# National Transportation Safety Board
# Aviation Accident Final Report

| | | | |
|---|---|---|---|
| **Location:** | BARROW, AK | **Accident Number:** | ANC98MA008 |
| **Date & Time:** | 11/08/1997, 0808 AST | **Registration:** | N750GC |
| **Aircraft:** | Cessna 208B | **Aircraft Damage:** | Destroyed |
| **Defining Event:** | | **Injuries:** | 8 Fatal |
| **Flight Conducted Under:** | Part 135: Air Taxi & Commuter - Scheduled | | |

## Analysis

The pilot, who was also the station manager, arrived at the airport earlier than other company employees to prepare for a scheduled commuter flight, transporting seven passengers and cargo to another village during hours of arctic, predawn darkness. Heavy frost was described on vehicles and airplanes the morning of the accident, and the lineman who serviced the airplane described a thin glaze of ice on the upper surface of the left wing. The pilot was not observed deicing the airplane prior to flight, and was described by the other employees as in a hurry to depart on time. The pilot directed the lineman to place fuel in the left wing only, which resulted in a fuel imbalance between 450 and 991 pounds (left wing heavy). The first turn after takeoff was into the heavy left wing. The airplane was observed climbing past the end of the runway, and descending vertically into the water. No preimpact mechanical anomalies were found with the airplane or powerplant. The aileron trim indicator was found in the full right wing down position. Postaccident flight tests with left wing heavy lateral fuel imbalances, disclosed that approximately one-half of right wing down aileron control deflection was used to maintain level flight, thus leaving only one-half right wing down aileron control efficacy. Research has shown that frost on airfoils can result in reduced stall angles of attack (often below that required to activate stall warning devices), increases in stall speeds between 20% and 40%, asymmetric stalls resulting in large rolling moments, and differing stall angles of attack for wings with upward and downward deflected ailerons (as when recovering from turns).

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's disregard for lateral fuel loading limits, his improper removal of frost prior to takeoff, and the resulting inadvertent stall/spin. Factors involved in this accident were the improper asymmetrical fuel loading which reduced lateral aircraft control, the self-induced pressure to takeoff on time by the pilot, and inadequate surveillance of the company operations by company management.

## Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: TAKEOFF - INITIAL CLIMB

Findings
1. (F) FLUID,FUEL - ASYMMETRICAL
2. (F) REFUELING - IMPROPER - PILOT IN COMMAND
3. (C) AIRCRAFT WEIGHT AND BALANCE - DISREGARDED - PILOT IN COMMAND
4. (F) AIRCRAFT CONTROL - REDUCED
5. (C) STALL/SPIN - INADVERTENT - PILOT IN COMMAND
6. (C) ICE/FROST REMOVAL FROM AIRCRAFT - IMPROPER - PILOT IN COMMAND
7. (F) SELF-INDUCED PRESSURE - PILOT IN COMMAND
8. (F) INADEQUATE SURVEILLANCE OF OPERATION - COMPANY/OPERATOR MGMT
---

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

## Factual Information

HISTORY OF FLIGHT

On November 8, 1997, at 0808 Alaska standard time, a Cessna 208B airplane, N750GC, was destroyed when it impacted water in the Arctic Ocean, about one-half mile west of Barrow, Alaska. The airline transport certificated pilot, and the seven passengers on board, sustained fatal injuries. The airplane was operated by Hageland Aviation Services, Inc., of St. Mary's, Alaska, under 14 CFR Part 135, as scheduled commuter Flight 500. The destination was Wainwright, Alaska. Night, visual meteorological conditions (VMC) prevailed at the time of the accident, and a VFR flight plan was filed.

At 0802, the pilot radioed to the FAA Flight Service Station (FSS) that he was taxiing for takeoff, and filed a flight plan to Wainwright with eight persons on board, two hours en route, and three hours of fuel. At 0804, the pilot reported that he was back taxiing for runway 24. At 0806, he transmitted that he was departing runway 24. At 0808, two annunciations of an Emergency Locator Transmitter(ELT) were heard on 121.5 MHz by the FSS specialist on duty.

The pilot of a Cessna 207 which had earlier departed runway 06 for Wainwright reported hearing the pilot say, "mayday, mayday" and that he saw the airplane's lights descend "straight down into the water." The witness pilot had been talking previously to the accident pilot on 127.77 MHz, and overheard the "mayday" call on that frequency. The witness pilot revealed that he was at 700 feet MSL, and that the accident airplane never reached his altitude.

The airplane came to rest submerged in twenty-one feet of water, approximately 200 yards offshore. The fuselage and left wing were recovered the evening of the accident, with the right wing, engine, and various other components recovered separately over the next two day period.

One passenger occupied the right-front crew seat, five passengers occupied the installed passenger seats, and a single infant was being held by her mother as a lap child. All occupants were recovered from the interior of the airplane, still restrained in their seats, except for the infant, who was located in the aft cabin.

The accident flight was the company's first flight of the day. The lineman who assisted the pilot prepare the airplane for departure, told the NTSB investigator-in-charge (IIC) that after he fueled the airplane's left wing, there were no "ribbons or strings" hanging down from the airplane, and there were no covers on the pitot tubes. The lineman, and the company dispatcher who was helping prepare the flight, described the pilot as "the same as he always was," and in a hurry to make the scheduled takeoff time.

DAMAGE TO AIRCRAFT

The airplane was destroyed by a combination of impact forces and recovery damage. The airplane was described by the divers who first arrived on scene to be resting upright on the ocean floor in 21 feet of water. The wings were attached to the fuselage, but the engine was not. These divers described the leading edges of both wings as damaged. During recovery of the airplane, ropes were attached to the wing struts and landing gear, for towing by boats. While being towed, the airplane rolled over, and the right wing separated. The left wing remained attached by cables.

PERSONNEL INFORMATION

The pilot held an airline transport pilot certificate for multiengine airplanes, and a commercial pilot certificate for single-engine airplanes. His first class medical certificate contained no restrictions. He also possessed an airframe and powerplant mechanic license. The pilot was first hired by the company as the station manager at McGrath, Alaska, on June 23, 1994. He had been employed by the operator as the station manager in Barrow since June of 1997, and had flown 220 hours in the Barrow area. According to the company president, the pilot's primary duty was to manage the station, and he was not required to fly as a pilot. The pilot's wife said he enjoyed flying, and normally would take the first flight in the morning, which then allowed him to concentrate on his management duties for the remainder of the day.

The pilot was qualified in Cessna 185, 206, 207, and 208 airplanes. At the time of the accident, he had accumulated about 3,500 hours of flight time. Between June 23 and 27, 1997, he attended initial training in the Cessna 208B at Flight Safety International, Inc., Wichita, Kansas. The pilot had accrued 161 hours of experience in the Cessna 208B, and had flown 20.1 hours in the week prior to the accident, all in the Cessna 208B.

The pilot's most recent 14 CFR Part 135 proficiency check was conducted on June 27, 1997, as part of his initial qualification in the Cessna 208B.

AIRCRAFT INFORMATION

General

The airplane was a Cessna 208B "Grand Caravan," manufactured in January 1996, by the Cessna Aircraft Company, Inc., of Wichita, Kansas. The airplane was operated as a company demonstration aircraft by Cessna Aircraft Company, Inc., until it was sold on May 16, 1997, to Gussic Ventures, Inc., of Anchorage, Alaska, who leased it to Hageland Aviation Services, Inc. The airplane was powered by a single Pratt & Whitney PT6A-114A turboprop engine, rated to produce 675 shaft horsepower. The airplane had accumulated 1,438 total hours in operation at the time of the accident.

The airplane was equipped with the capability of seating up to nine passengers. At the time of the accident, five passenger seats were installed. The remaining seats were stowed in the aft cargo compartment, to make room for a casket being carried as cargo in the cabin. The airplane also carried a cargo pod installed underneath the belly of the airplane.

The airplane was equipped for flight into instrument meteorological conditions (IMC), although at the time of the accident, the company's FAA approved Operating Specifications did not authorize passenger carrying operations in single-engine airplanes during IMC.

The airplane was maintained on a Cessna periodic maintenance schedule, under an Approved Aircraft Inspection Program (AAIP). This was approved on the company's Operations Specifications in paragraph D73. This AAIP was developed from the Cessna Aircraft Company Recommended Maintenance Program for the Cessna 208B airplane. It was comprised of 12 "Phase" inspections, one accomplished each 200 hours, with "mini" checks each intermediate 100 hours. When utilizing this AAIP, the entire aircraft is inspected with the completion of any four consecutive phase inspections. All inspections were current at the time of the accident. The most recent maintenance performed was a "Phase 4" inspection completed on November 1, 1997, 28 hours prior to the accident.

A review of maintenance records revealed no repetitive maintenance problems, except for a captain's Heading Situation Indicator (HSI) replacement on June 19, October 27, October 28,

and October 29, 1997. No further discrepancies with the captain's HSI were noted. The accident airplane was flown on three flights by a different pilot on November 7, the day prior to the accident. This pilot did not recall any discrepancies with the airplane.

Weight and Balance

When questioned on how much fuel remained in the airplane when he returned from the final flight on the evening of November 7, the previous pilot told the Safety Board that he believed the airplane had approximately 600 to 700 total pounds of fuel, with 350 pounds in each wing. He did not fuel the airplane upon his return from the flight which preceded the accident.

The morning of the accident flight, the pilot directed that the left wing be "topped off" by a new employee. This was the employee's second day on the job, and he had no previous experience working on, or around, airplanes. When interviewed by the NTSB operations group chairman, he described unrolling the fueling hose from its storage location, and fueling the left wing until fuel "sloshed" out of the overwing fueling receptacle. He assumed this meant the tank was full, and then stopped. He said he placed no fuel in the right wing.

In order to determine how much fuel the lineman may have actually placed in the left wing tank, the investigation team asked the employee to fill a Cessna 208B left wing in the same manner as he fueled the accident airplane. The fuel level in the test wing was then read from the fuel gauges in the cockpit to be 800 pounds. Each wing has a total capacity of 1,122 pounds of Jet-A fuel (167.5 gallons).

Cargo on board the airplane consisted of an estimated 280 pounds of passenger's personal baggage, 98 pounds of freight, 354 pounds of bypass mail located in the belly mounted cargo pod, and a 418 pound casket containing a deceased relative of the passengers. The casket was secured in the cabin by one-inch wide, tubular nylon webbing cargo straps, and located aft of the passenger seats. The dispatcher said that as she placed the passenger's luggage on the scales, the pilot removed them for loading before she could record the weights.

The airplane's published maximum allowable takeoff weight was 8,750 pounds. The takeoff weight of the airplane on the morning of the accident was calculated by the NTSB to be between 8,560 pounds and 8,882 pounds (considering the minimum and maximum fuel combinations), with a longitudinal center of gravity between 197 inches and 198 inches aft of datum. The longitudinal CG limits at these weights are between 196 and 204 inches aft of datum. These weights were derived from available weight and balance records, occupant weights provided by the FAA, coroner records, cargo/baggage information provided by the operator, and estimated fuel in each wing as described below:

Empty weight of airplane -- 4,948 pounds Pilot and Passengers -- 1,228 pounds Cargo(freight and casket) -- 516 Cargo(Bypass mail) -- 354 pounds Cargo (baggage) -- 364 pounds Zero Fuel Weight -- 7,410 pounds

Estimated fuel right wing -- 350 pounds Estimated fuel left wing -- 800 to 1,122 pounds

Total weight at takeoff -- 8,560 to 8,882 pounds

The fuel in the airplane at takeoff was derived by using the estimated fuel remaining in the wings from the previous flight, and the estimated fuel added to the left wing by the company lineman immediately prior to the accident flight.

Lateral fuel loading imbalance has a limit published in the Pilot Operating Handbook of 200

pounds. The lateral fuel imbalance (left wing heavy), is estimated to have been between a minimum of 450 pounds, to a maximum of 991 pounds.

METEOROLOGICAL INFORMATION

Morning civil twilight at Barrow on November 8 was 0924.

The reported weather at 0750 was a few clouds at 14,000 feet, 7 miles visibility, with winds from 170 degrees at eight knots. The outside air temperature was 12 degrees Fahrenheit, with a dew point of 7 degrees Fahrenheit.

The pilot of a DC-6 which landed about one hour before the accident indicated he was able to see Barrow from about 100 miles away. This pilot was preparing to depart when the accident occurred, and described light winds. He said in a written statement that he did not notice any ice or frost in the air, and that none formed on his airplane during his approximately one hour of ground time.

Heavy frost was described as having formed on vehicles and aircraft which were parked outside overnight, by the pilot of the Cessna 207 who witnessed the accident. The witness pilot told the NTSB that his airplane had accumulated a "heavy frost" and it took him approximately 15 minutes to clean it off. He said that it usually took him about five minutes to clean frost off his airplane. The company lineman who fueled the left wing of the accident airplane said he noticed a coating on the wings and described it as a "rough glaze like you get on a car window." He demonstrated what the ice looked like to the NTSB operations group by sliding a piece of ice off an automobile window. This piece was a very thin, fragile, transparent, piece of ice. The lineman said the lower surfaces and windows were free of ice and frost. Other town residents also described frost on vehicles.

The accident pilot was already at work loading his airplane when other employees arrived. Company employees interviewed by the NTSB were not aware of the pilot removing frost or ice from the airplane. The accident pilot had been observed on other occasions applying an unknown fluid to wing surfaces with a garden sprayer. This was not noted by company employees the morning of the accident.

COMMUNICATIONS

The local FSS and traffic advisory frequency is 123.6 MHz. The unofficial common frequency used by local pilots for air to air communications is 127.77 MHz.

The pilot filed his flight plan and made common traffic advisory transmissions on 123.6 MHz. All recorded voice transmissions from the pilot on 123.6 MHz were ground transmissions. No inflight transmissions were received or recorded. The accident pilot was also communicating with the pilot of the Cessna 207 who departed before him, on 127.77 MHz. The frequency 127.77 is not recorded.

The NTSB IIC, and members of the Operations Group, listened to recorded radio transmissions between the airplane and the FSS. None of the members could discern any noises on 123.6 MHz which corresponded to any cockpit warning horns.

AERODROME INFORMATION

The Will Rogers-Wiley Post Memorial Airport is located on the coast of the Arctic Ocean, and consists of a single, paved, 6,500 feet long runway, oriented 06-24. The runway is equipped with runway end identifier lights, runway edge lights, and medium intensity approach lights

located at the approach end of runway 06.

The accident airplane's takeoff from runway 24 departed over the water, and made a left turn toward Wainwright. The intended route of flight paralleled the shoreline. During hours of darkness, this direction of departure is toward dark water and featureless ice.

The airport is uncontrolled, and has an FAA Flight Service Station located at the field. This facility provides weather observations and traffic advisory services to pilots.

WRECKAGE AND IMPACT INFORMATION

The NTSB on site investigation began at 2200 on November 8, 1997. The NTSB IIC, and two FAA inspectors from the Fairbanks, Alaska, Flight Standards District Office (FSDO) arrived in Barrow and began an inspection of the wreckage which had been initially recovered. Additional NTSB and FAA representatives from Washington, DC, arrived on November 9. The investigative team then formed an Operations Group comprised of members from the NTSB, FAA, and the operator; and an Airworthiness / Maintenance Group comprised of members from the NTSB, FAA, the operator, Cessna Aircraft Company, and Pratt & Whitney.

The airplane was towed to the beach, with the left wing attached, where it was not disturbed until the NTSB conducted the initial examination. The airplane was then relocated to a hangar facility at the Navy Arctic Research Laboratory in Barrow, along with the right wing and powerplant, which were recovered separately.

The four aileron balance weights, and all attaching screws, were intact, tight, and showed no evidence of binding on the flight controls. The control column was inspected with no evidence that the control lock was installed at impact. The aileron trim control indicator was found on the full right wing down trim index. No indications of flight control system anomalies were noted.

The trailing edge flaps were found in the zero (0) degrees, or retracted position. The wing spoilers were retracted. The company procedure is to rotate the airplane for takeoff at 75 knots with flaps set at 20 degrees. Flaps are then retracted to 10 degrees at 85 knots, and retracted to 0 degrees at 95 knots.

The engine and propeller assembly separated from the fuselage and was recovered. Two of the three propeller blades fractured at the blade hubs and were not located.

A witness mark on the Interstage Turbine Temperature (ITT) gauge face read 850 degrees Centigrade. The takeoff temperature limits for the PT-6A-114A engine are 805 degrees Centigrade. The 2 second transient limit for ITT is 865 degrees Centigrade.

The leading edges of both wings were crushed aft along their entire span. Both wings exhibited outward bulging at the location of the integral fuel tanks.

The right wing separated from the fuselage during the recovery efforts, and the left wing remained attached by cables. Both fuel selector handles, located on the cockpit overhead panel, were found in the off position. The two left wing tank fuel selector valves, located in the left wing root, were found in the closed position. The two right wing tank fuel selector valves, located in the right wing root, were found in a partially open position. Push-pull cables connect the valves located at the wing roots to the selector handles located in the cockpit ceiling. These cables, when stretched outboard, move the valves toward the closed position.

A functional check of the "Fuel Selector OFF" warning system revealed that the system was

operable. This system activates if both Fuel Selector Valves are placed in the "OFF" position. The cockpit indications produced are a flashing "FUEL SEL OFF" warning light, and an aural horn.

During the inspection of the airplane in the NARL hangar in Barrow, the motive flow fuel line inside the reservoir tank was found twisted. The complete reservoir tank assembly was removed for further testing.

No discrepancies were found with the pitot-static system, or the flight attitude indicating system.

MEDICAL AND PATHOLOGICAL INFORMATION

A postmortem examination was performed on the pilot by the State of Alaska Medical Examiner, 5700 East Tudor Road, Anchorage, Alaska, on November 10, 1997. The examination report cited "multiple impact injuries" as the cause of death.

Toxicological samples taken from the pilot were analyzed by the FAA Civil Aeromedical Institute, Oklahoma City, Oklahoma. According to the toxicology report (attached), all tests were negative.

SURVIVAL ASPECTS

All occupants located in passenger seats 2A through 4B were still restrained in their respective seats. The integral lap belt/shoulder harness passenger restraints remained intact. These belts are designed so that the shoulder harness will be in place on the passenger when the lap belt is fastened. The seat frames fractured at the weld joints, allowing the seats to rotate forward. The seat legs all remained attached to the seat rails. These seats were installed under a Supplemental Type Certificate modification. These seats did not incorporate load limiting features.

The two cockpit seats, manufactured by Cessna, remained attached to the floor structure. Both of these seats exhibited forward, and right, ductile deformation. These seats incorporate design features which allow the seats to deform in the direction of impact, thereby attenuating the energy transmitted to the seat occupant.

The 418 pound casket carried as cargo in the cabin was secured to the floor using two fore and aft oriented, one-inch wide tubular nylon cargo straps. An additional strap was oriented diagonally across the casket between the two primary tiedowns. These straps were found parted at midspan, and the casket had moved forward, impacting the back of the seats located at positions 3A and 4B.

TESTS AND RESEARCH

Fuel samples taken from the company fuel supply tank nozzle and filters were tested by the Air Force fuels laboratory located at Elmendorf Air Force Base in Anchorage (see appended test results). These tests confirmed the fuel to be Jet-A. The accident airplane was the last airplane fueled from the company fuel tank prior to the sample.

On January 5, 1998, the NTSB IIC used a Cessna 208B to determine if the Telex model ANR-4100 active noise reduction headset worn by the pilot at the time of the accident could have eliminated his ability to hear stall or fuel selector warning horns. All aural warnings were clearly audible with the engine operating and the headset active.

The caution advisory panel light bulbs were examined at the Safety Board's metallurgical laboratory for evidence of illumination at impact. The RIGHT FUEL LOW bulb filaments exhibited hot, ductile stretching.

The Pratt & Whitney PT-6A-114A engine was examined at the Pratt & Whitney Engines, Montreal, Canada facility on December 17, 1997, with all parties to the investigation represented. Details are contained in the Airworthiness Group Chairman's Factual Report. No preaccident anomalies were noted. Rotational damage was observed throughout the powerplant. Impact marks on the propeller guides indicated a blade angle consistent with an applied horsepower of 497 shaft horsepower, plus or minus 50 horsepower (see Airworthiness Group Chairman's Factual Report). No indication of blade slippage in the propeller hub was noted.

The fuselage reservoir fuel tank was inspected by representatives of Cessna, the NTSB, and the FAA, at Cessna Aircraft Company on December 15, 1997. The entire assembly passed an acceptance test. The motive flow fuel pressure line, internal to the tank, was observed to be twisted. This line was installed into an operational Cessna 208B airplane, and the engine on that airplane operated within nominal acceptance parameters.

The NTSB IIC tested the reservoir fuel tank and determined that once the usable fuel in the tank was consumed, and the fuel supply line to the engine driven fuel pump was dry, there would be insufficient fuel remaining in the tank to refill the fuel line to the engine driven pump when the airplane was placed in a steep, nose down attitude.

Flight tests were conducted by Cessna Aircraft Company in August 1998, at the request of the Safety Board, to determine controllability of the Cessna 208B at various airspeed and lateral fuel imbalance combinations. A Cessna 208B was flown to a maximum 600 pound imbalance, at airspeeds between 70 and 120 knots, at flap settings of 0 degrees and 20 degrees. Control wheel deflection was measured to establish remaining control available. The maximum control wheel deflection attained was about 28 degrees. The maximum control wheel deflection available is 55 degrees. All tests were performed with an uncontaminated airfoil. No attempt was made to simulate frost during these tests.

One test included full left wing down aileron trim, combined with a left wing heavy imbalance of 600 pounds. In this condition, the airplane was controllable with flaps at 0 degrees, between 105 knots and 120 knots.

The test airplane was flown from takeoff to landing, in both a left and a right circling direction, with lateral trim neutral, and a 600 pound left wing heavy lateral imbalance. Winds were variable from 180 degrees to 220 degrees, at 13 knots gusting to 18 knots. The magnetic heading of the runway used was 193 degrees.

These tests provided control deflection versus lateral imbalance curves (attached) which, when extrapolated to an imbalance of 1,000 pounds for an airplane configured with 0 degrees of flaps, show an expected control wheel deflection of 26 degrees.

During September and October 1998, Cessna Aircraft Company performed a series of flight tests on a Cessna 208B to determine handling characteristic effects of simulated frost disruption of the main wing boundary layer. No boundary layer disruption source was applied to the horizontal stabilizer surfaces. Application of a disruptive sandpaper strip at the 25% chord line varied from 0% to 100% spans. Spans greater than 50% yielded an increase in published stalling speeds of three to five knots. These tests were not attempted at a surface

coverage greater than a 3-inch wide strip. No tufting of the wing surfaces to provide a visual presentation of boundary layer separation was utilized.

The Cessna 208B wing is comprised of a NACA 23012 airfoil section. Several ice contamination effects studies (excerpts appended) have been performed on the NACA 230XX series airfoil. In the investigation of the Comair EMB-120 accident near Monroe, Michigan, on January 9, 1997, the Safety Board examined experimental and computational data for the NACA 23012 airfoil used on the EMB-120 with ice contamination (reference NTSB report DCA-97-MA-017 for a full discussion of past and recent research), including recent experimental data from the University of Illinois. Also in support of this EMB-120 accident investigation, NASA performed a full Navier-Stokes CFD calculation report for the NACA 23016 airfoil with ice accretions and aileron deflections. In 1979, the Douglas Aircraft Company (under the direction of Dr. R. E. Brumby, PhD) completed several studies of the NACA 23012 airfoil used on the DC-9 hard wing. The results of these studies all showed the same trend of decreased stall angle of attack when contamination is present, and differing reductions in the stall angles of attack for contaminated airfoils with upward and downward deflected ailerons. According to these three studies, when the angle of attack on an airplane's wing increases beyond the contamination reduced stall angle of attack, and the airplane has oppositely deflected ailerons, the resulting asymmetric stall can impart a rolling moment to the airplane. This tendency can be aggravated during increasing angle of attack situations (such as raising of trailing edge flaps).

In researching the potential effects of frost contamination on the upper surface of wings, Douglas Aircraft Company (under the direction of Dr. R. E. Brumby, PhD), stated in "The Effect of Wing Ice Contamination on Essential Flight Characteristics" (appended):

1. "...for an airplane with ice contamination, not only does stall onset occur at a lower than normal angle of attack, the airplane angle of attack must be increased in order to produce the required lift at normally scheduled speeds. ... The increasingly unsteady airflow over the wing results in correspondingly degraded lateral stability, requiring larger and larger control wheel inputs to keep the aircraft from rolling off. ... the airplane becomes increasingly unstable, eventually stalling without stick shaker activation at speeds normally scheduled for takeoff."

2. "...it becomes readily apparent that it takes only a relatively small amount of roughness on the wing upper surface to cause large increases in stall speeds even with slats extended."

3. Figure 7 (appended) depicts the percent increase in stall speed versus roughness element height/wing chord (K/C). The simulated frost range adhering to the entire upper surface shows an increase in stall speed between 20% and 40%.

FAA Advisory Circular (AC) 20-117, "Hazards Following Ground Deicing and Ground Operations in Conditions Conducive to Aircraft Icing" states "Wind tunnel and flight tests indicate that ice, frost, or snow formations on the leading edge and upper surface of a wing, having a thickness and surface roughness similar to medium or coarse sandpaper, can reduce wing lift by as much as 30 percent and increase drag by as much as 40 percent." It goes on to say that "Ice, frost, or snow formed on these surfaces on the ground can have a totally different effect on aircraft flight characteristics than ice formed in flight."

Appendix 3 of AC 20-117 lists numerous effects of ice formations on flight characteristics. Among these are "(2)(ii) Surface roughness on the afterbody of a wing can have an effect

approximately equal to the effect of similar surface roughness on the leading edges of some airfoils. ... (v) Stall angle of attack will decrease and in some aircraft stall will occur prior to activation of stall warning devices. ... (vii) Controllability may be reduced requiring more stick deflection for maneuvers or stall recovery."

AC 120-58, "Pilot Guide - Large Aircraft Ground Deicing / Preface / Clean Aircraft Concept" states: "Thicker or rougher frozen contaminants can have increasing effects on lift, drag, stall speed, stability and control, with primary influence being surface roughness located on critical portions of an aerodynamic surface. These adverse effects on the aerodynamic properties of the airfoil may result in sudden departure from the commanded flight path and not be preceded by any indications or aerodynamic warning to the pilot. Therefore it is imperative that takeoff not be attempted unless the PIC has ascertained, as required by regulation, that all critical surfaces of the aircraft are free of adhering ice, snow, or frost formations."

The FAA publication, TIPS ON WINTER FLYING - FAA-8740-24 / OPERATION OF AIRCRAFT, says: "Removal of Ice, Snow, and Frost - A common winter accident is trying to take off with frost on the wing surface. It is recommended that all frost, snow, and ice be removed before attempting flight."

14 CFR Part 91.577 states, in part, that "(a) No pilot may takeoff an airplane that has- ...(2) Snow or ice adhering to the wings or stabilizing or control surfaces; or (3) Any frost adhering to the wings or stabilizing or control surfaces, unless that frost has been polished to make it smooth."

ADDITIONAL INFORMATION

Company Information

Hageland Aviation Services, Inc., began operation in 1985, and had about 115 employees, including 34 pilots, at the time of the accident. They were authorized to conduct scheduled and on demand operations with nine or less passengers. The company operated from eight communities in Alaska, and based airplanes in three communities. The aircraft fleet of 29 airplanes included four Cessna 208Bs, 20 Cessna single-engine piston airplanes, four Cessna 402C twin-engine airplanes, and one Beech E-18 twin-engine airplane. The majority of airplanes were owned by Hageland Aviation Services, Inc., or leased from Gussic Ventures, Inc., or individuals. Gussic Ventures, Inc., is a partnership of three principals from Hageland Aviation Services, Inc.

Since 1996, the company had four accidents, two involving fatalities. After the company had a fatal accident involving a Cessna 208B on April 10, 1997, the company created a position of safety officer. At the time of the accident, this position was filled by a contractor, not a company employee, who did not reside in Alaska.

Ground Icing Procedures

14 CFR 135.227(a) allows pilots of aircraft to takeoff "...with "frost adhering to the wings, or stabilizing or control surfaces, if the frost has been polished to make it smooth."

14 CFR 135.227 (b) says in part, "No certificate holder may authorize an airplane to takeoff and no pilot may takeoff... any time conditions are such that frost ... may reasonably be expected to adhere to the airplane unless ... one of the following requirements is met: (1) A pretakeoff contamination check, that has been established by the certificate holder and approved by the Administrator for the specific airplane type, has been completed within 5 minutes prior to

beginning takeoff. A pretakeoff contamination check is a check to make sure that the wings and control surfaces are free of frost, ice, or snow. (2) The certificate holder has an approved alternative procedure and under that procedure the airplane is determined to be free of frost, ice, or snow."

The company was authorized in the FAA approved Operations Specifications to operate airplanes under ground icing conditions, if conducted as outlined in the Hageland General Operations Manual. This manual stated in the "Pretakeoff Contamination Check" that "Any snow or ice adhering to any of the surfaces will have to be removed before a takeoff is attempted." The section titled Cold Weather and Ground Icing Operations stated that "No aircraft shall takeoff with frost, snow or ice adhering to its propeller, windshield, powerplant, and pitot-static system. No aircraft shall takeoff with snow, ice or frost adhering to the wings, stabilizers or control surfaces unless the frost has been polished smooth. ...all control surfaces, wings, stabilizers, windshields, propellers and pitot-static systems will be completely free of any frost, snow or ice before any takeoff is attempted."

At the time of the accident, Hageland did not have, nor were they required to have, an FAA approved deicing program.

During the investigation, the President of Hageland Aviation stated to the NTSB Operations Group Chairman that the company procedures are defined in the Operations Specifications; essentially, if there is any level of ice, it should be removed.

The Cessna 208B pilot operating Handbook, Section 4, Normal Procedures, has four "!WARNINGS" concerning removal of frost before flight. On page 4-4, 4-6, and 4-7, under "preflight," is the statement "!WARNING It is essential in cold weather to remove even small accumulations of frost, ice, or snow... ."

FAA oversight

The company area of operations extends over two FSDO's geographic areas of responsibility. The Certificate Holding District Office (CHDO) is located in Anchorage, Alaska. The FSDO responsible for providing geographic support for oversight of company line station operations in Barrow is located in Fairbanks, Alaska.

The Principal Operations, Maintenance, and Avionics Inspectors (POI, PMI, PAI) assigned to manage the Hageland Aviation Services, Inc., certificate were assigned to the Anchorage FSDO.

During Fiscal Year 1997 (October 1, 1996 to September 30, 1997), 22 required ("R" item) inspections were completed by the Anchorage FSDO, and 60 additional planned ("P" item) inspections were completed. This is an increase from FY-96, when 22 "R" item and 29 "P" item inspections were performed. During FY-96, the Fairbanks FSDO completed 1 inspection, and in FY-97, 14 inspections.

In none of the previous three years did any of the Principal Inspectors from Anchorage visit Hageland's Barrow station. The first record of the Fairbanks FSDO having visited the Hageland station in Barrow was the last week of October 1997, one week prior to the accident.

Three weeks after this accident, the FAA conducted a Regional Aviation Safety Inspection Program (RASIP) inspection (report attached) of Hageland Aviation Services, Inc. According to this report, the FAA found "the lines of authority were not well defined, and those that are defined sometimes are not followed." The report also found that "Use of checklists by pilots was done on an occasional basis. Pilot habit patterns indicated that these airmen were not

using checklists and were very uncomfortable with the need to do so because the FAA was onboard the aircraft. ... Some pilots were unable to determine the seat configuration of the airplane and the resultant empty weight and C.G. Many took an exceptional amount of time to do a weight and balance."

The RASIP report also stated, "1.07.07: Most company pilots do not follow the approved procedure in the company operations manual described on pages 3-5 and 3-5a, which says that the pilot-in-command shall compute the aircraft empty weight, considering the seat configuration, needed fuel load, pilot's weight, and then the pilot will confirm the available pay load weight. These calculations are worked in reverse order. The cargo is loaded first, then fuel. The pilot's don't know the aircraft empty weight until after the airplane is loaded. Some pilots can not read the seat configuration data sheet and describe which configuration the aircraft is in. Cargo handlers were observed putting cargo on the aircraft without the pilot's knowledge. Some pilots have calculated wrong weight and balances, and if they wouldn't have been challenged by the FAA inspector, they would have departed with the aircraft out of the center of gravity limitations."

Release of Aircraft Wreckage:

All wreckage except the engine, center fuel tank, instruments retained for laboratory inspection, and pilot records, was released to representatives of Hageland Aviation Services, Inc., on November 12, 1997. The remaining components were released to representatives of the company, or Professional Adjusters of Alaska, Inc., Anchorage, Alaska, between November 12, 1998, and October 19, 1998.

## Pilot Information

| | | | |
|---|---|---|---|
| **Certificate:** | Airline Transport; Commercial; Foreign | **Age:** | 40, Male |
| **Airplane Rating(s):** | Multi-engine Land; Single-engine Land | **Seat Occupied:** | Left |
| **Other Aircraft Rating(s):** | None | **Restraint Used:** | Seatbelt, Shoulder harness |
| **Instrument Rating(s):** | Airplane | **Second Pilot Present:** | No |
| **Instructor Rating(s):** | None | **Toxicology Performed:** | Yes |
| **Medical Certification:** | Class 1 Valid Medical--no waivers/lim. | **Last Medical Exam:** | 02/20/1997 |
| **Occupational Pilot:** | | **Last Flight Review or Equivalent:** | |
| **Flight Time:** | 3500 hours (Total, all aircraft), 200 hours (Total, this make and model), 3400 hours (Pilot In Command, all aircraft), 16 hours (Last 24 hours, all aircraft) | | |

## Aircraft and Owner/Operator Information

| | | | |
|---|---|---|---|
| **Aircraft Manufacturer:** | Cessna | **Registration:** | N750GC |
| **Model/Series:** | 208B 208B | **Aircraft Category:** | Airplane |
| **Year of Manufacture:** | | **Amateur Built:** | No |
| **Airworthiness Certificate:** | Normal | **Serial Number:** | 208B-0504 |
| **Landing Gear Type:** | Tricycle | **Seats:** | 7 |
| **Date/Type of Last Inspection:** | 11/01/1997, Continuous Airworthiness | **Certified Max Gross Wt.:** | 8750 lbs |
| **Time Since Last Inspection:** | 28 Hours | **Engines:** | 1 Turbo Prop |
| **Airframe Total Time:** | 1466 Hours | **Engine Manufacturer:** | P&W |
| **ELT:** | Installed, activated, did not aid in locating accident | **Engine Model/Series:** | PT6A-114 |
| **Registered Owner:** | GUSSIC VENTURES, INC. | **Rated Power:** | 675 hp |
| **Operator:** | HAGELAND AVIATION SERVICES INC | **Air Carrier Operating Certificate:** | Commuter Air Carrier (135); On-demand Air Taxi (135) |
| **Operator Does Business As:** | | **Operator Designator Code:** | EPUA |

## Meteorological Information and Flight Plan

| | | | |
|---|---|---|---|
| **Conditions at Accident Site:** | Visual Conditions | **Condition of Light:** | Night/Dark |
| **Observation Facility, Elevation:** | BRW, 10 ft msl | **Observation Time:** | 0806 AST |
| **Distance from Accident Site:** | 1 Nautical Miles | **Direction from Accident Site:** | 90° |
| **Lowest Cloud Condition:** | Scattered / 14000 ft agl | **Temperature/Dew Point:** | 12°C / 7°C |
| **Lowest Ceiling:** | None / 0 ft agl | **Visibility** | 7 Miles |
| **Wind Speed/Gusts, Direction:** | 8 knots, 170° | **Visibility (RVR):** | 0 ft |
| **Altimeter Setting:** | 29 inches Hg | **Visibility (RVV):** | 0 Miles |
| **Precipitation and Obscuration:** | | | |
| **Departure Point:** | (BRW) | **Type of Flight Plan Filed:** | VFR |
| **Destination:** | WAINWRIGHT, AK (AIN) | **Type of Clearance:** | VFR |
| **Departure Time:** | 0806 AST | **Type of Airspace:** | Class G |

## Airport Information

| | | | |
|---|---|---|---|
| **Airport:** | WILEY POST MEMORIAL (BRW) | **Runway Surface Type:** | Asphalt |
| **Airport Elevation:** | 10 ft | **Runway Surface Condition:** | Water--choppy |
| **Runway Used:** | 24 | **IFR Approach:** | None |
| **Runway Length/Width:** | 6500 ft / 150 ft | **VFR Approach/Landing:** | None |

## Wreckage and Impact Information

| | | | |
|---|---|---|---|
| **Crew Injuries:** | 1 Fatal | **Aircraft Damage:** | Destroyed |
| **Passenger Injuries:** | 7 Fatal | **Aircraft Fire:** | None |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 8 Fatal | **Latitude, Longitude:** | |

## Administrative Information

| | | | |
|---|---|---|---|
| **Investigator In Charge (IIC):** | MATTHEW L THOMAS | **Adopted Date:** | 02/22/2000 |
| **Additional Participating Persons:** | VICTORIA ANDERSON(FAA-AAI-100); WASHINGTON, DC<br>PAUL R MISENCIK; WASHINGTON, DC<br>THOMAS A BERTHE; S. BURLINGTON, VT<br>JEROME FRESCHETTE; WASHINGTON, DC | | |
| **Publish Date:** | | | |
| **Investigation Docket:** | NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/. | | |