Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

AWB 63-006 Issue 4 – 28 February 2023

Issues related to the Robinson Helicopter Company (RHC) R22 Main Rotor Drive System

An Airworthiness Bulletin is an advisory document that alerts, educates and makes recommendations about airworthiness matters. Recommendations in this bulletin are not mandatory.

1. Effectivity

Robinson Helicopter Company R22-series helicopters.

2. Purpose

The purpose of this AWB is to:

a. provide operators and maintainers' a consolidated summary of investigations carried out by CASA Airworthiness Specialists based on several information resources including the CASA Defect Reporting Service (DRS),

b. remind maintainers and operators of the need to strictly adhere to the requirements of all current RHC approved data for the operation and maintenance of the R22, and

c. provide a guide to the information available, including RHC data in relation to the main rotor drive system with an emphasis on the drive train v-belts (also known as the main drive belts).

NOTE:

The references to the various chapters of the manufacturers' Maintenance Manuals (MM), Pilots Operating Handbook (POH), Service Bulletins (SB), Service Letters (SL) and Safety Notices (SN) provided in this AWB are for general guidance only and may not be revised in this AWB. Reference to any existing data is not intended to exclude reference to and use of any other approved data or new information including Airworthiness Directives (ADs).

Cross-Section through a v-belt (Revision Z)
ATSB Transport Safety Report - Aviation Occurrence Investigation AO-2014-058

At this time, the airworthiness concern described in this Airworthiness Bulletin is not considered an unsafe condition that would warrant an Airworthiness Directive to be issued under Part 39 of the Civil Aviation Safety Regulations 1998.

3. Background

This AWB was originally issued in response to reports of R22 main rotor drive system failures, including low time-in-service main rotor drive belt failures. Investigations into local and overseas defect reports and fatal accidents involving the Robinson R22 helicopter showed a significant number of occurrences that involved catastrophic failure of the main rotor drive belts. Main drive belt failures may be attributed to a number of possible causes, which are considered under the headings of Maintenance related considerations and Operational related considerations.

Issue 2 raised in response to reports of P/No. A190-2 Drive Belts stretching beyond service limits at relatively low time-in-service and to highlight the effects on drive belts when gross weight limits are exceeded. Reference material has also been updated to provide a consolidated summary of investigations, current operational guidance, and maintenance best-practices.

4. Maintenance related considerations

a. Infant mortality of main drive belts

The CASA DRS data shows several failure mechanisms associated with newly installed and low hour main drive belts. Such reports typically describe new drive belts as feeling "sticky", "soft" and "stretchy" at the time of installation. With low hour belts presenting with tie-band splitting, debonding or stretched beyond serviceable limits. In one instance, a set of drive belts had a lumpy drive face profile, which caused excessive vibration at installation.

b. Incorrect main drive belt installation

This includes such factors such as incorrect belt tension rigging, sheave (drive pulley) "V" groove drive surface condition, sheave alignment, actuator rigging, and not adhering to the correct belt "break in" procedure for newly installed drive belts.

i. Main drive belt tension:

The actuator is designed to initially engage the engine to the transmission by gradually increasing main drive belt tension (so that the belts act as a friction clutch) and then monitor and maintain main drive belt tension during flight so that engine power may be transmitted to the main (and tail) rotor as designed. Care must be taken to ensure that the drive belt tension and free-play rigging is correct for new and used belts in both the disengaged and the engaged condition in accordance with the manufacturer's information. Main drive belt wear and stretch should be monitored in service by monitoring the clutch shaft angle.

Refer: CASA DRS database, RHC SL #39 Installation of New A190-2 Vee Belts; RHC SL#78 Engine-to-upper frame dimension, RHC MM Section 7 DRIVE TRAIN.

ii. Belt tension actuator gearmotor:

A high vibration condition (for example an out-of-balance cooling fan) may allow the actuator gearmotor to over-tension the drive belts without blowing the actuator fuse. To mitigate this, RHC designed an electronic time delay circuit to prevent motor operation until spring switch contacts remain closed for approximately ¼ second. Following this update, RHC determined as a gearmotor 'breaks-in' or ages the current draw may reduce directly effecting the time delay circuit. This can lead to intermittent or slow operation of the gearmotor. RHC has since revised the time delay circuit to accommodate differing current draws from both new and older actuator gearmotors. If operators experience slow or intermittent gearmotor operation, require updated design or information concerning the electronic time delay circuit/kit refer to RHC technical support and customer service.

Refer: RHC SB #113A A051-1 Belt Tensioner Actuator, SB #114 D602-3 Time Delay Assembly and KI-242 R22 Clutch Actuator Time Delay Installation Kit Instructions.

iii. Clutch actuator rigging and maintenance:

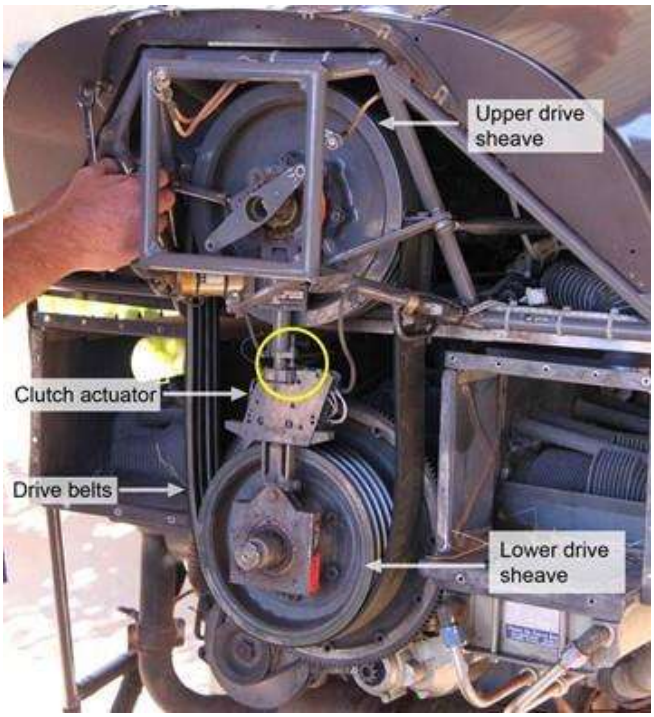
Actuator gearmotor worm gear lubrication and sealing "O" ring condition are critical, especially in a marine environment. The maximum extension dimension should be checked as an indication of main drive belt replacement. Main drive belts should be replaced when the maximum extension has been reached. The disengaged down limit switch should be adjusted to ensure correct main drive belt deflection with the actuator fully disengaged. Lateral positioning/rigging of the actuator also affects main drive belt sheave alignment.

Refer: CASA DRS database; RHC SL #39 Installation of New A190-2 Vee Belts; RHC MM Section 7 DRIVE TRAIN.

iv. Incorrect main drive belt "break in" procedures:

Newly installed drive belts are highly susceptible to failure. Experience has shown that newly installed main drive belts are more likely to roll in the sheave grooves and break or come off the sheaves in flight. RHC consider that once the belts have worn in with over 100 hours of service, main drive belt problems appear to reduce.

Refer: CASA DRS database, Transport Safety Board Canada Report A04P0314; RHC SL #39 Installation of New A190-2 Vee Belts; RHC SL #20A Vee Belt Installation.



Mechanical arrangement of the R22 rotor drive system
ATSB Transport Safety Report - Aviation Occurrence Investigation AO-2014-058

c. Sheave alignment

Main drive belt pulley sheave alignment is considered very critical. In particular, the engine height check that immediately precedes the alignment check must assure that the engine is correctly positioned first prior to checking sheave alignment. If the engine height is wrong, then correct alignment of the sheaves is not possible.

Tests conducted by RHC indicate that most main drive belt drive problems and failures of the fan shaft bearing or upper actuator bearings are caused by misalignment of the main drive belt sheaves. Misalignment will contribute to abnormal main drive belt and sheave wear and belts jumping out of the drive grooves. Adverse loadings on the main drive belt drive faces will result in adverse wear of the drive belts and the sheave grooves. In addition to abnormal wear, the structure of the main drive belts will be stressed in a way not anticipated by the design of the belt and may contribute to premature drive belt failure. Alignment should also be checked typically:

i. After each heavy landing

ii. Following the installation of new main drive belts and/or the installation of new engine mounts

iii. Any time any of the drive line components are disturbed for servicing,

iv. Main transmission / engine change,

v. Whenever the main drive belts are removed due to showing signs of distress, such as fraying / shredding.

Refer: CASA DRS database, Transport Safety Board Canada Report A04P0314; RHC MM Section 7 DRIVE TRAIN. RHC SL #20A Vee Belt Installation; RHC SL #23A Special Caution when Installing Vee Belts or Other Driveline Components. RHC SL #39 Installation of New A190-2 Vee Belts; RHC SL#35 Alignment of Vee Belt Sheaves.

d. Sheave configuration

There are various versions of upper and lower drive sheaves available for installation. The installer should ensure that only compatible types of sheaves are used together and that only the correct sheave is installed in the specified location. Use of the incorrect lower sheave, for example, may result in abnormal engine power pulses being transmitted to the belt which may result in premature main drive belt failure.

Refer: CASA DRS database, RHC MM Section 7 DRIVE TRAIN

e. Sheave condition

If main rotor drive belts are installed on pulley sheaves that do not meet the "V" section profile serviceability requirements of the RHC R22 MM, then the sheaves will not transfer engine power to the rotor system as intended. The condition of the lower sheave is to be inspected at each Daily or Pre-flight inspection. All sheave drive grooves must be maintained in a serviceable condition, for example, not notchy, pitted or worn, with smooth and uniform drive groove surfaces.

Refer: RHC MM Section 7 DRIVE TRAIN. RHC MM Section 2.508 Lower Sheave V-Belt Wear Pattern Inspection, RHC SB #66 Vee Belt – Lower Sheave Inspection, RHC SB-77 Replacement of V-Belt Upper Sheave (CASA AD/R22/44).

f. Main rotor drive belt condition

The drive belts should be checked at each pre-flight inspection and periodic maintenance inspection for condition. For example, no fraying, cracking, blistering or cuts etc, and that the main drive belts have the correct slack and are sitting correctly in the pulley grooves. Main drive belt stretch should be monitored by checking the clutch shaft angle.

Refer: RHC R22 Pilots Operating Handbook SECTION 4; RHC MM 7.240 Clutch Shaft Angle; RHC MM Section 2.507 V-Belt Inspection. RHC SL #20A Vee Belt Installation.

g. Upper and lower actuator pulley bearings

Some failures of the lower pulley bearing have been attributed by RHC to incorrect servicing of the lower pulley bearing. For example, too much grease or loss or lack of grease (incorrect servicing / seal failure) will ultimately result in bearing failure. Signs of impending bearing failure may be detected by turning the bearing by hand to detect roughness, observing increases in bearing noise during run-down, a flickering clutch light and "Teletemp" indications of increasing bearing heat. Failure of the actuator bearings may cause loss of power to the rotor system and could result in a serious accident.

Refer: RHC R22 SN #28 Early Detection of Impending Bearing Failure; POH; RHC SB-95 A181-4 Lower Actuator Bearing Assembly. RHC SB #58 Actuator Bearings.

h. Lower pulley (sheave) bracket

Reports of cracking of the lower pulley bracket have been attributed by RHC to excessive vibration from the engine cooling fan and lower pulley or sheave. Failure of this bracket may result in loss of drive to the main rotors. Engine cooling fan and lower pulley balancing should be carried out as required by the RHC MM.

Refer: RHC MM SECTION 6.240 Balancing Fanwheel.

i. The failure of an alternator drive belt in flight might interfere with the operation of the main rotor drive belts and could possibly cause the main rotor drive belts to malfunction or fail. The alternator belt should be checked for serviceability, for example, proper alignment, no cracks, missing teeth, fraying or delamination. Emergency Spare Alternator Belts should also be checked for any defects before use, including heat deterioration or permanent set.

Refer: Textron Lycoming Service Instruction (SI) 1129 Methods of Checking Alternator and Generator Belt Tension; RHC MM Section 2.410 Inspection Procedures and Checklist. RHC SL-57 Alternator V-Belts.

5. Operational related considerations

a. Aerial mustering flight profile and Certification requirements

The R22 is one of the most common rotary wing aircraft on the Australian Register and is a popular choice for many applications from private operation through to highly demanding aerial work. In particular, the use of the aircraft for mustering can be considered as unique to the Australian fleet. An ATSB commissioned study was undertaken in 2004 to establish the effects of this type of operation. The conclusion from the report of the study states:

"The R22 has been the most popular model for these types of operations, but owners and operators need to fully appreciate the stresses placed on aircraft during mustering operations, and the characteristics of aerial mustering operations, which may be quite different to the type of flying for which the type originally received certification."

Operators using the R22 for such demanding operations should be aware of the negative affect such operations may have on aircraft reliability.

Refer: ATSB Aviation Research and Analysis report - B2004/0292, Robinson R22 helicopter aerial mustering usage investigation.

b. Preflight – Drive belt slack

R22 and R44 drive belts must have the proper slack prior to engine start.

i. With clutch disengaged verify belts deflect approximately 1½ inches (4 cm).

ii. After engine start, engage clutch and verify rotor turns within 5 seconds. If rotor does not turn within 5 seconds, shut-down and have actuator adjusted prior to flight.

New drive belts may be tight and cause the rotor to turn during engine start which places unnecessary strain on the starter/drive system. Seek maintenance support if this situation persists.

NOTE:
Robinson SN-33 has been amended to remove the practice of static belt stretching due to the risk of belt displacement during subsequent engine starting.

Refer: ATSB Aviation Occurrence Investigation report AO-2014-058 and AO-2021-007.

c. Manifold pressure monitoring

Since the R22 was first introduced, there have been performance upgrades resulting from the factory installation of more powerful engines. This means that it is easy to apply excessive power, particularly at lower altitudes. To counter this, RHC have introduced strict manifold pressure (MAP) monitoring by the pilot as a means of limiting the power available. Operating the helicopter with the MAP in excess of the limits stated in the POH may result in premature main drive belt failure. Exceeding the permitted maximum gross weight and/or the application of excessive power will overstress the rotor drive system, including the main rotor drive belts.

As torque is transmitted from the lower to upper sheave, there is a difference in belt tension between left and right sides. Exceeding MAP limitations therefore leads to an excessive difference in tension. One half of the belt is subject to excessive slack in this condition and will be prone to vibrations and possible slippage that leads to belt damage and possibly causing one strand to move off the sheave or splitting the strand from its backing to allow it to roll-over within the sheave groove.

Any time the power limit or maximum gross weight is exceeded, a reduction in belt life should be anticipated.

Refer: CASA DRS database, ATSB Aviation Occurrence Investigation report AI-2009-038, Transport Safety Board Canada Report A04P0314; POH; RHC Safety Alert Issued 20 December 2004. EXCEEDING POWER LIMITS CAN BE FATAL.

d. POH Cautions

The R22 POH contains the following caution applicable to the main rotor drive belts and clutch light:
"…..if the light flickers or comes on in flight and does not go out within 10 seconds, pull CLUTCH circuit breaker and land as soon as practical. Reduce power and land immediately if there are other indications of drive system failure (be prepared to enter autorotation. Have drive system inspected for a possible malfunction".

Refer: RHC POH SECTION 3; 3-8 Warning Caution Lights

6. Recommendations

CASA strongly recommends that operators and maintainers:

a. Carefully inspect all newly manufactured main rotor drive belts for defects before installation,

b. Consider the importance of the Maintenance and Operational related considerations highlighted in this AWB and disseminate the information throughout their organisations.

NOTE: Operators are reminded of the requirements for maintenance to be conducted IAW approved maintenance data per CAR 42V.

7. Reporting

CASA encourages reporting any service difficulties with a R22 main rotor drive system via the Defect Report Service.

8. Enquiries

Enquiries with regard to the content of this Airworthiness Bulletin should be made via the direct link email address:

AirworthinessBulletin@casa.gov.au

or in writing, to:

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Aviation Group
Civil Aviation Safety Authority
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