Aviation Investigation Final Report

Location:	San Andreas, California	**Accident Number:**	WPR20LA228
Date & Time:	July 20, 2020, 09:38 Local	**Registration:**	N745BW
Aircraft:	Md Helicopter 600	**Aircraft Damage:**	Destroyed
Defining Event:	Fire/smoke (non-impact)	**Injuries:**	3 None
Flight Conducted Under:	Part 91: General aviation - Aerial observation		

Analysis

During low-altitude operations to visually assess power lines, the pilot and front seat passenger detected smoke in the cockpit when the helicopter was about 250 ft above ground level. The pilot elected to make a precautionary landing and rapidly lowered the collective. When the helicopter descended to an altitude of about 30 ft above ground level, the engine lost power. The helicopter then yawed to the left and landed hard, which caused the right landing gear to fail. A postaccident fire ensued and consumed most of the fuselage and tailboom.

Postaccident examination of the airframe revealed that most of the fuselage, tailboom, and cabin interior was destroyed due to extensive thermal damage. Flight control continuity could not be confirmed due to the thermal damage to the fuselage.

Examination of the engine revealed no mechanical malfunctions or failures that would have precluded normal operation. Data recovered from the engine control unit revealed primary exceedance messages for a main rotor droop, which was followed almost immediately by an engine surge then a flameout. Immediately after the main rotor droop, the torque and fuel flow dropped to zero, which was consistent with a complete loss of load. Additionally, the engine control unit data showed that the rotational speed of the engine rose above the rotational speed of the main rotor, which was consistent with a break in the main rotor drive system.

Examination of the main rotor drive system revealed the overrunning clutch subassembly remained attached to the power takeoff gear shaft on one end but had separated from the interconnecting driveshaft at the inner race output shaft. The output shaft of the overrunning clutch inner race fractured at the output bearing, which resulted in a loss of torque to the transmission and the main rotor system and a loss of load to the engine.

The output shaft deformed and fractured due to high-temperature overstress at the output bearing. The highest heat, which was localized to the area around the output bearing inner race, was not from the postaccident fire because the overall pattern of heating, scoring, and deformation was consistent with frictional heating from a failure of the output bearing. That

failure caused the output bearing to seize and spin on the clutch inner race. The flakes of stainless steel found between the balls, cage, and outer race were likely remnants of the stainless-steel insert that was part of the grease seal, and the accumulation of the flakes between the balls indicated the seal failed before the bearing seized.

A review of maintenance documents revealed that the bearing was inspected and repacked with grease as required by the manufacturer.

Probable Cause and Findings

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

The failure of the output shaft of the overrunning clutch inner race due to frictional overheating of the shaft, which resulted from the failure of the output bearing's stainless-steel grease seal.

Findings

Aircraft	Engine/transmission coupling - Malfunction

Factual Information

History of Flight

Maneuvering-low-alt flying	Fire/smoke (non-impact) (Defining event)
Emergency descent	Loss of engine power (total)
Landing	Hard landing
Post-impact	Fire/smoke (post-impact)

On July 20, 2020, about 0938 Pacific daylight time, a MD Helicopter 600N, N745BW, was destroyed when it was involved in an accident near San Andreas, California. The pilot and two passengers were not injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 aerial observation flight.

The pilot reported that he was performing low-altitude operations to visually assess power lines. While on the second circuit of the morning and at an altitude of about 250 ft above ground level, he and the right seat passenger detected the smell of smoke in the cockpit/cabin area and saw smoke rising from under the forward pilot and copilot seat area. As a result, the pilot made a rapid descent to an open area. During the descent, the helicopter's airframe began to vibrate, and the pilot reported that the vibration got "progressively worse" as the descent continued. As the helicopter descended to about 30 ft above ground level, the pilot heard a loud "pop" and thought that the engine lost power. The helicopter then yawed to the left about 90° despite the pilot's application of full right pedal. The helicopter landed hard, causing the right skid to fail. The pilot and the passengers evacuated the helicopter. A postcrash fire erupted, which consumed the helicopter.

Data recovered from the engine control unit revealed primary exceedance messages for a main rotor droop, which was followed almost immediately by an engine surge and then a flameout. Immediately after the main rotor droop, torque and fuel flow dropped to zero, consistent with a complete loss of load. Additionally, the engine control unit data showed that the rotational speed of the engine rose above the rotational speed of the main rotor,

Postaccident examination of the wreckage revealed that most of the fuselage and tailboom, including the cabin area, instruments, flight controls, and antitorque system, was consumed by fire. Most of the main rotor and antitorque flight control systems was fragmented and exhibited varying degrees of thermal damage. As a result, flight control continuity could not be confirmed.

Examination of the drive system, which transmits the torque that the engine produces to the main rotor system and the antitorque system, revealed the overrunning clutch (located between the engine and the main transmission driveshaft) had extensive thermal damage. (The overrunning clutch acts as a freewheeling unit if the engine fails to deliver power or the main

rotor systems turns faster than the engine output speed.) The outer housing was consumed by fire, leaving the subassembly exposed but still attached to the power takeoff gear of the engine accessory gearbox. The subassembly separated from the main transmission driveshaft at the inner race output shaft. The output bearing and its retainer separated from the overrunning clutch. An exemplar overrunning clutch is shown in figure 1.

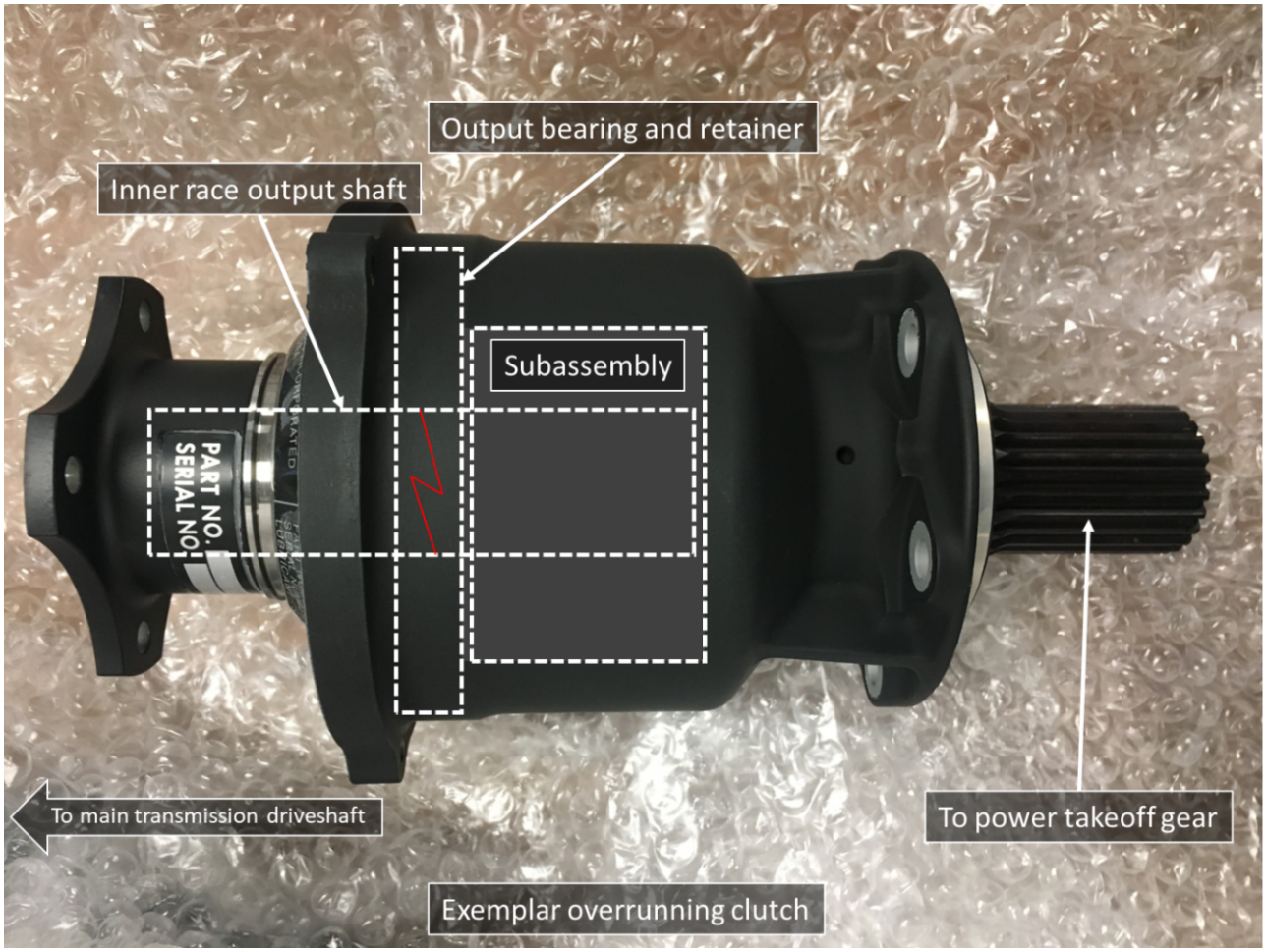

Figure 1. Exemplar overrunning clutch (Source: MD Helicopters).

Note: The output bearing, and retainer, subassembly, and inner race output shaft are internal and thus not visible in this figure. The red line indicates the location of the fracture in the accident overrunning clutch.

The main transmission driveshaft remained attached at the opposite end to the input to the transmission. A photograph of an exemplar clutch, main transmission driveshaft, and transmission is shown in figure 2.

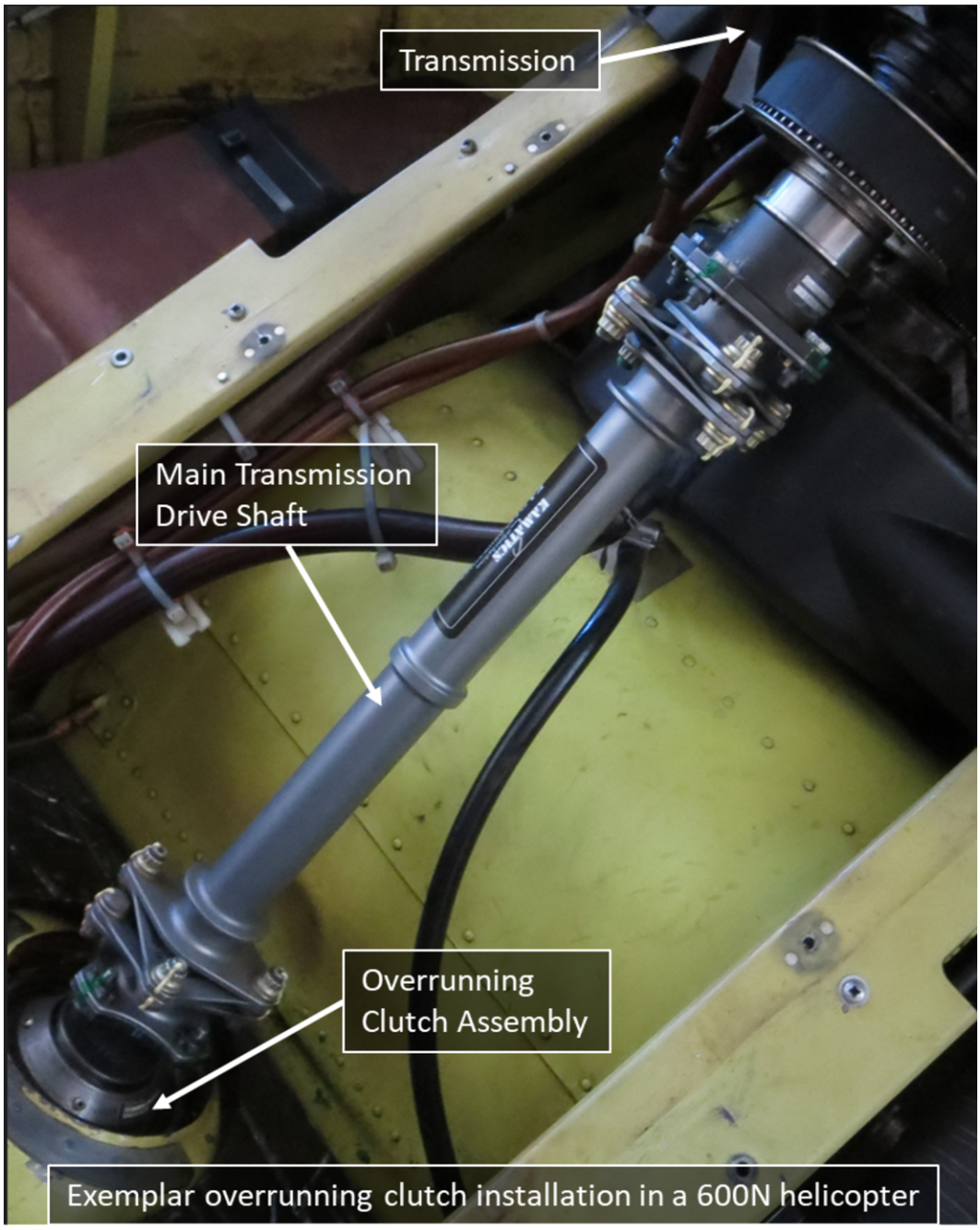

Figure 2. Exemplar overrunning clutch, main transmission driveshaft, and transmission (Source MD Helicopters.)

Note: The engine (not shown) is located behind the overrunning clutch.

Examination of the engine revealed significant thermal damage from the postaccident fire. Despite the thermal damage, no evidence indicated a mechanical malfunction or failure that would have precluded normal operation.

The overrunning clutch subassembly, output bearing, and retainer were sent to the National Transportation Safety Board Materials Laboratory. Examination revealed that the overrunning clutch inner race was fractured near its output shaft, as shown in figure 3. Circumferential scoring and metal deposits were observed on the external surface of the overrunning clutch inner race. The area of scoring and metal deposits corresponded to the installed location of the clutch output bearing on the clutch inner race.

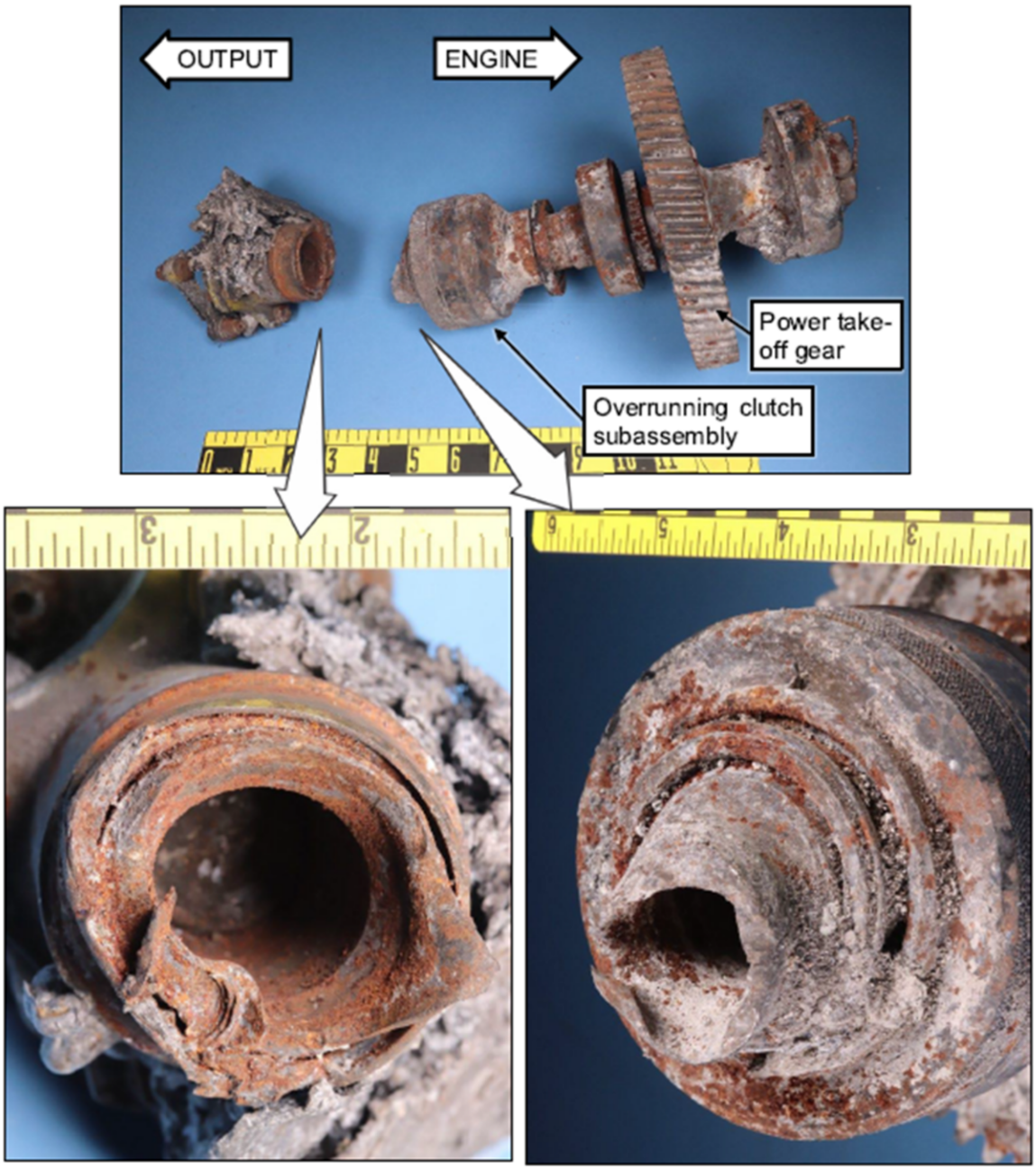

Figure 3. Separation of the inner race output shaft of the overrunning clutch subassembly.

Examination of the output bearing revealed that the inner race was substantially deformed radially outward, wrapping around the balls such that the inner diameter had a U-shaped profile. The output end of the retainer was also deformed radially outward, as shown in figure 4. Stainless steel flakes were observed in between the balls, cage, and outer race. A sample of the flakes was analyzed and found to be consistent with the stainless steel used on the grease seal.

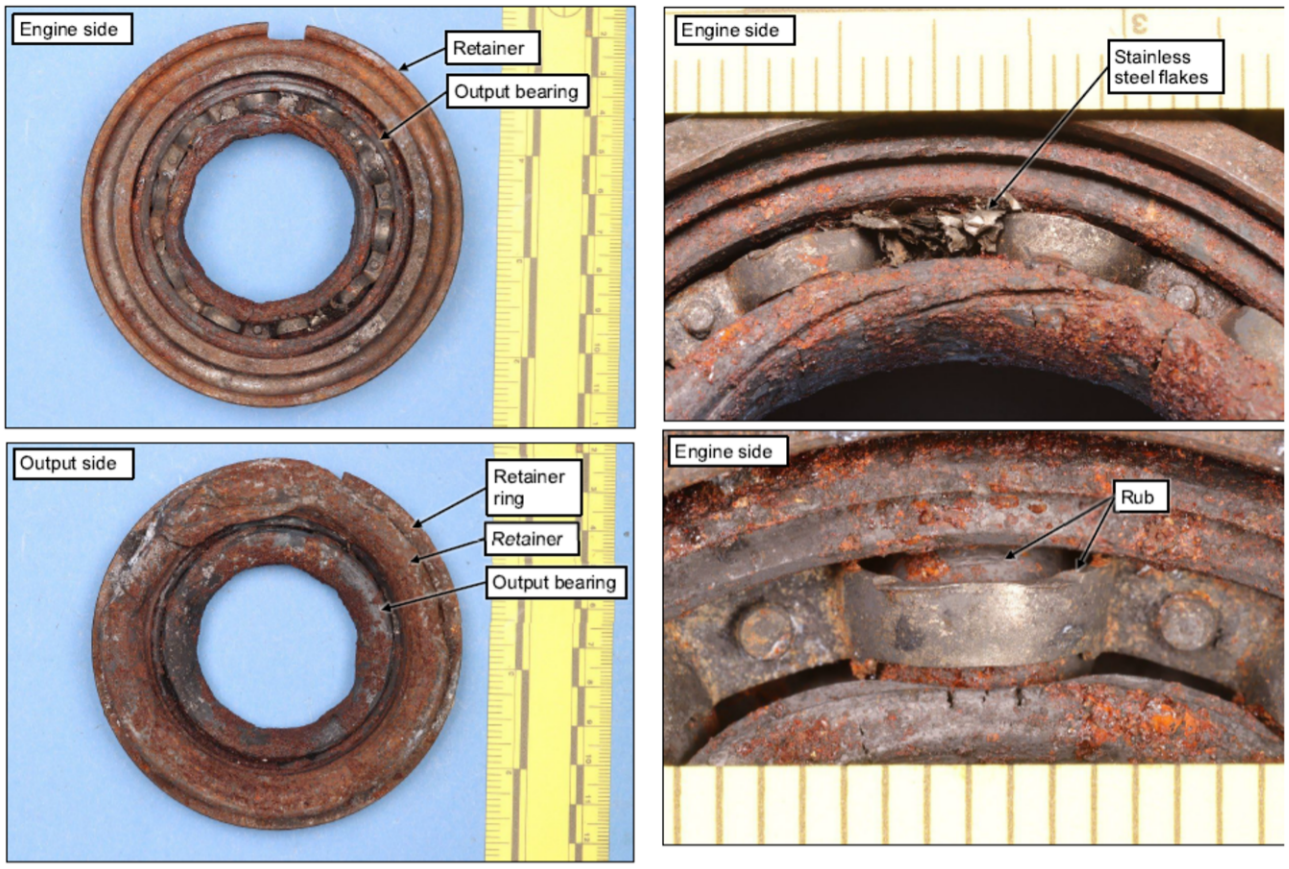

Figure 4. Output bearing and retainer damage to the inner race.

ADDITIONAL INFORMATION

According to the maintenance logbooks, the overrunning clutch was overhauled in October 22, 2017 when the helicopter had about 8,613 time since new. The clutch was installed in the helicopter on October 3, 2018. According to the manufacturer's *Maintenance Manual*, 300-hour inspection checklist, the overrunning clutch bearing should be removed, inspected, and repacked with grease every 300 hours. The last 300-hour inspection occurred on February 10, 2020, about 5 1/2 months before the accident.

Pilot Information

Certificate:	Commercial	**Age:**	33,Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	August 12, 2019
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	February 28, 2020
Flight Time:	2788 hours (Total, all aircraft), 152 hours (Total, this make and model), 2725 hours (Pilot In Command, all aircraft), 114 hours (Last 90 days, all aircraft), 46 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Passenger Information

Certificate:		**Age:**	
Airplane Rating(s):		**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	4-point
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:			

Passenger Information

Certificate:		**Age:**	
Airplane Rating(s):		**Seat Occupied:**	Right
Other Aircraft Rating(s):		**Restraint Used:**	4-point
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	Md Helicopter	**Registration:**	N745BW
Model/Series:	600 N	**Aircraft Category:**	Helicopter
Year of Manufacture:	1998	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	RN045
Landing Gear Type:	N/A; Ski	**Seats:**	8
Date/Type of Last Inspection:	June 25, 2020 AAIP	**Certified Max Gross Wt.:**	4100 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	7160.9 Hrs as of last inspection	**Engine Manufacturer:**	Allison
ELT:	C126 installed, activated, aided in locating accident	**Engine Model/Series:**	250-C47
Registered Owner:	Cobra Aviation Services LLC	**Rated Power:**	650 Horsepower
Operator:	Brim Equipment Leasing Inc	**Operating Certificate(s) Held:**	Rotorcraft external load (133), On-demand air taxi (135), Agricultural aircraft (137)
Operator Does Business As:		**Operator Designator Code:**	BVOA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	CPU,1328 ft msl	**Distance from Accident Site:**	5 Nautical Miles
Observation Time:	09:55 Local	**Direction from Accident Site:**	314°
Lowest Cloud Condition:	Clear	**Visibility**	
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:	29.98 inches Hg	**Temperature/Dew Point:**	25°C / 9°C
Precipitation and Obscuration:	N/A - None - Dust or sand whirls		
Departure Point:	Angels Camp, CA (NA)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Angels Camp, CA (NA)	**Type of Clearance:**	Unknown
Departure Time:	09:15 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Destroyed
Passenger Injuries:	2 None	**Aircraft Fire:**	On-ground
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	3 None	**Latitude, Longitude:**	38.206264,-120.71358(est)

Administrative Information

Investigator In Charge (IIC):	Salazar, Fabian
Additional Participating Persons:	Joan Gregorie; MD Helicopters Inc.; Mesa, AZ Nick Shepler; Rolls-Royce; Indianapolis, IN Scott T Terrell; Federal Aviation Administration; Fort Worth, TX Brook B. Stewart; Federal Aviation Administration; Sacramento, CA
Original Publish Date:	August 19, 2022
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=101636