Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

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Robinson R22/R44 Engine Intake Valve and Valve Seat Distress

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 R22 Beta and R44 Raven I Helicopters fitted with Lycoming O-360 and O-540 series engines, respectively.

2. Purpose

To advise owners, registered operators, pilots, maintenance organisations and Licensed Aircraft Maintenance Engineers of the increasing incidence of intake valve and valve seat distress, caused by intake valve deposit build-up likely occurring during extended ground operations in elevated ambient temperatures.

A failure to observe adverse indications or unusual behaviour of the engine may result in the situation developing to a point which results in an induction backfire, engine power loss and airframe yaw. In a severe event this could lead to several uncontrolled power and yaw reactions.

The content and scope of this document is based on preliminary investigation findings and may be updated as additional information becomes available.

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*.

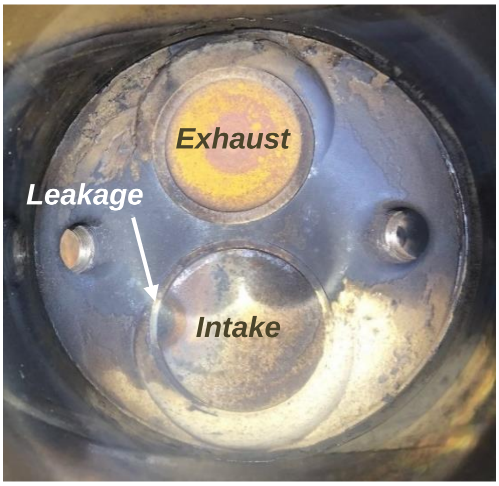

Figure 1

Figure 2

Combustion Chamber view on Intake Valve
Note crescent-shaped burn pattern due to severe and uneven heating at valve edge.
(Source: DRS No: 611852852)

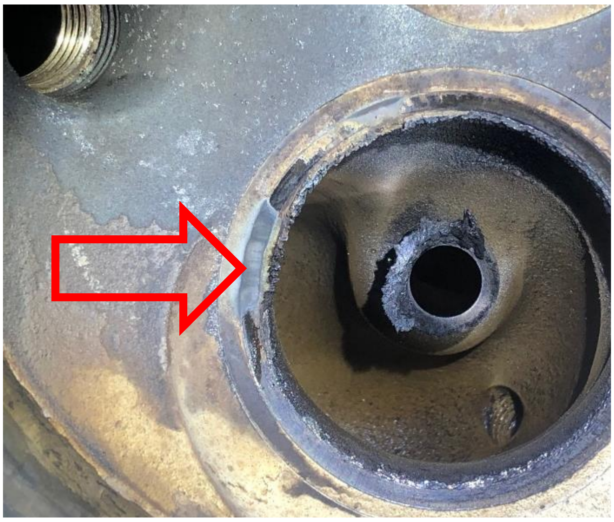

Figure 3

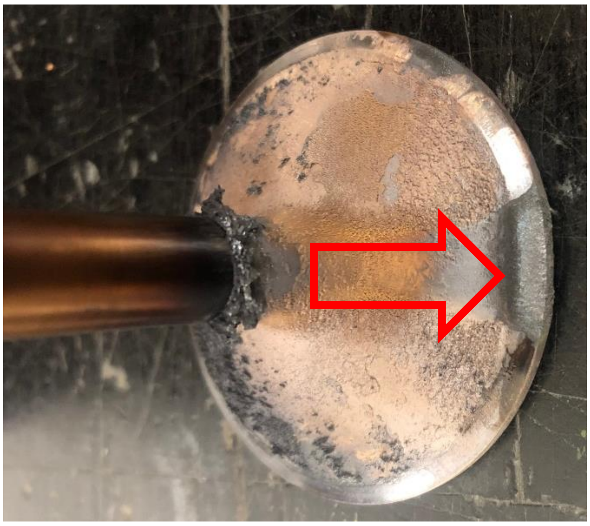

Figure 4

View showing corresponding Intake Valve seat face damage and carbon build-up (Source DRS No: 611852852)

3. Background

Industry participants are seeing a significant increase in incidence of premature engine cylinder removals due to intake valve and valve seat premature wear. The condition predominantly affects R22 Heli Mustering operations and R44 Heli Joy Flight operations across the northern regions of Australia.

The cause of the premature wear has not been established. At this time it has not been conclusively determined that any variations in AVGAS fuel composition is exacerbating or contributing to this airworthiness concern.

It has also been speculated that during extended ground operations at low Manifold Pressure (MAP) and high RPM, the intake valve rocker arm oil is migrating down the valve stem and accumulating on the head/induction side of the valve, leading to coking and carbon build-up.

The accumulated deposits are subsequently ignited with a flash-off event causing valve and/or valve seat damage (erosion). This enables combustion to continue past the unsealed intake valve into the intake manifold with a percentage of the fuel-air mixture being consumed within the manifold causing an induction backfire leading to power loss and airframe yaw.

A number of engine cylinder/valve examples were sent to the Lycoming laboratory for analysis with the source of carbon deposits confirmed to be from engine oil and not fuel or dirt contamination.

Lycoming have advised that while this issue is occurring globally, they are receiving a higher proportion of reported incidences originating from Australia.

A clear understanding of all potential causative factors needs to be established before any permanent solutions can be implemented.

4. References

CASA AWB 85-024 - Piston Engine Exhaust Valve and Valve Guide Distress

CASA AWB 85-019 - Piston Engine - Cylinder Differential Pressure Test

Robinson Helicopter POH insert – HOT CLIMATE COOL DOWN PROCEDURE

Note: Refer to the latest published revision.

5. Recommendations

A. Operating Procedures and Limitations

Aircraft Performance Limitations

Air cooling alone, may be insufficient to adequately cool all cylinder components in some elevated temperature operating environments.

For the above reason, it is critical that all aircraft operational and performance limitations as given in the applicable aircraft Pilot's Operating Handbook (POH) and Engine Operation Manual are strictly observed.

Powerplant limitations are given in Section 2 of the Robinson POH which identifies the Cylinder Head Max Temperature as 500°F (260°C). The colour code instrument markings for the Cylinder Head Temperature (CHT) identifies the Green arc from 200 to 500°F (93 to 260°C) with the Red line at 500°F.

The edge of the Red line identifies the operating limit and the pointer should not enter Red during any normal operations. These limitations need to be considered concurrently with the applicable Lycoming Operations Manual which states:

- Never exceed the maximum red line cylinder head temperature limit, and
- For maximum service life, cylinder head temperatures should be maintained below 435°F (224°C) during high performance cruise operations and below 400°F (205°C) for economy cruise powers.

Robinson has published a HOT CLIMATE COOL DOWN PROCEDURE for insertion within Section 4 of the POH to avoid potential unintended consequences resulting from inadequate engine cooldown during aircraft operations in hot climates.

Furthermore, Section 5 of the POH provides the following pertinent details on aircraft performance relative to operating temperatures:

- Satisfactory engine cooling has been demonstrated to an Outside Air Temperature (OAT) of 38°C (100°F) at sea level or 23°C (41°F) above ISA altitude.

Note: All associated aircraft performance data presented in the POH which is charted against OAT is limited to +40°C (+104°F).

Be aware that there is a cumulative effect of elevated temperatures on cylinder assemblies which will degrade the properties of those materials over time. Even a cylinder displaying a moderate CHT, can be suffering accelerated wear. Be mindful that a single probe CHT will not necessarily be indicative of all cylinders, nor represent even and consistent cooling of the entire cylinder assembly. CHT is also not necessarily indicative of actual valve temperatures.

For maximum service life of the engine, Lycoming recommends:

- maintain CHT between 150°F and 435°F, during continuous operation, and
- prior to engine shutdown idle until there is a decided decrease in CHT.

Lycoming has identified that the described condition related to intake valve deposit formation, wear and leaks appears to be aggravated by:

- ‘Hot Loading’ (extended ground operations of the engine above 75% RPM with collective at flat pitch/fully down). It is therefore recommended that wherever possible this operational configuration is avoided or limited.

- Inadequate engine cool down prior to engine shutdown in ambient temperatures above 38°C (100°F). It is therefore recommended that an extended cool down regime is initiated to ensure that engine CHT is as low as reasonably practical prior to engine shut down. This may require several minutes of run time to maximise the benefit.

B. Cylinder Borescope Inspection

Strict adherence to the aircraft and engine manufacturer’s maintenance schedule together with associated instructions for continuing airworthiness is essential for optimum performance and longevity of the engine.

A cylinder borescope inspection enables timely and direct visual inspection of the combustion chamber, including the valves. It is strongly recommended that a borescope inspection be carried out concurrently with the ‘Differential Pressure Test’.

1. With the spark plugs removed, position the piston at bottom dead centre at the end of the intake stroke.

2. Insert the borescope through the upper spark plug hole and inspect the intake valve and valve seat.

3. Inspect for signs of leakage or damage indicated by localised discolouration or erosion on the valve face and seat circumference. See previous example images.

4. Remove intake pipes and move the piston through the intake stroke whilst observing the valve through the intake ports.

5. Inspect for accumulation of carbon deposits around the valve stem, guide and fillet. See Figure 5.

Figure 5

6. Current evidence suggests that ultimately the accumulation and hardening of intake valve deposits may prevent rotating of the valves during operation. The ability of the valves to rotate is inherent in the valve train design and this is essential to valve longevity as it helps prevent deposits from building up around the seat, which in turn results in the loss of compression.

   If you find a burnt/damaged valve, closely inspect the valve tip (where the rocker arm contacts the intake valve) and associated rocker arm 'toe' for linear wear marks.

7. Report all borescope inspection findings, including nil defects, to CASA per Paragraph 6, (below).

6. Reporting

Report all instances of premature intake valve and valve seat degradation to CASA via the DRS system available on the CASA website. Details of the maintenance history for the engine should be provided in addition to information concerning the method of failure detection, the location and condition of the defective parts.

Operational parameters should also be reported i.e. OAT, RPM, MAP, CHT, Oil Temp, Est. Fuel Burn (lbs/hr) together with any other information on possible triggers for the reporting of occurrences involving an engine backfire or aircraft yaw/twitch event. This information will facilitate a detailed review of potential failure causes and contributing factors.

7. Enquiries

Enquiries regarding 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
GPO Box 2005, Canberra, ACT, 2601