Light Aircraft Association

BUILDING AIRCRAFT WITH THE LAA

1. Getting Started – Registering your project with the LAA

Having taken delivery of your plans or kit, now is the time to register your project with the LAA Engineering Department. It is important that you do this before even the first joint is glued or nut tightened, as your LAA inspector needs to be involved right from the start.

To do this, contact the Turweston Office stating which type of LAA accepted aircraft you are intending to build. LAA Engineering office will send you a registration pack which includes registration card to be completed and returned along with the project registration fee (£300 for kit built, £50 for plans built). You will then receive an LAA Project Inspection Record detailing the inspection stages required which your inspector will 'sign off' as the build progresses. This section is covered in more detail in LAA TL 1.01.

2. Choosing an LAA Inspector

When registering your project with the LAA we will send you Technical Leaflet TL 1.22 detailing how to contact a local LAA approved inspector. As 'Project Manager' it is your responsibility to make contact with a suitable inspector from that list before the work starts. Suitable in this case means one that is approved to certify aircraft construction (as opposed to maintenance) in the construction medium which you are dealing with, i.e. primary structures of wood, metal or composite (GRP).

Many inspectors are approved to sign out construction of aircraft but not to make the final recommendation that the aircraft should be cleared for first flight. In that case you will need a one off final inspection from a more 'senior' inspector. This really should not put you off a 'construction only' inspector as their skills and experience are not in question. They probably just have a background in aircraft initial construction rather than with operational aircraft and maintenance.

From this stage onwards it's up to you to liase with your inspector and to contact him in times of difficulty or whenever you reach a stage at which he has said he wishes 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 standard kit must be sought from LAA Engineering.

3. 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 fasten the flappy bit to the spindly thing 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 construction project the inspector will first want to find out what he can about you, the builder. 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.

4. Workshop and Storage facilities

The inspector will have to check your workshop facilities to make sure they are up to the job. True, you could at a pinch build your wooden wing ribs on the kitchen table with little more than a Stanley knife, a hammer and a few tacks, but anything more advanced is 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.

5. Plans and Manuals

If the inspector is not familiar with the type of aircraft you are building, he may ask you to give him a reference copy of the drawings or build manual so that he can study these at length at home. This will come in handy in future if you need to telephone him for advice on finer points of detail – the conversation will be much more constructive if you both have the drawings in front of you.

6. Sourcing of Materials

The inspector will need to satisfy himself of the origin and identity of the building materials 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.

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7. Frequency of Inspections

The build inspection schedule specifies each of the main inspection stages required for the project. There may be anything from, say, ten to thirty stages depending on the complexity of the aircraft type concerned but this does not mean that ten stages means ten visits from your inspector. Your inspector may feel the need to visit several times in order to satisfy one inspection stage, especially in the early part of the project as you are learning the construction techniques involved and he is trying to develop confidence and trust in your ability. Alternatively, he may be able to accomplish more than one stage in one visit, depending on your rate of progress and 'organisational skills'.

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.

8. 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.

9. 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' e.g. 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.

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10. 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.

11. Corrosion Prevention

It is essential to provide metallic parts with appropriate corrosion preventative measures, depending on the material concerned and any existing anti-corrosive treatments present (eg Alclad on aluminium, cadmium plating on steel), and how the aircraft is likely to be stored throughout its life. Some modern kitplanes that have not been properly protected have suffered serious corrosion problems after only a few years in service. The salty maritime atmosphere in the UK creates conditions that makes corrosion more of a problem than that in dryer continental regions so corrosion preventative measures suggested by US or east European kit manufacturers may not be adequate for a UK-based example of the type. Corrosion, if allowed to develop, is not only unsightly, it can quickly degrade the airworthiness of an airframe either through the obvious progressive disintegration of components or, more invidiously, by forming almost invisible corrosion pits which can trigger the development of fatigue cracks, particularly in highly stressed parts, leading to sudden and unpredictable catastrophic failure. Different specifications of broadly similar materials vary widely in their tendancy to corrode, for example the higher strength 2024 series aluminium alloys are much more prone to corrosion than the 6061 series, so the airframes constructed from 2024 series materials merit greater attention to corrosion prevention. Particular attention to corrosion prevention should be paid to areas of the aircraft which are 'boxed in' and so not able to be routinely inspected, for example the insides of control surfaces, wing struts, underfloor areas of fuselages etc. In rivetted or bolted structures, assembly compounds such as JC5 or Duralac should be used especially where materials of different types are in contact, likely to cause electrolytic corrosion – for example, steel bolts through aluminium brackets.

Corrosion is much more easily prevented than treated once it has been allowed to take hold, and can spread very quickly through critical parts of an airframe rendering it beyond economic repair. Common anti-corrosion treatments include epoxy primers, zinc chromate primers and Alocrom treatments. Be sure to follow the manufacturer's advice (particularly re health and safety) and be particularly careful when mixing and matching different products – not all are compatible. If plating processes are used for steel parts, this must be carried out to appropriate aircraft process specifications as incorrect plating treatments can cause degradation of the properties of the material, in particular through hydrogen embrittlement. Steer clear of homegrown plating plants or outfits servicing restorers of vintage cars or bikes which don't working to the appropriate aircraft standards.

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12. Standards of Workmanship

The inspector will probably advise you to start construction by building 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.

13. Aircraft built from Kits

If you are building from a kit, then this frees you from the burden of sourcing individual materials and parts, but nevertheless it is still up to the inspector to check the quality of parts and material supplied in the kit. Most kits do not come from any kind of 'released source' therefore while kit manufacturers will have some sort of quality control system in place, the parts will probably not have been checked by any CAA or LAA inspector prior to despatch. Take nothing for granted. If your inspector rejects any of the kit supplied parts you will be more likely to get replacements from the suppliers if you take it up with them shortly after the kit is received, not months or years later.

14. Compliance with the Drawings

Having satisfied himself with the workmanship, the inspector will also need to check that you have complied with the drawings or build 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.

15. Modifications

Errors apart, the inspector will probably already have warned you about the dangers of deviating from the drawings and in particular of the ease with which extra weight can be built in, leading to an overweight aeroplane with inadequate payload, likely to end up as a 'hangar queen'. He will advise you that any modifications from the drawings have to be cleared through LAA Engineering and whilst he will probably want to have an input in devising any modifications you

have in mind, he will not sign off any modified component until he has seen written evidence of LAA Engineering's acceptance of the change. Most inspectors will be less than happy if they find that having counselled you for an hour and a half of the rashness of carrying out a particular modification they find that on their next visit it has been incorporated nevertheless. Do this too many times and you will find yourself looking for another inspector, which will mean building up a working relationship all over again.

Please may we stress the importance of strictly following the drawings in all aspects of the build. LAA designs are usually accepted on the basis of satisfactory service experience built up on several examples, plus a design submission provided by the designer. Any modifications or departures from the drawings, or incorporation of new kit 'options' will need to be assessed against an appropriate design code, usually CS-VLA. Whilst many homebuilders feel the desire to incorporate their own modifications, you should do so only if it can be proven that your modification meets the requirements. Each modification must be authorised specifically by LAA Engineering. In general we also expect a modification to be approved by the designer.

It is particularly vital with light aircraft to avoid modifications which increase the aircraft's empty weight. With light aircraft, even a few pounds weight increase will make a noticeable difference to the aircraft's performance. Several builders have found, to their cost, that their modifications end up making their aircraft extremely limited in range and endurance.

CS-VLA can be downloaded from the following web-site:
http://www.easa.eu.int/home/certspecs_en.html

Modifiers of Microlight aircraft should refer to BCAR Section S which can be downloaded from the following web-site:
http://www.caa.co.uk/docs/33/CAP482.PDF

16. Repair

In the case of a repair following an accident, or following a build error (for example, if a 3/16" bolt hole were mis-drilled and needed to be 'opened out' to ¼" to give a round hole, with a matching ¼" diameter bolt substituted) then after discussing it with your inspector, details should be submitted to the LAA for assessment. If approved we will issue an Engineering Repair as a record of our acceptance of the change.

17. Paperwork

A major hurdle passes with the signing off by the inspector of each main component (fin, tailplane, wing, etc) in the project Inspection Record, indicating that the inspector is entirely satisfied that the part is fit to go on to the next stage. The inspector will want to sign up each stage as it is completed, so keep the build Inspection Record to hand for each visit.

18. Amateur Building Rules

Another function of the inspector is to verify that the aircraft has actually been built by the person claiming to have built it. The rule is that at least 51% of the build must be completed by the amateur builder(s). The amateur-building rules do not allow commercial construction on a commissioned basis, or building an aircraft expressly for the purpose of sale on completion. Were this to happen the finished aircraft would not be able to be issued with a Permit to Fly.

Should you decide to pay someone else to build parts of the aircraft for you, the inspector will warn you that whilst it is acceptable for some specialist work to be farmed out (eg welding, covering, etc) the majority of the work must be done on an amateur basis by the owner.

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19. Registering your Project with the CAA

At any time of your choosing, but prior to the first flight of your aircraft, you will need to apply to the CAA for a G-registration. The address for this is: Aircraft Registration, Civil Aviation Authority, CAA House, 45/59 Kingsway, London, WC2B 6TE. Telephone: 020 7453 6666.

Owners of aircraft may have any registration of their choosing as long as it has not been used before and isn't obscene (though some are known to have slipped through the CAA's modesty net!). Choosing an out-of-sequence registration will cost more – contact CAA for latest fee. The CAA will send you a form with which to apply for your registration. The important thing to point out here is that when entering the serial number of the aircraft the number to refer to is the LAA Project number assigned to your project, and that we have already written on the Project Inspection Record.

20. Noise Certification

Every microlight aircraft must have its own noise certificate to prove that it meets the stringent mandatory noise limits applicable. The fact that an identical machine has passed the noise test and been issued a noise certificate is not sufficient. If this is the case it is only a simple matter of applying to the CAA Noise Certification Section at Aviation House, Gatwick Airport, West Sussex, RH6 0YR, giving details of the EXACT type of aircraft, engine, reduction gear, propeller (including pitch and diameter), exhaust and intake mufflers fitted. You will then be issued a certificate on the basis of the test previously carried out on the other aircraft.

If you choose to use a different powerplant installation from one previously tested on your aircraft type, as well as getting the design change cleared through the LAA you will have to have a noise test done by the CAA to clear the installation. This can be complicated to arrange (co-ordinating ideal calm weather, your free time, CAA's noise test personnel etc, can take a long time), and there is always a chance you will fail the test. Overall it is much simpler if you can use an engine installation which has already been cleared.

The CAA currently charge £440 if they have to carry out a noise test before they can issue a certificate. If they don't have to carry out a test because an identical installation has already been approved on your aircraft type, then a Noise Certificate can be issued free of charge.

21. On Completion

Eventually the time will come when, standing before you is a shiny new 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?

Contact LAA Engineering to request a Project Completion Pack which will contain all the up-to-date forms and information that you will need in order to submit an application for Permit to Fly.

When you really are sure your aircraft is finished, and your inspector is satisfied, you will need to send the completed LAA Project Inspection Record and your Application for Permit to Fly to LAA Engineering. The initial permit fee is payable at this time – check the LAA website or Light Aviation for the latest fees. On receipt, 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. For aircraft types already accepted by the LAA, with a standard engine/propeller combination, a period of five hours flying followed by a formal flight test is usually 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.

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22. Further Information

The LAA booklist includes many works giving guidance about homebuilding. 'Sportplane Builder', 'Sportplane Construction Techniques' and 'Firewall Forward', all by Tony Bingelis, are particularly valuable sources of practical guidance. The comprehensive catalogues available from the larger aeronautical supply houses are also extremely helpful.

Another source of help available is to be found at your local LAA 'Strut' where you are likely to find other members involved with similar projects to yourself, and who might already have been through some of the routine building problems that inevitably crop up, and can perhaps help you in resolving yours. They may know of local sources of supply, or of tools which may be available on loan. Some of the more popular homebuilts also have a 'type club' which allows enthusiasts for a particular type to exchange information and ideas. But in receiving 'type club' advice about possible improvements and modifications, remember that it will be the LAA who decide whether your aeroplane can be cleared for flight, not the type club!

Don't forget to monitor 'Light Aviation' magazine too for all sorts of technical and administrative updates that you will need to know about, to be sure of making the best possible progress with your project.

Happy building!