

**NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF AVIATION SAFETY
WASHINGTON, D.C. 20594**

March 9, 2018

**ENGINE INSPECTION FACTUAL REPORT
NTSB ID: CEN17IA094**

A. INCIDENT

Location: Sioux Falls, South Dakota
Date: January 26, 2017
Time: 2148 central standard time (CST)
Aircraft: Eurocopter Deutschland GMBH MBB-BK 117 C-2, N911MK,
operated by Avera McKennan Careflight

B. PARTICIPANTS

Group Chairman: Carol M. Horgan
National Transportation Safety Board
Washington, DC

Member: Rao Edupuganti
Federal Aviation Administration
Washington, DC

Member: Jeff Musilek
Avera McKennan Careflight
Sioux Falls, South Dakota

Technical Advisor to the Accredited
Representative, Germany: Seth D. Buttner
Airbus Helicopters USA
Grand Prairie, Texas

Technical Advisor to the Accredited
Representative, France: Bryan Larimore
Safran Helicopter Engines USA
Grand Prairie, Texas

Technical Advisor to the Accredited
Representative, Germany:

Christian Bernhardt
Airbus Helicopters Deutschland
Donauwoerth, Germany

C. SUMMARY

On January 26, 2017, about 2145 central standard time (CST), a Eurocopter Deutschland GMBH MBB-BK 117 C-2 helicopter, N911MK, made a precautionary landing at Joe Foss Field Airport (FSD), Sioux Falls, South Dakota after experiencing an inflight engine fire. The airline transport-rated pilot and two crewmembers were not injured. The helicopter sustained minor damage. The helicopter, registered to Avera McKennan and being operated by MRIS, LLC, was doing business as Avera McKennan Careflight, under the provisions of 14 *Code of Federal Regulations* Part 135 as an air medical flight. Night visual meteorological conditions prevailed at the time of the incident and a company visual flight rules (VFR) flight plan had been filed. The helicopter departed McKennan Hospital Heliport (2SD1), Sioux Falls, at 2128 CST and was en route to Douglas County Memorial Hospital Heliport (08SD), Armour, South Dakota.

The pilot reported that, about ten minutes after departure and while flying westbound about 800 ft. above ground level, a No. 2 engine twist grip caution light illuminated, shut off, and flickered. All engine parameters were normal. Several seconds later, unidentified engine parameter cautions for both engines momentarily displayed. Shortly afterward, the pilot heard a “winding down” sound followed by a hissing sound and the smell of exhaust in the cabin. The No. 2 engine fire light illuminated, and a bright light was observed at the rear of the helicopter. The pilot initiated a turn back to Sioux Falls and activated both No. 2 engine fire extinguisher bottles. The engine fire light extinguished. The helicopter continued toward Sioux Falls with the No. 2 engine inoperative and executed a running landing without further incident.

A post-incident aircraft inspection found minor fire damage and oil on the engine deck and fuselage.

Airbus Helicopters and Safran Helicopter Engines (Safran HE) documented the helicopter condition Jan 30-31, 2017, at the Avera McKinnon Careflight hangar in Sioux Falls. The engine and oil system damage described in their reports¹ is summarized below.

The airframe fire damage was limited to the aft outboard section of the No. 2 engine deck and the outboard section of the engine cowling. The damage included local blistering to the

¹*Airbus Helicopters Fire & Heat Damage Investigation M911MK Serious Incident Investigation, February 24, 2017, and Safran HE On Site Examination Report Ref Rls 2017-001 RI 2017/013, February 2, 2017.* These reports may be viewed in NTSB Docket CEN17IA094.

deck paint. The viton sheath of a wiring harness was split and burned where it faced the cowling but the underlying wires were undamaged. There was no evidence of a pool fire. See Figure 1.



Figure 1. Thermal damage to engine deck and externals

The engine oil tank showed 1 to 1.5 quarts low. All of the engine and aircraft oil lines were checked and found tight. The right side of the fuselage was streaked with oil, and there was oil on the tailboom.

Axially-oriented holes were noted at two locations in the airframe-supplied elastomer tube that connects the engine vent pipe² to the 3-way union deck drain fitting. The 3-way union deck drain fitting (see Figure 2) was clogged with coke.³ A section of another elastomer drain tube, identified as part of an airframe collector drain line, was found lying on the engine deck and was separated/melted at both ends. The outside surfaces of the elastomer tubing were heat damaged but the insides appeared smooth. Oil and some debris, but no obvious coking, could be observed inside them.

² Safran refers to external rigid (steel) oil tubes as pipes.

³ Coking in this context is defined as the carbonaceous deposits that form as oil degrades when exposed to temperature conditions exceeding its tolerance range. The deposit formed is commonly referred to as carbon.

Raw oil was noted on the bottom of the engine. There were black deposits on the the rear bearing chip detector tip. The oil scavenge pipe between the rear bearing housing and the in-line strainer/chip detector contained an oily black substance. The rear bearing strainer housing union was partially obstructed by oily soot/coke where the rear bearing scavenge line attaches. The rear bearing chip detector housing and strainer were obstructed by coke.



Figure 2. Engine deck after engine removal

The engine was removed and shipped to Safran's Grand Prairie, Texas facility. A partial disassembly/inspection was performed on February 28-March 1, 2017. Following the inspection, the materials identified for further investigation were submitted to Safran HE.

D. DETAILS OF THE INVESTIGATION

1.0 Engine information

The aircraft was equipped with two Arriel 1E2 turboshaft engines.

1.1 Engine description

The Arriel 1E2 is a twin spool, free turbine turboshaft engine featuring a two-stage gas generator turbine driven by single-stage axial and single-stage centrifugal compressors, an annular combustion chamber, and a single-stage power turbine driving a reduction gearbox/power transmission shaft. The Arriel 1E2 engine has a maximum takeoff power rating of 708 shaft horsepower.

1.2 Engine data

The Arriel is fully modular.⁴ Engine data are presented in Table 1.

<i>assembly</i>	<i>serial number (S/N)</i>	<i>time since new (hours)</i>	<i>time since overhaul (hours)</i>	<i>MO3 cycles since new</i>
Engine	47069	6,197	2,603	8,655
MO1 (shaft & accessory gearbox)	15719	6,197	new	NA
MO2 (low pressure gas generator)	17628	6,197	new	NA
MO3 (high pressure gas generator)	22720	6,197	2,603	8,655
MO4 (power turbine)	21814	6,197	new	NA
MO5 (reduction gearbox)	21311	2,603	new	NA

Table 1. Engine data

1.3 Engine service history

According to Avera McKennan Careflight (Careflight), the helicopter was maintained using the MBB BK117 C-2 “High-Timer Flight Profile” continuous maintenance program as outlined in the BK117 C-2 master servicing manual (MSM). Review of the Careflight aircraft service records found that maintenance was current and was being performed in accordance with the MSM.

Entries from the last nine months of the engine service history were reviewed. There was no unscheduled maintenance during this period other than an oil system flush performed in an attempt to clear the No. 2 engine oil tank sight gauge. The last gas generator rear bearing scavenge oil flow rate (permeability) check was performed 383 flight hours (FH) before the

⁴ The axial stage of the gas generator is identified as a separate module (low pressure gas generator).

incident. The last rear bearing scavenge oil tube and in-line strainer maintenance was performed 209 FH before the incident. The engine oil was last changed and the lubrication system was serviced 51 FH prior to the incident and the rear bearing scavenge magnetic plug was inspected 12 FH prior to the incident. Oil change intervals during this period averaged 168 FH.

2.0 Engine inspection

A partial disassembly/inspection was performed at Safran's facility in Grand Prairie, Texas, February 28-March 1, 2017.

2.1 External inspection

The engine displayed a light coat of soot aft of the combustor section. There was light thermal damage to hose and harness insulation and to attachment hardware along the lower right side and bottom of the engine. The gas generator rotor was seized. No other external discrepancies were noted. See Figure 3.



Figure 3. View of left side of the engine

The pipes and harnesses were removed. Excepting connections that were broken during the on-site inspection, all air, fluid, and vent line connections were tight and the safeties were properly installed. The main engine oil filter element and housing contained a small amount of non-ferrous debris. The MO1 (transmission shaft/accessory gearbox module) strainer and main chip detector were found clean. The MO5 (reduction gearbox module) strainer was found clean.

The MO3 (high pressure gas generator module) rear bearing chip detector end was coated with a black substance. See Figure 4. No significant ferrous material was observed. The gas generator rear bearing oil scavenge pipe was clear at the housing end and heavily contaminated with oily carbon material at the rear bearing strainer end. See Figure 5.



Figure 4. Rear bearing chip detector

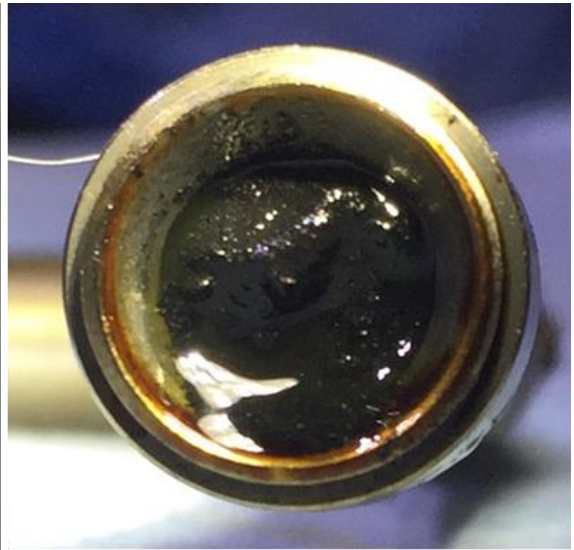


Figure 5. Rear bearing scavenge pipe

The rear bearing strainer housing union was obstructed by coke. The rear bearing scavenge strainer and magnetic chip detector housing were full of coke particles. See Figure 6.



Figure 6. Rear bearing strainer and magnetic chip detector housing

The rear bearing pressure oil supply pipe was clear; the teflon seal was deformed. The rear bearing vent pipe was clear.

2.2 Rear bearing lubrication investigation

The gas generator was disassembled to access the rear bearing.

Considerable force was required to remove the gas generator rotor from the bearing support assembly.

2.2.1 Gas generator turbine case

Carbon was adhered to the inside surface of the oil supply and oil scavenge struts. The oil vent strut was clear.

There was hard carbon adhering to the inside surfaces at the downstream end of the oil supply tube, with some carbon buildup.⁵ There was hard carbon adhering to the inside surfaces of the oil scavenge tube. The rear bearing housing vent tube was clear.

⁵Tubes installed in three hollow support struts in the turbine case connect the rear bearing cavity to the external piping.

2.2.2 Rear bearing support

The support assembly contained a large amount of loose carbon chunks and particles and the inner surfaces were coated with oily soot. Fragments of material consistent with the rear bearing inner race were found inside the support. The running surface for the small-diameter labyrinth on the piston shaft forward end was deeply grooved. Carbon was adhered to the inside surface of the passages that receive the oil supply and oil scavenge tubes. The inside surface of the passage that receives the oil vent tube was clear.

The piston shaft was intact. The turbine retention nut external splines exhibited slight roughness, however it was possible to fit the nut removal tool over the splines.

2.2.3 Rear bearing

The rear bearing was displaced on the turbine bolt. The retaining ring circlip was broken. A small amount of oil was present at the bearing. The bearing inner race was fragmented. The bearing color and texture were consistent with adhesion damage. The roller assembly exhibited extreme rotational scoring with only a small amount of material remaining. The scored surface was battered. See Figure 7.

2.2.4 Rear bearing support assembly

There were carbon deposits on the inner surfaces of the bearing support assembly cage outer race and vibration dampeners. All of the cage dampeners were damaged and a number were missing material. See Figure 8.



Figure 7. Gas generator rear bearing



Figure 8. Bearing support assembly

The cage bolt had carbon deposits inboard of the lock feature. There was gouging on the inside consistent with contact with the turbine bolt.

2.3 Air system

The forward face of the cover exhibited oil staining and splash marks axially coincident with the outlet ends of the three air supply tubes. The aft face exhibited coking 360° around and additional coking between 4 and 8 o'clock. See Figure 9. The aft side of the deflector exhibited splash marks coincident with the air tube exits.

The power turbine nozzle guide vanes were coked with oil at 6 o'clock. See Figure 10.



Figure 9. Cover showing splash marks



Figure 10. Oil on power turbine nozzle guide vane at 6 o'clock

3.0 Other gas generator components

3.1 High pressure turbine

The blade tips of both high pressure turbine stages were scored, consistent with rub. A negligible amount of laterite was found at the turbine shaft.

3.2 Combustion section

The combustion chamber was unremarkable.

3.3 Diffuser section

The inside surface of the injection manifold exhibited a shiny arc of heavy rub between 3 to 6 o'clock.

3.4 Centrifugal compressor

The centrifugal compressor impeller shroud exhibited heavy, 360° rub in the inducer area and an arc of rub along the outboard edge. There was an approximately 0.5-inch band of scattered deposits just inboard of the inducer area that appeared to be corrosion. The impeller exhibited 360° scoring at the inducer and exducer blade tips, consistent with the shroud indications.

3.5 Axial compressor

The axial compressor rotated freely by hand with no unusual noise. The axial compressor assembly was not disassembled.

4.0 Rear bearing chip detector test

The gas generator rear bearing chip detector was operationally tested using an engine installed on a Safran HE test cell. The test indicated that the black debris on the detector tip impeded the detector function:

Signal integrity was verified by bridging the engine's chip detector circuit and confirming a chip detector signal indication at the test cell control display. The test cell engine chip detector was then replaced with the incident gas generator rear bearing chip detector. There was no indication.

The incident chip detector circuit was mechanically bridged. There was no indication.

The debris coating the magnetic tip of the incident chip detector was wiped with a dry rag and the circuit was bridged again. This produced an indication.

See Table 3.

<i>chip detector installed</i>	<i>mechanically bridged?</i>	<i>chip indication?</i>
test engine	yes	yes
incident engine, as received	no	no
incident engine, as received	yes	no
incident engine, surface cleaned	yes	yes

Table 3. Chip detector functional test

5.0 Reduction gearbox visual inspection

The reduction gearbox was opened to note the condition of the oil/presence of sludge inside. No anomalies were noted.