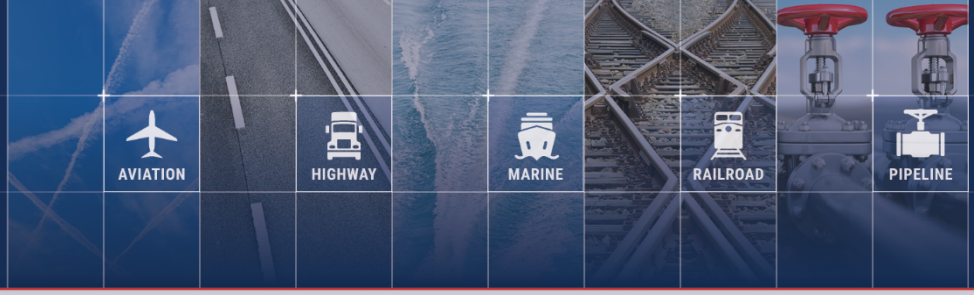

Aviation Investigation Final Report

Location:	LeRoy, Kansas	**Accident Number:**	CEN21LA187
Date & Time:	April 9, 2021, 10:12 Local	**Registration:**	N421PB
Aircraft:	Eurocopter EC120	**Aircraft Damage:**	Substantial
Defining Event:	Fuel starvation	**Injuries:**	2 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot and passenger were conducting a personal cross-country flight when the helicopter had a partial loss of engine power while in cruise flight at 2,000 ft. The pilot reported that the engine's free turbine speed and the helicopter's main rotor speed "drooped" and he was unable to maintain the main rotor speed with the collective and cyclic controls. An off-airport landing was made to a residential backyard, during which the tailboom struck the ground when the helicopter landed hard resulting in substantial damage to the tailboom.

Postaccident engine testing confirmed the pilot's report of being unable to maintain the engine's free turbine speed at 100% while under increased loads. Further examination and testing revealed a contaminated fuel injection manifold fuel filter, which restricted the amount of fuel that could be delivered to the engine's gas generator. A laboratory examination determined the contamination was consistent with a cellulose material, and its spectra closely matched that of white paper and white cotton. The engine's main fuel filter also was found to be contaminated and similar contamination was found throughout the engine's fuel control unit (FCU) during disassembly. Laboratory testing of the contamination recovered from the FCU was unable to identify the material as a whole or to its origin.

Based on logbook documentation, the helicopter accumulated 52.4 hours during the 14-month period before the accident, during which the engine's injection manifolds were replaced once, and the oil, main fuel, and FCU filters were replaced twice. The helicopter accumulated 2.9 hours since the oil, main fuel, and FCU filters were last changed about 6 weeks before the accident.

When asked if he was troubleshooting an ongoing fuel system issue, the helicopter's maintainer replied that there were no fuel system issues with the helicopter, and that he routinely replaced fuel filters because of their minimal cost. Additionally, he stated that they

never fueled from a non-standard source, such as a steel barrel, or had to transport fuel to an off-airport location to refuel the helicopter.

According to a field representative of the engine manufacturer, the passenger contacted him the day before the accident to discuss a trip that he was making to investigate a reported fuel filter bypass indication and illuminated fuel filter light on the helicopter. The passenger previously told the helicopter's maintainer to inspect and replace the fuel filter and shipped a new fuel filter to be installed. The helicopter's maintainer reportedly did not observe any evidence of fuel system contamination in the aircraft fuel cell or in the engine's main fuel filter. In a subsequent conversation after the accident, the passenger told the engine manufacturer field representative that the helicopter's maintainer told him that the fuel system issues were resolved and, as such, the passenger did not troubleshoot any fuel system components before the flight.

Based on the known information, the cellulose contamination found in the fuel injector manifold filter was likely introduced during associated fuel system maintenance at an undetermined date. The contaminated fuel injection manifold filter restricted fuel flow to the gas generator, which resulted in the partial loss of engine power during the flight. Additionally, the pilot likely delayed entering an autorotation after the partial loss of engine power, which resulted in insufficient main rotor speed and an excessive descent rate at touchdown.

Probable Cause and Findings

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

The contamination of the fuel injection manifold filter due to improper maintenance, resulting in a partial loss of engine power during cruise flight. Contributing to the accident was the pilot's delayed autorotation, which resulted in insufficient main rotor speed and an excessive descent rate at touchdown.

Findings

Aircraft	Fuel divider - Damaged/degraded
Aircraft	Fuel divider - Incorrect service/maintenance
Personnel issues	Scheduled/routine maintenance - Maintenance personnel
Personnel issues	Delayed action - Pilot
Aircraft	Engine out control - Incorrect use/operation
Aircraft	Prop/rotor parameters - Not attained/maintained

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Enroute-cruise	Fuel starvation (Defining event)
Landing	Off-field or emergency landing
Landing-flare/touchdown	Hard landing

On April 9, 2021, about 1012 central daylight time, a Eurocopter EC120B helicopter, N421PB, was substantially damaged when it was involved in an accident near LeRoy, Kansas. The pilot and his passenger were not injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The pilot reported that he departed on the cross-country flight from Philip Billard Municipal Airport (TOP), Topeka, Kansas, to Claremore Regional Airport (GCM), Claremore, Oklahoma, with about 90 gallons of fuel. He reported that about 35 minutes after departure, while in cruise flight at 2,000 ft, he heard the low rotor speed warning horn but no cockpit caution/warning lights illuminated. The pilot stated that the engine's free turbine speed and the main rotor speed were "drooped", and he reduced collective and moved the cyclic control aft to stabilize the main rotor speed. He was able to maintain main rotor speed with about "70%" collective input as indicated on the first limit indicator (FLI). The pilot stated that the main rotor speed continued to decrease as he flew toward an open field for a landing, but he eventually entered an autorotation before reaching the intended field because of the decreasing main rotor speed.

The passenger, who also was a helicopter-rated pilot, stated that during cruise flight between 1,700 ft and 2,000 ft, at 100 knots, the main rotor low speed warning horn briefly sounded. The engine's free turbine speed and main rotor speed were "drooped" but there were no cockpit caution/warning lights illuminated. The pilot used the collective to maintain main rotor rpm at "70%" as indicated on the FLI. The helicopter decelerated from 100 knots to 85 knots while the pilot maintained the helicopter's altitude. The pilot and the passenger began looking for suitable fields to land in, but about 2-3 minutes after the initial main rotor low speed warning horn, the horn resumed a sustained tone for the remainder of the flight. The passenger did not recall seeing any caution/warning lights, but his attention was outside the helicopter trying to locate a suitable landing area.

The passenger recalled that the pilot entered a right turn and made an immediate landing in a residential backyard. He was unsure if the pilot made an autorotation or if the helicopter landed hard, but the helicopter had a high descent rate when it touched down. After the hard

landing, the engine continued to run, and the pilot twisted the throttle to OFF before he selected the fuel shutoff to OFF.

Pilot Information

Certificate:	Commercial	**Age:**	64,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	August 19, 2020
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	September 26, 2020
Flight Time:	(Estimated) 541 hours (Total, all aircraft), 164 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N421PB
Model/Series:	EC120 B	**Aircraft Category:**	Helicopter
Year of Manufacture:	2005	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1403
Landing Gear Type:	None; High skid	**Seats:**	5
Date/Type of Last Inspection:	February 18, 2021 100 hour	**Certified Max Gross Wt.:**	3780 lbs
Time Since Last Inspection:	3.6 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	1435 Hrs at time of accident	**Engine Manufacturer:**	Turbomeca
ELT:	C126 installed, activated, did not aid in locating accident	**Engine Model/Series:**	Arrius 2F
Registered Owner:	Black Wolf Air, LLC	**Rated Power:**	504 Horsepower
Operator:	Black Wolf Air, LLC	**Operating Certificate(s) Held:**	None

Based on logbook documentation, the helicopter accumulated 52.4 hours during the 14-month period before the accident, during which the engine's injection manifolds were replaced once, and the oil, main fuel, and FCU filters were replaced twice. The helicopter accumulated 2.9

hours since the oil, main fuel, and FCU filters were last changed about 6 weeks before the accident.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	UKL,1174 ft msl	**Distance from Accident Site:**	13.2 Nautical Miles
Observation Time:	10:15 Local	**Direction from Accident Site:**	341°
Lowest Cloud Condition:	Clear	**Visibility**	10 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:	29.7 inches Hg	**Temperature/Dew Point:**	18°C / 6°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Topeka, KS (TOP)	**Type of Flight Plan Filed:**	None
Destination:	Claremore, OK (GCM)	**Type of Clearance:**	None
Departure Time:	09:35 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	38.095955,-95.634504(est)

The helicopter came to rest upright in a residential backyard. The landing gear skids were deformed outward from the hard landing. The aft tailboom exhibited evidence of buckling/crushing near the fenestron. The lower portion of the fenestron also exhibited buckling/crushing consistent with the tailboom impacting the ground during landing. Postaccident examination of the helicopter revealed proper flight control continuity and engine control continuity. The engine's main fuel filter delta-p bypass indicator was in the popped position.

Fuel samples were taken after the accident from the fuel service truck used to refuel the helicopter before the flight. The samples were free of contamination and exhibited a light straw color consistent with Jet-A aviation fuel.

The engine was removed from the airframe and mounted in a test cell for operational testing. All the original filters remained installed for the initial test, and the main fuel filter delta-p bypass indicator was reset before the initial engine start. Upon the first engine start, the fuel filter pre-clogging indication illuminated on the test bench control display, and the engine's physical delta-p bypass indicator popped. Applying a load to the engine caused the free turbine speed to droop and the gas generator could not accelerate above 83%. The engine was shut down and the main fuel filter examined. The main fuel filter showed significant discoloration when compared to a new filter, but there was no physical contamination visible on the filter's paper pleats.

A new main fuel filter was installed on the engine, and the engine restarted without any pre-clogging indication or bypass indication. A load was applied to the engine, and again the free turbine speed drooped, the gas generator could not accelerate above 83%, and the engine's gas generator began to oscillate. The engine was shut down to further troubleshoot the issue.

During subsequent engine test runs, the gas generator could not maintain the free turbine at a constant 100% when the load was increased on the system. After multiple tests and several component swaps, the fuel injection manifolds were determined to be the cause of the drooping power condition.

When bench tested, the left fuel injection manifold flowed within the design limits with an average flow of 21.3 liters/hour (limits 21.2 ± 0.8 liters/hour) and max deviation of 0.6 liters/hour (limits = 1.6 liters/hour). When bench tested, the right fuel injection manifold flowed significantly less than the design limits with an average flow of 4.3 liters/hour. The right fuel injection manifold houses a filter at the entrance to the manifold that protects both right and left injection manifolds where they connect inline to the adjusted valve. The original filter was removed, a new filter installed, and the right fuel injection manifold tested within the design limits with an average flow of 20.9 liters/hour and max deviation of 1.0 liters/hour. A microscope examination revealed contamination that obscured about 75% of the filter screen, as shown in figure 1.

The fuel injection manifold filter was sent to the National Transportation Safety Board Materials Laboratory for additional examination using Fourier Transform Infrared (FTIR) spectrometry. The FTIR spectrum for the unknown sample had signatures consistent with cellulose. Cellulose is found in natural plant fibers like paper and cotton. The spectra of known samples of white paper and white cotton were also compared to the unknown sample and exhibited strong matches.

The engine fuel control unit (FCU) was removed and dissembled. The fuel drained from the FCU was contaminated. During FCU disassembly, the same contamination was found

throughout the device. The engine's main fuel filter, previously removed during the engine testing, was placed in a clear glass jar and agitated. The main fuel filter contained particles similar in appearance to those found in the FCU. Additional laboratory testing of the contamination determined the elemental composition but was unable to identify the material as a whole or to its origin. The contamination was characterized as flakes and spheres measuring up to 0.5 mm and 0.2 mm, respectively.

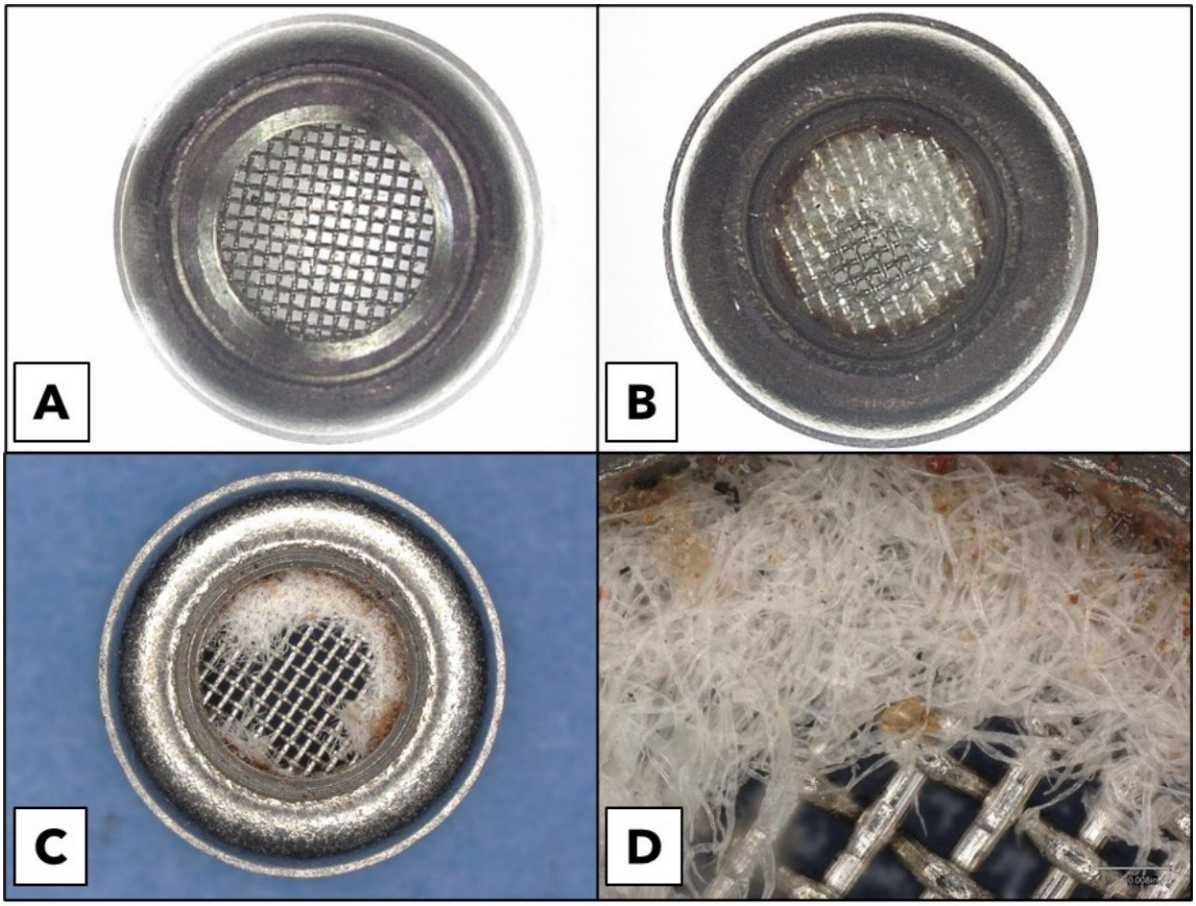

Figure 1 – (A) Exemplar fuel injection manifold filter; (B) Accident fuel injection manifold filter, wet; (C) Accident fuel injection manifold filter, dry; (D) Filter contamination at 200X magnification

Additional Information

A few months before the accident, the passenger, who also was an aviation mechanic specialized in helicopter maintenance, was contracted by the helicopter's maintainer to replace the helicopter's windshields. The passenger purchased the replacement windows and, on the day before the accident, the helicopter's maintainer flew a Pilatus PC12 to Dallas, Texas, to retrieve the passenger and the replacement windows. They flew to GCM where the replacement windows were offloaded into the maintainer's hangar where the work would be completed. However, due to inclement weather the helicopter was delayed in Topeka, Kansas, so the decision was made to continue to TOP where the passenger overnighted at the pilot's residence.

The passenger stated that he traveled to Topeka so he could examine the helicopter's windshields and discuss their removal process with the helicopter present. The decision was made that the passenger would accompany the pilot the following morning during the flight from TOP to GCM. The passenger then intended to return to Dallas for unrelated work on the afternoon of the accident.

When interviewed by the NTSB Investigator-In-Charge (IIC), the passenger stated that he was unaware of any unresolved maintenance concerns on the helicopter, believing that if there were any the helicopter's maintainer and/or the pilot would have asked him for his opinion/assistance. Additionally, the helicopter's maintainer did not mention any recent maintenance concerns in the days and weeks before the accident.

However, according to an engine manufacturer field representative, the passenger contacted him the day before the accident to discuss a trip to Kansas that he was making to investigate a reported fuel filter bypass indication and illuminated fuel filter light on the helicopter. The passenger previously told the helicopter's maintainer to inspect and replace the fuel filter and he shipped a new fuel filter to be installed. The helicopter's maintainer reportedly did not observe any evidence of fuel system contamination in the aircraft fuel cell or in the engine's main fuel filter. In a subsequent conversation after the accident, the passenger told the engine manufacturer field representative that the helicopter's maintainer told him that the fuel system issues were resolved and, as such, the passenger did not troubleshoot any fuel system components before the flight.

When interviewed by the NTSB IIC, the helicopter's maintainer was asked if he was troubleshooting an ongoing fuel system issue before the accident flight. The helicopter's maintainer replied that there were no fuel system related issues with the helicopter, and that he routinely replaced fuel filters because of their minimal cost. Additionally, he stated that they never fueled from a non-standard source, such as a steel barrel, or had to transport fuel to an off-airport location to refuel the helicopter.

Administrative Information

Investigator In Charge (IIC):	Fox, Andrew
Additional Participating Persons:	John "Rusty" Knox; Federal Aviation Administration (Kansas City FSDO); Kansas City, MO Seth D. Buttner; Airbus Helicopters North America; Grand Prairie, TX Bryan Larimore; Safran Helicopter Engines; Grand Prairie, TX Sébastien David; Bureau d'Enquêtes et d'Analyses; Le Bourget, OF
Original Publish Date:	August 16, 2023
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=102902