THE GLIDING FEDERATION OF AUSTRALIA

AN 98
(ISSUE 1)

AIRWORTHINESS ADVICE NOTICE

TYPE AFFECTED: ALL NEW GLIDER TYPES. (Includes local designs, major modifications and first of type amateur-built gliders which have not previously been flight tested and approved.)

SUBJECT: FLIGHT TESTING NEW GLIDER DESIGNS

BACKGROUND: This Airworthiness Note applies to the flight testing of new design, first of type and amateur built gliders, as well as major modifications to existing gliders. (Information relating to flight testing motorgliders and self-launching sailplanes will be the subject of another AN.)

Airworthiness procedures for Amateur Built sailplanes are provided in the MOSP Part 3 Section 48. These procedures cover all classes of amateur builts, including local designs, first of type and subsequently built gliders from a kit or plans.

Major modifications to a glider may require flight testing to establish that the modified aircraft still meets the appropriate standards. Major modifications usually involve external changes to the shape of the glider, such as extensions to the span, or fitting winglets, or alterations to the flight envelope. In such cases this AN may be used as a guide, and any non-appropriate parts ignored.

GFA Members may obtain further advice, relating to their specific projects, from the CTO/A, STO/A, DOO and the Design and Development Committee. This service is not available to persons outside the GFA.

SAFETY CONSIDERATIONS: Some years ago a GFA test pilot was killed when a first of type amateur built glider went out of control on approach. The likely cause was disconnection of the landing flap on one side, due to a lack of positive engagement. Because of the design this lack of engagement was difficult to see when the aircraft was assembled.

Some years before that we almost lost another test pilot who was conducting an aft centre of gravity spin test on a new type glider. The glider had small vee-form tail surfaces and great difficulty was experienced in inducing a spin. Although a number of the type were flying in the USA, it is likely that this was the first spin ever encountered in this type of sailplane. After attempting to recover several times the pilot decided to bail out and unfastened the harness. When moving forward to open the

SIGNED: CONVENOR DESIGN AND DEVELOPMENT	For and on behalf of: THE GLIDING FEDERATION OF AUSTRALIA

canopy the glider unstalled itself and the pilot regained control. Recovery height was below 1000 feet.

Recently we had another bad accident on the first test flight of an amateur-built glider. Although the type was a proven design, and many examples had been constructed and safely flown in Australia, the accident investigation indicated some queries on the location of the release, the incidence of the tailplane and the loading of the glider may not have been resolved before the test pilot attempted the first winch launch.

From these examples we can see that test flying can be hazardous. Like all flying the potential dangers need to be appreciated and suitable precautions taken to minimise the risks involved to the pilot. Because there are so many factors involved in the first flights of a new glider it is impossible to list them all here. On the other hand the great majority of new gliders, including prototypes, get up into the air and back down again successfully. It is expected that the test pilot will find things which require adjustment or modification, but that is the purpose of the test flight. Each flight should be carefully planned and alternative courses of action worked out in advance to cover the various emergencies which might occur.

All of those persons who have been connected with any phase of the design, construction, modification and inspection of the glider, have a duty to ensure that their work was carried out to the appropriate standards and that all required information is provided to the pilot and to the CTO/A.

BUILD STANDARD:

The build standard of the aircraft must be established and documented at the outset. In the case of an amateur built glider the design data will consist of all of those drawings and construction manuals specified by the designer, plus other design documents to control any changes which the builder may have made to the glider during construction. The aircraft must be inspected to ensure that it conforms to the design data. The builder is required to maintain records of stage inspections and complete a Construction Certification. It is the builders responsibility to ensure that documents exist to describe each item of hardware and for any changes made.

Builders should be aware that relatively minor changes to materials and processes may adversely affect safety. For example different rivet types have different shear strengths. Minor changes to materials can also lead to unexpected results. For example nylon bushes can cause rapid wear to steel parts. Any questions relating to specifications, parts substitutions, repairs and modifications, from the builder or inspector, should be referred to the RTO/A or the STO/A. The more complex changes will need to be referred to a person who is qualified to approve the design of modifications and repairs.

DESIGN ENGINEERING: In the GFA we are fortunate to have a number of qualified and experienced design engineers available to be consulted. The GFA Design and Development Committee can also provide advice relating to the certification of amateur built sailplanes and the more complex modification projects.

Any person may attempt the design of a new modification, or even a complete sailplane. Formal engineering justification will be required, to comprise part of the type record for the project, so appropriate engineering qualifications are necessary. Even if the person is well qualified and experienced they will need to work with a consultant or the D&D, to organise checking and obtain the eventual approval.

The design standards to be observed will normally be the current OSTIVAR or JAR 22, as called up in CAO Section 101.26. Modifications to existing sailplanes may be carried out to the standards current when the type was approved, unless specific features are known not to be satisfactory.

For amateur category sailplanes, which have been accepted on the basis of a demonstrated history of safe operation, the standard of the modification should be at least equal to the original design. Designs originating in the U.S.A. and flying there in the EXPERIMENTAL system, may be assumed to comply with the FAR 23 and the Basic Glider Criteria handbook. If no aerobatic manoeuvres are claimed the sailplane should be assumed to be in the NORMAL category, as far as the flight envelope, flight testing, and eventual clearance for manoeuvres is concerned.

INSPECTION: During construction an assigned inspector will have completed various stage inspections. These are organised to examine each part of the structure immediately before it is closed up.

Following completion the sailplane will be subjected to a "Form 2" inspection against the usual glider airworthiness standards. Where new construction is involved particular attention should be paid to the alignment of parts, by sighting from a distance, recording the actual incidences and deflections achieved, not just that they are within limits, and checking the controls for binding and friction. Normally there will be some excess paint to remove. Load the control surfaces in each direction and re-check clearances through the total deflection. It is appropriate to involve the test pilot in this part of the inspection, and also to clear the cockpit layout. Check combinations of controls together, against interference, and recheck with covers and cushions in place. Blow out the instrument lines and make sure that they are free of leaks. Ensure that the ASI is freshly calibrated.

Note that it is sometimes not possible to complete all of the items on a Form 2. For example it is not possible to make and install the limitations and loading placards until the flight tests are completed and the data is computed. Just note any items which are missing and any items of test equipment which are installed.

WEIGHT AND BALANCE: The builder should be aware of the need for weight control during construction, particularly if it is a small glider. Heavy control surfaces, too many modifications and excess cockpit furnishings can reduce the airworthiness and utility of the sailplane.

Each new sailplane must be weighed on completion. Some sailplanes subject to a major modification may also need to be re-weighed.

For the initial flights of a new sailplane the weight and balance inspector should concentrate on loading the aircraft in the centre of the nominated range. After weighing the glider empty, have the test pilot occupy the cockpit, in what is the optimum position for operating the controls. Note that the wearing of a serviceable parachute is mandatory for the first flights in any sailplane. For added support do not use thick cushions. Rather blocks of rigid foam plastic which are taped to the seat. Comfort here is secondary to safety. Calculate the position and weight of fixed ballast to achieve the desired central loading. After bolting the ballast to the correct station, re-weigh with the test pilot on board to confirm the result. Note that some small gliders may be "pendelled", or balanced on a piece of angle iron to check the C.G. position.

Subsequent tests will require the aircraft to be loaded to number of C.G. positions. At this early stage make only general allowance for this ballast. For instance provide longer attach bolts. The future test C.G. positions and ballast required will depend on the evaluation of results from the initial test flights.

TYPE INSPECTION: This is required for first of type sailplanes, including any amateur builts which happen to be a first of type. As noted in the MOSP 48-8 the CTO/A will direct whoever is to carry out this inspection as to the details and reports required.

This person should be particularly alert for any design features which appear to be unusual, or different from other sailplanes. Gliders have evolved by rejecting features which have been found to be unsatisfactory in service. Even so, an unusual design feature may acceptable, or even an advance on existing gliders. Report on the feature as you see it.

TEST FLYING : A flight test program should be drawn up for each new design sailplane which will include specific test schedules for initial flights, followed by a step by step expansion of the flight envelope, leading to critical flight test demonstrations.

Because amateur built sailplanes usually vary to some extent from the type design, each new glider of this category should follow the same test regime. If examination of the data indicates that the glider appears to be similar to an aircraft which has been previously been tested and approved, then the CTO/A may decide not to repeat certain tests.

INITIAL FLIGHT TEST SCHEDULE: At the time of application for an initial Permit to Fly it will not be possible to draw up a complete program of schedules for all tests. However the "APPLICATION" must include all of the information listed in the MOSP 48-9, plus sufficient information to enable the CTO/A to draw up an initial test schedule and issue a Permit to Fly. The following will be required;

THE TEST AREA. Built up areas are to be avoided. This is usually not a problem at gliding sites.

THE PILOT. The requirements are laid down in the MOSP 20.5.4. The level of skill and experience required for testing new design, or prototype, sailplanes is considerably more than is required for post-maintenance checks on approved sailplanes. As noted above a newly constructed sailplane of an established type may also contain a few variations from standard which need to be sorted out. The nominated pilot should have extensive experience flying a wide variety of aircraft. If the type to be tested has certain characteristics, then the pilot should be experienced on a similar design. Any queries should be addressed to the Director of Operations.

THE SCHEDULE will confirm the weight and C.G. location for the first flights. It will also nominate the speed limitations, which should not be more than 0.9 of the structural limiting speeds during the initial flights.

The purpose of the first flight will be to carry out a brief qualitative assessment of the control handling and to determine if there are any features which need to be fixed before testing begins. All controls should be functioned at altitude and low speed handling should be investigated. The glider should NOT be fully stalled at this stage.

THE LAUNCH METHOD<S> will be nominated. Aerotowing from an aerodrome or large field is recommended, as this enables the pilot to lift off and try out the controls gently before starting to climb. When wire launching this check is best carried out from a car tow. The field should be large enough to allow plenty of room for a landing at any stage of the flight. Wind strengths of up to 20 knots are usually not critical, provided the crosswind component is close to zero. Winch launches should only be scheduled after the gliders pitch control has been demonstrated to be adequate.

DE-BRIEFING: After the first flight the pilot should be thoroughly de-briefed by the designer and/or the person nominated by the CTO/A. If no major modifications or adjustments are required then the formal part of the initial flying may proceed. Some adjustments will normally be required. If the adjustments are major, then the procedure for design, inspection and initial flight test must be repeated. At all stages the CTO/A is to be informed of these developments.

INITIAL TEST FLIGHTS: Following the first qualitative assessment that the sailplane appears to fly normally, the next stage is to obtain some test data. Stick position, and thus elevator angle, should be measured against indicated airspeed. This requires some sort of crude, but moderately accurate, measuring scale to be mounted in the cockpit.

Next we need to measure the static position error over the speed range. This requires an additional calibrated ASI in the panel, plumbed to a trailing static source. This is located at the end of 15 metres or so of plastic tubing. The GFA can provide details of a cheap and accurate trailing static system. It is possible to obtain the data from just one flight, but an aerotow to about 6000 feet is necessary.

The margin of control in pitch, at the mid-C.G. position, is determined from the plot of elevator angle against true air speed. If an adequate margin exists we can proceed to the next step.

FURTHER FLIGHT TESTS: The flight test program should then proceed methodically to expand the test envelope to the sailplanes design limits. At each stage the data should be evaluated, to determine if it is safe to proceed to the next step. The major goals in this program will be;

Measure elevator angles at various C.G. positions, flap and/or spoiler positions. Measure control forces. Determine the neutral point and stability margin.

Determine the stall speeds at various flap and/or spoiler positions. Check low speed handling and stall behaviour from straight flight and turns at various C.G. positions.

Establish freedom from buffet to the demonstrated diving speed.

Demonstrate spin recovery at various configurations and C.G. positions. (See below.)

If, at any stage, a problem occurs or is foreseen, the designer or the CTO/A may elect not to proceed further. This means that the type's approved flight envelope may be within the design structural envelope.

SPIN TESTING: The spinning trials for a new design sailplane are such a major and critical part of the flight test effort that it is worth special mention. Assuming that the rest of the flight envelope has been cleared, the stall and high speed dive tests have been completed, then we are ready to start spin testing.

The least requirement, to permit a gentle stall only clearance in the FAR 23 NORMAL category, is an attempted one turn spin and recovery with normal controls applied. This is the minimum flight demonstration that the GFA insists that all sailplanes should undergo for the issue of a C of A in the amateur-built category. Note that the MOSP 48-9 (3) refers to "Extended Aft C.G. Limit" tests. These are only applicable to gliders designed to the BCAR-E.

Spin tests are conducted at height and away from built up areas. The test pilot should have a definite plan of action in the event that the sailplane does not respond to normal recovery action. For example Vee and Tee tailed gliders will sometimes recover better with no rudder applied and forward stick. The bail-out height should be set at no less than 1000 feet above the terrain.

Start at the most forward C.G. and work backwards. Tail ballast, if required, may be jettisoned in flight if it is water or sand. This can provide an additional means of safety during the critical test. A tail parachute might also be considered as an alternative, although deployment may not be as reliable as dumping ballast.

Many sailplanes, particularly amateur builts, will exhibit different spin modes between left and right, due to slight inaccuracies in the wings. This is acceptable as long as each recovery meets the requirement.

If a full spinning clearance is desired (for an amateur-built type) or is mandatory (as is the case for the JAR 22 Requirements) the above procedures are then repeated for two, three, four, and finally five turn spins. These demonstrations will take up a great deal of flight time, and should be organised to take advantage of good soaring weather, unless there is lots of money to pay for the aerotows. The test pilot needs to be methodical and cautious. Any tendency for the spin to flatten and/or increase in rate should be thoroughly investigated before proceeding to the next series of tests.