

Fox Todd

From: Fox Todd
Sent: Wednesday, February 8, 2023 10:17 AM
To: LARIMORE Bryan (SAFRAN HELICOPTER ENGINES USA)
Cc: Fox Todd; Rodi Jennifer
Subject: RE: CEN21LA187 - Engine Run Report
Attachments: A-2021-004 Engine Exam Report.pdf

Importance: High

Follow Up Flag: Follow up
Flag Status: Flagged

Mr. Larimore,

Thank you for the follow-up message and authorization to include Safran HE Report No. A-2021-004 with the NTSB public docket materials associated with NTSB Investigation No. CEN21LA187.

Sincerely,
Andrew Todd Fox
NTSB, Air Safety Investigator

From: LARIMORE Bryan (SAFRAN HELICOPTER ENGINES USA) [REDACTED]
Sent: Wednesday, February 8, 2023 8:30 AM
To: Fox Todd [REDACTED]
Cc: Rodi Jennifer [REDACTED]
Subject: RE: CEN21LA187 - Engine Run Report

Hello Todd,

You have the permission of Safran HE to place this report in the public docket of CEN21LA187.

Best regards,

Bryan

From: Fox Todd [REDACTED]
Sent: Thursday, February 2, 2023 9:02 AM
To: LARIMORE Bryan (SAFRAN HELICOPTER ENGINES USA) [REDACTED]
Cc: Rodi Jennifer [REDACTED]; Fox Todd [REDACTED]
Subject: RE: CEN21LA187 - Engine Run Report

Bryan,

Thank you for emailing me a copy of your final engine examination/test run report (attached)... if possible, the NTSB would like to include this report in our public docket materials.

As such, could you please run this report through your legal department and provide me authorization to include it with our public docket materials?

INVESTIGATION REPORT	Preliminary ☐
	Final ☒

Data				
ACCIDENT (RA) ☒		INCIDENT (RI) ☐		No RI/RA ☐
RA n° (21-095)				
Date of occurrence	Occurrence place	Operator		
9APR2021	LeRoy, KS, USA	Black Wolf Air LLC		
Aircraft type	S/N	Registration		
EC120	1403	N421PB		
Engine type	S/N	TSN		
Arrius 2F	34455	1432.7 as of 18FEB21		
Modules / Accessories				
Designation	P/N	S/N	TSN	
FCU	0319878010	601	1127.7 as of 18FEB21	
Circumstances reported to SAFRAN HELICOPTER ENGINES				
Reposition Flight Topeka, KS to Claremore, OK lost power and set down in a back yard while attempting to make it to an open field.				
Conclusion				
Test cell run was able to confirm the pilot's report of main rotor droop. While applying a load to the engine the Nf would droop and Ng was unable to accelerate above $\approx 83\%$. It was found that contamination had clogged the injection manifold filter by approximately 75% restricting the amount of fuel that could be delivered to the gas generator. The main fuel filter was also found clogged with contamination and caused an electric pre-clogging indication as well as a physical bypass indication (ΔP). Contamination was found in the main fuel filter, fcU fuel filter, injection manifold filter, and throughout the fuel control unit.				

VALIDATION		APPROVAL	
DATE		DATE	
19SEP2022			

SUMMARY

1 HISTORY

1.1 TECHNICAL DOCUMENTATION

Maintenance:

Date	TSN (TSO)	Task	Operated by	Remarks
6FEB2020	1383.2	Injection manifolds replaced	Black Wolf Air LLC	
6FEB2020	1383.2	Power Assurance check	Black Wolf Air LLC	T4 -64°C TRQ +6.4%
6FEB2020	1383.2	Oil, Main Fuel, and FCU fuel filters all changed.	Black Wolf Air LLC	
18FEB2021	1432.7	Oil, Main Fuel, and FCU fuel filters all changed.	Black Wolf Air LLC	

Remarks:

Modular composition:

Modules	S/N	TSN	TSO	CSN	CSO	Remarks
70EMO18000	01151	1432.7	N/A	N/A	N/A	Original module
70EMO28040	00223	3819.6	1108.5	N/A	N/A	O/H in 2008
Items	P/N	S/N	Remarks			
FCU	0319878010	601	Installed in 2014			

Remarks:

1.2 UPDATED CIRCUMSTANCES (NTSB PRELIMINARY REPORT)

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 (CFR) Part 91 personal flight.

The pilot reported that he departed on the cross-country flight from Philip Billard Municipal Airport (TOP) to Claremore Regional Airport (GCM) 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. The pilot stated that the engine's free turbine speed (Nf) and the main rotor speed (Nr) were less than normal, and that he reduced collective and moved the cyclic control aft to stabilize the main rotor speed. The pilot identified a suitable landing area and made a right turn toward an open field. However, the pilot entered an autorotation before reaching the intended field because the main rotor speed continued to decrease. A main rotor blade struck the tail boom when the helicopter landed hard in a residential backyard.

A post-accident examination of the helicopter revealed proper flight control continuity and engine control continuity. Fuel samples taken from the fuel service truck used to refuel the helicopter before the flight and from the helicopter after the accident were free of contamination and exhibited a light straw color consistent with Jet-A aviation fuel. The helicopter and its engine were retained for additional examinations and testing.

1.3 RESULTS OF FIELD INVESTIGATION

A visual examination of the engine did not reveal an obvious cause for the pilots reported loss of rotor RPM. It was noted that the main fuel filter cap had been rounded off and that the safety latch to prevent loosening of the fuel and oil caps was broken consistent with trying to remove either cap without loosening the safety first. Both fuel and oil caps were found tight. Rigging between twist grip and throttle was checked and found good as well as collective to anticipator. All fuel lines found tight and no evidences of leaks. No disassembly was performed in order to preserve the engine as original state as possible for test at a later date.



Fuel Filter Cap onsite



Cap Safety onsite

2 REVIEW OF INVESTIGATION

Description of equipment	P/N S/N	Date of review	Work performed	In the presence of
FCU	0319878010 / 601	9/10 AUG 2022	Test Cell / Disassembly	NTSB
Left Injection Manifold	0319730420 / 308T	9/10 AUG 2022	Test Cell / Flow Check	NTSB
Right Injection Manifold	0319730410 / 283T	9/10 AUG 2022	Test Cell / Flow Check	NTSB
Preference Injection Manifold	0319730440 / 70T	9/10 AUG 2022	Test Cell / Flow Check	NTSB

2.1 ENGINE EXAMINATION

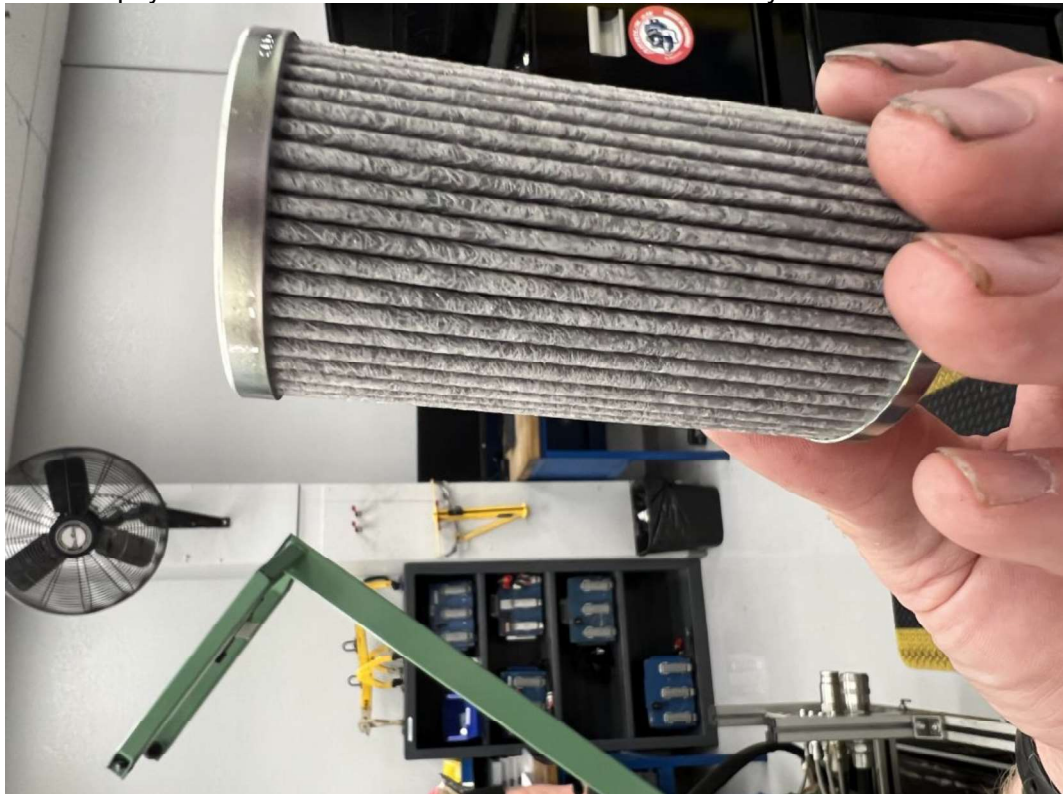
2.1.1 Engine Removal

Safran HE USA and NTSB traveled to the operator's hangar in Claremore Oklahoma on 8AUG2022 and removed the engine from the airframe. It was noted prior to removal that the main fuel filter delta p bypass indicator was popped. The engine was placed on an engine stand in a engine crate and transported back to Safran HE USA for test and examination.

2.1.2 Engine testing

The engine was installed on the test cell in same condition removed from the helicopter. All the original filters remained installed for the test and the main fuel filter delta P bypass indicator was reset prior to first cranking of the engine. Upon first start the fuel filter pre-clogging indication illuminated and the physical bypass indicator (ΔP) popped. Applying a load to engine caused the Nf to droop and the gas generator could not accelerate past $\approx 83\%$. The engine was shutdown.

Examination of the main fuel filter showed discoloration compared to a new filter however physical contamination was not visible to the naked eye.



Accident filter upon removal



Accident filter compared to a new filter

A new filter was installed on the engine as well as checking the astatic valve and ejector. No visual anomalies were noted however the ejector was found at approximately 11:00 when normally at 9:00. It was left as found and did not have an effect on operation. The engine was restarted. The pre-clogging indication did not illuminate and the bypass indicator did not pop. A load was applied to the engine and once again the Nf drooped and the Ng could not accelerate past 83% and began to oscillate. The engine was shut down and fuel control was replaced with a shuttle unit. The engine was restarted and results were the same when a load was applied. It was decided to install a shuttle lubrication device with the original fuel filter. Results were the same and the pre-clogging and delta P were both activated. The new fuel filter was installed but the results were still the same when a load was applied. Shuttle left and right injection manifolds were installed. When a load was applied the gas generator responded appropriately and was able to maintain the Nf at 100%. The gas generator was accelerated to 95% and maintained there for 10 minutes with no anomalies. The engine was returned to its original state by re-installing the original FCU, Lubrication Device and fuel filter however the shuttle injection manifolds remained. The engine was restarted and again the pre-clogging and delta p indicated however the when a load was applied the gas generator was able to respond appropriately and maintain Nf at 100% as the load was applied up to 95% Ng again. This was maintained for another 10 minutes. After shutdown the new filter was installed and the engine restarted. No pre-clogging indication or delta P was activated proving the original filter was clogged. The test was concluded and the injection manifolds taken to the LRUS shop for a flow test.

2.2 EQUIPMENT

Left and Right injection manifolds. Preference Injector.



Manifold testing bench

2.2.1 Testing (equipment)

The left injection manifold was tested first and flowed within limits with an average flow of 21.3 (limits 21.2 ± 0.8 l/ph) and max deviation of 0.6 (limits ≤ 1.6 l/ph)

The right injection manifold was tested second and the flow was well below limits with an average flow of 4.3 (limits 21.2 ± 0.8 l/ph) and max deviation of 0.2 (limits ≤ 1.6 l/ph). It should be noted that the right injection manifold houses a filter at the entrance of the manifold that protects both manifolds where they connect in line to the adjusted valve.



Exemplar of manifold filter

The original filter was removed and a new filter installed and the right injection manifold was flow tested again. With the new filter installed the manifold flowed within limits with an average flow of 20.9 (limits 21.2 ± 0.8 l/ph) and a max deviation of 1.0 (limits ≤ 1.6 l/ph).

The preference injector was tested and flowed within limits with a flow of 23.1 (limits 22.5 ± 0.7)



Accident manifold filter on left. New exemplar filter on right.



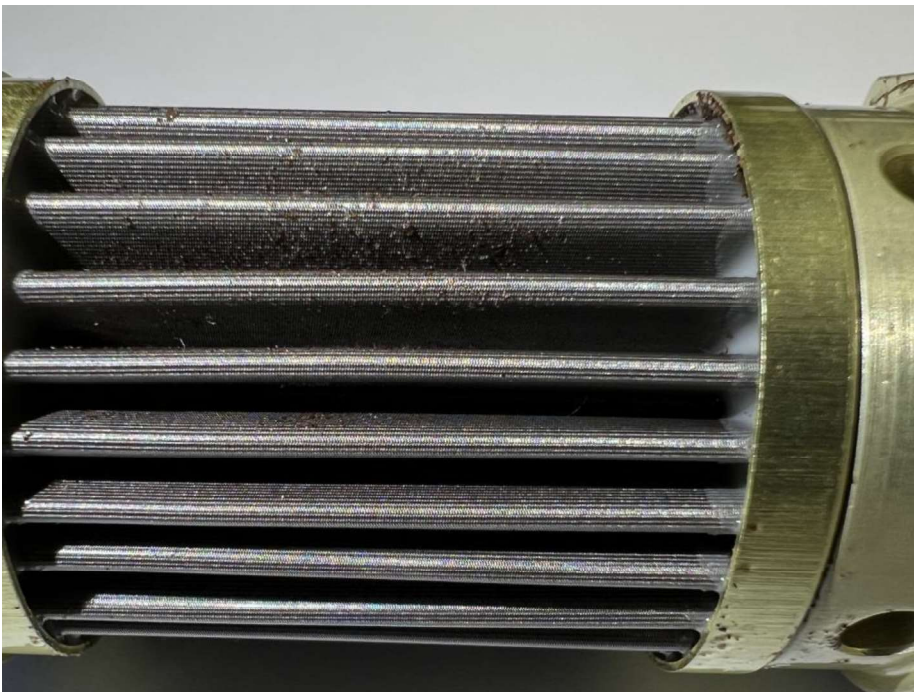
Close up of accident manifold filter

2.3 ADDITIONAL EXAMINATIONS

Fuel Control Unit (FCU) filter was removed for examination. The escaping fuel was captured in a clean stainless steel bowl. Physical contamination was observed in the bowl. These particles were captured in a clean sample bottle for analysis at a laboratory.



Contamination captured when FCU filter was removed

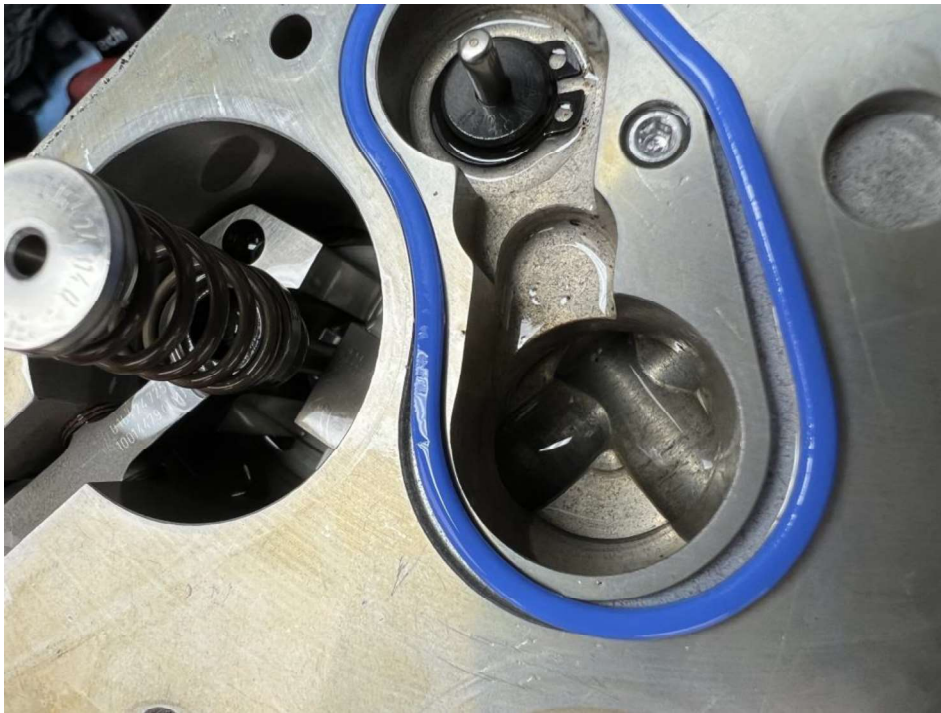


20 micron FCU filter

The FCU was disassembled and the same contamination found in the filter was found throughout the FCU.



Contamination in FCU



Contamination in FCU

The accident main fuel filter was placed in a jar and agitated. The same particles observed in the FCU filter could be observed in the bottom of the jar.



Particle contamination found in main fuel filter

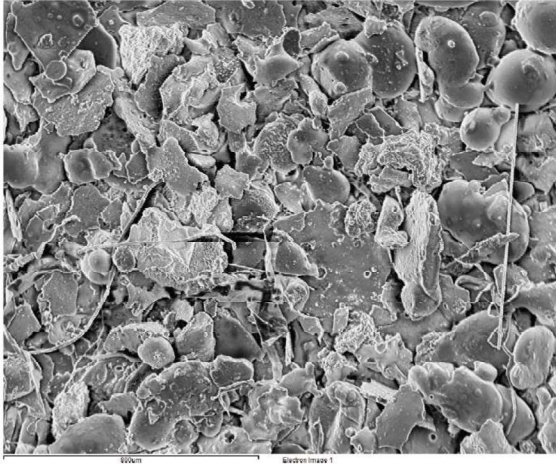
A sample of the captured contamination was sent to JET-CARE laboratory for analysis. The lab was able to identify the elemental composition however they could not identify the material as a whole or the origin. The sample was sent to the NTSB lab with the same results.



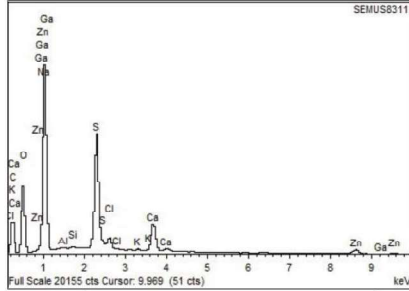
Sample sent to JET-CARE and NTSB

SPECTRO JET-CARE		DEBRIS & FILTER ANALYSIS REPORT	
Attention §	Greg Hart	Laboratory Reference	SEMUS8311
CC §	---	Purchase No. §	---
Company §	Safran Helicopter Engines USA	Sample Date §	10 Aug 22
Address §	Grand Prairie, Texas	Report Date	15 Aug 22
Tel / Fax / Fax2 §	---	Date Received	15 Aug 22
CC2 §	---	Aircraft Registration §	N421PB
Equipment Type / SN §	Safran Helicopter Engines, S.A Arrius 2F / 34455	Aircraft Type §	Airbus - EC120
Position §	Single Engine	Aircraft Serial §	---
Hours/Cycles §	---	Ticket/IMO #	---
Description §	Debris from Fuel Sample	Report Issue	1

General Visual Information



Measurement Result



Element	Series	Atomic %	Weight %
Al	K	0.10	0.14
C	K	25.53	16.28
Ca	K	1.94	4.13
Cl	K	0.91	1.72
Ga	K	0.04	0.16
K	K	0.10	0.20
Na	K	19.62	23.96
O	K	43.18	36.70
S	K	7.29	12.42
Si	K	0.09	0.13
Zn	K	1.20	4.16
Totals			100.00

Main Constituent	*Material (nearest match (1dp))	Form	Condition	Size (mm)
MAJOR: Miscellaneous	Typically containing approximately 36.7% Oxygen, 24.0% Sodium, 16.3% Carbon, 12.4% Sulfur, 4.2% Calcium, 4.2% Zinc, 1.7% Chlorine, 0.2% Potassium, 0.1% Gallium, 0.1% Aluminum, 0.1% Silicon.	Flakes and Spheres	NA	up to 0.5 and 0.2 respectively
MINOR:				
TRACE:				

SPECTRO | JET-CARE

Opinions and Interpretations included in this report are outside the scope of UKAS accreditation.
* The validity of the comments (interpretations) may depend on the accuracy of the sample data supplied.
All tests carried out in accordance with in house documented methods.
M013 Composition of solid particles using SEM and EDX analysis expressed in % or nearest match.

By authority of Pam Kaur, Laboratory Manager. UKAS accredited testing laboratory No. 1961.
§ indicates information supplied by customer.
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F197 ISS 3 - Sample Type: Debris1

APPROVED BY:

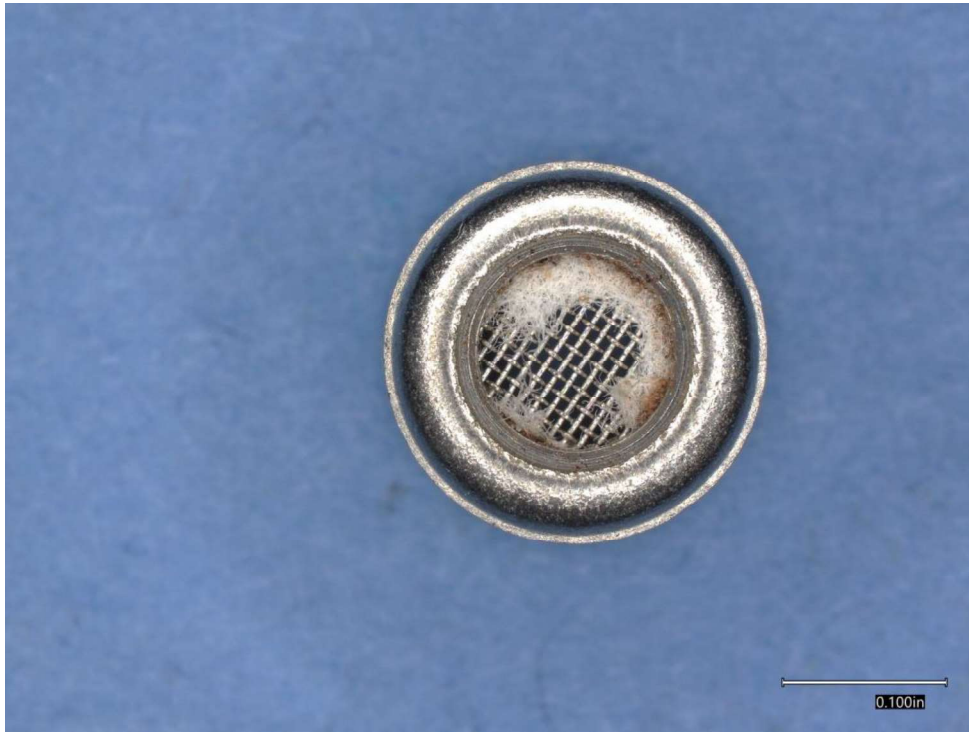
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The manifold filter was sent to the NTSB laboratory for analysis. The FTIR spectrum was consistent with a cellulosic material likely a cloth or paper source.



Accident manifold filter with residual fuel removed.



Magnified 150X



Magnified 200X



FTIR sample magnified 100X