Aviation Investigation Final Report

Location:	Canton, Mississippi	**Accident Number:**	ERA13LA421
Date & Time:	September 19, 2013, 21:27 Local	**Registration:**	N810LE
Aircraft:	AMERICAN EUROCOPTER LLC AS350B2	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Serious, 3 Minor
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled - Air Medical (Medical emergency)		

Analysis

As the helicopter departed the helipad, a witness saw dark black smoke coming out of the engine exhaust. (This smoke would not have been visible to the pilot.) The pilot reported that, about 10 minutes after departure, he noticed the illumination of the low engine oil pressure warning light. He noted that the oil pressure gauge was also showing low pressure but that there was no rise in the oil temperature or the exhaust gas temperature. Because the pilot had recently experienced an intermittent oil pressure gauge problem in another helicopter, he assumed the accident helicopter was experiencing a similar problem and continued toward the intended destination while attempting to verify the loss of engine oil pressure. Several minutes later, the pilot noticed a low-torque indication but no rise in the oil temperature or exhaust gas temperature. About 25 minutes after departure, the pilot saw a rise in the exhaust gas temperature and lowered the collective to reduce power. After briefly decreasing, the exhaust gas temperature began rising again, and the pilot located an open field to perform an off-airport landing. The engine experienced a total loss of power before the helicopter reached the open field; the pilot performed an autorotation, and the helicopter landed hard.

Postaccident examination revealed that the engine oil tank was empty and that the engine had sustained heat damage consistent with overtemperature due to oil exhaustion. An obstruction of solidified oil carbon was found in the rear bearing chip detector housing union, which would have restricted the oil scavenge of the rear bearing. According to the engine manufacturer, failure to scavenge the oil in the rear bearing would cause overpressurization of the rear bearing housing area, which would force engine oil out of the rear bearing vent line. In addition, oil overpressurization could overcome the labyrinth seal of the piston shaft, which would allow oil to flow into the gas exhaust path. It is likely that this occurred because oil flowing into the exhaust path would result in black smoke coming from the engine exhaust as was observed by the witness. The continued operation of the engine in this condition likely resulted in the depletion of the oil reservoir, the illumination of the low engine oil pressure warning light, and, subsequently, as the flight continued, a total loss of engine power.

A review of data recovered from a flight recorder installed in the helicopter indicated that, about 2 minutes after departure (about 26 minutes before the accident), the oil pressure dropped from about 4 bars to about 0.2 bar, which would have illuminated the low engine oil pressure warning light. The flight manual and the cockpit emergency checklist both directed that, when the low engine oil pressure warning light was illuminated and the engine oil pressure gauge indicated low oil pressure (as reported by the pilot), the procedure was to land immediately. If the pilot had followed this procedure instead of continuing the flight with the warning light illuminated, it is likely that the accident would have been prevented.

Review of the helicopter's maintenance records indicated that, about 12 flight hours before the accident flight, the engine's 2nd-stage turbine disk (T2) was replaced. During the replacement of the T2, the maintenance technician determined that the rear bearing was "clean"; therefore, he did not clean the rear bearing even though the maintenance procedures required a systematic cleaning when the T2 was replaced regardless of the condition of the bearing. If the cleaning had been performed, as called for in the maintenance procedures, it is likely that the oil carbon deposit in the rear bearing chip detector housing union would have been discovered and removed, thus averting the accident.

Probable Cause and Findings

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

The pilot's improper decision to continue flight with a low engine oil pressure warning light instead of landing immediately in accordance with the flight manual emergency checklist. Contributing to the accident was the maintenance technician's failure to clean the rear bearing in accordance with the engine manufacturer's guidance when replacing the 2nd-stage turbine wheel, which resulted in an obstruction of solidified oil carbon in the rear bearing chip detector housing union, subsequent oil exhaustion, and engine failure.

Findings

Aircraft	Oil system - Damaged/degraded
Personnel issues	Scheduled/routine inspection - Maintenance personnel
Aircraft	Oil - Fluid level
Personnel issues	Use of checklist - Pilot
Personnel issues	Decision making/judgment - Pilot

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Enroute-cruise	Loss of engine power (total) (Defining event)
Emergency descent	Off-field or emergency landing
Landing	Hard landing

On September 19, 2013, about 2127 central daylight time, a Eurocopter AS350B2 emergency medical service (EMS) configured helicopter, N810LE, experienced a hard landing in a field following a total loss of engine power near Canton, Mississippi. The airline transport pilot incurred serious injury and the two medical flight crewmembers and a passenger incurred minor injuries. The helicopter was owned and operated by Metro Aviation Inc., under the provisions of Title 14 Code of Federal Regulations Part 135 as an on-demand Emergency Medical Services flight. The intent of the flight was a patient transfer. Night visual meteorological conditions prevailed for the medical patient transfer flight and a company visual flight rules flight plan was filed. The flight originated from a private hospital helipad in Ackerman, Mississippi, at 2054, with the intended destination of Jackson, Mississippi.

According to the pilot, about 10 minutes after departure, a low engine oil pressure indicator warning light illuminated and the oil pressure gauge indicated between 0 and 2 psi. He noted that there was no rise in the oil temperature indication or engine temperature indicator and continued toward the intended destination while attempting to verify the loss of engine oil pressure. Several minutes later the pilot noticed a low torque indication and again noted that there was no rise in the oil temperature or engine temperature. About 25 minutes after departure, the pilot saw a rise in the engine temperature gauge and subsequently lowered the collective. He then observed the engine temperature rising at a higher rate and located an open field in order to perform an off airport landing. The engine lost total power prior to reaching the open field and the pilot performed an autorotation. After impacting the ground, the pilot performed the emergency shutdown procedures. In addition, the pilot stated that he was using night vision goggles during the accident flight.

According to a witness, as the helicopter was departing the helipad there was "dark black" smoke coming out of the engine exhaust at the back of the helicopter. The smoke was "heaviest when [the helicopter] tilted to go west." In addition, the helicopter started to make a "clanking" noise as it accelerated away from the helipad. As it departed the area, the helicopter continued to fly forward without making any type of turn.

Pilot Information

Certificate:	Airline transport; Commercial; Flight engineer; Flight instructor	**Age:**	42
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	3-point
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Helicopter; Instrument airplane; Instrument helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	August 8, 2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	April 24, 2013
Flight Time:	3380 hours (Total, all aircraft), 77 hours (Total, this make and model)		

According to the pilot and Federal Aviation Administration (FAA) records, he held an airline transport pilot certificate for airplane multiengine land, a commercial pilot certificate for airplane single-engine land, helicopter, and instrument helicopter. In addition, he held a flight instructor certificate for airplane multiengine and single-engine land, helicopter, and instrument. He also held an advanced ground instructor, instrument ground instructor, and flight engineer certificate. He held a first-class medical certificate, which was issued on August 8, 2013. He had accumulated 3,380 total hours of flight experience, 1,200 hours of flight experience in helicopters, and 77 of those hours were in the same make and model as the accident helicopter.

Aircraft and Owner/Operator Information

Aircraft Make:	AMERICAN EUROCOPTER LLC	**Registration:**	N810LE
Model/Series:	AS350B2	**Aircraft Category:**	Helicopter
Year of Manufacture:	2010	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	4924
Landing Gear Type:	High skid	**Seats:**	
Date/Type of Last Inspection:	September 12, 2013 AAIP	**Certified Max Gross Wt.:**	4960 lbs
Time Since Last Inspection:	12 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	2219 Hrs as of last inspection	**Engine Manufacturer:**	Turbomeca
ELT:	C126 installed	**Engine Model/Series:**	Arriel 1D1
Registered Owner:	METRO AVIATION INC	**Rated Power:**	750 Horsepower
Operator:	METRO AVIATION INC	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:		**Operator Designator Code:**	HDNA

According to FAA records the helicopter was issued an airworthiness certificate in 2010 and was registered to Metro Aviation Inc. on May 27, 2010. It was powered by a Turbomeca Arriel 1D1 series, 732-shaft horsepower engine.

The helicopter's most recent maintenance inspection, under the approved inspection program, was completed on September 13, 2013, which was about 12 flight hours prior to the accident. The maintenance inspection included a replacement of the second stage turbine disk (T2) in the engine. The engine manufacturer required that a maintenance center level III technician had to perform the replacement of the T2 on the engine. The maintenance technician was required to have and did have manufacturer specific engine training and utilize a maintenance technical instruction manual provided by the engine manufacturer for the T2 replacement. During the replacement of the T2, the maintenance manual stated that the preliminary procedures required the technician to "clean the rear bearing – free turbine nozzle guide vane assy." During the maintenance, the rear bearing had been judged "clean" by the maintenance technician and no cleaning had been carried out. However, review of manufacturer's maintenance procedures required a systematic cleaning of the rear bearing when the T2 was replaced every 4,000 cycles no matter the condition of the bearing. The recorded cycles on the T2 was 3990.58 at the time of the T2 replacement.

Engine Oil System

The engine oil system consisted of a tank, which held 5.7 liters of oil, pumps, a filter, strainers, a cooler, breather, and indicating devices. The gas generator rear bearing was lubricated by oil passing through an external tube, then through a restrictor, and a tube screwed into the bearing housing. The oil coated the bearing, lubricated it, and the bearing housing was sealed by pressurized labyrinth seals. Then the oil traveled by gravity to the bottom of the housing, through a tube in the bottom of the casing, an external tube, through a strainer, then finally through the scavenge pump. During the lubrication process, the

air/oil mist that resulted from lubrication passed through a tube connected to the rear bearing housing and an external tube, which vented any excess air/oil mist or over pressurization of the gas generator rear bearing housing into the exhaust of the engine.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	JAN	**Distance from Accident Site:**	20 Nautical Miles
Observation Time:	20:54 Local	**Direction from Accident Site:**	26°
Lowest Cloud Condition:	Few	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	8 knots /	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	160°	**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	30.01 inches Hg	**Temperature/Dew Point:**	26°C / 21°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Ackerman, MS	**Type of Flight Plan Filed:**	Company VFR
Destination:	Jackson, MS	**Type of Clearance:**	None
Departure Time:	20:54 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	3 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious, 3 Minor	**Latitude, Longitude:**	32.609283,-90.029792(est)

The helicopter came to rest upright in an open field that was surrounded by trees. Postaccident examination of the landing gear crosstubes revealed that they were bowed downward. The tailboom separated from the helicopter and came to rest just aft of the fuselage. The main rotor blades remained intact and attached to the rotorhead.

Communications

During the accident flight, flight following was being conducted on the helicopter by a communications center, as part of the operator's protocol. Two times during the accident flight the pilot was contacted by communications center personnel in order to verify if the flight was proceeding without any anomalies. Approximately 14 minutes prior to the destination, which was about halfway through the accident flight, the pilot reported that "operations were normal."

Tests and Research

Engine Examinations

Under the supervision of an FAA inspector, the engine was removed from the airframe, and shipped to the manufacturer in Grand Prairie, Texas. On October 11, 2013, technical representatives from Turbomeca USA, American Eurocopter, and Metro Aviation Inc. examined the engine under the supervision of an NTSB investigator.

The engine was disassembled during the examination. The five modules of the engine were separated and continuity was confirmed through the reduction gearbox, accessory gearbox, and free turbine modules. The gas generator rear bearing exhibited heat damage. Due to the heat damage, the rear bearing housing was disassembled with a plasma torch in order to examine the rotating assembly. Carbon was found in the scavenge pipe and union from the rear bearing housing. No anomalies other than the heat damage, which is consistent with a lack of lubrication, were detected.

An additional examination was performed on October 31, 2013, under the supervision of an FAA inspector in order to examine the TU208 strainer. An obstruction of solidified oil carbon was found in the rear bearing chip detector housing union of the oil return pipe of the rear bearing located just prior to the strainer.

Detailed notes documenting the engine examination and teardown are available in the official docket of this investigation.

Vehicle Engine Multifunction Display (VEMD)

The VEMD was installed on a training bench on October 11, 2013, and power was applied. The flight reported complete for the accident flight, which was about 32 minutes in duration.

The VEMD revealed an analytical inconsistency between the NG (gas generator rotation speed), torque (TRQ) and the gas temperature at the gas generator turbine outlet (T4) parameters, at 05 minutes, 31 seconds, which concerned the TRQ information that appeared in yellow on the screen. The last consistent TRQ parameter values recorded two seconds prior to the failure was 71.9 percent and 70.0

percent at the time of the fault detection. The VEMD recorded the same analytical inconsistency between the NG, TRQ, and T4 parameters, on the right module, at 05 minutes, 32 seconds.

The overlimit detected by the VEMD was a T4 Temperature excedance, which the maximum value reached 1215 degrees C during the starting phase. According to the manufacturer, the starting phase can correspond with two phases of the flight. It corresponded to the beginning of a flight when the NG increased from 10 percent to 60 percent and at the end of the flight when the NG decreased from 60 percent to 10 percent. In this instance, the temperature was recorded during the later of the phases due to the time it was recorded, when the NG decreased from 60 percent to 10 percent.

Detailed notes documenting the VEMD examination and teardown are available in the official docket of this investigation.

Recorded Flight Data

The North Flight Data Systems Outerlink Voice and Video Recorder (OVVR) was capable of recording video, flight data, and up to 6 audio channels. Data was stored on a Compact Flash (CF) card mounted inside the device as well as an SD card located in the Quick Access Recorder. The downloaded data was related to engine operation during the entire accident flight. A graphical report was made by the NTSB recorders lab of the North Flight Data Systems OVVR that was found onboard the helicopter. The NTSB recorders laboratory report illustrated several parameters for the including, the Engine Oil Pressure, Oil Temperature, Torque, T4 Temperature, rotor rotation speed (NR/NF) and NG against time.

The data indicated that the helicopter departed about 2056:30 CDT. At 2058:30, the oil pressure decreased from approximately 4 bar to around 0.2 bar for the remainder of the flight. Then, the gas generator speed began to drop at 2124:25 and the oil temperature and turbine outlet temperature began climbing at 2125:10. The last data was recorded at 2125:26.The engine torque reading dropped to approximately 0 at 2058:30, along with the drop in oil pressure. The engine oil temperature gauge measured the oil temperature from a switch that was located downstream of the oil filter. In addition, the engine temperature was measured by a sensor located at the gas generator turbine outlet. On this engine, the torque reading is driven by oil pressure. A detailed report regarding the recorded flight data can be found in the official docket of this investigation.

Flight Manual Emergency Procedures

According to the airframe manufacturer's flight manual, it stated that if an abnormal engine parameter was observed, to check the "ENG P" light, and if the light was illuminated, to check the oil pressure gauge, then land immediately if the gauge indicated "low or nil" oil pressure.

Cockpit Emergency Checklist

According to a checklist found in the cockpit of the accident helicopter, the checklist stated that if the "ENG P" light was illuminated, the pilot was to "Land ASAP."

Additional Information

According to the pilot, he had an intermittent oil pressure gauge issue in a different helicopter a "couple of weeks" prior to the accident flight so "[he] thought this was a similar issue at first."

According to FAA Publication "Pilot's Handbook of Aeronautical Knowledge," (FAA-H-8083-25A) that "for the past several decades, research into how people actually make decisions has revealed that when pressed for time, experts faced with a task loaded with uncertainty, first assess whether the situation strikes them as familiar. Rather than comparing the pros and cons of different approaches, they quickly imagine how one or a few possible courses of action in such situations will play out. Experts take the first workable option they can find. While it may not be the best of all possible choices, it often yields remarkably good results.

The terms naturalistic and automatic decision-making have been coined to describe this type of decision-making. The ability to make automatic decisions holds true for a range of experts from fire fighters to chess players. It appears the expert's ability hinges on the recognition of patterns and consistencies that clarify options in complex situations. Experts appear to make provisional sense of a situation, without actually reaching a decision, by launching experience-based actions that in turn trigger creative revisions.

This is a reflexive type of decision-making anchored in training and experience and is most often used in times of emergencies when there is no time to practice analytical decision-making. Naturalistic or automatic decision-making improves with training and experience, and a pilot will find himself or herself using a combination of decision-making tools that correlate with individual experience and training."

Administrative Information

Investigator In Charge (IIC):	Moats, Heidi
Additional Participating Persons:	Chris L Mackey; FAA/FSDO; Jackson, MS Tarek Loutfy; Metro Aviation; Shreveport, LA
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