LAA TYPE ACCEPTANCE DATA SHEET
TADS 346
JABIRU J160

Issue 3	Amended UK contact details. Addition of required mods to section 2.6. Addition of manufacturer's service information to section 3.3. Minor editorial changes.	Dated 19/01/18	JV
Revision A	Minor editorial changes. Addition of JSB042-1.	Dated 13/12/19	JV
Revision B	Addition of JSB044-1.	Dated 03/02/21	JV

This TADS is intended as a summary of available information about the type and should be used during the build, operation and permit revalidation phases to help owners and inspectors. Although it is hoped that this document is as complete as possible, other sources may contain more up to date information, e.g. the manufacturer's website.

Section 1 contains general information about the type.
Section 2 contains information about the type that is **MANDATORY** and must be complied with.
Section 3 contains advisory information that owners and inspectors should review to help them maintain the aircraft in an airworthy condition. If due consideration and circumstances suggest that compliance with the requirements in this section can safely be deferred, is not required or not applicable, then this is a permitted judgement call. This section also provides a useful repository for advisory information gathered through defect reports and experience.

Section 1 - Introduction

1.1 UK contact

Dave Almey, Skycraft Ltd, Riverside House, Bloodfold Farm, Ravens Bank, Saturday Bridge, Holbeach, PE12 8SR.

Tel: 01406 371779
Email: sales@sky-craft.co.uk
Website: www.sky-craft.co.uk (also www.jabiru.net.au)

Note that earlier kits were supplied by the previous agent, ST Aviation.

1.2 Description

The Jabiru J160 is a variant of the tricycle-undercarriage, high-wing, two-seat SEP aeroplane of simple composite construction, fitted with the four-cylinder, four-stroke Jabiru 2200A engine and wooden fixed pitch propeller. Note that the only propeller(s) approved for an individual aircraft are those listed on the individual aircraft's Operating Limitations document or in the PTL/1 (Propeller Type List) for the type. This variant is an amateur-build version of the type-certificated J160C.

The wings consist of fibreglass sandwich skins and moulded composite spars. The wing is supplied pre-formed leaving the builder only to bond flap and aileron attachments and fill any imperfections prior to painting. Basically the builder is tidying up the surface finish, locating air voids in the gel coat and finishing the leading edge by sanding and filling etc. The fuselage consists of upper and lower composite sandwich mouldings which are supplied with most of the hard points and attachment points pre-installed. The tail plane, like the wings, is pre-moulded, and supplied largely ready to fit. The fin is also pre-moulded. The J160 has 'wet' wings (integral

wing fuel tanks). Inspectors should be aware of the differences in the construction between the J160 and previous versions of Jabiru 2-seaters which have foam core wings and fuselage mounted tanks.

The J160 model is a development of the earlier 2-seater models, with greater size and heavier construction to accommodate the latest generation of more powerful Jabiru engines.

Section 2 – Mandatory information for owners, operators and inspectors

At all times, responsibility for the maintenance and airworthiness of an aircraft rests with the owner. Condition No 3 of a Permit to Fly requires that: *"the aircraft shall be maintained in an airworthy condition".*

2.1 Fast Build Kit 51% Compliance

The technical leaflet TL.11 shows the contents of the accepted fast build kit.

2.2 Build Manual

Jabiru supplies a Build Manual for the J160 model.

2.3 Build Inspections

Build inspection schedule 35 (Jabiru two-seat aircraft).
Inspector approval codes A-A or A-C1. Inspector signing off final inspection also requires 'first flight' endorsement.

2.4 Flight Manual

Jabiru supplies a Pilot's Manual JP-FM-06 for the J160 model. Note that information contained in the pilot's manual is not always consistent with LAA data. Where a conflict exists, LAA Permit to Fly data takes precedence over Jabiru Pilot's Manual information.

2.5 Mandatory Permit Directives

Applicable specifically to this aircraft type:

2006-001 Installation of fuel header tank
2006-002 Inboard lower seat belt attachments

Also check the LAA website for MPDs that are non-type specific (TL 2.22).

2.6 LAA Required Modifications (including LAA issued AILs, SBs, etc)

Additional modifications are required by the LAA for acceptance of the type in the UK, as follows:

MOD/346/001 issue 2	09/08/10	Control surface clearance
MOD/346/002	31/10/13	Main undercarriage bolts (see also LAA/AWA/13/08)
MOD/346/003	03/01/18	Mogas prohibition (see also LAA/AWA/18/01)

Also:

- Throttle control mounted on instrument panel rather than under seat (as per the factory option)
- Engine instrumentation to be fitted as on J60C certified model
- Fuel pressure warning light to be fitted as on J160C certified model

2.7 Additional engine operating limitations to be placarded or shown by instrument markings

Notes:

- Refer to the engine manufacturer's latest documentation for the definitive parameter values and recommended instruments.
- Where an instrument is not fitted, the limit need not be displayed.

With Jabiru 2200A: Max CHT: 210°C
Oil temp: 50-110°C
Oil pressure 125-525 kPa @ 3100 RPM

2.8 Control surface deflections

Control surface deflections are defined by templates supplied with each kit. It is essential that these are kept with the aircraft documentation and transferred to the new owners when the aircraft is sold.

2.9 Operating Limitations and Placards

(Note that the wording on an individual aircraft's Operating Limitations document takes precedence, if different.)

1. Maximum number of occupants authorised to be carried: Two

2. The aircraft must be operated in compliance with the following operating limitations, which shall be displayed in the cockpit by means of placards or instrument markings:

   3.3 Aerobatic Limitations
   Aerobatic manoeuvres are prohibited.
   Intentional spinning is prohibited.

   3.3 Loading Limitations
   Maximum Total Weight Authorised: 540 kg
   CG Range: forward limit 180 mm aft of datum at gross weights up to 440 kg varying linearly to 233 mm aft of datum at gross weight of 540kg; aft limit 292 mm aft of datum.
   Datum Point is: the leading edge of the wing
   Maximum baggage weight: 36 kg

2.3 Engine Limitations
Maximum Engine RPM: 3300

3.3 Airspeed Limitations
Maximum Indicated Airspeed (V_{NE}): 140 knots IAS
Maximum Manoeuvring Speed (Va): 102 knots IAS
Normal operating limit (VNO): 112 knots IAS
Max Indicated Airspeed Flaps Extended: 84 knots IAS

3.3 Other Limitations
The aircraft shall be flown by day and under Visual Flight Rules only.
Smoking in the aircraft is prohibited.
Aircraft to be operated in accordance with Pilot's Operating Handbook JP-FM-06.

Additional Placards:

"Occupant Warning – This Aircraft has not been Certificated to an International Requirement"

A fireproof identification plate must be fitted to fuselage, engraved or stamped with aircraft's registration letters.

3.3 Maximum permitted empty weight

Not applicable.

Section 3 – Advice to owners, operators and inspectors

3.3 Maintenance Manual

Jabiru supplies an Operators Manual for the J160 model which contains a maintenance schedule.

3.3 Manufacturer's/Standard Options

Adjustable rudder pedals.
Throttle mounted on panel rather than under seat (mandatory).
Sensenich W62HJ-48G propeller or Jabiru 60" x 42" (note that an aircraft's permit to fly lists the permitted propeller(s) for that individual aircraft).

3.3 Manufacturer's Information (including Service Bulletins, Service Letters, etc)

In the absence of any over-riding LAA classification, inspections and modifications published by the manufacturer should be satisfied according to the recommendation of the manufacturer. It is the owner's responsibility to be aware of and supply such information to their Inspector.

Ref	*Date*	*Description*
JSL 001-1	7/12/04	Wing fuel tank system management

JSL 003-2	11/3/05	Jabiru fuel tank sealant
JSL 005-1	1/9/08	Starter motor earth cable
JSL 007-7	1/11/17	Alcohol, lead, compression ratio: fuel guidance
JSL 017-1	26/6/15	Pattern parts
JSL 019-2	14/12/15	Rudder cable end inspection
JSL 021-1	9/1/18	Charging system operation procedures
JSB 006-1	21/10/04	Noseleg pivot bolt ¼ to 5/16
JSB 007-1	29/11/04	Main undercarriage stub axle
JSB 008-1	31/3/05	Main undercarriage bolts
JSB 009-1	4/4/05	Alternate propeller mount system
JSB 011-1	16/8/05	Inner seat belt attachment
JSB 016-1	19/4/07	J160 family engine cooling
JSB 019-2	29/2/08	Control surface clearance
JSB 020-1	4/3/08	Aileron bellcrank cover
JSB 024-1	9/1/09	Fuel line routing
JSB 025-2	7/5/09	Undercarriage bolt life
JSB 026-1	15/1/09	Adjustable rudder pedals
JSB 027-1	9/7/09	Control cable clamp inspection
JSB 037-1	20/3/15	Wing attachment bolts
JSB 041-1	13/7/17	Elevator cable
JSB 042-1	16/5/19	Aileron control tube
JSB 044-1	8/1/21	Control surface hinge inspection (see also airworthiness alert LAA/AWA/21/03)
STSB-002	19/10/05	Minimum fuel in wet wings
STSL-004	13/2/08	Aileron clearance jammed control in-flight plus rudder check

3.4 Special Inspection Points

- Adequate clearance between shrouds of control surfaces and shrouds of fixed surfaces to prevent a jam occurring. With the control surface positioned so that the shrouds are just on the point of overlap, there should be a minimum of 3mm clearance between the shrouds at this point, up the entire length of the hinge line.

- Peel ply is factory fitted on the wing skin at each flap hinge and aileron hinge attachment. It is essential that this peel ply is removed by the builder to expose a good surface for bonding, to ensure good adhesion when the builder fits these components. The red peel ply may be hidden by the white gel coat, so it is imperative that the builder locates and removes the peel ply just prior to bonding items such as flap arms and aileron reinforcements. One builder omitted to remove the peel ply before bonding flap and aileron attachments. Fortunately this potentially disastrous mistake was picked up by inspection prior to painting.

- Aileron cable attach point inside the wing may require moving if correct aileron throws cannot be attained.

- A common mistake is to place unnecessary washers under heads of bolts that in turn do not leave enough thread protruding through the nut. In particular, check rudder pedals, rudder control horn, control column, and flap pivot bolts for this hazardous feature.

- Fixed elevator tabs, as moulded into kit-supplied elevator, must always be used as they apply positive control loads to the elevator control circuit and augment the pitch stability of the aeroplane.

- Several problems have cropped up with the installation of rod end bearings in the control system. Freedom of rotation is sometimes lacking if small steel spacers are not fitted as per the manual drawings. Oversize ¼" washers are used to prevent connection coming adrift in case of housing failure.

- Male threaded rod ends are screwed into aluminium push rods that are drilled with a thread inspection hole. Sometimes a burr on the thread can make screwing in the rod end difficult – some builders have forced the rod end by placing a bolt or drill through the ball and turning. This caused the soft metal outer bearing housing to become deformed and seize, which in turn applied bending stresses on the 3/16" thread which in one case failed after an estimated 2800 cycles. The correct procedure would have been to carefully use a tap to clear the thread.

- All rod ends should be checked for freedom of rotation and thread security. It is common to find rod end locking nuts incorrectly installed only finger tight.

- Inclusion of the wing tip drain hole is commonly forgotten, but make sure that the ventral fin and cockpit drain holes are also not forgotten or blocked with debris.

- A common problem is over torquing of the propeller bolts. This can cause cracking in the varnish and wood and can cause the propeller to quickly crack further and become unserviceable.

- Jabiru propellers suffer with leading edge abrasion in the root area and require regular varnish touch-up here. If a tip comes into contact with anything, e.g. soft ploughed earth or long grass, use a bright light or sun to look for small chord-wise cracks in the glass skin. Any delamination, however minor, must be treated seriously as cases have occurred where the entire glass cloth covering has been shed in flight, having originated from a small area of delamination.

- It is common for the attach/pivot bolt of the flap actuating handle to not be tightened sufficiently. This can lead to the flap disengaging on approach with potentially serious consequences if not caught quickly by the pilot.

- It is common for unwanted stiction to develop in the elevator control due to the nylon block at the rear of the push-pull cable failing to slide freely over the aluminium rod. This can lead to notchy control feel and cause over-control problems on takeoff and landing. ST Aviation recommended the use of a silicon-based lubricant here. The wrong type of lubricant can swell the nylon block and increase friction.

- Care must also be taken to avoid undue friction in the rudder control system, which can lead to failure of the rudder controls to self-centre in flight. The throttle control cable must also be routed with smooth curves to avoid undue friction or notchiness in the throttle control system.

- The Jabiru models also have a rather narrow cg range and care must be taken to produce a satisfactory empty cg position if the loaded cg is to fit within the limits. Particularly with an extensive instrument panel, it is often found necessary to fit a

small amount of tail ballast in the ventral fin to bring the empty cg back to an acceptable location.

- For permit renewal inspections, all normal practices apply and in addition to the Jabiru maintenance schedule, owners and inspectors should pay particular attention to the following items:
    - Rod end bearings – free rotation and no bent threads.
    - Check main undercarriage legs by getting someone to lift the wingtip and check for fore / aft movement. If movement is found, this is probably because attachment bolts have become loose due to the gear 'bedding in'. Be careful that bolts have not become thread-bound, use additional washers if necessary.
    - Lift nose and check noseleg for shimmy and up/down movement.
    - Check noseleg housing for tightness of bolts, cracks or whiteness associated with stressing.
    - Check flap arms and all piano hinges for security and play.
    - Paint chips should be touched up.
    - Propeller leading edge varnish abrasion, cracks in varnish or wood.
    - Wheels for dents, cracks and hardware security.
    - Brake pad adjustment and wear.
    - Lower flaps and check play, excessive indicates loose rod end bearing bolt, usually at flap handle.
    - Check that drain holes are not blocked with debris.
    - Elevator travel in particular down elevator travel (Jabiru bulletin refers).
    - As aircraft are getting older, play is being found in the strut attachment points due to the bush being loose or the holes being enlarged. Contact Skycraft for repair advice.

3.5 Operational Issues

- Pilots involved in flight testing Jabirus are strongly advised to read Appendix A of this TADS as this contains important advice relevant to flight testing.
- Fixed elevator tabs, as moulded into kit-supplied elevator, must always be used as they apply positive control loads to the elevator control circuit and augment the pitch stability of the aeroplane
- With Jabiru engines, it is imperative that the cylinder head bolts and tappets are checked at 5, 10, 15 and 20 hours. Omitting this check can lead to head leaks and damage at around 25-50 hours. Have a good look around the rocker boxes and make sure oil is present and that there are no signs of overheating in the form of burnt, lacquered oil. New engines with hydraulic tappets need only to have the head bolts checked.
- With Jabiru engine, encourage test pilot to work the engine quite hard to avoid glazed piston bores, vary rpm settings and do not fly at low power settings for too long.

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Please report any errors or omissions to LAA Engineering: engineering@laa.uk.com

APPENDIX A to TADS 346, Jabiru Airworthiness

The following advice was issued by LAA to Jabiru owners in April of 2004, and is reproduced here in full for information purposes as most still remains pertinent:

As the numbers of Jabiru aircraft and engines in the UK have grown, inevitably there have been some accidents with the type and indeed the Jabiru has recently come to feature in the AAIB's accident reports more frequently than we would like. A number have been either damaged or written off (happily without serious injury) and one or two common features have begun to emerge which clearly warranted closer attention. With this in mind, and with a number of LAA'ers itching to get cracking on building the as-yet unapproved four seat J400 Jabiru, I decided to accept an invitation from Jabiru and their UK agents ST Aviation to visit the Jabiru works at Bundaberg in February of this year to explore these issues. During the week-long trip to Australia I spent several days in meetings with designer Rod Stiff, certification engineer Alan Kerr, and MD Phil Ainsworth, visiting the several different manufacturing facilities and having an opportunity to fly the J400 as well as the latest development of the two-seat UL model.

This note is a report on the findings of the trip and contains guidance which I hope will allow you to get the best from your Jabiru, operate it safely and avoid unplanned cost and down-time through accident repairs.

Avoiding Nose Leg Collapses

The Jabiru is of course equipped with a conventional nosewheel type undercarriage, bolted to the front of the firewall, with trailing-link suspension using rubber blocks in compression as the spring element. Several accidents have occurred with the noselegs of Jabirus collapsing on landing, the worst scenario being a touchdown at too high a speed and too flat an attitude leading to a bounce, and a subsequent arrival slightly nosewheel-first. While the noseleg has been designed to comply with the rigorous Section S noseleg strength requirements, and shown to meet them by practical test, when abused in this way it is common for the noseleg attachment to break away from the firewall and allow the noseleg to fold back. This type of accident is common to other types of aircraft, including the Cessna 152 – noselegs are intended to support the nose of an aircraft while taxiing and to withstand a moderate impact but not to accept the whole weight of an aircraft in a nosewheel-first arrival.

As with all other nosewheel equipped aircraft, the Jabiru should always be landed with the stick well back, at close to the stall speed, giving initial ground contact on the mainwheels only, the nosewheel being gently lowered to the ground as speed decays. Landing the aircraft 'flat' on all three wheels together puts higher loads on the noseleg and invites a bounce or wheelbarrowing. And most importantly of all, if you should find yourself in a bounce, you should either keep that stick back to hold a slightly nose-high attitude and wait for the next touchdown or, if it is a high bounce, open up the power and go round again. Never check forward on the stick during a bounce, as to do so is almost certainly going to mean a nosewheel-first arrival.

A related issue here is the single very short central control column which the Jabiru is fitted with. This feature makes it impossible for a pilot undergoing a conversion to type to have his instructor 'follow through' on the controls, which while of little consequence at other times can be critically important during the last few seconds of a landing approach or in dealing with a landing which is going wrong. One or two

noseleg failures and propstrikes have occurred during conversion flying, the instructor being helpless to avoid the situation developing. We now recommend that when carrying out conversion flying, a short temporary control column extension is fitted which allows the instructor to take control more easily if needs be.

Another operational issue is to take care when taxiing over ridges or rough ground, runway edges etc, to avoid excessively loading the noseleg. Such ground features, if they cannot be avoided, should be approached at slow speed and at an angle (ie not perpendicular 'head on') to allow the nosewheel to ride over them more easily. The Jabiru is not suitable for operating from fields as rough as slower-speed microlights with bigger wheels might use.

The attachment of the steel tube noseleg to the fuselage firewall is via a fiberglass moulded bracket attached at its periphery by several small bolts. This is intended to carry the normal landing loads with ease but to allow the whole assembly to break away in a heavy landing without doing major damage to the fuselage or firewall, thus limiting the extent of the required repairs. Experience is showing however that at best this also results in a broken propeller and shock loaded engine, but when the noseleg breaks free on soft ground there is a risk of the base of the firewall digging into the earth rather than skidding over it and consequently the aeroplane may end up on its back. This is very alarming and potentially dangerous for the crew, and also, in turning over, major damage can be done to the wings, struts and wing attachments. We feel that it would be preferable to carry out even a major repair to the firewall than risk a turn-over accident, and conclude that for the UK climate at least, a stronger noseleg attachment which stands more chance of survival will be preferable in safety terms to Jabiru's current break-free arrangement. Jabiru have therefore agreed to the idea of reinforcing the attachment of the noseleg to the fuselage, and are currently designing a suitable stronger bracket for the four seat J400 model which they intend will be equally applicable to the two-seater models. We are also able to supply details of a simply-fitted modification number 10451 (see enclosed sketch) which adds an additional support to the noseleg and increases the strength of the attachment, for very little weight penalty. We recommend owners incorporate this modification on their aircraft particularly if you operate (or intend to operate) from a rough strip. For full details of the mod, contact LAA Engineering. It is also recommended that owners keep an eye on the moulded fiberglass flange around the perimeter of the fiberglass noseleg bracket, to check whether there are any signs of the flange progressively delaminating in the vicinity of the bolt holes, suggesting that the bolt heads might be close to the point of pulling through. Progressive delamination is shown up by local whitening of the fiberglass moulding.

The trailing link noseleg suspension has also been under development recently, the tubular steel rod on which the rubber suspension bushes are threaded being replaced with a solid steel version following problems with the tubular version buckling when overloaded in a heavy landing. Buckling of the tube (exaggerated by a 'falling rate' action caused by the trailing link geometry) can result in the trailing link 'kneeling down' to the point where the base of the noseleg may strike the ground, causing a 'sudden stop' and further noseleg attachment damage. The uprated parts are available from ST Aviation. Another indicator of noseleg overload having taken place is cracking of the paint on the steel lugs on the noseleg which mount the suspension unit, caused by the lugs having distorted under extreme load.

Avoiding Main Undercarriage Collapses

The Jabiru is fitted with separate port and starboard cantilever spring legs, of fiberglass construction, each attached to strong points in the fuselage via one inboard bolt and two outboard bolts, all bolts being of AN5 size ie 5/16" diameter. There have been a number of occurrences of main undercarriage collapse due to the rear outboard bolts breaking, allowing the leg to fold forward. While in one case the AAIB found during the accident investigation that the bolts used were of doubtful quality (defective heat-treatment and evidence of having been re-plated over old defects suggesting they were 'bogus parts'), the root cause of undercarriage bolt failures is almost certainly that the bolts have become loose in service, allowing the legs to graunch about under load and this in turn applies excessive bending loads to the bolts. It is essential that these undercarriage attachment bolts are kept properly torqued up so that no relative movement takes place between the legs and their mountings. It is normal for the bolts on a newly-finished Jabiru to loosen a little as the clamped-up assembly beds in after a few landings, so the gear legs should be checked for signs of looseness during the initial flight testing, and from time to time during subsequent pre-flight checks. The tightness of the undercarriage can be checked by having someone lift each wing tip in turn to raise a wheel off the ground, while another pushes backwards and forwards on the raised wheel. You will not be able to detect any movement with the wheel on the ground because the forward sweep on the legs means that the wheel will always be pressing hard against the forward limit of any 'free play'.

Due to variations in the thickness of the fuselage lay-up in the area of the main gear attachments, problems are sometimes experienced with the main leg attachment bolts being of the wrong length for the job. The shank length of each of the bolts should be checked before installation and changed if necessary for new bolts of proper length to match your installation. It is particularly important that the bolts are not too long, resulting in the nuts bottoming out on the end of the thread ('threadbound') rather than clamping up on the leg. Not only does this leave the leg loose, the damage done to the bolt by the cutting action of the nut may precipitate bolt failure from that point. Check the number of threads visible on the bolt outside of the nut – one and a half to three threads is good, if more than four threads are visible then the nut is most likely threadbound. You can cure this either by fitting a shorter bolt or fitting washers under the nut. If the aeroplane has been flying with the bolts loose or threadbound, or both, then you would be best advised to change the bolts anyway incase they have been damaged.

The rear pair of bolts are much more highly loaded than the front pair, due to the geometry of the forward-swept legs, and of the three it is the rear bolts which have always failed. Jabiru have been loath to fit stronger bolts here in the past because they felt that in a crash landing it would be better for the bolts to break cleanly than for the bolts to tear the fiberglass bottom out of the fuselage, making a much bigger repair scheme necessary. They have agreed however that such a repair would be quite localized and not particularly difficult nor would it have any serious safety implications, and so with Jabiru's somewhat reluctant blessing we have cleared a modification (number 10818 - copy available from LAA Engineering) which replaces the rear pair of AN5 bolts by stronger AN6 bolts. In addition to making frequent checks on their undercarriage attachments for any signs of looseness developing, we recommend owners fit this modification especially if they fly from a rough strip.

Directional Control Problems

Accidents have occurred with pilots of Jabiru aircraft having trouble coping with crosswinds, especially when flying from narrow strips. The rudder fitted to the Jabiru originally only occupied the bottom half of the height of the fin, which gives perfectly adequate control in normal use (including spin recovery), and crosswind landings have been demonstrated successfully with this rudder configuration, using the recommended 'wing down technique'. This does require use of the full rudder deflection however and it can be alarming to find you have full control applied in the flare and nothing 'in hand' (under foot ?) for eventualities. Some owners have ended up in the boondocks after the Jabiru got away from them directionally on landing. The long-wing UL model needs particular care because of its responsiveness to gusts and the relatively small size of the ailerons compared to the wingspan (brought about by the need for the flaps to be as long as possible to get the stall speed down to the microlight limit) which results in a slower roll response, and adverse yaw, not helped by a ponderous rudder response. Some time ago Jabiru introduced an alternative tall rudder of almost twice the area which occupies the whole height of the fin, and is applicable to all three two-seat variants. The modification (LAA Mod number 10958), is easily incorporated at build or retro-fitted on an existing aircraft, using a kit of parts available from ST Aviation. The new rudder provides significantly greater rudder control authority which makes cross wind landings more comfortable, and we recommend that owners of the UL model in particular install this modification at the earliest convenience. This 'series' modification can be installed in accordance with the mod sheet without reference to LAA Engineering. On completion your LAA inspector must inspect the job, raise a suitable airframe logbook entry and new Permit Maintenance Release, and check the amendment to the weight and balance schedule (although the weight change is normally ounces only).

As a result of the development flying done by Jabiru on their type-approved factory built UL model, Jabiru have now come up with a significantly bigger fin for this version which improves directional stability, reducing adverse yaw effect which is particularly welcome with the long-winged –UL model. The big fin is mounted slightly further forward on the fuselage, requiring changes to the rear bulkhead installation. I had the chance to fly this model in Australia and found it a significant improvement on the standard UL. The latest kits to arrive in the UK are provided with the new big fin, and while it would not be easily retro-fitted to an existing finished aircraft, any owners at an early stage of build might well consider obtaining the new larger fin from Jabiru and benefit from the enhanced flying qualities that it gives.

Uncommanded Flap Retraction

A contributing factor quoted in one Jabiru UL accident report was the uncommanded retraction of the flap when on 'short finals' during a forced landing. The flap gate system on the Jabiru is a simple one in which a peg on the back of the flap lever engages in a series of holes arranged in an arc about the pivot point in an aluminium plate. The flap lever, which is of composite construction, is pulled laterally to release the peg from the hole which then enables the flaps to be moved to a new position. Experience has shown that it is important to set and maintain the tightness of the flap lever pivot bolt in order to provide a suitable pre-load tending to hold the peg in place, otherwise there is a risk of the flap control jumping the gate. As the gate is about six inches from the pilot's eyes when seated in the cockpit it is easy to check that the gate is operating satisfactorily as part of the pre-flight checks.

Airframe Repairs

If you should be unfortunate enough to have an accident with your Jabiru, particularly if it involves repairs to the composite airframe components, please be aware that repair work of this type is a specialized business and must be carried out to an approved repair scheme and by a person or organization suitably skilled and equipped to do the job, under strict supervision from a suitable LAA inspector. With composites it is easy to do a cosmetic cover-up job which may look as good as new, but while these techniques are fine for dealing with a dented wing on your car, they have no place in a highly-stressed composite airframe like the Jabiru. Great care is required to firstly, determine the true extent of the damage, then decide what parts are salvageable and which must be replaced, decide on a repair scheme, (which must then be approved by LAA Engineering) and finally implement it. Standard repair techniques are described in a repair manual issued by Jabiru, but it is stressed that such work is usually beyond the scope of an amateur repairer working in his garage, and requires greater (and different) composite skills than are needed in building the original kit. If you hear some hopeful at your club talking of buying up so-and-so's wrecked Jabiru and fixing it up in a few weekends as a quick and cheap way to get himself an aeroplane, a word from you (or better still, the local inspector) might just stop the chap (or worse, the chap he sells the aeroplane to) becoming a victim of his misguided enthusiasm. If botched repairs are discovered there is no option but to tear the work apart and start again. If they are undiscovered, the risks a of course much more serious. Structural failure in flight ruins your whole day.

Jabiru Engines

The 2200cc four cylinder engine and subsequent six cylinder model which have been developed by Jabiru and built locally in Bundaberg by CAMit have become a popular choice for an amazingly wide variety of aircraft.

The Jabiru engine is unusual in that all the major components are CNC machined from bars or billets, with virtually no castings or forgings. This has allowed the engine design to be developed relatively quickly and cheaply as experience was gained, as the need for improvements was recognized. We were frustrated at one time by the continually changing design standard of the Jabiru engine, but are now reassured that the design development has been properly documented and has been a logical progression towards achieving an engine that is more powerful, more reliable and robust.

Cylinder head distortion

The most significant development issue with the engine has been preventing the cylinder heads distorting in the vicinity of the hold-down bolt in the vicinity of the exhaust valve. As with many air-cooled engines, the peak temperatures in this area are very close to the temperature at which the aluminium alloy head starts to creep under stress, and it was soon found that variations between individual installations and between individual operating techniques were enough to make the difference between the heads being stable or distorting. The distortion is visible as the head becomes dished downwards at the periphery, in an extreme case by several millimeters. Six design changes have taken place on the heads over the years to solve the problem, experimenting with different bolt configurations and more noticeably, with a steady increase in the amount of finning provided to keep the heads cool.

Jabiru have found that cylinder head distortion is often initiated by the engine being allowed to continue to operate with leaking exhaust valves, leaking head to barrel joints or leaking exhaust flange to head joints. The leaking exhaust gas then causes the temperature of the heads to rise to the point where they distort locally. When distortion of the head occurs, further problems develop include jamming valves and exaggerated leakage at the head to barrel joint, and the situation rapidly deteriorates to the point where the engine fails.

With earlier type heads, the hold-down bolts were a close fit in the holes through the heads consequently as soon as the heads distort the bolts tend to press hard against the sides of the bolt holes. This means that when the cylinder head bolts are subsequently 'torqued up' at the next maintenance check, they may appear to be tight, but in fact what is being felt is the friction torque between the bolt shanks and the holes in the head rather than the torque signifying a properly tensioned thread. Operating with one or more of the head bolts loose (but thinking them to be tight) is sure to cause leakage from the head to barrel joint and further distortion.

Regular checks of the cylinder head bolts and the tappet clearances are essential with the Jabiru engine, as called for by the engine's maintenance schedule. While loose cylinder head bolts will be likely to cause cylinder head leaks which will then cause head distortion, equally, it is important not to tighten up the bolts that little extra bit 'for good measure', as over-torquing them will also be likely to cause problems. After the first few hours use, when the engine has settled down, you should find that the torque checks do not result in the bolts needing to be tightened up. If you find that at each torque check you have to wind the bolts down further, this is a sure sign that the heads are distorting and further investigation is required before the damage becomes terminal.

The other essential preventative measure is to carry out cylinder head leak-down checks as called for by the maintenance schedule. The leak-down check (otherwise known as a compression check) uses a compressed air source and differential pressure tester to measure the amount of leakage that takes place from the combustion space when a given air pressure is applied. The leak down check is a standard check carried out on Lycoming and Continentals to monitor the health of the 'top end', so any properly-equipped maintenance outfit should have the necessary kit and be familiar with its use. Owners will however most likely have to obtain a suitable 12mm threaded adaptor to match the shop leak-down test rig to the smaller size of the Jabiru's spark plug holes. The leak-down check is carried out with a warm engine and, essentially, with the engine turned over so that the cylinder being tested is at 'top dead centre'. A minimum of 65/80 on each cylinder is the lowest acceptable result, any worse than this means that the cylinder concerned needs to be investigated and put right – most likely the exhaust valve needs lapping in, or the cylinder head to barrel joint is blowing.

In between leak-down checks, you should keep an eye out for signs of leaks developing by turning the engine over by hand through eight blades as part of the pre-flight check. The compressions should feel even and there should be no audible hisses. If a leak should be detected, try running the engine briefly to see whether this solves the problem. If the leak is caused by a carbon particle holding a valve open, running the engine will most likely blow it away. If the problem persists, carry out a proper leak-down check and investigate as soon as possible.

If the cylinder head is one of the earlier models (engine prior to serial number 1004) and is found to have distorted, then your best plan is to buy a new set of heads of the

latest design. Alternatively it may be possible to prolong the useful life of the old heads by lapping in the valves and joints and then very carefully opening up the cylinder head hold-down bolt holes by drilling and reaming to the current size. This avoids the problem with the hold-down bolts jamming in the bore of the holes.

The other essential to avoid cylinder head distortion problems is to avoid running the engine at cylinder head temperatures above the red line. Some owners report that their temperatures never get near the limits while others complain of having to throttle back soon after take-off to keep the temperatures under control. Problems with high engine temperatures may be caused by:

- Slow aeroplane. Adequate cooling is obviously more difficult to achieve if you have the engine fitted to a draggy aeroplane like a FRED which climbs out at 50 knots at full throttle than it does in a sleek Jabiru, Pulsar or Dyn Aero Banbi which accelerate to 80 knots as they climb away, and will happily cruise-climb with reduced throttle if needs be. The slower the aeroplane, the more care is going to be needed to get enough cooling air past those cylinders. As with any air cooled engine, after getting airborne it is much kinder on the engine to climb away at a shallow angle and higher speed rather than clawing skywards at the airspeed for best climb angle – it will also give you a better forward view!

- Poor Intakes. The cooling ducts intakes must flow smoothly into the shape of the ducts, with no turbulence-producing sharp corners. It is also important that the propeller chosen is one in which the aerofoil shape of the blades is continued inboard to extend over the area infront of the cooling intakes, so as to produce a forced draft through the cooling system. Problems have not surprisingly occurred with round-shanked blades which just churn the air up in the root area rather than producing a blast of air through the system.

- Poor ducting. It is important that all the air passing through the engine bay is used to good effect in cooling the engine. There is no point in gathering air at the front just to let it rush around under the cowling willy-nilly, hoping it will take some heat with it as it goes. Jabiru provide neat little moulded fiberglass ducts to channel the cylinder head cooling air past the hottest parts of the head and cylinders, and it is important that these are trimmed to provide a close fit so that air is forced between the engine's cooling fins. Any gaps can be sealed using a small three-ply fiberglass lay-up added locally and trimmed to suit. It is also important to provide an effective cooling air outlet, usually at the base of the cowling, typically at least a third bigger in area than the area of the cooling air intakes.

- CHT probe Problems. Cylinder head temperature probes take the common form of washer-like thermocouple probes fitted between the spark plugs and the head. Problems are sometimes found with these probes (and/or the associated gauges) giving inaccurate readings. If in doubt, calibrate the probe and instrument. Jabiru also warn that if the probes used are of slightly too large, typically having 14mm diameter holes through them rather than 12mm diameter to suit the Jabiru's plug diameter, there is a risk that when the plugs are tightened up the thin periphery of the probe may be extruded out from the joint and cause a gas leakage path. Combustion gases leaking over the probe then cause an excessively high CHT reading on that cylinder. If your engine is fitted with the 14mm diameter probes, watch out for this effect but better still, replace with the proper probes with 12mm diameter holes to suit the plugs.

You also need to make sure you have the correct type of thermocouple junction to suit the CHT instrument in your aeroplane, of course.

- Uneven fuel distribution. If the rear cylinders consistently show hotter looking plug colours than the front pair, on an engine prior to serial 729, this is most likely due to the earlier design of intake manifold being used which tends to make the rear cylinders run leaner than the front pair. If cylinder head temperatures on the rear cylinders are running close to red line then it may be worth changing to the later type induction manifold, which also needs the matching new sump.

- High oil temperatures may be due to the level of oil in the sump being too high – the effect being that the oil is then agitated to a much greater degree than normal by the flailing crankshaft and conrods, which causes aeration of the oil and raises its temperature. A common cause of over-filling with oil is the difficulty of reading the oil level properly using the small oil dipstick provided with the engine – the oil on the dipstick tends to be wiped off as the dipstick is withdrawn from the crankcase. An alternative is to use a piece of semi-rigid small-bore transparent plastic tubing as a dipstick, pushing it through the dipstick hole and then blocking the top end with a finger tip before withdrawing the tube to take a reading from the level of the column of oil left trapped inside. In either case, Jabiru suggest taking a number of reading and then roughly averaging the results, rather than risk being mislead by a single attempt. They also remind owners of the need to re-calibrate the dipstick when the engine is fitted to a taildraggger, to take into account the change in static oil level when the engine is not level.

- On no account bleed off air from the cylinder head cooling duct as a source of cabin ventilation. This not only robs the engine of much-needed cooling air, more seriously it risks contaminating the cabin with poisonous exhaust fumes should the engine develop any leaks from the cylinder head in future.

Engine Power Output

The power output of early examples of the Jabiru 2200 engine was found to be several horsepower less than the rated 80 BHP. From engine serial number 729, the engine was provided with an improved inlet manifold, originally fitted to give more even front-to-back mixture cylinder mixture distribution, and from serial number 699 the 32mm diameter bore Bing carburettor was replaced by one of 40mm bore for consistency with the six cylinder model of the engine. A very slight change to the combustion chamber detail design was carried out at around the same time. With these changes, which also required a new design of sump to accommodate the new manifold, a significant power increase occurred which brought the engine up to the rated output figure. Indeed the power increase was such that in many cases it has been necessary to fit a slightly coarser pitch propeller to match the output of engines post serial 728 as compared to those pre serial 728.

Should the performance of a Jabiru powered aeroplane be disappointing, Jabiru suggest that owners first check the correct operation of the throttle control arm of the carburettor, as believe it or not several cases have occurred where the problem was simply that the maximum movement on the throttle control cable was not getting the 'carby's' throttle wide open, sometimes due to the throttle arm having been mounted at the wrong angle. Another source of trouble is an inappropriate location of the

carburettor cold air intake in the vicinity of the cowling outlet and exhaust, causing the engine to breath air that is either pre-heated or low-pressure, or both.

Carburettor ice

Several engine failures that have occurred have been put down to carb ice. There is no doubt that the Jabiru engine can suffer from carb ice, and in this respect its behaviour is similar to many small Continental and VW conversions. It has also been demonstrated that the Jabiru-supplied heat muff is effective in preventing the build-up of ice in the carburettor, provided that carb heat is selected regularly and for long enough periods in flight. Jabiru's flight manual gives comprehensive advice on the subject. Carburettor icing takes place whenever the dew point is close to the ambient air temperature, and this may occur at any time of year, not just in the winter. The more throttled back the engine, the more prone is the carburettor to ice formation. The engine can start to ice whilst taxying out, particularly over a damp grass surface, so a generous application of carb heat should be used to disperse it during the run-up – ie full heat for twenty seconds at cruise power setting, not just a quick in-out on the control to check that you get an rpm drop. A good idea is to check, for a few seconds just prior to take off, that the engine idles smoothly with the throttle closed, as this is a reliable check that you are not about to take-off with a partially iced-up carburettor. Likewise in flight, pilots accustomed to two-stroke engines who may not be familiar with carb heat controls need to get into the habit of using carb heat every few minutes, and particularly applying continuous full heat during descents at low power. Remember that as the carburettor heat is generated from the exhaust system, if the ice in the carburettor is allowed to accumulate to the point where the engine loses power, then the exhaust will cool and you will have less heat available to clear the ice. Frequent use of carb heat prevents the ice building to the point where it causes rough running. In conditions of severe icing it is best to avoid making long glide approaches to land, as the amount of heat available from the muff may be insufficient to prevent ice developing, and the risk that the engine will not respond to the throttle should you need to stretch the glide or 'go around'. A powered approach, with full carb heat, is the safer option under severe carb ice conditions.

Symptoms of carburettor ice may also occur if the intake air filter becomes damp after flying through rain. With a hot engine, no ill effects are observed, and the effect does not usually become apparent until the next start-up, when attempting to idle with a cold engine. A few minutes at higher power setting, with full carb heat, has been found to solve the problem. Later type carb air intake boxes have a drain hole arrangement which minimizes the effect, those with early aircraft are advised to add an intake drain hole as specified in the latest manual.

Distributor rotor arms

A problem was experienced at one point with rotor arms becoming slightly loose on their shafts, usually indicated by tell-tale signs of brown coloured dust in the hole in the rotor arm indicating where the joint has been 'working'. If this is found to have occurred, either the rotor arm must be replaced or a small dab of epoxy in the hole has been found to solve the problem – but avoid de-greasing the shaft first or you will make the rotor arm a permanent fixture!

Fuel choice

The Jabiru is a relatively high compression engine so it is important to use fuel of sufficient octane rating to avoid detonation problems, 100LL being the preferred fuel. Later engines have a slightly reduced compression ratio to allow 95 RON unleaded Mogas to be used. Particularly if using Mogas, always use fresh supplies. Fuel which has been hanging around in jerry cans for months may cause detonation trouble due to the evaporation of some of the more volatile constituents having lowered the fuel's octane rating.

Paper fuel filter

Jabiru supply an automotive type disposable paper element fuel filter for use in their kits. A recent engine power loss problem has highlighted the importance of changing these filters at 50 hour intervals as called for by the maintenance schedule. The paper element can otherwise become clogged by a build up of very fine sediment. This is not necessarily due to solid contaminants imported with the fuel, or from the walls of the tank, problems are sometimes experienced with fine fuel filters clogging with a thin layer of an algi-type biological growth which amazingly enough (cue for Richard Attenborough?) grows at the interface between petrol and water. Owners of infrequently flown Jabirus (less than fifty hours a year) would do well to change these filters at the annual check, ie imposing a calendar time limit as well as an 'hours flown' one.

Oil Choice

Only the correct specification of aviation type oil must be used in the air-cooled Jabiru engine. If an automotive type oil is used, the cylinder bores have been found to be irretrievably damaged after just forty hours running.

Propellers

Please note that while several different types of propeller have been cleared by the LAA on Jabiru aircraft (eg Jabiru, GT, Kremen, Lodge) you may only use a propeller on your own aircraft of the type(s) stated on the individual aeroplane's Permit to Fly 'Operating Limitations' sheet. Use of any other type of propeller (even if it is the same as one you know has been cleared by the LAA on another similar Jabiru) invalidates the Permit to Fly and renders flight illegal. The only exception to this is when LAA HQ raise a Permit Flight Release Certificate (or Permit to Test) specifically to authorise test flights with a propeller of a new type. If you wish to fit a propeller of a type not stated on your aircraft's Permit to Fly, you must first contact LAA Engineering to check your proposal and if satisfactory, we will then either authorise flight tests or (if the propeller is already well established as to its suitability for this application) add the new propeller type to your Permit to Fly straightaway without the need for a flight test.

Bear in mind that:

- The difference in power between the early and late model engines means that slightly different propellers are optimum.

- Any propeller change needs to result in an update to the weight and balance schedule, and the weight and cg will need to be checked. If the aeroplane is very close to the weight limit then fitting a heavier propeller may not be an option.
- When a new propeller is fitted the propeller and its installation on the aircraft will need to be inspected by your inspector who will also need to make appropriate logbook entries and raise a new Flight Release Certificate.
- Changing the propeller on a microlight aircraft means you must have a new noise certificate issued by the CAA before the change can be made to the Permit paperwork. A noise certificate is not needed during the test flying phase however. Provided the propeller is of a type that has already passed the noise test on another Jabiru, yours probably won't need a noise test to be carried out, the CAA will simply issue the noise certificate straight away based on the previous successful noise test result from their database. CAA Noise Dept can be reached at 01293 573095.

This letter seems to have stretched to twelve pages, for which I apologise. I certainly found it interesting gathering the information that went into it, and while I claim no originality as regards content (much has already appeared elsewhere), I hope that the advice contained will be helpful. Keep flying, but safely!

Francis Donaldson.
Chief Engineer