

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



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AIRWORTHINESS

Group Chair's Factual Report

August 5, 2024

A ACCIDENT

Location: West Lafayette, Indiana
Date: March 6, 2024
Time: 2140 eastern standard time
Helicopter: Airbus Helicopters Deutschland MBB-BK117 C-2, registration N191LL

B AIRWORTHINESS GROUP

Group Chair	Chihoon Shin National Transportation Safety Board Washington, District of Columbia
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Group Member	Mark Breton Metro Aviation Shreveport, Louisiana
Group Member	Seth Buttner Airbus Helicopters Grand Prairie, Texas
Group Member	Axel Rokohl Bundesstelle für Flugunfalluntersuchung Braunschweig, Germany

C SUMMARY

On March 6, 2024, about 2140 eastern standard time, an Airbus Helicopters Deutschland (Airbus) MBB-BK117 C-2, N191LL, sustained substantial damage when it was involved in an accident at Purdue University Airport (LAF) in West Lafayette, Indiana. The pilot and two medical crew members were not injured. The pilot reported that, while in a hover taxi to accelerate for takeoff, he felt a thud and the helicopter began to yaw to the right. The pilot was unable to arrest the right yaw with pedal inputs. The helicopter landed hard, which damaged the skids, and the tail rotor gearbox and tail rotor separated from the vertical fin. The wreckage was subsequently recovered and transported to Paradigm Aerospace facilities in Mount Pleasant, Pennsylvania (PA) for further evaluation.

On March 20, 2024, representatives from the National Transportation Safety Board (NTSB), Federal Aviation Administration (FAA), Metro Aviation, and Airbus convened at Paradigm Aerospace facilities in Mount Pleasant, PA to examine the wreckage. On April 3, 2024, NTSB investigators interviewed a Metro Aviation maintenance shop manager and two mechanics involved in maintenance of the accident helicopter.¹

D DETAILS OF THE INVESTIGATION

1.0 Helicopter Information

1.1 Helicopter Description

The Airbus MBB-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 MBB-BK117 C-2 helicopter is equipped with two Safran Helicopter Engines (formerly Turbomeca) Arriel 1E2 turboshaft engines. The MBB-BK117-series helicopter is type certificated under Federal Aviation Administration (FAA) type certificate data sheet No. H13EU.

1.2 Accident Helicopter History

The accident helicopter, N191LL, was serial number (S/N) 9319 and was manufactured in 2009. At the time of the accident, the helicopter had accumulated an aircraft total time (ATT) of 7435.0 hours.

2.0 Accident Helicopter Examination

2.1 Tail Rotor Control System Description

Inputs to the cockpit pedal controls are transmitted to the tail rotor in order to change tail rotor blade [collective] pitch. Tail rotor blade pitch changes result in changes to the lateral thrust produced by the tail rotor, allowing for directional control of the helicopter. The left and right cockpit pedal controls are interconnected via a dual control linkage rod between the two pedal bellcranks. A yaw trim actuator, which functions in parallel to the crew pedal inputs, is installed below the cabin floor to the left of the right cockpit seat and is connected to the pedal bellcrank via a control rod. A yaw control flexball cable, routed longitudinally along the airframe, is connected to the right seat pedal control bellcrank at its forward end and to the aft bellcrank (located near the base of the vertical fin, mounted to the intermediate

¹ Transcripts of these interviews can be found in the docket for this investigation.

gearbox housing) at its aft end. A single yaw smart electromechanical actuator (SEMA), connected to the aft bellcrank, provides stability augmentation in the yaw channel. The yaw SEMA is connected to the input control for the tail rotor hydraulic actuator, which provides hydraulic assistance to move the tail rotor controls. The tail rotor hydraulic actuator's output piston is connected to the pitch change bellcrank.

The pitch change bellcrank, which is mounted to the tail gearbox housing, is connected to the outer ring of the stationary section of the sliding sleeve assembly via a T-bolt, which functions as an unthreaded dowel (**Figure 1**). Two smaller, threaded attachment bolts secure the T-bolt to stationary sliding sleeve. The rotating section of the sliding sleeve, which moves axially along the tail gearbox output shaft, is connected to the tail rotor blade pitch change links. Movement of the sliding sleeve assembly results in pitch changes to the tail rotor blades.

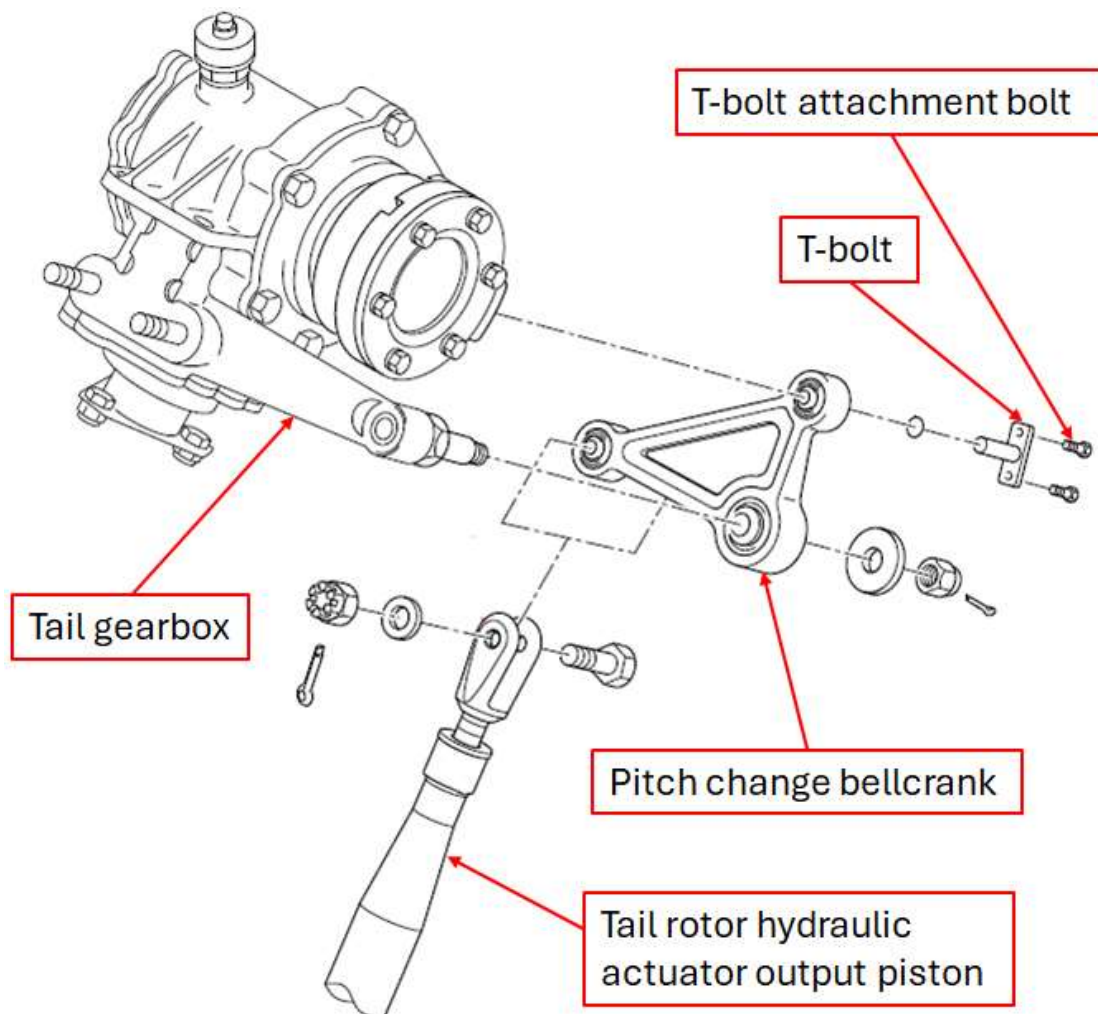


Figure 1. A diagram of the installation of the T-bolt and associated attachment hardware onto the pitch change slider. (Courtesy of Airbus, modified by NTSB)

2.2 On Scene Summary²

The accident helicopter came to rest upright with the left side slightly low due to the collapsed landing gear (**Figure 2**). The main and tail rotor systems did not show evidence of ground contact. The tail gearbox remained attached to the upper end of the vertical fin, but the upper end of the vertical fin had fractured and structurally separated from the remainder of the vertical fin but remained attached via wiring (**Figure 3**). The tail rotor drive shaft within the vertical fin, between the intermediate gearbox and tail gearbox, remained installed but its output flexible coupling had fractured and separated from the tail gearbox input flange adapter. The tail rotor remained installed on the tail gearbox, but one of the two tail rotor blades exhibited significant impact damage and splintering (**Figure 4**). The accident helicopter was recovered and transported to Paradigm Aerospace facilities in Mount Pleasant, PA.



Figure 2. The accident helicopter at LAF. (Courtesy of Metro Aviation)

² NTSB investigators did not travel to the accident site for this investigation.



Figure 3. The tail gearbox attached to the separated upper portion of the vertical fin. (Courtesy of Metro Aviation)

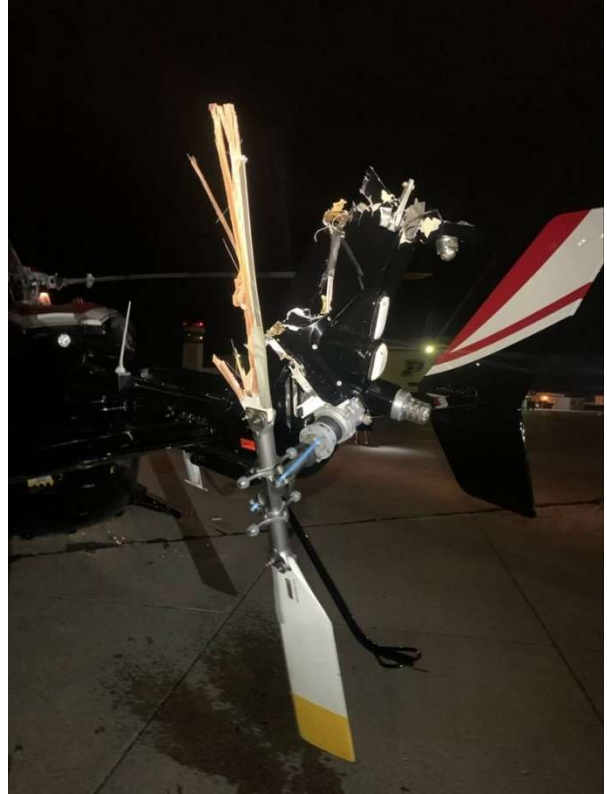


Figure 4. The tail rotor blades. (Courtesy of Metro Aviation)

2.3 Structures

The vertical fin remained installed on the tail boom except for its upper portion, which had fractured and separated. Wrinkling deformation was observed at the base of the vertical fin on both the left-forward and right-forward sides. The upper portion of the vertical fin, with the tail rotor gearbox and tail rotor head assembly still attached, remained partially attached to the helicopter only via wiring. The wiring was previously cut to facilitate recovery of the helicopter. At the forward end of the tail boom, at its attachment flange to the fuselage, the underside of the tail boom structure exhibited wrinkling deformation.

The landing gear exhibited impact deformation. The horizontal stabilizer and its left and right vertical stabilizers had remained installed but were removed to facilitate shipment. On the left side of the horizontal stabilizer, the trailing edge exhibited impact deformation. The remainder of the horizontal stabilizer and its left and right vertical stabilizers did not exhibit anomalous damage.

2.4 Tail Rotor

The tail rotor head assembly remained installed on the tail rotor shaft. The two tail rotor blades remained installed on their respective blade mounting forks (grips), which remained installed on the tail rotor head. One tail rotor blade, whose data plate had separated from impact damage³, exhibited an impact fracture about 25 inches outboard of the blade fitting bushings and the blade afterbody⁴ had separated along the span of the blade (**Figure 5**). About a 4.5 inch segment of the leading edge abrasion strip, outboard of the impact fracture, had also separated.



Figure 5. The tail rotor blade exhibiting a fractured leading edge abrasion strip and missing its afterbody.

The second tail rotor blade, S/N 1511, was whole but had impact damage on its leading and trailing edges. On the second tail rotor blade, one leading edge impact, located about 10.5 inches outboard of the blade grip fastener, had imprints of threads. The thread imprint matched that of the attachment bolt for the tail rotor control T-bolt (**Figure 6**). A main rotor blade exhibited impact damage at its tip end leading edge that was similar in size to the leading edge of the tail rotor blade. The underside of this main rotor blade had an impact divot into the blade core.

³ According to maintenance records, this tail rotor blade was S/N 4100.

⁴ The blade afterbody is the structure behind the spar which includes the skin and core.



Figure 6. A T-bolt attachment bolt (found on the ground at the accident site) and the impact damage to the leading edge of tail rotor blade S/N 1511.

The tail rotor gearbox remained installed on a remnant piece of the vertical fin, the latter of which had fractured and separated from the vertical fin of the airframe. Manual rotation of the tail rotor resulted in rotation of the tail gearbox input flange; the rotation was smooth with no evidence of binding or restriction. The tail gearbox bellcrank attachment arm, to which the pitch change bellcrank attaches as a hinge point, had fractured and separated from the tail gearbox housing; the fracture exhibited signatures of overload.

2.5 Tail Rotor Controls

The tail rotor sliding sleeve assembly remained installed on the tail rotor shaft. The two tail rotor pitch links remained installed between the sliding sleeve assembly and each blade mounting fork. The sliding sleeve assembly was able to be manually moved in the axial (pitch change) and rotational directions with no evidence of binding or restriction.

The pitch change bellcrank remained installed on the vertical fin and was connected to the tail rotor hydraulic actuator's output piston (**Figure 7**). The pitch change bellcrank was not connected to the sliding sleeve assembly. The spherical bearing for the pitch change bellcrank, to which the stationary sliding sleeve attaches, exhibited smooth movement and did not exhibit anomalous damage. The two attachment bolt holes, on the outer ring of the stationary section of the sliding sleeve assembly, did not exhibit elongation and the internal threads did not exhibit evidence of anomalous damage (**Figure 8**). The installation hole for the T-bolt, on the outer ring of the stationary section of the sliding sleeve assembly, appeared intact and did

not exhibit anomalous damage such as elongation or ovalized appearance. Remnant grease was observed within the bottom T-bolt hole.



Figure 7. The pitch change bellcrank on the upper side of the vertical fin.



Figure 8. The pitch change slider with the holes for the T-bolt (blue arrow) and T-bolt attachment bolts (red arrows).

One T-bolt attachment bolt was found on the ground at the accident site and did not exhibit anomalous deformation or damage, such as excessively worn threads (**Figure 6**). The second T-bolt attachment bolt was found within the area of the No.1 (left) engine bay. The second T-bolt attachment bolt did not exhibit excessively worn threads or fracture, but one side of its threads exhibited a flattened appearance (**Figure 9**). Neither of the T-bolt attachment bolts showed remnant safety wiring attached to them or within their safety wire holes. The No. 1 engine exhaust cowl exhibited a puncture, and the engine exhaust duct exhibited an impact mark, both consistent in size with contact by the attachment bolt. The T-bolt was found lodged into a honeycomb panel at the aft-lower area of the fuselage, adjacent to the fuel cell (**Figure 10**). A puncture into the fuselage skin, just below the aft clamshell doors, was found near the T-bolt. Except for the pitch change slider connection to the pitch change bellcrank, all fasteners remained installed with their appropriate safety wiring or cotter pins. The pedals in the cockpit were moved both full left and full right pedal forward, resulting in movement of the pitch change bellcrank at the vertical fin.



Figure 9. The second T-bolt attachment bolt, found near the No. 1 engine exhaust duct, exhibiting a flattened appearance on a portion of its threads.



Figure 10. The T-bolt found lodged into a honeycomb panel. (Courtesy of Metro Aviation)

3.0 Maintenance

The accident helicopter was maintained by the operator under an approved aircraft inspection program (AAIP). On December 15, 2023, under Metro Aviation work order No. AC9319151223 at an ATT of 7,314.5 hours, maintenance was conducted on the accident helicopter to troubleshoot a discrepancy in which the helicopter was not holding a heading in a hover with feedback in the pedals. The yaw control flexball cable was found to exhibit binding and was replaced on December 19, 2023. Under the same work order, yaw trim actuator S/N 1046 was found serviceable but removed from the accident helicopter on December 15, 2023, for use on another company helicopter. Yaw trim actuator S/N 1046 was reinstalled on the accident helicopter on December 20, 2023, and the helicopter was released for service on the same day.

From February 29 to March 6, 2024, maintenance to the accident helicopter was conducted at a Metro Aviation hangar in Indianapolis, Indiana. The helicopter had an ATT of 7,434.5 hours at the time this maintenance was conducted, which was documented under Metro Aviation work order No. AC9319290224. This maintenance included a 3-year weighing as well as troubleshooting of a discrepancy involving feedback from the pedals. For troubleshooting of the pedal feedback discrepancy, the following was accomplished by Metro Aviation mechanics in several iterations, which included:

- Verification of the yaw SEMA angle
- Yaw ball bearing (flexball) control cable installation verification

- Tail rotor control rigging verification
- Replacement of the yaw flexball cable
- Replacement of the yaw SEMA
- Checking the tail rotor breakout pedal forces
- A friction check of the tail rotor blade mounting forks (blade grips)
- Removal of yaw trim actuator S/N 1046 and installation of serviceable yaw trim actuator S/N 448

Until replacement of the yaw trim actuator, each troubleshooting step ended with a release for an operational check flight and a subsequent determination of an unsatisfactory operational check flight due to persistence of the pedal feedback discrepancy. A task for the removal of the T-bolt and its attachment hardware was not present in work order No. AC9319290224. However, according to interviews with the mechanics involved in work order No. AC9319290224, the T-bolt and its two attachment bolts were removed to facilitate the friction check of the tail rotor blade mounting forks. Additionally, a mechanic saw another mechanic struggling with the installation of the sliding sleeve, and reinstalled the T-bolt, with its attachment bolts installed "finger-tight", to assist in the sliding sleeve installation. The mechanic who installed the T-bolt stated that shortly after the T-bolt installation, he was moved to another task on another company helicopter that had just been pulled into the maintenance hangar.

At the end of the maintenance troubleshooting on the accident helicopter, it was determined that the yaw trim actuator replacement had fixed the pedal feedback discrepancy with a satisfactory result for the operational check flight. The helicopter was released and conducted a flight from the maintenance base to LAF for refueling on March 6, 2024. The subsequent flight after refueling was the accident flight.

Attachment 1 contains a copy of Metro Aviation work order No. AC9319290224. **Attachment 2** contains excerpts from the accident helicopter's logbook dated February 29, 2024, and March 6, 2024.

E LIST OF ATTACHMENTS

1. Attachment 1 - Metro Aviation Work Order No. AC9319290224
2. Attachment 2 - N191LL Aircraft Logbook Sheets dated February 29, 2024, and March 6, 2024

Submitted by:

Chihoon Shin
Aerospace Engineer - Helicopters