



Aviation Investigation Final Report

Location:	Ironside, Oregon	Accident Number:	WPR15LA248
Date & Time:	August 19, 2015, 19:15 Local	Registration:	N1043T
Aircraft:	Sikorsky S 61A	Aircraft Damage:	Substantial
Defining Event:	External load event (Rotorcraft)	Injuries:	1 Minor, 1 None
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The commercial pilot reported that they had picked up 4,000 lbs of water from a pond for a helicopter firefighting operation and were starting a climbing left turn. About 20 ft above the ground, the No. 2 (right) engine lost power, and the rpm dropped. The pilot dumped the water from the bucket and attempted to gain airspeed and altitude as the helicopter entered a small valley. The pilot also attempted to release the longline and bucket to no avail. The second pilot used the emergency throttle, but the helicopter continued to lose engine and rotor rpm. Unable to gain altitude and with the terrain rising, the pilot landed the helicopter, which subsequently rolled over and came to rest on its right side. Before touchdown, the longline and bucket had impacted brush and trees and the bucket became entangled in a fence, which likely hindered the pilot's ability to successfully land the helicopter.

On-scene examination revealed that the fuselage belly hook released the longline as intended; however, one of the two hydraulic quick-disconnect couplings failed to release the longline. A safety wire was used to connect the fitting on the quick-disconnect mechanism to the coupling. The use of the safety wire did not allow the quick-disconnect mechanism to function as intended and release the longline.

The examination of the No. 2 (right) engine revealed metallic debris on all four magnetic plugs. The front frame accessory drive was manually rotated, and no concurrent rotation of the centrifugal fuel purifier drive splines was observed. Removal of the radial driveshaft revealed scallop-shaped wear marks around the shaft, which matched the mating female splines of the pinion assembly. In addition, about 0.10 inch of material wear was observed on the front frame housing consistent with pinion gear assembly contact. Removal of the pinion gear assembly from the accessory gearbox revealed that the pinion gear, which mates with the bevel gear, exhibited wear on the gear teeth and some metal smearing along the tips, which is consistent with gear disengagement. When the bevel and pinion splines disengaged, the fuel and oil pumps were no longer being driven, so fuel and lubrication to the engine were cut and the engine lost power.

Disassembly of the pinion support assembly revealed roller ball, bearing cage, and race damage to the upper support bearing and wear to the bevel gear teeth consistent with that observed on the mating pinion. Aluminum oxide particles were embedded in the cage pocket and inner races of both bearings and likely contributed to the bearing wear that eventually caused bevel and pinion gear disengagement.

According to the manufacturer, aluminum oxide is not present in this engine's bearing or any component within the oil lubrication system pathway. However, aluminum oxide can be introduced into the engine during the overhaul/repair process if measures are not taken to maintain a clean environment, including management of air flow when bearings are exposed. Aluminum oxide is abrasive and, once embedded into the bearing, will typically result in uneven wear and accelerated failure. The last engine light overhaul was completed about 1 year before the accident, and it is likely that the aluminum oxide was introduced at that time.

Probable Cause and Findings

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

A loss of power to the No. 2 engine due to the failure of the accessory gearbox drivetrain. Also causal was the pilot's inability to release the external longline due to the use of a safety wire across the coupling of the quick-disconnect mechanism, which interfered with his efforts to land. Contributing to the accident was the repair facility's failure to maintain a clean environment, which resulted in the inadvertent introduction of a contaminant during the engine overhaul/repair process.

Findings

Aircraft	Agricultural/external load sys - Malfunction
Aircraft	(general) - Failure
Aircraft	(general) - Fatigue/wear/corrosion
Aircraft	(general) - Incorrect service/maintenance
Environmental issues	Fence/fence post - Contributed to outcome

Factual Information

History of Flight

Maneuvering-low-alt flying	Loss of engine power (partial)
Maneuvering-low-alt flying	Off-field or emergency landing
Maneuvering-low-alt flying	External load event (Rotorcraft) (Defining event)
Maneuvering-low-alt flying	Collision with terr/obj (non-CFIT)

On August 19, 2015, about 1915 Pacific daylight time, a Sikorsky S-61A helicopter, N1043T, experienced a partial loss of power to the No. 2 (right) engine and subsequently landed on a mountainside and rolled over about 7 miles west of Ironside, Oregon. The commercial pilot was not injured; the airline transport pilot sustained minor injuries. The helicopter sustained substantial damage to the tailboom. The helicopter was registered to and operated by Croman Corp as a Title 14 *Code of Federal Regulations* Part 133 firefighting flight. Visual meteorological conditions prevailed for the flight which operated under a company flight plan. The flight originated from Baker City Municipal Airport (BKE), Baker City, Oregon at 1715.

The commercial pilot reported that they picked up 4,000 pounds of water from a pond then made a climbing left turn to the east towards the fire. About 20 ft above the ground, there was an engine power loss and a drop in RPM. The pilot dumped the water from the bucket at the end of the longline and attempted to gain airspeed and altitude as they entered a small valley. The pilot was keeping the bucket clear of the ground and obstacles when he attempted to release the longline, but it would not fully release from the helicopter fuselage. The second pilot used the emergency throttle, but the engine did not respond; they continued to lose engine RPM and rotor RPM. With the terrain rising, they found the flattest accessible spot and began to slow the helicopter. The pilot landed the helicopter as level as possible, however, the helicopter rolled onto its right side. Prior to the helicopter touching down, the bucket impacted brush and trees and became tangled in a wire fence.

Pilot Information

Certificate:	Commercial	Age:	67,Male
Airplane Rating(s):	None	Seat Occupied:	Left
Other Aircraft Rating(s):	Helicopter	Restraint Used:	3-point
Instrument Rating(s):	None	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 2 With waivers/limitations	Last FAA Medical Exam:	October 14, 2014
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	April 3, 2015
Flight Time:	26062 hours (Total, all aircraft), 14863 hours (Total, this make and model), 24500 hours (Pilot In Command, all aircraft), 145 hours (Last 90 days, all aircraft), 52 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport	Age:	65,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	3-point
Instrument Rating(s):	Helicopter	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 2 With waivers/limitations	Last FAA Medical Exam:	January 20, 2015
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	August 15, 2015
Flight Time:	17016 hours (Total, all aircraft), 14177 hours (Pilot In Command, all aircraft), 17 hours (Last 90 days, all aircraft), 17 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Sikorsky	Registration:	N1043T
Model/Series:	S 61A	Aircraft Category:	Helicopter
Year of Manufacture:	1982	Amateur Built:	
Airworthiness Certificate:	Restricted (Special)	Serial Number:	61083
Landing Gear Type:	Tailwheel	Seats:	2
Date/Type of Last Inspection:	August 9, 2015 Continuous airworthiness	Certified Max Gross Wt.:	21000 lbs
Time Since Last Inspection:	56 Hrs	Engines:	2 Turbo shaft
Airframe Total Time:	40309 Hrs as of last inspection	Engine Manufacturer:	GE
ELT:	Installed, not activated	Engine Model/Series:	T58-GE-402
Registered Owner:	CROMAN CORP	Rated Power:	1500 Horsepower
Operator:	CROMAN CORP	Operating Certificate(s) Held:	Rotorcraft external load (133)
Operator Does Business As:		Operator Designator Code:	JYEL

The accident helicopter was equipped with two General Electric T58-GE-402 turboshaft military engines. The General Electric T58-GE-402 features a ten-stage axial compressor with variable inlet guide vanes, an annular combustor, a two-stage gas generator turbine, and an independent single stage power turbine.

Maintenance on the helicopter was accomplished by Croman Corp. The last engine light overhaul was completed on August 27, 2014 at which time the helicopter had accumulated 903 hours since major overhaul. This was the first of four light overhauls on the engine that are completed at 1,000-hour intervals. After the fourth light overhaul the TSO is set to zero. The accessory gearbox was separated and examined during the last light overhaul. The last magnetic plug inspection was completed 41.3 hours prior to the accident flight as part of a 35-hour phase inspection. Magnetic plug inspections are required every fourth phase inspection (140 hours).

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	BKE,3373 ft msl	Distance from Accident Site:	32 Nautical Miles
Observation Time:	18:53 Local	Direction from Accident Site:	23°
Lowest Cloud Condition:	Clear	Visibility	6 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	6 knots / None	Turbulence Type Forecast/Actual:	/ None
Wind Direction:	250°	Turbulence Severity Forecast/Actual:	/ N/A
Altimeter Setting:	29.88 inches Hg	Temperature/Dew Point:	21°C / 11°C
Precipitation and Obscuration:	N/A - None - Haze		
Departure Point:	Baker City, OR (BKE)	Type of Flight Plan Filed:	None
Destination:	Baker City, OR (BKE)	Type of Clearance:	None
Departure Time:	17:15 Local	Type of Airspace:	Unknown

Wreckage and Impact Information

Crew Injuries:	1 Minor, 1 None	Aircraft Damage:	Substantial
Passenger Injuries:		Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Minor, 1 None	Latitude, Longitude:	44.338333,-118.11

On scene examination by a Federal Aviation Administration inspector revealed that the bucket was entangled in a barbed wire fence. The line was tight, off the ground, and stretched around a tree before it continued straight towards the main wreckage. Impact damage was consistent with the helicopter impacting the ground on its tailwheel first followed momentarily by main landing gears. The tailwheel was found separated from the airframe and impact marks indicated the tail rotor impacted the ground. In addition, marks consistent with main rotor blade impact were also observed on the ground near the main wreckage.

Examination of the longline revealed that the attachment point on the fuselage of the helicopter indicated that the hook released the longline as expected, however one of the two hydraulic quick disconnect (QD) couplings failed to release. The hard mounted quick disconnect system for the hydraulic lines was examined and it was noted that only one of the fittings released from the coupling. The longline side of the released fitting was undamaged; it had a stretched and fractured a safety wire that was secured to it. The other fitting was fracture separated and did not appear to release from the hard mount system until the helicopter hit the ground. Part of the fitting was still secured to the longline, and the remaining part was still secured to the coupling with a safety wire securing it in place.

Number 1 Engine Examination and Run

Initial visual examination of the number 1 engine revealed minimal damage. The engine was rotated, and continuity was verified through the Ng drivetrain, which included the compressor and gas generator turbine, and Nf drivetrain, which is the independent power turbine spool. The magnetic plugs were removed and all four exhibited light residue accumulation which was considered normal for service run engines according to General Electric and Croman Corp.

The engine was installed into a test cell; the engine started normally and idled with normal indications. Initially, smoke was observed emanating from the power turbine area, however, it ceased after a few minutes of run time. The engine was cycled between idle and about 100% Ng several times to ensure the control system was functioning properly. The fuel control topping set point was checked, and it was recorded at 101.8% Ng, which is 1.9% Ng below manual specifications.

Number 2 Engine Examination

During the examination and disassembly of the number 2 engine, all exterior engine surfaces were intact and in good condition. The magnetic plugs were removed, and all four plugs had metal debris accumulation, with the most debris noted on the accessory gearbox and power turbine accessory plugs. The front frame accessory drive was manually rotated at the inlet, and no concurrent rotation of the centrifugal fuel purifier drive splines was observed. The accessory gearbox, fuel control, and oil lube pump were removed from the engine. The radial driveshaft was then removed from the front frame and scallop shaped wear marks were observed around the shaft, which matched the mating female splines of the pinion assembly. In addition, about 0.10 inch of material wear was observed on the front frame housing consistent with pinion gear assembly contact.

The pinion gear assembly was removed from the accessory gearbox. The pinion gear, which mates with the bevel gear, exhibited wear on the gear teeth and some metal smearing concentrated along the tips, consistent with gear disengagement. The pinion support assembly was disassembled and the upper support bearing exhibited roller ball, bearing cage, and race damage. In addition, the bevel gear exhibited wear on the teeth consistent with what was observed on the mating pinion.

The accessory gearbox pinion, bevel gears, the upper and lower pinion support bearings, and all four magnetic plugs underwent metallurgical examination. An energy dispersive x-ray scan, microstructure analysis, and hardness testing indicated that both the bevel and pinion gears met material specifications. Both the pinion and bevel gears had excessive wear on 50-75% of the outer tooth span at the gear tooth tip, which is also consistent with gear disengagement. In addition, cracks were noted on two adjacent bevel gear teeth.

The pinion upper support bearing was disassembled, and spalling was observed on the balls, inner, and outer raceways. Wear was mostly concentrated on the upper pinion support bearing inner race land. Energy dispersive x-ray and scanning electron microscopy identified aluminum oxide particles embedded in the cage pocket and inner races of both bearings. The debris accumulation on the magnetic plugs was analyzed and found to be consistent with bearing and gear material.

According to the manufacturer, aluminum oxide is not present in any T58-GE-402 bearing or component within the oil lubrication system pathway. Historically, aluminum oxide has been inadvertently introduced into the engine during the engine overhaul/repair process. Aluminum oxide is abrasive and once it is embedded into the bearing it can cause uneven wear and accelerated failure.

Administrative Information

Investigator In Charge (IIC): Link, Samantha

Additional Participating Persons: Ian Hansen; Federal Aviation Administration; Boise, ID
David Gridley; GE Aviation; Lynn, MA
Brian Beattie; Croman Corp; White City, OR
Anne Cottle; Sikorsky Aircraft; Stratford, CT

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Last Revision Date:

Investigation Class: [Class](#)

Note: The NTSB did not travel to the scene of this accident.

Investigation Docket: <https://data.nts.gov/Docket?ProjectID=91834>

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