Aviation Investigation Final Report

Location:	SKWENTNA, Alaska	**Accident Number:**	ANC97FA099
Date & Time:	July 5, 1997, 09:30 Local	**Registration:**	N5164G
Aircraft:	de Havilland DHC-2	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	4 Fatal, 1 Serious
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

The pilot boarded the 4 passengers and cargo (unsecured) for a chartered flight to a fishing lodge. The floatplane departed uneventfully. About 45 min. later, while cruising about 1,700 ft. above rugged terrain and a river, the engine began to lose power and the floatplane descended. The pilot attempted a forced landing in a small lake that was 1,200 ft. in length and located about 1 mile west of the river. During the approach to landing, the airplane stalled and impacted swampy terrain at the lake's edge in a steep nose down attitude. An examination of the wreckage revealed that the no.1 engine exhaust pushrod had failed in fatigue just below the top (valve) ball end. Examination of the pushrod revealed that material had been pushed away from the rod during installation of the ball end. The fatigue crack may have initiated from a score mark produced by the installation. Pushrod life is reduced due to surface scratches. The life of the failed pushrod could not be determined. Insufficient information exists in the overhaul manual regarding pushrod life/inspection.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: a loss of engine power due to the fatigue failure of the no.1 exhaust push rod. Factors contributing to the accident were: insufficient information on pushrod inspection and overhaul from the manufacturer, unsuitable terrain available for landing, and the pilot's failure to maintain airspeed during the approach which led to an inadvertent stall.

Findings

Occurrence #1: LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation: CRUISE - NORMAL

Findings
1. (C) ENGINE ASSEMBLY,PUSH ROD - FATIGUE
2. MAINTENANCE,OVERHAUL,MAJOR - INADEQUATE - OTHER MAINTENANCE PERSONNEL
3. (F) CONDITION(S)/STEP(S) INSUFFICIENTLY DEFINED - MANUFACTURER

Occurrence #2: FORCED LANDING
Phase of Operation: EMERGENCY DESCENT/LANDING

Occurrence #3: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: EMERGENCY DESCENT/LANDING

Findings
4. SECURITY OF CARGO - NOT PERFORMED - PILOT IN COMMAND
5. AIRCRAFT WEIGHT AND BALANCE - EXCEEDED - PILOT IN COMMAND
6. (F) AIRSPEED - NOT MAINTAINED - PILOT IN COMMAND
7. STALL - INADVERTENT - PILOT IN COMMAND

Occurrence #4: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
8. TERRAIN CONDITION - SWAMPY
9. (F) TERRAIN CONDITION - NONE SUITABLE

Factual Information

HISTORY OF FLIGHT

On July 5, 1997, about 0930 Alaska daylight time, N5164G, a de Havilland DHC-2 floatplane, operated by Alaska Bush Carrier, Inc., collided with terrain and was substantially damaged during a forced landing attempt near Skwentna, Alaska. The forced landing was precipitated by a loss of engine power during cruise flight. The commercial rated pilot and three passengers were killed. A fourth passenger was seriously injured. Visual meteorological conditions prevailed and a company flight plan had been filed. The on-demand air taxi flight departed from Lake Hood, Alaska, at 0840 and was destined for Chelatna Lake, Alaska. The flight was conducted under Title 14 Code of Federal Regulations Part 135.

According to the sole survivor of the accident (interview synopsis and written statements attached), he and the three other passengers arrived at the dock of Alaska Bush Carriers (ABC) sometime between 0700 and 0800 on the morning of the accident for a chartered flight to a fishing lodge. The group was greeted by an ABC employee (interview synopses attached) who asked the passengers how much they weighed. The survivor stated that the accident pilot fueled the airplane and then began loading the baggage. He further stated that he helped load the airplane, and that "light" items were loaded first, followed by a large raft and numerous large bags. The survivor stated that the height of the cargo load did not exceed the height of the rear bench seat back. He said that he was "certain" that the baggage was not secured after it had been loaded; no one had strapped the bags down and he did not see any cargo netting. The survivor further stated that "all of the gear did not fit" in the airplane, and the rest was left behind on the dock.

After all the passengers had boarded, the pilot started the engine. According to the survivor, the airplane then departed on a "normal takeoff." The survivor stated that the airplane flew about 2,000 feet over a "small river" after the takeoff and climbout. He remembered that he noticed the altitude displayed on the airplane's altimeter, and that he compared the readings from the airplane's Global Positioning System (GPS) display with the display of his hand-held GPS.

The survivor stated that there were some "sporadic" and "light" clouds around, but it was still "sunny." He said that he could "always see the ground" during the flight, and that the airplane stayed at 2,000 feet, without any low passes over the ground during the flight.

About "a half an hour to 45 minutes" into the flight, the survivor noticed that the engine suddenly "cut out" for less than a second, then came back in again and sounded "normal." He described the "cut out" as a "cough" that lasted for a "split second." When this occurred, the "pilot immediately started to react" and "banked left." The survivor stated that the pilot

"seemed mostly intent on finding a place to land." He stated that he and the other passengers "did not panic" when the engine cut out, because it sounded like the engine came back to "normal" again.

The survivor stated that the initial left turn "was not severe," and it seemed that the pilot leveled the wings again after the left turn. The survivor remembered that the airplane was "slowly going down" and that the pilot continued to fly and look out the windows for a period of time that was probably "greater than 60 seconds and less than five minutes." During this time, the engine periodically cut out and coughed for brief moments, and then came back to sound "normal" again. He remembered that this occurred more than two times, but less than ten times. The survivor stated that the momentary cough would occur about every 10 to 15 seconds, but he was not sure of the time, and that the period of time between each cough was random. He also stated that he never heard any loud noise coming from the engine (relative to what the engine sounded like to him in a "normal" mode), nor did he hear any loud mechanical banging noise. He stated that the engine did not vibrate severely, and he did not recall a decrease in the engine noise, as if the pilot had turned the engine off.

The survivor stated that the pilot appeared to be talking on the radio and looking out of the airplane during this time. Then, the pilot said something like "we're going down." The survivor stated that he then began to worry. Shortly thereafter, one of the other passengers asked: "Where are we going to land?" According to the survivor, the pilot indicated that he was going to land on a lake directly beneath the airplane. The survivor remembered that the airplane "turned left real hard" and began to descend steeply. He said the turn was "drastic" and he felt like he was "dropping." The survivor stated that it was "obvious" that the airplane was "too high" to land at the lake.

The survivor then remembered feeling that the airplane "lost control." He said he must have "blacked out" at that time, because the next event he remembered was when he was on the ground in the wreckage and partially submerged in water.

According to the Director of Flight Operations for ABC, he arrived at Lake Hood after the accident flight had departed. He told his son, an ABC pilot, to fly the remaining baggage left over from the accident airplane to Lake Chelatna. His son flew to Lake Chelatna later that morning, noticed that the accident airplane had not arrived, and began to search for it along its intended route over the Lake Creek river. The airplane was spotted at the edge of a small lake by the pilot about 3 hours after the accident. It was found about 70 nautical miles northwest of its departure point, and about 40 nautical miles from its destination, along nearly direct routing.

The accident occurred during daylight conditions at the following coordinates: North 62 degrees, 00.57 minutes; West 150 degrees, 57.96 minutes. PERSONNEL INFORMATION

The pilot, male, age 27, possessed a commercial pilot certificate containing ratings for single-engine land, single-engine sea, multiengine land, and instrument airplanes. According to FAA

records, the pilot was issued an FAA Second Class Medical Certificate on February 8, 1997, with no restrictions.

An examination of FAA records, ABC's pilot training records, and daily flight logs (excerpts attached) indicate that the pilot had accumulated a total of about 3,350 hours of flight time, including 2,200 hours in type. The records further indicate that the pilot had flown 3.9 hours in the accident airplane the day before the accident, and 3.2 hours in the accident airplane two days before the accident.

Three days before the accident, on July 2, 1997, the pilot satisfactorily completed an FAA Part 135 Airmen Competency/Proficiency Check (FAA Form 8410-3 attached) in a de Havilland DHC-2. The check ride, conducted by an FAA aviation safety inspector from Anchorage, was 0.8 hours in duration and included "Powerplant Failure," "Approaches to Stalls," and "Emergency Procedures."

Ten months prior to the accident, on September 3, 1996, the pilot was involved in another ABC accident that occurred after takeoff in Port Alsworth, Alaska. According to Safety Board records, the accident involved a Cessna 206 floatplane. The Safety Board determined that the probable cause was "the pilot's inadequate compensation for the wind conditions. A factor associated with the accident was the unfavorable wind." According to ABC pilot training records, the director of flight operations provided additional training to the pilot two days after the accident and reassigned the pilot to full flight status. He also notified the Anchorage FAA Flight Standards District Office of the action. There was no record of any FAA enforcement actions against the pilot.

According to the survivor, the pilot appeared to be in a "normal" mood immediately prior to the accident flight; the pilot did not appear to be "excited" about the flight, nor did he appear to be in poor spirits. The pilot did not complain about any problems with himself or the airplane to the survivor. An investigation did not reveal any significant physical or emotional events for the pilot in the 24-hour period before the accident.

AIRCRAFT INFORMATION The aircraft, N5164G, a de Havilland DHC-2-MK1 "Beaver," was manufactured in 1953. It had been owned and operated by ABC since 1987. The airplane was equipped with floats and was powered by a single Pratt & Whitney R-985-AN14-B radial engine rated at 450 horsepower.

The accident airplane was capable of seating up to six passengers in three rows of seating. According to ABC's seat installation weight and balance sheet (attached), the last row of seats was removed from the airplane on June 28, 1996, creating a total passenger seating capacity of four with additional cargo space.

No receipts and logs were available to determine how much fuel was placed in the airplane by the pilot immediately before the accident flight. However, the director of flight operations stated that it was routine procedure to fill up the forward fuselage tank, and then place a

partial amount of fuel in the center tank that was appropriate for the duration of the flight. According to the director of operations, the aft tank was almost never filled due to weight and balance concerns.

The airplane's published maximum gross takeoff weight was 5,090 pounds in the seaplane configuration. The takeoff weight of the airplane on the morning of the accident was estimated (supporting data attached) by Safety Board investigators to be 5,178 pounds, using the following data derived from available weight and balance records, assumed fuel load, occupant weights provided by the Alaska State Troopers, and baggage weights:

Empty weight of airplane (including oil) -- 3,435 lbs. Usable fuel on board (50 gallons) -- 300 lbs. Pilot & Passengers -- 809 lbs. Baggage and Cargo -- 534 lbs.

Total Weight at Takeoff -- 5,178 lbs. (Fuel consumed during flight -- 90 lbs.) Total Weight at Accident (after 15 gals. fuel burn) - 5,088 lbs.

The Safety Board estimated that the airplane would have consumed about 15 gals. (90 lbs.) of fuel during the accident flight, which left the airplane at least 2 pounds under its published maximum gross takeoff weight at the time of the accident. Calculations also revealed that the airplane was loaded slightly within the aft limit of its published center of gravity limits for both the time of the takeoff and the time of the accident. The Safety Board examined all available maintenance records (excerpts attached) for the airframe and the engine; no unresolved discrepancies were found. The most recent maintenance entry was for a 100-hour inspection that was dated 9 days prior to the accident on June 26, 1997. Another entry, dated 6 months before the accident on January 1, 1997, indicated that the airframe was partially disassembled and overhauled, and that a newly overhauled engine had been installed. The engine was overhauled by a Aero-engines, Inc., an FAA certified repair station in Los Angeles, California. According to the tachometer times recorded in the log book as compared with the time found in the wreckage, the airplane had flown 24.7 hours since its last inspection, and 124.1 hours since the engine overhaul.

The Safety Board reviewed the "Flight Manifest" sheets (excerpts attached) for all flights that occurred in the accident airplane for 3 months prior to the accident. At the bottom of each sheet is a section for "squawks." No remarks were made in this section on any of the sheets reviewed.

According to the DHC-2 Flight Manual, page 4A in the Operating Data Charts Appendix, the total landing distance in the seaplane configuration over a 50-foot obstacle is about 1,500 feet under the following conditions: 55 degrees F, landing flaps, no wind, calm sea. According to page 36 of the manual, the stall speed of the airplane in a 60 degree bank and with no flaps is 115 miles per hour. The manual also states: "In tight turns, flight load factors may reach their limit loads, and may also increase the danger of an unintentional stall."

METEOROLOGICAL INFORMATION

The following surface conditions were reported at the Skwentna Airport about 30 minutes prior to the accident: cloud ceiling -- broken at 1,500 feet above the ground; visibility - 15 statute miles; temperature - 55 degrees F; dew point - 52 degrees F; winds out of 155 degrees magnetic at 5 knots; remarks - partial fog. The Skwentna Airport sits at an elevation of 149 feet above mean sea level (msl) and is located about 8 nautical miles southwest of the accident site.

WRECKAGE AND IMPACT INFORMATION

The airplane wreckage was examined at the accident site by the Safety Board on July 6, 1997, one day after the accident, and again on July 24, 1997, in Willow, Alaska.

The accident site (topographic map attached) was located at the edge of a lake that was about 1,200 feet long (as measured with a topographic map along its longest axis, oriented northeast-southwest), and 700 feet wide. The location of the accident site was about 1 mile to the west of the Lake Creek river at it's closest proximity (according to ABC, the normal routing of the flight is along the Lake Creek river toward Chelatna Lake).

The elevation of the accident site was about 260 feet msl. The terrain surrounding the accident site consisted of rolling hills that were heavily wooded with trees about 60 feet in height above the terrain. An aerial survey of the terrain within a 2-mile circular radius of the accident site revealed rugged, rolling, heavily-wooded terrain with few flat areas or lakes larger than the accident site lake. The Lake Creek river consisted of a narrow, shallow, rocky river with steep banks in the vicinity of the accident site.

A ground scar (wreckage diagram attached) that was about 4 inches deep and 2 feet in length was found 36 feet from the center of the wreckage. It was oriented along a magnetic bearing of 060 degrees toward the wreckage. Another ground scar was found about 10 feet from the first ground scar and was similar in length to the span of the left wing.

An examination of the wreckage revealed that the entire aircraft, including it's floats, was partially buried into swampy terrain in a nose-down attitude. The longitudinal axis of the fuselage formed an impact angle of about 90 degrees nose-down with the horizon. Both wings and both floats remained partially attached to the airframe. The left float was buried slightly deeper that the right float. The wings remained about perpendicular to the fuselage and were facing toward a northerly heading; their leading edges were undamaged. The right wing protruded into the water's edge on the lake, while the left wing was lying on the swampy terrain. The left wing tip was curled upward about 60 degrees and crushed aft.

The fuselage and float structure aft of the wings, including all tail surfaces, received only minor damage. The forward portion of the fuselage structure, beginning at the wing attach points, was buried into the terrain. No evidence of fire or in-flight structural failure was found. All of the flight control surfaces were accounted for at the accident site. The elevator trim tab was

found in the neutral position. The wing flaps were partially detached from the wing and a reliable flap setting could not be determined from their position.

The wreckage was removed from the accident and examined further in a hangar. No evidence of a preimpact flight control malfunction was found. The exposed portion of the hydraulically driven flap actuator revealed that it was in the fully extended position.

The majority of the flight instruments and cockpit gauges were intact and undamaged. The electric clock was stopped at 9:19. The tachometer time read 0124.1 hours. The hour meter read 6033.0 hours. The airspeed indicator needle read zero miles per hour. The vertical speed indicator read 1,000 feet per minute descent. The attitude indicator read a 10-degree nose up pitch attitude and a 15-degree right bank. The flap indicator needle read "FULL FLAPS."

The throttle control was found in the full open (forward) position. The mixture control was found in the full rich (forward) position. The propeller control was found about half way from the full decrease position. The carburetor heat control was in the COLD position. The fuel selector valve was found in the forward tank position.

The tachometer read 3,000 revolutions per minute. The oil temperature gauge read 30 degrees C (just outside of the green arc). The oil pressure gauge read 50 pounds per square inch. The fuel pressure gauge and the suction gauge were pegged to the left (no reading) position.

The ignition switch was found jammed in the "RIGHT" magneto position. The electrical master switch was found in the OFF position. The Emergency Fuel and Oil Shut Off switch was found in the stowed (normal) position with the safety wire intact.

The engine remained attached to its engine mounts and was displaced aft about 6 inches. All cockpit control linkages remained intact. A visual examination of the engine mounts did not reveal any evidence of preimpact twisting or damage. A visual examination of the exterior of the engine also did not reveal any evidence of preimpact catastrophic mechanical failure. The two-bladed propeller remained attached to the propeller flange. Both blades were bent back slightly, beginning at the center of their spans. Slight twisting was noted at the outboard portions of each blade. The propeller spinner did not exhibit any torsional damage.

All of the pushrod tubes were intact and undamaged except for cylinder nos. 7 and 8. The propeller rotated smoothly throughout 360 degrees of rotation after the removal of water from the cylinder nos. 5, 6, and 7.

The engine was removed from the airframe and taken to an engine repair facility in Anchorage, Alaska, under Safety Board supervision. On August 14, 1997, the engine was partially disassembled and inspected by the Safety Board. The inspection revealed that the no. 1 cylinder did not hold compression during a differential air pressure compression check. The no. 1 cylinder was removed for further examination. The examination revealed that the no. 1 exhaust pushrod had fractured just below the ball end fitting on the exhaust valve side of the

rod. The fractured pieces and the entire no. 1 cylinder assembly were secured for further analysis, along with a sampling of the other pushrods from the engine.

Prior to the removal of the pushrods for cylinder nos. 2 through 9, their valve clearances were measured. Both the intake and exhaust valves for the no. 2 cylinder had a cold valve clearance of about .020 inches (the published maximum allowable valve clearance is .015 inches). Both the intake and exhaust valves for the no. 9 cylinder had a clearance of about .015 inches. All other valve clearances ranged between .010 and .015 inches. An examination of the exhaust cam lobes did not reveal any remarkable wear patterns. No other preimpact anomalies or discrepancies were found with the engine.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the pilot by Dr. Franc G. Fallico, M.D., on July 7, 1997, at the State of Alaska Office of the Medical Examiner in Anchorage, Alaska. According to the report of autopsy, the cause of death was "Blunt impact injury due to airplane crash ... ." Specimens taken from the pilot were analyzed by the FAA Civil Aeromedical Institute, Oklahoma City, Oklahoma. According to their report dated October 14, 1997 (attached), negative results for carbon monoxide, cyanide, alcohol, and all screened drugs were reported.

SURVIVAL ASPECTS

The survivor stated that he sat in the right side of the airplane, in the rear bench seat. He stated that he was wearing his lap belt, and he felt that the other passengers were also wearing their lap belts. No shoulder harnesses were installed in the aircraft for the rear seat occupants.

The survivor stated that after the accident, he noticed that there were bags pinning the front seat passenger under the water, and he could see the bags move upward as if the passenger was attempting to push up on them so that he could get his head above the water. He saw the bags move a "couple of times," then stop. He also observed the pilot attempt to get his head above the water. The survivor then remembered that he waited for a period of time (that he could not determine) until help arrived.

According to the first rescuer to arrive at the site (interview synopsis attached), the sole survivor could be heard in the wreckage. The rescuer stated that the survivor could not be seen at first, because there was a "pile of items" that had "tumbled on top of" the three occupants in the rear seat. She stated that she and the rescue pilot spent "about 15 minutes" removing the baggage. She recalled that a raft was one of the first items they removed, followed by some lighter items and a "dry red bag" that they had cut open in order to facilitate removal. She stated that she cut away cargo netting as they began to move the tumbled bags, and that the bags were not restrained by the netting. She remembered cutting the netting just to get it out of the way, and that the cutting occurred near the back of the airplane.

The rescuer stated that the survivor was able to keep his head above the water level because of the positioning of an oar near him, and because the airplane was leaning in such a way as to "favor" him. The two occupants seated next to the survivor had their faces pressed into the water by the bags on top of them. The rescuer also stated that the pilot and front seat passenger were completely submerged in the water.

No emergency locator transmitter (ELT) signal had been received after the accident. An examination of the ELT at the accident site revealed that it was found out of its tailcone-mounted bracket. The power and antenna cables remained attached to the ELT. The ELT switch was found in the "OFF" position. The Safety Board could not confirm whether rescue personnel had turned the ELT off. The ELT was manufactured by ACK Technologies, Inc., model number E-01, serial number 023437.

TESTS AND RESEARCH

Engine Overhaul Information.

An examination of the engine maintenance log book revealed that the engine was overhauled by Aero-Engines, Inc., on January 16, 1996. A log book entry indicated that the engine had accumulated an estimated 6,132 hours of operating time before the overhaul, and that it was "ground test run" for 5 hours and 4 minutes at the completion of the overhaul. The Safety Board requested and received all available records (attached) associated with the overhaul. According to the overhaul records, none of the pushrods and ball ends that came into the Aero-Engines prior to the overhaul were rejected during the overhaul process.

Metallurgical Examination of the Pushrod.

All of the pushrods from the accident engine, except for cylinder nos. 7 and 8, were examined at the Safety Board's Materials Laboratory Division in Washington, DC. According to the technician's factual report (attached), the undamaged areas of the fracture face on the no. 1 exhaust pushrod tube that remained in the ball end " ... suggest a progressive failure." A portion of the pushrod tube material that remained in the ball end was then removed and examined. The surface of the material "... contained longitudinal assembly scratches as well as a series of heavier circumferential marks ... indicating assembly increments."

The report also states: "The other 12 pushrods submitted were examined and the identifications that were permanently etched on the ball ends were noted. As many as three different identifications were noted on a pushrod and not all of them were on the same ball end ... . The examination also revealed pushrod material that had been pushed forward when the ball end was installed on the tube."

Pushrod total lengths and diameters were measured and met manufacturer's specifications. A determination of the pushrod material was also performed; the determination revealed that the material found was consistent with the manufacturers' specified material.

A band of scratches measuring about 0.27 inches in length was found on the fractured pushrod about 1/2-inch below the fracture face of the no. 1 exhaust pushrod. This measurement corresponds with the lift of the cam drum which is 0.284 inches. According to the report, "... a number of cracks had been initiated... " at intermittent intervals along the edge of the band close to the fracture face.

Pushrod Overhaul Procedures.

According to a representative of Aero-Engines, an attempt is made to reuse most of the parts that are attached to an engine when it comes in for overhaul. The engine is disassembled and the pushrods are removed. The ball ends on each pushrod are then removed from the pushrod with the use of a tool that resembles a slide hammer. The tool clamps down (two halves) onto the pushrod and repetitive movement of the slide allows the ball end to be pulled away. The ball ends and pushrods are then cleaned in a solution and visually inspected for material impurities and nicks. The ball ends are then magnetically inspected, and their inner diameters are measured. Specimens are rejected if they exhibit, too much wear or damage, in the opinion of the technician. The accepted pushrods are then checked to ensure that they are not bent.

The accepted ball ends and the pushrods are then measured with a micrometer to ensure that they meet the manufacturer's specified dimensions. The ball ends are then heated in an oven for about 30 minutes, and the pushrods are cooled in a freezer for a similar period of time. The ball ends are then placed on the pushrods and are manually tapped onto the rod with a soft hammer. The ball ends are then secured to the rod via an interference fit. Washers may be installed inside the ball ends to adjust the overall length of the assembled pushrods. The pushrods are then placed in the overhauled engine and the valves are adjusted as per the manufacturer's specifications. The engine is then test run for five hours and the valves are readjusted, if necessary.

The most recent revision date of overhaul manual (excerpts attached) that is published by Pratt & Whitney for the R-985 engine is October 1979. The manual is used by Aero-Engines. According to page 112A, under "Inspection...Pushrods," the following guidance is provided:

"Remove ball-ends and magnetically inspect ball-ends and retain those found to be in a serviceable condition. Inspection of steel exhaust pushrods [used on the R-1340 engine] shall be accomplished by fluorescent penetrant method. Check the rods for straightness by rolling them on a flat plane. Reject any rod bent more than 0.005 inch as measured by feeler stock. No attempt shall be made to straighten the rod. Carefully inspect each end of the rod. Reject any rod on which longitudinal or circumferential scoring greater than 0.002 inch-deep is present. Polish out any light scoring taking care not leave any circumferential marks or steps, or reduce [outer diameter] size relative to fitting pushrods."

Under the "Assembly...Pushrods" sections of the overhaul manual, the following guidance is provided:

"One of the ballends on each pushrod bears the number of the cylinder into which it fits. The exhaust rods are marked with an "Ex". After the cylinder number and the intake rods are marked "in". Scoring of the rods when installing the Pushrods could create an undesirable shoulder. To preclude this, chill the rods in dry ice for five to fifteen minutes and heat the Pushrods in oil heated to 350 [degrees} F (1777[degrees C) for fifteen minutes. Assemble the ballends on the pushrods using the required quantity of spacers. Care must be taken to maintain the proper alignment between the ballend and the rod when assembling the parts."

Failure History of the Pushrod.

The Safety Board reviewed all de Havilland DHC- 2 reported accidents that occurred since 1983, and all reported accidents that involved the Pratt & Whitney R-985 engine. The review revealed no accidents involving a failed pushrod. One accident (brief attached) that occurred on September 15, 1988, involved the failure of an unspecified exhaust valve on a R-985 engine. According to the Safety Board's brief of the accident: "While cruising, the pilot-in-command experienced a rough engine and finally an unexplained power reduction to idle. He was unable to glide the float equipped airplane to a body of water and executed a forced landing on the tundra where the airplane sustained substantial damage. Examination of the engine revealed a failed exhaust valve." The Safety Board determined that the probable cause of the accident was the failure of the exhaust valve, and a contributing factor was unsuitable terrain.

The Safety Board also conducted a review of all FAA Service Difficulty Reports since 1990 that cited a pushrod discrepancy in the R-985 engine. The review revealed two reports (attached), one of which was reported as a result of this accident. The other report was dated October 20, 1997, and cited the following: "Ball end of [no. 1] cylinder pushrod came loose, cocked and lodged in the exhaust valve causing the engine to run rough." The Safety Board contacted a mechanic with a Canadian operator, Air Rainbow, that submitted the report. According to the mechanic, the pushrod was not fractured. Instead, the ball end slipped off the end about 3/4 of its travel and became lodged against the exhaust valve. The mechanic stated that the problem was reported by a ground agent who heard the engine run rough, and that the roughness was intermittent. The mechanic also stated that the engine had accumulated 715 hours since its last overhaul, and that he later replaced the entire pushrod assembly. He stated that he did not know why the ball end was loose.

ADDITIONAL INFORMATION

The aircraft wreckage, except for the entire engine and the GPS unit, was released to Mr. Derrill Fulkerson, of AIG Aviation, Los Angeles, California, on July 24, 1997. Mr. Fulkerson was representing the registered owner of the airplane at the time of the release. The GPS unit and engine, including the failed pushrod, were later released to Mr. Fulkerson on April 1, 1998.

Pilot Information

Certificate:	Commercial	**Age:**	27,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	February 8, 1997
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	3350 hours (Total, all aircraft), 2200 hours (Total, this make and model), 3200 hours (Pilot In Command, all aircraft), 100 hours (Last 90 days, all aircraft), 81 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	de Havilland	**Registration:**	N5164G
Model/Series:	DHC-2 DHC-2	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	506
Landing Gear Type:	Float	**Seats:**	5
Date/Type of Last Inspection:	June 26, 1997 100 hour	**Certified Max Gross Wt.:**	5090 lbs
Time Since Last Inspection:	24 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	13864 Hrs	**Engine Manufacturer:**	P&W
ELT:	Installed, not activated	**Engine Model/Series:**	R-985-AN14-B
Registered Owner:	ALASKA BUSH CARRIERS, INC.	**Rated Power:**	450 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:		**Operator Designator Code:**	EMHA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	SKW	**Distance from Accident Site:**	8 Nautical Miles
Observation Time:	08:53 Local	**Direction from Accident Site:**	224°
Lowest Cloud Condition:	Unknown	**Visibility**	15 miles
Lowest Ceiling:	Broken / 1500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	155°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	13°C / 11°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	LAKE HOOD	**Type of Flight Plan Filed:**	Company VFR
Destination:	CHELATNA LAKE	**Type of Clearance:**	None
Departure Time:	08:40 Local	**Type of Airspace:**	Class G

Airport Information

Airport:		**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	0	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 Fatal, 1 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	4 Fatal, 1 Serious	**Latitude, Longitude:**	61.930221,-151.730972(est)

Administrative Information

Investigator In Charge (IIC):	Guzzetti, Jeffrey
Additional Participating Persons:	MAURICE HENDRICKSON; ANCHORAGE , AK DAVID KLOSTERMAN; ANCHORAGE , AK
Original Publish Date:	November 10, 1998
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=2938