Aviation Safety Investigation Report 199502624

Bell Helicopter Co 412

15 August 1995

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Aviation Safety Investigation Report

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Occurrence Number: 199502624 **Occurrence Type:** Incident
Location: Maitland
State: NSW **Inv Category:** 3
Date: Tuesday 15 August 1995
Time: 1030 hours **Time Zone** EST
Highest Injury Level: None

Aircraft Manufacturer: Bell Helicopter Co
Aircraft Model: 412
Aircraft Registration: VH-HRS **Serial Number:** 33118
Type of Operation: Non-commercial Aerial Ambulance
Damage to Aircraft: Minor
Departure Point: Newcastle NSW
Departure Time:
Destination: Newcastle NSW

Crew Details:

Role	Class of Licence	Hours on Type	Hours Total
Pilot-In-Command	ATPL	400.0	6500

Approved for Release: Thursday, March 6, 1997

FACTUAL INFORMATION

The helicopter had undergone a maintenance check which included changing both forward and aft coupling assemblies of the main driveshaft and the forward boot assembly. Prior to release for service, vibration monitoring tests were carried out on the ground and during flight. On the final flight, whilst climbing to 4,000 ft in preparation for a descent test, the maintenance crew observed an increase in longitudinal vibration of the main driveshaft. On reaching 4,000 ft, there was a noticeable grinding noise and all power to the main rotor was lost. Following the driveshaft failure, the pilot carried out an autorotation into the only available open field. The field initially appeared flat but as the helicopter approached the ground level, the pilot saw that it was undulating and sloped upwards in the direction of his approach. The pilot was unable to correct for this in time to avoid a heavy landing.

A coupling is fitted to each end of the driveshaft. Each coupling is a splined unit packed with grease as a lubricant between its inner and outer components. A rubber boot assembly bolts to the outer coupling to contain the grease as the assembly rotates. An O-ring packing is retained in a groove in the boot as a seal between the boot and the outer coupling.

Investigation found that the main driveshaft forward coupling assembly had failed. The outer coupling remained intact but the splines of the inner coupling had failed. A metallurgical examination determined that, though the coupling had probably met manufacturing specification, it had been subjected to high temperature which resulted in weakening of the core material underlying the nitrided zone. The splines were then unable to transmit the applied torque to the outer coupling and failed from overload. The associated rubber boot assembly had disintegrated, its attaching bolts were loose and the locking wires were broken. There was some charred debris in the O-ring groove of the boot, which was probably the remains of the O-ring which formed the seal between the boot and the coupling. The grease lubricant, normally retained in the coupling by the boot assembly, had been ejected and was spattered over the driveshaft well.

The forward boot assembly had been requisitioned from stock under the existing part number. However, the boot had been modified by the manufacturer, given a new part number, and issued as a replacement part. The modification included securing the grease dam in the boot assembly by a process known as roll staking. This process consisted of mechanically removing material from the O-ring groove wall and rolling it to lock the dam in position. The operation modified the O-ring groove profile so that steps were formed in the inner circumference of the groove. There was no information provided by the manufacturer to advise maintenance personnel of the modification.

ANALYSIS

The failure of the driveshaft coupling was consistent with a failure of the O-ring. This provided an open path for the grease to be ejected by centrifugal action as the driveshaft rotated at its operating speed of 6,000 RPM. Failure of the O-ring would immediately reduce the torque on the attachment bolts. It is likely that the ensuing vibration resulted in failure of the locking wire. The loss of the grease resulted in overheating of the coupling gears which eventually failed and all power to the main rotor was lost.

Maintenance personnel, unaware of the modification to the O-ring groove, probably allowed the O-ring to be pinched between the boot and the coupling during assembly. Bolt torque would have appeared normal but during operation the O-ring would fret between the mating surfaces until it failed, leaving a path for the grease to escape.

SIGNIFICANT FACTORS

1. The manufacturer did not provide adequate details of the modification to maintenance personnel.

2. Maintenance personnel, unaware of the modification to the boot, probably allowed the O-ring to be pinched when the boot was mated to the coupling during assembly.

SAFETY ACTION

The Bureau of Air Safety Investigation made the following recommendations to the Civil Aviation Safety Authority and to Bell Helicopter Textron Inc on 23 January 1997:

"R960155

"The Bureau of Air Safety Investigation recommends the Civil Aviation Safety Authority advise all Bell Helicopter 412 operators in Australia of the potential, during installation, for the O-ring (PN 204-040-691-003) to sag in the O-ring groove of the (PN 212-040--688-003) coupling and hence, become pinched between it and the (PN 212-040-176-101) boot assembly. This would allow a path for the grease lubricant to escape due to the centrifugal forces acting on the driveshaft during its normal operation, thereby causing the coupling to overheat and fail."

"R960156

"The Bureau of Air Safety Investigation recommends that Bell Helicopter Textron Inc. include a cautionary note in the relevent section of the Bell 412 maintenance manual (BHT-412-CR&O, at 63-9 ASSEMBLY-MAIN DRIVE SHAFT), warning of the possibility for the O-ring to sag during installation in the replacement PN 212-040-176-101 boot assemblies and hence, allow the potential for pinching to occur between the boot and coupling assemblies. This would allow a path for the grease lubricant to escape due to the centrifugal forces acting on the driveshaft during its normal operation, thereby causing the coupling to overheat and fail."