Aviation Investigation Final Report

Location:	Aniak, Alaska	**Accident Number:**	ANC17LA052
Date & Time:	August 18, 2017, 14:00 Local	**Registration:**	N92DC
Aircraft:	Cessna A185	**Aircraft Damage:**	Substantial
Defining Event:	Part(s) separation from AC	**Injuries:**	4 None
Flight Conducted Under:	Part 91: General aviation		

Analysis

The pilot/operator was taxiing the airplane for takeoff. While the airplane was moving about 15 mph and about 2,700 rpm, a blade from the metal two-blade propeller separated. After the separation, the pilot maintained control of the airplane and shut down the airplane. The engine mount sustained substantial damage from excessive vibrations caused by the propeller blade separation.

An examination of the fractured propeller blade revealed that it had failed due to fatigue cracking that had initiated from a nick in the leading edge. Measurement of the nick revealed it was within tolerance for a field repair although a field repair had not been performed.

The airplane was frequently used at unpaved runways and airstrips in remote locations. It is likely a nick was sustained on the propeller during the backcountry operations; however, it could not be determined when that nick occurred or when the fatigue crack was initiated.

The airplane manufacturer owner's manual indicates that the propeller should be checked for nicks during the preflight inspection. It is likely the pilot/operator did not adequately inspect the propeller during the preflight inspection. Had an adequate inspection been completed, the nick likely would have been identified and could have been field repaired.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's inadequate preflight inspection, which failed to detect a crack in the propeller blade, which led to the separation of a section of a propeller blade due to fatigue.

Findings

Aircraft	Propeller blade section - Failure
Aircraft	Propeller blade section - Fatigue/wear/corrosion
Personnel issues	Preflight inspection - Pilot

Factual Information

History of Flight

Prior to flight	Aircraft inspection event
Taxi	Powerplant sys/comp malf/fail
Taxi	Part(s) separation from AC (Defining event)

On August 18, 2017, about 1400 Alaska daylight time, a tailwheel-equipped Cessna A185F airplane, N92DC, sustained substantial damage from a propeller blade separation at the Aniak Airport (ANI), Aniak, Alaska. The private pilot and three passengers sustained no injury. The airplane was registered to and operated by the pilot, dba Adams Guiding Service, as a visual flight rules business flight under the provisions of Title 14 *Code of Federal Regulations (CFR)* Part 91. Day visual meteorological conditions prevailed at the time of the accident, and no flight plan was filed. The flight originated from ANI, about 1400.

The pilot reported the purpose of the flight was to depart from ANI and take the three passengers on a remote guided hunting operation south of Aniak, Alaska. While the airplane was taxiing for takeoff at about 15 mph and about 2,700 rpm, a blade from the metal two blade propeller separated. After the separation, the pilot was able to maintain control of the airplane and shutdown the airplane without further incident as shown below in figure 1. No injuries to personnel on the ground occurred after the propeller blade separation.

Figure 1 – View of the airplane after it was shutdown (courtesy of the pilot).

Prior to the propeller blade separation, the pilot reported there were no known mechanical malfunctions or failures with the airframe, the engine, and the propeller.

Pilot Information

Certificate:	Private	**Age:**	62,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Glider	**Restraint Used:**	3-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	January 3, 2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	March 22, 2017
Flight Time:	(Estimated) 14500 hours (Total, all aircraft), 5200 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N92DC
Model/Series:	A185 F	**Aircraft Category:**	Airplane
Year of Manufacture:	1975	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	18502828
Landing Gear Type:	Tailwheel	**Seats:**	4
Date/Type of Last Inspection:	July 13, 2017 Annual	**Certified Max Gross Wt.:**	3350 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	8193.6 Hrs at time of accident	**Engine Manufacturer:**	Continental
ELT:	Installed, not activated	**Engine Model/Series:**	IO-520 Series
Registered Owner:	On file	**Rated Power:**	300 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The airplane was equipped with a McCauley Propeller Systems controllable pitch (also known as a constant speed) aluminum propeller, model number D2A34C58-0 (serial number 951968), which had amassed 1,575.5 hours since the propeller was overhauled (conducted on April 15, 2008).

A review of the maintenance records revealed that the propeller had undergone a 100-hour inspection on July 13, 2017, at which time it had accumulated 1,544.6 hours since the propeller was overhauled. The propeller had also undergone a 100-hour inspection on March 16, 2017, at which time it had accumulated 1,489.2 hours since the propeller was overhauled.

An examination of the maintenance records revealed no evidence of uncorrected mechanical discrepancies with the propeller.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PANI,85 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	20:56 Local	**Direction from Accident Site:**	25°
Lowest Cloud Condition:	Scattered / 1600 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Broken / 2700 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	8 knots / None	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	340°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.7 inches Hg	**Temperature/Dew Point:**	10°C / 7°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Aniak, AK (ANI)	**Type of Flight Plan Filed:**	None
Destination:	Aniak, AK	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class E

Airport Information

Airport:	ANIAK ANI	**Runway Surface Type:**	Asphalt
Airport Elevation:	95 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	29	**IFR Approach:**	None
Runway Length/Width:	6001 ft / 150 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	4 None	**Latitude, Longitude:**	61.581665,-159.543334(est)

A postflight inspection by the pilot revealed the engine mount sustained substantial damage from excessive vibrations caused by the propeller blade separation as shown below in figure 2.

Figure 2 – View of the fractured engine mount (courtesy of the pilot).

Tests and Research

The intact propeller blade (referred to as blade #1), including the separated blade (referred to as blade #2), were recovered and transported to the National Transportation Safety Board Materials Laboratory in Washington, District of Columbia, for an examination. The complete examination report with pictures is in the public docket for this accident.

The #2 blade of the submitted propeller separated into two pieces as shown below in figure 3. The separation was located approximately a third of the blade length from the root of the blade. The crack extended from the leading edge and was roughly v-shaped along the chord of the blade. The blades were disassembled from the hub.

Figure 3 – View of the separated blade (blade #2).

The fracture surface was sectioned from the root half of the blade. There was a distinct thumbnail-shaped pattern emanating from a small nick in the leading edge of the blade.

The size of the nick measured approximately 0.07 inches by 0.08 inches, with a maximum depth of roughly 0.02 inches. A long grain was observed on the fracture surface adjacent to the forward side of the blade. The orientation of the long grain likely contributed to the v-shape of the crack path along the chord length of the blade.

The nick exhibited no signs of a prior field repair. It could not be determined when the fatigue crack was initiated.

The fracture surface was examined using a Zeiss Auriga 40 field emission scanning electron microscope. The fracture surface had transgranular features consistent with fatigue. Crack arrest lines on the fracture surface indicated the fatigue emanated from a corner of deformed material that resulted from the nick in the leading edge.

A portion of the #2 blade was sectioned and sent to Lehigh Testing Laboratories (New Castle, Delaware) for chemical analysis and mechanical property testing. The chemistry of the blade material was inspected using inductively coupled plasma spectroscopy. The chemical composition was consistent with 2025 aluminum alloy per AMS-QQ-A-367A. The material specified per the forging drawing was 2025-T6 aluminum.

Three tensile specimens were sectioned and machined from the blade and tested to failure per ASTM B557-15A. The 0.2% offset yield strength averaged 37 ksi and the ultimate tensile strength averaged 56 ksi, with an average 19% elongation (in 2 inches). All of these mechanical test data exceed the minimums stated in AMS-QQ-A-367A.

The average hardness of the blade material measured per ASTM E10-15A was 119 HBW, which is above the specified 100 Brinell hardness minimum per AMS-QQ-A-367A.

Organizational and Management Information

Cessna

The Cessna A185F Owner's Manual discusses the preflight procedures and states in part:

Check propeller and spinner for nicks and security.

The Cessna A185F Owner's Manual also discusses care for the propeller and states in part:

Small nicks on the propeller, particularly near the tips and on the leading edges, should be dressed out as soon as possible since these nicks produce stress concentrations, and if ignored, may result in cracks.

McCauley

McCauley has published Service Letter 1995-4C Field Inspection and Repair of Propeller Blades. This document discusses stress riser damage and the associated repair requirements and states in part:

Stress risers can cause failure of a blade if not repaired.

A stress riser is an increase in stress intensity surrounding an area of reduced cross-sectional area. A sharp stress riser is an increased stress intensity attributed to a notch-like displacement of material resulting from a sharp object impact, leaving a very small radius at the bottom of the displaced material.

Sometimes a stress riser in the propeller may be referred to as a nick.

Stress riser damage found during a routine inspection must be field repaired if it is not beyond the field repair limits. If damage is beyond the field repair limits, the blade must be evaluated and/or replaced by an FAA approved Part 145 Propeller Repair Station or international equivalent.

This document states that for damage that is located on the leading or trailing edges of blades must not exceed 0.094 inches in depth. Damage exceeding 0.094 inches in depth is not classified as field repairable and a 14 *CFR* Part 145 repair station must perform the repair work.

McCauley has published Service Bulletin 137AF Revised Time Between Overhaul. This document states that for the D2A34C58-0 model propeller, the overhaul frequency is 1,500 hours or 60 calendar months, whichever occurs first (the exception is for agricultural aircraft installations, where the overhaul frequency is 1,200 hours or 60 calendar months, whichever occurs first). This document discusses time between overhaul (TBO) requirements and states in part:

TBO specifications are based on normal aircraft with normal and continuous usage. Flight time and calendar limit must not be the only factors considered in determining when a propeller needs to be overhauled. Factors such as operating conditions or environment often demand that a propeller, governor, or accumulator be overhauled prior to TBO. Even though a propeller may be operating normally and have a good external appearance when the TBO flight time or calendar limit is reached, operation beyond the specified TBO limits is not permitted.

The accident hub assembly and propeller blades do not have a published life limit that requires replacement. The hub assembly and propeller blades can be used indefinitely if an overhaul is preformed every 1,500 hours or 60 calendar months (whichever occurs first), and all components remain in a serviceable condition.

It was undetermined why the propeller was not overhauled during the most recent 100-hour inspection (July 13, 2017 – 1,544.6 hours accumulated) or the second most recent 100-hour inspection (March 16, 2017 – 1,489.2 hours accumulated). For both inspections, the same airframe and powerplant mechanic (with inspection authorization), performed the work. Copies of the maintenance records are in the public docket for this accident.

Federal Aviation Administration

The Federal Aviation Administration has published Advisory Circular 20-37E Aircraft Propeller Maintenance. This document discusses propeller design and causes of propeller failure and states in part:

A propeller is one of the most highly stressed components on an aircraft. During normal operation, 10 to 25 tons of centrifugal force pull the blades from the hub while the blades are bending and flexing due to thrust and torque loads and engine, aerodynamic and gyroscopic vibratory loads. A properly maintained propeller is designed to perform normally under these loads, but when propeller components are damaged by corrosion, stone nicks, ground strikes, etc., an additional unintended stress concentration is imposed and the design margin of safety may not be adequate. The result is excessive stress and the propeller may fail.

Additional causes of overstress conditions are exposure to overspeed conditions, other object strikes, unauthorized alterations, engine problems, worn engine vibration dampers, lightning strike, etc. Most mechanical damage takes the form of sharp-edged nicks and scratches created by the displacement of material from the blade surface and corrosion that forms pits and other defects in the blade surface. This small-scale damage tends to concentrate stress in the affected area and eventually, these high-stress areas may develop cracks. As a crack propagates, the stress becomes increasingly concentrated, increasing the crack growth rate. The growing crack may result in blade failure.

This document also defines a nick and a crack on a propeller blade and states:

Nick. A sharp notch-like displacement of metal usually found on leading and trailing edges.

Crack. A physical opening or fissure within the body of a material. May be either internal within the material or at the surface (surface breaking). On a propeller, cracks can be started by cuts, nicks, or

corrosion.

Adams Guiding Service

The pilot is the owner of Adams Guiding Service and the airplane was used in conjunction with the business. The airplane was used throughout various remote locations in western Alaska for guided fishing and hunting operations, including usage on unpaved runways and airstrips.

Additional Information

Backcountry Flight Operations

Mountain, Canyon, and Backcountry Flying by Amy L. Hoover and Richard K. Williams provides guidance on preflight inspection areas that are unique for airplanes used for backcountry flight operations. This book discusses the preflight inspection of a propeller and states in part:

The propeller should be inspected before every flight, and blade nicks, cuts, or gouges must be properly dressed.

Administrative Information

Investigator In Charge (IIC):	Hodges, Michael
Additional Participating Persons:	Gregory Varner; FAA Anchorage FSDO; Anchorage, AK Henry Soderlund; Textron Aviation; Wichita , KS
Original Publish Date:	August 3, 2020
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=95998