Aviation Investigation Final Report

Location:	Forks, Washington	**Accident Number:**	WPR19FA091
Date & Time:	March 8, 2019, 07:05 Local	**Registration:**	N64RA
Aircraft:	Bell UH1B	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The pilot departed on his first external load flight of the day; shortly thereafter, employees heard a mayday call over the company radio. The helicopter was found inverted in the designated logging area, with the cargo line attached to the cargo hook and the grapple attached to a log. Examination of the airframe and cargo hook revealed no anomalies or mechanical failures that would have precluded normal operation.

Examination of the engine revealed that the gas generator first stage sealing disk had fractured and separated into three major pieces. Multiple internal components of the engine were subsequently damaged as a result, including all four turbine rotors and nozzles. An examination of the first stage sealing disk revealed fracture features consistent with low cycle fatigue.

The overhauled engine was installed into the accident helicopter about 8 months before the accident. The sealing disk was installed into the engine at the time of overhaul and had previously accrued 1,067.3 hours and 2,134.6 cycles.

The operator had not kept an accurate documentation of engine cycles, and it was unknown who was responsible for documenting the engine cycles into the daily flight logs. A review of maintenance records and the helicopter's electronic cycle counter revealed that the sealing disk had exceeded the published life limit of 6,900 cycles. The last documented cycle value was 9,023.13. The cycle counter had recorded 12,023.19 cycles.

Following the sealing disk separation, and subsequent internal damage, the engine lost all power, necessitating a forced landing via autorotation. Due to the low altitude and densely tree covered terrain, it is unlikely that the pilot had reaction time to release the load which became entangled in the trees as he was attempting autorotation.

Probable Cause and Findings

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

A total loss of engine power due to the failure of the gas generator sealing disk as a result of the operator's exceedance of the sealing disk life limits at too low an altitude for the pilot to accomplish a successful autorotation which resulted in the collision with terrain.

Findings

Personnel issues	Aircraft/maintenance logs - Pilot
Personnel issues	Use of equip/system - Pilot
Aircraft	Turbine section - Failure
Aircraft	Turbine section - Not serviced/maintained
Aircraft	Altitude - Attain/maintain not possible

Factual Information

History of Flight

Maneuvering-hover	Loss of engine power (total) (Defining event)
Maneuvering-hover	Off-field or emergency landing
Maneuvering-hover	Attempted remediation/recovery
Maneuvering-hover	Collision with terr/obj (non-CFIT)

On March 8, 2019, at 0705 Pacific daylight time, a Richards Heavylift Helo Inc (Bell) UH-1B helicopter, N64RA, was substantially damaged when it was involved in an accident near Forks, Washington. The pilot was fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 133 external load operation.

The operator was conducting heli-logging operations using a hydraulic grapple attached to a cargo line that was secured to the helicopter by the cargo hook. The helicopter was staged at a remote location located about 1/4 mile from the accident site. Typically, the pilot would depart the staging area, fly to the logging site, establish the helicopter in an out of ground effect hover, grapple a log, and return to the staging area, where the log would be released. The pilot would repeat the process throughout the day. A part time pilot with the company stated that the cargo line they used was 180 feet in length. He stated the standing trees were about 40 to 50 feet below the helicopter when they were grappling a log.

On the day of the accident, a helicopter mechanic located at the staging area assisted the pilot in the preflight inspection of the helicopter in preparation for a day of heli-logging activity. The mechanic stated that he observed a normal engine start, run-up and takeoff. The mechanic continued with his morning activities, and while walking into the maintenance support trailer, he heard three distress calls from the pilot over the company radio. Several coworkers heard the same distress calls on their radios, and they all began a search of emergency landing areas around the staging area. After finding the emergency landing areas empty, one employee hiked to the logging site and found the wreckage. (See figure 1.)

Figure 1. The helicopter at the accident site. A blue cargo line and two black hydraulic hoses can be seen running uphill to the grapple hook.

The mechanic stated that the helicopter was fueled that morning with 1,000 pounds of Jet A fuel. He stated that he did not conduct a check of the cargo hook release that morning but had done so the day before.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	44,Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	February 18, 2019
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 6610 hours (Total, all aircraft), 729 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N64RA
Model/Series:	UH1B	**Aircraft Category:**	Helicopter
Year of Manufacture:	1965	**Amateur Built:**	
Airworthiness Certificate:	Restricted (Special)	**Serial Number:**	65-12854
Landing Gear Type:	Skid	**Seats:**	2
Date/Type of Last Inspection:	January 29, 2019 100 hour	**Certified Max Gross Wt.:**	8500 lbs
Time Since Last Inspection:	96.3 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	15834.3 Hrs as of last inspection	**Engine Manufacturer:**	Honeywell
ELT:	Not installed	**Engine Model/Series:**	T-53-L13
Registered Owner:	On file	**Rated Power:**	
Operator:	On file	**Operating Certificate(s) Held:**	Rotorcraft external load (133)

The helicopter was manufactured in 1965 as a UH-1B, and after military service, was demilitarized and sold to a private company. In 1997, a Lycoming T 53-L13B engine was installed in accordance with supplemental type certificate (STC) #SR00073DE. The helicopter was purchased by the pilot on October 5, 2018.

During an interview, the mechanic stated that it was the pilot's responsibility to record the engine cycles accrued during the flights. Review of engine maintenance records showed that the engine was overhauled on August 1, 2017, at a time since new of 4,572.3 hours and installed onto the accident helicopter on July 2, 2018, at 5,845.0 hours Hobbs time and an airframe time of 14,859.5 hours. The

engine had accumulated 1,068.1 flight hours, 30,509 turns, 294 engine starts, and 934 takeoffs since installation on the accident helicopter.

A review of the maintenance logs revealed that the first stage sealing disk, part number 1-100-135-03, serial number 3694, was installed in the accident engine during the overhaul. The sealing disk had a historical time of 1,067.3 hours and 2,134.6 cycles.

Documentation of engine cycles was not accomplished daily. Engine cycles were documented irregularly from July 2, 2018, to September 17, 2018, after which there was no documentation of engine cycles. At the time of last documentation, the cycle count for the gas generator cumulative cycles components, which included the sealing disk, was 9,023.13 cycles.

The helicopter was equipped with an AKV N1/N2 cycle counter. The cycle counter was examined at AKV Inc, Camarillo, California. The unit operated normally and contained the correct software for the installed engine. The AKV cycle counter had recorded an N1 cycle count of 12,023.19 cycles. The cycle counter allowed for the operator to manually add historical values to the device, however; there was no documentation of the operator manually adding the historical cycles of the sealing disk to the cycle counter.

Honeywell Aerospace issued service bulletin (SB) T53-L-13B-0020, which stated, in part:

Reason:

1. *To inform operators of service life limits of rotating components in operating hours and cycles.*
2. *Noncompliance may result in component failure, causing a partial or complete power loss, and the possible production of projectiles capable of serious or fatal bodily harm and property damage.*

WARNING
Rotating life components have two distinct failure modes, stress rupture and low cycle fatigue, and must have two separate parameters recorded. Stress rupture is hour dependent and low cycle fatigue is cycle dependent. Components must have both hours and cycles tracked and they must be removed from service prior to exceeding the hourly or cycle limitation. Life management of these components to only one parameter is not allowed and can result in partial or complete power loss and the possible production of projectiles capable of causing serious or fatal bodily harm and /or property damage.

Based on the guidance provided by the service bulletin, the hour/cycle life limit of the first stage sealing disk was 25,000 hours or 6,900 cycles.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KCLM,291 ft msl	**Distance from Accident Site:**	26 Nautical Miles
Observation Time:	06:53 Local	**Direction from Accident Site:**	82°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Broken / 4200 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	7 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	240°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.26 inches Hg	**Temperature/Dew Point:**	-1°C / -3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Forks, WA	**Type of Flight Plan Filed:**	None
Destination:	Forks, WA	**Type of Clearance:**	None
Departure Time:	07:05 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	48.101112,-124.095(est)

The helicopter came to rest on steep, mountainous terrain about 1/4 mile from the company's staging area. The area was covered with felled and standing trees. All major structural components of the helicopter were located within a very small debris field around the helicopter. There was no post-crash fire. A cargo line remained attached to the cargo hook and extended uphill 180 feet to a hydraulic grapple hook. Two hydraulic fluid hoses extended from the belly of the helicopter and followed the cargo line uphill and were attached to the grapple. The grapple was resting against a standing tree and held a log in its jaws. (See figure 2.) Visual examination of the area around the grappled log revealed the grappled log rested perpendicular to the cargo line running downhill to the helicopter, and a portion of the grapple had caught the standing tree consistent with establishing an anchor point.

Figure 2. The grapple hook, attached to a log, and learning against a standing tree. The cargo line and two hydraulic lines are contained in a green protective sheath and run downhill to the helicopter.

Examination of the airframe and cargo hook at the accident site, and again at a secure facility following recovery of the wreckage, revealed no evidence of preaccident mechanical malfunctions or anomalies that would have precluded normal operation. The pilot's cargo hook release button, located on the cyclic grip, was examined and functioned normally.

The engine was examined at Honeywell Aerospace on April 24, 2019; the following findings were noted. The first stage sealing disk mounted in front of the first stage gas producer turbine wheel had fragmented into three pieces and separated. Cracks were observed at all six cooling holes on the sealing disk. Damage was found on the four turbine wheels and other components downstream from the sealing disk. Magnified examination of the fracture surfaces on the sealing disk revealed multiple arc-shaped "beach mark" striations.

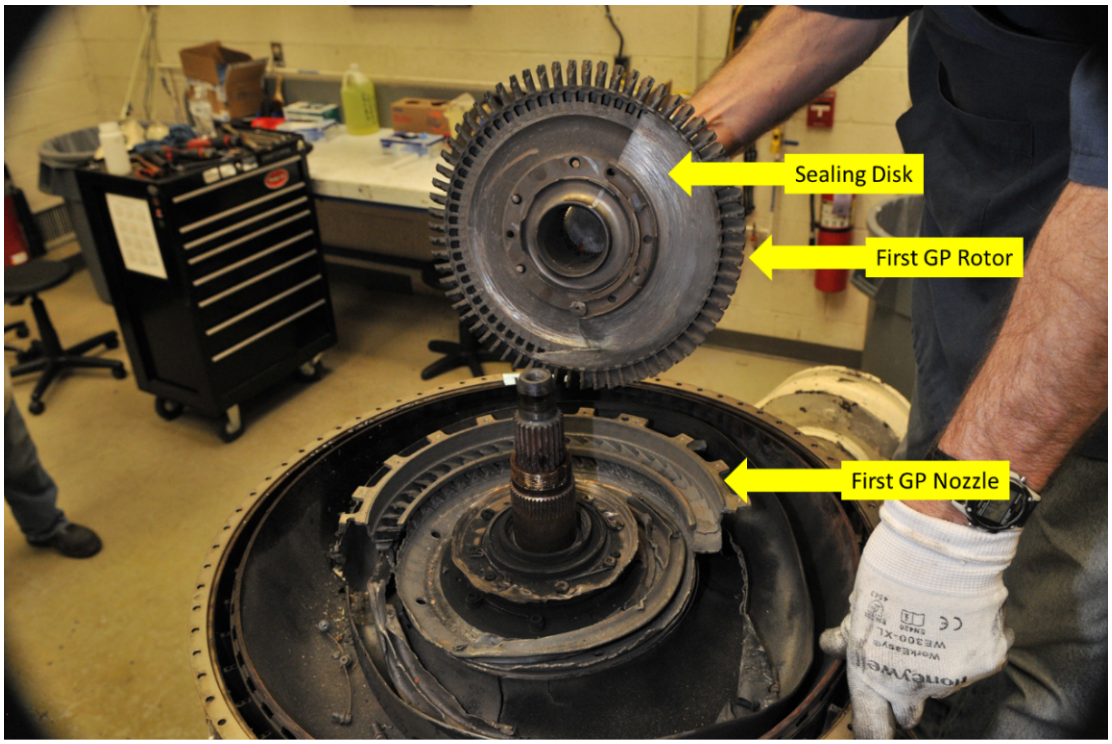

Figure 3. Engine showing first stage gas producer (GP) turbine rotor with sealing disk fragment attached.

Figure 4. First Stage Sealing Disk. Photo courtesy of Honeywell Aerospace.

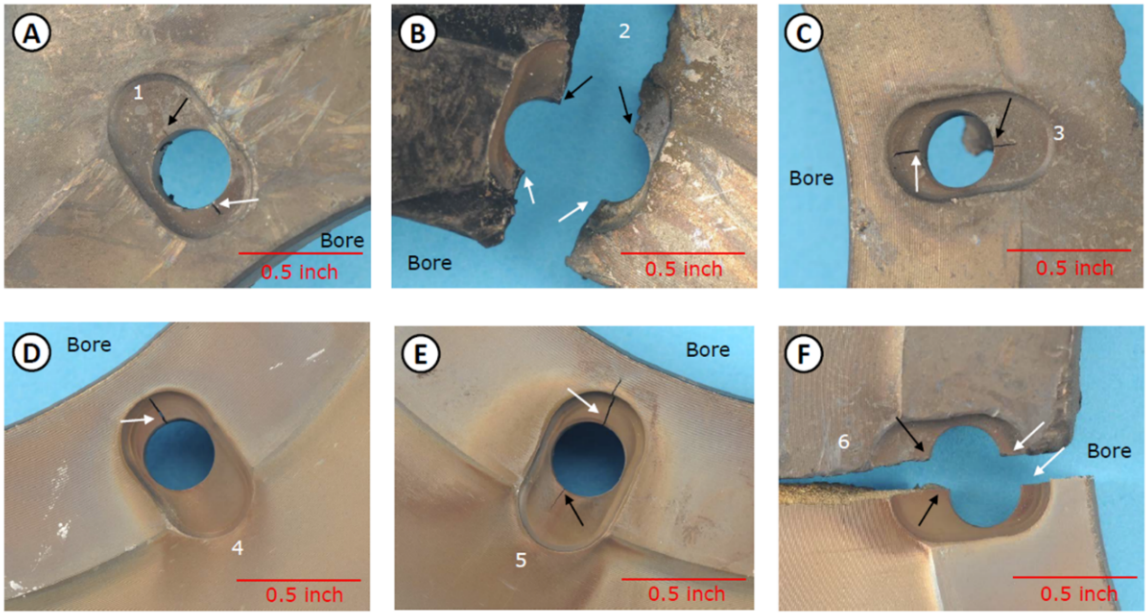

Figure 5. First stage sealing disk showing the six cooling holes, each with cracks formed. Photo courtesy of Honeywell Aerospace.

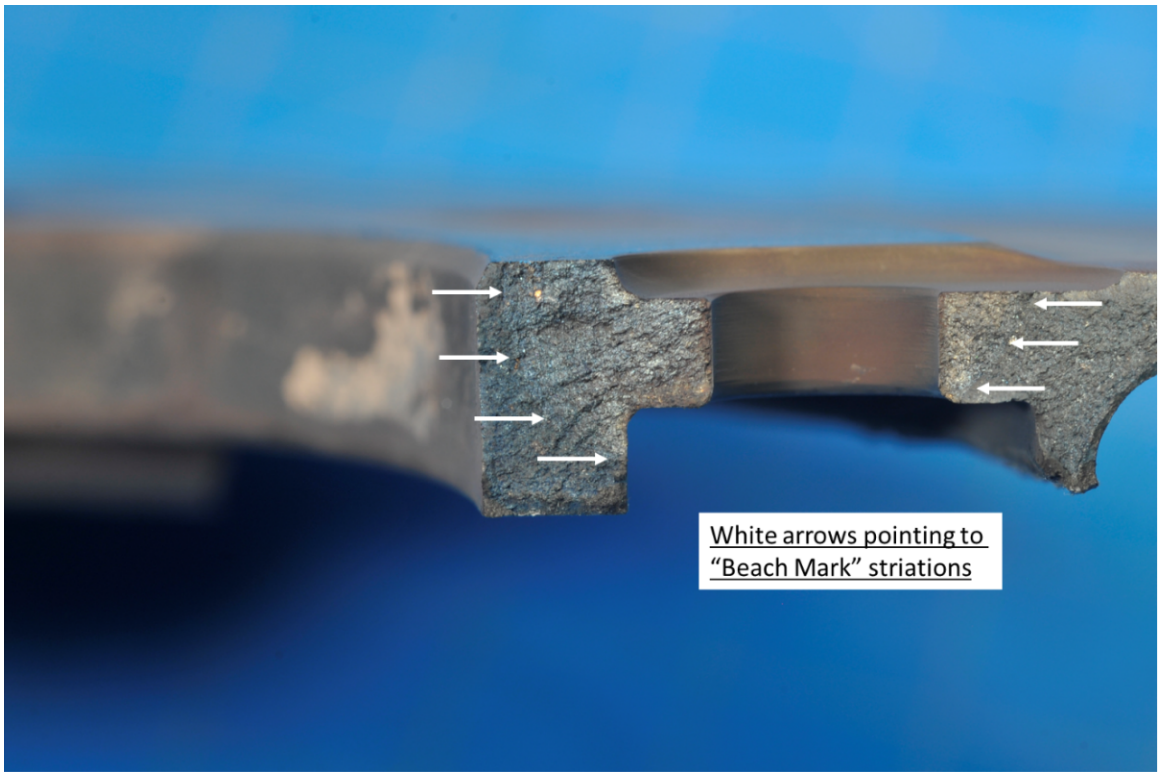

Figure 6. First Stage sealing disk, side view, showing beach mark striations. Photo curtesy of Honeywell Aerospace.

The sealing disk was further examined by Honeywell Aerospace. Microscopic examination revealed that the sealing disk separated in low-cycle fatigue. Both major and minor cycles were present on the fracture surface of the disk.

Medical and Pathological Information

The Federal Aviation Administration Forensic Sciences Laboratory performed toxicology testing on the pilot's tissue samples, which identified famotidine, naproxen, triamterene, and pseudoephedrine in the blood (cavity) and urine. Doxylamine was detected in the urine but was inconclusive in the blood (cavity). Norpseudoephedrine, a metabolite of pseudoephedrine, was detected in the urine only.

Famotidine (Pepsid) is a stomach acid suppression medication. Naproxen (Aleve or Naprosyn) is an anti-inflammatory medication. Pseudoephedrine is (Sudafed) is a nasal decongestant medication. Norpseudoephedrine is a metabolite of pseudoephedrine. These drugs are over-the-counter medications and not generally considered impairing.

Triamterene is a prescription drug used to treat high blood pressure and is not generally considered impairing. Doxylamine is sedating antihistamine medication, considered by the FAA as a "do not fly" medication.

Additional Information

According to the US Army technical manual, 55-1520-210-10, the emergency procedure for an engine malfunction-hover is "autorotate". The document also states, "*Note: If time permits, during the autorotative descent, transmit a "May Day" call Set transponder to emergency, jettison external stores, and lock shoulder harness."*

In a series of emails, from April 30, 2019 to March 9, 2020, a part time pilot with the operator stated that the accident pilot could easily lift 29 logs per hour. The part-time pilot also stated that he did not track cycles in previous jobs, and it was the same for the accident operator.

Administrative Information

Investigator In Charge (IIC):	Salazar, Fabian
Additional Participating Persons:	Kevin McKee; Seattle Flight Standards District Office; Des Moines, WA Marlin J Kruse; Honeywell Aerospace; Phoenix, AZ
Original Publish Date:	May 5, 2021
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=99074