LAA TYPE ACCEPTANCE DATA SHEET TADS 264

DR-107 ONE DESIGN

Issue 3 Para 13 – Aft CG limit revised.
dated 14.5.07
Addition of Appendix B

1. UK contact

Nil. Plans available from Aircraft Spruce and Specialty, 225 Airport Circle, Corona, CA, USA 92889-2527. Tel (909) 372 9555.

2. Description

The Rihn DR107 One Design is a single-seat aerobatic low-wing monoplane. The aircraft has welded 4130N steel-tube construction fuselage and tail surfaces of conventional design. The fuselage is covered with sheet aluminium from the firewall aft to the cockpit and is fabric covered from the cockpit aft to the tail. The streamlined glass fibre cowl is split horizontally for access.. The wing is a plywood-covered one-piece unit with a laminated spruce solid main spar and a relatively light rear spar. The wing is bolted directly to the fuselage frame truss. The ailerons are push rod operated and fitted with a mass balance along their leading edges. The ailerons have aerodynamic balance provided by aileron 'spades' and an aft-set aileron hinge. The tail surfaces are externally braced using streamlined stainless steel wires. The elevator is fitted with servo/trim-tabs and is push rod actuated. The rudder is unbalanced and is cable actuated. A cantilever sprung aluminium alloy main undercarriage is fitted with dual disk brakes. A steerable tailwheel is fitted to a cantilever steel spring. Two fuel tanks are fitted forward of the cockpit one above the other, the lower one a collector tank with flop tube for inverted flight, the other a large capacity main tank. A Lycoming 0-360-B4A engine is fitted to G-IDII. A Bendix fuel injection system is fitted to the engine, together with a Christen inverted oil system for sustained inverted flight. G-IIID is fitted with a Lycoming 0-360-A4N. A Hoffman HO 27HM-180 160 propeller is fitted to G-IDII, which has been checked to ensure a satisfactory engine/propeller match. G-IIID is fitted with a Sensenich 76EM8-0-66 propeller.

It has come to light that the typical empty weight of these aircraft is somewhat more than the designer predicted, consequently the designer's specified 'max aerobatic weight' is exceeded when a typical weight of pilot and fuel is added. This means that it has been necessary to raise the aerobatic weight above that specified by the designer, consequently reducing the aerobatic 'g' limits proportionally. it is important to note that G-IDII is a lightly built example, fitted with a Lycoming IO-360-B4A engine and a wooden fixed-pitch propeller. The aircraft has only just sufficient useful load to be practical. The Lycoming IO-360-B4A is a 180hp engine with parallel valve cylinders, and is a much lighter engine than the 200hp angle-valve engines. Therefore, it is important that you build the aircraft light, and fit an engine and propeller that will ensure that the aircraft does not weigh any more than G-IDII. We have been approached in the past by people wishing to fit 200hp engines and even constant speed propellers, but it is very unlikely that an aircraft so fitted would be permitted to fly because the useful load would become too small.

3. Fast Build Kit 51% Compliance

Not applicable – aircraft built from plans or plans plus slow-build kit.

4. Build Manual

Nil – aircraft built from plans.

5. Build Inspections

Build inspection schedule 3 (wood/metal aircraft).
Inspector approval codes A-A or A-W. Inspector signing off final inspection also requires 'first flight' endorsement

6. Maintenance Manual

Nil. In the absence of manufacturer's schedule refer to LAMS schedule.

7. Flight Manual

Nil. LAA flight test report available – see Appendix A.

8. Mandatory Permit Directives

None applicable specifically to this aircraft type, but note

MPD: 1998-019-R1 Flexible Fuel Tubing Applies to all aircraft

9. LAA Mandatory Modifications

Wing Colour. The UK prototype aircraft wing has been assembled using West Systems Epoxy as called up on the plans. This adhesive has not been shown to be water boil-proof and as such the glue strength will be temperature limited. Therefore, the structure of the wing over the main spar area must be painted white if West Systems or other epoxy adhesives have been used..

10. Service Bulletins

Nil known

11. Standard Options

Spruce or Douglas Fir wing main spars, both accepted. When Douglas Fir used, design of spacer at wing attachment (to suit thinner Douglas Fir spar) must be cleared by LAA Engineering

12. Special Inspection Points

Nil known

13. Operating Limitations and Placards

Maximum number of occupants authorised to be carried: One
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:

Aerobatic Limitations
Intentional spinning is permitted.
Aerobatic manoeuvres are permitted not exceeding +6g or –4g.
Max airspeed for full control deflection VA = 118 kts
Loading Limitations
Maximum Total weight Authorised: 1150 Lbs
Maximum aerobatic weight: 1150 Lbs
CG Range: 81.2 inches to 85.25 inches aft of datum.
Datum Point is: 62.0" forward of the front face of the firewall
Engine Limitations
Maximum Engine RPM: 2700
Airspeed Limitations
Maximum Indicated Airspeed: 240 mph
Other Limitations
The aircraft shall be flown by day and under Visual Flight Rules only.
Smoking in the aircraft is prohibited.

Additional Placard
"Occupant Warning - This Aircraft has not been Certificated to an International Requirement"

Stainless steel fireproof plate to be fitted engraved with aircraft registration.

14. Maximum Permitted Empty Weight

G-IDII weighed just under 900 Lbs as built. With a 1150 Lbs max gross weight, the minimum allowable useful payload would be that sufficient for a 190lb pilot and enough fuel for one hour a full throttle. However, the aircraft would be very impractical if limited to this payload.

15. Special Test Flying Issues

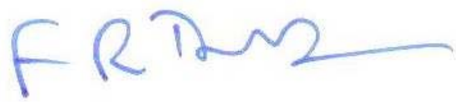
According to the designer, the U.S. prototype aircraft has been spin tested at all CG extremes stated on the drawings for the aircraft- that is 19.3% MAC to 27.5% MAC. However, the designer states that it was not possible to test quite at those extremes, as the aft limit required zero fuel to be carried. Hence, flight testing and flight clearance was limited to a narrower CG range, which was 19.3% MAC (81.20 inches aft of datum) to 24.0% MAC (83.50 inches aft of datum). These limits were fixed by practical limitations on pilot and fuel loads. Subsequently, G-IIID was successfully flight tested with a cg at 27.5% MAC (85.25 inches aft of datum), therefore the aft cg limitation for the type has been revised accordingly.

It was noted during flight testing that there is no pre-stall buffet on this aircraft. This lack of pre-stall buffet is considered acceptable on this aircraft because the stall characteristics are benign, including stalls in the approach configuration from side-slipping flight. Reference CAA Flight Dept. communication dated 12/9/00 on this issue. In addition, there is considerable margin between the stall and typical approach speeds on this aircraft type. It must be noted that clearance of future aircraft without some form of artificial stall warning will depend on an evaluation of the stall characteristics of each aircraft.

16. Control surface deflections

Ailerons	Up:	TBD degrees
	Down:	TBD degrees
Elevators	Up:	TBD degrees
	Down:	TBD degrees
Rudder	Left	TBD degrees
	Right	TBD degrees

Approved:



F.R.Donaldson
Chief Engineer

APPENDIX A

G-IDII - ONE DESIGN DR107
INDEPENDENT FLIGHT TEST
LEICESTER AERODROME - 27th AUGUST 2000
PILOT - ALAN WADE

The one design is a single seat, tail wheel aircraft designed for advanced aerobatic competition flying. It is intended for amateur construction and to be flown on a UK Permit to Fly. G-IDII is the first example to be constructed and flown in the UK. The aircraft has completed initial test flying and an independent overview of the aircraft's handling characteristics has been requested by the Popular Flying Association.

The aircraft was flown at maximum all up weight and a mid range C of G position. The following areas were evaluated:

1 External
2 Internal
3 Starting
4 Ground Handling
5 Take-off
6 Climb
7 Cruise
8 Stability
9 Stalling
10 Spinning
11 Approach and Landing
12 Aerobatics

1 External

The test aircraft is built and finished to an extremely high standard. In addition to normal light aircraft pre-flight inspection a number of other items specific to this type should be undertaken prior to flight:

1 Correct adjustment of pilots seat and the removable pip pins are correctly refitted.
2 Accurate measurement of the fuel contents using a dipstick to allow programming of the engine information system.

2 Internal

The cockpit is well laid out and comfortable. All controls are sensibly positioned and work in a logical sense. The instrument panel is suitably equipped for aerobatic flying. The flight instruments (ASI, Altimeter and G Meter) are on the left hand side and the engine instruments (RPM Gauge and Electronic Engine Information System - EIS) are on the right hand side. The centre panel contains a removable GPS, an E2B compass and a slip ball. With the GPS removed, a sequence card for competition flying can be mounted on the perspex panel provided. Fuel gauging is via the Engine Information System or by the fuel tank sight tube calibrated for the level flying attitude. The panel also houses a stopwatch, VHF Corns, electric fuel pump switch and master switch. Warning lights are provided for the starter relay and electric fuel pump. The EIS has an attention-getter warning light positioned above the flight instruments. This illuminates when any of the pre-set engine limitations are exceeded. Fuel cock, mixture control and throttle are well placed and work in the correct sense.

3 Starting

Normal starting procedures are all that are necessary with the addition that the canopy is closed and locked before the engine is started. The canopy could be damaged if left open with the engine running.

4 Ground Handling

Forward vision is very limited so caution is needed whilst taxiing. The tail wheel steering and differential braking are very good; weaving to clear the area ahead is easy. The aircraft shows no tendency to nose over provided sensible braking is used.

5 Take-off

During the take-off run the aircraft accelerates quickly. All the flying controls are very light and effective at low airspeeds, only small control inputs are needed to keep the aircraft running straight. The tail can be lifted to improve forward vision and the aircraft can be flown off at 5Omph IAS.

6 Climb

The aircraft climbs steeply at 100mph IAS. 120mph gives a better forward for a small reduction in climb performance.

7 Cruise

The test aircraft is fitted with a wooden Hoffman fixed pitch propeller. It achieves 160mph in level flight at 2800rpm. In this configuration the aircraft is easy and pleasant to fly. All the flying controls are light, well harmonised and very effective.

8 Stability

The aileron breakout forces are low and the roll rate rapid - in excess of 360°/second. There is sufficient self-centering of the ailerons to make fast rolling manoeuvres easy and precise. The aileron control loads become heavier with increasing airspeed but not excessively.

The elevator control loads are light and the elevator responsive without being over sensitive. The stick loads increase with G and airspeed but do not become heavy. The aircraft is dynamically stable in pitch. Selecting the extreme attitudes required during aerobatics is easy given the low pitch inertia and the high pitch rates possible with no apparent tendency to overshoot.

Directional stability is positive. The rudder control is light and powerful with no tendency to over balance. The aircraft exhibits little yaw-roll coupling with application of rudder which is a desirable characteristic bearing in mind the design role of the aircraft.

9 Stalling

The power-off erect stall occurs at 60mph in the 1G configuration. There is no pre-stall light buffet or warning. The stall itself produces heavy buffet and a 10° nose down pitch. The ailerons provide roll control throughout the stall and the recovery is instant.

Dynamic stalls with or without power show similar characteristics.

Power-off inverted stalls are difficult to achieve as the elevator runs out of authority before the full inverted stall occurs. By applying power or by dynamically stalling the aircraft inverted stalling is possible and shows similar characteristics to the erect stall.

All stall recoveries are instant and roll control is maintained throughout.

10 Spinning

5 turn erect spins in both directions show similar characteristics. The spin is fast with a pitch angle of approximately 60° nose down. Standard spin recovery, ie power off - ailerons neutral - full opposite rudder - followed by progressive down elevator, stops the spin in less the 180°. In-spin aileron tends to recover the spin into a spiral descent.
Inverted spin entries require the use of power; but once stabilised the inverted spin is similar to the erect spin but the rotation is notably faster. The recovery is as easy and precise as the erect spin using standard inverted spin recovery.
During erect and inverted spin entries any aileron inputs tend to prevent the aircraft from entering the spin and a spiral descent develops.

11 Approach and Landing

At approach speeds the forward view is limited and a curving or slipping approach is required to maintain sight of the runway. Accurate speed control is important as there is no pre-stall warning. As threshold speed is typically 1.5Vs this should provide sufficient safety margin above the stall during the latter stages of an approach.
The aircraft is aerodynamically clean so any excess airspeed is not easily lost during the landing flair. The ground angle is quite shallow so low threshold speeds result in the tail wheel touching first. Any excess speed at the threshold may result in excessive float, this is not desirable given the limited forward vision. Main wheel landings are possible but require a longer ground roll.
Throughout the flare and ground roll, all the flying controls remain light and very effective. Only small inputs are needed to keep straight and care must be taken not to over control the aircraft. Moderate braking can be used to reduce the ground roll.

12 Aerobatics

The aircraft is designed for competition aerobatics. All standard aerobatic figures can be flown without requiring exceptional skills from the pilot. The maximum level speed of the test aircraft -160mph - is sufficient for all basic aerobatic figures to be flown comfortably.
Inside and outside loops are easily flown leaving ample airspeed to allow rolling flight off the top. An entry speed of 160mph allows for 3 upward vertical rolls to be completed with sufficient remaining speed to push, pull or stall turn to the vertical down.
Aileron rolls and slow rolls require a small pitch input during the inverted segment to hold the desired line. Only small rudder inputs are needed during slow rolls.
Stall turns to the left (with the engine) are very easy and to the right (against the engine) are possible without the need to reduce power.
Flick rolls - positive and negative - require firm application of rudder and sensitive handling in pitch. Over pitching on entry results in heavy stall buffet, a slow roll rate and high divergence. With practice flick rolls can be flown accurately from all the competition attitudes. Vertical up flicks are easy to initiate and stop. Multiple flicks require careful unloading in pitch to maintain the rotation and aileron inputs are not necessary.
Tail slides - the reverse air loads on the controls during tail slides and torque rolls are not excessive. The controls can be held in the neutral position quite comfortably.

APPENDIX B

FLIGHT TEST REPORT G-IIID 6th April 2007

Following fitment of a lighter wooden propeller the aeroplane was tested to establish if it displayed any different or undesirable handling characteristics when flown with an aft C of G outside of the range previously allowed in its UK Permit to Fly and up to the aft limit suggested by the designer.

The first flight began with the C of G at the LAA's present aft limit and the handling in this position was used as the datum for comparison. Fuel burn moved the C of G aft by approx 0.4 inches during each flight. 2 further flights were carried out, the last of which finished with the C of G at the proposed aft limit.

To summarise the results, there was no detectable difference in any of the handling tests carried out when C of G position was changed to the design aft limit.

First flight:

C of G at start: 83.402"

C of G at end 83.833"

Second flight:

C of G at start 84.135"

C of G at end 84.455"

Third flight:

C of G at start 84.726"

C of G at end 85.23"

Unstick speed 65 kts, Rpm 2380, no unusual characteristics,

Climb from 500 to 1500 feet, 30 seconds at 90 knots, RPM 2420,

Power off stall: Stall speed 48 knots, there is no warning buffet as such in any configuration so I have not given any buffet speeds, at the stall there is no wing drop but a gentle wing rocking (coincident with a gentle nose drop) from 10-15 degrees left to 10-15 degrees right. Recovery is immediate on moving the stick about 2 inches forward.

Power off stall inverted: Stall speed 52 knots, this is the minimum speed attainable with full forward stick but the aeroplane had not stalled, the nose dropped gently due to insufficient down elevator. With power on (2000 RPM) stall speed was 42 knots, there was a gentle buffet as the nose dropped gently with no wing drop.

Approach configuration stall: Stall speed 38knots at 1700 RPM, same comments as above.

Dynamic stall: At 60 degrees of bank buffet began at 60 knots and consisted of wing rocking from 55-65 degrees, recovery was immediate on relaxing back pressure.

Max speed test: No unusual behaviour or signs of flutter, engine RPM easily contained below Max.

Simulated baulked landing: RPM 2420, Oil pressure 80 psi, trim change gently nose up, engine response immediate.

Lateral and directional stability:

At both idle and full power releasing rudder causes yaw towards the lower wing. Releasing aileron the bank angle remains constant. There was no tendency towards rudder lock-over at speeds up to Va with power at idle or full power.

Pitch stability:

At cruise power it demonstrated weak positive stability.

Stick forces were 6lbs at 2G, 10 lbs at 3G, 15 lbs at 4G.

As with any aeroplane of this performance a wide range of entry speeds is possible for aerobatic figures however loops, barrel rolls and stall turns could be accomplished from 160 knots, a slow roll 150 knots, loop with roll out 180 knots and flick rolls (positive) 85-90 knots. All could be performed without any unusual skills being required.

Erect spins:

Power off entry, left and right - began with ½ turn and increased number of turns up to 3 in stages. It spins very nose down with a rapid and constant rate of rotation. IAS increased steady until after 3 turns 90-100 knots were indicated. At any point, relaxing either back pressure or moving rudder towards neutral caused the spin to stop within ¼ turn. Reversed recovery does not impair spin recovery. Height loss after 3 turns was 1500 feet.

Applying in spin aileron increased rate of turn slightly, recovery was the same.

Applying out-spin aileron slowed rate and reduced bank angle slightly but recovery was the same.

Applying full power caused the rate of turn to increase and reduce every 2 seconds but had no effect on recovery even with full out-spin aileron.

Inverted spins:

Power off entry, left and right - Spin entries with elevator and rudder only were not guaranteed to produce a spin.

Applying out-spin aileron prevented a spin or caused the spin to stop if applied during the spin.

Applying in-spin aileron was the best way to guarantee a good spin. However the speed increased and after 3 turns 100 knots were indicated. Recovery was achieved in ¼ turn as soon as either elevator or rudder were moved towards neutral.

Applying full power neither significantly changed the spin nor delayed recovery.

No significant difference could be detected in any of the above tests during the three flights and I concluded that extending the C of G range therefore would not expose the pilot to any changes in handling or recoveries from stalls or spins.

Peter Kynsey

ATPL 204550H/A

13th April 2007

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