SERVICE LETTER: JSL 014-5

Issue: **5**

Date: **19th December 2017**

Subject: **Jabiru Cylinder Head Inspection**

Release Date: **19th December 2017**

Effective Date: **19h December 2017**

Affected Models: **All Jabiru Engines up to S/N 22A3811 & 33A2768 (excludes Gen 4 engines)**

1 Table of Contents

2 Revision history

Table 1 below provides the revision history for this service letter. Changes made in revision 5 are indicated by red text

Table 1 - Table of revisions

Issue	Changes	Date
1	Original issue - Released 1st Dec 2014	Cancelled
2	Released 5th Aug 2015	Cancelled
3	• Jabiru Go-Nogo gauges and reams referenced • Double valve spring upgrade detailed – Released 17th June 2016	Cancelled
4	• Additional detail for subsequent inspections – Released 1st July 2016	Cancelled
5	• Gen 4 engines excluded	Current

3 General

- This service letter has been prepared to assist operators in identifying and addressing a range of potential issues affecting the operation of Jabiru engines. It replaces JSL 014-4.

NOTE

Incomplete review of all the information in this document can cause errors. Read the entire Service Letter to make sure you have a complete understanding of the requirements.

3.1 Recurrence

- The inspections detailed herein are carried out **ONCE** except as detailed below.
- Where an engine is assessed as Group 2, 3 and 4 it is **recommended** that, after the initial inspection in accordance with Table 2, one cylinder head is removed at each 100-hourly or annual inspection (whichever is the sooner) and inspected as detailed in Section 6.1. The applicability procedure detailed below should be repeated at each inspection to monitor for changes to risk grouping.
- Subsequent cylinder head inspections conducted as detailed in section 6.1 are generally only recommended if other normal maintenance inspections indicate the need. These may include but are not limited to:
    - Low cylinder leak-down results.
    - Excessive movement of cylinder head bolts during re-torqueing indicating severe cylinder head overheating.
    - If these sort of service issues are detected a subsequent cylinder head inspection should be conducted on the subject cylinder head (i.e. the one with the lowest leak-down or the hottest.

4 Applicability

- As noted above, this letter addresses several different potential issues. A range of contributing factors have been identified and the process below is used to determine how much risk applies to a given engine and, from that, what level of work is recommended.
- The risk factors for the engine are primarily environmental or operational and so this approach has been used instead of conventional serial number range applicability format.
- This is a self-administered risk assessment, designed to minimize imposition on low-risk engines while recommending appropriate inspections on high risk engines.

- Honesty and subjectivity is critical to achieving the desired result. Examples are provided and Jabiru Aircraft may be consulted if there are questions on any points: if in doubt, use the higher value.

4.1 Applicability Process

i. Refer to Table 3: Read each and select the answer most applicable to the engine.
ii. Write the “Response Value” for each answer in the “Results” column of the table.
iii. Add all of the entries in the results column and write the total in the box provided.
iv. Reading from Table 4, determine which group the engine falls into.
v. Carry out inspections / follow-on inspections as detailed.

Table 2 – Inspection Requirements by Group.

Group	Inspections
Group 1	Rocker chamber inspection detailed in Section 6.4. Visual inspection of engine, follow-up on points detailed in Section 6.3
Group 2	Inspect **1** critical cylinder heads of engine as detailed in Section 6.2. Follow-up on points detailed in Section 6.3
Group 3	Inspect **2** critical cylinder heads of engine as detailed in Section 6.2. Follow-up on points detailed in Section 6.3
Group 4	Inspect **ALL** cylinder heads of engine as detailed in Section 6.2. Follow-up on points detailed in Section 6.3

Table 3 – Applicability Assessment

Criteria	Response Value					Result
	0	**1**	**2**	**3**	**4**	
CHT: Does the engine experience CHT indications above the start of the yellow line (180°C or 350°F) during operation.	Never	Sometimes close	In exceptional conditions.	Regularly	All the time.	
Oil Temp: Does the engine experience Oil Temp indications above the start of the yellow line (100°C or 212°F).	Never	Sometimes close	In exceptional conditions.	Regularly	All the time.	
EGT: Does the engine experience EGT indications above 750°C or (1382°F) during operation.	Never	Sometimes close	In exceptional conditions.	Regularly	All the time. EGT gauge not on all cylinders	
Flight Training: Is the engine used for flight training (or hired out for any other purpose).	Never	25% or less of the time.	25-50% of the time.	50 - 75% of the time.	75 - 100% of the time.	
Time Since Overhaul: How many hours since the engine had a "top end overhaul" or equivalent maintenance (including replacement of all valves)	0 – 200 hours	200 – 300 hours	800 – 1000 hours	600 – 800 hours	300 – 600 hours.	
Fuels: Is the engine operated strictly in accordance with Jabiru operating recommendations for the particular fuels being used – detailed in Service Letter JSL007.	Always	100 – 75% of the time.	75 - 50% of the time.	50 - 25% of the time.	25% or less of the time.	
Dust: Is the engine operated in dusty environments.	Never	25% or less of the time.	25-50% of the time.	50 - 75% of the time.	75 - 100% of the time.	
Operational History: Have you had low leak downs or upper cylinder issues with Jabiru engines in the past 2 years.	Never	1 or 2 minor issues.	Several minor issues	1 or 2 significant issues.	Several significant issues	
					TOTAL➔	

Table 4 – Applicability Group

	Group 1		Group 2		Group 3		Group 4	
TOTAL➔	**0 - 4**	**5 - 8**	**9 - 12**	**13 - 16**	**17 - 20**	**21 - 22**	**23 - 28**	**28 - 32**

4.1.1 Example 1:

An engine is operated in a flying school based in rural Queensland. The owner flies his aircraft about once a month, the rest of the time it is in the hands of the CFI, his instructors and the local maintenance organisation. In summer the instructors note that engine temperatures are frequently high. No EGT gauge is fitted. The engine had a top-end overhaul 809 hours ago and almost never operates from gravel runways. MOGAS from the above-ground airstrip tank (which holds several thousand litres and is refilled every few months) is used. The fuel is supplied by the owner of the airstrip; documentation is not provided. The engine has had chronic low compression problems with cylinder #3 since 400 hours TIS. The seat has been re-cut twice and the exhaust valve replaced 150 hours ago. Another Jabiru engine in the same flying school suffered an exhaust valve failure 18 months ago.

Response Values:
CHT: 3, **OIL** T: 3, **EGT**: 4, **Flight Training**: 4, **TSO**: 2, **Fuel**: 4, **Dust**: 1, **Operational History**: 3.
TOTAL➔ 24.
Applicability Group ➔ 4, actions per Table 2.

Notes:

- **Temperatures:** These answers are subjective as the person completing the assessment is not always in the aircraft to monitor temperatures. Use the higher value!

- **Fuel:** Jabiru's fuel guidance as detailed in JSL007 notes that, when operating an aircraft on MOGAS "…Drums, jerry cans and above-ground tanks are not considered approved tanks…" And "…Do not use MOGAS which has been stored for more than 2 weeks outside of an approved gasoline storage tank…". In this case the tank is not an approved type, is supplied without documentation and is stored improperly. JSL007 also notes that "Due to QA considerations, operators who use MOGAS do so at their own risk." In this case, fuel is a high risk point for the engine.

- **Operational History:** The issues affecting this engine directly would score a 2. However, an engine operated and maintained by the same organisations has had a severe issue within 2 years. How an engine is operated and maintained is a critical factor in its reliability and it is reasonable to expect that the engine in question was operated and maintained in the same way as the engine which failed – therefore the higher value was used.

4.1.2 Example 2:

An engine operated in an owner-run flying school based in rural South Australia. During summer the owner/instructor flies morning and afternoon to avoid peak temperatures, teaches his students to manage engine temperatures but sometimes notices engine temperatures in the yellow range. No EGT gauge is fitted. The engine had a top-end overhaul 633 hours ago and often operates from gravel runways. AVGAS is used wherever possible but a few times a month MOGAS from drums has to be used. The operator monitors pull-through and leak down results closely and 100 hours ago re-cut a valve seat to restore compression on cylinder #2.

Response Values:
CHT: 2, **OIL** T: 2, **EGT**: 4, **Flight Training**: 4, **TSO**: 3, **Fuel**: 2, **Dust**: 4, **Operational History**: 1.
TOTAL➔ 22.

Applicability Group ➔ 3, actions per Table 2.

Notes:

- In this case cylinder #2 has required attention and as the valve was re-cut and re-used (not replaced) would be a natural choice for checking. Cyl #4 would typically be the second head checked.

4.1.3 Example 3:

An engine is operated in a private share-syndicate aircraft based in rural Victoria. One or another of the owners fly the aircraft once every few months. The aircraft is maintained by a local maintenance organisation. The aircraft is fitted with a digital engine instrument monitoring temperatures (including EGT) on 2 cylinders only. The owners have never seen out-of-limit temperatures indicated though they know that on really hot days the temperatures are in the upper-green range. The engine has completed 241 hours TIS. The owner keeps the aircraft topped up with MOGAS about half of the time – the remainder he fills it with AVGAS at a neighbouring airport. Compression on Cylinder #4 is slightly lower than the rest of the cylinders but within limits. The aircraft operates mostly from bitumen or well-grassed strips.

Response Values:
CHT: 2, **OIL T**: 2, **EGT**: 4, **Flight Training**: 0, **TSO**: 1, **Fuel**: 4, **Dust**: 1, **Operational History**: 1.
TOTAL➔ 15.
Applicability Group ➔ 2, actions per Table 2.

Notes:

- **Temperatures:** These answers are subjective as the person completing the assessment is not always in the aircraft to monitor temperatures and not all cylinders are monitored. In the case of EGT this has resulted in a higher response value.

- **Fuel:** The type of operations described results in the aircraft sitting for long periods and then operating with mixtures of MOGAS and AVGAS in its tanks: this is strongly discouraged in JSL007.

5 Time of Compliance

- The effective date of this Service Letter JSL 014-3 is 21st June 2016.
- All requirements prescribed in Section 6 are **recommended** to be performed at the next scheduled maintenance.
- All current maintenance requirements including those revised in section 7 must be practiced at the time intervals prescribed in the relevant Engine manuals.

6 Recommended Action

6.1 Cylinder Head Removal and Inspection.

CAUTION

TO PREVENT BURNS, LET THE ENGINE COOL FOR 1 HOUR OR LONGER AFTER SHUTDOWN BEFORE REMOVAL OF THE HEAD.

- Remove the number of cylinder heads specified in Table 2 from the engine and carry out the inspections detailed below. Ideally the head which is inspected should be that which typically operates the hottest or highest EGT or lowest leakdown. CHTs and EGTs will be known if an Engine Management System (EMS) is installed. The amount that head bolts turn when checking bolt torque during maintenance is a good indication of operating temperature – the more a bolt turns the hotter the head – so the head with bolts that move the most is the best candidate for these inspections.
    - Follow the instructions for cylinder head disassembly as detailed in the Engine Overhaul Manual (JEM0001) such that the rockers, valves, collets, valve springs and valve spring washers are removed from the head.
    - Visually inspect the inlet and exhaust valve seat, check the seats do not have excessive carbon build-up and the seats are level in the head (i.e. not protruding or sunken).
    - Inspect the valve guides. Check there is not excessive carbon build-up. Check the diameter of the guide is within the limits specified in the build tolerances table in JEM0001, using a ‘Go-No Go’ tool. Ream out valve guides if required to meet the tolerances specified in the Engine Overhaul Manual (JEM0001). Go-No go gauges and the hand ream can be purchased as a kit from Jabiru Aircraft.
    - The procedure of measuring and reaming valve guides requires extensive skill and experience as well as specialized tools. As noted in Section 8, only appropriately trained and approved personnel must carry out these tasks.

Figure 1: Valve guide Go-No go gauges and hand ream (available as a kit from Jabiru Aircraft)

- Inspect both valves, checking for corrosion and abrasion on the stem. Inspect the bottom of the stem using a 10X magnifying glass. This area will first need to be polished clean (using non-abrasive methods to avoid damaging the valve) so the surface can be inspected. Check the stem for bluing and transverse stress cracks which would indicate overheating. If cracks are found then all valves in the engine must be replaced. (See Figure 2). Report to Jabiru using Continued Operating Safety Form COSM2-1 below.

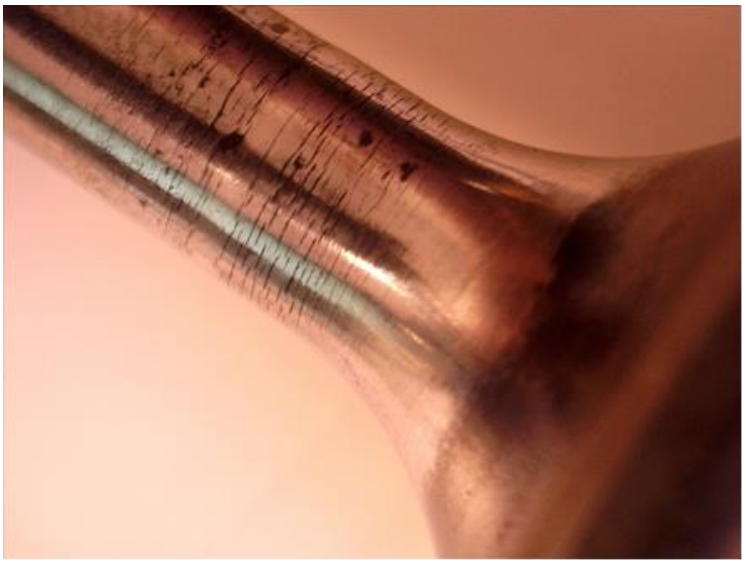


Figure 2: Valve with extensive stress cracks.

- Check the collet grooves on the valves are clean and free from corrosion and other contaminants, clean as necessary. Similarly check the collets themselves. Reassemble the collets on the valve stem and check the valve can freely rotate. Binding parts are unacceptable. Replace parts if necessary.

- Inspect the top and bottom spring washers for wear. Signs of excessive wear also indicate washer rotation caused by binding collets. Replace parts if necessary.
- Visually inspect the valve springs with at least 10X magnification. If any nicks, inclusions or corrosion pitting is seen, all springs in the engine must be replaced. Measure the length of the uncompressed spring, check it is within the limits of the Engine Wear table in JEM0001 and replace parts falling outside these limits. While springs are removed it is highly recommended they be replaced with the double valve spring upgrade (see section 6.2.1).
- Inspect rockers. In particular inspect the condition of the rocker bushes, check the bush for melting or other deterioration. Insert the rocker shaft and check that the rocker moves freely (but not loosely) on the shaft. Replace rocker bushes with new parts if required. In the photograph below the rocker bush has most of the inner lubricant material melted away. All yellow rocker bushes from all cylinder heads should be replaced. Report to Jabiru using Continued Operating Safety Form COSM-1 below.

Figure 3: Badly worn rocker bush.

- If any issues are detected on the one cylinder head inspection, then all the other cylinder heads must also be removed and the fore mentioned inspections conducted.
- Re-assemble and install head as per Overhaul Manual JEM0001.
- The inspection details are to be noted in the engine maintenance log including any corrective action that was required. Use Form below and include in log. Note the cylinder which was removed and inspected. Quote this service letter in the log (i.e. JSL014-5)

- It is recommended that this ‘single cylinder head inspection’ regime be repeated whenever a cylinder head is removed from the engine. This enables continued monitoring of these components. A note should be made in the engine maintenance log for any additional single cylinder head inspections conducted.
- If issues were found or parts needed replacement during the single cylinder inspection it is recommended that this procedure is repeated on all cylinder heads.

6.2 Replacement hardware

- If it is found that valves need to be replaced they should be replaced on all cylinder heads.
- Valve (both inlet and exhaust) can only be purchased as a kit which includes the valve a pair of collets and a Top Spring washer.
- Every valve kit has an individual valve fitted for an individual Top spring washer and a pair of collets. At the factory the parts are 'pre-fitted' together to ensure there is no collet binding and the valve is free to rotate.
- When installing new inlet or exhaust valves it is of critical importance that the collets and top spring washer supplied with a given valve are used on that valve. DO NOT mix and match collets or Top spring washers and DO NOT reinstall old collets or top spring washers.
- Similarly if the top spring washers are to be replaced, the valves and collets must also be replaced with those supplied in the exhaust valve or inlet valve kits.

6.2.1 Double Valve Spring Upgrade

- After substantial design work and testing Jabiru Aircraft has released a configuration upgrade to the valve train. The double valve spring assembly.
- The double valve spring assembly features a small inner spring inside a larger outer spring, the coils are wound in opposite directions to prevent coil binding.

Figure 4 - New double valve spring vs the previous single spring configuration

- The valve seated pressure (i.e. valve closed pressure) is greater than for the single valve spring which can improve valve sealing. This can help prevent problems with compression and valve leakage which may contribute to preventing a valve failure. With a second spring there is now an element of redundancy in the system.
- Double Valve springs can be retrofitted into all Jabiru 2200 and 3300 engines. This upgrade is highly recommended for all engines.
- Upon inspection even if the condition of valves, springs or washers does not necessitate replacement, it is highly recommended that the double valve spring system be installed while cylinder heads are off the engine. In upgrading to double valve springs the following items must be replaced:

- Inner and Outer Valve Springs – replaces the existing single valve spring. **Do not install only the outer spring.**
- Bottom spring washer – The double valve spring assembly requires a specially stepped bottom spring washer with lands for both springs. Double valve springs should not be installed with the existing single spring washer.
- Top spring washer, collets and valves – Similarly the double valve spring assembly requires a special double stepped top spring washer. Since the top spring washer is being replaced the collets and valves themselves must also be replaced with pre-fitted hardware kits. The valves, collets and double land top/bottom spring washers are provided in the double spring inlet and exhaust valve kits.

- When upgrading to double valve springs. The springs (and other items listed above) must be replaced on all cylinder heads (both inlet and exhaust valves) at the same time. **An engine cannot have a mixture of single and double valve springs.**
- Double valve spring upgrades should be noted in the engine maintenance log.

6.3 Continued Operations

Certain of the items noted above may be caused by other defects in the engine, by incorrect operation or by maintenance factors. Operators are encouraged to contact Jabiru Aircraft where issues are found to identify contributing factors and correct them.

Note that if the cause is not addressed there is every chance that the issue will recur and an unsafe condition result. In some cases this may ultimately cause engine failure, potentially leading to the loss of the Crew, airframe or engine.

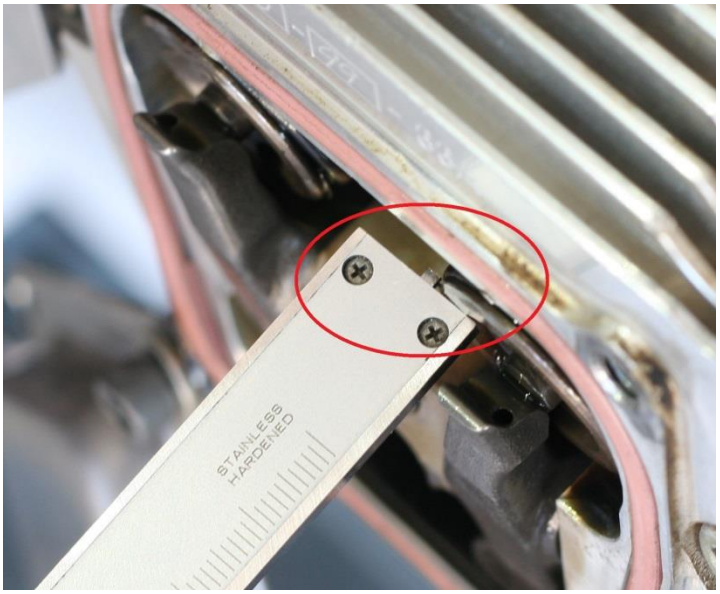
A full discussion of these are beyond the scope of this document, however a brief sample is included below.

- Valve seat recession or “movement”. Most often due to extended operation at elevated temperatures (particularly CHT). Check for leaks in intake/exhaust system and take steps to reduce CHT in operation (i.e. increase climb airspeed, step-climb, minimize ground running etc.)
- Valve guide carbon. Potentially due to dirty or excessively hot oil. Poorly sealing valves may also contribute. Check oil change frequency and aircraft operating methods to reduce oil temperature. If leak-down results are poor valves may need to be cleaned or lapped.
- Valve stem cracking. Typically due to operation at excess exhaust gas temperatures. Check EGT using EGT sensors such as a fully instrumented EMS (contact Jabiru Aircraft for more information). Check for leaks in intake/exhaust system. Check carburettor settings and mixtures. Check fuel freshness. Check valve is sealing.
- Valve collets binding on valve stem. Potentially due to dirty or excessively hot oil. Operations in dusty environments also a potential contributor leading to oil contamination. Check oil change frequency and aircraft operating methods to reduce oil temperature. Check blow-by on piston rings contaminating engine oil.
- Valve washer wear. Typically related to binding collets. See notes above. Excessively “sharp” spring ends another potential factor.
- Valve spring corrosion. Typically caused by storage in humid environments or by not being run often or long enough. Using more frequently or improved inhibition for storage may be required.
- Rocker bush wear. May be caused by elevated head, oil or exhaust temperatures or high rpm on cold start up. Troubleshoot as noted above.

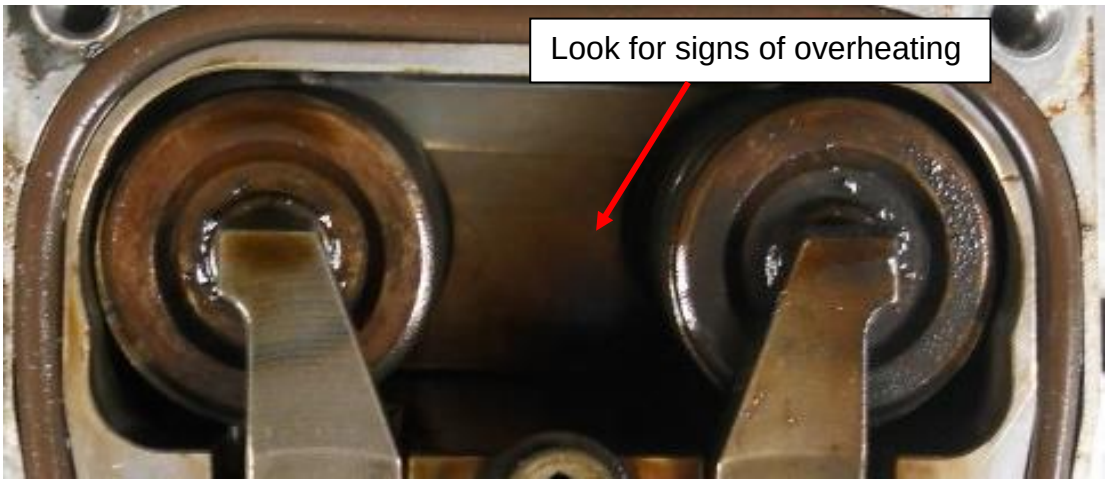
6.4 Rocker Chamber Inspection

- Remove the rocker covers from all heads (see Head Bolt Tension JEM0002 Jabiru Maintenance Manual).

- Set depth vernier at 1.5mm and compare with the top spring washer and look for any signs indicating wear. If signs are present, proceed with **6.1 Cylinder Head Removal and Inspection**.



- Look for signs of overheating. If signs are present, proceed with **6.1 Cylinder Head Removal and Inspection**.



7 Jabiru engine manuals

The Engine Manuals as referenced by this Service Letter are:

i. JEM0001 (Jabiru Engine Overhaul Manual)

ii. JEM0002 (Jabiru Engine Maintenance Manual)

iii. JEM2202 (Jabiru 2200 Engine Installation Manual)

iv. JEM3302 (Jabiru 3300 Engine Installation Manual)

Always use the latest issue of any manual. Check regularly for manual updates on the Jabiru Aircraft website.

8 General Engine Maintenance Notes

The work detailed in this Letter requires extensive skills, experience and training in engine maintenance – as well as special tools and equipment. Unskilled personnel or those lacking the correct tools and training **must not attempt this work**. Refer to the current Jabiru Engine Overhaul Manual, Document JEM0001 (use latest issue) for personnel, tool & equipment requirements. The cylinder head could be mailed to Jabiru for checking and reassembly as an option.

9 Reminder of current practices

This section promotes the practices current (at the time of writing) for Jabiru Engine Maintenance as they relate to the components of the cylinder head. Refer to the latest approved revisions of Jabiru Manuals for details.

i. Ensure the engine oil and oil filter are changed at every **25 hourly inspection** (as prescribed by the Engine Maintenance Manual – JEM0002). Frequent oil changes reduce the amount of contaminant buildup in the oil which can cause valve seizure. In addition there now exists the requirement for the oil and oil filter to be changed every **6 months** if this time elapses before the engine reaches the next 25 hourly.

ii. If an engine is prepared for long term storage, ensure that the current practice (as prescribed in JEM0002) of applying corrosion inhibitor into the each of the rocker chambers is observed.

iii. Ensure the engine carburation system is updated to current jetting configuration as prescribed in the current Engine Overhaul and Maintenance Manuals (JEM0001 and JEM0002).

iv. Owners and Operators should also familiarise themselves with the Jabiru Service Letter JSL007 (use most current issue) which gives guidance with regards to different fuels and how they affect the engine, particularly the deposits produced in the combustion chamber.

Warning:
Several valve failures have been attributed to operating with fuel mixtures containing both AVGAS and MOGAS.

v. The requirement for **50 hourly** cleaning and inspection of the carburettor air filter must be adhered to (and mandatory replacement at every **100 hourly or annual inspections**). This minimizes the amount of contaminant inducted into the engine.

vi. It is recommended that when operating in dusty conditions a more regular air filter servicing schedule is used. Also remember crankcase breathers are not filtered and, for some earlier aircraft models, neither is intake air with carburettor heat ON.

vii. **DO NOT** make any unapproved modifications to the valve guide **(such as replacement with K-liners)** or any other modifications to the componentry of the cylinder heads and the cylinder heads themselves.

viii. **DO NOT** use top end cylinder lubricants or fuel additives.

9.1 Notes of operation

i. As previously mentioned the oil must now be changed every 6 months if the engine has done less than 25 hours in that time period. This is necessary because engines that are largely inactive will accumulate contaminants including moisture, acids and sludge. These contaminants are expunged from an engine when it is operated regularly. After long periods of inactivity, short ground runs should be avoided as this will not allow enough time for the engine to remove these contaminants which can cause valve sticking.

ii. Exposing the engine to shock cooling during low-powered rapid descents or shutting the engine down hot (i.e. not allowing a sufficient idle period to gradually bring temperatures down) will promote the build-up of contaminants and may induce valves sticking.

10 Checklist.

Engine Cylinder Head Inspection	
Aircraft Registration:	**Aircraft model:**
Engine Serial Number:	**Date of Inspection:**
TTIS for Engine:	**Inspection done by:**
TTIS for Heads:	
Response Value TOTAL:	**Engine Applicability Group:**
Task	**Finding/Corrective Action**
Visually inspect the inlet and exhaust valve seat, check the seats do not have excessive carbon buildup and the seats are level in the head (i.e. not protruding or sunken	
Inspect the valve guides. Check there is not excessive carbon buildup. Check the diameter of the guide is within the limits specified in the build tolerances table in JEM0001	
Inspect both valves, checking for corrosion, cracking, blueing and abrasion on the stem. Inspection the bottom of the stem using a 10X magnifying glass. This area will first need to be polished clean so the surface can be inspected.	
Also check the collet grooves on the valves are clean and free from corrosion and other contaminants, clean as necessary. Similarly check the collets themselves. Reassemble the collets on the valve stem and check they can freely rotate without too much friction.	
Inspect top and bottom spring washers for wear.	
Visually inspect the valve springs with at least 10X magnification. If any nicks, inclusions or corrosion pitting is seen, the springs must be replaced.	
Inspect rockers. In particular inspect the condition of the rocker bushes, check the bush for melting or other deterioration. Insert the rocker shaft and check that the rocker moves freely (but not loosely) on the shaft.	
Re-assemble and install head	

Add a copy of this completed checklist to the engine log book.

11 Continued Operating Safety Reporting Form

Document: COSM2-1

The owner/operator of a LSA is responsible for notifying the manufacturer of any safety of flight issue or significant service difficulty upon discovery. **RETURN DEFECTIVE PART TO JABIRU AIRCRAFT WITH THIS FORM.**

Date:	
Aircraft Model	
Aircraft Registration	
Aircraft S/No.	
Engine S/No.	
Details of item:	
Name of Reporter:	
Preferred Contact Details of Reporter	

Form No.COSR-1

LSA Service Notification: JSN 014-5

Issue: 5

Effective Date: 19th December 2017

Subject: Jabiru Cylinder Head Inspection

Applicability:

The content of this directive is applicable to all Jabiru engines:

Requirement:

It is recommended that operators of engines within Light Sport Aircraft categories comply with the requirements of Jabiru Service Letter JSL 014-5

Compliance:

The compliance details are given in JSL 014-5

Background:

This Service Notification has been prepared to make applicable the requirements of JSL 014-5 for engines operating within Light Sport Aircraft Categories.