Aviation Investigation Final Report

Location:	Westwater, Utah	**Accident Number:**	WPR24FA083
Date & Time:	February 7, 2024, 10:48 Local	**Registration:**	N900VA
Aircraft:	HAWKER BEECHCRAFT CORP HAWKER 900XP	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of control in flight	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The flight crew, comprised of the pilot-in-command (PIC) and second-in-command (SIC), was conducting a stall test in the airplane following the recent removal, inspection, and reinstallation of the wing leading edges and de-ice panels as part of routine maintenance. The airplane departed normally, entered a climbing right turn to the northeast, and leveled off about 20,000 ft mean sea level (msl). In its final minute of flight, the airplane entered a rapid vertical descent consistent with a flat spin and never recovered.

The airplane was mostly consumed by postcrash fire and was highly fragmented, which precluded a complete and thorough wreckage examination of the airframe and engines. A review of the flight data showed no anomalies with the flight controls or engines, as the flight control surface movements were consistent with the flight control inputs and engine performance matched the power lever movement.

Performance data indicated that before the airplane entered the spin, it decelerated and its pitch attitude increased, consistent with the flight crew preparing to perform their planned post-maintenance stall warning and identification system checks. The airspeed then slowed further, with flaps retracted for the first system check. Performance calculations showed that the stick shaker activated about 117.5 kts, one knot below the activation speed for the stick shaker at flaps zero. The stick pusher then activated at 113.5 kts, 3 kts above the stick pusher activation speed. Given the airplane's weight and load factor, the shaker and pusher both activated at appropriate speeds; however, the airplane entered the stall at the same time the stick shaker activated, which provided no warning to the flight crew.

The correct stall warning sequence should be stick shaker, stick pusher, then, if the pilot does not attempt a stall recovery, stall entry. The stall warning sequence for the accident flight, with the stall occurring at the same time the stick shaker activated, was likely due to a degradation in the relationship between lift and angle of attack (AOA) from wing contamination, either by icing or the airplane's recent maintenance. A weather study showed that the airplane was in instrument meteorological conditions (IMC) during some or all of its climb from 5,000 ft through 16,700 ft msl and could have accreted up to 1 mm of ice on the wings during this time. An icing study determined that even a 2-minute icing encounter could have reduced the maximum coefficient of lift by up to 40% and reduced the stall AOA by up to 6°.

Wing Contamination

Two AIRMETs were issued about 2.5 hours before the accident flight for moderate icing throughout the airplane's climb and cruise altitude for the stall test. In addition, video showed that the departure airport was surrounded by obscuration and precipitation during takeoff. Evidence showed that the flight crew was aware of the presence of sleet and "storm" conditions before departure during their interactions with maintenance personnel. The presence of these conditions should have given the flight crew pause before they executed the stall test, which required visual meteorological conditions and no icing according to the airplane's Pilot's Operating Manual (POM).

The airplane recently underwent routine maintenance to inspect the wing leading edges for signs of cracks and corrosion. This inspection included an extensive inspection of the flight controls and wing ribs that required a removal of the leading edges, numerous inspection panels, and control surfaces. After maintenance, the wings were subject to multiple inspections for the reinstallation of the TKS panels and wing leading edges and a final post-maintenance inspection of the leading edges. While the postcrash fire prevented the investigation from determining if there was any wing contamination that was introduced by the maintenance team during reassembly, the number of post-maintenance and preflight inspections decreases the likelihood of improper maintenance.

Stall Test Conditions

During the flight, the crew complied with most of the stall test conditions required by the POM: an empty ventral tank, an operative stall identification system, and autopilot OFF. However, the pilots did not follow the cloud clearance and height limitations prescribed by the stall test procedure. Audio from the cockpit voice recorder also indicated that the flight crew knowingly chose to execute the stall test above clouds about 2,000 ft above the prescribed maximum altitude. There is also no evidence they attempted to verify that the external surfaces were free of ice after flying through IMC and icing conditions despite the airplane being equipped with an ice detection spotlight system that could have been used to illuminate the wing fairings. The airplane was also equipped with an ice detector that had to be manually activated by the flight crew as it was not directly connected to the airframe ice protection system.

Flight recorder data and cockpit voice recorder audio indicated that the flight crew intentionally departed without engine ice protection and likely without airframe ice protection. The reason for this decision is unknown but may have been to prevent the de-icing fluid from contaminating the airflow over the wing during the stall test.

After the airplane entered the stall, the flight crew input full left-wing-down aileron when the airplane abruptly banked right and applied full power and full aft control column, which aggravated the aerodynamic stall/spin. The flight crew's attempted remedial action suggested that they were insufficiently trained for the flight and the brief guidance from the POM provided no clear instructions for the possible consequences of "unacceptable stall characteristics" referenced as a cautionary note or a proper recovery.

Stall Test Pilot Qualifications

The structural repair manual (SRM) offers only a broad definition of those qualified to perform the stall test flight, requiring that the pilot be "familiar with the stall identification system and stall characteristics" of the airplane. Further, the stall section of the POM states that "pilots conducting stall checks should have prior experience in performing stalls in the Hawker and must be prepared for unacceptable stall behavior at any point leading up to and throughout the maneuver."

In the previous year, the flight crewmembers attended separate simulator training sessions at a commercial facility for the SIC's initial training and the PIC's recurrent training. These courses covered the operation of the stall warning and identification system (shaker and pusher), which is focused on recognizing and avoiding stalls. The simulator training was not designed to teach full stalls, including stall entry, or to prepare the crew for a possible uncommanded roll as described in the stall section of the POM. Although the PIC participated in a stall test flight 4 years before the accident, it was likely with limited involvement in the test as he was SIC at the time. The SIC for the accident flight had not participated in a stall test before the accident flight. Therefore, it is unlikely that the flight crewmembers' simulator training on the stall warning and identification system and the PIC's previous participation in a stall test flight adequately prepared them to safely conduct a stall flight test or address any unacceptable stall behavior.

The accident was the result of the flight crew's decision to conduct a post-maintenance stall test in an area of icing conditions, which resulted in wing contamination that significantly degraded the airplane's critical angle of attack. The airplane manufacturer's lack of training and experience requirements to ensure flight crew preparedness to safely conduct the stall test resulted in an attempted remedial action that aggravated the aerodynamic stall and led to a loss of control from which the flight crew was unable to recover. Contributing to the accident was the flight crew's failure to follow the test conditions related to cloud clearance, altitude limit, visual meteorological conditions, and ensuring all external surfaces were free from ice.

Probable Cause and Findings

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

The flight crew's decision to conduct a post-maintenance stall test in an area of icing conditions, which resulted in wing contamination that significantly decreased the airplane's critical angle of attack. Also causal was the airplane manufacturer's lack of training and experience requirements for the flight crew to safely conduct the stall test, which resulted in an attempted remedial action that aggravated the aerodynamic stall and led to a loss of control from which they were unable to recover. Contributing to the accident was the flight crew's failure to follow the test conditions regarding cloud clearance, altitude limit, visual meteorological conditions, and ensuring all external surfaces were free from ice.

Findings

Personnel issues	Decision making/judgment - Flight crew
Personnel issues	Total instruct/training recvd - Flight crew
Personnel issues	Use of policy/procedure - Flight crew
Personnel issues	Use of equip/system - Flight crew
Personnel issues	Aircraft control - Flight crew
Aircraft	Angle of attack - Not specified
Aircraft	Pitch control - Incorrect use/operation
Environmental issues	Conducive to structural icing - Decision related to condition
Environmental issues	Conducive to structural icing - Effect on equipment
Organizational issues	Adequacy of policy/proc - Manufacturer

Factual Information

History of Flight

Maneuvering	Loss of control in flight (Defining event)

On February 7, 2024, about 1048 mountain standard time, a Hawker 900XP, N900VA, was destroyed when it was involved in an accident near Westwater, Utah. The PIC and SIC were fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations (CFR)* Part 91 positioning flight.

The airplane, which was owned by Vici Aviation, LLC, and operated by Clay Lacy Aviation, Inc., arrived at West Star Aviation's facility at Grand Junction Regional Airport (GJT), Grand Junction, Colorado, on December 20, 2023, for routine maintenance. According to the maintenance facility, multiple routine inspections were completed on the airplane including a required removal of the wing leading edges and de-icing panels to inspect for cracks and signs of corrosion. The airplane was subsequently returned to service on February 6, 2024.

The flight crew planned to fly the airplane from GJT to Gig Harbor, Washington, on the day of the accident while performing a required post-maintenance stall warning and systems check en route to their destination.

At 1036:41 the SIC reported to the PIC that anti-ice was off while the airplane was on the ground before departure.

ADS-B and flight data recorder (FDR) data indicated that the airplane departed GJT at 1037 and entered a climb on a southeast heading. At 1038:45, the flight crew asked departure control for a block of altitude in the "mid-teens for about ten minutes." Thirty-two seconds later the SIC reported again that "anti-ice is off." At 1039:54, the PIC told the SIC "we'll request a ah altitude once we get above in V-M-C." The airplane made a right turn northwest as it continued to climb. During the climb, at 1042:25, the SIC asked Denver Center for a block of altitude from FL180 to FL200. Denver Center approved the altitude block and the airplane continued to climb and subsequently leveled off at 20,000 ft msl.

The FDR data showed that at 1044:00, airspeed began to decrease from 219 kts as the airplane's pitch attitude and AOA began to increase. At 1044:41, the flight crew began to discuss the stall test. One second later the SIC is asked "so we're taking indicateds, right" and the PIC responded "ah yeah indicated, we're lookin' for shaker, pusher, Ill call mark on pusher if you can't, see it for, some reason." The FDR showed that the autopilot was disconnected at 1045:01. At 1045:51, a sound consistent with the gear warning horn is heard, followed by an acknowledgment from the PIC and then at 1046:33 the cockpit area microphone (CAM) recorded a sound consistent with the stick shaker and the SIC reported “one nineteen.” The airplane’s pitch attitude continued to increase while simultaneously decelerating until 1046:37. While decelerating from 118 kts, at an AOA of 0.91% and 0.93% for the right and left, respectively, a pitch attitude of 15.12° for both the right and left, Stall Valve A opened. At 1046:37, the CVR CAM recorded a rattling sound that was accompanied by the sound of the stick shaker.

At 1046:47 the flight track data show the airplane began a rapid descent in a pattern resembling the shape of a corkscrew. The airplane’s flight track made multiple circular rotations before ending at 1047:44.

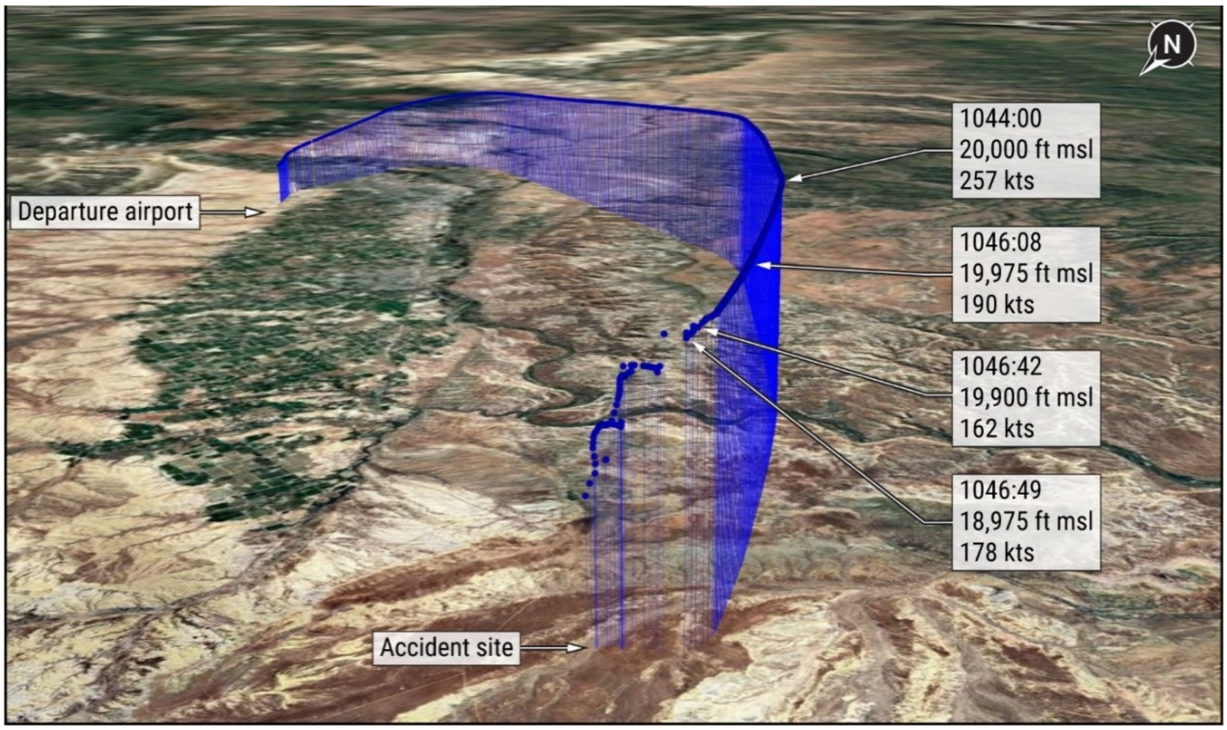

Figure 1: Accident airplane flight track and corkscrew descent

Please refer to the Flight Recorders section of this report for a detailed description of the FDR parametric data.

Pilot Information

Certificate:	Airline transport	**Age:**	58,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	December 11, 2023
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 6, 2023
Flight Time:	8188 hours (Total, all aircraft), 70 hours (Total, this make and model), 4062 hours (Pilot In Command, all aircraft), 32 hours (Last 90 days, all aircraft)		

Pilot Information

Certificate:	Airline transport	**Age:**	65,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:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Waiver time limited special	**Last FAA Medical Exam:**	December 11, 2023
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 28, 2024
Flight Time:	15734 hours (Total, all aircraft), 2249 hours (Total, this make and model), 12190 hours (Pilot In Command, all aircraft), 32 hours (Last 90 days, all aircraft)		

The PIC and SIC completed their most recent training at a commercial simulator training facility. According to one of the facility instructors, *"we will do a demonstration especially for the initial class of…stick pusher on the airplane. That's up a simulator high altitude like, I don't know, 30,000 ft or so, and we'll have them slow right down and we demonstrate the features of the stall protection system. So, once they get into the caution regime. We do this on autopilot, because we demonstrate that once the stick shaker goes off, your autopilot turns off. So now you've got to fly the airplane, but then we have them wait because if you haven't recovered by then, you're going to get a stick pusher, and that's hydraulically actuated. So it's dramatic and they just descend down, and it's a demonstration. There's no proficiency required for that."* An instructor at the facility reported that they do not teach full stalls.

The PIC completed his most recent recurrent training in a Hawker 800XPi simulator at the same facility in October 2023, about 9 months before the accident. He was rated satisfactory in all categories including stall prevention with flaps, without flaps, on landing, and unusual attitudes.

The SIC completed initial training in the Hawker 800XPi 4 months before the accident, and also received a satisfactory rating in every category, including the stall prevention categories referenced above. The initial training included 60 hours of ground training and 31.4 hours in the simulator; 17 hours as the pilot flying and 14.4 hours as the pilot monitoring. One simulator session dated October 24, 2023, noted that the pilot received a rating of “1” under the inflight maneuver category “Stall Prev[evention] Part/Flap,” which indicated “insufficient progress in acquiring the knowledge and skills to achieve proficiency.” The SIC also received a rating of “1” in six other areas during the same simulator session. The following day the SIC repeated the same simulator sessions and achieved a grade of “3” in each area, which is considered “proficient. The exercise has been mastered and performance is consistently repeatable.” During the checkout on October 28, 2023, the pilot received a grade of “S” (satisfactory) for all events including the “Stall Prev” areas.

The operator’s records indicated that the PIC conducted an inflight stall test once before, on December 7, 2019, and was the second-in-command on that flight. There was no record that the SIC had conducted an inflight stall test before the accident flight.

Aircraft and Owner/Operator Information

Aircraft Make:	HAWKER BEECHCRAFT CORP	**Registration:**	N900VA
Model/Series:	HAWKER 900XP	**Aircraft Category:**	Airplane
Year of Manufacture:	2007	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	HA-0020
Landing Gear Type:	Retractable - Tricycle	**Seats:**	10
Date/Type of Last Inspection:	February 2, 2024 Annual	**Certified Max Gross Wt.:**	28120 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo fan
Airframe Total Time:	4704 Hrs as of last inspection	**Engine Manufacturer:**	Honeywell
ELT:	C126 installed, not activated	**Engine Model/Series:**	TFE731-50R-1H
Registered Owner:	VICI AVIATION LLC	**Rated Power:**	4750 Lbs thrust
Operator:	Clay Lacy Aviation, Inc.	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Clay Lacy Aviation	**Operator Designator Code:**	

According to the type certificate data sheet (TC), the Hawker 900 XP was launched in 2006 by Raytheon Aircraft Company. The type certificate was transferred to Hawker Beechcraft Corporation on March 26, 2007, and then Beechcraft Corporation on April 12, 2013, and on October 12, 2016, to Textron Aviation, Inc., the TC holder at the time of the accident.

Before the accident, the airplane had undergone several phase inspections in addition to numerous required task inspections as a part of routine maintenance. The maintenance facility released the airplane on the day of the accident.

Stall Test Requirement

The recent maintenance that required the stall test was outlined in the structural repair manual (SRM), which required the removal of the wing leading edges every 4 years to access and remove the de-icing panels for a visual inspection of cracks and signs of corrosion (SRM task code No. 570026).

According to Section 57-41-00 of the repair manual, "WINGS LEADING EDGE AND LEADING EDGE DEVICES WING LEADING EDGE GENERAL REPAIR,"

"In accordance with the Flight Manual procedures the airplane must be test flown by a pilot familiar with the stall identification system and stall characteristics of the 750, 800, 800XP, 850XP, and 900XP series if:

> *The leading edge assembly was removed as a whole for any reason*
> *Two or more TKS* [de-icing] *wing distribution panels on one side are removed or installed"*

This section of the SRM also refers the operator of the Series 900XP airplane to Section V of the Pilot's Operating Manual for the procedure and technique to complete the stall test.The manual requires that, before taking the test flight, the operator verify that the Stall Warning and Identification System is functioning properly while on the ground.

Stall Test Procedure from Pilot's Operating Manual (POM)

The airplane's POM contained instructions on operating limitations, system descriptions, flight planning, flight handling, and ground information.

Section V Sub-section 1 (Page 1-16) of the POM contains the required conditions and techniques to complete the stall test, separate from the SRM.

The required conditions for the stall test included an altitude above 10,000 ft above ground level, 10,000 ft above clouds and below 18,000 ft mean sea level. In addition, this check flight should only be conducted during day visual meteorological conditions with a good visual horizon, with the autopilot disengaged, an operative stall identification system, external surfaces free of ice, the ventral tank empty, and weather radar on standby.

The POM also noted that stalls should be made in "wings level" flight with thrust set and maintained throughout the approach to stall and recovery. In addition, the airplane should be trimmed to 1.4 V_{s1} and airspeed should be reduced at no more than 1 kt/second. The flight crew is also required to avoid any rapid or violent control movements during the approach to the stall, particularly at airspeeds below the activation of the stick shaker.

Accident Flight Stall Test

According to the flight data recorder, the flight was flown with an empty ventral tank, and the autopilot was switched off before the flight crew began the stall test. The stall identification system was operative at the time. The flight was flown in VMC conditions about 5,000 ft above clouds and about 2,000 ft above the maximum prescribed altitude of 18,000 ft msl. The flight crew's visual horizon at the time and weather radar status are unknown.

The crew decelerated the airplane at 1kt/second as prescribed by the published stall technique while maintaining level flight and no rapid movements were observed in the FDR data until the stall break. The flight crew's control inputs are captured in the FDR section of this report.

Stall Characteristics

The stall test section of the POM also contained a description of the stall characteristics with a "Caution" advisory. The section noted a moderate roll was acceptable provided that the use of the ailerons limits the roll angle to no more than 20°. In addition, the advisory discussed the potential for experiencing "aileron snatch," which should not be considered acceptable. In the case of aileron snatch, the POM advised that elevator control should be moved forward to decrease angle of attack and to allow the return of normal aileron control. The section also advised the pilot to be prepared to recover from an unusual attitude.

According to the POM's "Caution" advisory:

> PILOTS CONDUCTING STALL CHECKS SHOULD HAVE PRIOR EXPERIENCE IN PERFORMING STALLS IN THE HAWKER AND MUST BE PREPARED FOR UNACCEPTABLE STALL BEHAVIOR AT ANY POINT LEADING UP TO AND THROUGHOUT THE MANEUVER.

The POM also warned that there is no natural stall warning or aerodynamic buffet before the stall. The airplane type certificate holder (Textron Aviation) provided the following definition of aileron snatch:

Roll upset can be caused by airflow separation (aerodynamic stall), which induces self-deflection of the ailerons and loss of, or degraded, roll handling characteristics. For example, on an airplane with a fully functioning ice protection system, a roll upset can occur when the icing conditions are severe enough to result in water droplets that flow back past the wing's ice-protected leading edge. When these water droplets freeze, ridges form that can cause flow separation and an uncommanded deflection of the ailerons, resulting in a roll upset.

This, combined with a possible uncoordinated flight condition during the approach to a stall, can place the airplane in the position of entering into a spin.

Depending on the severity of the flow separation, the control force necessary to overcome the uncommanded deflection of the ailerons can be beyond the pilot's physical capability.

The NTSB interviewed a former test pilot of the airplane type certificate holder who conducted factory stall tests and now conducts Hawker stall tests on a contract basis. According to him, there is no guidance that directs a pilot on the number of configurations to test, where an initial stall warning should occur, or that it should coincide with the low side of the speed tape. He noted that an unacceptable stall test could be due to airplane roll, overbalanced ailerons, or aileron snatch, which he defined as airflow separation over the aileron instead of at the wing root. This state causes the control yoke to “snatch.”

Stall Recovery from Operator Guidance

The operator’s Standard Operator Procedures Manual, dated January 27, 2020, provided the following guidance on “Enhanced Stall and Stick Pusher Training:”

“1. Notwithstanding any specific "aircraft profile" listed here in the following general procedure shall be used during training and checking of Stall and Stick Pusher, as applicable:

> *a. The reduction of angle of attack is required to initiate recovery of all types of stalls during training and testing.*
>
> *b. All aircraft, that have an installed Stick Pusher, will conduct Stick Pusher training allowing the Pusher to reduce the Angle of Attack (AOA).*
>
> *c. Note: Deliberate activation of the pusher is not an evaluated maneuver during testing.”*

Stall Warning and Identification System

The airplane was equipped with a two-channel stall warning (stick shaker) and identification (stick pusher) system.

According to the POM, the stall warning portion of the system becomes armed during takeoff when no weight-on-wheels is recognized and the stall identification portion of the system is armed 6 seconds after takeoff, at which time it begins to monitor the pitch attitude of the airplane. The stall warning system uses an electrically driven stick shaker on each control column to provide a physical warning of an approaching stall. Angle of attack is derived from two heated airflow angle sensor vanes mounted on the fuselage.

The stall identification system is comprised of a hydraulic stick pusher that forces the control column forward at the calculated point of stall. Hydraulic pressure to the stick pusher is controlled via two independent stall valves (A and B) and both must be open to activate the unit. The point of the stall is calculated by the signal summing unit (SSU) using vane sensor and flap angle inputs.

According to the flow logic, if the system detects that angle of attack is increasing, the separate signal summing unit (SSU) channels will calculate an approaching stall and initiate a warning (shaker) signal. The warning signal can come from either individual SSU channels, which will then disconnect the autopilot and generate the stick shaker. If the flight crew does not take preventative actions (lower AOA) at this point, and angle of attack continues to increase, the stall identification trigger point will be modified by the rate of angle of attack increase and when both SSUs agree the airplane is at the point of stall, the stick pusher will automatically activate.

De-Icing System Description

The airplane was equipped with an airframe fluid ice protection system for the leading edges of the wings and the horizontal stabilizers. According to the POM,

"The system is controlled by a single timer switch. An audio warning is given when the system switches off."

"A WING/TAIL ANTICE timer switch controls an electrically-operated pump for up to 10 minutes. When initially selected, the first minute of operation is at a high flow rate, after which, the system reverts to normal flow. If icing conditions still prevail or are expected, and therefore a further period of operation is required, this should be selected before the timer switch reaches zero. Using this procedure the system will remain on the normal flow rate, without first delivering a high rate flow and therefore fluid will be conserved. When the timer switch returns to zero, the pump is de-energized and a warning chime sounds via the airplane audio system."

The POM also contains a description of the system operation. When the timer switch is ON, de-icing fluid is drawn from the tank through a system of filters, check valves, and a compensating valve to the individual distributor panels. At each distributor panel, fluid is fed through a metering tube into a cavity where the fluid passes through a micro-porous plastic sheet and through a titanium outer skin of greater porosity to escape into the atmosphere. Airflow then directs the fluid to spread rearward over the wings and horizontal stabilizer surfaces.

The airplane was also equipped with an ice detector that is not connected to the de-icing system. The formation of ice is detected automatically after takeoff with manual selection of the detector available for operation while on the ground.

The airplane was also equipped with two ice detection spotlights, one on each wing fairing, that were controlled by an ICE/LOGO switch located on the EXTERIOR LIGHTS section of the flight compartment overhead roof panel forward extension. According to the POM, *"when the ICE/LOGO switch is selected to ICE, the spotlights illuminate the left and right wing leading edges for night visual inspection."*

Section 4.10 of normal procedures in the AFM contains the procedure for flight into icing conditions:

"ENG IGN 1   ON

ANTICE 1   ON

ENG IGN 2   ON

ANTICE 2   ON

Notes:

1. *The airframe system should be maintained fully primed by selecting the timer on for 30 seconds at the start of climb, for 2 minutes at the top of descent and if icing conditions are expected, preferably for 2 minutes prior to entering icing conditions.*
2. *When icing conditions prevail, a further period of operation should be selected prior to the timer reaching zero.*

WING/TAIL ANTICE   Select before entering icing and set for 10 minutes."

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KGJT,4839 ft msl	**Distance from Accident Site:**	25 Nautical Miles
Observation Time:	11:53 Local	**Direction from Accident Site:**	108°
Lowest Cloud Condition:	Few / 6000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Overcast / 10000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	260°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.59 inches Hg	**Temperature/Dew Point:**	8°C / -1°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Grand Junction, CO (GJT)	**Type of Flight Plan Filed:**	IFR
Destination:	Tacoma, WA (TIW)	**Type of Clearance:**	IFR
Departure Time:	10:37 Local	**Type of Airspace:**	Class A;Class E

A High-Resolution Rapid Refresh (HRRR) model sounding from the National Oceanic and Atmospheric Administration showed broken or overcast cloud layers between about 8,200 ft and 15,000 ft msl at the accident site. Modeling also showed that the freezing level was about 6,500 ft msl at the time of the accident and identified the potential for light or moderate clear, rime, or mixed icing between 7,800 ft and 15,300 ft msl.

Very-High-Resolution Radiometer showed that the minimum infrared cloud-top temperatures near the accident site were about -25°C, which corresponded to cloud top heights of about 17,500 ft msl.

A Graphical-Airmen's Meteorological Information (G-Airmet) was issued about 0800 on the day of the accident for moderate icing between the freezing level (6,500 ft msl) and 22,000 ft msl at 0800 that was valid for the accident site. A G-Airmet was also issued at the same time for moderate icing between the freezing level and 20,000 ft msl that was valid for 1100 at the accident location.

A Graphical Forecast for Aviation (GFA) icing probability analysis for 18,000 ft msl at 1045 showed a zero percent probability of icing. The GFA cloud cover analysis for 1045 depicted broken clouds at 8,000 ft msl with cloud tops to 28,000 ft.

Ice Accretion

The National Center for Atmospheric Research conducted model forecasting of the level of ice accretion and reported a true value of ice accretion of less than 1 mm.

Video of Departure

A security camera video of the airplane's departure for the accident flight showed numerous low-altitude clouds surrounding the airport. According to a witness, he noticed precipitation and sleet during the flight crew preflight inspection and asked the PIC "if they would be able to find an opening in the storm clouds to be able to do that stall check." The PIC replied, "we'll just get above them."

Flight Crew Interaction with Mechanic

According to a mechanic employed by the maintenance facility, he observed "precipitation and sleet" while accompanying the flight crew during their preflight before their departure on the accident flight.

Airport Information

Airport:	GRAND JUNCTION RGNL GJT	**Runway Surface Type:**	
Airport Elevation:	4861 ft msl	**Runway Surface Condition:**	
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	On-ground
Ground Injuries:		**Aircraft Explosion:**	Unknown
Total Injuries:	2 Fatal	**Latitude, Longitude:**	39.26625,-109.05652(est)

The airplane came to rest in flat open terrain about 25 nm northwest of GJT at an elevation of about 4,800 ft mean sea level and oriented on a west heading. The airplane's major structures were all accounted for at the accident site. A debris path was traced from the main wreckage to the end of a burn area that was about 200 ft long and 175 ft wide at the widest point, oriented on a magnetic heading of 345°. A silhouette of the left wing, fuselage, and both engines was located about 10 ft south of the main wreckage.

Figure 2: Accident site main wreckage

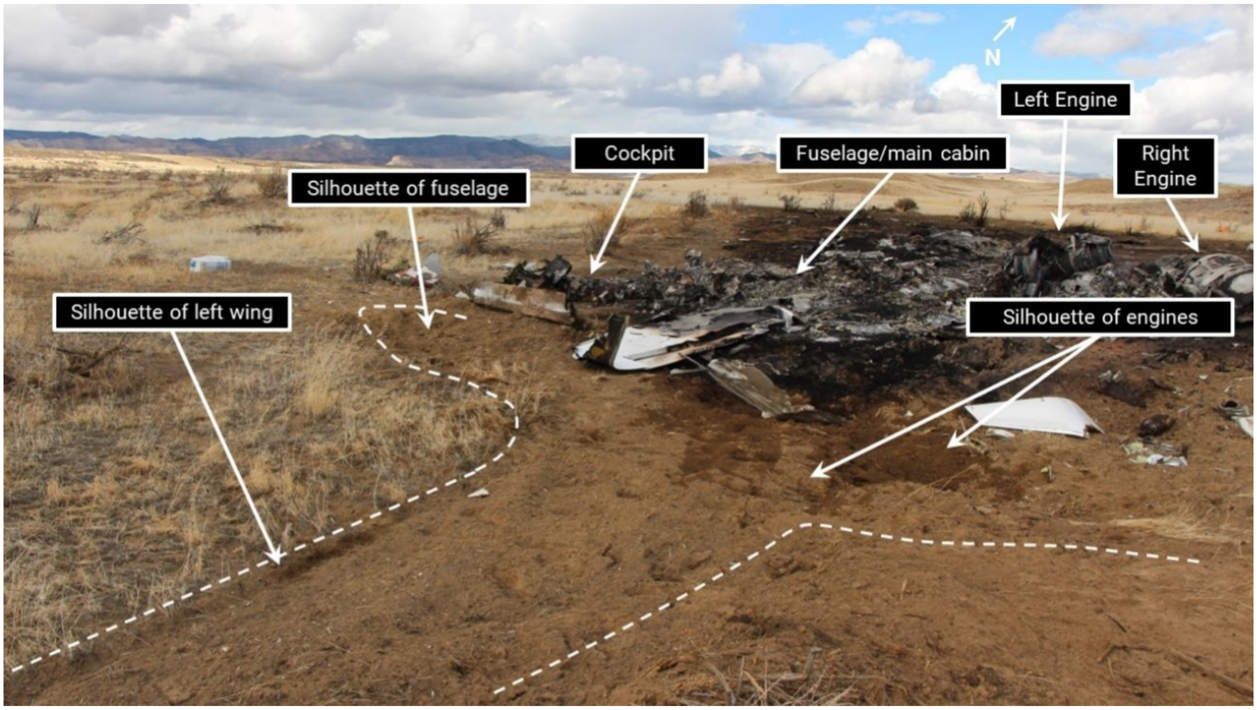

Figure 3: Silhouette of left wing and fuselage with consumed main wreckage in background

Flight recorders

Flight Data Recorder (FDR)

According to the airplane's FDR, at 1046:37 the airplane abruptly rolled to the right beyond 45°, at a roll rate in exceedance of 40° per second. The flight crew applied and maintained full left aileron and full aft control column. The airplane's heading also began to turn right at this time while vertical acceleration decreased from about 0.9g to about 0.6g and the pitch attitude decreased from about 15° to about 6°. Engine PLA was also advanced from the idle setting. At this time, the Stall Valve A was recorded in the OPEN state, consistent with the stick shaker being active.

One second later, the pitch continued to decrease while the roll reached a 64° right bank. The recorded angle of attack decreased to 0.85% and 0.78% on the left and right AOA, respectively, and Stall Valve A and B were recorded in the NOT OPEN state.

At 1046:39, at an airspeed of 115 kts the left and right AOA showed 0.80% and 0.90%, respectively, at which time both Stall Valve A and B transitioned to the OPEN state, consistent with the activation of the stick pusher. The flight crew maintained full left aileron at this time.

The roll reached about 72° right bank and the pitch reached 7.7° nose down. A Master Caution was recorded on the right primary flight display (PFD) at this time. The next second also recorded both stall valves in the OPEN state along with a Right PFD roll compare warning.

At 1046:41 the right roll had reached 84.7° at which time the airplane began to roll to the left. The pitch attitude continued to decrease past 20° nose down. AOA at this time was 0.97% and 0.88% for the left and right, respectively, and both stall valves were NOT OPEN.

Over the next 10 seconds the airplane rapidly rolled to the left through full inverted and back upright while the pitch angle remained in a nose-down attitude, reaching a peak of -75.4°. Both AOA values were 1.0% for the remainder of the recording and both stall valves remained OPEN for the duration of the recording, consistent with stick pusher activation.

Medical and Pathological Information

An autopsy of the PIC and SIC was completed by the Utah Department of the Medical Examiner, Taylorsville, Utah, with the cause of death for both as blunt force injuries. Toxicology testing by the FAA forensic sciences division did not identify any substances of abuse in any of the samples submitted for the SIC.

The FAA toxicology testing detected unknown quantities of Zolpidem and Terbinafine in the PIC's kidney and muscle. Zolpidem is a non-benzodiazepine receptor modulator primarily used in the FDA-approved short-term treatment of insomnia aimed at patients with difficulty falling asleep. Terbinafine is an anti-fungal used to treat fungal infections.

Tests and Research

Performance Study

A performance study using FDR data from the accident airplane was completed by a specialist from the NTSB vehicle performance division.

The FDR data showed that airplane pitch slowly increased from about 10° nose-up to 15° nose-up as the airspeed decreased from 146 kts at 1046 MST to 118 kts at 1046:37. At 118 kts, the airplane banked right 83° in two seconds, followed by the flight crew's immediate full left-wing-down control input. The airplane's load factor changed from 1g to about 0.6g at this time. The flight crew also added power to 89% maximum engine rpm at this time and then reduced engine power to 58% before finally advancing power to 100% rpm at 1047:00.

The airplane's stick shaker is set to operate at an indicated airspeed of 7% to 9% above the stall speed. The FDR records the stick pusher through discrete parameters "Stall Valve A" and "Stall Valve B." The pusher is activated if both valves are engaged.

FDR data from the accident and lift coefficient data provided by the airplane manufacturer indicate that the stick shaker activated about 117.5 kts, one knot below the design activation speed for the stick shaker. The stick pusher subsequently activated about 113.5 kts, 3 kts above the stick pusher speed. The performance study determined that the stick shaker and stick pusher triggered at their appropriate speeds based on the airplane weight and load factor. However, the airplane stalled at the same time the stick shaker activated, which provided no warning to the flight crew. The airplane then rolled right and entered an unusual attitude from which the flight crew did not recover.

The study found that the accident stall warning sequence was likely due to a degradation in the relationship between lift and AOA.

Wing Contamination

The NTSB performance study concluded two possible explanations for the degraded lift: ice accretion due to exposure to icing conditions during the accident flight or routine maintenance, as the wing leading edges had recently been removed to facilitate an inspection of the wings and TKS panels. The study noted that the proper reinstallation of the leading edges and panels is critical to wing performance and the reason the manufacturer requires post-maintenance test flights.

Icing Analysis

The National Aeronautics and Space Administration (NASA) Glenn Research Center, Icing Branch, performed an airfoil analysis, meteorological and flight data analysis, and a comparison to existing experimental data to determine the likelihood of the airplane's exposure to icing and the possible effect on performance during the stall test. NASA determined that the Hawker 900XP airfoil was similar in shape and loading (high front loading) to an airfoil they tested in their icing tunnel. The data from these tests showed that even with short exposure (about 2 minutes), the stall angle is reduced by over 6° and the maximum lift coefficient is decreased by about 40%. Thus, the analysis concluded that the accident airplane used a front-loaded airfoil design that is known to be sensitive to leading edge contamination. While the potential icing exposure would have been short, comparative data showed that such an exposure can significantly reduce the maximum coefficient of lift, and the stall angle of attack, which would have posed a significant safety risk during a stall test.

Routine Maintenance

The airplane wings and leading edges were mostly destroyed by postcrash fire. Those areas that remained intact were either significantly damaged or covered in soot.

According to the maintenance facility, after a technician completed an inspection or squawk, an inspector was then brought in to review the work and its surrounding area. The inspector then examined the quality of the work performed and ensured the areas were properly cleaned of any excess sealant, grease, tape, cleaning agents, or tooling. After the airplane was refueled and the ground runs were completed, they performed a pre-delivery inspection in which all areas were given a final inspection that included the fuselage, wings, flight controls, tail assembly, engines, and landing gear.

A work order from the maintenance facility noted that the wing leading edge structural inspection began on January 3, 2024, at which time the TKS panels were also removed. On January 4, 2024, the TKS panels were cleaned and closed except for the left and right No. 2 stall trigger panels. Both the left and right stall trigger TKS lines were found leaking and were re-sealed, along with the installation of new seals on the right and left wing stall trigger TKS lines. The stall trigger work was signed off and inspected on January 11, 2025, and a double inspection was completed 9 days later. On January 18, 2024, the left and right leading edges were prepped and installed on the wings. This installation entry noted that one screw was missing from the right leading edge and that the right TKS proportioning valve had a leaking line. A technician sealed the taped panels and noted that some sealant was required on the leading edges. The structural inspection of the wing leading edges was completed and signed off on January 30, 2024, and both an inspection and double inspection were also endorsed the same day.

In addition, the operator used an internal post/preflight checklist that required a visual inspection of the exterior of the airplane that included the leading edges of the wings and tail.

CAE Simulator Flight

A simulator evaluation was conducted at the commercial training facility responsible for the PIC’s most recent recurrent training and the SIC’s most recent initial training in the accident airplane type. The objective of the evaluation was to document the indications and handling characteristics of the simulator, the stall system procedures from the POM, any control force required to overcome pitching motion, and to capture any audible sounds related to the stall system including the altitude alert and auto-pilot disconnect.

A total of 6 test runs were completed in the simulator in the following configuration and cloud heights:

- Weight: 23,890 lbs
- Fuel: 7,290 lbs
- % MAC: 24

- Outside air temperature: 8°C on ground; dew point -1°C
- Cloud heights: Scattered 6,000 ft above ground level (agl), overcast 10,000 ft agl, tops at 17,000 ft msl.
- Stalls were carried out about 18,000 ft msl

During the test run in icing conditions, ice was simulated as “light” and the following indications were noted: max pitch attitude was 16° nose-up, airspeed at stick shaker was 122 kts, pitch attitude during recovery was 8° nose-up, the roll angle was 0° left/right, and the lowest altitude before the airplane recovered was 17,800 ft msl. It was also noted that after the autopilot and the stick shaker disengaged the stall response from the simulator was subtle. There were also no roll indications throughout the maneuver and the autopilot disconnected at the onset of the stick shaker.

The next test included a stall with the airplane in a clean configuration to demonstrate the stick pusher. During this test the max pitch attitude was 15° nose-up, the airspeed at the stick shaker was 121 kts, the pitch attitude during recovery was 5° nose-down, the roll angle was 0° left/right, the altitude when the shaker activated was 18,000 ft msl, and the lowest altitude before the airplane recovered was 17,100 ft msl. During the test, stall valve A and B illuminated nearly simultaneously. It was also noted that after the autopilot disengaged the stall occurred with the stick pusher at 115 kts. The test pilot noted that the airplane would typically have about a 10° nose-down pitching moment and that the pusher force was representative of the airplane.

Additional Information

Previous Accident (CHI06IA127)

The NTSB conducted an investigation of an incident with similar circumstances that involved a British Aerospace (BAe 125-800A) airplane, which is on the same type certificate as the accident airplane. According to the final report, during a stall test the airplane rolled to the right about 11 kts above the anticipated stick shaker speed and the nose dropped. The flight crew did not unload the airplane by pushing the control yoke forward and the airplane then rolled several times before the flight crew was able to recover the airplane to controlled flight. The investigation determined that the pilot in command failed to maintain control during the initial roll at the onset of the stall due to his improper remedial action related to stall recovery.

Further, the investigation found that the stall was initiated with wing contamination due to icing, which resulted in the stall occurring at a higher-than-anticipated airspeed.

Raytheon Aircraft Company, the type certificate holder at the time of the event, created a 2-page stall training syllabus that the NTSB published in the docket.

Administrative Information

Investigator In Charge (IIC):	Stein, Stephen
Additional Participating Persons:	Patrick Lusch; FAA; Washington, DC Jay Eller; Honeywell; Phoenix, AZ Ricardo Asensio; Textron Aviation; Wichita, KS Dondi Pangalangan; Clay Lacy; Van Nuys, CA Ed Mirzhakanian; Clay Lacy; Van Nuys, CA Allen McReynolds; West Star; Grand Junction, CO
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