National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

ERA22LA145

AIRWORTHINESS

Group Chair's Factual Report

December 16, 2022

A. ACCIDENT

Location: Abingdon, Virginia
Date: March 6, 2022
Time: 23:59 eastern standard time
Helicopter: Airbus BK117 C-2, registration N29VA

B. AIRWORTHINESS GROUP

Group Chair	Chihoon Shin National Transportation Safety Board Washington, District of Columbia
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C. SUMMARY

On March 6, 2022, at 2359 eastern standard time, an Airbus BK117 C-2 helicopter, N29VA, was substantially damaged when it was involved in a hard landing in Virginia Highlands Airport, Abingdon, Virginia (VA). A pilot and two flight paramedics were on board the helicopter. The pilot sustained serious injuries and the two flight paramedics were not injured. The helicopter was operated by the Virginia State Police as a public use aircraft.

D. DETAILS OF THE INVESTIGATION

1.0 Background Information

The Airbus BK117 C-2 helicopter has a four-bladed, rigid main rotor system that provides helicopter lift and thrust. A two-bladed tail rotor system provides directional control of the helicopter. The helicopter's flight controls are hydraulically assisted by a dual hydraulic system. The helicopter is equipped with a skid landing gear. The BK117 C-2 helicopter is equipped with two Safran Helicopter Engines (formerly Turbomeca) Arriel 1E2 turboshaft engines. The BK117-series helicopter is type certificated under Federal Aviation Administration (FAA) type certificate data sheet No. H13EU.

The accident helicopter, N29VA, was serial number (S/N) 9374 and was manufactured in 2010. At the time of the accident, the helicopter had accumulated an aircraft total time (ATT) of 2,650.2 hours. After the accident occurred, the helicopter was recovered by Virginia State Police to a hangar at Virginia Highlands Airport (**Figure 1**). On April 26-27, 2022, members of the Airworthiness Group, composed of representatives from the NTSB, the FAA, Airbus Helicopters, and the Virginia State Police, convened at Virginia Highlands Airport to examine the recovered helicopter. The helicopter's engines were examined by the Powerplants Group. The engine examination findings can be found in the Powerplants Group Chair Factual Report in the docket for this investigation.

Figure 1. The accident helicopter at the accident site. (Photo courtesy of Virginia State Police.)

2.0 Structures

The main fuselage was whole and the tail boom and empennage remained attached to the main fuselage (**Figure 2**). The forward nose, nose shell, and bottom access panels of the main fuselage exhibited ground impact deformation. The right chin bubble window and right windscreen were fractured. The left chin bubble window and left windscreen were intact. The right sliding cabin door and both left and right cockpit doors were separated from the main fuselage. The left sliding cabin door remained installed on the airframe. The clamshell doors remained installed at the aft end of the main fuselage.

The right landing gear skid tube and step had fractured and separated from the landing gear. The left skid tube and step remained attached to the landing gear crosstubes but were deformed outward. The landing gear's forward and aft crosstubes remained attached to the airframe. Th forward crosstube was fractured on its right side, near its fuselage attachment point. The aft crosstube was fractured near its right skid attachment point. Both crosstubes had moved laterally to the right in relation to the landing gear fittings.

Figure 2. The accident helicopter after recovery to a hangar.

3.0 Main Rotor System

3.1 Main Rotor

All four main rotor blades remained attached to the hub and were whole (**Figure 3**). The 'red' and 'yellow' blades exhibited impact damage on its leading edge consistent with contact with the upper wire strike cutter. The 'blue' and 'green' main rotor blades exhibited impact marks on their lower surfaces consistent with contact with the upper wire strike cutter. The main rotor head remained attached to the main rotor shaft. There were no missing or separated components from the main rotor head. The oil reservoir at the top of the main rotor head showed no observable oil level. When the access panel in the cabin, underneath the main transmission, was removed, residual oil, likely from the main rotor head, was observed dripping down.

The swashplate assembly remained installed and intact. All four pitch change links remained connected between the rotating swashplate and the main rotor blades. The rotating scissors remained connected between the drive plate, connected to the bottom side of the main rotor hub, and the rotating swashplate. The pitch, roll, and collective control levers remained installed and exhibited no anomalous damage.

Figure 3. The main rotor head.

3.2 Main Rotor Drive System

The main transmission remained installed on the airframe. There was no anomalous damage observed on the main transmission and main rotor drive shaft. The main transmission chip detector was removed and contained no magnetic chips. The input drive shafts (also known as the engine-to-transmission drive shafts), remained installed and exhibited no fractures or deformation. The power turbines of each engine were manually rotated, resulting in a corresponding rotation of their respective input drive shaft. Normal freewheeling unit functionality was confirmed on both freewheeling units via manual rotation of each power turbine in both directions and observing rotation and nonrotation of the input drive shafts. Manual rotation of the main rotor was smooth with no evidence of binding or restriction and resulted in a corresponding rotation of the tail rotor.

4.0 Tail Rotor System

4.1 Tail Rotor

The two tail rotor blades remained connected to the tail rotor hub (**Figure 4**). The tail rotor pitch change links, sliding sleeve, and pitch change bellcrank (mounted on the tail rotor gearbox) remained installed with no anomalous damage. Movement of the gearbox-mounted bellcrank resulted in corresponding pitch changes to the tail rotor blades.

Figure 4. The tail rotor and vertical fin.

4.2 Tail Rotor Drive System

The tail rotor drive shafts remained installed along the tail boom and exhibited no twisting or fractures. The four hanger bearings remained installed and had no anomalous damage. Manual rotation of the tail rotor drive train resulted in rotation of the tail rotor. The rotation was smooth with no signs of binding or restriction.

The intermediate and tail gearboxes remained installed on the tail boom and vertical fin, respectively. Examination of the intermediate and tail gearbox chip detectors revealed no magnetic chips.

5.0 Flight Control System

5.1 Cockpit Controls

Only the right seat cockpit flight controls were installed (**Figure 5**). Covers were present over the left seat cockpit flight control connections. The cyclic and collective controls remained installed with no deformation or damage. Manual movement of the cyclic and collective controls resulted in a corresponding movement of the swashplate. Additionally, movement of the collective control resulted in a corresponding movement of the anticipator on both engines. The collective control had shifted laterally and longitudinally in relation to the collective lock due to airframe deformation, such that the collective locking pin could not engage with the locking latch.

Figure 5. A view of the cockpit showing the right seat controls.

Both the Nos. 1 and 2 collective-mounted engine twist grips were in the off ("0") position (**Figure 6**). Both twist grips were rotated from the off position to flight ("F") position and the movement was smooth with no restriction. A tactile detent engagement was felt when the twist grips were placed in the flight position. Both emergency guards were stowed, preventing movement of the twist grip into the emergency ("EMER") range. For each twist grip, the investigation team opened the emergency guard and rotated the twist grip through the emergency range. The movement was smooth with no evidence of restriction. The idle stop, designed to prevent movement of the twist grip past idle toward the off position, was present. The twist grips would not rotate past the idle stop button unless the button was actuated. The rigging between the engine twist grips and the engine fuel control unit (FCU) throttles were documented by the Powerplants Group.

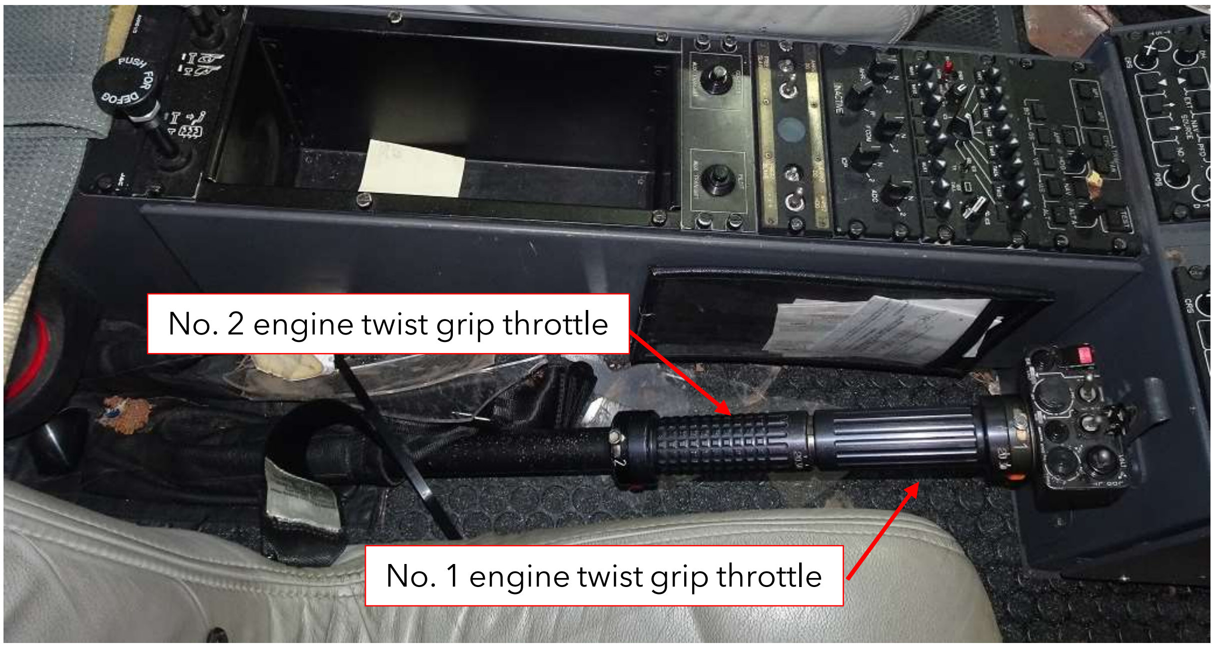

Figure 6. The collective control and twist grip throttles.

After application of battery power to the helicopter, the engine trim beeper, on the head of the collective control, was actuated and a corresponding movement of the engine speed trim motors as well as the FCU input were observed.

5.2 Rotor Controls

The upper flight control linkages, above the cabin and forward of the main transmission, remained installed and intact. The main rotor hydraulic actuators as well as the pitch and roll smart electric mechanical actuators (SEMA) exhibited no anomalous damaged. The tail rotor hydraulic actuator and SEMA also remained installed and had no anomalous damage.

5.3 Hydraulic System

The Nos. 1 and 2 hydraulic systems remained installed. None of the hydraulic lines exhibited evidence of leakages or breaks. All hydraulic lines and electrical connectors remained installed on the main rotor hydraulic actuators. The two hydraulic pumps remained installed on the main transmission and had no visible damage.

The No. 1 hydraulic reservoir sight glass contained hydraulic fluid along with air.[1] The No. 2 hydraulic reservoir sight glass was full of hydraulic fluid. For both the Nos. 1 and 2 hydraulic system, their filter bowls were removed and residual hydraulic fluid within the filter bowl had a normal color and contained no debris. The Nos. 1 and 2 hydraulic filter elements were present and contained no debris as well.

6.0 Powerplants

The two engines remained installed on the airframe. The airframe-mounted engine oil reservoirs remained installed and contained oil. Removal of the fuel lines to the engine FCUs revealed the presence of residual fuel within those lines. The engine fire suppression system remained installed and had not activated. For additional details on the engines, see the Powerplants Group Chair Factual Report in the docket for this investigation.

7.0 Cockpit Instruments

After application of battery power to the helicopter, the vehicle and engine management display (VEMD) and the caution advisory display (CAD) were powered up in order to access their maintenance mode. The accident flight displayed as flight No. 443 and was about 17 minutes in duration (the last recorded ground-flight-ground cycle). For flight No. 443, the flight report history showed a mast moment[2] exceedance of >90% for 2.8 seconds and a maximum recorded mast moment of 108.1%. **Figures 7 through 11** shows the maintenance mode screens for flight No. 443.

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[1] According to the BK117 rotorcraft flight manual preflight check, the presence of air within the hydraulic reservoir sight glass is acceptable as long as hydraulic fluid is visible within the sight glass.

[2] A cyclic input tilts the main rotor disc in a particular direction, resulting in the airframe moving in that direction. For helicopters with a rigid rotor system, cyclic inputs to the main rotor transmits bending forces to the main rotor mast, called the mast moment. These bending forces are typically low during normal flight, but with large and abrupt cyclic displacements, particularly when the airframe is in contact with the ground, the bending forces can be very high. When the mast moment exceeds the limits (value and duration) defined by the airframe manufacturer, it may trigger maintenance actions such as inspections. On the BK117 C-2 helicopter, the mast moment system is part of the main transmission monitoring and indication system. The bending moments on the rotor mast are constantly indicated and color coded, and any threshold exceedance triggers a caution and an aural signal.

Figure 7. Flight No. 443 mast moment exceedance information on the VEMD.

Figure 8. Flight No. 443 failures summary on the VEMD.

Figure 9. Flight No. 443 inflight failures screen on the VEMD.

Figure 10. Flight No. 443 inflight failure parameters on the VEMD.

Figure 11. Flight No. 443 inflight failures screen on the CAD.

Submitted by:

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