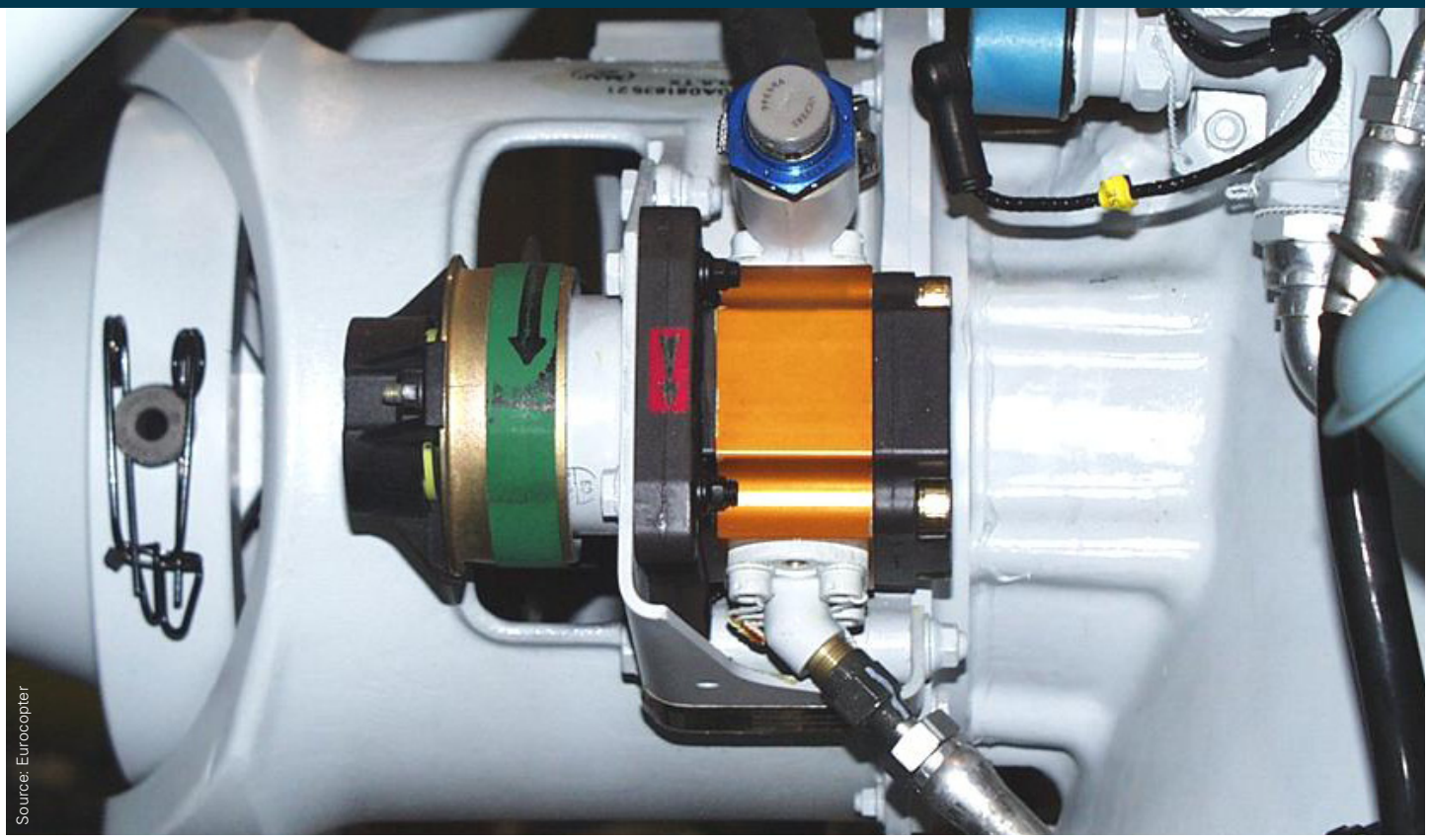
Australian Government
Australian Transport Safety Bureau

Loss of control involving Eurocopter AS350BA, VH-RDU

93 km N of Rockhampton Airport, Queensland | 8 September 2011



Source: Eurocopter

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Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

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Introduction

On 5 September 2013, the Australian Transport Safety Bureau (ATSB) released its final investigation report into the loss of control involving Eurocopter[1] AS350BA, registered VH RDU, which occurred 93 km north of Rockhampton Airport, Queensland on 8 September 2011. Subsequently, the ATSB became aware of new and significant evidence in relation to the helicopter's hydraulic pump drive system, including the associated drive belt. Information had been provided through the ATSB's confidential reporting scheme (REPCON) indicating the reporter's safety concerns about the hydraulic pump drive belt. As a result, and in accordance with clause 5.13 of Annex 13 to the Convention on International Civil Aviation Aircraft *Accident and Incident Investigation*, the ATSB reopened the investigation.

This supplementary report highlights the additional information gained as a result of reopening the investigation and confirms that the drive belt that was installed in VH-RDU at the time of the accident was authorised for use and within its service life limit. Review and analysis of the additional information determined that, while it would be beneficial to add some additional information to the final investigation report, no change was necessary to the findings in the report that was released to the public on 5 September 2013.

[1] The company was renamed Airbus Helicopters on 2 January 2014.

New and significant information

Hydraulic pump drive belt

The helicopter's original design flat, coated-fabric, hydraulic pump drive belt had a service life limit of 600 hours. The hydraulic pump drive belt, along with an adjacent compressor drive belt, was not found at the accident site or during the subsequent wreckage examination. Although the belts were most likely liberated during the impact sequence due to displacement of the drive pulleys, the alternative possibility of an in-flight failure of the hydraulic pump drive belt could not be eliminated.

Examination of the helicopter's maintenance documentation showed that replacement hydraulic pump drive belts were generally installed in the helicopter coincident with major maintenance in the engine and drive shaft area. During such maintenance, the pulleys were more readily accessible. This provided for considerable savings in time and labour and increased helicopter availability, rather than separately disassembling and reassembling the surrounding structures and drive mechanism again at the scheduled time of the belt change.

Since February 2008, successive hydraulic drive belts were changed by the operator after the following periods in service:

- 391.9 hours, coincident with the replacement of the adjacent air conditioning belt
- 366.3 hours, when the still-serviceable belt was affixed to the airframe near the pulley as a spare (permitting a more efficient in-field belt change if and when required)
- most recently, at 596.4 hours. This belt was replaced by the belt that was installed in the helicopter at the time of the accident.

At the time of the accident the fitted drive belt, which was manufactured in October 2008, had been in service for 405.5 hours.

AS350-series helicopter hydraulic pump drive unit history

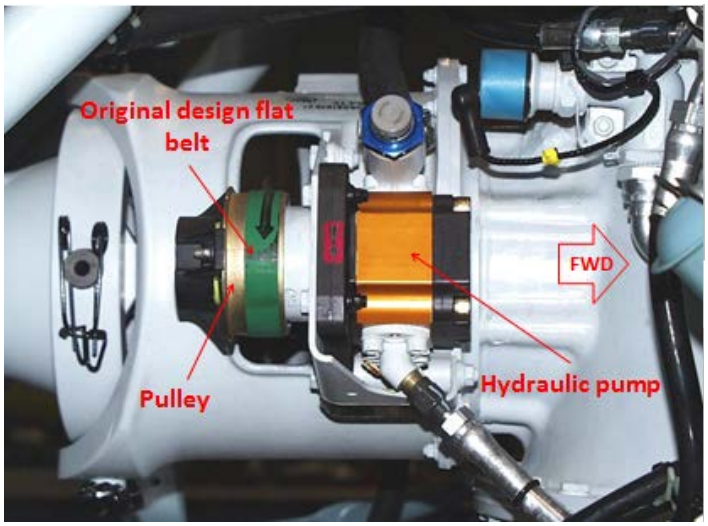
The AS350-series helicopter hydraulic pump drive unit, including the hydraulic pump drive belt, has, as can generally be the case with aircraft items and components, undergone a series of modifications and enhancements during the life of the helicopter type. Such modifications and enhancements can result from a number of factors, including manufacturer enhancement of their products and commercial decisions and national airworthiness authority action.

The following sections outline the modifications and enhancements to the AS350-series helicopter hydraulic pump drive unit up to the release of this supplementary report, and related action by some national investigative and airworthiness authorities. A chronology of this activity is in the appendix.

Initial Eurocopter modification of the hydraulic pump drive unit

An original design, flat drive belt installation is at Figure 1.

Figure 1: Original design hydraulic drive system, showing the green flat drive belt



Source: Eurocopter, labelled by the ATSB

In 2001, the hydraulic pump drive unit in production AS350-series helicopters was changed by Eurocopter to incorporate an improved 'Poly-V'[2] drive belt with a significantly longer service life of 1,500 hours (later increased to 1,800 hours). This modification also incorporated a different drive, pulley and pulley bearing.

In May 2002, Eurocopter issued Service Bulletin (SB) 63.00.08. This SB recommended that operators of AS350-series helicopters, including the BA variant, replace the flat hydraulic pump drive belt installation with the Poly-V belt unit, as installed in production aircraft since 2001.

Transportation Safety Board of Canada investigation of a January 2003 accident involving an AS350B2 helicopter in Ontario, Canada

Following its investigation of a January 2003 fatal accident in Ontario, Canada, involving a Eurocopter AS350B2 helicopter, the Transportation Safety Board of Canada (TSB) concluded that the pilot experienced a hydraulic system failure. Although the TSB could not determine if a failed hydraulic pump drive belt contributed to the loss of hydraulic system pressure, they considered it most likely as examination of the helicopter's flat drive belt revealed that it had failed at the manufacturing seam. TSB examination of similar in-service drive belts revealed extensive cracking in the same location. Furthermore, the TSB determined that visual inspection of installed drive belts was unlikely to reveal cracking or weakening at the seam. Detection of such cracks required removal of the belt, turning it inside out and tensioning before inspection.

In December 2003, the TSB issued Aviation Safety Advisory AO30019 to the Canadian aviation regulator, Transport Canada (TC), to address the 'extensive cracking deficiency on the [flat] hydraulic pump drive belt'. The TSB noted that although the helicopter manufacturer had issued an SB offering an improved belt, there were numerous operators that continued to operate their helicopters with the flat hydraulic pump drive belts. On 22 April 2004, TC issued an airworthiness directive (AD) mandating the Poly-V drive belt installation in Canadian-registered Eurocopter AS350-series helicopters by 30 September 2004, in accordance with Eurocopter SB 63.00.08.

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[2] The trapezoidal-shaped 'Poly-V' drive belt had multiple longitudinal 'v' shapes on its inner surface that mated with similar grooves on the pulley.

United States National Transportation Safety Board investigation of a May 2004 accident involving an AS350BA helicopter in New York, United States

The United States (US) National Transportation Safety Board (NTSB) investigation of a May 2004 non-fatal accident in New York, US, involving a Eurocopter AS350BA helicopter concluded that the pilot lost control due to a hydraulic system failure resulting from a failed hydraulic pump drive belt. The investigation determined that that the flat drive belt had failed at approximately 460 hours of its 600-hour service life limit. An examination revealed that the belt had been installed inside out.

The NTSB searched its occurrence database and the Federal Aviation Administration's (FAA) Service Difficulty Report (SDR) database and found that from 1995 to 2005, there were 43 instances of either failure or premature replacement of these types of hydraulic pump drive belts. Twenty of these drive belts were replaced because they were found to be prematurely stretched or worn past their service limits during routine maintenance inspections. The remaining 23 drive belts failed in flight after an average of 277 hours of time in service. Three of these failures, including the 2004 occurrence, resulted in an accident following a loss of hydraulic system pressure.

On 9 January 2006, the NTSB issued Safety Recommendations A-05-36 and -37 recommending that the FAA require operators of Eurocopter AS350-series helicopters to comply with the provisions of Eurocopter SB 63.00.08 and to identify an appropriate life limit or inspection interval for the flat-type hydraulic pump drive belt until compliance with the provisions of the SB could be met. On 23 April 2007, the FAA issued AD 2007 06 15 mandating incorporation of the Eurocopter SB in US-registered AS350-series helicopters and a requirement that it be complied with at or before the next 500-hour time-in-service inspection.

Action by National Airworthiness Authorities

French Direction Générale de l'Aviation Civile

The French Direction Générale de l'Aviation Civile (DGCA) and its successor, the European Aviation Safety Agency (EASA), were responsible for the issue of state of design airworthiness directives for AS350-series helicopters. These agencies did not issue any airworthiness directives mandating incorporation of Eurocopter SB 63.00.08.

Australian Civil Aviation Safety Authority

The Australian Civil Aviation Safety Authority (CASA), under Civil Aviation Safety Regulation (CASR) 1998 Part 39 - Airworthiness Directives, required operators to comply with ADs issued by the state of design. As neither DGCA nor EASA had issued an AD in respect of Eurocopter SB 63.00.08, CASA did not issue an Australian-specific AD. Consequently, compliance with Eurocopter SB 63.00.08 was not mandated in Australia. This approach paralleled that by the New Zealand Civil Aviation Authority.[3]

On 11 March 2008, CASA produced Airworthiness Bulletin 67-3 (Issue 1) AS350 Series Flight Control Hydraulic Pump Drive, that 'strongly recommended that operators consider implementing Eurocopter SB 63.00.08'. The CASA bulletin also stated that '…the manufacturer's response is that failures of the flat belt were due to a quality control issue which had been addressed…'. The bulletin further emphasised that these belts required continual and careful inspection for defects and that the Eurocopter SB recommended replacing the belt with one having a longer service life limit.

An ATSB search of the CASA Service Difficulty Report database from 2003 to 2013 identified one reported failure of a flat drive belt in AS350-series helicopters in Australia. That failure was reported to have occurred in-flight in an AS350BA that was operating in Antarctica in March 2005.

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[3] As in Australia, New Zealand regulations required operators to comply with airworthiness directives issued by the state of design.

Ongoing Eurocopter modification of the hydraulic pump drive unit

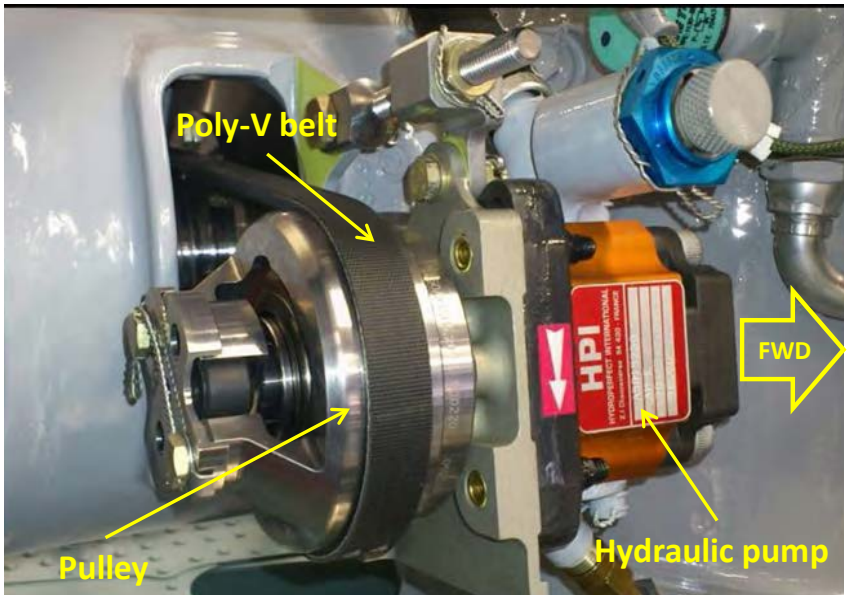
In 2010, Eurocopter redesigned the hydraulic pump drive system in the AS350-series helicopter to incorporate the Poly-V belt with a new hydraulic pump, a keyed drive to replace the splined drive, and a stainless steel (driven) pulley with a dual-row ball bearing (Figure 2). The redesigned drive system was incorporated into Modification MOD 07.9566 and, in December 2011, Eurocopter issued SB 29.00.15 to support the upgrade of in-service AS 350-series helicopters with this modification.

Subsequently, following several incidents involving seizure of the dual-row ball bearing in the stainless steel drive pulley, Eurocopter introduced a periodic inspection of this type of bearing. A replacement bearing and new fitting procedure was promulgated in Alert Service Bulletin EASB 00.05.72 Revision 0, issued in February 2013 and Revision 1, issued in June 2013.

Shortly after, EASA issued AD 2013-0044-E on 27 February 2013 to mandate the manufacturer's alert service bulletin effective 1 March 2013. The AD did not apply to AS350-series helicopters fitted with the flat belts, or to those fitted with the Poly-V belts modified to SB 63.00.08. This AD was subsequently superseded by EASA Emergency AD 2013-0284-E on 2 December 2013, mandating Eurocopter EASB 00.05.72, Revision 2. Both EASA ADs were promulgated by CASA, the latter on 4 December 2013.

Eurocopter advised that the original design flat drive belts were authorised for use until the existing stocks were exhausted.

Figure 2: Redesigned hydraulic drive system, with Poly-V belt



Source: Eurocopter, labelled by the ATSB

Conclusion

This supplementary report highlights new and significant information in respect of the history, modification status and airworthiness requirements affecting the AS350-series helicopter hydraulic pump drive unit, including the associated drive belt. Review and analysis of this information has determined that no change is necessary to the findings in final investigation report AO-2011-110 that was released to the public on 5 September 2013. Of note, it was confirmed that the flat drive belt that was installed in VH-RDU at the time of the accident was within its service life limit, was authorised for use, and is authorised for ongoing use in AS350-series helicopters until existing stocks are exhausted.

APPENDIX

Chronology of changes to the AS350-series helicopter hydraulic drive unit and belt

The following chronology lists the modifications and enhancements to the AS350-series helicopter hydraulic pump drive unit up to the release of this supplementary report, and related action by a number of national investigative and airworthiness authorities. The format of the chronology is colour-coded for ease of reference as follows:

- Information in blue is directly related to AS350-series helicopters fitted with original design flat drive belts (includes VH-RDU).
- Information in black related to AS350-series helicopters fitted with, or modified to use Poly-V belts.

Date	Event
2001	**Eurocopter Modification 07.9555** production AS350-series helicopters were fitted with a modified hydraulic drive unit that incorporated a Poly-V-type belt with an improved service-life of 1,500 hours or 6 years.
27 May 2002	**Eurocopter Service Bulletin (SB) AS350 No. 63.00.08** issued, offering operators a modification to incorporate the hydraulic drive unit with a Poly-V belt, as fitted to production helicopters in 2001 (Modification 07-9555). The SB did not mandate modification of the existing fleet.
21 January 2003	Fatal accident involving an AS350B2 helicopter at Mekatina, Ontario, Canada. The Transportation Safety Board of Canada (TSB) investigation found that the helicopter crashed after a hydraulic system failure that was likely to have been due to the failure of hydraulic pump drive belt.
22 January 2003	**Eurocopter Service Letter 1588-63-02** reminded operators of the applicable maintenance and information concerning the installation of the hydraulic drive unit with a Poly-V belt.
22 October 2003	**TSB Aviation Safety Advisory A03O0019** issued to Transport Canada (TC) to address the issue of failed flat belts.
30 December 2003	**Eurocopter Technical Information Letter EC 006-2003** promulgated non-technical information (commercial aspects) associated with the Poly-V belt kit and was valid until 31 December 2004.
12 March 2004	**Eurocopter Technical Information Letter EC 009-2004** listed steps taken in relation to hydraulic failures in the single-engine Ecureuil helicopter (AS350-series helicopters).
22 April 2004	**TC Airworthiness Directive (AD) CF-2004-10** issued to Canadian operators, mandating Eurocopter SB 63.00.08 in Canadian-registered helicopters by 30 September 2004.

Date	Event
4 May 2004	Non-fatal accident involving an AS350BA helicopter at Brooklyn, New York, United States (US). The National Transportation Safety Board (NTSB) investigation determined that failure of an incorrectly installed hydraulic pump drive belt resulted in the loss of hydraulic system pressure and subsequent loss of control.
7 May 2004	**Eurocopter SB 63.00.14** advising of the Poly-V belt revised tension adjustment (Modification 07.9563).
7 May 2004	**Eurocopter SB 63.00.08 Revision 1** issued, incorporating the revised belt tension. Note: a compliance date of 1 January 2004 applied to the belt tension of helicopters delivered after 1 January 2001 and not upgraded with the service bulletin.
22 November 2005	**Eurocopter Service Letter 1737-63-05** issued, advising of possible deterioration of Poly-V belts due to misalignment and reminding operators that belt tension had been reduced (as per SB 63.00.14).
9 January 2006	**NTSB Safety Recommendation AO-05-36 and -37** issued to the US Federal Aviation Administration (FAA) recommending that the FAA require operators of AS350-series helicopters to comply with the provisions of Eurocopter SB 63.00.08, Revision 1, and for the FAA to identify an appropriate life limit for existing belts.
23 April 2007	**FAA Airworthiness Directive (AD) 2007-06-15** issued to US operators, mandating the provisions of Eurocopter SB 63.00.08 with a requirement that it be complied with or before the next 500-hour time-in-service inspection.
15 June 2007	**Eurocopter Amendment 39-14996** issued, advising operators of FAA AD 2007-06-15.
25 January 2008	**Eurocopter Technical Information Letter** issued, advising that the flat-type hydraulic pump drive belts would progressively become obsolete (by 2010 belts may not be able to be procured) and reminding operators of SB 63.00.08.
11 March 2008	**Australian Civil Aviation Safety Authority (CASA) Airworthiness Bulletin 67-003** issued, advising Australian operators of AS350-series helicopters of in-flight failures of the flat hydraulic pump drive belt and of the hydraulic pump spline drive coupling. The bulletin also '…strongly recommended that operators consider implementing Eurocopter Service Bulletin No. 63.00.08 [Poly-V belt modification 07-9555].'
2010	**Eurocopter Modification 07.9566**.Eurocopter redesigned the hydraulic pump drive system with the introduction of the AS350B3e and incorporated it on all AS350-series helicopters. The redesign incorporated a new hydraulic pump with a keyed drive replacing the splines, an improved support bracket, a stainless steel driven pulley, a dual-row pulley ball bearing, the Poly-V belt and a simplified belt-tensioning system.

Date	Event
4 April 2011	**Eurocopter Service Bulletin 63.00.08 Revision 2** issued, incorporating a replacement pulley and other minor components (washers) in post-modification 07-9557 hydraulic drive units.
19 December 2011	**Eurocopter SB AS350-29.00.15** issued, offering operators of AS350-series helicopters a modification to incorporate the redesigned hydraulic drive unit (Modification 07-9566) to upgrade the existing fleet.
12 January 2012	**Eurocopter SB 63.00.08 Revision 3** issued, incorporating an extension of the Poly-V belt service life to 1,800 hours or 6 years.
24 December 2012	**Eurocopter Service Information Notice 2541-S-29** issued, relating to the new hydraulic pump drive pulley bearing seizure and rupture of the Poly-V drive belt (post-modification 07-9566-direct drive pump).
26 February 2013	**Eurocopter Emergency Alert Service Bulletin (EASB) 00.05.72 Revision 0**, issued relating to a reduction of the time limits of inspections of the hydraulic pump drive pulley bearing (post-modification 07-9566) as a result of several instances of hydraulic pump drive belt failure caused by seizure of the hydraulic pump pulley bearing.
27 February 2013	**European Aviation Safety Agency (EASA) Emergency Airworthiness Directive (AD) 2013-0044-E** issued, mandating the Eurocopter EASB 00.05.72.
1 March 2013	**CASA** advised Australian operators of the mandatory EASA emergency AD 2013-0044-E.
11 June 2013	**Eurocopter EASB 00.05.72 Revision 1** issued, providing an alternative of replacing only the driven pulley bearing.
2 December 2013	**Eurocopter EASB 00.05.72 Revision 2** issued, relating to a refinement of inspections of the hydraulic pump drive pulley bearing and replacement of certain identified installed bearings.
2 December 2013	**EASA Emergency Airworthiness Directive (AD) 2013-0284-E**, mandating the Eurocopter EASB 00.05.72, Revision 2.
4 December 2013	**CASA** advised Australian operators of mandatory EASA Emergency AD 2013-0284-E.

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