Light Aircraft Association

REBUILDING AN AIRCRAFT UNDER THE LAA SYSTEM

Eligibility

Each year, a number of aircraft in the UK emerge from long-term rebuilds under LAA supervision. Before commencing such a project, the first thing to do is to establish whether the rebuild can be carried out under the auspices of the LAA. If the individual aircraft has been operating on an LAA permit previously, and has not since then operated on a C of A, then almost certainly it can.

If on the other hand the aircraft has not previously been on an LAA (or PFA) permit and previously operated on a C of A, or has been operating on the foreign register, or is an ex-military aircraft, then only in very special circumstances will it be able to transfer to the LAA system. Basically, these circumstances are:

- The aircraft must be of a type which is either amateur-built, or an EASA Annex II type which is either ex-military or orphaned and not supported by a type certificate holder. Under the new CAA policy established in 2011, the existence of a TRA (Type Responsibility Agreement) for the type does not exclude owners from the possibility of a Permit to Fly should they choose, rather than a Certificate of Airworthiness. Non annexe II types such as the Piper J3 and Luscombe are no longer eligible to transfer to the LAA system but individual aircraft which were formally accepted by the CAA for transfer to the PFA/LAA prior to this change in policy are still allowed to continue on the LAA route.
- The aircraft must be of a type that is supported by adequate evidence of airworthiness and within the LAA limits in terms of power, speed, seating capacity and weight.
- The individual aircraft must be able to be shown to be airworthy as regards design, build and maintenance standard.

Contact LAA to find out what the position is BEFORE committing to the project. If it looks promising, the LAA will apply to the CAA for the aircraft to be transferred to LAA control. Alternatively, you can contact CAA Applications and Approvals Department directly for advice. The CAA may take several weeks to reach a conclusion and the results of their deliberations are unpredictable because the criteria which the CAA applies follows a complex protocol.

LAA inspection

You need to establish contact with a suitably approved LAA inspector. The LAA website contains a search tool to identify inspectors in your area. You need to use an inspector whose approval includes the class of aircraft you are involved with, eg wood and fabric, metal or composite. Ideally you will find an inspector who has previous experience of the aircraft type you are involved with, or at least with similar types eg Cub, Auster, Taylorcraft.

Your inspector will need to carry out an initial examination of the project ‘as is’, talk you through what work will be needed and at what points he wants to inspect your progress. At this stage you need to submit a proposal to LAA Engineering describing the extent of the work required for the intended rebuild, the manuals (maintenance manual, repair manual) you have on hand to work to, and the expected inspection stages.

From this stage onwards it’s up to you to liaise with your inspector and to contact him in times of difficulty or whenever you reach a stage when he’s asked to be called in.

Your inspector is always your first port of call in the event of a technical query and inspectors are generally only too happy to give advice if they can. In inspecting your project it is his decision that counts. If he says do it again – then do it again you shall. Of course you have a right to swap inspectors on the way but we strongly advise that it’s in your interest to use one inspector

throughout the construction stages as the continuity this provides is most likely to allow a good working relationship to flourish.

The commercial arrangements between you and your inspector are a matter for yourselves. Some LAA inspectors are also busy professionally qualified licensed aircraft engineers and may make a charge but some are keen experienced builders themselves and we know of a few who are embarrassed to accept anything more than expenses. One thing your inspector can never do is approve modifications. Permission to deviate from the plans or manuals must be sought from LAA Engineering.

What your LAA Inspector can expect from you

Although all inspectors approved to certify the construction of LAA aircraft have expressed a willingness to do so, they are under no obligation. There are all sorts of good reasons why an inspector may not be available at a particular time. Generally an inspector is willing in the first place because he is an interested enthusiast himself, but he will not expect to be telephoned in the dead of night in order to tell you how to safety wire a turnbuckle when such questions could perhaps wait until his next visit.

When he does call, keep him warm, fed and watered and give him as much of your time as he needs. He may wish to be left alone for a while to concentrate on his task. Don't waste his time by asking him to visit when you know you haven't actually done what he's asked you to do. Give him plenty of notice that you are about to reach a stage and will require a visit. It does help if, with small components, you take them to him for inspection rather than ask him to come to you.

For a new rebuild project the inspector will first want to find out what he can about you, the restorer. He is not going to be there most of the time you are building your aircraft, so to assure himself of the integrity of your handiwork he will need to develop an idea of how much help and advice you are going to need and how much you can be left to get on with it. Err on the side of caution – better to appear too ignorant and get more guidance, rather than making a better impression and having your wing spar scrapped later – or worse, building a lethal defect into your aeroplane.

Workshop and Storage facilities

The inspector will have to check your workshop facilities to make sure they are up to the job. You are going to need a dedicated working area with adequate lighting, heating and ventilation, and an appropriate collection of tools. If yours is a composite project he will be particularly intent on checking the means of monitoring the temperature and humidity and keeping them within the allowable limits for the resins. He will need to be satisfied that you have proper storage space for the aircraft materials, for example lengths of wood will have to be stored horizontally and properly supported in a reasonably stable environment otherwise they will warp and twist like a dog's hind leg. It is essential that glass cloth is kept free of contamination by dust, grease etc when in store and you will need some sort of clean work surface for preparing the glass cloths as well as storage for your rolls. Epoxy resins and glues must be stored at room temperature – not out in the shed where they may be alternatively frozen or overheated depending on the time of year.

The inspector will also need to check that the glues and resins are 'in date'. Some resin manufacturers are prepared to take time-expired resin back to test and re-validate it, but this is usually uneconomic. The answer is to buy resin in relatively small quantities, resisting the temptation to purchase enough to build the whole aeroplane at a discounted price.

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Sourcing of Materials and Processes

The inspector will need to satisfy himself of the origin and identity of the building materials and parts you are using. Not all materials need to be 'released' but he will need to be convinced that they are adequate, and he will want to check the paperwork for all the more significant items of raw material and hardware used. With metal parts he will have to check not only the type of metal specification but also the state of heat treatment – some commonly used aircraft metals (such as S.514) are supplied in the softened form for ease of cutting and bending the parts to shape but must be hardened by a carefully controlled process of heat treatment to achieve their full strength before being painted and bolted into place. Failure to harden the parts could result in the structure failing at a drastically reduced load. The heat treatment must be done by an organisation approved for this kind of process and again, the inspector will want to see the paperwork relating to the heat treatment. The same applies to processes such as anodising, plating etc which are similarly critical to airworthiness and must be done to appropriate aircraft specifications.

Frequency of Inspections

The inspector should be invited to look at any structure or system just before it is 'closed off', for example in the case of a wooden box spar he will want to see the job fully prepared (including the internal varnishing and preparation of the closing web) before the closing web is glued in place, rendering the internals invisible from then on.

Wooden Aircraft Structure

The inspector will need to check each piece of wood carefully to ensure that the grain count (grains per inch) is no less than the minimum allowable, the orientation of the grain is correct and the grain is not running out excessively along the length of the piece, and that there are no other visible defects. In some cases he may insist on samples of the wood undergoing a compression strength test. The fact that you bought the wood from a reputable source will cut no ice with the inspector if the wood doesn't meet the applicable British Standards BS 2V.37 and BS 2V.38 (spruce), V36 (douglas fir) or 3V.4 (ash). He may need to examine the wood under a magnifying glass to check for almost invisible compression shakes, which can drastically reduce its tensile strength. Shakes are usually caused by the tree having been felled carelessly, allowing the trunk to crash to the ground rather than lowering it gently, with the result that the wood fibres are overstressed in bending. Compression shakes of this type are particularly hard to see in Douglas fir and particular care is therefore needed in selecting this type of wood.

Glue Joints

Glue used in the construction of a wooden aircraft must be of an approved type. The standard glues used are Ciba-Geigy Aerolite 306 and Aerodux 500, the latter being more slow-setting and used mainly for complicated jobs which require longer 'shuffling time' eg laminating wooden spars, ply skinning, etc. Certain epoxies are also acceptable. Whatever glue is used, it is essential that all the glue manufacturer's instructions are strictly followed with regard to storage, mixing, application, clamping pressures, etc as these can critically affect the strength of the joint.

The inspector will want to test to destruction sample glue joints made from each batch of glue you use. As each batch of glue is mixed he will ask you to bond scrap pieces of spruce together

and date them, so that upon his next visit he can break the joint apart and check that it is the wood rather than the adhesive bond which fails. If the adhesive fails, all joints made with that batch of glue become suspect and will need to be remade. Either the glue batch might be at fault or poor joint preparation might be the cause – any grease or other contamination will drastically reduce the strength of the joint. Failure to lightly sand the surface of plywood to remove the remains of the waxy ply press release agent, or to plane off the oxidised surface of wooden members to reveal clean new wood will have the same effect. Incorrect mixing of the glue or too miserly or liberal an application in the joint will also reduce its strength. With some types of glue it may be preferable to leave a glue fillet around each joint, in others (such as Aerolite 306) this may cause distortion of thin plywood panels and shrinkage cracks which can provide a route for moisture to penetrate the joint and precipitate an early glue failure, in which case excess glue is best wiped away before it sets.

Welding

If your project requires welding to be done, then it is required that any welding which is 'of significance to airworthiness' must be carried out by a CAA approved welder. 'Of significance to airworthiness' includes primary structure, engine mountings, control system, undercarriage and anything else which would be critical if it were to fail in flight. Many homebuilders have gone through the process of gaining CAA approval in order to weld their own projects – if you are skilled enough at welding to work on a flying machine then you will find the CAA's welding tests quite straightforward. Details of the welder's approval process can be found on the CAA website – refer to BCAR chapter A8-10 (CAP 553)

Alternatively, you can take the work to someone local already CAA approved for welding. We have a list of CAA Approved Welders on Technical Leaflet TL 3.04 which is downloadable from the website or your inspector can probably point you in the direction of a welder familiar with LAA type work.

Restoration practices

The restoration needs to be carried out in accordance with accepted rebuild procedures, e.g. as laid down in AC43.13 (available from the LAA booklist, or the FAA website) and CAP 562 (available from the CAA website). Any deviations from the original design must be cleared through ourselves. In general we would discourage any variations: the original aircraft has normally established a reputation for reliable operation over many years, which you will compromise if you start making arbitrary changes. You may find it worthwhile to contact other owners and 'type clubs' to discuss worthwhile upgrades which may have already proved themselves worthwhile, for example substitution of modern wheels and brakes. It is advisable to get any changes cleared BEFORE any work is started on the change, in case we have any objections or suggestions to make.

Standards of Workmanship

The inspector will probably advise you to start the job by rebuilding a relatively small assembly such as the rudder or tailplane, so that any mistakes made while you are on the steepest part of the learning curve will not result in the scrapping of a large and costly assembly such as a wing or fuselage. When the time comes for the inspector to view the first assembly he will be keen to check the quality of workmanship. Wood parts should be planed smooth but not to the extent that the cross-section of the members is less than that called for on the drawings. Metal fittings must be free of scratches and burrs, all file marks carefully dressed out and all bend radii suitably large and smooth to avoid fatigue cracks starting in the bends in service. All bends will need to be formed over a suitable radiussed form block – any parts bent directly in the jaws of a

vice will be terribly scored and will be consigned to the scrap bin. Some drawings specify the orientation of the grain of the metal (yes, metal has a grain direction too) and the inspector may have to show you how to determine this. All holes drilled must be round, correct in size and drilled in the correct position so that the edge margin is as shown on the drawings. If a drawing shows four bolts holding a fitting in place, the bolts cannot go just anywhere – they must be positioned exactly as shown on the drawing. A bolt hole too close to the edge of a fitting or the underlying wood block will drastically weaken the attachment.

Compliance with the Drawings / Manuals

Having satisfied himself with the workmanship, the inspector will also need to check that you have complied with the drawings or manuals, that you have used the correct materials and the orientation of grain in wood or glass cloths in a composite structure are as specified. He will need to check that all the critical dimensions called up on the drawing have been followed, both to check that the finished aeroplane will fly properly and have adequate strength reserves but also to try to save you from that awful moment later on when 'somehow the wings just won't fit onto the fuselage'. He will be wary of the fact that even the best aircraft drawings contain an error here and there and it is well worth checking through the drawings for arithmetic mistakes made by the draughtsman. If, for example, two bolt holes are shown 3" apart on a bracket and 4" apart on the component which the bracket is bolted to, it will be better to find this out before the parts are made rather than after.

LAA Worksheets

Between you and your inspector, you will need to write up worksheets describing the rebuild, to be signed up by your inspector as you go along. A copy of the worksheets are to be submitted on completion of the rebuild. It's a good plan to make a photographic record of the work as it is being undertaken, and submit that along with the worksheets.

Continued Airworthiness Information

You will need to check that all applicable AD, SBs and MPDs are complied with, and submit a checklist at the end describing the compliance status against each one.

Alternative engine or propeller type

Sometimes restorers wish to fit a different type of engine during the rebuild. Apart from such issues as rated power, torque, engine weight, fuel consumption, noise output etc, it's essential to check that the engine you wish to use is a type accepted by the LAA for use in this class of aircraft, which is a reflection of its expected reliability. For example it would not be acceptable to replace the Continental A65 engine in a Luscombe 8A with a Rotax 582 two-stroke, because (apart from the cg problems that would arise due to the disparity in engine weights) the A65 is a certified engine whereas the 582 is not. The Rotax 582 is only approved by the LAA for use in microlights and very light amateur-built aircraft.

It will be necessary to submit a mod application dealing with the engine installation, engine mount, cowlings, controls, cooling system, exhaust, propeller, spinner, tachometer temp gauges, oil pressure gauge, etc. You need to show that you have complied with the requirements of the engine manufacturer's installation manual and the applicable requirements of an appropriate design code, e.g. CS-23, see particularly paras 361, 363 and the whole of subparts D and E. You can download CS-23 off our website, from the 'Engineering Publications'

page which is itself accessed from the list of options found at the base of the 'Engineering' homepage.

It will be as well to get the design of the engine mount and the general layout of the installation cleared with LAA before you start cutting metal. The mount could be cleared by analysis, or by limit and ultimate load testing (although this should be treated as a last resort) or by comparison with another, already accepted very similar mount.

Engine history

We will need details of the engine history. We do not encourage the fitting of a 'time expired' engine into a newly restored aircraft. If you are determined to fit an engine that has passed its TBO, you will need to make the case that the engine is in good shape, and fit for return to service. This might include, for example, the results of a strip inspection and dimension / wear check against engine manufacturer's specified tolerances.

Aircraft with more than two seats

If the aircraft has more than two seats, an LAA requirement is that the engine and propeller be either certified or of equivalent safety. This means that engines and propellers that you may have seen on LAA single and two seaters may not be acceptable. For example if you were looking for a variable pitch propeller, a non-certified type such as a Woodcomp or Arplast PV50 would probably not be accepted; you would need to use a certified one such as an MT or Hoffman.

Shoulder harness

Imported aircraft are sometimes found to be without shoulder harnesses on the front seats, as required in the UK by the ANO. Unless the aircraft is one of a very small number of types that are exempted from this requirement because it is impractical to fit shoulder harness, it will be necessary to have an acceptable shoulder harness installation before a UK Permit to Fly can be issued. If the shoulder harness installation is not original fit, you will need to show that the design of the installation meets appropriate requirements.

Substitute Parts

Substitute parts must be cleared through LAA Engineering who will require you to demonstrate that they are fit for purpose. Making parts 'to pattern' is often possible, but depends on knowledge of the original material specification, manufacturing processes, etc. For example a machined part may not be as strong as an original forged part, or a tie rod with cut threads will most likely have inferior fatigue characteristics to an original tie-rod with rolled threads. The heat treatment condition of metals has a major effect on the properties, and material specifications that appear similar may perform very differently – for example the yield strength of aluminium alloy 2024-0 is less than a quarter that of 2024-T3.

Placards, instruments and markings

In the case of an imported with foreign-language placards, it will be necessary to change the cockpit placards and controls/switch annotations (eg 'fuel pump', 'on/off' etc) to English language, and the instruments will need to be reviewed for suitability, i.e. altimeter in feet and millibars. While we always encourage the use of knots or miles per hour, for a European-built

aeroplane an airspeed indicator calibrated in km/hr is acceptable providing the operating limitations and flight manual are in these units.

It will be necessary to fit a fireproof plate with the UK registration engraved on it, in the vicinity of the cockpit, along with the new markings on the fuselage and wings.

Any existing foreign registration markings must be removed / permanently painted out as it is not permitted to display more than one registration mark.

Weight and balance

It will be necessary to re-weigh the aircraft and create a new schedule. A special LAA weight and balance schedule can be downloaded from the LAA website.

Logbooks

Unless they are already in place, it will be necessary to raise new UK logbooks of the CAA (or LAA) approved type.

On Completion

Eventually the time will come when, standing before you is a shiny newly restored aircraft, new paint scheme and ready to go. But stop, is it really finished? Did you put that split pin in that you were going to leave till the end? Did you tighten that hose that you tried for size six months ago?

Final inspection / sign-off

When the rebuild of the aircraft is complete, a final inspection must be carried out. Normally this takes the form of an annual check as listed in the LAMS schedule or the LAA generic maintenance schedule (see TL 2.19). In addition, a symmetry check and in-depth rigging check is carried out and all systems calibrated and tested, fuel flows checked and engine ground run.

Application for approval to flight test

An application form will need to be submitted on completion, which can be downloaded from the LAA website. LAA Engineering will need to check through the rebuild paperwork and the proposals for the flight testing, including details of the proposed pilot and airfield to be used. The LAA Permit to Fly issue fee is payable at this time. Check the latest copy of 'Light Aviation' for the appropriate fee.

When you really are sure the aircraft's finished, and your inspector is satisfied, you will need to send the completed set of worksheets and application form to LAA Engineering. We will usually write back or 'phone to discuss one or two technical queries – it is not possible to address all the issues at stake in a simple application form. Your application will of course get prompt attention, but if it arrives in the busy summer period when our work load is high, then a short delay is unavoidable.

Once attended to, and all queries cleared up, the aircraft will be cleared for test flying by a suitable pilot. A minimum period of five hours flying followed by a formal flight test is required before a full Permit to Fly can be issued. This assumes that no great snags are encountered or modifications required, in which case further testing may be needed.