Aviation Investigation Final Report

Location:	Chamberlain, South Dakota	**Accident Number:**	CEN20FA022
Date & Time:	November 30, 2019, 12:33 Local	**Registration:**	N56KJ
Aircraft:	Pilatus PC12	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of control in flight	**Injuries:**	9 Fatal, 3 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot and passengers flew in the day before the accident and the airplane remained parked outside on the airport ramp overnight. Light to moderate snow and freezing drizzle persisted during the 12 to 24-hour period preceding the accident. In addition, low instrument meteorological conditions existed at the time of the accident takeoff.

Before the flight, the pilot removed snow and ice from the airplane wings. However, the horizontal stabilizer was not accessible to the pilot and was not cleared of accumulated snow. In addition, the airplane was loaded over the maximum certificated gross weight and beyond the aft center-of-gravity limit. A total of 12 occupants were on board the airplane, though only 10 seats were available. None of the occupants qualified as lap children under regulations.

The takeoff rotation was initiated about 88 kts which was about 4 kts slower than specified with the airplane configured for icing conditions. After takeoff, the airplane entered a left turn. Airspeed varied between 89 and 97 kts during the initial climb; however, it decayed to about 80 kts as the airplane altitude and bank angle peaked. The airplane ultimately reached a left bank angle of 64° at the peak altitude of about 380 ft above ground level. The airplane then entered a descent that continued until impact. The stall warning and stick shaker activated about 1 second after liftoff. The stick pusher became active about 15 seconds after liftoff. All three continued intermittently for the duration of the flight.

A witness located about 1/2-mile northwest of the airport reported hearing the airplane takeoff. It was cloudy and snowing at the time. He was not able to see the airplane but noted that it entered a left turn based on the sound. He heard the airplane for about 4 or 5 seconds and the engine seemed to be “running good” until the sound stopped.

The airplane impacted a dormant corn field about 3/4-mile west of the airport. A postaccident airframe examination did not reveal any anomalies consistent with a preimpact failure or

malfunction. On board recorder data indicated that the engine was operating normally at the time of the accident.

An airplane performance analysis indicated that the accumulated snow and ice on the empennage did not significantly degrade the airplane performance after takeoff. However, the effect of the snow and ice on the airplane center-of-gravity and the pitch (elevator) control forces could not be determined. Simulations indicated that the pitch oscillations recorded on the flight could be duplicated with control inputs, and that the flight control authority available to the pilot would have been sufficient to maintain control until the airplane entered an aerodynamic stall about 22 seconds after lifting off (the maximum bank angle of 64° occurred after the critical angle-of-attack was exceeded). In addition, similar but less extreme pitch oscillations recorded on the previous flight (during which the airplane was not contaminated with snow but was loaded to a similar center-of-gravity position) suggest that the pitch oscillations on both flights were the result of the improper loading and not the effects of accumulated snow and ice.

Flight recorder data revealed that the accident pilot tended to rotate more rapidly and to a higher pitch angle during takeoff than a second pilot who flew the airplane regularly. Piloted simulations suggested that the accident pilot's rotation technique, which involved a relatively abrupt and heavy pull on the control column, when combined with the extreme aft CG, heavy weight, and early rotation on the accident takeoff, contributed to the airplane's high angle-of attack immediately after rotation, the triggering of the stick shaker and stick pusher, and the pilot's pitch control difficulties after liftoff. The resulting pitch oscillations eventually resulted in a deep penetration into the aerodynamic stall region and subsequent loss of control.

Although conditions were conducive to the development of spatial disorientation, the circumstances of this accident are more consistent with the pilot's efforts to respond to the activation of the airplane stall protection system upon takeoff. These efforts were hindered by the heightened airplane pitch sensitivity resulting from the aft-CG condition. As a result, spatial disorientation is not considered to be a factor in this accident.

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 shortly after takeoff, which resulted in an inadvertent, low-altitude aerodynamic stall. Contributing to the accident was the pilot's improper loading of the airplane, which resulted in reduced static longitudinal stability and his decision to depart into low instrument meteorological conditions.

Findings

Personnel issues	Aircraft control - Pilot
Aircraft	Angle of attack - Capability exceeded
Personnel issues	Decision making/judgment - Pilot
Aircraft	Maximum weight - Capability exceeded
Aircraft	CG/weight distribution - Capability exceeded
Environmental issues	Low visibility - Effect on operation

Factual Information

History of Flight

Initial climb	Loss of control in flight (Defining event)
Initial climb	Aerodynamic stall/spin
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On November 30, 2019, at 1233 central standard time, a Pilatus PC-12/47E airplane, N56KJ, was destroyed when it was involved in an accident near Chamberlain, South Dakota. The pilot and 8 passengers were fatally injured, and three passengers were seriously injured. The airplane was operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The pilot and passengers flew to Chamberlain Municipal Airport (9V9) the day before the accident, arriving about 0927. The airplane then remained parked outside on the ramp.

A representative of a local lodge reported that the pilot and passengers stayed overnight. The morning of the accident, the pilot and one passenger stayed back while everyone else went hunting. The representative took the pilot and passenger to the airport to check on the airplane. The pilot thought there would be favorable weather between 1130 and 1430. They took a ladder from the lodge and stopped at a local hardware store to buy isopropyl alcohol. The pilot and passenger worked for about 3 hours to remove the snow and ice that had accumulated on the airplane overnight. The representative noted that the ladder they brought from the lodge was approximately 7 feet tall and did not reach to the top of the tail on the airplane. The pilot stated that they needed to get home, that the airplane was 98% good, and the remaining ice would come off during takeoff. The lodge representative recalled that it was snowing hard at the time the pilot took off.

At 1224, the pilot contacted Minneapolis Air Route Traffic Control Center (ARTCC) and requested an instrument flight rules (IFR) clearance from 9V9 to Idaho Falls Regional Airport (IDA). The pilot advised he planned to depart from runway 31 and would be ready in 5 minutes. At 1227, Minneapolis ARTCC issued an IFR clearance to the pilot with a void time of 1235. No radio communications were received from the pilot, and radar contact was never established.

Data recovered from the Lightweight Data Recorder (LDR) installed on the airplane revealed that the accident takeoff began from runway 31 at 1231:58. The airplane lifted off 30 seconds later and immediately entered a left turn. Initial airplane bank angles varied from 10°left wing down to 5° right wing down. Ultimately, the airplane reached a bank angle of 64° left wing down at the airplane's peak altitude of approximately 380 ft agl. The airplane then entered a descent that continued until impact. The airspeed varied between 89 and 97 kts during the initial climb; however, it decayed to about 80 kts as the airplane altitude and bank

angle peaked. The stall warning and stick shaker became active approximately 1 second after liftoff. The stick pusher became active about 15 seconds after liftoff. All three continued intermittently for the duration of the flight.

A witness located about ½ mile northwest of the airport reported hearing the airplane takeoff. It was cloudy and snowing at the time. He was not able to see the airplane but noted that it entered a left turn based on the sound. He heard the airplane for about 4 or 5 seconds and the engine seemed to be "running good" until the sound stopped.

The property owner discovered the accident site about 1357.

Pilot Information

Certificate:	Private	**Age:**	48,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	January 17, 2019
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	November 29, 2018
Flight Time:	2314 hours (Total, all aircraft), 1274 hours (Total, this make and model), 10 hours (Last 90 days, all aircraft), 2 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Pilatus	**Registration:**	N56KJ
Model/Series:	PC12 47E	**Aircraft Category:**	Airplane
Year of Manufacture:	2013	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1431
Landing Gear Type:	Retractable - Tricycle	**Seats:**	10
Date/Type of Last Inspection:	November 14, 2019 Annual	**Certified Max Gross Wt.:**	10450 lbs
Time Since Last Inspection:	17.4 Hrs	**Engines:**	1 Turbo prop
Airframe Total Time:	1725 Hrs as of last inspection	**Engine Manufacturer:**	Pratt & Whitney Canada
ELT:	C126 installed, activated	**Engine Model/Series:**	PT6A-67P
Registered Owner:	On file	**Rated Power:**	1200 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The airplane was approved for day/night operations under visual and instrument flight rules, including flight into known icing conditions. The accident airplane was configured with two flight crew seats and eight passenger seats (a total of ten seats). However, twelve individuals were on board during the accident flight and none of them qualified as lap children (less than 2 years of age) under Federal Aviation Administration (FAA) regulations.

An estimated weight & balance calculation for the accident flight indicated that the airplane was about 107 lbs. over the approved maximum gross weight. Center of gravity (CG) calculations indicated that the airplane was loaded 3.99 inches to 5.49 inches beyond the aft CG limit. The CG range was estimated assuming the unseated occupants and baggage were either all in the forward cabin (most forward CG) or the aft cabin (most aft CG). In any case, the actual CG was located within 12.76 inches of the aft CG limit due to the location of the main landing gear and because the airplane was stable on the ramp. If the actual CG was located aft of the main landing gear pivot point, the airplane would have tended to tip back on its tail.

An image study of photos and video footage revealed accumulated precipitation, presumably snow, on the upper surface of the horizontal stabilizer and on the vertical stabilizer with icicles present on the horizontal stabilizer bullet fairing with the airplane parked on the airport ramp and as it began to taxi before the accident takeoff.

According to the airplane flight manual, the specified takeoff rotation speed at maximum gross weight in icing conditions was 92 kts.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	9V9,1696 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	12:35 Local	**Direction from Accident Site:**	90°
Lowest Cloud Condition:		**Visibility**	0.5 miles
Lowest Ceiling:	Overcast / 500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots / 0 knots	**Turbulence Type Forecast/Actual:**	Terrain-Induced / Terrain-Induced
Wind Direction:	20°	**Turbulence Severity Forecast/Actual:**	Moderate / Unknown
Altimeter Setting:	29.3 inches Hg	**Temperature/Dew Point:**	1°C / 1°C
Precipitation and Obscuration:	Moderate - None - Snow		
Departure Point:	Chamberlain, SD (9V9)	**Type of Flight Plan Filed:**	IFR
Destination:	Idaho Falls, ID (IDA)	**Type of Clearance:**	IFR
Departure Time:	12:32 Local	**Type of Airspace:**	Class G

Observations indicated that winter weather had persisted for 12 to 24 hours in the vicinity of the accident site. Light to moderate snow, freezing drizzle, and mist occurred throughout the night and morning with 2.1 inches of accumulated snow from 0730 the day before the accident until 0730 on the morning of the accident. Surface observations indicated low instrument flight rules (LIFR) conditions existed about the time of the accident. The observation taken at 1215 noted light snow; however, moderate snow was observed at 1235. Atmospheric sounding data indicated that moderate or greater airframe icing conditions were likely from the surface to 11,500 ft mean sea level.

Airman Meteorological Information (AIRMET) advisories for moderate turbulence, moderate icing conditions, and instrument flight rules (IFR) conditions due to precipitation, mist, fog, and blowing snow were in effect at the time of the accident.

The pilot's most recent preflight weather briefing was obtained at 1204. It included current surface observations (METARs), pilot reports (PIREPs), and terminal aerodrome forecasts (TAF). The pilot did not request the current AIRMET information as part of the briefing.

The airport manager reported that he was plowing snow at the airport beginning about 0830 and estimated that up to 2 inches had fallen over the past 24 to 36 hours. In his opinion, the weather seemed to be deteriorating at the time of the accident.

Airport Information

Airport:	Chamberlain Muni 9V9	**Runway Surface Type:**	Asphalt
Airport Elevation:	1696 ft msl	**Runway Surface Condition:**	Snow
Runway Used:	31	**IFR Approach:**	None
Runway Length/Width:	4299 ft / 75 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	8 Fatal, 3 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	9 Fatal, 3 Serious	**Latitude, Longitude:**	43.765556,-99.337219

The accident site was located approximately 3/4 mile west of the airport in a dormant corn field. The debris path was approximately 85 ft long and oriented on a 179° heading. The engine was separated from the firewall. The left wing was separated from the fuselage at the root. The engine and left wing were both located in the debris path. The main wreckage consisted of the fuselage, right wing, and empennage.

A postaccident airframe examination did not reveal any anomalies consistent with a preimpact failure or malfunction. The examination revealed the wing flaps were set at 15° and the landing gear was retracted at the time of impact. The trim system – aileron, elevator, rudder – was set within the specified takeoff range. Data recovered from the LDR revealed the recorded engine parameters were consistent with the engine producing rated takeoff power. No indications of an engine anomaly were observed in the data.

Medical and Pathological Information

Toxicology testing performed at the FAA Forensic Sciences Laboratory found no drugs of abuse.

Tests and Research

An airplane performance study which utilized both computer-driven ("desktop") simulations and piloted simulations in an FAA-approved PC-12 Level D full flight simulator (FFS) was completed by the NTSB. The simulations indicated that the flight control authority available to the pilot was sufficient to maintain control until the airplane entered an aerodynamic stall about 22 seconds after lifting off. The maximum bank angle of about 64° occurred after the critical angle-of-attack was exceeded. Furthermore, the simulations did not reveal any significant airplane performance degradation resulting from the residual snow and ice on the empennage. Although, the effects of these accumulations on the airplane CG and airflow over the horizontal stabilizer (which could have affected the elevator hinge moments and column forces) are unknown.

Airplane loading on the previous day's flight from IDA to 9V9 was likely similar to the accident flight (heavy weight and extreme aft CG). LDR data revealed the takeoff from IDA involved a rotation pitch rate of approximately 4.3°/sec, a pitch angle above the 9° flight director target, and pitch oscillations that may have been due to decreased stability and light column forces. A review of previous takeoffs known to have been flown by the accident pilot revealed similar rotation pitch rates and pitch angles beyond 9°. The accident takeoff pitch angle was initially 11.8°, where it paused for less than 1 second before continuing to 15.8°. Rotation was initiated about 88 kts, which was about 4 kts slower than that specified for takeoff at maximum gross weight in icing conditions.

A comparison of LDR data revealed differences in the takeoff rotation technique between the accident pilot and another pilot that flew the airplane. Takeoffs performed by the second pilot employed takeoff rotation pitch rates of 3°/sec and a lower initial pitch angle of 5° before gradually increasing to 9°.

The piloted simulations conducted in the Level D FFS suggested that the accident pilot's rotation technique, which involved a relatively abrupt and heavy pull on the column, when combined with the extreme aft CG, heavy weight, and early rotation on the accident takeoff, contributed to the airplane's high angle-of-attack immediately after rotation, the triggering of the stick shaker and stick pusher, and the pilot's pitch control difficulties. The resulting pitch oscillations eventually resulted in a deep penetration into the stall region and subsequent loss of control. The FFS participants found the takeoff much easier to control using a rotation technique that involved lower pitch rates and angles than the technique used by the accident pilot.

Administrative Information

Investigator In Charge (IIC):	Sorensen, Timothy
Additional Participating Persons:	Eric West; FAA Accident Investigation; Washington, DC Martin Pohl; Swiss Transportation Safety Board; Payerne Markus Kohler; Pilatus Aircraft Ltd; Stans
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