Aviation Investigation Final Report

Location:	Stagecoach, Nevada	**Accident Number:**	WPR23MA113
Date & Time:	February 24, 2023, 21:14 Local	**Registration:**	N273SM
Aircraft:	Pilatus PC-12/45	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	5 Fatal
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled - Air Medical (Discretionary)		

Analysis

The pilot, two medical crew members, and two passengers departed on the medical transport flight, which was operating on an instrument flight rules (IFR) flight plan in night instrument meteorological conditions (IMC). Onboard data and ADS-B flight track information showed that, between 1 and 3 minutes after takeoff, the autopilot disengaged and then reengaged; however, the airplane continued to fly a course consistent with the published departure procedure. About 11 minutes after takeoff, the airplane turned about 90° right, away from the next waypoint along the departure procedure, and remained on that heading for about 47 seconds. Around this time, the airplane's autopilot was disengaged again and was not reengaged for the remainder of the flight. Also, about this time, the airplane's previously consistent climb rate stopped, and the airplane maintained an altitude of about 18,300 ft mean sea level (msl) for about 20 seconds, even though the pilot had been cleared to climb to 25,000 ft msl. The airplane subsequently turned left to a northeasterly heading and climbed to about 19,400 ft msl before entering a descending right turn. Shortly after entering the right turn, the airplane's rate of descent increased from about 1,800 ft per minute (fpm) to about 13,000 fpm, and the rate of turn increased before ADS-B tracking information was lost at an altitude of about 11,100 ft msl, in the vicinity of the accident site.

The distribution of the wreckage at the accident site was consistent with a low-altitude in-flight breakup. Examination of the airframe and engine revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation, and data obtained from onboard recording devices showed that the engine was developing power at the time of impact. Postaccident examination of the autopilot, trim servos, and trim actuators did not reveal any evidence of mechanical malfunction or failures that would have precluded normal operation.

Recorded weather conditions at the departure airport about the time of departure included 1 ¾ statute miles visibility and a cloud ceiling 1,700 ft above ground level (agl). The departure airport and surrounding areas had been impacted by significant winter weather throughout the day of the accident, and the pilot who was on call for the accident operator earlier that day turned down a flight request due to the weather conditions. Another air medical operator, who operated the same make and model airplane as the accident airplane, also turned down a request for a flight in the area due to the low visibility, turbulence, and icing conditions.

The accident airplane was equipped for flight into known icing conditions. Review of weather information indicated that the airplane was likely operating in IMC above 6,000 ft msl, and likely did not accumulate much, if any, structural icing. Icing conditions would have been present between 5,000 and 10,000 ft msl. Although turbulence was likely present in the area, there was no evidence to support that the accident airplane encountered hazardous turbulence during the flight.

The airplane was equipped with several sources of recorded data, including a central advisory and warning system (CAWS) computer. The CAWS computer, which captured autopilot status, among other parameters, was significantly impact damaged and missing one of the memory chips that stored time information; therefore, the two autopilot disengagements could only be identified as occurring in two-minute windows after elapsed takeoff time, with the first about 1 to 3 minutes after takeoff, and the second between about 2 and 4 minutes before the accident. There are several ways in which the autopilot could have been automatically or manually disengaged during the accident flight; however, based on the available CAWS data and examination of the airplane and system components, the reason for the two autopilot disengagements during the accident flight could not be determined.

Following the second autopilot disengagement, the pilot would have been required to manually maintain control of the airplane while operating in IMC, which increased his susceptibility to spatial disorientation. The airplane's subsequent flight path was consistent with a phenomenon known as a "graveyard spiral," a sensory illusion in which a pilot believes they are flying in a wings-level descent; however, the airplane is actually in a descending turn. Attempts to arrest the descent by pulling back on the control yoke have the effect of tightening the turn and losing altitude at an increasing rate until the airplane's structural limits are exceeded, resulting in an in-flight breakup, or until the airplane impacts the ground. Graveyard spirals are most common at night or in poor weather conditions where no horizon exists to provide a visual reference to correct misleading inner-ear cues.

Autopsy of the pilot revealed a 3 cm fibroblastic meningioma (tumor) in the right parietal section of the brain. The parietal lobe is one of the four major components of the cerebral cortex and has a primary role in the integration of sensory information, including spatial and navigational information. The parietal lobe is also primarily responsible for the integration of visual and vestibular information. The presence and location of the tumor may have impacted the pilot's ability to synthesize and respond to sensory interpretation from the conditions under

which he was flying; however, it is also possible that the tumor may have been an incidental finding without any significant symptoms, and the pilot's next of kin indicated no changes in his behavior or health before the accident. Based on the available information, whether the effects of the pilot's undiagnosed brain tumor contributed to the accident could not be determined.

The accident pilot was not permanently assigned to the base from which the accident flight departed; rather, he was classified as a "float" pilot, who rotated across the operator's bases throughout the country. The operator did not have any formal training or mentoring procedures in place to ensure that local area knowledge was passed along to pilots new to a specific operating area; the investigation was unable to establish the pilot's experience operating in night IMC over mountainous terrain. All three crewmembers of the accident flight were relatively new in their respective roles. The pilot was hired by the operator about five months before the accident, while both clinicians had been assigned to the airplane for about six months. The company's website highlighted the "Three to say go, one to say no" protocol as a best practice among air ambulance providers that empowers any member of the flight team, for any reason, to raise a safety concern. For rotorcraft flights, the operator required that clinicians with less than one year of experience be paired with clinicians with more than one year of experience, a practice that leveraged the flight team's collective experience to benefit flight safety. However, fixed-wing operations were not subject to this requirement.

The operator's procedures also required company dispatchers to inform flight crews if a flight had been turned down by another operator. Although the weather can change throughout the course of a given day, the fact that other pilots and operators turned down flights due to weather in the area on the day of the accident should have been relayed to both the pilot and medical crew as part of their decision-making process. However, review of communication logs did not indicate that the company's dispatchers made the accident crew aware of the turndowns earlier on the day of the accident.

The operator also required that a flight risk assessment be completed before each flight; however, no such assessment was located for the accident flight. Even if a risk assessment had been conducted, the crew's relative inexperience, and lack of information about the earlier turndowns, increased the likelihood of a knowledge-based error during the risk assessment and decision-making process. That an inexperienced flight crew was permitted to accept the accident flight given the weather conditions and the previous flight turndowns with no additional approval demonstrated an insufficient risk assessment process and lack of organizational oversight. Another fatal accident involving the accident operator occurred 71 days before this accident; the investigation into that accident also revealed the lack of a preflight risk assessment.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The pilot's loss of control due to spatial disorientation while operating in night instrument meteorological conditions, which resulted in an in-flight breakup. Contributing to the accident was the disengagement of the autopilot for undetermined reasons, as well as the operator's insufficient flight risk assessment process and lack of organizational oversight.

Findings

Personnel issues	Use of equip/system - Pilot
Aircraft	Lateral/bank control - Not attained/maintained
Personnel issues	Spatial disorientation - Pilot
Aircraft	Autopilot system - Unknown/Not determined

Factual Information

History of Flight

Enroute-climb to cruise	Loss of control in flight (Defining event)

On February 24, 2023, about 2114 Pacific standard time, a Pilatus PC-12/45, N273SM, was substantially damaged when it was involved in an accident near Stagecoach, Nevada. The pilot, flight paramedic, flight nurse, and two passengers were fatally injured. The airplane was operated by Guardian Flight, LLC dba Care Flight under the provisions of Title 14 *Code of Federal Regulations (CFR)* Part 135.

The flight was a non-emergency transport of a patient from Reno-Tahoe International Airport (RNO), Reno, Nevada, about 2100 on an instrument flight rules (IFR) flight plan, to Salt Lake City International Airport (SLC), Salt Lake City, Utah.

According to the Guardian Flight pilot on duty from 0700-1900 on the day of the accident, he had received a flight request but declined the flight due to visibility at RNO. The day shift pilot said that the visibility was "down all day," and that he notified the oncoming (accident) pilot about it. At 1851, Care Flight received a request for transport of the patient again, and the accident crew received notification about 1858. The notification only included the destination, and the crew did not receive any specific patient information before accepting the flight. The unit was assigned about 1914.

Another air ambulance operator, who also operated a PC-12/45, received a request to transport a patient from RNO to SLC. The operator turned down the flight at 1455 due to "snow drifts, high winds, Reno below min[imums]." Additionally, that operator had another flight request to transport a patient from Northeastern Nevada Regional Hospital located in Elko, Nevada, to Renown Regional Medical Center, Reno, Nevada, at 2241, which was also turned down due to "low vis, turbulence and icing."

According to Guardian Flight, LLC personnel, dispatchers were required to inform pilots if the same patient flight request had been turned down by another operator. Care Flight personnel reported that the flight crew and medical crew would be made aware of a turndown by another transport unit for the same patient flight request. A review of the communication log produced by Care Flight did not indicate that the accident pilot was advised of the earlier turndown by Care Flight, nor the turndown by another air ambulance transport company.

About 2020, the ground transportation unit, which consisted of two paramedics, the accident flight medic, the accident flight nurse, and the two accident flight passengers, departed the

hospital for the airport and arrived at the airplane about 2029. The pilot contacted the RNO ground controller about 2052 and was instructed to taxi to runway 17L. About 1 minute later, the ground controller observed the accident airplane “getting lost” while exiting the ramp and asked the pilot if he needed assistance locating the exit. At 2054, the ground controller informed the accident pilot to “use caution the taxiway hasn’t been plowed in a while.” The controller subsequently instructed the pilot, “right turn now, you’re past the centerline of the taxiway.” About 2055, the pilot advised the controller they “have it now.” The RNO automated weather observation about this time included 1 ¾ statute miles visibility in light snow with an overcast cloud ceiling at 1,700 ft above ground level.

The flight was issued an instrument flight rules clearance to SLC that included the ZEFFR7 standard instrument departure procedure from RNO via the BLKJK transition (see figure 1). BLKJK was a GPS waypoint located about 20 nautical miles (nm) east of RNO. The pilot was cleared for takeoff from runway 17L about 2059, and ADS-B data showed the airplane was airborne about 45 seconds later. About 1 minute later, the pilot was given a frequency change and instructed to contact departure control, which the pilot acknowledged.

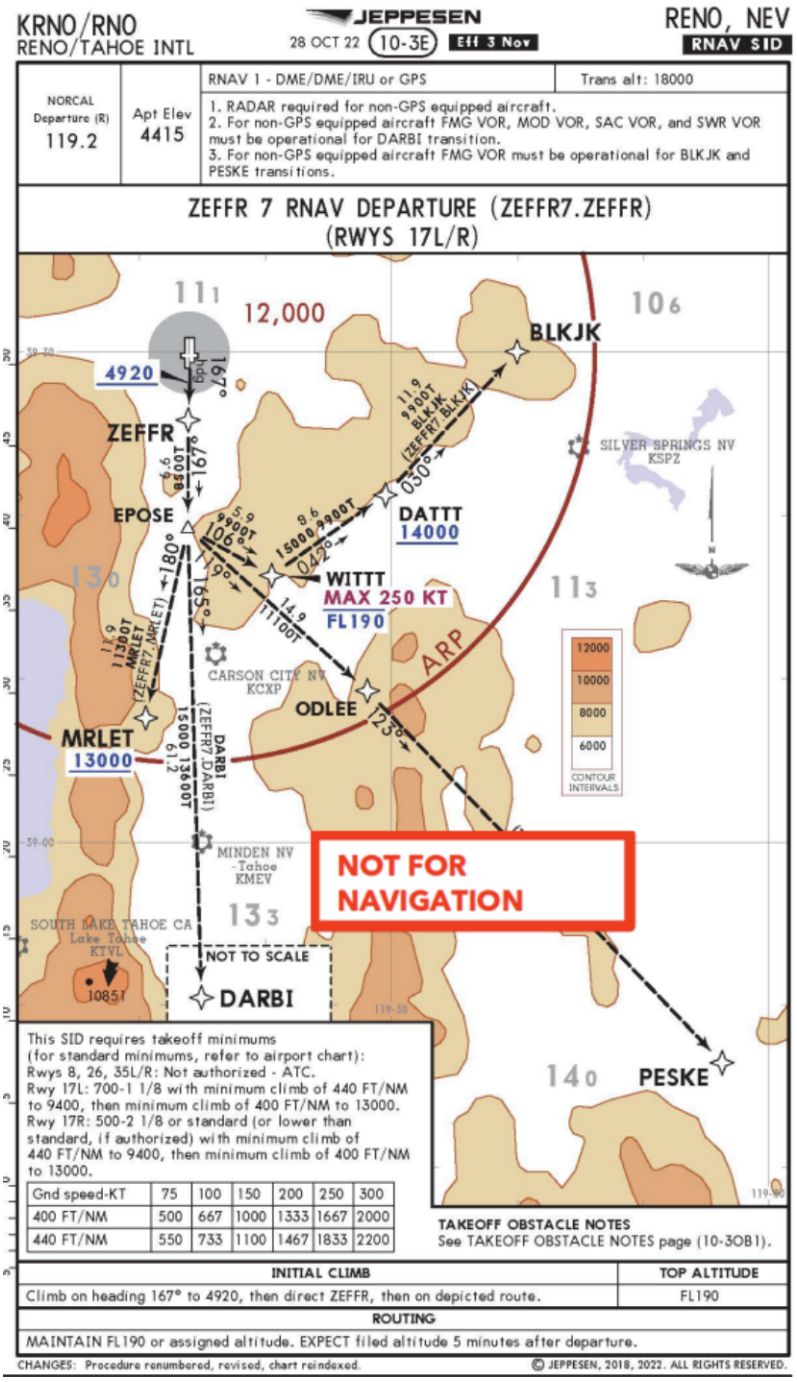

Figure 1. ZEFFR7 Standard Instrument Departure Procedure (Source: Jeppesen)

The airplane continued on a southerly heading until about 2105:50, in the vicinity of the EPOSE waypoint, when it turned left to a southeasterly heading, at an altitude about 12,100 ft msl. At 2108:37, the pilot contacted the Oakland Air Route Traffic Control Center as instructed by departure control and reported that he was climbing through 15,400 ft mean sea level (msl). The controller instructed the pilot to climb and maintain flight level 250 (25,000 ft msl)

and issued a caution for light to moderate turbulence. The pilot acknowledged the altitude assignment shortly thereafter; no additional radio transmissions were received from the accident pilot. The airplane continued to climb on a southeasterly heading until about 2108:50, when it turned northeast in the vicinity of the WITTT waypoint.

About 2111:15, the airplane began a right turn before reaching the DATTT waypoint, which was the next waypoint along the departure procedure. About this time, the airplane's previously consistent climb rate stopped, with the airplane continuing at an altitude of about 18,300 ft msl for about 20 seconds. The ADS-B data showed that the airplane remained on this heading for about 47 seconds and climbed to about 19,000 ft msl before turning left to a northeasterly heading. The airplane continued on a northeasterly heading and climbed to about 19,400 ft msl before entering a descending right turn about 2113:20. About 2113:30, the airplane's rate of descent increased from about 1,800 ft per minute (fpm) to 13,000 fpm, and the rate of turn increased. The airplane remained in a descending right turn until ADS-B contact was lost about 2114:12 at an altitude of 11,100 ft msl in the vicinity of the accident site. Figure 2 shows the airplane's ADS-B flight track.

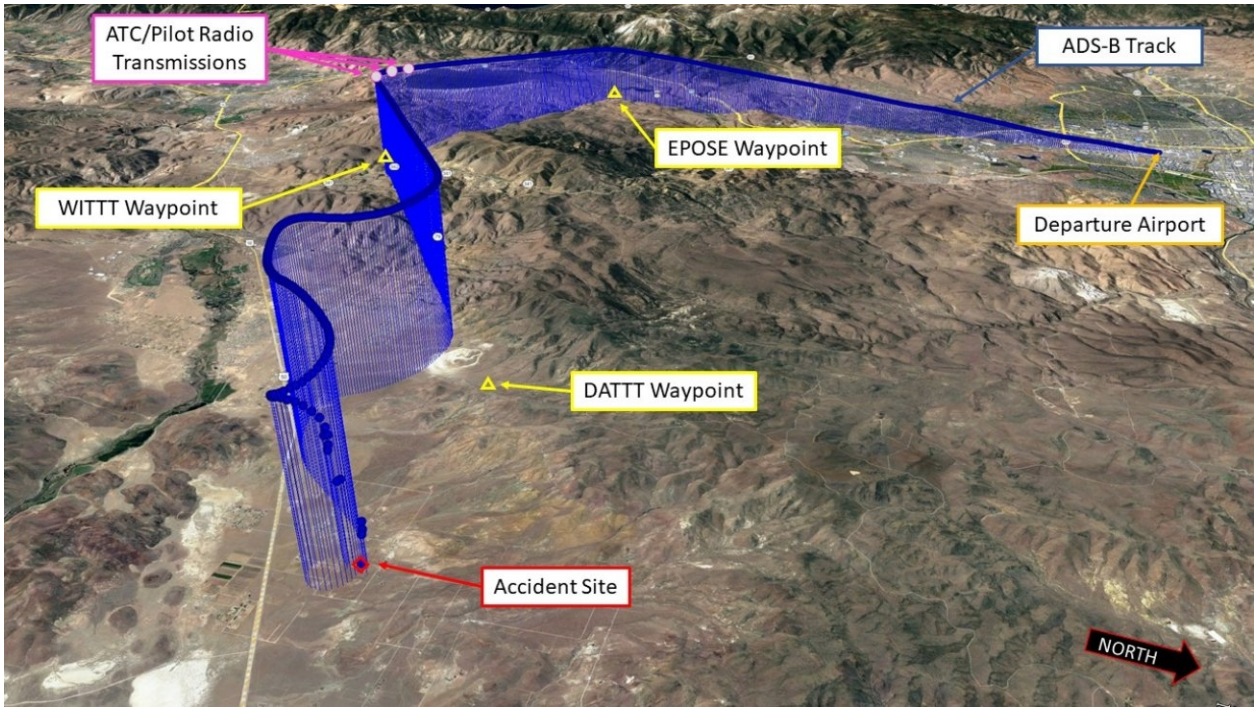

Figure 2: ADS-B flight track data with waypoint, accident site, and radio communication reference points annotated.

Pilot Information

Certificate:	Commercial	**Age:**	46,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine; Instrument airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	June 1, 2022
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 11, 2022
Flight Time:	2136 hours (Total, all aircraft), 94.9 hours (Total, this make and model), 45 hours (Last 90 days, all aircraft), 21.3 hours (Last 30 days, all aircraft)		

The pilot was hired on September 6, 2022, as a float pilot who rotated across Guardian Flight's bases throughout the country. The accident pilot had requested extra shifts, and was originally given an assignment out of Yuma, Arizona; however, due to staffing issues, he was assigned to the RNO base for a week rotation. According to an assistant chief pilot who oversaw the float pilot program, the accident pilot had previously flown two shifts in Ely, Nevada, with one of those shifts within the 4 to 6 weeks before the accident. The assistant chief pilot reported that the accident pilot was familiar and comfortable with the RNO area. The accident pilot arrived on Monday, began with a day shift on Tuesday, and then a night shift on Wednesday before the accident occurred on Friday.

The following information about the pilot's training was provided by a representative of Guardian Flight, LLC:

Date of Hire	September 6, 2022
Most Recent Hazardous Materials	September 8, 2022
Most Recent Special Curriculum Segment	September 10, 2022
Most Recent Crew Resource Management	September 10, 2022
Emergency Training - PC-12/45	September 10, 2022
Initial Ground Training in the PC12/45	September 16, 2022
Aircraft Ground - PC-12/45	September 16, 2022
Most Recent Recurrent 135.293, .297, and .299 Check	October 11, 2022
Initial Operating Experience in the PC-12/45 - Completed	October 25, 2022

A review of the pilot's training record from the operator indicated that he began his initial PC-12 flight training on October 5, 2022, and concluded on October 10, 2022, for a total of 8.1 hours. On the flight dated October 10, 2022, of the 53 flight subject training areas, 33 subject

areas were graded “S” or “satisfactory” and 20 were graded “W” or “waived.” Of those 53 flight subject training areas, one was titled “autopilot system” and another was titled “Nav and Avionics System”; on two previous separate flights (October 5th and 7th), the pilot received a grade of “U” or “unsatisfactory” for those areas and subsequently graded satisfactory on October 9, 2022.

Training records also indicated that, between September 19, 2022, and September 23, 2022, the pilot received a total of 7.1 hours of simulator training. All grades were marked as either a “1” or a “2.” A grade of “1” was considered “Proficient” and a grade of “2” was considered “Normal Progress.”

Before being hired by the accident operator, the pilot worked as a Cessna 208 pilot for a cargo operator based in Michigan. A review of training records indicated that the pilot was initially hired by that operator on November 14, 2021. His most recent *CFR* 135.293, 135.297, 135.299 checks were completed on June 9, 2022, during his employment with that operator. Of the 30 entries, all indicated “Satisfactory”; however, the entry for item #24 “Approaches: GPS” indicated that the first attempt was unsatisfactory, and the second attempt was satisfactory. The remarks stated: “Retrain and retested items #24 GPS. Satisfactory.”

The accident pilot was employed from May 10, 2021, until August 12, 2021, by a Part 121 airline. The airline reported that the accident pilot was unable to satisfactorily complete the training program. The reasons provided were pre-departure, climb, descent, and approach procedures.

Aircraft and Owner/Operator Information

Aircraft Make:	Pilatus	**Registration:**	N273SM
Model/Series:	PC-12/45	**Aircraft Category:**	Airplane
Year of Manufacture:	2002	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	475
Landing Gear Type:	Retractable - Tricycle	**Seats:**	11
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Turbo prop
Airframe Total Time:		**Engine Manufacturer:**	P&W CANADA
ELT:	Installed	**Engine Model/Series:**	PT6A-67B
Registered Owner:	GUARDIAN FLIGHT LLC	**Rated Power:**	1200 Horsepower
Operator:	GUARDIAN FLIGHT LLC	**Operating Certificate(s) Held:**	On-demand air taxi (135)

Autopilot

The accident airplane was equipped with a Bendix/King KFC 325 Digital Flight Control System (AFCS). The KFC 325 Digital AFCS had three axis controls for pitch, roll, and yaw. The Bendix/King Digital Flight Control System Pilot's Guide provided, in part, the following information about the KFC 325 flight control system:

The KFC 325 monitors autopilot operations continuously through sensors that monitor the aircraft's pitch attitude and acceleration, as well as servo motor operation. If monitors in the KFC 325 detect a problem, the autopilot will disconnect, illuminate a flashing AP annunciation, and provide an aural disconnect tone. If an autotrim failure is detected, the TRIM annunciator on the mode controller illuminates and the trim fail tone sounds. If a manual electric trim failure is detected, the TRIM annunciator illuminates and the trim fail tone sounds. The malfunction continues until the pilot takes action to stop it.

In event of autopilot or flight director malfunction pay primary attention to basic aircraft control prior to attempting to diagnose the exact nature or cause of system failure. Once aircraft control is assured, the crew may attempt to reengage the affected autopilot or flight director mode by pressing the related mode pushbutton.

Autopilot Emergencies

The KFC 325 Pilot's Guide stated, in part, in the event of an autopilot malfunction, the flight crew should immediately execute the following procedures:

1. *Airplane Controls - GRASP FIRMLY AND REGAIN AIRCRAFT CONTROL.*

2. *Simultaneously PRESS AND HOLD the Autopilot Disconnect/Trim Interrupt Pushbutton located on the yoke. Autopilot and yaw damper will disconnect and trim power is interrupted.*

3. *While HOLDING the Autopilot Disconnect/Trim Interrupt Pushbutton, pull the autopilot circuit breaker.*

4. *After the autopilot has been disengaged, DO NOT REENGAGE. Resume normal manual flight operations.*

5. *Refer to aircraft flight manual supplement for procedures.*

There were seven means by which the pilot could manually disconnect the autopilot, including the autopilot mode pushbutton, the autopilot disconnect/trim interrupt switch, the manual electric trim switch, the go-around pushbutton, the autopilot circuit breaker, the autopilot power switch (if installed), and the avionics master switch.

CAWS

The CAWS integrates the display functions of aircraft systems. The CAWS comprises a Central Advisory Control Unit (CACU) and a Central Advisory Display Unit (CADU). The CADU is installed in the lower center section of the instrument panel and 45 of the available 48 indicators display individual captioned annunciations, which indicate warning, caution, and advisory conditions. A warning light is red and indicates a condition that requires an immediate corrective action by the pilot. It is accompanied by a voice callout and the master WARNING light.

A caution light is amber and indicates a condition that requires a pilot's attention, but not an immediate reaction. It is accompanied by the master CAUTION light and an aural gong. An advisory light is green and indicates that a system is in operation.

Pneumatic Wing Deice System

The airplane was also equipped with a pneumatic wing deice system that was comprised of inflatable neoprene boots installed on the leading edges of the wings and horizontal tail surfaces. Their purpose was to inflate and dispense any ice that may accrete on their surface during flight in atmospheric icing conditions. When not in use, a vacuum is applied to the boots to prevent partial inflation while in flight.

A green CAWS caption illuminates when the wing deice system is set to on with no failures of the system. Should the inflation pressure at the individual pressure switches not reach the nominal filling pressure of 11 psi during the inflation sequence, indicating failure, then the amber caption DE ICE BOOTS on the CAWS is illuminated with an aural gong.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	KRNO,4405 ft msl	**Distance from Accident Site:**	17 Nautical Miles
Observation Time:	21:40 Local	**Direction from Accident Site:**	297°
Lowest Cloud Condition:	Scattered / 1300 ft AGL	**Visibility**	1.75 miles
Lowest Ceiling:	Overcast / 2000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots / None	**Turbulence Type Forecast/Actual:**	Clear air / Unknown
Wind Direction:	360°	**Turbulence Severity Forecast/Actual:**	Severe / Unknown
Altimeter Setting:	29.82 inches Hg	**Temperature/Dew Point:**	-1°C / -3°C
Precipitation and Obscuration:			
Departure Point:	Reno, NV (RNO)	**Type of Flight Plan Filed:**	IFR
Destination:	Salt Lake City, UT (SLC)	**Type of Clearance:**	IFR
Departure Time:	21:00 Local	**Type of Airspace:**	Class A;Class G

The Current Icing Potential imagery for the accident region provided by the National Center for Atmospheric Research (NCAR) showed that a 10 to 20% chance of trace to light icing existed between 14,000 ft and 16,000 ft at the time of the accident.

A High-Resolution Rapid Refresh (HRRR) model sounding for near the accident site at 2100, using an elevation of 4,418 ft, was retrieved from the National Oceanic and Atmospheric Administration Air Resources Laboratory and analyzed by the RAwinsonde OBservation (RAOB) program. Clouds were identified by RAOB between about 5,000 and 28,000 ft msl. The freezing level was at the surface, and RAOB identified the presence of light icing below about 15,000 ft, with moderate icing between about 9,500 and 11,500 ft msl. RAOB identified the potential for “severe” turbulence between about 11,000 and 12,000 ft msl and between about 15,000 and 16,500 ft msl. The wind at about 15,000 ft msl was from the southeast about 30 knots.

NCAR-provided HRRR data identified positive values of liquid water content between 5,000 ft and 10,000 ft along the accident airplane’s flight path, and RNO observations about the time of the airplane’s departure recorded overcast ceilings near 6,100 ft above mean sea level.

Geostationary Operational Environmental Satellite (GOES)-18 infrared data imagery from 2111 showed temperatures over the accident site were about -41°C, which corresponded to cloud top heights about 24,000 ft msl.

There were no Convective SIGMET advisories active at the time of the accident. At 1829, SIGMET Victor 2 was issued by the National Weather Service Aviation Weather Center (AWC) for an area to the south through east of the accident location that was valid until 2228 and

advised of occasional severe turbulence below 15,000 ft due to strong low-level winds, mountain wave activity, strong updrafts, and low-level wind shear.

Data from pilot reports, model data, and weather-reporting aircraft showed a turbulent environment at various altitudes. Analysis and additional data provided by NCAR showed the presence of turbulence due to wind shear and the possibility of mountain wave action; however, the derived turbulence severities were not considered hazardous, and there was no evidence of significant turbulence despite the environment, though severe turbulence could not be ruled out.

Around the time of the accident, an airline crew was descending into RNO in the vicinity of the accident site. That crew reported that they were in “complete IMC throughout our entire descent.” The crew also reported that they encountered light to moderate turbulence and some light rime ice in the area.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	4 Fatal	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	5 Fatal	**Latitude, Longitude:**	39.355219,-119.43889(est)

The airplane impacted flat, sagebrush-covered, high desert terrain about 0.31 miles northeast of the last ADS-B target. The wreckage debris field extended about 0.9 miles southwest of the main wreckage. The main wreckage, which included the fuselage, left wing, inboard right wing, vertical stabilizer, and rudder, was oriented upright on a magnetic heading of about 018°. The suspected point of initial impact contained various debris from the airframe and a propeller blade. The fuselage was mostly crushed vertically with a large hole above and aft of the rear cargo door. The vertical stabilizer and rudder remained partially attached to the fuselage. The left wing was mostly intact and remained attached to the fuselage with the left aileron partially attached and the left flap separated. The right inboard wing was mostly intact and attached to the fuselage with the inboard portion of the right flap attached.

Two pieces of the right aileron, portions of the right flap, and several pieces of right wing structure were located about 0.70 miles southwest of the main wreckage. Two sections of the outboard right wing were located about 0.34 miles southwest of the main wreckage. The right

horizontal stabilizer was located about 0.52 miles southwest of the main wreckage and the left horizontal stabilizer was located about 0.33 miles southwest of the main wreckage.

The fuselage was mostly intact, but damaged throughout. The landing gear were in the retracted position. The forward fuselage was fractured between the firewall and the lower edge of the windshields. The pilot windshield frame was fractured along the lower edge near the center post. The lower forward fuselage was deformed and crushed aft and up at an angle of about 45°.

The pilot windshield was shattered and mostly separated, with a majority located inside the cockpit. The co-pilot windshield outer pane was fractured. The pilot direct vision window was separated and located in the cockpit. There was no evidence of oil on the windshields. The fuselage was crushed downward. There was significant upward crushing of the lower fuselage structure noted when the airplane was lifted for recovery.

An area of fuselage impact damage on the right side between the aft side of the 4th right window and aft side of the 5th right window extended diagonally over the crown just forward of the tip of the dorsal fin to the left side aft of the cargo door. The fuselage structure was fractured and deformed inward and there was gouging, material transfer, and scoring identified. Immediately forward of the hole was an area of black rubber transfer marks diagonally oriented with parallel linear marks consistent with the wing deice boot. The rubber transfer marks were immediately aft of the upper VHF antenna, but the antenna was undamaged. The fuselage fracture and damage continued aft and over the crown to the left upper area of the aft pressure bulkhead.

The left wing remained attached to the fuselage and was mostly intact. The left winglet was separated, and portions were recovered in the debris field. The left wing fuel tank was breached and there was a strong odor of jet fuel. The left aileron remained attached but was rotated down beyond normal limits, so the trailing edge was forward. The left flap was separated and lying upside down under the left wing trailing edge. The outboard portion of the left wing was permanently deformed slightly upward. The left wing upper skin exhibited diagonal wrinkling between the spars along its length. The upper skin was deformed, separated from the spar, and pushed upward above the location of the left main landing gear.

The inboard right wing remained attached to the fuselage and was mostly intact and undamaged outboard to between rib 10 and rib 11. The right wing main spar upper cap was fractured about wing station (WS) 126 and the lower spar cap was fractured about WS 131. The main spar upper spar cap had buckling deformation at the fracture location and the lower spar cap had no obvious deformation. The auxiliary spar upper cap was fractured about WS 97, and the lower cap was fractured about WS 109. The auxiliary spar upper and lower caps were deformed upward at the fracture location. The wing skins and stringers were deformed upward in the area immediately inboard of the fracture. The right fuel tank was breached and there was a strong odor of jet fuel. The inboard portion of the right flap, about 87 inches long,

remained attached to the wing. The right wing upper skin was deformed, separated from the spar, and pushed upward above the location of the right main landing gear.

The right wing, outboard of about rib 11 was recovered in two main pieces and several smaller pieces in the debris field. The inboard portion was about 101 inches long. The fracture and deformation at the inboard end of the piece matched the fracture and deformation on the inboard portion of the right wing, which remained attached to the fuselage. The outboard portion of the separated right wing was about 44 inches long and included the wing end rib. The outboard section had significant hard body impact damage and was crushed accordion style aft and down. The weather radar pod was separated from the right wing tip and recovered mostly intact and undamaged in the debris field. The right winglet was separated and several pieces were recovered in the debris field.

The right side of the horizontal stabilizer was recovered in the debris field, mostly intact and undamaged with a portion of the elevator attached. The elevator section was mostly intact with little damage from the inboard end to the outboard hinge. The inboard section of the right elevator torque tube, about 4 inches long, was fractured from the right elevator and remained attached to the center bellcrank and left elevator torque tube. The outboard end of the attached elevator section displayed upward deformation. The right elevator counterweight was separated and recovered in the debris field by a resident. A section of the inboard right horizontal stabilizer upper skin forward of the rear spar, about 10 inches by about 13 inches, was recovered in the debris field by a resident. The skins and spars at the inboard end of the right horizontal stabilizer were deformed upward. A portion of the elevator, about 34 inches long, between the right side of the center fitting and the right center hinge was recovered separately with upward deformation at both ends.

The left side of the horizontal stabilizer was recovered in the debris field, mostly intact and undamaged. The skins and forward spar at the inboard end of the horizontal stabilizer were deformed upward. The inboard end of the rear spar was deformed up and twisted aft. A portion of the inboard left elevator, about 37 inches long, with the left elevator torque tube, center bellcrank, and a small section of the right elevator torque tube attached was recovered separately and displayed downward deformation at the outboard end. The elevator center bellcrank was fractured at the control rod attach point. The left elevator counterweight was separated and recovered. The elevator between the left center and left outboard hinge points, and a section of the inboard left horizontal stabilizer upper skin forward of the rear spar were also recovered in the debris field.

All the fracture surfaces examined visually exhibited a dull, angled, grainy appearance consistent with overstress separation. There was no evidence of corrosion or preexisting fractures on any of the structure examined.

Flight control continuity was established from the cockpit to all primary flight control surfaces.

The Attitude and Heading Reference System (AHRS) units exhibited impact damage; however, downloaded data showed that the last stored history was between 154 and 419 operating hours before the accident flight.

The rudder trim actuator was at 97.3% of the nominal extension. The wiper was near the extend limit switch. According to Pilatus, the airplane can require close to full right trim at high power settings to compensate for the propeller torque. The unit passed an acceptance test procedure (ATP), except that the actual stroke of 0.90 inches was longer than the allowed 0.89 inches; and midpoint potentiometer check was 8.36 volts versus a minimum of 8.78 volts.

The aileron trim actuator ATP was attempted but the actuator ram did not move. Disassembly revealed damage to the motor that was consistent with impact.

The aileron servo actuator, rudder servo actuator, and pitch servo actuator exhibited impact damage. The clutch, motor, and tachometer were tested and operated. There was no indication of pre-accident damage.

The rudder servo actuator was tested and passed all tests except the electrical trim sense in the clockwise direction. There was no indication of pre-accident damage.

The autopilot computer exhibited impact damage to the outer case and printed circuit boards (PCB). Due to the impact damage, the computer or individual boards could not be tested.

The Air Data Computer (ADC) exhibited impact damage to the exterior case and internal PCBs. The ADC passed all functional tests except for the vertical accelerometer. Visual examination of the PCB with the vertical accelerometer revealed that the solder joints for the vertical accelerometer pins were free of anomalies; however, the PCB showed numerous localized surface indications indicative of cracks. The accelerometer pins were de-soldered, and the accelerometer was separated from the PCB. The pins of the accelerometer were all bent relative to the direction of travel. The accelerometer was tested and the measurements obtained were consistent with accelerometer function.

The trim adapter exhibited impact damage to the external case and internal PCBs. There was no evidence of any pre-impact defects; however, the logic board, connector board, and monitor board could not be tested due to impact damage.

The stick pusher computer exhibited impact damage to the external case. The audio-transformer on the aural warning generator PCB was separated, and four integrated circuits were separated from their sockets. The non-volatile memory chips were removed and captured a 0° angle of attack (AOA) setpoint, which was within the acceptable range. The initial functional test of the AOA printed circuit boards was unsuccessful. Voltage checks showed that the DC/DC converters were broken. The DC/DC converters were replaced. The repaired AOA PCBs were checked per the manufacturer’s testing procedure, with satisfactory results.

The standby attitude indicator exhibited indications of contact between the case assembly and the gimbal housing assembly. The pitch dial also had indications of contact between the 60 and 70° bands. The mark on the pitch dial was consistent with a wings level and 40 to 50° descent at the time of impact.

Flight recorders

Flight track data recovered from the Garmin GTN 750 and GTN 650 GPS units contained longitude, latitude, groundspeed, GPS altitude, pressure altitude, vertical speed, heading, fuel quantity, and active waypoint data.

The CAWS computer was heavily damaged. The device stored its log on a series of four Non-Volatile Random Access Memory (NVRAM) chips that were soldered to a circuit board. The log data was stored on two of the NVRAM chips, alternating between the two chips for each byte of data; time was stored as a byte for hours, a byte for minutes, and a byte for seconds. One of the NVRAM chips was separated from the circuit board and was not located. The bytes for hours and seconds were recorded on the missing chip; while the chip containing the byte for minutes was present.

Time was correlated with the GPS data using the takeoff time, which was recorded by the CAWS as occurring during minute 5, indicating that takeoff occurred between 2059:35 and 2101:35. The CAWS data captured several events during the accident flight.

The CAWS computer recorded an autopilot disengagement between 1 and 3 minutes after takeoff (between 2101:35 and 2103:35), as shown in figure 3. The CAWS data showed that the autopilot was reengaged shortly thereafter.

Figure 3: CAWS data map overlay showing the takeoff event and first autopilot disconnect.

After the autopilot was reengaged, the CAWS data indicated that the de-ice boots cycled and the pusher ice mode was activated, along with the autopilot trim being operated six times.

A second autopilot disengagement occurred in minute 16 of the data, or a correlated GPS time between 2110:35 and 2112:35, as shown in figure 4.

Figure 4: CAWS data map overlay showing the second autopilot disconnect.

The CAWS log did not record any annunciations between the last autopilot trim operation and the second autopilot disconnect. This gap was approximately five minutes. After the second autopilot disconnect, the pusher ice mode, pusher and (de-ice) boots green annunciators cleared.

The Skytrac ISAT-200A is a satellite uplink transmitter and flight data recorder designed to track an aircraft's position, attitude, and 3-axis acceleration with onboard sensors. Onboard data was stored on a Micro Secure Digital (MicroSD) card and contained 75 recorded sessions.

Data from the Skytrac transmitter (as shown below in figure 5), showed that recorded acceleration values asymptotically approached 2g, but never exceeded that value. Skytrac was asked if this was unusual and responded that "The maximum value it will display is the 2G." Pitch, roll, yaw rate, and acceleration data from the Skytrac transmitter was considered as trend data.

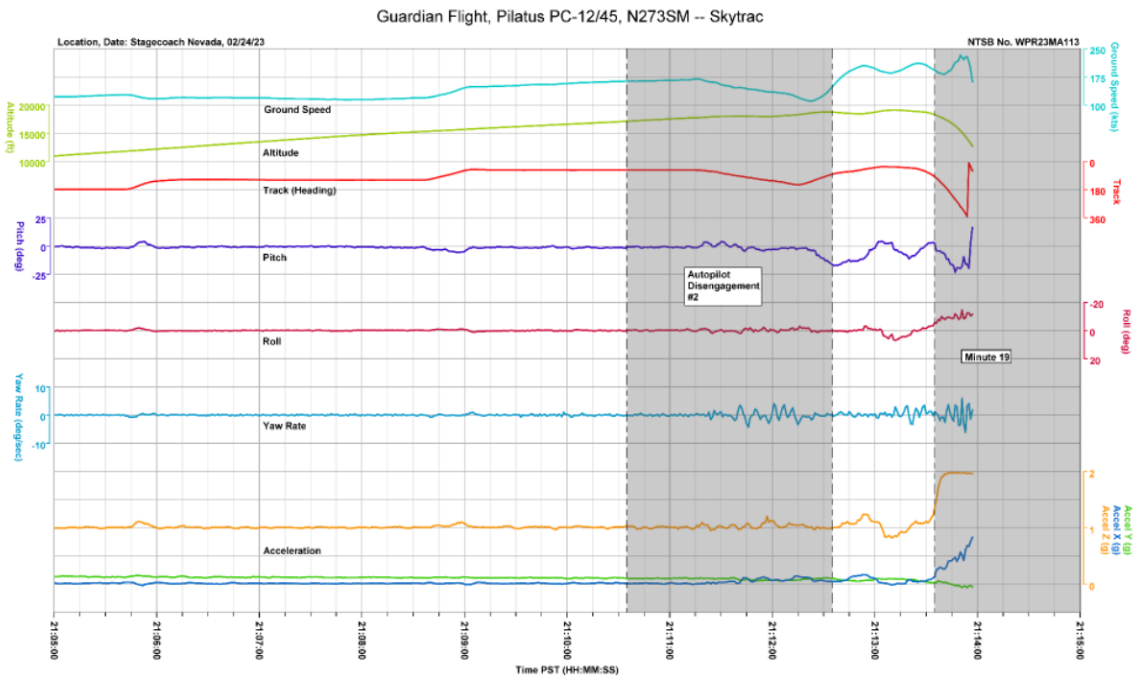

Figure 5: Plot of the accident sequence recorded by the Skytrac ISAT-200A The estimated time frame of the second autopilot disengagement and minute 19 are shown in gray.

The Pilatus Engine and Fuel computer exterior case was bent and warped, and the connectors on the back were deformed. The data recovered from the unit showed that the constant speed propeller was operating at a constant 1,700 rpm.

Medical and Pathological Information

According to the pilot's autopsy report, his cause of death was multiple blunt force injuries, and his manner of death was accident. The autopsy revealed a 3 cm right parietal brain tumor with underlying indentation of the lateral right parietal cerebrum. The tumor was determined to be a fibroblastic meningioma. The remainder of the autopsy did not identify other significant natural disease.

The pilot's tumor was located on the surface of the right parietal lobe of the brain. The parietal lobe is one of the four major components of the cerebral cortex. It has a primary role in integration of sensory input information, including spatial and navigational information. The vision system in humans is dependent on normal cortical structure and normal function of the brain. The vestibular system, based on structures in the inner ear, is responsible for

coordination of balance and movement and for sensing rotational movement and linear acceleration in space. The parietal lobe is primarily responsible for integration of visual and vestibular information.

When asked, the pilot's next-of-kin reported that she was not aware of the pilot's condition and reported no changes in his behavior or health.

The pilot's postmortem toxicology testing detected the non-sedating antihistamine medication loratadine and its metabolite desloratadine in liver and muscle tissue. Caffeine was presumptively detected in liver tissue.

Loratadine, sometimes marketed as Claritin, is an over-the-counter non-sedating antihistamine medication used for treating symptoms of allergies. Desloratadine is both a prescription medication antihistamine that is longer active than loratadine and a metabolite of loratadine. Caffeine is a central nervous system stimulant that is commonly ingested, included in coffee, tea, soft drinks, and chocolate. It is also an ingredient in certain anti-drowsiness and headache medications. Loratadine, desloratadine, and caffeine are not generally considered impairing.

Tests and Research

Video information was obtained from security cameras on a nearby house. The video showed nighttime weather conditions. A sound spectrum study established that the sound of the airplane was clearly audible for about the last 131 seconds of the flight. The study indicated that, after accounting for the Doppler effect, the engine rpm was about 1,700 rpm during the entire descent, consistent with the recorded engine data. The study established that ground impact occurred at a GPS time of 2114:12 and the engine was operating normally until impact.

Organizational and Management Information

Guardian Flight LLC and Regional Emergency Medical Service Authority (REMSA) dba Care Flight operate a hybrid air ambulance program under the name "Care Flight", with Guardian Flight LLC providing aviation services, including aircraft, pilot, and aviation maintenance technicians and REMSA d/b/a Care Flight, a Nevada non-profit corporation, providing the clinical crews, medical direction, and communications services for the program.

Pilot in Command Duties

Guardian Flight's General Operations Manual (GOM), section 2.15 "*Pilot in Command,"* stated in part that:

The Pilot in Command of the aircraft is at all times directly responsible for, and is the final authority as to, the operation of that aircraft. Prior to flight, each Pilot in Command is responsible for familiarizing him or herself with all available information concerning that flight, including the current maintenance inspection status of the aircraft.

The GOM further stated in part that the pilot in command was responsible for providing the operation risk management number to the communications center, and for cancelling or delaying flight assignments for weather or safety reasons.

Green on Green REMSA Clinical Crew Policy

Care Flight Operations Memo number 18, originally dated March 20, 2014, and revised November 20, 2022, with the subject "Shift Bid Rules" stated in part that "All fixed wing shifts are 24 hours 0700-0700" and that "Any staff member with less than one year tenure after completion of orientation on rotor wing may not bid with another staff member with less than one year tenure after completion of orientation at Care Flight. Any exception to this rule needs to be approved by management in collaboration with the education coordinator."

According to the REMSA Care Flight Safety Officer, "…we are of the opinion when Guardian sends us a float pilot and they get some orientation to the area…but that they're coming in as experienced pilots." When asked if they pair an inexperienced pilot with an inexperienced medic crew, she stated, "I have never been brought into that conversation. And honestly, until you just pointed that out, I hadn't really thought about that."

The REMSA safety officer classified the accident medical crew clinicians as "…new crew members absolutely. Less than a year with the company." Care Flight rotorcraft operations stated that any clinician with less than one year of experience must be paired with a clinician with more than one year of experience. The REMSA safety officer stated that she did not know why fixed-wing operations were not subject to this requirement.

Risk Assessment

The Guardian Flight, Flight Standard Manual, Chapter 4, "Operations" provided the following guidance on ascertaining the risk involved with flight operations:

It is imperative to ascertain the risk involved with flight operation to determine the safety of the flight. At GFL [Guardian Flight, LLC] a risk assessment found on the Baldwin Aviation Website is used to translate the amount of risk associated with each flight into a number. This number

must be determined accurately and communicated to the communications specialist prior to every flight.

If the risk assessment is calculated at a 3 or lower, it is the crew's decision as to whether to proceed with the flight. If the risk assessment is 4, the PIC must contact the PMOC (Pilot Management on Call) or Alaska Ops Manager on Call (AKOPS) and discuss the flight with them to determine whether to proceed with the flight. A risk assessment of 5 also requires consult with PMOC. This conversation will focus on attempts to mitigate the risk back to a 4. If the risk is not able to be mitigated to a 4, the flight will likely be cancelled. Acceptance of a flight in RA 5 is only at the agreement of both the pilot(s) AND PMOC. If the RA is 4 or 5, the pilot must relay to the communications specialist that a conversation with PMOC has occurred and that either:

- *both are in agreement with the go determination or;*
- *No-go decision has been made.*

  NOTE: 14 CFR 91 reposition flights outside of a scheduled 14-hour duty period require a call to PMOC for approval. PMOC notification is also required If anticipated flight time totals exceed the following during any 24-hour window:

- *7.5 hours or greater for single pilot operations or*
- *9.5 hours or greater for dual pilot operations*

Guardian Flight, LLC provided a copy of a blank Baldwin risk assessment. The report, which was typically completed online using the company-provided electronic flight bag, was about six pages in length. The chief pilot reported that the risk assessment number for the accident flight was a "3," however, no risk assessment was located for the accident flight. Additionally, no risk assessment was found during another accident investigation (ANC23FA008) for an accident that occurred December 15, 2022, also involving Guardian Flight.

According to a Care Flight aircraft communications specialist who notified the accident flight crew of the request for the accident flight, he was "surprised" that the pilot accepted the flight due to the weather conditions.

Information provided on the Care Flight page of the REMSA Health website stated:

SAFETY ABOVE ALL ELSE

The "Three to say go, one to say no" protocol is a best practice among air ambulance providers and empowers any member of the flight team, for any reason, to raise a safety concern.

Accident Clinicians

According to a senior provider who also served as a preceptor for Care Flight, the two clinicians onboard the airplane were "a newer crew… our two newest providers together, two lowest seniority people that would be even allowed to work together, working together" and that they had only been cleared to work 14 days before the accident.

The Care Flight safety officer stated the clinicians had “just cleared” their 6-month orientation and were “actually green.” The preceptor stated the accident clinicians were so new they did not know how to appropriately fill out the paperwork for the “ride-a-long” (the patient’s family member) to come on the flight and that he had to retrieve some of their medical equipment that they had forgotten to bring.

The Care Flight safety officer confirmed the accident clinicians were considered a “green” crew and that a pairing of that nature was “common practice” for the fixed-wing and ground operations.

The preceptor stated that he did not think staffing for the Guardian Flight-vended fixed wing platform was good and noted a lack of consistency regarding the pilots the clinicians would fly with. He said that the base pilots were excellent and that he was very comfortable with them, but the float pilot program did not integrate the same way, which would affect how well the crews worked together. One key difference was that base pilots would stay in the same facilities as the clinicians when they were on call, while float pilots would stay at a different Guardian facility, which created a physical distance between the crew members and could hinder trust building.

Additional Information

Spatial Disorientation

The FAA's Pilot's Handbook of Aeronautical Knowledge contained the following guidance:

> *Under normal flight conditions, when there is a visual reference to the horizon and ground, the sensory system in the inner ear helps to identify the pitch, roll, and yaw movements of the airplane. When visual contact with the horizon is lost, the vestibular system becomes unreliable. Without visual references outside the airplane, there are many situations where combinations of normal motions and forces can create convincing illusions that are difficult to overcome.*

The FAA’s Airplane Flying Handbook (FAA-H-8083-3) described hazards associated with flying when visual references, such as the ground or horizon, are obscured:

> *The vestibular sense (motion sensing by the inner ear) in particular tends to confuse the pilot. Because of inertia, the sensory areas of the inner ear cannot detect slight changes in the attitude of the airplane, nor can they accurately sense attitude changes that occur*

at a uniform rate over a period of time. On the other hand, false sensations are often generated; leading the pilot to believe the attitude of the airplane has changed when in fact, it has not. These false sensations result in the pilot experiencing spatial disorientation.

The FAA's publication "Spatial Disorientation Visual Illusions" (OK-11-1550), stated in part the following:

False visual reference illusions may cause you to orient your aircraft in relation to a false horizon; these illusions are caused by flying over a banked cloud, night flying over featureless terrain with ground lights that are indistinguishable from a dark sky with stars, or night flying over a featureless terrain with a clearly defined pattern of ground lights and a dark starless sky.

The publication provided further guidance on the prevention of spatial disorientation. One of the preventive measures was "when flying at night or in reduced visibility, use and rely on your flight instruments." The publication also stated the following:

If you experience a visual illusion during flight (most pilots do at one time or another), have confidence in your instruments and ignore all conflicting signals your body gives you. Accidents usually happen as a result of a pilot's indecision to rely on the instruments.

The FAA publication "Medical Facts for Pilots" (AM-400-03/1) described several vestibular illusions associated with the operation of aircraft in low-visibility conditions. The somatogravic illusion, which involves the semicircular canals of the vestibular system, was generally placed into the "graveyard spiral" Category. According to the publication text, the graveyard spiral:

"…is associated with a return to level flight following an intentional or unintentional prolonged bank turn. For example, a pilot who enters a banking turn to the left will initially have a sensation of a turn in the same direction. If the left turn continues (~20 seconds or more), the pilot will experience the sensation that the airplane is no longer turning to the left. At this point, if the pilot attempts to level the wings this action will produce a sensation that the airplane is turning and banking in the opposite direction (to the right). If the pilot believes the illusion of a right turn (which can be very compelling), he/she will reenter the original left turn in an attempt to counteract the sensation of a right turn. Unfortunately, while this is happening, the airplane is still turning to the left and losing altitude."

Administrative Information

Investigator In Charge (IIC):	Cawthra, Joshua
Additional Participating Persons:	David Keenan; Federal Aviation Administration; Washington, DC Igor Canepa; Swiss Transportation Safety Investigation Board - Aviation Division (STSB-AV); Payerne Paul Kirchner; German Federal Bureau of Aircraft Accident Investigation; Braunschweig Dana Metz; Honeywell; Phoenix, AZ Markus Kohler; Pilatus; Stans Michael Koenes; Guardian Medical Response; Lewisville, TX
Original Publish Date:	June 4, 2025
Last Revision Date:	
Investigation Class:	Class 2
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=106784