers, and managers had very similar opinions about the pilot. In interviews or communications with multiple individuals, they consistently reported that the pilot was a quiet individual who did well in training, was competent, and did not cause or voice any problems with the airline.

MEDICAL AND PATHOLOGICAL INFORMATION

The Gila County Sheriff's Office autopsy report indicated that the cause of death was blunt force trauma. The FAA Civil Aeromedical Institute conducted forensic toxicology examinations on specimens from the pilot, and reported that no carbon monoxide, cyanide, ethanol, or any screened drugs were detected.

AIRCRAFT INFORMATION

FAA information indicated that the airplane was manufactured in 1976, and was registered to UAS Transervices Inc. of Pasadena, CA. It was equipped with two Lycoming TIO-540 series engines, and two three-blade Hartzell propellers. The left engine rotated clockwise, and the right engine rotated counter-clockwise, as viewed from the rear. The tricycle-style landing gear was retractable.

Review of Ameriflight-provided information indicated that the airplane was within its weight and balance limits, and that there was sufficient fuel onboard for the planned flight legs.

Maintenance records information indicated that the airplane had about 19,200 hours total time in service, and had accumulated about 23,400 flight cycles. The left engine had accumulated about 1,300 hours since its most recent overhaul, and the right engine had accumulated about 59 hours since its most recent overhaul.

Review of the maintenance records did not reveal any significant items or trends. The airplane had several unscheduled maintenance items related to the ice protection systems accomplished in April and May 2012. In September 2012, some de-ice boot patches were replaced, and in October 2012 a pneumatic pump was replaced. No records of any subsequent discrepancies associated with the ice protection systems were located, nor were any records of any uncorrected maintenance items located.

According to airline representatives, the airplane was equipped with VOR (very high frequency omni-range) and glide slope equipment for navigation. The airplane was not equipped with weather radar, or any system to receive and display ground-based weather radar information. The airplane was not equipped with a GPS receiver, and no evidence to suggest that the pilot had any personal or hand-held GPS units was obtained.

The airplane was equipped with a Century Altimatic IIIC autopilot, which was capable of controlling aircraft in the roll, pitch, heading, and altitude hold modes. The Ameriflight Standard Operating Procedures (SOP), General Operations Manual (GOM), and the applicable Limitations section of the PA-31 Pilots Operating Handbook/Airplane Flight Manual (POH/AFM) did not contain any information regarding autopilot usage in turbulence or icing conditions. The autopilot did not have any automatic disconnect capability, but could be readily deactivated by the pilot. A "CAUTION" in the PA-31 POH/AFM stated "Do not overpower Autopilot pitch axis for periods longer than 3 seconds because the Autotrim System will operate in a direction to oppose the pilot and will, thereby, cause an increase in the pitch overpower forces." In addition, Paragraph 3.15 (Rough Air Operation) of Section 3(Emergency Procedures) of the PA-31 POH/AFM stated that "when flying in extreme turbulence or strong vertical currents and using the autopilot, the altitude-hold mode should not be used."

The airplane was approved for flight into light to moderate icing when equipped with wing and empennage deicing boots, electric propeller deicers, electrically heated windshield, and an ice detection light. Ameriflight representatives and guidance indicated that the airplane was equipped with all four systems.

The airplane was not equipped with the manufacturer-supplied supplemental oxygen system. Ameriflight representatives and guidance indicated that the airplane was equipped with a portable supplemental oxygen system.

In May 2008, the FAA published a SAFO (Safety Alert for Operators notice) that advised pilots and operators about unexpected in-flight openings of PA-31 nose baggage doors. The SAFO reported that such occurrences "could adversely affect the flight characteristics of the airplane." The SAFO contained a reference to an FAA supplement delineating FAA-recommended actions regarding the doors and door opening events. That supplement was primarily focused on actions to prevent inadvertent door openings.

Although the supplement also stated that the "operator's pilot training program should include emergency procedures training on how to react" and "what to expect [including]...handling," the FAA did not include any specific information, guidance, or references regarding those aspects. The FAA did not, either during airplane certification or after issuance of the SAFO, require the airplane manufacturer to develop or provide any such information. The reasons for the incongruity between the FAA recommendation for such information and training, and the lack of any FAA follow-up to ensure the development and promulgation of the same, could not be determined.

In November 2008, Piper published mandatory Service Bulletin 1194A, which required certain nose baggage door inspections, and placed life limits on certain nose baggage door components. Effective July 2009, FAA Airworthiness Directive (AD) 2009-13-06 mandated compliance with Piper Service Bulletin (SB) 1194A. Ameriflight representatives indicated that the airplane was in compliance with the SB and AD.

According to airline representatives, the airline "incorporated the recommendations of SAFO 08013 [in] the summer of 2008." The airline's response included references to the mechanical and inspection aspects of the supplement. The airline subsequently clarified that it "adopted [SAFO] recommendations 1-4," and correctly noted that it "could not locate any flight procedures" in the FAA or Piper guidance.

METEOROLOGICAL INFORMATION

PAN Automated Weather Observations

The 1615 automated weather observation at PAN included winds from 180 degrees at 7 knots, visibility 10 miles, broken cloud layers at 2,800 and 3,000 feet above ground level (agl), temperature 6 degrees C, dew point 2 degrees C, and an altimeter setting of 29.82 inches of mercury.

The 1635 observation was similar, but with a broken cloud layer at 3,000 feet agl, and an overcast layer at 5,000 feet agl.

The 1655 observation, which was about 5 minutes before the flight's departure from P14, was similar, with broken cloud layers at 2,700 and 3,400 feet agl, and an overcast layer at 4,400 feet agl.

The 1715 observation, which was about 15 to 20 minutes prior to the flight's estimated arrival at PAN, was similar, with broken cloud layers at 3,100 and 3,500 feet agl, an overcast layer at 4,200 feet agl, and an altimeter setting of 29.80 inches of mercury.

By 1735, which was about the flight's initial estimated arrival time into PAN, the observation included similar conditions, but with scattered clouds at 2,600 feet agl, and an overcast layer at 3,300 feet agl.

Weather Forecasts

The National Weather Service (NWS) area forecast for the flight and accident region, issued at 1345, called for an overcast ceiling at 7,000 feet, with tops at FL180, visibilities between 3 and 5 miles, and mist. After 1700 the forecast called for scattered light snow showers, mist, and visibilities around 3 miles.

Sierra, Tango, and Zulu AIRMETs issued between 1345 and 1419, and valid for the flight and accident region for the period of the flight, warned of IFR conditions with ceilings below 1,000 feet, and visibility below 3 miles in precipitation and mist, mountains obscured by precipitation and clouds, moderate turbulence below 14,000 feet, and moderate icing between 7,000 feet and FL250. Review of observed meteorological data indicated that all of those conditions were present at the accident site at the time of the accident.

No SIGMET, Center Weather Service Unit (CWSU) Advisory, or CWSU Meteorological Impact Statements were active for the flight and accident region for the period of the flight. No PIREPs for severe icing or severe turbulence were received by ATC.

Supercooled liquid water droplets (SLD) is the term for the airborne phenomenon of liquid precipitation at or below freezing temperatures, and SLD can become freezing drizzle or freezing rain when it strikes a suitably cold surface, such as the ground or an aircraft. For any official NWS weather products, a weather forecaster would only issue a weather product that contained the terms "freezing drizzle" or "freezing rain" for the surface forecast; such forecasts are indicative of SLD aloft.

By design, AIRMETs will include forecasts for moderate icing if applicable, but will not include either the type of icing expected, or any SLD prognoses. Some National Weather Service products do provide SLD and other icing information, but those products remain "supplemental," meaning that they are not automatically included in any official aviation weather briefings, and must be specifically sought or requested by the persons or agencies obtaining the briefing.

None of the forecasts or AIRMETs applicable to the flight contained any references to freezing drizzle, freezing rain, or SLD.

Sunset occurred at 1719, and civil twilight ended at 1746 at PAN. The moon was a waxing crescent of 35 percent, and was at its peak elevation at 1724.

Weather Observations and Weather Models

The NWS 1700 Surface Analysis Chart depicted a cold front from southern Nevada southward off the west coast of Mexico, and a stationary front from southern Nevada eastward into central Colorado. The station models around the accident site depicted air temperatures between about 0 and 8 degrees C, with temperature-dew point spreads of 10 degrees C or less, a southwest to south wind between 10 and 20 knots, cloudy skies, and light rain and/or light snow.

The NWS 1700 Constant Pressure Charts depicted a mid-level trough just to the west of the accident site, with southwest to west-southwest winds above the accident site increasing from 30 to 80 knots. The accident site was located in the region of an upper-level jet streak that is typically conducive to precipitation, and vertical motion in clouds.

Upper air data indicated that the freezing level was located at an altitude of about 7,400 feet. Rime and mixed icing was likely in a cloud layer between 8,000 and 13,000 feet.

Low-level wind shear was indicated from the surface through 9,000 feet, with several layers of possible clear-air turbulence from the surface through 30,000 feet. Infrared data from the Geostationary Operational Environmental 15 (GOES-15) Satellite indicated an abundance of cloud cover over and around the accident site at the accident time, with approximate cloud-top heights of about 26,000 feet.

Sounding data and data from the Weather Surveillance Radar-1988, Doppler (WSR-88D) indicated that SLD was likely at the flight's altitude at the time of the accident, and that it was likely that AMF3853 encountered the SLD several minutes before the accident time.

Although several PIREPs of light to moderate icing for central Arizona were issued prior the accident, none reported SLD conditions. The standard format for PIREPS specifies only the "type and intensity" of icing. In contrast, while SLD can result in icing, it is neither a type nor intensity of icing. SLD is a meteorological condition that is not necessarily directly detectable by pilots, and would not be included in a PIREP.

There were no lightning strikes near the accident site around the accident time.

A simulation program was run to model the three-dimensional air movements near the accident site at the accident time. The program indicated that mountain wave activity, as well as updrafts and downdrafts, were likely near the accident site. Up- and downdraft velocities of just over 1,000 feet per minute (fpm) were likely, and the largest and most rapid transitions from up- to downdrafts occurred near the accident site. According to the model, the last AMF3853 radar target was located in a downdraft with a velocity between 600 and 1,000 fpm.

Air Traffic Controller Weather Information

According to the information provided by the FAA, the ZAB controllers working the flight had access to the METARs, TAFs, AIRMETs, and PIREPs that were current for the route of the flight. The Weather and Radar Processor (WARP) was the system that depicted weather information on the controller's radar display. WARP data was limited to precipitation only, and was sourced from the NEXRAD/WSR-88D system. Precipitation was able to be displayed in either three or four intensity levels, as a function of the facility. Regardless, the minimum precipitation reflectivity (expressed in "dBZ," a logarithmic scale) required in order for precipitation to be depicted was 30 dBZ. Review of the WRS-88D reflectivity data revealed that the values in that area at that time were never higher than 5 dBZ, and therefore, would not have been depicted on the controller's display.

FAA ATC data archiving permitted the re-creation and playback (referred to as "SATORI") of the aircraft tracks and data tags for the time and location of the accident airplane's flight, but the system does not capture many of the controller-selectable display variables. The investigation was unable to determine any details regarding the display settings in use at the time of the accident. Therefore, the SATORI re-creation is not necessarily an exact depiction of what the controller was presented (scale, colors, etc) during that period.

As noted above, there were AIRMETs valid for the airplane's route of flight. Typically, those are broadcast to aircraft by controllers when received. AIRMET notification and information is normally provided to controllers by the controllers' supervisor, who receives the information from CWSU personnel or via the Flight Data Input/Output (FDIO) terminal. If the AIRMET is applicable to a particular aircraft's route of flight, information on how to obtain the AIRMET specifics is provided when that flight checks onto the frequency. Voice recordings indicate that the controller did not pass any weather related information, including AIRMETs or PIREPs, to the pilot. The controller's written statement did not indicate what PIREPS or other specific weather information he was aware of at the time, and the controller was not interviewed by the NTSB subsequent to the accident. Therefore, the investigation did not determine whether the controller was aware of the AIRMETs, PIREPS, or other weather-related information.

In May 2014, as a result of this and several other accidents, the NTSB issued four Safety Recommendations (A-14-13 to A-14-16) to the FAA, and five to the NWS (A-14-17 to A-14-21), to improve the communication between the NWS and FAA regarding potentially hazardous weather phenomena such as mountain waves and turbulence, and to improve the consistency and dissemination of such information to the aviation community.

Accident Pilot's Weather Information

Because the flight was departing from P14, which was not equipped with an Ameriflight dispatch office, the pilot had to obtain his weather and certain other flight-related information either telephonically from the dispatcher, or from one of the approved internet sources via computer or personal mobile device. Records indicated that the pilot did not contact flight service or DUAT/DUATS for that information, but such tracking accountability for the other Ameriflight/FAA approved weather information sources was not available.

Interviews with the dispatchers indicated that the pilot had independently obtained at least some weather information, but the specifics, particularly regarding the pilot's awareness of the icing AIRMETs, was not able to be determined. The investigation was unable to determine the sources, timing, specific type, or amount of weather information that the pilot obtained prior to the flight.

The airplane was not equipped with weather radar, or any other weather detection or uplink capability, and the pilot did not have any personal devices with which he could obtain in-flight weather data. The pilot's only sources of in-flight weather information were the airplane's radios.

COMMUNICATIONS

ATC Communications

The first recorded contact by AMF3853 with any ATC facility occurred at 1811:26, when the pilot contacted ZAB for an IFR clearance to PHX. At 1814:35, after internally coordinating the handling of the flight, the controller cleared AMF3853 directly to "Phoenix," with an altitude crossing restriction of 10,000 feet 40 miles "north of Phoenix." The pilot questioned whether the clearance was for him; the controller then repeated the clearance, and the pilot read it back.

No other communications occurred between ATC and AMF3853 until 1823:55, when the pilot requested "lower" due to some "heavy up- and downdrafts." The controller responded that he was unable to issue lower, that the radar was indicating that the airplane was 500 feet below the assigned altitude of 10,000 feet, and that the ATC minimum vectoring altitude for that area was 9,700 feet. At 1824:18, the pilot acknowledged that transmission with his flight number and "roger," which was the final transmission from the airplane.

At 1825:17, the controller advised AMF3853 that radar contact had been lost. The controller attempted to contact the flight directly, without success. He also requested other aircraft in the vicinity to attempt to reach AMF3853 by radio, to listen for an emergency locator transmitter (ELT) signal, and to "keep an eye out for lights...or a fire" on the ground. At 1845:58, the controller asked another aircraft to make a slight track deviation to visually look for a fire. No aircraft reported any contact with, or indications of, AMF3853. At 1903:23, the controller began communicating on his land line with another controller about the missing flight, and at 1904, an ALNOT (alert notice) for the missing airplane was issued.

Ameriflight Communications Provisions

According to the Ameriflight General Operations Manual (GOM), the airline's primary means of communicating with its flights was via radio. The GOM stated that "Ameriflight is able to always be in contact with all of its aircraft" and provided the following ordered list of methods: "Company radio, ARINC [a commercial vendor], phone patch, Contract service handlers frequencies, [and] ATC." The GOM stated that all Ameriflight aircraft are equipped with a minimum of two VHF (very high frequency) communications transceivers, and mandated that, exclusive of "arrivals into high density terminal areas," operations in busy terminal areas, flight crews shall continually monitor an appropriate company frequency at all times during flight operations. The GOM specified that "Company radio-telephony is to be used for...company business only," including the relay of messages between Ameriflight airplanes. The GOM also stated that flight crews shall not initiate business related radio communications on company frequency during taxi, flight below 10,000 feet above mean sea level (msl), except in cruise, and other high cockpit workload periods.

The GOM noted that the airline used two VHF frequencies for company communications, 131.9 MHz (megahertz) inside California, and 122.875 MHz for all other locations. Outside California, pilots could contact ARINC via the appropriate network frequency, which was depicted on a map stored in each airplane.

AIRPORT INFORMATION

According to FAA information, P14 was not equipped with an operating air traffic control tower (ATCT). The airport elevation was 5,262 feet msl. PAN was located about 72 miles southwest of P14. Maximum terrain elevation between the two airports was about 8,000 feet msl; that terrain was the Mogollon Plateau. South of the plateau, the terrain descended rapidly, and the southern edge of the plateau, which was oriented approximately east-west, was known as the Mogollon Rim. PAN was situated in the basin about 10 miles south of, and 3,000 feet below, the Mogollon Rim.

PAN was equipped with a single paved runway designated 06-24. The runway measured 5,504 by 75 feet, and field elevation was reported as 5,157 feet. PAN was not equipped with an operating ATCT. There was only one published instrument approach procedure (IAP) for PAN. The IAP was an RNAV (GPS)-A approach, with category A and B minimum descent altitude minima of 5,720 feet msl, which was 563 feet above airport elevation, and 1 statute mile visibility.

The nearest Victor Airway to PAN was V95. V95 was defined by the 197 degree radial of the Winslow VOR, had a minimum enroute altitude (MEA) of 10,000 feet msl, and passed about 3 miles to the west of PAN.

WRECKAGE AND IMPACT INFORMATION

On-Scene Observations

The coordinates of the accident location were determined to be W 34º 06' 27.76", N 111º 28' 14.09", at an elevation of 7,023 feet msl. The accident site was located on an approximate 40 degree slope, with an approximate downslope direction of 120 degrees magnetic. The terrain was primarily solid or fractured rock, with numerous loose rocks and small boulders. Much of the wreckage was snow-covered. The pre-accident snow cover appeared to be approximately 1 to 2 feet.

There was evidence of a ground fire, but fire damage was relatively localized. Examination of virgin snow in the wreckage vicinity at about midday December 20 revealed that there was a soot layer present approximately 1-2 inches below the existing top of the snow layer at that time.

The wreckage was highly fragmented. Approximately 90 percent of the observed wreckage was confined to an area approximately 40 feet by 25 feet. The long axis of that wreckage portion was oriented approximately northeast-southwest, which was cross-slope. Within that area, the main wreckage was tightly contained in an area that could be enclosed by an approximate 15 foot diameter circle. Some fragments were strewn irregularly to the southwest, and the furthest fragment was located approximately 150 feet away from the main wreckage.

A wreckage database and a debris field map were developed. Examination of the debris map, combined with ground scars and vegetation damage, provided evidence that was consistent with the airplane impacting the ground in a near-vertical trajectory, in a near vertical, nose-down, attitude. The approximate heading at impact was 225° magnetic.

Portions of the wing spar, both inboard wings, the main landing gear, both aft engine nacelles, and empennage were identified in the main wreckage area. The central, fire-damaged portion of the wreckage appeared to be the center wing spar/cabin area. The inboard segments of the left and right flaps were attached to their respective wing sections, and their positions were consistent with the flaps being retracted at the time of impact.

All three stabilizers remained attached to the aft fuselage. The horizontal stabilizers retained their respective movable control surfaces, and the left horizontal stabilizer was relatively intact. The right horizontal stabilizer exhibited significant leading edge crush damage in the aft direction. Both horizontal stabilizers bore evidence of leading edge de-ice boots, but their pre-accident condition and operability could not be determined. The vertical stabilizer exhibited significant crush damage in the aft and down directions

Fragments of some airplane instruments or avionics were observed in the main wreckage area. Numerous flight- and airplane-related papers, including cargo manifests, maintenance sheets and operating guidance, were found in the debris field

Recovery Facility Observations

The recovered components were identified when possible, and separated into three main groups of airframe, engine, and propeller. All major components were identified in the wreckage, and no evidence of any in-flight separation or fire was observed. The nature and extent of the damage precluded any functional testing of any systems, subsystems, or components

The left wing separated from the fuselage at the root area. The wing was fragmented into multiple sections, and many sections also exhibited crush damage. Both the flap and aileron were present. The flap drive exhibited no exposed threads, which was consistent with the flaps being retracted at the time of impact. The aileron was separated from the wing, and the aileron counterweight assembly was separated from the aileron, but was located in the wreckage. Portions of the main landing gear assembly remained attached to the wing, but damage precluded determination of whether it was retracted or extended at impact. Similar damage conditions and findings were obtained during the examination of the right wing.

The empennage was fracture-separated from the aft fuselage at the approximate station of the leading edges of the horizontal stabilizers. The left stabilizer and elevator surface sustained thermal damage, but the outboard section of the elevator was separated, and was not thermally damaged. The right elevator was fractured into several sections, and only the inboard section remained attached to the stabilizer. Both the left and right elevator caps were recovered. The elevator stops did not exhibit any peening or bending damage associated with control surface flutter. The elevator nose trim drum shaft exhibited one exposed thread, which correlated to about 4.5 degrees tab trailing edge up (out of a possible 9 degrees) trim setting.

The vertical stabilizer exhibited significant aft crushing, nearly to its aft spar, along its entire span. The rudder remained attached to the vertical stabilizer. The rudder trim tab was fracture-separated separated from the rudder, but was still connected by the rudder trim push/pull tube assembly. The rudder trim drum shaft exhibited seven exposed threads, which correlated to a slight airplane nose right trim setting.

The fuselage and cabin structure, including the wing carry-through spars, was extensively fractured and crushed, and partially fire-damaged. Damage precluded determination of the presence or open/closed status of the nose baggage door. The forward cockpit structure, furnishings and instrument panel were severely fractured and crushed. The throttle quadrant was located, but damage precluded the provision of any useful information. The center console, which contained the fuel selector levers, was not identified in the wreckage.

Several nose landing gear components were identified, but no conclusions regarding gear position at impact were able to be made.

Both fuel selector valves were identified. Examination of the internal passages indicated that one valve was in the "off" position, and that the other valve was in the "on" position. One of the two fuel shutoff valves was located; it was in the open (fuel on) position. Damage precluded association of any valves with either engine.

No components that could be associated with any supplemental or portable oxygen system were identified in the wreckage.

The physical evidence confirmed that the airplane was equipped with pneumatic deicing boots and electric propeller de-icing. Damage precluded determination of component or system configuration, integrity, or functionality for any of the ice-protection systems.

Engines

Both engines were recovered and examined in detail. Both engines sustained significant impact damage and some fire damage. Impact damage precluded manual rotation of either engine during the examination. No evidence of any pre-impact deficiencies or failures that would have precluded continued operation was observed.

Propellers

The recovered wreckage included all six blades, a fragment of one propeller piston, a liberated fragment of one hub, and the aft ends of both propeller hubs, which remained attached to their respective engines. The damage to both propellers was consistent with severe frontal impact; the propeller hubs were fragmented, and the blades were separated from their respective hubs. The blades were able to be associated with either the left or right engine due to the fact that the left and right engines rotated in opposite directions. One or more blades from each propeller assembly exhibited indications of rotational scoring, severe leading edge damage, twisting, and tearing of blade tips. The blade damage on both propeller assemblies was consistent with engine/propeller rotation under power at the time of impact. No evidence of any pre-impact deficiencies or failures that would have precluded normal operation was observed.

Pitot Tube

According to Piper and Ameriflight documentation, the airplane was equipped with two heated pitot tubes, mounted on the underside of the airplane nose. The two switches for the two pitot heat systems were located on the right overhead switch panel.

A portion of one of the two pitot tubes was recovered in the wreckage and retained for detailed laboratory examination, with the ultimate goal of determining whether pitot heat was being applied at the time of impact. Although the component serial number was visible on the recovered fragment, the item was not tracked by serial number in the airplane records, and therefore, the investigation was unable to determine which system (left or right) the component was from.

Computed tomography (CT) radiographic scans were conducted at a private laboratory under NTSB supervision to examine and document the internal configuration of the pitot tube. Review of the images showed that there were a number of high density particles within the body of the pitot tube.

Subsequent to the scans, the probe fragment was sent to the NTSB Materials Laboratory for examination, and mechanical sectioning of the unit to determine the nature and possible source of the particles. The examination revealed that the separated ends of the sleeve section and the heaters exhibited features consistent with overstress fracture and gross mechanical deformation. Neither the sheared ends nor the external surfaces of the heaters exhibited signatures of electrical arcing.

The heater sheaths shared a common ground with the mast housing, and there were no shorts between the heater sheaths and their respective heating element core wires. Electrical measurements indicated that there were no continuity breaks in the heating element core wires within the recovered pitot tube fragment. Finally, there were no shorts between the heating element core wires.

The particles in the CT scan were about 1 mm or less in diameter. Most of the particles observed inside the pitot tube were either small balls of braze filler metal that were stuck to the side of the wall, or small sand fragments. The particles observed in the CT scans were not independently extracted or examined in detail for composition or other characteristics. Based on the available evidence, NTSB systems engineering personnel determined that the high density particles were artifacts of the manufacturing process, and that there was no evidence of any internal arcing event in the probe.

The investigation was unable to determine the pre-accident functionality or operating status of the heater from the recovered pitot tube. The CT scans and the Materials Laboratory report are available in the NTSB public docket for this accident.

ADDITIONAL INFORMATION

Ameriflight Background Information

Ameriflight was a FAR Part 135 operator, which almost exclusively transported cargo. The airline was headquartered in Burbank, California, but operated in, and had 12 bases across, the United States. The airline also operated into Canada and Mexico. The cargo fleet consisted of PA-31, BE-99/1900, SA-227, and EMB-120 airplanes. The airline did not have or utilize any PA-31 or BE-99 FAA-approved motion-based flight training devices. The airline had 12 assistant chief pilots (one per base), about 250 line pilots, and typically hired between 5 and 15 pilots per month.

The airline had several senior dispatchers. One of them, who was based at Burbank, was also the hazmat program manager. In an NTSB interview, he stated that he spent about 30 percent of his time in the dispatch function, and the remainder in the hazmat function. The FAA certificate managers, including the principal operations inspector (POI), were based at the Van Nuys FSDO.

The Phoenix base had about 20 pilots, and primarily operated PA-31 and BE-99 airplanes. Other base personnel included three dispatchers, a station manager, and an assistant chief pilot.

Ameriflight guidance for flight operations was primarily contained in two airline-produced documents and one Piper-produced document. The two airline documents were the GOM and the Standard Operating Procedures (SOP) manual. The GOM was company-wide in its applicability. The SOP and the Piper POH/AFM were specific to the airplane type.

Ameriflight Director of Safety

Although the position was not required by FAR Part 135, Ameriflight had utilized a Director of Safety (DOS) for several years prior to the accident. The DOS was stationed at the airline's base in Oakland, California. He was also a "Division Manager" responsible for operations, sales, and maintenance services in central California and Nevada. The DOS stated that he spent about "5 to 10 percent" of his time on DOS duties, and had no safety subordinates or assistants, but could obtain support when necessary. The DOS stated that at the time of the accident, his position was still being defined. He had two basic safety tasks, which were analyzing safety issues as they arose, and developing an incident database. The DOS stated that neither his department nor the airline had a dedicated safety budget.

His primary safety concerns included pilot experience levels in terms of time and variety, especially with IFR operations and weather, pilot decision making ability and judgment, and training-related issues. He noted that the company had observed that the Phoenix based pilots tended to have more difficulties and perform less well in IFR than Portland (Oregon) based pilots, and that this was likely a result of the typically more benign weather in Phoenix.

Although the airline did have a telephonic "safety hotline" that was open to all employees, including pilots, as of the date of the accident, the hotline had received few inputs. The airline also had a non-punitive written event and hazard reporting system referred to as its "immunity-based Safety Reporting System." Employees, including pilots, could also email or telephone the DOS directly, or visit the Safety Department office in person. The scope of these reports was not limited to flight operations only; it included all safety-related aspects of all company operations. Employee reporting of events or hazards was not mandatory.

The reporting system did not automatically compile, categorize, or assign risk levels to the reports. All events and reports were reviewed by the DOS or other company safety personnel, and dispositioned accordingly. When significant procedural changes were implemented, employees were advised of such changes via internal Alert Bulletins, and those changes were eventually incorporated into the GOM.

As of the date of the accident, the DOS was developing a "safety incident database," which was being physically populated by the DOS, based on his review of inputs from the Safety Reporting

System. The DOS stated that his planned risk mitigation strategies included increased standardization of flight procedures across airplane types and bases, modifying training to account for root causes for mistakes, and developing and implementing more proactive risk management strategies.

Ameriflight Dispatch Information

FAR Part 135 did not require Ameriflight to maintain or use FAA-defined dispatch personnel or procedures. According to Ameriflight representatives, the airline employed dedicated personnel in a dispatch-like capacity, but some of those personnel did not hold FAA dispatcher certificates. The Ameriflight GOM stated that the airline "shall provide enough Ameriflight qualified dispatchers...to ensure proper operational control of each flight, and cited the FAA definition of operational control, which was the exercise of authority over initiating, conducting, and terminating a flight. Ameriflight dispatchers report to their assigned Assistant Chief Pilot (ACP).

Normal Ameriflight dispatch procedures included creating flight releases for the pilots. The releases contained weather, aircraft, maintenance, flight time, duty time, cargo, and fuel information. All weather products in the flight release were provided by a commercial vendor, WSI. The GOM stated that prior to "each flight, the Captain and Dispatch must review...meteorological information that could affect the safety of flight," and that dispatchers "will advise flight crews of actual weather, which could affect the safety of the flight enroute."

According to the GOM, there were six internet-accessed weather data sources that the FAA approved the airline to utilize. These were DUAT/DUATS, Jeppesen, WSI, Meteorlogix, Fltplan.com, and Aviation Digital Data Service (ADDS). The GOM also noted that "each Dispatcher is to complete thorough pre-flight planning for each flight under his control," including variables such as weather, NOTAMs, facility irregularities, and other temporary conditions.

Pilots departing from an airport where there was an Ameriflight dispatch office physically reported to the office to speak with the dispatchers, access and review flight- and weather-related information, and obtain their releases. As was the case for AMF3853, pilots whose flights originated at remote airports spoke to the dispatcher and obtained their release information via telephone. At such airports, pilot access to flight- and weather-related information was a function of the facilities and equipment (primarily a computer terminal with internet access) available at the airport, as well as whether other pilots were using or waiting for the same access. Ameriflight representatives reported that pilots could use their personal mobile devices as an alternate means of accessing that information. They also stated that the pilot was not provided with a company-issued mobile telephone, computer, or tablet.

According to at least two Ameriflight representatives, pilots were required to notify dispatch once they were airborne, in order to communicate their departure and estimated arrival times. In contrast, the GOM implied, but did not mandate, that pilots were to contact dispatch to communicate their departure times after they were airborne. The SOP did not contain any guidance regarding this procedure, nor would it be expected to. Discussions and communications with other Ameriflight personnel indicated that dispatchers also relied on pilots' estimated departure times, and/or telephone notifications by UPS drivers who transferred cargo to or from the flights.

Pilots were responsible to notify dispatch if they were unable to complete their planned flight legs, and those notifications could be accomplished via radio while airborne. According to the Operations Manager, if there was any pre-flight doubt about the potential to complete the flight, the pilots and dispatchers would agree on possible diversion plans, as well as communication plans. The typical diversion contingency plan was for the flight to continue on to its hub/base airport. In the case of AMF3853, although no such pre-flight discussion occurred between the pilot and dispatcher, the default plan if the flight could not land at PAN was for the flight to continue on to PHX, the hub/base airport.

Ameriflight dispatchers used a computer software suite that they referred to as "FlightOps," which included weather depiction capability, to conduct a significant portion of their tasks, including flight monitoring and tracking, and weather overlays. The GOM stated that "FlightOps is Ameriflight's proprietary data collection and management system for all flight operations." As one subset of its capabilities, the system provided three levels of alerts to dispatchers when a flight was overdue. The system alert function was not de-selectable by any personnel.

According to one of the Burbank-based senior dispatchers, the automated FlightOps system alert levels were a function of the how late (5, 10, and 15 minutes) the flight was beyond the arrival time that was input by the dispatch personnel. The senior dispatcher stated that the 15 minute alert provided both visual and aural notifications to the dispatchers. The GOM also stated that the system had three alert levels, but specified the overdue times as 15, 30, and 45 minutes after the estimated arrival time.

Ameriflight Dispatch Activity Summary

On the evening of the accident, there were two persons working in the Phoenix dispatch office, which was the office responsible for AMF3853. One was a dispatcher, and the other was a dispatcher/operations manager. NTSB interviews with those two personnel revealed that they did not have any flight-safety concerns regarding the weather, and that they expected the pilot to be able to land at PAN.

According to the dispatcher, per company procedure, the pilot first telephoned about 1600 to "check in." At that time, the pilot was at P14, and he told the dispatcher that he would call back for his "full release" once he had the values for the weight of his cargo. After that conversation, the dispatcher checked the PAN weather, and observed that there was a broken cloud layer at 3,000 feet agl, and an overcast layer at 5,000 feet agl.

About 1650, the pilot telephoned the dispatcher, and provided his cargo weight and some other information, including the fact that the weather at both P14 and PAN "was VFR." The pilot and dispatcher did not discuss the weather in detail, and did not discuss how the pilot planned to descend into PAN, given the cloud cover and the lack of navigation equipment required to conduct an instrument approach into PAN. The dispatcher provided the flight release for the flight to PAN, and then on to PHX.

According to Ameriflight representatives, the pilot did not notify dispatch that he had departed P14. The dispatchers based his departure time on the pilot's estimated departure time, and then confirmed that in a telephone call with the UPS driver who provided the cargo at P14, and reportedly observed the airplane depart.

At some point between the two telephone calls from the pilot to the dispatcher, the UPS driver who was scheduled to meet the airplane in PAN called the airline. The driver inquired of the airline's Operations Manager whether the pilot was expected to land at PAN, because the weather was deteriorating there. The manager told the driver that he did not yet know, because there was no terminal area weather forecast available for PAN. The manager told the driver that he would call the driver as soon as the airline knew that the flight would not be able to land at PAN.

About 1740, the UPS driver again called the airline to inquire about the status of the flight, since it was about 10 minutes overdue at PAN. The Operations Manager was aware that the airplane departed P14 about 1700, but he told the UPS driver that he did not have any more-recent information. Subsequent to that call, the dispatch department attempted to contact the pilot directly via radio and the pilot's personal mobile telephone, without success. They also attempted to reach the pilot indirectly via radio through other company flights.

About 1805, just as the Operations Manager was initiating the company's lost aircraft procedure, the dispatch department received word that the pilot of another company flight, AMF2863, was in touch with the subject flight, AMF3853. The dispatchers asked AMF2863 to instruct AMF3853 to forego landing at PAN and proceed to PHX. AMF2863 relayed the request, and received an acknowledgement from AMF3853. No further communications between AMF3853 and either dispatch or any other Ameriflight flights occurred. About 1835, the dispatchers received a telephone call from PHX terminal radar approach control (TRACON) that contact with AMF3853 had been lost.

Neither individual in the PHX dispatch office reported that he received any automated FlightOps alerts regarding the flight, either for when it was due at PAN, or at PHX. A subsequent re-check with Ameriflight personnel indicated that they did not receive any alerts. Due to the facts that predicted arrival time was manually input by the dispatchers, and neither those times nor the times of any of the flight-related telephone calls were known with certainty, it was possible that either the requirements to trigger the system alerts had not been met, or that the dispatchers were already working to locate the flight when the alerts were issued. The investigation was unable to determine whether those alerts were generated, or if not, why not.

Ameriflight IFR vs VFR Operations

The GOM stated that the airline's flight operations will be conducted utilizing either FAA visual flight rules (VFR) or IFR flight plans, or in accordance with approved Ameriflight company flight locating procedures. According to the Operations Manager, if there was doubt that a flight could be completed under VFR, the airline prefers that the flight be conducted IFR. Due to the potential for delays and circuitous routes associated with IFR flights, in the interests of expediency, many Ameriflight flights are conducted VFR, particularly in the Phoenix area.

The GOM stated that night operations were to be conducted under IFR, except that "in the few locations where IFR operation is impracticable, company approved VFR night routes are available." At IFR flight plan could be closed within 10 miles of the destination airport, and the flight continued VFR, if the destination weather was reported to be 10 miles or greater visibility with a ceiling was 4,000 feet or higher, the destination airport was in sight by the pilot, and would remain so through the landing.

The GOM stated that the approval of any VFR night route was to be accomplished by the Chief

Pilot or the Director of Operations, that each VFR night route would be published at each base for review, and that a copy would be maintained by the Chief Pilot. It also stated that "verbal VFR night routes are not approved." The airline did not maintain historical records of their VFR night routes, and therefore the investigation was unable to determine whether the P14 - PAN route was an approved VFR night route on the date of the accident.

Neither the GOM nor the SOP defined "night." The FAA defined night as "the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the Air Almanac." The FAA, GOM, and SOP did not define evening civil twilight, and the Air Almanac was no longer in publication. The United States Naval Observatory (USNO) defined evening civil twilight as ending "when the center of the Sun is geometrically 6 degrees below the horizon." According to a representative, the airline uses the FAA definition of "night."

Based on the flight's expected arrival time of about 1730 into PAN, and the USNO civil twilight end time of 1746, the P14-PAN leg of the flight would not qualify as a night flight.

According to the GOM, "Ameriflight used IFR flight plans stored in FAA Air Route Traffic Control Center computers...[which]...automatically become available at the departure point about 30 minutes prior to scheduled departure time and will be held for about 1.5 hours past departure time." The GOM noted that flight crews could extend the time window by contacting the appropriate ATC facility.

Ameriflight Unusual Attitude Training

The FAA Principal Operations Inspector (POI) assigned to Ameriflight reported that the airline conducted its PA-31 unusual attitude training in actual aircraft, instead of ground-based simulators or procedures training devices, due to the limitations of the ground-based equipment. However, he stated that the airborne training was conducted "correctly" and "well." He noted that the airline conducts full stalls in aircraft types for which it does not have simulators. The Ameriflight PA-31 SOP contained explicit guidance regarding unusual attitude recovery completion standards. According to airline records, the pilot successfully completed the Ameriflight unusual attitude training.

Supplemental Oxygen Information

Paragraph 91.211 ("Supplemental Oxygen") of the Federal Aviation Regulations required that the pilot be provided with and use supplemental oxygen for that part of the flight that was of more than 30 minutes duration at cabin pressure altitudes above 12,500 feet msl and up to and including 14,000 feet msl, in order to preclude hypoxia.

According to FAA publication FAA-H-8083-25, Pilot's Handbook of Aeronautical Knowledge, the brain is "particularly vulnerable to oxygen deprivation. Any reduction in mental function while flying can result in life threatening errors." The document further stated that "All pilots are susceptible to the effects of oxygen starvation, regardless of physical endurance or acclimatization. When flying at high altitudes, it is paramount that oxygen be used to avoid the effects of hypoxia" and as "altitude increases above 10,000 feet, the symptoms of hypoxia increase in severity."

The GOM stated that all Ameriflight airplanes carried enough supplemental oxygen to satisfy the applicable FAA regulations, and that flight crews were responsible for ensuring the quantities were sufficient prior to each departure. The GOM specified that PA-31 pilots were to utilize supplemental oxygen for any portion of a flight greater than 30 minutes above 10,000 feet through 12,000 feet, and continuously whenever the airplane was operating above 12,000 feet.

PA- 31 Ice Protection Systems and Procedures

Wing and empennage deicing was accomplished via pneumatic boots on the leading edges of the wings and all three stabilizers. System operation was controlled by a pilot-activated, momentary-on switch located in the overhead switch panel. Each manual actuation of the switch activates all the boots a single time. Propeller deicing is accomplished via a series of electrical resistance heating pads on the propeller blades. Activation of the propeller deicing system results in automatic, cyclic heating of all blades until the system is selected off by the pilot. The electrically heated windshield was controlled by a switch on the overhead switch panel.

The Section 9 Supplement of the Piper POH/AFM provided the following guidance regarding the use of the wing and empennage deicing boots: "Most effective surface deicing is obtained if a thickness of 1/4 to 1/2 inch of ice is allowed to accumulate before the deicers are activated."

The Ameriflight GOM stated that flight crews were to activate pitot heat any time the aircraft was flying in visible moisture, regardless of the temperature. However, the Ameriflight pitot heat procedures differed between the PA-31 and the BE-99; PA-31 procedures were per the GOM, while in contrast, BE-99 normal procedures called for activation of pitot heat after engine start, and use for the entire flight.

The GOM stated that in order to "preclude the formation of structural ice, flight crews shall activate all de-ice/anti-ice systems, except leading edge de-icing boots, prior to temperatures reaching" 5 degrees C during flight in visible moisture. Finally, the GOM noted that the pneumatic leading edge de-icing boots were to be activated "upon the first indication that the adhering ice has reached the point where it can be removed by the expansion of the boots."

The Ameriflight PA-31 SOP stated that "it is important that the flight crew be able to properly recognize what kind of ice is likely to form and what kind of ice is accumulating on the aircraft. There is a significant amount of contradictory information regarding in-flight anti/de-icing techniques published by various sources. At Ameriflight, we DO NOT [capitals original] begin exercising pneumatic boots at the first sign of ice accumulation....Company guidelines direct the flight crew to use pneumatic boots when ice accumulation is between ¼ - ½ inch on the boot surface." The SOP then stated that "'due to dynamic situations the guidelines are variable and will change from situation to situation," and that "the captain must make the overall determination as to when the pneumatic boots will be used." The SOP did not provide any elaborating guidance regarding the variability of the guidelines, or any specifics regarding "situation" changes.

Industry Guidance Regarding De-Icing Boots

For over 60 years, pilots have been taught to wait for a prescribed accumulation of ice before activating the deicing boots, in order to prevent "ice bridging." Ice bridging is a perceived phenomenon associated with the premature activation of deicing boots while operating in icing conditions. The theory holds that with thin, "plastic" accumulations of ice, boot activation re-shapes the ice profile around the expanded boot, which remains after boot deflation, thus rendering the boot ineffective at removing ice.

In the 1990s, as a result of several icing-related accidents, the FAA led an industry review of icing phenomena, and in-flight de-icing practices and effectiveness. In 2007 the FAA issued Advisory Circular (AC) 91-74A, followed by a 2008 NTSB Safety Alert (SA). The AC discussed a broad spectrum of icing information and procedures, while the SA focused on the use of deicing boots. These two documents included the following information and guidance:

- As little as 1/4 inch of leading-edge ice can increase stall speed 25 to 40 knots
- There are no known cases where ice bridging has caused an incident or accident
- Ice bridging is extremely rare, if it exists at all
- Autopilot usage can mask changes in the handling qualities of the airplane; such changes could be precursors to premature stall or loss of control
- Deicing boots should be activated as soon as icing is encountered, unless the manufacturer's guidance specifically directs otherwise
- Limit the use of, or deactivate, the autopilot in icing conditions

Industry Guidance on Freezing Rain and Freezing Drizzle

Freezing drizzle and freezing rain were conditions that were not included in the FAA certification requirements for all aircraft, including the accident airplane make and model. This means that even when an aircraft is approved for flight into known icing, that approval does not include freezing rain or freezing drizzle, or conditions with a mixture of supercooled droplets and snow or ice particles.

In 2000, the New Zealand Civil Aviation Authority (NZ CAA) published its "Aircraft Icing Handbook." In part, the document stated that "Pilots should rely on visual and tactile cues to determine the presence of SLD. After confirming SLD, they must divert immediately." It then stated that pilots should "Disengage the autopilot and hand-fly the aeroplane. The autopilot may mask important handling cues, or may self-disconnect and present unusual attitudes or control conditions."

The NZ CAA Handbook also stated that "Flight crews must be especially wary of automation during icing encounters. Autopilots ... can mask the effects of airframe icing and even contribute to ultimate loss of control." It continued by noting that autopilots can and have disconnected due to icing conditions, and that the "autopilots are not malfunctioning; they are conforming to design parameters. When they were approved, the rules assumed they were non-mandatory equipment. The assumption was that the crew would remain continuously aware of what the autopilot was doing and how it is flying the aeroplane. That, of course, is not always a valid assumption." The Handbook also stated that "When workload allows, crews should manually fly their aeroplane in icing conditions so they can monitor control forces and feel trim changes."

The 2007 FAA Advisory Circular (AC) 91-74A "Pilot Guide: Flight in Icing Conditions" presented a discussion of meteorological circumstances and visual cues to help pilots recognize the possible existence of SLD conditions. The AC advised that "care should be exercised when using an autopilot in icing conditions.... When the autopilot is engaged, it can mask changes in handling characteristics due to aerodynamic effects of icing that would be detected by the pilot if the airplane were being hand flown." It also stated that if the autopilot disconnects abruptly, "the pilot is suddenly confronted by an unexpected control deflection." Finally, the AC stated that pilots "may consider periodically disengaging the autopilot and hand flying the airplane when operating in icing conditions. If this is not desirable because of cockpit workload levels, pilots should monitor the autopilot closely for abnormal trim, trim rate, or airplane attitude. As ice accretes on aircraft without autothrottles, the autopilot will attempt to hold altitude without regard for airspeed, leading to a potential stall situation."

In 2010, in response to an accident that was the result of an encounter with freezing rain/drizzle, the FAA issued Safety Alert for Operators (SAFO) 100006, entitled "In-Flight Icing Operations and Training Recommendations." The stated purpose was to provide "information concerning approved training programs for flight crewmembers and inadvertent encounters of in-flight icing conditions, including freezing drizzle/freezing rain." The SAFO stated that "Freezing drizzle and freezing rain aloft are considered synonymous with supercooled large droplets (SLD), i.e. those icing conditions containing droplets larger than those required to be demonstrated in aircraft icing certification criteria. SLD may result in ice formation beyond the capabilities of the airplane's ice protection system to provide adequate ice protection."

Ameriflight Procedures Regarding Freezing Drizzle and Freezing Rain

According to an Ameriflight representative, the airline provided a discussion of supercooled large droplets in initial training, and "guidance for the icing issues that will develop from these droplets is also trained and discussed" in the airline's manuals.

The GOM prohibited departures "during" either freezing drizzle qualified as moderate or heavy, or freezing rain qualified as moderate or heavy. The GOM prohibited flight into severe icing, which was congruent with the FAA-approved POH. The GOM defined severe icing as a situation "where the rate of accumulation is such that de-icing/anti-icing equipment fails to reduce or control the hazard," and stated that "immediate diversion is necessary."

The deicing fluid holdover time tables noted that "no holdover time guidelines exist" for freezing drizzle, or light, moderate, or heavy freezing rain. Neither the POH nor the GOM explicitly stated that, once airborne, flight into moderate or heavy freezing drizzle or freezing rain was prohibited, although it could possibly be inferred or extrapolated from the departure guidance.

ATC Ground Tracking Radar Information

Two sets of ATC ground tracking radar information associated with AMF3853 were provided to the NTSB investigation. The first set consisted of an annotated image of radar flight tracks, and extended from 1704 to 1824. This set contained only coarse-interval time and altitude annotations; no corresponding electronic file of the radar target data was provided by the FAA. The second set was an electronic file of radar target data, with a sample rate of 12 samples per second. That dataset extended from 1811 to 1824, which partially overlapped the time period of the first segment.

ATC Radar Flight Track Annotated Image

The annotated image of radar flight tracks was developed by FAA personnel from the Denver Air Route Traffic Control Center (ZDV), using data from ZAB. The image depicted radar tracks for two different aircraft. One track was associated with AMF3853, and the other was for a Beech King Air, N918VS.

The AMF3853 track was annotated with 10 text boxes that presented time, location, altitude, and transponder code information. Review of the AMF3853 track information revealed that it consisted of two distinct segments. The first segment captured the period from 1714 to 1731, and the second segment captured the period from 1755 to 1824. The investigation was unable to determine the location and altitude of airplane between 1731 and 1755.

The first segment was derived from 1200 transponder code target data which FAA personnel determined to be from AMF3853, after its departure from P14, but before it was assigned the discrete transponder code 2651 for the IFR portion of its flight. The second segment began with 1200-code portion of the flight, but also included the full discrete-code portion of the flight.

The first annotated target in the first segment of the track was at 1703:52, and was located about 8 miles southwest of P14. No altitude data was provided for that target. The track progressed southwest directly towards PAN, but then made a 180 degree left turn about 15 miles northeast of PAN, and terminated about 25 miles northeast of PAN. The last radar target in that segment of the track had a time tag of 1731:10. The track data indicated that the airplane reached a maximum altitude of 13,500 feet just after the course reversal turn, and then descended to 12,600 feet by the end of that track segment.

The first radar target in the second track segment was situated about 7 miles northwest of the last target in the first segment, 25 miles northeast of PAN, at an altitude of 10,600 feet. That target had a time tag of 1755:09, which was 24 minutes after the last target of the first segment. According to FAA personnel, there were no radar targets in that area during that time period that could be associated with AMF3853. They also noted that due to the radar antenna location and the intervening topography, the most likely explanation for the gap in target data for AMF3853 was that the airplane was below the radar coverage floor during that interval. After the gap, the track proceeded northwest (which was not towards PAN) about 20 miles, before turning south, and then southwest. The maximum altitude annotated on that segment of the track was 13,800 feet. The latter portion of that second track segment bore the discrete 2651 transponder code that was assigned to AMF3853, and was congruent with the second, electronic dataset.

ATC Radar Data Dataset and Derived Airplane Performance

The target data for this dataset was provided by the Phoenix air route surveillance radar (ZPHX ARSR-1E) facility, which was located approximately 18 miles south of the impact location. NTSB engineering personnel conducted a brief radar study to derive selected airplane performance values, in order to assist the investigation.

The first secondary radar target associated with the airplane was recorded at 1811:57, which indicated the airplane was at an altitude of 13,600 feet. The last secondary target was recorded at 1824:21, and indicated an altitude of 9,900 feet. The impact site was situated about one half mile beyond the last target location, along a line extrapolated from the recorded ground track, at an elevation of 7,023 feet.

The airplane's ground speed and rate of climb were calculated from the radar data. The raw-calculated groundspeed values displayed significant variations that were not consistent with the airplane's performance capabilities. Some of those variations were artifacts of the data uncertainties of the radar system, and data-smoothing techniques were applied to provide more realistic values. The smoothed data revealed that the airplane began a descent about 1815, and leveled off near 10,000 feet about 1820. The descent to 10,000 feet was conducted at a rate of about 900 fpm. From 1817 to 1820, the ground speed was approximately 160 knots. As the airplane leveled off, the speed decreased, and at the time of the last radar target, the ground speed was calculated to be 120 knots. The altitude trace from 1820 on was relatively constant, except for a rapid 400 foot loss, and a slower increase, during the last 36 seconds.

According to the manufacturer's POH, the clean-wing stall speed was approximately 75 knots. The normal airspeed operating range (green arc) was 77 to 185 knots, the smooth air caution range (yellow arc) was 185 to 236 knots, and the never exceed speed (red line) was 236 knots. The minimum control speed was 76 knots.

Comparison of the airplane's published performance capabilities and limitations with the radar-derived performance did not reveal any exceedances or discrepancies between the two.

ATC Radar Data Altitude Summary

Review of the radar data indicated that the airplane was above 10,000 feet for at least two different periods. The first period began no later than 1714 and ended no sooner than 1731. The second period began no later than 1755 and ended at 1819. Based on these data, the total time above 10,000 feet, although possibly discontinuous, was at least 41 minutes.

Review of the ATC radar data indicated that the airplane was above 12,000 feet for at least two different periods. The first period began no later than 1725 and ended no sooner than 1731. The second period began no later than 1805 and ended at 1816. Based on these data, the total time above 12,000 feet, although discontinuous, was at least 18 minutes.

Beech King Air N918VS Information

The FAA-provided annotated radar track image also presented a partial track of another, similar airplane, Beech King Air N918VS. That track indicated that N918VS was operating in approximately the same location, about the same time, as AMF3853, but was 2,000 feet higher. In addition, at the time of the accident, N918VS was on the same ATC frequency, and communicating with the same controller, as AMF3853. N918VS was using the radio call sign "lifeguard" in its communications with ATC. Immediately after the controller lost radar and radio contact with AMF3853, he solicited N981VS for assistance in contacting AMF3853, and also listening for an emergency locator transmitter (ELT) signal or visually detecting the other airplane. N981VS rendered the requested assistance, but was unsuccessful in all three aspects. N918VS reported that it was "in and out of the [cloud] tops," which impeded its crew's ability to visually detect the other airplane or the ground.

The N918VS radar track began about 1800:00, and the last annotated radar target on that track was for time 1826:57. Comparison of the AMF3853 and N918VS radar tracks indicated that N918VS was about 6 minutes behind the accident airplane. The N918VS radar track traversed southwest, parallel to, and offset about 3 miles southeast of, the final section of the AMF3853 track. The N918VS radar track depicted that the airplane remained level at 12,200 feet msl, and flew almost directly over the last tracked location of AMF3853.

In an interview with an FAA inspector, the pilot of N981VS reported that he encountered "almost continuous moderate turbulence" and trace amounts of ice during that flight segment. Review of the communications between N918VS and the ATC controllers revealed that N918VS did not report any weather-related abnormalities or difficulties during its transit of the accident locale, and did not request any altitude or route changes due to the weather conditions.

History of Flight

Enroute-cruise	Loss of control in flight (Defining event) Structural icing Turbulence encounter

Pilot Information

Certificate:	Flight Instructor; Commercial	**Age:**	28
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Unknown
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Without Waivers/Limitations	**Last FAA Medical Exam:**	
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	1908 hours (Total, all aircraft), 346 hours (Total, this make and model), 185 hours (Last 90 days, all aircraft), 54 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	PIPER	**Registration:**	N62959
Model/Series:	PA-31-350	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	3107752008
Landing Gear Type:	Retractable - Tricycle	**Seats:**	2
Date/Type of Last Inspection:	12/17/2012, AAIP	**Certified Max Gross Wt.:**	7600 lbs
Time Since Last Inspection:	0 Hours	**Engines:**	2 Reciprocating
Airframe Total Time:	19188 Hours at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Installed	**Engine Model/Series:**	TIO-540
Registered Owner:	UAS Transervices	**Rated Power:**	350 hp
Operator:	Ameriflight	**Operating Certificate(s) Held:**	On-demand Air Taxi (135)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	PAN, 5157 ft msl	**Distance from Accident Site:**	12 Nautical Miles
Observation Time:	1735 MST	**Direction from Accident Site:**	45°
Lowest Cloud Condition:	Scattered / 2300 ft agl	**Visibility**	10 Miles
Lowest Ceiling:	Broken / 3300 ft agl	**Visibility (RVR):**	
Wind Speed/Gusts:	7 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	170°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.78 inches Hg	**Temperature/Dew Point:**	6°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Holbrook, AZ (P14)	**Type of Flight Plan Filed:**	None
Destination:	Payson, AZ (PAN)	**Type of Clearance:**	IFR
Departure Time:	1700 MST	**Type of Airspace:**	

Airport Information

Airport:	Payson (PAN)	**Runway Surface Type:**	
Airport Elevation:	5157 ft	**Runway Surface Condition:**	
Runway Used:	N/A	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	34.107778, -111.471111 (est)

Administrative Information

Investigator In Charge (IIC):	Michael C Huhn	**Report Date:**	06/18/2015
Additional Participating Persons:	Daren DuFriend; FAA FSDO; Scottsdale, AZ Charles Little; Piper Aircraft; Vero Beach, FL Mark Platt; Lycoming Engines; Williamsport, PA Andrew Lotter; Ameriflight; Dallas, TX Dan Boggs; Hartzell Propeller; Piqua, OH		
Publish Date:	06/15/2015		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=85847		