Australian Government
Australian Transport Safety Bureau

Safety Advisory Notice

Robinson helicopter industry

Number: AO-2017-078-SAN-001

Replacement of self-locking nuts on Robinson helicopters

The standard industry practice of re-using self-locking nuts on Robinson helicopters may inadvertently result in the omission to replace MS21042L or NAS1291-series nuts with D210-series corrosion resistant (CRES) nuts on critical fasteners.

What happened

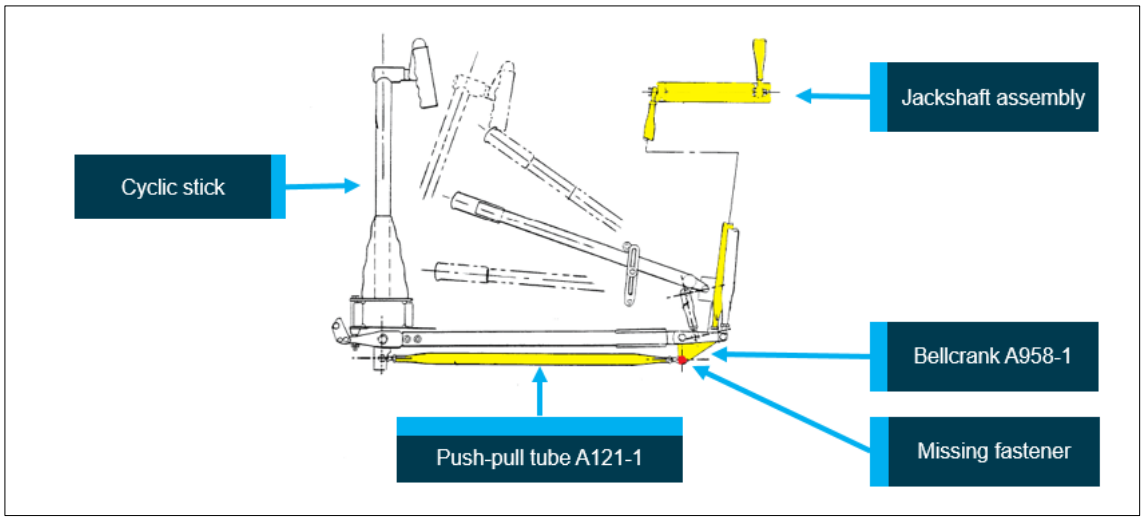
On 2 August 2017, a Robinson R22 Beta helicopter impacted terrain about 7 km north-north-west of Cloncurry Airport, Queensland. The pilot, who was the only person on board, was fatally injured and the helicopter was destroyed. The accident flight was the first commercial flight post the helicopter's second 2,200-hour overhaul.

Finding of increased risk

During the review of on-site accident photographs to verify the flight control joints, the ATSB noted an anomaly with the helicopter's bellcrank (part number A958-1) in the cyclic control system. The fastener, which attached the horizontal push-pull tube (part number A121-1) to the bellcrank, was missing. The bellcrank's remaining fasteners were all attached. The bellcrank and missing fastener bolt were recovered, but the reason for the separation of the nut from the bolt has not yet been determined.

The missing fastener was part of the longitudinal cyclic pitch control system, which controls the fore-aft tilt of the main rotor disc (Figure 1).

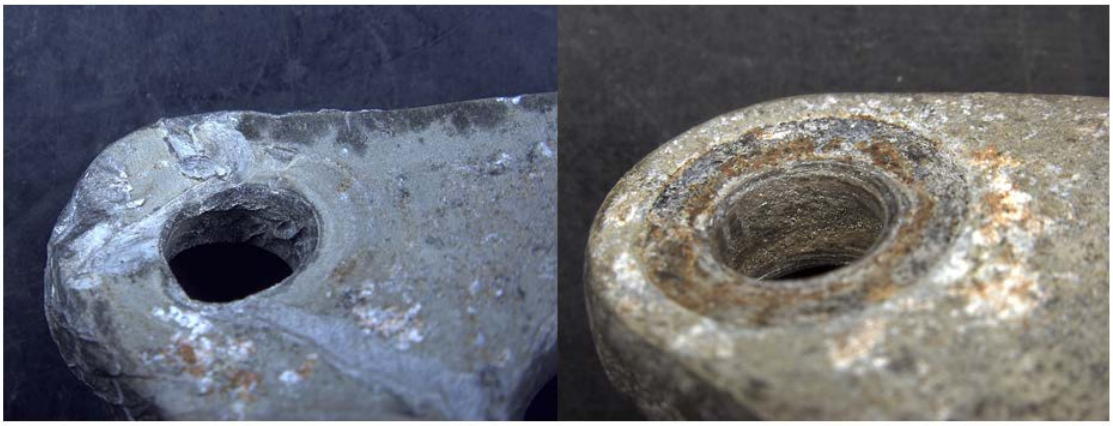
Figure 1: Robinson R22 helicopter cyclic control system



Robinson R22 helicopter cyclic control system schematic: The horizontal push-pull tube, bellcrank, vertical push-pull tubes and jackshaft are highlighted in yellow. The location of the missing fastener is highlighted in red.
Source: Robinson Helicopter Company, modified by ATSB

The examination of the bellcrank found that the bolt-holes for the missing fastener exhibited heat damage different to that of the bolt-holes for the remaining fasteners (Figure 2). In addition, the deformation of the bellcrank prevented the installation of a bolt where the fastener was missing, but did not prevent the removal of the remaining fasteners. This indicated that the bolt was not in-situ at the time of the post-impact fire.

Figure 2: Comparison of the bellcrank bolt-holes



Left: bolt-hole for the missing fastener. Right: bolt-hole for a removed fastener.
Source: ATSB

Re-use of self-locking nuts

Cracking from hydrogen embrittlement of the type of nuts fitted to Robinson helicopters has been previously identified.[1] In October 2014, the Robinson Helicopter Company (RHC) published service letters for the R22 (SL-64), R44 (SL-50) and R66 (SL-09) helicopters on the subject of *D210 Corrosion-Resistant (CRES) Nuts*. The service letters stated that, whenever maintenance that involves the disassembly and reassembly of a critical fastener is performed, the MS21042L or NAS1291 nut should be replaced with a D210-series nut.[2] The R22 maintenance manual was amended in October 2014 to incorporate what was stated in SL-64. For specific instances of cracked nuts, RHC have published service bulletins for their replacement within a compliance period.[3]

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1 Refer to Civil Aviation Safety Authority Airworthiness Bulletin: 14-002, Cracked MS 21042 / NAS 1291 – Series Nuts – Hydrogen Embrittlement; and Transport Canada Civil Aviation Safety Alert 2013-04: Defective Standard Aircraft Hardware – Self-Locking Nuts – MS21042 and NAS11291.

2 In August 2018, Textron published an information letter to owners and operators of Bell helicopters to inform them of the supersession of MS21042 and NAS1291 series nuts in response to reports of cracking from hydrogen embrittlement.

3 For example, R44 Service Bulletin SB-88: *Landing Gear Attach Nuts*, required the replacement of NAS1291-7 nuts with D210-7 within 100 flight hours or by 28 February 2015.

The R22-series maintenance manual included the following information under section 1.300 Fastener Torque Requirements:

> **D. Critical Fastener:** A critical fastener is one which, if removed or lost, would jeopardize safe operation of the helicopter. This includes joints in the primary control system, and non-fail-safe structural joints in the airframe, landing gear, and drive system.
>
> **CAUTION:** D210-series nuts, which supersede MS21042L-series and NAS1291-series nuts, are required on critical fasteners.

In the course of interviewing personnel employed by the maintenance organisation, the ATSB noted a low level of awareness of the need to replace MS21042L/NAS1291-series nuts with the D210-series nuts when critical fasteners were reassembled. In accordance with the R22 maintenance manual, critical fasteners include a self-locking nut in their assembly. It is a standard practice within sectors of the aviation industry to re-use self-locking nuts provided the nut cannot be turned onto the bolt thread by hand and the published torque value for the fastener is achieved.

During the course of the investigation the ATSB spoke with another maintenance organisation, who reported they employ the same practice of re-using self-locking nuts, and the helicopter manufacturer confirmed this was an acceptable practice. The United States National Transportation Safety Board reported on this practice as accepted by the manufacturers of light helicopters in their aircraft accident report AAR-13/01.[4] They noted that guidance on the re-use of self-locking nuts was provided by Eurocopter (now Airbus Helicopters), Sikorsky, Bell and the United States Federal Aviation Administration.

In December 2018, the ATSB received the accident helicopter's jackshaft, which had the fasteners attached. The jackshaft was one of a number of parts within the flight control system that was disassembled and sent for non-destructive inspection during the 2,200-hour overhaul. The bellcrank was not subject to non-destructive inspection and therefore not required to be disassembled. In late January 2019, the ATSB completed semi-quantitative chemical analysis of the nuts fitted to the jackshaft and found they were consistent with a carbon/alloy steel, and therefore not consistent with D210-series stainless steel corrosion-resistant nuts. The nuts fitted to the jackshaft had similar markings to the nuts fitted to the bellcrank, which were consistent with MS21042L/NAS1291-series nuts.

At the time of the reassembly of the accident helicopter, the current *R22 Illustrated Parts Catalog* detailed the part number D210-4 for the nuts fitted to the jackshaft, and RHC confirmed there was no alternate part number to the D210-series nuts.

In consideration of the evidence, the ATSB concluded that the industry practice of re-use of self-locking nuts on Robinson helicopters may result in the omission to install D210-series nuts when critical fasteners are reassembled.

The ATSB advises that this finding of increased risk applies to all approved maintenance organisations for Robinson helicopters and at present has not been identified as a contributing factor to this accident.

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[4] National Transportation Safety Board, 2013. *Loss of Control, Sundance Helicopters, Inc., Eurocopter AS350-B2, N37SH, Near Las Vegas, Nevada, December 7, 2011*. Aircraft accident report NTSB/AAR-13/01. Washington, US.

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The Australian Transport Safety Bureau advises all maintenance personnel for Robinson helicopters to ensure that before re-using a self-locking nut, that the correct part number is fitted, and that the D210-series corrosion-resistant nuts are used for reassembly of critical fasteners in accordance with the Robinson Helicopter Company instructions for continued airworthiness.

Released: 28 March 2019