BGA AIRWORTHINESS AND MAINTENANCE PROCEDURES

PART 3, LEAFLET 3-4

DESIGN AND CERTIFICATION PROCEDURES FOR HOMEBUILT SAILPLANES

INTRODUCTION

1. **General**. This leaflet sets out guidelines for the recommended procedures by which a person or group should set about the design and construction of a homebuilt glider with a view to achieving certification by the BGA. The CAA approval of the BGA as an organisation responsible for all airworthiness aspects of sailplane operation in the UK is of particular value to the home designer/builder, since it enables the designer to communicate directly with experts in the gliding field with the minimum of formality. Consequently the BGA must be assured that the sailplane, particularly if it is home designed, meets the required standard of preparation and is safe for flight under the variety of conditions which it will meet. Only when this has been achieved will the aircraft be permitted to fly from BGA sites. The insurance companies are also conscious of the need for adequate certification and will generally only consider sailplanes cleared and certified by the BGA.

2. **Control and Inspection**. All technical matters related to the design, construction, certification and operation of sailplanes in the UK are the responsibility of the BGA Technical Committee. Matters requiring investigation outside the committee are progressed by the BGA's Chief Technical Officer (CTO). The BGA CTO also manages the approval of BGA maintenance inspectors and it is through one of these inspectors that the first contact with the BGA is likely to be made. Whilst the design experience of an inspector may not be great, he will be able to give a practical insight into what is required in the repair and construction of sailplanes and an idea of the problems likely to be met. Early contact with BGA inspector is strongly advised. If difficulties arise in finding such a person (most gliding clubs have a number within their membership), the Technical Committee can usually suggest the name of a suitable individual.

SAILPLANE DESIGN

3. **Design Approach**. A sailplane is an attractive proposition to a home designer because it is a simplified form of an aeroplane and is, in general, a less complex design task. Nonetheless, the design of a successful sailplane is a specialised art requiring particular care and attention in certain areas not necessarily common to those of normal aircraft design. Sailplane design has progressed apace over the past fifteen years and the modern high performance sailplane has become more and more advanced. The prospective home designer should be careful to take a realistic view of his/her ambitions (especially in regard to the likely achieved performance of his craft), with due regard to the resources and facilities available.

4. **Design Requirements**. Whilst the overall configuration and performance of the sailplane may be varied over wide limits to suit its envisaged role, the handling and strength requirements have been firmly set. The issue of a Certificate of Airworthiness is conditional on the design, construction and flight characteristics satisfying an approved set of sailplane design requirements. The BGA currently accepts gliders designed to the following requirements.

a. Joint Aviation Requirement (JAR) - Part 22.

b. OSTIV Airworthiness Requirements for Sailplanes 1998.

c. British Civil Airworthiness Requirements (BCAR) Section E - for vintage gliders and sailplanes only.

5. **Compliance With Requirements**. Compliance with these requirements will ensure that the sailplane is capable of safe operation in the wide variety of flight conditions to which a modern sailplane may be subjected whilst retaining every opportunity of producing an effective design solution in respect of both performance and economy. The BGA Technical Committee may be prepared to grant a CofA in cases where the aircraft does not entirely fulfil these requirements, provided that evidence of any deviation is forwarded to the Committee for its consideration in the particular case. Provided that the Committee is satisfied that safety is not jeopardised it may issue a concession against the particular requirements.

6. **Role of The Technical Committee**. It is strongly recommended that the BGA Technical Committee be contacted at an early stage of the proposed design, certainly before any significant expenditure is incurred. Generally speaking, the junction at which basic research has been completed and a provisional configuration has been established is a convenient waypoint. At this early stage the Technical Committee will probably suggest contact with one of its members as a design monitor who will keep the Committee informed of progress and attempt to provide assistance and information should it be required. The monitor's presence should in no way act as a constraint, the initiative being left firmly with the designer.

TYPE RECORD AND DESIGN SURVEY

7. On completion of design work, the Technical Committee will require the submission of sufficient evidence to establish the compliance of the sailplane with the relevant Design Requirements. Whilst there is no objection to the submission of all design calculations to the Committee, this is by no means necessary provided the required information is set out in a shorter form in the TYPE RECORD. This document should be prepared by the applicant for the Design Survey of the proposed sailplane. At a minimum it should contain:

(a) A three-view General Arrangement drawing, a list of component drawings and a statement of the aircraft geometry sufficient to define the configuration of the aircraft for subsequent calculations.

(b) A summary of design assumptions. This is a statement of the leading dimensions and principal aerodynamic and weight data upon which the design calculations are based, including such design criteria and assumptions used during the design calculations. This should include:

(i) The design envelopes, (manoeuvring and gust) of the sailplane with particular reference to operational and limit speeds.

(ii) The weight distribution assumed in the strength calculations, including moments of inertia and centre of gravity positions.

(iii) Aerodynamic calculation required for item (c) including:

Spanwise lift distribution.

Lift and drag estimates.

Pitching moments of wing and fuselage.

Downwash at tail.

Basic longitudinal and lateral characteristics.

(c) Strength and stiffness summary. This is a statement of design loads, critical cases, reserve factors and stiffness achieved, for all primary structure, including reference to design criteria and assumptions on which calculations have been made.

(d) The approach to be adopted to determine resistance to flutter within the desired flight envelope. This may be done by resonance testing and calculation, and/or by a carefully orchestrated test programme.

8. The design surveyor will normally be a member of the BGA Technical Committee, appointed by the Chairman. Following an initial examination of the Type Record and supporting evidence the surveyor will almost certainly wish to discuss various aspects of the design with the designer and where necessary may require further checks or, in the case of novel construction features, practical tests to be carried out before full approval is given to the design. Whilst it is quite likely that the construction of the aircraft will have started before the design is fully surveyed and cleared, it should be noted that changes may be required following the design check and thus it is as well not to proceed too far ahead with construction work without reference to the design monitor. He will be able to give some idea of the degree of confidence with which early construction of various components may be approached in order to facilitate parallel design and construction. The design survey can be arranged to be carried out in several stages. Following completion of the design survey, formal BGA Technical Committee involvement is complete until the Engineering Assessment is required.

CONSTRUCTION, INSPECTION, TEST AND CERTIFICATION

9. The procedures to be adopted for the construction, inspection, test and certification of homebuilt or kit-built sailplanes are described below.

10. **Plans and Kits**. When investigating plans or kits from other sources it is important to ascertain the design standard to which the aircraft is built. Most foreign design requirements are acceptable to the BGA but there may be exceptions. Should the choice be a foreign design not previously flown in this country there will naturally be some extra investigation to be carried out; probably extra flight trials and a minor design survey. As with amateur designer's sailplanes, it is worthwhile making contact with the inspecting authority at an early stage. In the case of recognised designs it is only necessary to make contact with an inspector (or senior inspector) but in cases of difficulty, or if a new and unrecognised design is being built, the BGA Technical Committee should be contacted.

11. **Materials**. In order to comply with design requirements the sailplane structure must be built from approved materials. All sailplane repair stations stock a variety of approved materials (wood, metal, GRP, etc) and Aircraft General Standard (AGS) parts. Those parts not available from repair stations can be obtained direct from factory or manufacturer, although some manufacturers are reluctant to supply small quantities. Only where special action has been taken is it permissible to use non-approved parts in primary and secondary structure since these materials require a larger reserve factor to cater for greater variation in quality. In special cases consult an inspector for further advice.

12. **Overview of Materials**. In making the choice of a particular sailplane construction, the facilities and circumstances of the builder's workshop must be considered. The specialised conditions of temperature and humidity required for work in Glass Fibre Reinforced Plastics (GRP) structure has rendered it unpopular with home builders. The specialised tooling required for metal structures has also discouraged homebuilders in metal although this is becoming less of a restraint. Anyone with a background or skill in metalwork may be justifiably attracted to this medium. Nevertheless by far the most attractive material for general homebuilt construction is wood (aircraft

Spruce or Pine); it is a forgiving medium and can be worked with the minimum of tools. Though requiring some skill in working, wood can be relied on to produce a workmanlike finished article.

13. **Workmanship**. During construction it is vital that absolute integrity of workmanship is observed. Any job which does not, when completed, hold the builder's full confidence with respect to finish standard or strength should be stripped out and redone. If doubt exists on any point a second opinion should be obtained; an inspector will undoubtedly look sympathetically on any such request for guidance. Only in this way will full confidence in the structural integrity of the machine be retained.

14. **Inspection**. The inspector should be consulted on any problems which arise during practical construction. He will be able to give or obtain advice on such matters. It is important that a working relationship is established with him such that a mutual confidence is achieved. He will be sympathetic to the builder's problems provided that the builder is open with him and willing to learn from his previous experience. The inspector will require notification, in advance, of such stages as completing the wing torsion box, completing control circuits, painting etc., so that he can carry out a final inspection before the evidence is enclosed. The inspector will, however, give his own guidance on the frequency of such visits as he will require.

15. **Final Inspection and Pre-flight Tests**. When construction is approaching completion the inspector will advise on the degree of inspection cover he will require before flight:

a. **Recognised Designs**. In these cases the degree of inspection and the amount of pre-flight testing will vary depending on the recommendations of the designer or kit manufacturer. Well established designs may require only a local inspector and the recommended pre-flight tests. These will certainly include weighing and a check of CofG calculations and control circuit stiffness checks. Proof load testing of structures is rarely required for sailplane designs but it is not unknown for some foreign designs to call for this. In such cases reference to the Technical Committee may be required to clarify such requirements.

b. **Amateur Designs**. In these cases the Technical Committee will require to carry out an "engineering assessment". This is an appraisal of the glider carried out by a member of the Technical Committee in conjunction with the designer at a suitable stage of construction at or near completion. The appraisal embraces all engineering aspects of the glider not covered by the design survey and is intended to ensure, as far as possible, that the glider can be operated satisfactorily and can be maintained in an airworthy condition without undue difficulty, by the operators for whom it is intended.

c. **Pre-Flight Tests.** The degree of pre-flight tests will be required as defined in the relevant airworthiness requirements. Those normally required for a new design are as follows:

1. Weight and CofG determination.

2. Control Circuit stiffness tests.

3. Longitudinal control circuit calibration.

4. Wing Torsional stiffness test.

5. Tow rope release test.

6. Brake parachute release test (when applicable).

All of these tests are quite easily organised using the minimum of equipment and basic measuring tools. The engineering assessor may wish to be present at some or all of these tests and since he will have previous experience of these exercises, will probably be able to render valuable assistance on methods and techniques.

16. **Flight Tests.** The extent of the interest that the Technical Committee will need to take in the flight testing of a new sailplane will depend on the previous experience gained with the type. Following the final inspection (or engineering assessment if applicable) the inspector responsible will liaise with the Technical Committee (through the CTO) who will decide on the degree of flight trials required. When this has been decided, the CTO will issue a permit to Test Fly, probably only valid for three months, setting out the limitations to range, flight envelope and operational limits. A typical programme is a follows:-

(a). General Handling.

(b) Operational Limitations (cross wind takeoff and landing limits, max. tow speeds, etc).

(c) Airspeed calibration (if not previously carried out).

(d) Quantitative Longitudinal stability analysis and determination of CofG range.

(e) Behaviour at high speed.

(f) Behaviour at low speed, stalling and spinning (as required).

(g) Flutter testing, if not proven by calculation.

As a rule about twelve to sixteen flights will probably be required for the full flight test programme. The test pilot will prepare a detailed written report on all aspects of the sailplane's behaviour and in conclusion any recommended modifications to be embodied before C of A award. This, together with the Design Survey and Engineering assessment, will form the basis of final C of A application.

CERTIFICATION PROCEDURE

17. Following completion of the flight test report, this and all other supporting information (eg type record, report on ground test, Design Surveyor's report etc) should be submitted to the BGA Technical Committee with a formal request for the granting of a CofA. Provided that good liaison has been maintained with the inspector, CTO and Technical Committee this should be a formality required only as an assurance that any modifications required have been carried out. Two categories of certification are available. Should there be uncertainty as to the classification of a particular project, a discussion with the CTO should define the most suitable category.

18. **Permit to Fly**. This category can be considered as very limited approval to continue operation in cases where paperwork is incomplete or while some undesirable feature is still in the process of being removed. Appropriate flight limitations and operational restrictions will be observed during this period and naming the pilots cleared to carry out the testing. Broadly, the requirements can vary between the two examples given below.

(a) Well established and tried designs (ie those which have previously achieved type certification). In this case the glider may be flown by a nominated individual(s), eg Club CFI, experienced local pilot or the constructors themselves. The experience of the proposed pilots should be included in the 'Permit To Test Fly' application. General handling tests only will be required including low and high speed flight, stalling and such manoeuvres as the machine has previously been cleared to carry out. A short report should be attached to the

CofA application on completion of the trials. As a general rule about four to six flights will probably be needed to cover this sort of clearance.

(b) Completely new design. In cases of entirely new sailplanes the engineering assessment will probably have been carried out by the CTO or member of the Technical Committee. The details of the flight test programme will then be defined by the Technical Committee. A permit to fly will then be issued detailing the limitations on operation including type(s) of launch, pilots, flight limitations and purposes of operation. All pilots must be approved by the BGA. The designer/builder(s) will be added to the list of pilots on the permit provided their experience is considered sufficient. In that case the owners will generally be permitted to carry out their own development flying; mutually agreed pilot(s) will carry out the initial development flying.

(c) When flight development has reached an acceptable conclusion the flight tests acceptance trials for a CofA will be carried out by a BGA Test Group. These groups are situated at various gliding sites around the country and the constructor may choose whichever is most convenient to him. In cases of difficulty a new local test pilot may be appointed by the Technical Committee for a particular task.

(d) The test pilot will carry out trials in accordance with the relevant design requirements. These flight tests will cover all regimes of flight for which certification is to be sought including clearance of the CofG to be included on the permit which must be renewed, generally, every three months. While a sailplane can, in theory, exist in this manner indefinitely, the requirement for regular inspection and permit renewal will become inconvenient to both BGA and owner and applicants are to be encouraged to progress to a more permanent certification category.

20. **Full Certificate of Airworthiness**. This is the category that is held by the vast majority of production sailplanes flying in the UK. It is subject to annual renewal pending the normal annual inspection. Successful home designed sailplanes can qualify for this certification standard when they have successfully completed the formal procedures laid down above and have demonstrated their airworthiness and maintainability over a period on a permit or an experimental CofA. Prospective kit builders should check that their kit possesses, or is likely to achieve, this airworthiness standard.