National Transportation Safety Board
Aviation Accident Final Report

Location:	Fargo, North Dakota	**Accident Number:**	CEN19LA039
Date & Time:	November 30, 2018, 13:53 Local	**Registration:**	N941JM
Aircraft:	Cessna 550	**Aircraft Damage:**	Substantial
Defining Event:	Aerodynamic stall/spin	**Injuries:**	9 Minor, 2 None
Flight Conducted Under:	Part 91: General aviation		

Analysis

The commercial pilot was conducting a cross-country, business flight with 10 passengers onboard the 8-passenger airplane. He reported that air traffic control cleared the flight for an instrument landing system (ILS) approach to the runway. While descending, the airplane entered instrument meteorological conditions (IMC) at 3,100 ft mean sea level (msl), and ice started to accumulate on the wing's leading edges, empennage, and windshield. The pilot activated the pneumatic deice boots multiple times during the approach and slowed the airplane to 120 knots. The airplane then exited the clouds about 400 ft above ground level (agl), and the pilot maintained 120 knots as the airplane flew over the airport fence; all indications for landing were normal. About 100 ft agl, the airplane started to pull right. He applied left correction inputs, but the airplane continued to pull right. He applied engine power to conduct a go-around, but the airplane landed in grass right of the runway, sustaining damage to the wings and landing gear. Witnesses and passengers reported that the airplane stalled.

During examination of the airplane immediately after the accident, about 1/2 to 1 inch of mixed ice was found on the right wing's leading edge, the vertical and horizontal stabilizers, and the angle of attack probe. Ice was also observed on the windshield. The flaps were found in the "up" position. Flight control continuity was established.

Although the airplane was originally certificated for two-pilot operation, the pilot was flying the airplane under a single-pilot exemption. The pilot received a logbook endorsement indicating that he had received single-pilot training and was properly qualified under the single-pilot exemption. However, he had not met the turbine flight time qualifications (1,000 hours) to be properly authorized to conduct the flight under the single-pilot exemption because he only had 500 hours.

A review of cockpit voice recorder information indicated that, although the pilot verbalized that the landing gear was "all green," followed by stating "check, check, check," he did not verbalize all the approach or landing checklist items nor did he make any audible comments about activating the pneumatic deice boots or windshield anti-ice.

A review of radar data for the flight indicated that, during the last 2 minutes of flight, while the airplane was on final approach to the runway, the indicated airspeed got as low as 99 knots. The last recorded radar return indicated that the airplane had an airspeed of 104 knots at 900 ft msl. The pilot's lack of minimum flight experience required to fly the airplane without a copilot likely led to task saturation as he flew the airplane entered IMC and icing conditions while on an ILS approach. He subsequently failed to lower the flaps during the approach, which resulted in a no-flap approach instead of a full-flap landing. The ice on the leading edges of the wings, the no-flap approach, and the low airspeed likely led to the exceedance of the airplane's critical angle of attack, which resulted in an aerodynamic stall.

Probable Cause and Findings

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

The pilot's failure to lower the flaps during the approach and maintain sufficient airspeed while flying in instrument meteorological and icing conditions and the accumulation of ice on the wings' leading edges, which resulted in the exceedance of the airplane's critical angle of attack and subsequent aerodynamic stall. Contributing to the accident was the pilot's lack of proper qualification to operate the airplane under a single-pilot exemption due to his lack of total turbine time, which led to task saturation and his failure to properly configure the flaps for landing.

Findings

Aircraft	Configuration - Incorrect use/operation
Aircraft	Airspeed - Not attained/maintained
Aircraft	Angle of attack - Capability exceeded
Personnel issues	Use of equip/system - Pilot
Environmental issues	Conducive to structural icing - Effect on operation
Personnel issues	Qualification/certification - Pilot
Personnel issues	Task overload - Pilot

Factual Information

HISTORY OF FLIGHT

On November 30, 2018, about 1353 central standard time, a Cessna 550, N941JM, departed controlled flight and impacted terrain while on approach at the Hector International Airport (FAR), Fargo, North Dakota. The pilot and one of the passengers were not injured, and 9 passengers received minor injuries. The airplane sustained substantial damage. The airplane was registered to Slice of the 406 LLC and operated by the pilot under the provisions of the Title 14 *Code of Federal Regulations* Part 91 as a business flight. Instrument meteorological conditions prevailed at the time of the accident and the flight was operating on an instrument flight plan. The flight departed from the Sloulin Field International Airport (ISN), Williston, North Dakota, about 1250 with FAR as the destination.

The pilot reported that after departure, the flight was cleared direct as filed on the instrument flight plan. He obtained the destination weather when the flight was 100 nautical miles (nm) and 30 nm from FAR. Air traffic control (ATC) provided radar vectors to the inbound course for the FAR ILS RWY 18 approach and subsequently cleared the flight for the approach. He stated that he completed the approach checklist, activated the deicing equipment, and started a descent to 2,500 ft mean sea level (msl). The airplane was about 10 nm from FAR when it entered a layer of clouds, which were at 3,100 ft msl, at an airspeed of 160 kts. He stated that ice started to accumulate on the wings, so he activated the de-ice boots. While inbound to FAR from the final approach fix, he switched the radio to the tower frequency, maintained 140 kts airspeed, completed the landing checklist, and was cleared to land. He reported that he activated the de-ice boots several times on the approach and slowed the airplane to 120 kts airspeed for the final approach. The airplane exited the clouds at 400 ft above ground level (agl), and it was right of centerline with the airport and runway in sight. He reported that he turned the autopilot and yaw damper off, corrected to the left to line up with the centerline, and maintained 120 kts airspeed over the airport fence. He stated that all indications were normal for landing. He stated that at approximately 100 ft agl, the airplane started to pull to the right. He applied left corrective control inputs, but the airplane continued to pull to the right. He applied engine power to perform a go-around, but the airplane landed in the grass just right of runway 18. He shut the engines down, turned the battery off, and conducted an emergency evacuation through the main cabin door.

A witness, who observed the accident from his office window which faced the approach threshold for runway 18, reported that he "watched the airplane fall out of the sky." He explained that he saw the wings slowly "fluttering" back and forth and recognized that the airplane was about to stall from an altitude of 130 to 140 ft agl. He said the airplane's nose pitched up and then the right wing went down. He could see the belly of the airplane and he estimated that the angle of bank was possibly 80°.

Another witness said that he saw the airplane as it was on final approach over the runway threshold. He said the airplane looked "odd." The airplane was over the runway, but it was 30 – 50 ft high. He said it was way too high for the flare. The nose was high and then it leveled off. Then the nose rose up and the wings started "waffling" and was about to stall. The right wing dropped and hit the ground about 2 seconds later. He estimated that the angle of bank was about 40°.

The passenger, who was sitting in the right seat of the cockpit, reported that the airplane started to take on ice on the windshield and the deicing boot on the right wing while they were on the approach in the clouds. He reported that the approach was normal until they neared the ground when the tail started "fish tailing." He saw the pilot push the throttles forward; however, the left wing climbed and the airplane "pulled hard to the right." The airplane impacted the ground on its right wing and then impacted back on its belly.

The passenger who was sitting on the couch directly behind the copilot's seat reported that the airplane was in the clouds for about 15 minutes and she saw ice forming on the windshield. When they were about to land, she said the pilot had the control wheel all the way toward him. She did not see any lights or hear any "bells," but she did see the pilot holding the control yoke as hard as he could and as close to his chest as he could. She said his arms were shaking because he was pulling back so hard. She said the pilot said an expletive, and then the airplane crashed seconds later.

PERSONNEL INFORMATION

The 41-year-old pilot held a commercial pilot certificate with single-engine land, multi-engine land, and airplane instrument ratings. He held a second-class airman medical certificate that was issued on July 12, 2018 with no limitations. The pilot reported that he had a total of 1,513 flight hours with 263 hours in a Cessna 550, and a total turbine time of 432.9 hours

The pilot's flight logbook indicted that he passed his commercial, multi-engine check ride on July 31, 2016, when he had a total of 479.1 flight hours. On May 11, 2017, he passed a check ride in a Cessna 550 when he had a total of 1,071.8 flight hours with 69.6 hours of turbojet time and 85.1 hours of turboprop time. On June 28, 2018, he passed the Pilot Proficiency Check 14 CFR 61.58 check ride for single-pilot operation in a Cessna 550 when he had a total of 1,420.5 flight hours with 257.5 hours of turbojet time and 85.1 hours of turboprop time.

Single-pilot Exemption

The logbook entry for single-pilot exemption #9917 stated that the pilot, "… has met all requirements for FAA exemption No. 9917 published at docket No. FAA-2009-0373, received training and review of the Practical Test Standards listed in FAA-S-8081-5F, and has completed the FAA Approved Training Course by 'VUE, Inc.'"

The pilot received single-pilot exemption training through VUE, Inc., the company which held the Exemption No. 9917. The exemption was from FAR 91.9 (a), and 91.531 (a) (1) and (2) of Title 14, *CFR* to the extent possible to allow VUE to train and check pilots of certain Cessna Citation airplanes covered by the CE-500 type rating to operate those airplanes with a single pilot, rather than with two as required by their type certificate sheets, subject to certain conditions and limitations.

One of the pilot requirements was that the pilot must have logged at least 1,000 hours of total pilot flight time, including at least 50 hours of night flight time; 75 hours of instrument flight time; 40 hours of which are in actual instrument meteorological conditions; and 500 hours as pilot-in-command (PIC), second-in-command (SIC), or both, in turbine-powered airplanes.

A review of the pilot's flight logbook indicated that he had less than 500 hours as PIC or SIC in turbine-powered aircraft which was required to exercise the single-pilot exemption.

AIRCRAFT INFORMATION

The Cessna 550 is a low-wing airplane powered by two Pratt & Whitney Canada JT-15B-4 turbofan engines which produced 2,500 lbs of thrust each. It is equipped with straight wings with integral wet-wing fuel tanks, a conventional tail, and retractable tricycle landing gear. The accident airplane was manufactured in 1980 and had a seating capacity of seven passengers and two pilots and had a maximum gross weight was 13,500 lbs.

According to the *Cessna Citation Model 500 Airplane Flight Manual* (AFM), the airplane was originally certificated under 14 CFR Part 25, which requires that a two-pilot crew operate the airplane. However, the FAA subsequently allowed for certain exemptions, including the VUE, Inc. No.9917 exemption, which allowed for single-pilot operation of the CE-500 and other specific airplanes.

A Federal Aviation Administration (FAA) inspector reported that according to the airplane's maintenance records, in 1986, two of the regular forward-facing passenger seats were removed from the cabin and replaced with a 3-person couch. The installation of the couch was installed without approved data for the accident airplane. During the accident, the cable for the seat belt attachment for the mid and aft passenger failed during ground impact.

The FAA inspector also reported that the factory installed toilet seat (and bench that covered the toilet seat) was a non-belted seat. It was not designed to be used as a passenger seat during takeoffs and landings. The seat belt installation for the toilet seat on the accident airplane was not approved and did not meet FAR Part 25 requirements.

During the accident flight, one of the passengers was sitting in the copilot's seat, 5 passengers were sitting in the originally installed cabin passenger seats, 3 passengers were sitting on the side facing couch located on the right, front side of the cabin, and 1 passenger was sitting on the bench which was over the toilet seat located in the rear of the cabin. All the passengers were wearing the seatbelts that were provided with the seats.

The Cessna 550 AFM had the following description of the airplane's stall warning system:

"Stall warning is achieved aerodynamically, aided by stall strips on the inboard section of each wing. The strips disrupt airflow over the wing, causing that area to stall first accentuating prestall buffet. The pilot is alerted to impending stall by aerodynamic buffeting which occurs at approximately VS1 + 10 in the clean configuration and VS0 + 5 in the landing configuration."

The airplane was also equipped with an optional Teledyne Angle-of-Attack System. The Supplement to the AFM stated that "the angle-of-attack system can be used as a reference for approach speed (1.3 VS1) at all airplane weights and center-of-gravity locations at zero, takeoff/approach, and landing flap positions.

Flaps

The airplane had three flaps settings: Flaps UP, Takeoff and Approach (T.O. & APPR), and LAND. The Before Landing checklist found in the Cessna Citation II Operating Manual's Performance Section states that the flaps should be extended to the T.O. & APPR below 202 knots indicated airspeed (KIAS) and to

verify the flap indicator position during the approach. Prior to landing, the manual states that the flaps LAND should be selected. The manual states:

"Flaps may be extended to T.O. & APPR below 202 KIAS and LAND below 176 KIAS. Should be in LAND position for all normal landings. Check indicator to verify position. Handle must be pushed in to clear T.O. & APPR detent when LAND flaps are desired."

The manual further states:

"After passing the instrument approach fix outbound or nearing the airport traffic area, airspeed should be reduced below 202 KIAS and the flaps extended to the APPR (15°) position. Approaching the final instrument fix inbound (one dot from glideslope intercept, on an ILS), or a downwind abeam position, extend the landing gear below 176 KIAS. At the point where final descent to landing is begun, extend FULL flaps, establish the desired vertical rate, and adjust power to maintain VREF to V_{REF} + 10 KIAS indicated airspeed."

The Cessna AFM Performance section indicated that at a gross weight of 12,100 lbs, the V_{REF} speed was about 106 KIAS. The landing performance charts are predicated on full flaps (LAND).

Ice Protection

The Cessna 550 Citation II was equipped with an anti-ice system to prevent ice on the windshield and a separate de-ice system that provided for removal of ice on the leading edge of the wing and tail by pneumatically expanding boots.

METEOROLOGICAL INFORMATION

At 1353, FAR reported a wind at from 200° at 10 knots, visibility of 5 statute miles, mist, ceiling overcast at 400 feet above ground level, temperature of -1° Celsius (C) and a dew point temperature of -1°C, altimeter setting of 29.91 inches of mercury; remarks: station with a precipitation discriminator, sea level pressure of 1014.2 hectopascals (hPa), temperature of -1.1°C and a dew point temperature of -1.1°C.

The Terminal Aerodrome Forecast (TAF) issued at 1133 CST for FAR forecasted for the accident time: a variable wind at 6 knots, visibility of 5 statute miles, mist, ceiling overcast at 300 feet agl.

At 0845 CST, an AIRMET ZULU was issued for moderate icing below 10,000 feet.

Images provided by the National Center for Atmospheric Research included the Current Icing Potential (CIP) and the Forecast Icing Potential (FIP) valid between 1300 and 1400 CST. Both the CIP and FIP indicated a 60% to 70% chance of light icing below 3,000 ft mean sea level (msl) in the vicinity of the accident. In addition, about 30 minutes after the accident, the pilot of a Citation Excel at 3,000 ft and close to FAR reported overcast skies and moderate rime ice with a temperature of -2°C. See the NTSB Meteorology Weather Study for more details about the accident weather conditions.

FLIGHT RECORDERS

Multiple Electronic Devices Examination

The National Transportation Safety Board's (NTSB) Vehicle Recorders Division examined the following electronic devices: 1) Sandel ST3400 Terrain Awareness Warning System, 2) Honeywell KLM 900, 3) Garmin AT MX20 Chart View. The data downloaded from the devices did not have pertinent data concerning the accident airplane while it was flying the ILS RWY 18 approach to FAR.

Cockpit Voice Recorder

The airplane was equipped with a Fairchild GA-100 cockpit voice recorder (CVR) designed to record 30 minutes of analog audio, including channels for each flight crewmember and the cockpit area microphone, on a continuous loop tape. The magnetic tape was retrieved from the crash-protected case and was successfully read out. A CVR group was not convened, and a summary of the recording was made and is included with the docket material associated with this investigation.

The summary CVR report indicated that the pilot did not verbalize out loud the approach and landing checklist responses. Approximately 45 seconds after ATC instructed the pilot to switch to the tower frequency and subsequently cleared to land on runway 18, the CVR recorded a sound consistent with landing gear extension and a voice stating, "all green." The pilot responded, "check, check, check," followed by the "outer marker, four miles." There was no other indication on the CVR that the pilot verbalized any checklist items, nor did the pilot make any audible comments about activating the pneumatic de-ice boots or windshield anti-ice.

Flight Data Recorder

The airplane was not equipped, and was not required to be equipped, with a flight data recorder.

WRECKAGE AND IMPACT INFORMATION

The examination of the accident site revealed that the airplane's right wingtip impacted the right edge of runway 18. After the initial impact, the airplane bounced and skidded on the grass infield for about 635 ft before coming to a stop resting on its belly. There was no ground fire. Immediately after the accident, about ½ - 1 inch of mixed ice was found on the leading edge of the right wing, vertical stabilizer, horizontal stabilizer, and the angle of attack (AOA) probe. Ice was also observed on the windshield. The ice accretion found on the leading edge of the vertical stabilizer was the same size and shape on the de-icing boots as that of the ice on the unprotected surfaces.

The initial examination of the airplane revealed that the right wing's outboard section was pushed up and aft. The nose wheel landing gear assembly was bent to the right, and the nose wheel trunnion assembly was broken in two pieces. The nose wheel assembly was separated from the fuselage with part of the trunnion attached to the wheel assembly. The left main landing gear was found folded into the gear wheel well, and the landing gear components were pushed upwards through the upper wing surface above the gear well. The left and right pitot tubes located on the left and right side of the nose of the airplane were broken. The AOA probe on the right side of the fuselage was intact; however, the operation of the AOA's heat element could not be verified when tested. The wing flaps were found in the up (0.0 degrees) position. The limited damage to the bottom surface or trailing edge of the flaps was consistent with the flaps being in the UP position. The examination of the cockpit revealed that the flap handle was found in the LAND (down) position, but the flap indicator was found in the UP position.

FAA inspectors examined the wreckage to verify the flap position based on the cable and drive chain position. The number of chain links visible confirmed that the flaps were in the full up position at the time of the accident. Both primary and secondary cables for the left and right flaps were both in the same position and the cables and surrounding structure did not show signs of damage. The continuity of the flap indicator cable was confirmed.

TESTS AND RESEARCH INFORMATION

NTSB Radar Performance Study

The NTSB Vehicle Performance Division conducted a radar performance study of the accident flight. Radar track data indicated that the airplane approached FAR from the west and was receiving vectors from air traffic control to capture the instrument landing system (ILS) signal for runway 18. The airplane encountered icing conditions for about 9 - 10 minutes while it was flying the ILS approach. The radar data indicated that during the last 2 minutes while the airplane was on final approach to the runway, the indicated airspeed was as low as 99 kts. The last radar return recorded indicated 104 kts airspeed and was at an altitude of 900 ft msl, the same as the touchdown zone elevation for runway 18.

The radar study included a simulation using models that were used to match altitude and position data from radar. The simulation indicated that during the last 2 minutes of flight, the angle-of-attack (AOA) approached angles very close to the stall AOA, and the AOA momentarily exceeded the linear portion of the Cessna 550 "no-ice" lift curve with flaps in the retracted position. When the lift coefficient was reduced by 5% to model the effect of ice accretions on the airplane's wings in the simulation, the AOA with the lift reduction was consistently into the non-linear portion of the no-ice lift curve for the last 30 seconds of flight.

ADDITIONAL INFORMATION

Operational Control of the Flight

FAA inspectors interviewed the passengers of the accident flight to determine who had operational control of the airplane. The passenger who made the flight arrangements reported that he contacted the pilot via text message and made all the arrangements for the flight with the pilot. He stated that the pilot was responsible for operation of the flight, to include fuel, maintenance, pilot qualifications and weather. He stated that the pilot was the single source provider for the flight. He was not informed that it was a charter flight, or that there was a separate lease for the airplane and for the pilot services. The passenger stated that he would be billed for the flight, and then he would sub-bill the cost of the flight to the other parties (passengers).

History of Flight

Approach-IFR final approach	Other weather encounter
Approach-IFR final approach	Aerodynamic stall/spin (Defining event)
Approach-IFR final approach	Loss of control in flight

Pilot Information

Certificate:	Commercial	**Age:**	41,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	3-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	July 12, 2018
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	September 2, 2018
Flight Time:	1513 hours (Total, all aircraft), 263 hours (Total, this make and model), 649 hours (Pilot In Command, all aircraft), 57 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N941JM
Model/Series:	550 No Series	**Aircraft Category:**	Airplane
Year of Manufacture:	1980	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	550-0146
Landing Gear Type:	Retractable - Tricycle	**Seats:**	11
Date/Type of Last Inspection:	March 23, 2017 Continuous airworthiness	**Certified Max Gross Wt.:**	13500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo jet
Airframe Total Time:	7180 Hrs as of last inspection	**Engine Manufacturer:**	Pratt & Whittney
ELT:	Installed	**Engine Model/Series:**	JT 15B-4
Registered Owner:		**Rated Power:**	2500 Lbs thrust
Operator:	On file	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument (IMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	FAR,901 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	13:53 Local	**Direction from Accident Site:**	0°
Lowest Cloud Condition:		**Visibility**	5 miles
Lowest Ceiling:	Overcast / 400 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	200°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.9 inches Hg	**Temperature/Dew Point:**	-1°C / -1°C
Precipitation and Obscuration:	N/A - None - Mist		
Departure Point:	Williston, ND (ISN)	**Type of Flight Plan Filed:**	IFR
Destination:	Fargo, ND (FAR)	**Type of Clearance:**	IFR
Departure Time:	12:50 Local	**Type of Airspace:**	

Airport Information

Airport:	Hector International FAR	**Runway Surface Type:**	Concrete
Airport Elevation:	901 ft msl	**Runway Surface Condition:**	Wet
Runway Used:	18	**IFR Approach:**	ILS
Runway Length/Width:	9001 ft / 150 ft	**VFR Approach/Landing:**	Full stop

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	9 Minor, 1 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	9 Minor, 2 None	**Latitude, Longitude:**	46.920555,-96.815834(est)

Administrative Information

Investigator In Charge (IIC):	Silliman, James
Additional Participating Persons:	Robert Laux; FAA Fargo FSDO; Fargo , ND Henry Soderlund; Textron Aviation; Wichita, KS
Original Publish Date:	April 13, 2020
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=98729