Aviation Investigation Final Report

Location:	Willow, Alaska	**Accident Number:**	ANC18FA055
Date & Time:	July 18, 2018, 19:00 Local	**Registration:**	N9878R
Aircraft:	De Havilland DHC-2	**Aircraft Damage:**	Destroyed
Defining Event:	Aerodynamic stall/spin	**Injuries:**	1 Fatal, 2 Serious
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

The pilot was conducting an on-demand air taxi flight in a float-equipped airplane from a seaplane base on a public lake to a remote lakeside home, with a passenger and her young son. The passenger brought cargo to transport as well, including an unexpected 800 lbs of mortar bags. Witnesses who labored to push the airplane out after loading reported that the airplane appeared very aft heavy and the pilot said he would offload "cement blocks" if he could not take off. A review of witness videos revealed that the pilot attempted one takeoff using only 3/4 of the available waterway, then step taxied around the lake and performed a step-taxi takeoff, again not using the full length of the lake. The airplane eventually lifted off, and barely climbed over trees on the south end of the lake, before descending and impacting terrain.

A home surveillance video that captured the airplane seconds before the crash revealed that 3 seconds before ground impact, the estimated altitude of the airplane was 115 ft above ground level (agl) and the groundspeed was about 64 miles per hour (mph), which was low and much slower than normal climb speed (80 mph). As the airplane banked to the left to turn on course, it rolled through 90° likely experiencing an aerodynamic stall. Analysis of the engine rpm sound revealed that the engine was operating near maximum continuous power up until impact, and a postaccident examination of the airframe and engine revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation.

A calculation performed by investigators postaccident revealed the airplane's estimated gross weight at the time of the accident was 75 lbs over the approved maximum gross takeoff weight, and the airplane's estimated center of gravity was 1.76 inches aft of the rear limit.

The pilot had been recently hired by the operator and he flew his first commercial flight in the same make and model, float-equipped airplane the week before the accident. He had accumulated 12.9 flight hours, and 13 sea landings/takeoffs in the accident model airplane since being hired as a part-time pilot.

Although the airplane was able to takeoff, the aircraft's out-of-limit weight-and-balance condition increased its stall speed and degraded its climb performance, stability, and slow-flight characteristics. When the pilot turned the airplane left, the critical angle of attack was exceeded resulting in an aerodynamic stall at low altitude. If the pilot had performed a proper weight and balance calculation, he may have recognized the airplane was overweight and out of balance and should not have attempted the flight without making a load adjustment.

Probable Cause and Findings

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

The pilot's exceedance of the airplane's critical angle of attack during departure climb, which resulted in an aerodynamic stall. Contributing to the accident was the pilot's improper decision to load the airplane beyond its allowable gross weight and center of gravity limits, coupled with his lack of operational experience in the airplane make, model, and configuration.

Findings

Personnel issues	Aircraft control - Pilot
Aircraft	Angle of attack - Capability exceeded
Personnel issues	Decision making/judgment - Pilot
Personnel issues	Weight/balance calculations - Pilot
Aircraft	Maximum weight - Capability exceeded
Aircraft	CG/weight distribution - Capability exceeded
Personnel issues	Total experience w/ equipment - Pilot

Factual Information

History of Flight

Prior to flight	Aircraft loading event
Initial climb	Loss of control in flight
Initial climb	Aerodynamic stall/spin (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)
Post-impact	Fire/smoke (post-impact)

On July 18, 2018, about 1900 Alaska daylight time, a float-equipped De Havilland DHC-2 (Beaver) airplane, N9878R, was destroyed when it was involved in an accident near Willow, Alaska. The pilot sustained fatal injuries and the two passengers sustained serious injuries. The airplane was operated as a Title 14 *Code of Federal Regulations* (*CFR*) Part 135 on-demand air taxi flight.

The director of operations (DO) for Regal Air reported that the flight was chartered by the Alaska Medicaid Travel Office to provide roundtrip transportation for two passengers from a private residence at a remote lake, to the Willow Seaplane Base (2X2) and then return them home 2 days later. A different company pilot flew the passengers (a woman and her 2.5-year-old son) from their home to Willow Seaplane Base on July 16, and the accident flight was the return trip. The accident pilot had not flown out of Willow Lake as a company pilot-in-command or to the destination lake before, so the DO reviewed the lakes, route, and fuel load with him before the flight. The company vice president called the passenger before the flight and obtained an expected cargo load of 600 lbs.

A review of Federal Aviation Administration radar and automatic dependent surveillance-broadcast (ADS-B) track data, revealed the airplane departed Lake Hood Seaplane Base (LHD), the operator's home base, about 1755 and arrived at Willow Seaplane Base at 1817.

Witnesses reported that after arriving at the Willow Seaplane Base, the pilot loaded the passenger's cargo. According to the passenger, the cargo consisted of 800 lbs of masonry mortar bags, three totes full of food and stores, two propane tanks, a utility sink, and miscellaneous baggage and supplies. No one witnessed the pilot weighing or loading the cargo; therefore, it is unknown where items were stowed or the exact calculated weight and balance. The passenger stated that the bags of mortar were piled up on the floor behind the pilot in the second-row, and she was seated in the second-row right seat with her son on her lap. Two witnesses helped push the airplane off the shore after loading because the floats were deep and stuck on the lake bottom. They stated that the airplane appeared very deep and heavy, especially the aft end of the floats. The pilot stated to the witnesses that he planned on offloading some "cement bricks" if he could not takeoff.

Other lakeside witnesses observed the airplane maneuvering on the lake. A review of various witness videos and statements revealed that the pilot made one take-off attempt to the south-southeast. The airplane then taxied back to the north end of the lake, with the aft end of the floats deep under water in almost a plow taxi, then he step taxied (taxied fast on-plane) around the center portion of the lake with

the flaps up, and finally performed a step taxi takeoff with the flaps in the takeoff position, heading south-southeast. One witness stated that the pilot did not use the entire length of the lake for takeoff but rather started the takeoff with 1,300 ft of waterway behind the airplane at the north end of the lake.

According to the witnesses, the airplane slowly lifted off and attained a nose high attitude as it barely climbed over trees at the southeast end of the lake (see figure 1). The passenger stated that after takeoff, as the airplane turned left in the direction of the destination, it rolled left and crashed. After the impact, she noted that the pilot was unresponsive as the airplane became engulfed in fire, and she immediately evacuated with her son.

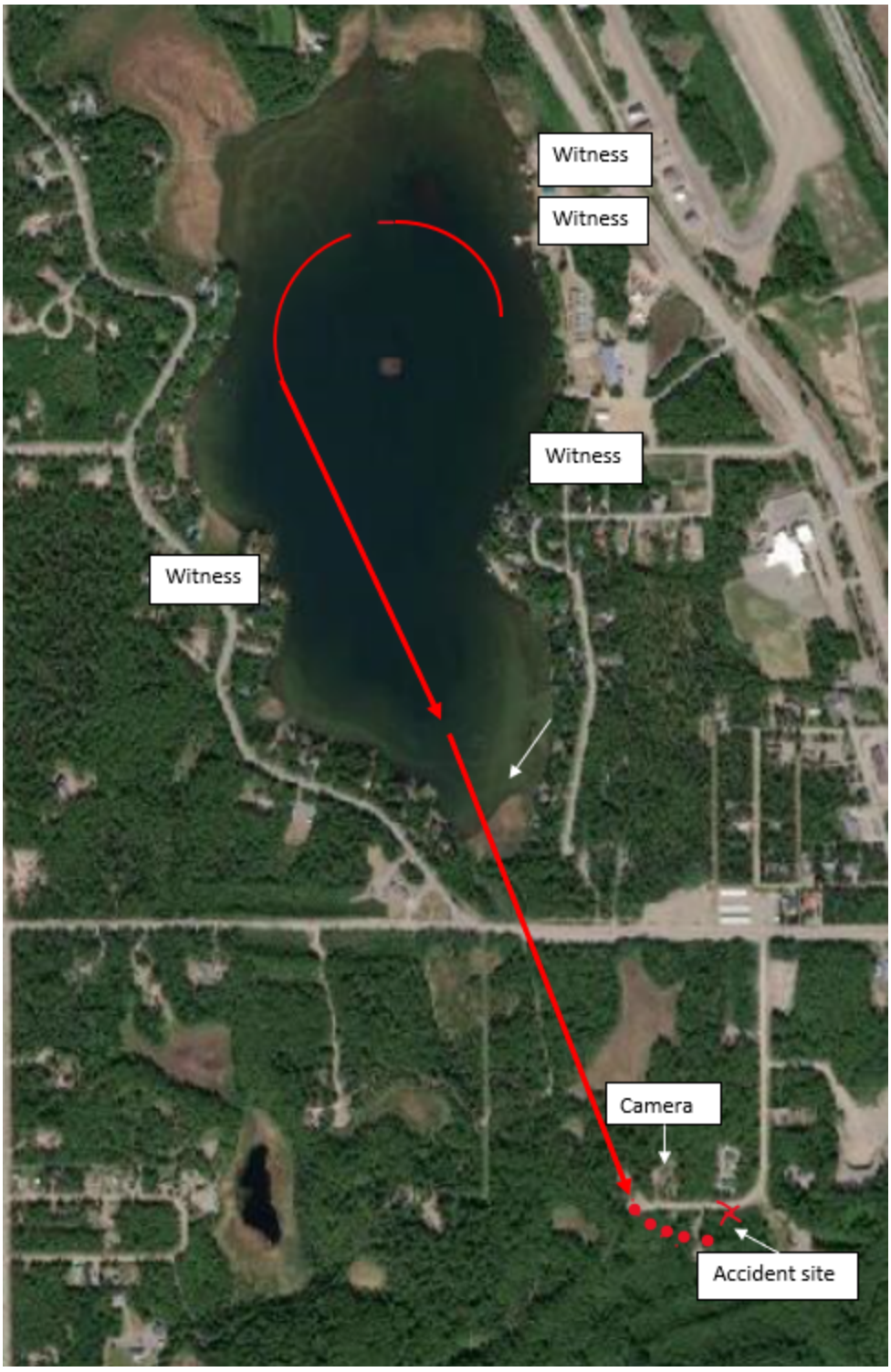

Figure 1. Willow Lake with approximate water and flight tracks based on witness videos.

A home surveillance video camera near the accident site captured the seconds before impact as the airplane flew east-southeast. The National Transportation Safety Board performed a video study that revealed that 3 seconds before ground impact the airplane's altitude was estimated at 115 ft above

ground level (agl) and about 56 knots (64.4 miles per hour) groundspeed, in a 25° left turn. The airplane then rolled rapidly left through 90° as it descended in a nose-down attitude. The engine speed was estimated, using propeller sound spectrum analysis, at a constant 2235 rpm up until ground impact, which was slightly above maximum continuous power. A copy of the video and sound spectrum study is included in the public docket for this accident.

About 1900, multiple residents in a neighborhood southeast of Willow Lake heard a loud impact and witnessed smoke rising above the site. A neighbor responded and discovered the passenger walking with her son in her arms outside of the airplane which was nose down and engulfed in flames. The Willow Fire Department, Alaska State Troopers, and personnel from the Alaska Rescue Coordination Center responded.

Pilot Information

Certificate:	Airline transport; Commercial; Flight instructor	**Age:**	24,Male
Airplane Rating(s):	Single-engine land; Single-engine sea	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	May 22, 2018
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	May 17, 2018
Flight Time:	2685.3 hours (Total, all aircraft), 345.8 hours (Total, this make and model), 1903 hours (Pilot In Command, all aircraft), 274.7 hours (Last 90 days, all aircraft), 82.3 hours (Last 30 days, all aircraft), 3.2 hours (Last 24 hours, all aircraft)		

The pilot worked for multiple operators in Anchorage. He was a part time pilot for Regal Air and Fly Denali, and also worked full time for Corvus Airlines (doing business as Ravn Alaska.) On the day of the accident, the pilot reported for duty at Ravn Alaska at 0615 as a first officer on a DHC-8 at the Anchorage base. He flew 6 legs and was released from duty at 1551. The DO described him as a real "go-get-getter" and remarked that he seemed well rested the day of the accident. The pilot had flown a total of 137.28 hours for Ravn in June and July.

The pilot also worked part time for Fly Denali as a pilot-in-command of a DHC-2T "turbine Beaver" on wheels. He had accumulated over 320 DHC-2T flight hours, and his last flight was June 29, 2018.

A review of Regal Air personnel records indicated that the pilot was a part-time pilot who was recently hired. He completed initial company training (both land and sea initial flight training and proficiency checkrides were in Cessna 206 airplanes) and was assigned as pilot-in-command (PIC) for single-engine wheeled airplanes on May 5, 2018, and single-engine seaplanes May 17, 2018. Examination of pilot records revealed the pilot received 3 hours of DHC-2 "transition-floats" flight training on June 16 and he flew his first DHC-2 float plane commercial flight the week before the accident. He had no proficiency

check ride in the DHC-2, nor was he required to by regulation. He had accumulated 12.9 flight hours and 13 sea landings/takeoffs in the DHC-2 since he was hired.

A review of the pilot's personal logbook revealed he had experience in many different airplanes. He had accumulated a total of 216.6 hours of airplane single-engine sea flight time, and about 4 of those hours were in a DHC-2 many years before working for Regal Air. His initial seaplane training was conducted at Willow Lake. He was known by company personnel to be a professional and highly competent pilot. His family members stated that he loved flying and had no health issues.

Aircraft and Owner/Operator Information

Aircraft Make:	De Havilland	**Registration:**	N9878R
Model/Series:	DHC-2	**Aircraft Category:**	Airplane
Year of Manufacture:	1956	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1135
Landing Gear Type:	Float	**Seats:**	8
Date/Type of Last Inspection:	July 8, 2018 100 hour	**Certified Max Gross Wt.:**	5600 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	22605.8 Hrs as of last inspection	**Engine Manufacturer:**	Pratt and Whitney
ELT:	C126 installed, activated, aided in locating accident	**Engine Model/Series:**	R-985
Registered Owner:	Laughlin Acquisitions LLC	**Rated Power:**	450 Horsepower
Operator:	Alaska Skyways, Inc.	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Regal Air	**Operator Designator Code:**	METC

The accident airplane was equipped with Aerocet model 5850 floats and had a Wipaire 5600 lb gross weight increase kit installed, which increased the maximum takeoff weight to 5,600 lbs.

The Viking DHC-2 AFM, section 4.6.1, stated stall speed with the flaps up was 60 mph indicated airspeed and with landing flaps (50°) stall speed was 45 mph indicated airspeed. No stall speed for takeoff flaps (35°) was provided.

Weight and Balance

The estimated weight and balance at the time of the accident was calculated using the company's documented preflight fuel quantities, reported weights of the passengers, actual weights of recreated passenger purchased items (from receipts), estimated weights of miscellaneous items, likely load placement and company weight and balance figures. The operator recorded 70 gallons of fuel (35 gallons in the forward tank and 35 gallons in the center tank) before the pilot's initial departure from LHD. The flight to Willow Lake was about 25 minutes, and according to the Viking DHC-2 Airplane

Flight Manual (AFM), about 15 gallons would have been used.

Using the calculated values, the gross weight of the airplane at the time of the accident was estimated to be 5,675.8 lbs, which was 75.8 lbs over the maximum gross takeoff weight for the airplane. The estimated center of gravity arm at the time of the accident was 107.76 inches, which was 1.76 inches aft of the rear limit.

Performance

The AFM operating data chart for seaplanes was used to calculate the takeoff distance required to climb above a 50-ft obstacle had the airplane been operating within takeoff limits. The Aerocet Supplement indicated that an additional 90% of the calculated distance should be added to the distance. Using the maximum gross weight and ambient conditions, the takeoff distance required was 1,670 ft without the Aerocet floats, and the Aerocet adjustment resulted in 3,173 ft of required distance.

The AFM section II Normal Procedures, paragraph 2.9 stated that after takeoff, "*…climb at 65 mph. As soon as safe height has been attained, reduce power to 33.5 inches manifold pressure and 2200 rpm if fully loaded. Slowly increase airspeed from 65 mph to 80 mph and retrim. At an altitude of 500 ft- flaps to CLIMB and retrim.*" The best angle of climb is listed as 80 mph.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PAWS,354 ft msl	**Distance from Accident Site:**	17 Nautical Miles
Observation Time:		**Direction from Accident Site:**	123°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.14 inches Hg	**Temperature/Dew Point:**	22°C / 8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Willow, AK (2X2)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Skwentna, AK	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class G

A review of the witness videos revealed that at the time of the takeoff, the wind was calm on the west side of the lake, and light and gusting from the southwest at the east side of the lake. Witnesses reported that the outside air temperature was much warmer than usual. The calculated density altitude at the time of the accident was 976 ft.

Airport Information

Airport:	Willow SPB 2X2	**Runway Surface Type:**	Water
Airport Elevation:	200 ft msl	**Runway Surface Condition:**	Water-calm
Runway Used:	13W	**IFR Approach:**	None
Runway Length/Width:	3600 ft / 400 ft	**VFR Approach/Landing:**	None

Willow Seaplane Base is located on a public lake at 200 ft elevation, and consists of waterways 13W and 31W, which are 3,600 ft long and 400 ft wide in the Alaska Chart Supplement. The full length of the lake is about 4,500 ft. Remarks in the supplement indicated that all aircraft are requested to depart to the south, weather permitting. The terrain area around the lake is relatively level, with a slight increase in elevation to the southeast.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	2 Serious	**Aircraft Fire:**	On-ground
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 2 Serious	**Latitude, Longitude:**	61.732223,-150.048049(est)

The airplane came to rest in a level, wooded, residential lot in a nose-down attitude, on a heading of about 300°. The postcrash fire incinerated the fuselage, cockpit instruments, empennage, floats, engine components, and cargo (see figure 2.)

Figure 2. Accident airplane at the accident scene.

The wreckage consisted primarily of the wings, forward fuselage frame, floor structure and engine with propeller attached. The wreckage exhibited either soot, charring, oxidized metal, or melted aluminum. Hardened masonry mortar was intermixed with the airframe and engine components. The right wing was mostly intact with some fore-to- aft buckling on the outboard leading edge and the flap and aileron were attached. The left wing had significant leading edge buckling near the outer edge. The left flap and aileron were attached, but the flap control rod was disconnected at the C clamp. The left aileron inboard edge had impact damage that matched the adjacent flap edge damage with the flaps extended about 30°, which indicated the flaps were likely at or near the takeoff position at the time of impact.

Aileron flight control continuity was established from the control column through the lower pulley frame to recovery cable cuts, and then from the wing root aileron bell cranks to the aileron surfaces. The rudder control system was continuous from the left rudder pedals to the rudder torque tube, which was fractured, then through recovery cable cuts to the aft rudder bellcrank. The elevator controls were continuous from the cockpit control column to the forward torque tube attachment point. The aft

elevator control cable was disconnected from the torque tube, was covered in melted material and was continuous aft to recovery cable cuts. Full system flight control continuity and control could not be established due to thermal, impact and recovery damage.

The hydraulic reservoir, flap hand pump and flap selector assembly were located on the airframe floor covered in debris. The flap selector lever was in the down position (flaps extended) and the hydraulic hand pump lever was down. The assembly was cleaned and removed from the airframe. Dark purple hydraulic fluid was present at the disconnected lines. The reservoir contained about ¼ inch of fluid. The flap selector lever was manually moved from detent to detent and exhibited smooth operation throughout. The flap selector lever was placed in the down position and the pump handle was moved from stop to stop which resulted in positive hydraulic fluid flow out the down port. The flap selector lever was placed in the up position and hydraulic fluid flowed out the up port when the pump handle was moved.

The engine sustained significant impact and thermal damage. The engine rear accessory section was melted, which liberated the accessory gears from the assembly. Cylinder no. 4 head was detached, and cylinder no. 5 control rods and valves were incinerated. The spark plugs were removed for cylinders 1 through 3 and 5 through 9 and indicated normal wear with orange and white oxidation deposits. All oil lines were charred or missing. The carburetor exhibited extensive thermal damage with the throttle valve separated and melted with the throttle control arm attached. The propeller was attached, and each blade exhibited thermal discoloration or deformation. One blade was bent aft with some torsional twist, and the other two blades were straight with impact and thermal deformation at the outer ends. The engine crankshaft could not be rotated due to extensive damage and melted mortar debris, therefore valvetrain and crankcase continuity was not established.

The examination of the airframe and engine revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation.

Medical and Pathological Information

The Alaska State Medical Examiner, Anchorage, Alaska conducted an autopsy of the pilot. The cause of death was attributed to multiple blunt force injuries.

The FAA's Bioaeronautical Research Sciences Laboratory, Oklahoma City, Oklahoma, performed toxicology tests on specimens from the pilot; results were negative for ethanol and drugs. Carbon monoxide and cyanide tests were not performed.

Tests and Research

A mobile phone believed to belong to the pilot was recovered from the accident scene and examined at the NTSB Recorder Laboratory. The device was damaged extensively by fire and prevented any

information retrieval.

A flap control actuator that was badly burned and melted was recovered from the wreckage. The actuator and housing were too badly burned to determine the exact flap position at impact.

Organizational and Management Information

At the time of the accident, Regal Air was headquartered at LHD and conducted cargo, charter, and sightseeing flights throughout Alaska. The operator's fleet was comprised of three Cessna 206s and three float-equipped de Havilland DHC-2s.

The company had an approved training manual, revision 11, that included categories of training of initial new-hire, initial equipment (specific make and model), and transition training. Initial new-hire training was designed for pilots who had no experience with the operator and included basic indoctrination that reviewed performance, weight and balance procedures, and human factors. Initial ground and flight training was also taught. Company instructors stated that maximum weight takeoffs were taught in initial training on floats, even though it was not listed in the curriculum. The pilot received initial training and qualification in the Cessna C206 on wheels. Transition training was for personnel who have been previously trained and qualified by the operator for a specific duty position (on any company airplane) and were being reassigned to a different aircraft type. It required 3 hours of flight training. The pilot received transition training for the C206 and the DHC-2 on floats.

A pilot who previously worked for Regal Air stated that there was pressure to fly and that the senior check airmen, who subsequently was killed in another fatal company airplane accident, told him that he was concerned about new hire training and particularly the technique of step taxi takeoffs being taught as standard procedure.

As a result of the accident investigation, the company issued policy change on July 25, 2018, that included the following:

- *No intersection takeoffs. Always taxi to the furthest point of a lake to achieve maximum room for takeoff.*

- *Step-turn takeoffs are not authorized unless the procedure has been satisfactorily demonstrated to both the CP and DO. Such takeoffs will not be considered for first-year pilots.*

- *In the event of an aborted takeoff due to available takeoff distance/load, the load *must* be reduced prior to attempting another takeoff.*

Additional Information

Stalls

The FAA Airplane Flying Handbook (FAA-H-8083-3A), chapter 4, stated the following concerning stalls:

A stall is an aerodynamic condition which occurs when smooth airflow over the airplane's wings is disrupted resulting in loss of lift. Specifically, a stall occurs when the AOA-the angle between the chord line of the wing and the relative wind-exceeds the wing's critical AOA. It is possible to exceed the critical AOA at any airspeed, at any attitude, and any power setting.

Child Seat Belt Use

Title 14 *CFR* 135.128 stated that:

...each person on board an aircraft operated under this part shall occupy an approved seat or berth with a separate safety belt properly secured about him or her during movement on the surface, takeoff, and landing. A child may be held by an adult who is occupying an approved seat or berth, provided the child has not reached his or her second birthday.

The 2.5-year-old passenger, who was held on his mother's lap during the accident, received a serious injury to his foot during the accident. His mother was wearing a lap belt. She could not recall where her son was after impact or how she evacuated the wreckage.

Administrative Information

Investigator In Charge (IIC):	Price, Noreen
Additional Participating Persons:	Paula Huckleberry; Federal Aviation Administration; Anchorage, AK Michael Laughlin; Regal Air; Anchorage, AK
Original Publish Date:	December 3, 2020
Last Revision Date:	
Investigation Class:	Class 2
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=97819