# Aviation Investigation Final Report

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| **Location:** | Pacific Ocean, | **Accident Number:** | ANC18LA020 |
| **Date & Time:** | January 26, 2018, 11:25 UTC | **Registration:** | N339EV |
| **Aircraft:** | EUROCOPTER FRANCE SA330J PUMA | **Aircraft Damage:** | Substantial |
| **Defining Event:** | Flight control sys malf/fail | **Injuries:** | 2 None |
| **Flight Conducted Under:** | Part 133: Rotorcraft ext. load | | |

## Analysis

According to the pilot, after landing the helicopter on the deck of the ship, power was increased on the No. 2 engine, while the No. 1 engine was reduced to ground idle in preparation for a freshwater rinse of the engines to prevent corrosion. Once the engines were configured, the pilot saw the lead mechanic squeeze the trigger on the wand, and then there was a rumbling sound followed by a rough shudder through the airframe. He then looked back at the cockpit instruments and everything looked normal for the condition the controls were in at the time. About that time, there was another shudder through the airframe, and he heard a change in the tone of the engine and gear box noise. He saw that the rotor speed had started to rise, and the gas generator speed of the No. 2 engine had also started to increase. He shut down the engines. Examination of the helicopter revealed that the tail rotor drive shaft had sheared, disconnecting the tail rotor from the main gear box.

Examination of the main gear box right freewheel assembly revealed that the small roller bearings were dislocated, the bearing cage was fragmented, and both tabs of the shur-lok washer showed signs of deformation with visible impact damage. Damage to these tabs is consistent with a sudden engagement of the bearing, resulting in an instantaneous spike in torque, known as freewheel jerk.

During the transition of the No. 2 engine from the idle position to the flight position, the condition of the freewheel small roller bearings likely prevented the freewheel cage from maintaining the large freewheel rollers on the ramp due to the effect of the freewheel spring. This situation is unstable until an "imbalance" modifies it and suddenly causes the cage and the freewheel rollers to rise on the ramp, imparting a torque spike into the rotor drive system.

The freewheel jerk felt during the rinsing operation of the No. 2 engine, with the No. 1 engine at idle, is likely the consequence of the degradation/dislocation of the roller bearing of the right freewheel (No. 2). Evidence of the degradation of the freewheel unit bearing was present in the two previous oil analyses. Although samples were taken before the accident in the most recent inspection, one sample was

misplaced and not sent for analysis until after the event. Although not required per the maintenance manual at the time taken, had both of these samples been analyzed at the time of the inspection, it is likely the operator would have been able to detect the increase in metal before the bearing wear became severe enough to cause the jerk. After the accident, the operator implemented an internal requirement for oil sample analysis in shorter intervals.

## Probable Cause and Findings

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

The worn rear bearing of the freewheel unit. Contributing to the accident was the delay in analyzing an oil sample, which would have detected the increase in metal contaminants from the worn bearing.

### Findings

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| **Aircraft** | Main rotor gearbox - Damaged/degraded |
| **Aircraft** | Main rotor gearbox - Inadequate inspection |
| **Personnel issues** | Scheduled/routine maintenance - Maintenance personnel |

# Factual Information

## History of Flight

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| **Prior to flight** | Aircraft maintenance event |
| **Standing-engine(s) operating** | Flight control sys malf/fail (Defining event) |

On January 26, 2018, about 1125 universal coordinated time (UTC), an Airbus Helicopters SA330J, N339EV, sustained substantial damage during a fresh water engine rinse aboard the USNS Wally Schirra while in international waters of the Pacific Ocean. The two commercial pilots sustained no injuries. The flight was being operated as a 14 *Code of Federal Regulations* (CFR) Part 133 visual flight rules external load flight. Visual Meteorological conditions prevailed and company flight following procedures were in effect. The helicopter was shuttling supplies from the Wally Schirra to other naval vessels in the area.

According to the pilot, after landing on the deck of the ship, power was increased on the #2 engine, while the #1 engine was reduced to ground idle in preparation for a fresh water rinse of the engines in order to prevent corrosion from sea spray. The #1 engine was rinsed first, then power was increased on the #2 engine and reduced on the #1 engine in order to rinse the #2 engine. Once the engine speeds were stabilized, he saw the lead mechanic squeeze the trigger on the wand and then there was a rumbling sound followed by a rough shudder through the airframe. He then looked back at the instruments in the cockpit and everything looked normal for the condition the controls were in at the time. About that time there was another shudder through the airframe, and he heard a change in the tone of the engine and gear box noise. He looked back at the gauges and saw that the rotor speed (Nr). had started to rise and the gas generator speed (Ng) of the #2 engine had started to increase also.

The pilot further stated that at this point he secured the fuel boost pumps and the engine control switches both to the off position. He waited for the Nr to slow to below 120 rpm and applied the rotor brake. When the main rotor stopped, the lead mechanic informed him that the tail rotor was still spinning.

The engine rinse procedure utilized by the crew was approved by Turbomeca in 2002 at the request of the operator in order to conduct a rinse with the engines running. The 2002 approved procedure as well as the procedure from the June 2013 Safran Helicopter Engines work card CT 71-00-12 are contained in the public docket for this accident. In the 2002 procedure, the rinse is approved to be completed with both engines running, while the 2013 procedure requires only the engine being rinsed to be running with the other engine shutdown.

Upon inspection, a gash was present along the cover over the #7 tail rotor drive shaft. The #7 tail rotor drive shaft was fractured torsionally about mid-span.

A cockpit voice recorder (CVR) on board confirmed that the crew followed the fresh water rinse procedure as approved by Turbomeca in 2002.

On October 15, 2018, the main gear box was examined at Airbus Helicopters under the supervision of an aerospace engineer from the National Transportation Safety Board. After removal of the rear casing, some metal fragments of the freewheel unit roller bearing cages were observed in the cavities of both 8,000RPM rear reduction pinions and were coated with a black greasy substance. Dislocation of the small roller bearings was evident when the left freewheel was removed. Metal pitting were visible on the guide ramps of the freewheel cage.

When the right freewheel assembly was removed, both tabs of the shur-lok washer showed signs of deformation. Impact damage was visible on the rotational stop of the cage of the freewheel rollers. The 8,000RPM rear reduction pinion contained longitudinal roller marks with equally spaced tangential marks. After removal of the right freewheel unit, it was observed that the small roller bearings were dislocated and flat faces were observed on the small rollers .

The left and right 8,000RPM shafts were removed and inspected. The part number (P/N) of these shafts was 330A32-5059-03 and each had modification 07-52390 . This modification was constituted by four half bushings (2 on each end of the shaft) held together by 2 O-rings. The purpose of this modification was to create a "pool" of oil in the vicinity of the both side coupling splines to limit the wear of these splines. The splines on the input side contain small wear and the corresponding bushings are damaged, mainly on the side of the input. On this same side, the O-ring was missing. The O-ring on the freewheel side was in place, but no longer contained the original flexibility. An O-ring was submitted to the NTSB Materials Laboratory for examination. The O-ring had fractured into several pieces and was brittle and stiff. It was visually examined using a 5-50X zoom stereomicroscope and found to be slightly flattened on the top and bottom. The inner diameter exhibited surface crazing and cracking as shown in the attached photographs. There was no sign of excessive heating or chemical degradation. The hardening and crazing were indicative of long term compression and age-related degradation.

Oil samples from the main gearbox, tail rotor gearbox, intermediate gearbox and Engine #1 were submitted to the NTSB Materials Laboratory for examination. The samples were sent to an independent, third-party lab for examination. The samples were tested using Inductively Coupled Plasma Optical Emission spectroscopy (ICP-OES) to look for the presence of metals and other elements. No significant anomalies were found in any of the samples. The slightly elevated presence of iron (Fe) in the main gear box sample was indicative of typical wear particles found in mechanical systems. The elevated presence of phosphorous in the Engine #1 sample can be indicative of the presence of anti-wear additives in the oil. The metal/element amounts in the other two samples were negligible.

Laboratory results were obtained from the two prior oil samples. The first, dated February 13, 2016 listed Fe at 3.3 parts per million. The second sample, taken in November of 2017 was misplaced by the operator and not found until after the accident. When it was sent for analysis on February 4, 2018, Fe was detected at 14.7 parts per million. The maintenance manual for the SA330 helicopter requires the oil analysis be performed every 150 hours for the main gear box and every 50 hours for the intermediate gear box. The two samples taken were 88.4 hours and 2 years apart

Following the accident, the operator implemented an internal requirement for oil samples to be analyzed every 25 hours or 3 months.

A weather observation taken aboard the vessel at the time of the accident was reporting, in part, light and variable winds; visibility 25 miles; clouds and ceiling clear; temperature 28° C; altimeter 29.89 inches of Mercury.

## Pilot Information

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| **Certificate:** | Commercial; Flight instructor | **Age:** | 51,Male |
| **Airplane Rating(s):** | Single-engine land | **Seat Occupied:** | Right |
| **Other Aircraft Rating(s):** | Helicopter | **Restraint Used:** | 4-point |
| **Instrument Rating(s):** | Helicopter | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Helicopter | **Toxicology Performed:** | No |
| **Medical Certification:** | Class 2 Waiver time limited special | **Last FAA Medical Exam:** | September 30, 2018 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | September 27, 2017 |
| **Flight Time:** | 5685 hours (Total, all aircraft), 406 hours (Total, this make and model), 4817 hours (Pilot In Command, all aircraft), 13 hours (Last 90 days, all aircraft), 5 hours (Last 30 days, all aircraft) | | |

## Co-pilot Information

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| **Certificate:** | Commercial; Flight instructor | **Age:** | 46,Male |
| **Airplane Rating(s):** | Single-engine land | **Seat Occupied:** | Left |
| **Other Aircraft Rating(s):** | Helicopter | **Restraint Used:** | 4-point |
| **Instrument Rating(s):** | Helicopter | **Second Pilot Present:** | Yes |
| **Instructor Rating(s):** | Helicopter; Instrument helicopter | **Toxicology Performed:** | No |
| **Medical Certification:** | Class 2 Without waivers/limitations | **Last FAA Medical Exam:** | March 17, 2017 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | July 12, 2017 |
| **Flight Time:** | 6382 hours (Total, all aircraft), 73 hours (Total, this make and model), 5239 hours (Pilot In Command, all aircraft), 21 hours (Last 90 days, all aircraft), 8 hours (Last 30 days, all aircraft) | | |

## Aircraft and Owner/Operator Information

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| **Aircraft Make:** | EUROCOPTER FRANCE | **Registration:** | N339EV |
| **Model/Series:** | SA330J PUMA J | **Aircraft Category:** | Helicopter |
| **Year of Manufacture:** | 1974 | **Amateur Built:** | |
| **Airworthiness Certificate:** | Transport | **Serial Number:** | 1285 |
| **Landing Gear Type:** | Tricycle | **Seats:** | |
| **Date/Type of Last Inspection:** | April 29, 2017 Continuous airworthiness | **Certified Max Gross Wt.:** | 16303 lbs |
| **Time Since Last Inspection:** | | **Engines:** | 2 Turbo shaft |
| **Airframe Total Time:** | 6689.1 Hrs | **Engine Manufacturer:** | Safran |
| **ELT:** | C126 installed, not activated | **Engine Model/Series:** | TURMO IVC |
| **Registered Owner:** | SQN HELO 7 LLC | **Rated Power:** | 1495 Horsepower |
| **Operator:** | Erickson Helicopters | **Operating Certificate(s) Held:** | Rotorcraft external load (133), Commuter air carrier (135), On-demand air taxi (135), Agricultural aircraft (137) |
| **Operator Does Business As:** | | **Operator Designator Code:** | 9EKA |

## Meteorological Information and Flight Plan

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| **Conditions at Accident Site:** | Visual (VMC) | **Condition of Light:** | Day |
| **Observation Facility, Elevation:** | | **Distance from Accident Site:** | |
| **Observation Time:** | | **Direction from Accident Site:** | |
| **Lowest Cloud Condition:** | Clear | **Visibility** | 25 miles |
| **Lowest Ceiling:** | None | **Visibility (RVR):** | |
| **Wind Speed/Gusts:** | / | **Turbulence Type Forecast/Actual:** | None / None |
| **Wind Direction:** | | **Turbulence Severity Forecast/Actual:** | N/A / N/A |
| **Altimeter Setting:** | 29.88 inches Hg | **Temperature/Dew Point:** | 28°C |
| **Precipitation and Obscuration:** | No Obscuration; No Precipitation | | |
| **Departure Point:** | | **Type of Flight Plan Filed:** | VFR |
| **Destination:** | | **Type of Clearance:** | VFR |
| **Departure Time:** | | **Type of Airspace:** | Class G |

## Wreckage and Impact Information

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| **Crew Injuries:** | 2 None | **Aircraft Damage:** | Substantial |
| **Passenger Injuries:** | | **Aircraft Fire:** | None |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 2 None | **Latitude, Longitude:** | 35.245555,157.236389(est) |

## Administrative Information

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| **Investigator In Charge (IIC):** | Williams, David |
| **Additional Participating Persons:** | Dave Keenan; FAA; Washington, DC<br>Chris Callahan; Erickson Helicopters; Medford, OR |
| **Original Publish Date:** | June 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=96658 |