National Transportation Safety Board
Aviation Incident Final Report

Location:	Peach Springs, AZ	**Incident Number:**	WPR09IA140
Date & Time:	03/03/2009, 1045 MST	**Registration:**	N197AE
Aircraft:	EUROCOPTER AS 350 B2	**Aircraft Damage:**	Minor
Defining Event:	Loss of engine power (total)	**Injuries:**	7 None
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled - Sightseeing		

Analysis

The pilot heard a loud pop while descending into a canyon and had a loss of main rotor rpm. The pilot entered an autorotation to an open area and landed successfully. Examination of the engine revealed that it was intact and exhibited minimal impact related damage. Disassembly of the engine revealed that the rear bearing support housing was intact and undamaged. The number three bearing was intact, however, did not rotate freely. The inner race and ball bearings exhibited heavy rub marks and thermal damage and the outer race exhibited thermal damage. No oil residue was observed on the bearing components. The damage to the number three bearing was consistent with oil starvation. Debris was observed within the oil scavenge passage of the rear bearing support housing near the oil feed ring assembly. The rear bearing support housing (RBSH) was removed and placed on a flow test bench. The RBSH assembly flowed approximately one-half of the normal oil flow rate and irregular flow patterns were observed. Examination of the RBSH revealed no significant damage; however, the oil passages that feed oil to the number three bearing assembly contained deposits that most likely obstructed oil flow to the bearing. Analysis of the deposited material found that it was composed of coked synthetic oil. Prior to the incident, the engine manufacturer issued an Operating Information Letter that outlined recommended engine shutdown procedures. The two-step process consisted of a two minute idle period prior to shutdown followed after shutdown by motoring the engine with the starter motor for 10 seconds. The Operating Information Letter indicated that not following the procedures could result in coke build up in the number 2 and number 3 bearing oil jets and sump area. The operator reported that company pilots were instructed to comply with the recommended engine idle cool down procedure; however, company policy did not direct pilots to comply with the recommended post shutdown motoring after engine shutdown procedure due to concerns about depletion of oil in the engine oil reservoir. It was not determined if the bearing failure was a direct result of the operator not complying with the complete recommended shutdown procedure outlined by the engine manufacturer.

Probable Cause and Findings

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

A loss of engine power due to the failure of the number three engine bearing as a result of oil starvation due to coked oil obstructing the oil passages.

Findings

Aircraft	Engine (turbine/turboprop) - Failure (Cause)

Factual Information

HISTORY OF FLIGHT

On March 3, 2009, at 1045 mountain standard time, a Eurocopter AS 350 B2 helicopter, N197AE, sustained minor damage following a loss of engine power and subsequent forced landing near the Canyon West Airport, Peach Springs, Arizona. The helicopter was registered to XEBEC, LLC, and operated by Papillon Airways, Inc., under the provisions of 14 Code of Federal Regulations (CFR) Part 135. The commercial pilot and six passengers were not injured. Visual meteorological conditions prevailed and a company visual flight rules flight plan was filed for the air tour flight. The flight originated from the Boulder City Airport, Boulder City, Nevada, at 1015.

In a written report submitted to the National Transportation Safety Board (NTSB) on March 3, a representative employed by the operator reported the purpose of the flight was to transport passengers from the departure airport to a remote sightseeing area in the Grand Canyon. Approximately 30 minutes after departure, during the descent to the landing area, the pilot heard a "loud pop" followed by a loss of main rotor RPM. The pilot transmitted a mayday call and performed an autorotation.

The pilot reported that while descending into a canyon, he heard a loud pop followed by a loss of rotor rpm and subsequent low rotor rpm warning horn. The pilot lowered the collective and regained rotor rpm when he observed multiple warning lights illuminated on the instrument panel. The pilot stated that he raised the collective to "check if I had any power available" and heard the low rotor rpm warning horn a second time. The pilot initiated an autorotation to a clear area adjacent to his position and landed without further incident. The pilot added that after landing, the engine was not running, however, the rotor blades were still turning.

PERSONNEL INFORMATION

The pilot, age 27, held a commercial helicopter pilot certificate, and a helicopter instrument rating. In addition, he held a flight instructor certificate, with a rotorcraft helicopter and instrument rating. His most recent second-class medical certificate was issued March 3, 2009, with no limitations.

According to operator, the pilot had accumulated approximately 1,968 total flight hours, with 503 hours in AS350 series helicopters.

HELICOPTER INFORMATION

The single-engine, seven-place helicopter was a Eurocopter AS350 B2 that had been converted to an AS350 “SD2” under Supplemental Type Certificate SR01647SE. This STC conversion included the installation of the Honeywell LTS101-700D-2 engine in the AS350B2 in place of the original Turbomeca Arriel 1D1 engine.

The most recent maintenance performed on the engine was a 150-hour inspection on January 28, 2009. At the time of inspection, the engine time since new (TSN) was 8319.9 hours, time since overhaul (TSO) 2095.9 hours, Ng cycles of 13192.05, and Np cycles of 9279.25.

TESTS AND RESEARCH

The Honeywell LTS101-700D-2 turboshaft engine was removed from the helicopter and

shipped to Honeywell Aerospace, Phoenix, Arizona, for examination and disassembly. The examination commenced on May 5, 2009 under the supervision of NTSB investigators.

The engine was intact with nominal impact damage noted. Various airframe components including the aircraft starter/generator, power shaft and adapters, aircraft fire detection system, torque measurement transducer and associated hardware, engine exhaust tailpipe, inlet adapter, and various airframe clamps and bracket hardware remained installed on the engine.

The power turbine rotated about 5 degrees by hand before binding. The gas producer shaft rotated freely via the axial compressor rotor. Rotational continuity was established throughout the power turbine accessories, accessory gearbox, and output shaft.

The gas generator module was intact. The compressor bearing retainer assembly was intact and undamaged. The number one bearing liner and seal rotor were intact and undamaged. The compressor vane assembly and axial compressor rotor were intact and undamaged. A black residue was observed on all axial compressor rotor blades. The compressor impeller was intact and undamaged. Evidence of oil was observed near the hub of the inducer of the compressor impeller. Rub marks were observed on the compressor impeller blades near the inducer.

The compressor assembly shaft was intact and undamaged. The impeller shroud was intact and appeared undamaged. Evidence of oil was observed along the flowpath of the impeller shroud. Rotational score marks were observed at the inducer of the impeller shroud at the 11 o'clock position. The compressor diffuser assembly, diffuser housing assembly, and Gas Producer (GP) turbine nozzle were intact and undamaged.

The GP turbine nozzle ring seals were intact and undamaged. The compressor shaft spur gear and low fence link assembly actuator were intact and undamaged. The number two roller bearing was intact and black in color. When the number two roller bearing was rotated, some resistance was noted.

The number one ball bearing was intact, undamaged and rotated freely. The number one ball bearing was not removed from the compressor housing. Evidence of seal leakage was noted.

Examination of the power turbine module revealed that the rear bearing support housing was intact and undamaged. Debris was observed within the oil scavenge passage of the rear bearing support housing near the oil feed ring assembly. The oil sump area of the rear bearing support housing was black in color. The rear bearing support was removed and installed on a flow test bench. The flow test revealed that the assembly flowed approximately one-half of the normal oil flow. Irregular flow patterns were observed from the oil feed ring during the flow test.

The combustor liner assembly was intact and undamaged. The power turbine nozzle assembly was intact. Rotational scoring was observed around a 360-degree circumference of the power turbine nozzle assembly which corresponded to the power turbine blades.

The number three bearing spacer was undamaged. The oil feed ring assembly was intact and black in color. Debris was observed adhering to the oil feed ring assembly.

The number two bearing outer race was intact and black in color. The number two bearing seal assembly was intact.

Scoring was observed on the power turbine shaft, which corresponded to the number three bearing inner race. The shaft of the power turbine rotor assembly was intact and discolored near the number three bearing.

Further examination of the number two bearing, number three bearing, oil feed ring and rear bearing support housing revealed the following:

Number Two Roller Bearing

Examination of the number two roller bearing revealed nominal mechanical damage. The outer liner, inner race, cage, and rolling elements of the bearing exhibited heat discoloration. The inner race rotated freely with respect to the cage and rolling elements. The rolling elements rotated freely within the pockets. Light and uniform wear was observed on the bearing components. Oil residue was observed on the bearing components.

Rear Bearing Support Housing

Examination of the rear bearing support housing revealed no significant damage. The accessible oil passages that feed the oil supply ring and number three ball bearing were examined internally using a borescope. The borescope examination revealed evidence of deposits consistent with coked oil on the walls of each passage.

Oil Feed Ring

X-ray examination of the oil feed ring revealed a blockage in the main oil passage. A cross section through the oil passages revealed long, smooth flakes/chips of black colored material in the main passage, near the aft end. The flakes/chips blocked the inlets of the two aft oil jets, which feed the number three ball bearing. An Energy Dispersive x-ray (EDX) and infrared analysis revealed that the flakes/chips were "most likely composed of coked synthetic oil."

Number Three Bearing

Examination of the number three bearing revealed that the inner race sections and balls exhibited rub type damage, deformation and heat like discoloration. The outer race exhibited a zone of "highly heat affected microstructure emanating from the rubbed ball contact surface." Heat affected material from the balls and/or the forward race was deposited on the outer race, aft inner race, and cage. The cage was intact and exhibited a moderate amount of pocket wear. No distinct evidence of oil residue was observed on the bearing components.

Additional details pertaining to the teardown, exam and maintenance records are contained within the public docket for this accident.

ADDITIONAL INFORMATION

On January 30, 2009, Honeywell International Inc, issued an Operating Information Letter (OIL) to all owners, operators, airframe manufacturers, distributors, sales and service organizations, and field service representatives utilizing the LT101 series engine. The purpose of the letter was "to provide information which specifies the intent of the non-emergency engine shutdown procedure and maintenance actions to be taken if these shutdown procedures cannot be followed."

The letter stated, in part "...The shutdown procedure consists of the following steps. The first step requires the power lever to be set to idle for a minimum of 2 minutes prior to shutdown. This second step after shutdown is that the engine is to be motored using the starter motor for

10 seconds. These steps provide a means to stabilize the engine component temperatures to idle conditions prior to shutdown and ensure temperature stabilization to the engine. If the procedure is not followed based on experience seen in development and fielded engines, coke built up in the No 2 and No 3 bearing oil jets and sump area will occur. Coke build up in these locations may result in a loss of oil flow to the bearings which will lead to a bearing failure."

During the course of the examination, a representative from the operator reported that company pilots were instructed to comply with the recommended engine idle cool down procedure; however, company policy did not direct pilots to comply with the recommended post shutdown cranking/motoring after engine shutdown procedure due, in part, to operational concerns regarding the depletion of oil in the engine oil reservoir.

History of Flight

Enroute-descent	Powerplant sys/comp malf/fail Loss of engine power (total) (Defining event)
Emergency descent	Off-field or emergency landing

Pilot Information

Certificate:	Flight Instructor; Commercial	**Age:**	27, Male
Airplane Rating(s):	Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter; Instrument Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 None	**Last FAA Medical Exam:**	03/03/2009
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	03/26/2008
Flight Time:	1968 hours (Total, all aircraft), 503 hours (Total, this make and model), 1078 hours (Pilot In Command, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	EUROCOPTER	**Registration:**	N197AE
Model/Series:	AS 350 B2	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	3909
Landing Gear Type:	High Skid	**Seats:**	7
Date/Type of Last Inspection:	01/26/2009, 100 Hour	**Certified Max Gross Wt.:**	4961 lbs
Time Since Last Inspection:	34 Hours	**Engines:**	1 Turbo Shaft
Airframe Total Time:	4602 Hours as of last inspection	**Engine Manufacturer:**	Honeywell
ELT:	C91 installed, not activated	**Engine Model/Series:**	LTS 101
Registered Owner:	XEBEC LLC	**Rated Power:**	732 hp
Operator:	Papillon Airways	**Operating Certificate(s) Held:**	On-demand Air Taxi (135)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	LAS	**Observation Time:**	0545 PST
Distance from Accident Site:	52 Nautical Miles	**Direction from Accident Site:**	83°
Lowest Cloud Condition:	Thin Broken / 16000 ft agl	**Temperature/Dew Point:**	17°C / 5°C
Lowest Ceiling:	Broken / 16000 ft agl	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	Calm	**Visibility (RVR):**	
Altimeter Setting:	29.92 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Boulder City, NV (61B)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Grand Canyon, AZ	**Type of Clearance:**	None
Departure Time:	0915 PST	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Minor
Passenger Injuries:	6 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	7 None	**Latitude, Longitude:**	35.990278, -113.816389

Administrative Information

Investigator In Charge (IIC):	Dennis J Hogenson	**Adopted Date:**	07/22/2010
Additional Participating Persons:	Charlie W Bierman; FAA FSDO; Las Vegas, NV Lindsay Cunningham; American Eurocopter; Grand Prairie, TX Dana Metz; Honeywell Aerospace; Phoenix, AZ Dean Brandt; Papillon; Boulder City, NV		
Publish Date:	07/22/2010		
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		