Two-Seater Glider Flight Test Evaluation

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1. INTRODUCTION

During the 1978 annual Operations' Seminar it became apparent that the next generation of two-seat gliders, which Clubs intend purchasing for use as basic trainers, may have different handling characteristics from those currently being flown. The decision was taken to evaluate the new gliders in order to ascertain if changes in instructing techniques, and hence the GFA Instructors Handbook, would be required.

At that time it was not clear as to the extent of the exercise or how best to make the evaluation. However, publication of the NASA sponsored evaluation of six single-seat gliders, Ref. 1, using the Cooper-Harper rating system, Ref. 2, provided an ideal basis.

A set of 104 evaluation tasks was prepared, see Table 1, and four two-seaters were made to be available for the 1979 National Gliding School held at Gawler in South Australia. The aim of the exercise was not to compare the gliders against each other; by using the Cooper-Harper rating system it was possible to evaluate each glider.

This report contains a description of the evaluation exercise and a summary of the ratings together with some comments on the handling characteristics considered pertinent to training flights.

2. GLIDERS EVALUATED

The four gliders chosen for evaluation were considered representative of the training gliders available for two-seater instruction. Glider nos. 3 and 4 were considered to be typical of the new generation and nos. 1 and 2 the current basic trainers.

Although glider no. 4 may be intended for training cross country and competition pilots, it is the practice of clubs to use high performance gliders in the basic training role. Furthermore, it is only a few years between gliders being flown in World Championships to their becoming the first solo machines.

The evaluation pilots were able to satisfy the placarded cockpit loadings without the addition of ballast in the front cockpit. None of the gliders was flown with water ballast in the wings.

The principal geometric and some other relevant parameters are contained in Table 2.

Glider No. 1

This glider was chosen because it represented the transition from medium to high performance regarding handling characteristics and reduced stick forces. The horizontal tailplane mounted on top of the fuselage has a fixed horizontal stabilizer with a fairly large chord elevator fitted with an anti-servo trim tab. The fixed landing gear is behind the centre of gravity. The glider is equipped with Schempp-Hirth airbrakes. Construction of the glider comprises wooden wings and tailplane with a steel tube fuselage, and the complete airframe is fabric covered.

Glider No. 2

The glider is of all metal construction with fabric covered control surfaces. It has a retractable main wheel forward of the centre of gravity. The control columns are long when compared with other gliders. The horizontal tailplane, mounted on top of the vertical fin, can be folded down; each half consists of a fixed horizontal stabilizer and elevator, fitted with a trim tab. The glider is equipped with flaps and Schempp-Hirth airbrakes. The glider is fully aerobatic when flown solo and at certain dual weights.

Glider No. 3

This glider has been proposed by the designer as a basic trainer and is constructed from glass fibre reinforced plastic. The retractable landing gear is located forward of the centre of gravity. The glider is fitted with upper surface Schempp-Hirth airbrakes. The T tail consists of a removable horizontal stabilizer and elevator. Trimming is achieved with an adjustable spring in the evevator circuit.

Glider No. 4

The glider is of glass fibre reinforced plastic construction and is intended for advanced and high performance cross country training. The model evaluated was fitted with a removable all-flying T configuration tailplane (later variants have a horizontal stabilizer and elevator). The glider is equipped with flaps, upper surface drag spoilers, and a tail parachute. The main landing wheel is fixed, and since it is near the centre of gravity a nose wheel is fitted. The aft seat had been shaped to provide some rearwards slope for the back of the pilot.

3. EVALUATION PILOTS

All the pilots taking part in the evaluation exercise were active experienced instructors, and involved in the conduct of training schools for gliding instructors.

In Australia there are five Regional Technical Officers plus a number of assistants who have the responsibility for training and categorising gliding instructors. There are a number of full-time clubs and commercial operations that train about 80% of the ab-initio glider pilots. There is also a full time Advisory Technical Officer who visits Clubs and Commercial Operators to assess whether the GFA standard procedures are being followed and maintained (see Refs. 3 and 4).

The twelve pilots who volunteered came from this population and their relevant statistics are contained in Table 3. None of the pilots had previously used the Cooper-Harper rating system, and only one had other than series test flying experience. Most had considerable cross country flying and competition experience, including World Gliding Championships.

Unfortunately, there was not sufficient time available for all pilots to fly every glider, nor did some pilots manage to fly from both the front and back seats.

4. PILOT RATING DATA ACQUISITION

Each pilot was provided with a copy of the questionnaire, the Cooper-Harper rating scale (see Figure 1.) a brief description of the flight exercises, and a number of relevant pages from Ref. 1 (copies of the complete report were available for perusal).

An extensive briefing session acquainted the pilots with the 104 tasks to be evaluated, and the conduct of the flight exercises as outlined in Table 4. Many of the tasks contained in the questionnaire (see Table 1), were taken directly from Ref. 1, and further series devised to cover various aspects of pilot training from the viewpoint of the instructor.

Initial planning was for pilots to make two flights from each seat in a glider using both a knee pad and a compact cassette recorder for comments, and from these arrive at evaluation ratings immediately following a flight. Those pilots familiar with a particular glider were able to make their evaluations without completing the four flights. A total of 45 glider flights was made during the four days, and a total of 19 hours of flight time recorded even though all the gliders were not available for the full period.

All flights proceeded to 1000 feet during which take-off characteristics were evaluated, then the pilot "boxed the tow plane," (i.e., moved out to the left clear of the slipstream, climbed into high tow, moved across to the right, descended into low tow, and then returned to the normal low tow position). The towing speed was then increased to the maximum permitted for the glider and the use of trim and air brakes evaluated, the glider was then moved into high tow and the tests repeated. Upon returning to low tow the speed was reduced and launching continued to 3000 feet AGL. The GFA emergency hook-up procedures were evaluated before release. The air exercises commenced with stalls and spins and any thermals available were used to extend the flight time if required.

During each flight the pilots made use of all the time available, and when not recording the second pilot was required to act as a safety pilot because of traffic density and airspace restrictions.

One tow plane provided the launches and although gliders and tug were radio equipped it was not required. The whole exercise was completed without incident.

5. RATINGS AND COMMENTS

As might be expected, the twelve pilots generated a large amount of data for analysis, and numerous comments to be summarized. The individual ratings have been reduced to show the number of pilots who rated the task, the mean value of their ratings and the standard deviation (SD). The latter figure indicated that approximately 68% of the ratings lay within the range of mean value plus and minus the SD.

Examination of the mean values must include consideration of the SD since a large SD indicates that pilot preference or judgement varied considerabley. Many of the pilots did not give an overall rating for groups of tasks; however, those available have been included.

5.1. Rigging and Inspection

Every glider was regarded as being too heavy with the possibility of being damaged during rigging, however glider no 1 became manageable with practice.

Locking methods for connection of controls and attachment of wings was considered to be vague (i.e., not easily seen to be positively locked) especially in the case of glider no. 3.

5.2. Cockpit Arrangement

The adjustment of seating position in a training glider should be an easy task; however, in the four gliders it ranged from no adjustment possible to a difficult task.

Even though placards included symbols, the fact that the words were not English led to some confusion. The materials from which they were made were not durable and in the case of glider no. 3 the legibility had been reduced to zero after about 5 weeks of exposure to the Australian summertime sunlight.

There was a lack of stowage space (none in glider no. 1) and it was considered that it should be possible to easily stow items such as pupils logbook, maps, drinking water, barograph, and food.

5.3. Instructional Needs

The degree of duplication of controls was considered to be adequate for all gliders except no. 3; however, the ability of the Instructor to overpower the pupil was regarded as being inadequate and impossible for the rudder in glider no. 4.

Many control knobs and levers were found to be too close to each other, making inadvertent operation by a pupil possible.

The rear seat in glider no. 3 did not provide adequate comfort or visibility for many of the pilots.

In all gliders the cockpit ventilation was regarded as being inadequate for hot conditions.

The rear pilot was not able to easily observe that either canopy was properly locked shut.

Except in the case of glider no. 2, there was no provision for safe and easy placement of ballast in the front cockpit. It is now an Australian airworthiness certification requirement for all cockpit ballast to be capable of being easily locked into position.

Since training gliders tend to be flown where traffic density is high, and hence risk of collision not negligable, it is highly desirable that parachutes can be worn by both occupants. The ratings and comments for this item indicate that most pilots were not comfortable when wearing a parachute, and also they experienced some interference during operation of controls.

Rear cockpit instrumentation was inadequate in all gliders except no. 4.

Gliders 2 and 3 were too heavy for repeated lifting at the tail and it was considered that there was a risk of doing structural damage unless the tail dolly was fitted for ground handling.

Both the effectiveness and method of operation of the wheel brake was considered to be poor and needing improvement for all gliders.

Difficulty in maintaining roll control was experienced with glider no. 4 during the early stage of the take-off run, unless full negative flap was selected.

The rudder operating force (especially in the rear seat) was considered to be too high for all the gliders, with glider no. 4 being rated as the highest.

5.4. Trimming

Two aspects of glider trimming were investigated, namely the effect on pitch attitude of operating the flaps, undercarriage and airbrakes, and the capability of the glider to be trimmed during flight.

5.4.1 Attitude Change

The gliders were trimmed to fly at their recommended approach speeds, and the effect of the following (if applicable) on pitch attitude noted:

1. Glider clean
   a. Gear Down
   b. Flaps down
   c. Airbrakes open

2. Glider with gear down
   a. Flaps down
   b. Airbrakes open

3. Glider with gear and flaps down
   a. Airbrakes open

All pilots reported the following experiences with each glider.

Glider No. 1 - Pitched up slightly when the airbrakes were opened.

Glider No. 2 - Experienced a slight nose down pitch in every case resulting in the airspeed remaining virtually constant.

Glider No. 3 - Similar behaviour to glider No. 2, although one pilot detected a slight nose up change when the landing gear was lowered.

Glider No. 4 - Diverged rapidly nose down when the flaps were lowered and the exercise could not be continued.

5.4.2 Effectiveness of Trim Device

Gliders nos. 1 and 2 were trimmed by means of tabs while 3 and 4 had adjustable springs. None of the devices were fully effective for some areas of normal gliding flight (for example, during aero towing). Furthermore none of the gliders could be trimmed over their full speed range. The trimming devices for gliders 3 and 4 being the least effective.

5.5 Stability

Few instrtuctors would suggest that a training glider should have zero stick-free stability, however the amount of stick-fixed stability can be debated. Pupils during the early stages of learning to fly are often sensitive to the amount of control stick movement required to maneuver the glider. All of these aspects were investigated for the four gliders.

5.5.1 Stick-fixed Stability

Although no measurements were made, the stick force required to produce a change in airspeed was regarded as being adequate (i.e. not too small) and was of the correct sense in all cases. Glider no. 4 had the smallest stick force gradient.

The amount of movement at the top of the central stick was measured for each glider over the range of airspeed from 40 to 100 knots for a number of pilot combinations.

Actual measurements are given in Table 5. It is interesting to note the experimental variations in the total stick movement recorded. All results obtained were plotted with the origin at 60 knots, however, for the sake of clarity only the two bounds are shown in Figure 2 (i.e. all other plots lie between the two curves).

5.5.2 Stick-free Stability

A qualitative, instead of a quantitative assessment, was made with the pilots ascertaining whether each glider had positive, negative or neutral stability. They also explored the sensitivity of each glider in the pitching plane.

Glider no. 4 was found to be very responsive to elevator input (with a very low stick force gradient).

Both glider no. 3 and 4 demonstrated neutral to negative stability for the pilot weight combinations flown.

Glider no. 4, when flown "hands-off" would start to pitch nose down after a few seconds. This pitching was slow in the beginning but would suddenly increase with the airspeed rising to at least 100 knots with no sign of recovery.

5.6 Handling in Thermals

Some pilots found glider no. 4 difficult to center in a thermal, leading to comments such as "needed to allow for inertia" and "difficult to maintain control of airspeed."

A number of pilots also commented that rudder and aileron response was sluggish for glider no. 3, however, this was not reflected in the ratings given.

5.7 Operation of Airbreaks

The operation of the airbrakes during the landing phase presented only minor difficulties in all four gliders and was not considered to be significant for pupils. The comments noted a tendency to suck open, and closure loads increasing with an increase in airspeed.

During aerotow, the force required to close the airbrakes on glider no. 3 was very high at the maximum permitted speed. Glider no. 4 tended to overrun the tow rope at the higher towing speeds; however, this was easily prevented by using the airbrakes to remove any slackness.

5.8 Spinning Characteristics

The flight test program covered the stall, incipient spin, and full spin characteristics, and the gliders were initially flown in the "as received" condition within the pilot weight limits permitted by the cockpit placards.

There were adverse comments on all four gliders, arising from the fact that their spinning characteristics changed markedly depending upon cockpit loading (i.e. position of loaded C.G.). The spin behavior ranged from not capable of being spun, through automatic recovery after half a turn, to remaining in a stable spin.

Glider no. 4 differed from the other three in that when spun it adopted a steep nose down attitude very quickly and during recovery it was not possible to prevent the speed from exceeding 100 knots.

Glider no. 3 had no clear stall warning and, if the stall was approached slowly, a very high sink rate of about 800 feet per minute could be reached in level flight. This glider could not be spun in the "as received" condition.

Since stalling and spin characteristics are affected by the amount of "up" elevator available, this was checked against the handbook figure for each type. All the gliders were within tolerance except no. 2 which had 1 degree more than specified. Both glider nos. 1 and 3 were at the lower limit and glider no. 4 was at the nominal position.

Reference to the Flight Manual for glider no. 3 revealed that it could only be held in a spin at the aft CG limit. The position of the empty glider CG was checked and found to be close to the forward limit. Lead weights were then strapped to the fuselage just forward of the fin to move the CG back towards the middle of range. Subsequent tests with pilot no. 2 (67kg) in the front and pilot no. 3 (83kg) in the rear seat produced a sustained spin, however, the glider assumed a pitch attitude which gave the impression of being beyond the vertical.

6. CONCLUDING REMARKS

At the end of the flying exercises but before the ratings had been collated, the evaluation pilots discussed the various aspects on which they had made comments.

There was unaminous agreement that it is essential that an instructor must be able to demonstrate and train glider pilots in spinning and subsequent recovery. Hence, it caused some concern to find that none of the gliders evaluated would stay in a stable spin over the range of centre of gravity positions that were flown.

Glider no. 4 was considered to have handling characteristics, particularly with regard to longitudonal stability and spin behaviour, which would make it inappropriate for use as a basic training glider.

Glider no. 3 was found to have a number of features which, with modification, would greatly improve the glider for instructional purposes.

The pilots agreed that there was no need to change any of the flying training syllabus contained in the GFA Instructors Handbook. The need for gliding clubs to either own or have access to two-seater gliders in which the complete syllabus could be covered must be taken into consideration. This aspect has become apparent to other instructors in Australia as indicated by Ref. 5.

Collation and analysis of the ratings confirmed the well known opinion that glider pilots are individuals. The large value of standard deviation for many of the tasks illustrates this fact. In only two instances did a significant number of pilots give the same rating. The first concerned the difficulty of assembling glider no. 1, and the other involved ability to center glider no. 2 in a thermal.

There were two items whose rating indicated that all pilots considered that some improvement was needed, namely operation of the wheel brake and adjustment of seat position.

The ratings contained in Table 1 show that none of the gliders received a good rating for all tasks, indicating that the need still exists in Australia for a two seater suited for basic training.

7. ACKNOWLEDGEMENTS

The conduct of this evaluation exercise was made possible by the large amount of effort that was given by the Instructors who volunteered their time. The gliders were provided by the Adelaide Soaring Club and Riley Aeronautics.

8. REFERENCES

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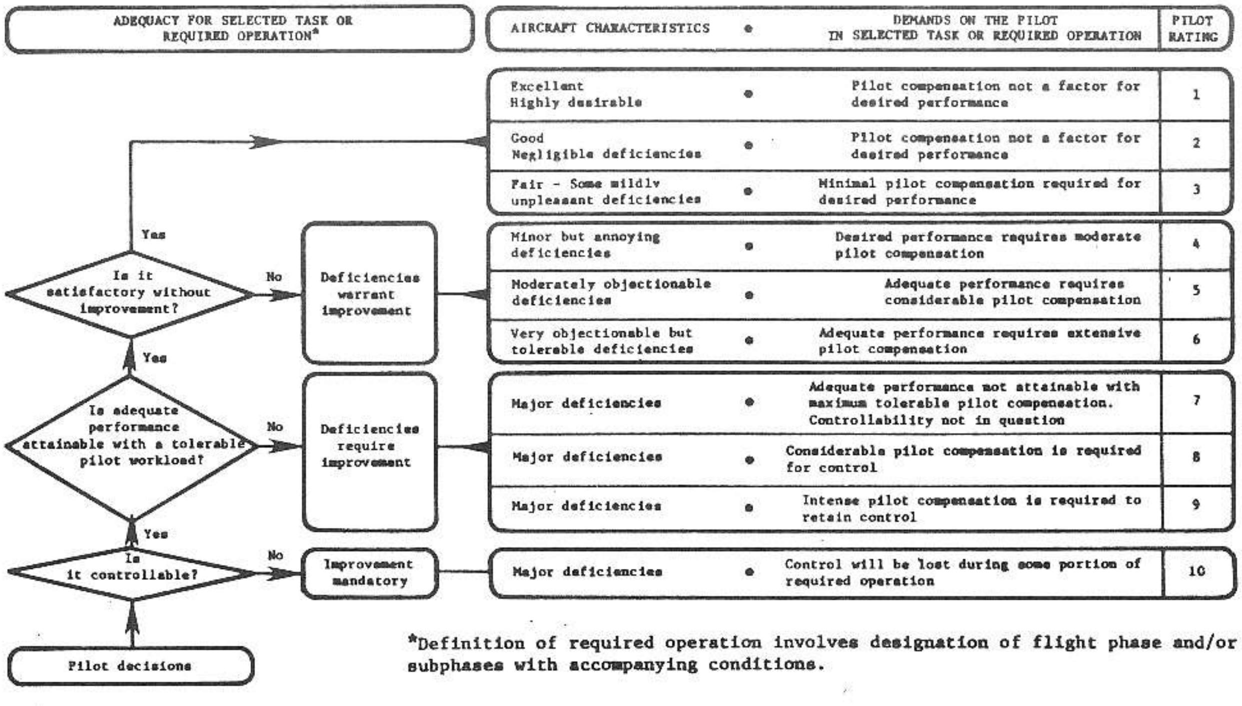

Figure 1. Cooper-Harper Rating Scale

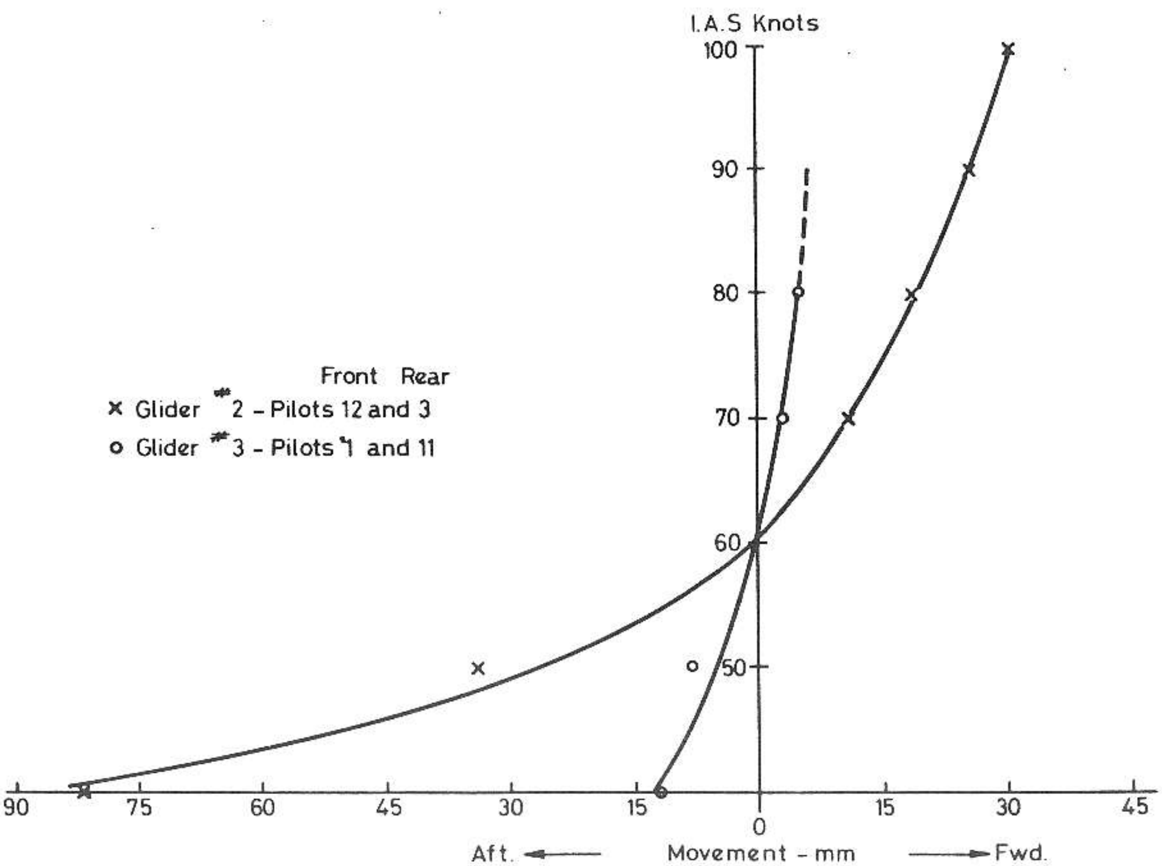

FIG.2 STICK DEFLECTION vs I.A.S FOR GLIDERS 2 AND 3 FROM 60 Kt POSITION

TABLE 1 SUMMARY OF RATINGS FOR TWO SEAT GLIDERS

Task		1 n	1 AVG.	1 S.D.	2 n	2 AVG	2 S.D.	3 n	3 AVG	3 S.D.	4 n	4 AVG	4 S.D.
1	I. Design	4	2.75	0.50	4	3.25	.95	3	3.00	1.00	3	3.33	1.52
2	A. Pilot Opin. of Const. & Rigging	7	2.85	1.06	4	3.00	1.15	5	4.60	.54	7	4.00	1.73
3	1. Ease of Inspection	7	2.28	.95	6	2.33	1.03	5	3.20	.44	6	2.50	1.30
4	2. Safety of Control Sys.	7	1.57	.53	6	2.50	.56	5	3.00	.70	6	2.50	.53
5	3. Ease of Assembly	7	3.00	0	3	2.66	1.15	5	5.00	1.22	5	4.00	1.41
6	B. Pilot Opin. of Cockpit Layout	7/6	2.28/2.33	.48/.51	7/5	2.71/2.80	.75/.83	5/5	1.80/4.20	.83/3.34	6/6	2.00/3.66	.63/2.25
7	1. Pilot Comfort	10/7	3.00/3.14	.81/1.21	8/6	2.00/2.33	.53/1.03	6/6	1.66/4.33	.51/1.36	8/8	1.87/3.87	.35/2.58
8	2. Control Sys. Arrang.	10/7	2.00/1.85	.65/.69	8/6	2.50/2.66	.53/1.03	6/6	2.16/4.50	.75/3.00	8/8	2.12/3.50	.99/2.32
9	3. Instrument Display	10/7	1.40/1.85	.54/.69	8/6	2.25/2.66	.70/1.21	6/6	1.66/1.66	.51/.51	8/8	1.62/2.87	.51/1.88
10	4. Pilot Visibility	10/7	1.60/2.14	.51/.69	8/6	1.62/2.66	.74/.81	6/6	1.33/2.00	.51/.89	8/8	1.50/2.87	.53/1.88
11	5. Pilot Safety	9/6	1.88/2.00	.60/.63	7/5	1.85/2.00	.37/.70	5/5	1.80/1.80	.83/.83	8/8	1.75/1.75	.70/.70
12	C. Pilot Opin. Suitability as Trainer	4	2.00	.81	5	2.80	1.30	5	3.80	.83	4	4.25	2.06
13	1. Communication	10/7	2.70/2.70	.82/.75	10/6	2.10/2.16	.56/.75	8/8	1.87/1.87	.83/.83	10/8	2.30/2.12	1.25/.99
14	2. Ventilation	10/7	2.40/2.71	1.42/1.79	10/6	2.10/2.33	.56/.81	9/8	2.55/3.00	1.13/2.26	10/8	1.60/1.75	.51/.70
15	3. Clear View Panels	10/7	2.10/1.85	.73/.69	9/6	2.11/2.16	.78/.75	9/8	1.66/1.75	.70/.70	9/7	1.66/1.71	.70/.75
16	4. Canopy Lock-Security	10/7	2.10/1.85	.78/.69	10/6	2.30/2.16	.94/.98	9/8	2.00/2.12	1.42/1.24	10/8	2.80/3.00	1.13/1.19
17	5. Placard Info.	9/6	2.77/3.66	.44/1.50	10/6	3.10/3.66	1.44/1.63	8/7	2.75/2.71	.46/.48	9/7	2.66/2.71	.86/.95
18	6. Ballast Loc. and Security	12	4.25	1.13	10	1.9	.73	8	4.00	1.19	9	4.33	1.22
19	7. Loc. of Anc. Controls	10/7	2.40/2.57	.84/.97	10/6	3.10/2.83	1.19/1.32	9/8	2.11/2.12	.60/.64	10/7	2.30/2.28	.46/.48
20	8. Operation of Anc. Cont.	10/7	2.90/2.85	1.19/1.06	10/6	2.80/2.66	1.91/1.21	9/8	2.55/2.25	1.01/.46	10/8	2.20/2.87	.78/1.24
21	9. Duplication of Controls	13	1.76	.43	12	1.75	.75	9	4.44	2.78	12	1.91	1.16
22	10. Instr. ability to override pupil	13	2.38	.65	12	2.58	.51	8	2.75	.70	11	5.36	3.44
23	11. Storage Space	10/7	3.50/3.28	1.17/1.11	10/6	2.90/2.66	1.10/1.21	9/8	2.44/2.62	.88/1.06	8/6	3.12/3.83	1.88/1.83
24	12. Comfort with Parachute	7/4	3.85/4.25	1.46/1.89	10/6	2.80/2.16	1.98/.75	9/8	2.22/3.75	.97/1.48	10/8	2.50/3.00	2.06/1.69
25	13. Instrumentation	10/7	2.40/2.14	.69/.69	10/6	2.30/3.00	.82/2.00	9/8	1.77/2.37	.66/1.18	10/8	0.80/1.87	.63/.64
26	14. Ident. of Anc. Controls	10/7	2.20/2.28	.42/.48	10/6	2.30/2.50	.67/.83	9/8	2.00/2.37	.70/1.18	10/8	2.40/2.87	.69/.83
27	15. Ground Handling	12	1.91	.51	12	3.33	1.23	8	1.08	1.16	9	3.20	1.64
28	16. Wheel Brake operation	7/4	4.00/4.00	1.00/1.40	9/6	3.66/3.83	1.00/.98	8/7	3.50/3.70	1.19/1.11	8/7	3.32/3.57	2.13/2.47
29	17. Seat Adjustment	7/6	4.85/5.33	1.77/1.50	9/6	2.44/3.00	1.01/1.26	9/8	3.55/4.87	1.81/1.24	9/7	4.11/4.57	1.83/1.81
30	18. Instr. for Operation of Anc contr.	10/7	3.00/3.57	.94/1.27	8/5	3.00/3.20	1.19/1.30	8/7	2.37/2.42	.74/.53	8/6	2.62/3.66	.74/.81
31	II. Smooth Air Manoeuvring	3	2.00	1.00	4	1.79	.50	3	2.00	0	-	-	-
32	A. Pilot opin. of Initial Take-off Roll	9	2.11	.78	8	1.62	.51	7	1.71	.48	11	2.90	1.57
33	1. Towline Hookup	9	1.44	.52	10	1.80	.78	9	1.55	.52	10	2.60	1.17
34	2. Control of glider in Init. Roll	9	2.00	.70	10	2.10	.78	9	2.22	.66	11	3.00	1.34
35	B. Pilot Opinion of Tow	9	2.44	1.33	7	1.85	.37	7	2.42	.53	9	2.11	.78
36	1. Ease of Maint. Position	9	2.44	1.33	10	1.60	.51	9	1.77	.44	11	2.27	.90
37	2. Aircraft Trim	9	2.44	1.32	10	2.10	.99	9	3.00	1.22	10	2.20	.91
38	3. Control in Wake	9	2.22	.66	10	2.00	.66	9	1.88	.60	11	2.18	1.16
39	4. Release characteristics	9	2.22	1.09	10	1.80	.42	9	1.66	.50	11	1.72	.46
40	C. Pilot Opin. of Long. Handling	8	2.00	.75	8	1.67	.35	6	2.16	.75	10	2.60	.69
41	1. Ease of estab. & maint. airspeed	10	2.10	.87	10	2.10	.73	9	2.00	.70	11	2.36	.50
42	2. Glider trim over speed range	9	2.77	1.09	10	2.80	1.13	9	3.88	1.45	10	2.56	.70
43	3. Pitch sensitivity	10	2.10	.73	10	2.10	.56	9	1.88	.33	11	2.96	1.30
44	4. Stick force gradient	10	2.10	.31	10	2.50	.97	9	2.22	.66	11	2.90	.83
45	5. Stick fixed stability	10	2.20	.42	10	2.40	.69	9	2.22	.66	9	3.11	1.26
46	6. Stick free stability	9	2.44	.72	10	2.40	.84	8	3.25	.70	8	3.12	1.35
47	7. Return to trim	9	2.66	1.00	9	2.44	.72	8	3.12	.83	9	3.33	1.22
48	8. Manoeuvring Response	10	2.20	.91	10	2.00	.47	8	2.00	.75	11	2.45	1.03
49	9. Phugoid characteristics	8	2.87	.99	10	2.30	.48	6	2.75	.88	7	2.71	.95
50	10. Dive Recovery	7	2.14	.37	10	2.10	.56	9	2.33	.86	9	2.66	1.32

51	D. Pilot Opin. of Lateral Handling	9	2.22	.66	7	2.00	.57	7	2.00	.57	6	2.66	1.21
52	1. Aileron force gradient	10	2.20	.42	10	2.50	1.08	9	2.11	.78	10	2.70	.82
53	2. Rudder force gradient	10	2.10	.56	10	2.00	.47	9	2.00	.70	10	3.20	1.93
54	3. Roll rate over Speedrange	10	2.40	.69	10	2.10	.56	9	2.00	1.00	10	2.40	.96
55	4. Slide slip characteristics	7	2.42	.78	7	2.57	.78	6	2.33	1.03	5	3.20	.44
56	5. Ease of turn entry	10	2.00	.94	10	1.90	.31	9	2.11	.78	10	2.30	.82
57	6. Yaw due to aileron	9	2.66	1.00	9	2.77	.83	8	2.37	.51	9	2.33	.86
58	7. Yaw due to roll	9	2.55	.52	9	2.22	.44	7	2.42	.53	9	2.22	.66
59	8. Ease of Maint. 45° Bank Turn	10	2.30	.67	10	1.80	.63	9	1.88	.78	10	2.00	.66
60	9. Ease of Maint. 60° Bank Turn	10	2.50	.84	10	2.10	.99	9	1.77	.97	10	2.10	.73
61	E. Pilot Opin.of Glider Stall-Spin Char	7	2.42	.53	5	2.60	.54	6	4.66	1.36	10	2.60	1.26
62	1. Rudder Ail. effect during stall	10	2.10	.67	9	2.22	.66	9	2.00	1.00	10	2.10	.31
63	2. Stall warning	10	2.40	.69	9	2.00	.86	9	2.66	1.11	11	2.36	.80
64	3. Steep stall-tendancy to spin	9	2.00	.70	9	2.66	.86	8	2.25	1.28	8	2.50	.92
65	4. Stock force gradient	10	2.10	.56	9	2.11	.78	9	2.11	.78	10	2.30	.67
66	5. Stall recovery, altitude loss	10	2.10	.73	9	2.44	.88	8	1.87	.64	11	2.00	1.00
67	6. Spin entry	9	2.66	.50	9	2.77	1.09	8	4.12	1.45	8	3.00	1.41
68	7. Spin recovery	9	2.22	.97	9	2.55	1.01	8	2.87	1.45	8	2.50	1.77
69	8. Stall from turn a'. low speed	10	2.30	.67	9	2.66	1.50	8	3.25	1.98	8	1.75	.88
70	F. Pilot Opin. of Glider Landing Char.	7	1.85	.69	6	1.66	.51	6	2.00	.89	9	2.33	1.32
71	1. Pilot Visibility	9	1.66	.70	10	1.80	.63	9	1.66	.70	11	2.09	.70
72	2. Glide Slope Control	10	1.50	.70	10	1.60	.69	9	1.66	.86	11	2.18	1.07
73	3. Airspeed cont., Airbrake usage	10	2.60	1.26	10	2.10	.56	9	1.66	.70	11	1.90	.70
74	4. Ease of Landing at Intended Spot	10	2.00	.66	10	1.60	.51	9	1.77	.83	11	2.09	.94
75	5. Ease of contr. sink at touchdown	10	1.90	.87	10	1.80	.42	9	1.88	.78	11	2.54	1.29
76	6. Control during rollout	10	2.10	.56	10	1.80	.63	9	1.77	.97	10	2.20	.91
77	III. Flight Characteristic in Thermal	3	2.00	0	3	1.33	.57	4	2.00	.81	2	3	0
78	A. Pilot Opinion of Tow	6	1.66	1.21	3	1.33	.57	4	1.75	.50	5	2.40	1.14
79	1. Ease of Maint. Position	6	2.00	.63	6	2.00	.89	4	1.75	.50	5	2.20	1.30
80	2. Response to Vertical Gusts	6	2.00	1.09	6	2.16	.98	4	1.50	.57	5	1.80	1.09
81	3. Release	6	1.50	.83	5	2.20	1.09	4	1.25	.50	5	1.60	.89
82	B. Pilot Opinion of Circling Flight	8	1.62	.51	7	1.85	.37	7	1.71	.48	6	1.83	.75
83	1. Low speed handling	10	1.30	.67	8	2.25	1.03	7	1.71	.75	6	1.83	.75
84	2. Stall-spin susceptibility	10	1.66	.69	8	2.50	1.51	7	1.57	.53	6	1.66	.81
85	3. Ease of centering thermal	10	1.80	.78	8	2.00	0	7	2.28	.75	6	2.16	.98
86	4. Speed Control	10	1.70	.67	8	1.75	.46	7	2.14	.69	6	2.33	1.03
87	C. Pilot Opinion of Cruising Flight	5	2.40	.89	4	1.75	.95	4	1.50	.57	6	1.66	.51
88	1. Ease of Controlling Airspeed	8	2.12	.83	4	1.90	.57	4	1.25	.50	6	1.66	.81
89	2. Pull up into thermal	8	2.25	1.16	4	1.75	.95	4	1.50	.57	6	1.56	.54
90	3. Ease of Perf. Secondary Tasks	8	1.87	.99	4	1.55	.50	4	1.75	.95	6	2.33	.81
91	4. Ride quality	6	2.00	1.09	4	1.25	.50	4	1.50	.57	6	1.66	.51
92	5. Ease of Maint. Straight Flight	6	1.83	1.16	3	1.33	.57	4	1.25	.50	6	1.50	.54
93	IV. Emergency Release Procedure	4	1.50	1.00	4	1.75	.95	4	1.75	.95	3	1.66	1.15
94	A. Pilot Opinion of Procedure	9	2.00	.70	9	1.88	.60	7	1.85	.69	10	2.10	.87
95	1. Ease of moving out of station	10	1.80	.63	9	1.77	.66	8	1.75	.70	10	1.90	.87
96	2. Ease of return to tow position	9	1.88	.60	9	1.66	.50	8	1.75	.88	10	1.80	.78
97	B. Pilot Opinion of Landing on Tow	-	-	-	-	-	-	-	-	-	-	-	-
98	1. Ease of Descending	2	2.50	2.12	-	-	-	-	-	-	-	-	-
99	2. Ease of landing on tow	3	2.00	1.00	-	-	-	-	-	-	-	-	-
100	V. Ferry Towing at Max Aerotow Speed	6	2.33	.51	4	1.75	.95	4	3.50	1.29	6	2.00	1.09
101	1. Ease of Maintaining Position	9	2.22	.83	7	1.57	.53	6	2.16	.98	10	2.00	.81
102	2. Trim capability high tow	8	2.12	.35	7	2.00	.57	6	2.66	1.21	10	2.40	1.07
103	3. Trim capability low tow	9	2.44	.72	7	2.00	.57	6	3.33	1.21	9	2.33	1.11
104	4. Ease of using air brakes	9	2.44	1.23	7	1.71	.48	5	4.00	1.41	8	2.87	1.35

TABLE 2 GLIDER DIMENSIONAL PARAMETERS

* WITHOUT WATER BALLAST

PARAMETER	UNITS	GLIDER 1	2	3*	4
Wing Span	m	15.9	17	17.5	18.2
Wing Area	m^2	17.5	18.24	17.9	16.6
Aspect Ratio		23	15.8	17	20
MAC	m	1.09	1.13	1.01	0.91
Max Weight	kg	480	590	540	620
Wing Loading	n/m^2	268.7	316.9	295.6	366.02
Root Chord	m	1.5	1.46	1.28	1.2
Tip Chord	m	0.6	0.65	0.45	0.48
Fuselage Length	m	8.18	8.3	8.12	8.57
Fuselage Width	m	0.70	0.70	.74	0.71
Horiz. Tail Area	m^2	2.25	4.09	2.11	1.24
Horiz. Tail Span	m	3.00	3.48	3.3	2.7
Elevator c_f/c		.46	.43	.29	1.0
Vert. Tail Area	m^2	1.21	2.31	1.86	1.24
L/D (Handbook)		28	34	39	39
C.G Range	mm	70 - 247		260 - 460	30 - 300
	% MAC		22-40.6		

TABLE 3 EVALUATION PILOTS - STATISTICS

(A) FLIGHT EXPERIENCE - HOURS

AIRCRAFT TYPE	PILOT IDENT. NO. 1	2	3	4	5	6	7	8	9	10	11	12
GLIDER - TOTAL	1110	700	1320	1475	1800	3600	450	400	950	2000	1280	1600
NO. 1	600	100	120	50	50	10	1	100	500	120	15	60
NO. 2	1	0	5	0	20	400	0	0	15	150	18	40
NO. 3	1	50	8	0	20	400	20	50	0	1	20	10
NO. 4	1	1	-	30	180	5	1	20	0	50	12	12
POWER - TOTAL	90	0	440	30	300	8000	0	1000	450	1300	350	60
SEL	90	0	440	25	300	7400	0	1000	450	1285	350	60
MEL	0	0	0	5	0	600	0	0	0	15	0	0

(B) PILOT MASS - KG

95	67	83	87	83	78	65	85	89	90	79	70

TABLE 4 EVALUATION FLIGHT EXERCISES

A. TAKEOFF
EVALUATE CONTROL OF GLIDER DURING INITIAL ROLL INCLUDING CROSSWIND EFFECTS.

B. DURING LAUNCH
1. EVALUATE TAKE-OFF.
2. EVALUATE TOW CHARACTERISTICS; BOX TOW PLANE.
3. TOW AT MAX. AEROTOW SPEED; CHECK TRIM IN HIGH AND LOW TOW, CHECK USE OF AIR BRAKES.

C. FREE FLIGHT
1. EVALUATE STALLING ENTRY AND RECOVERY.
2. INVESTIGATE INCIPIENT AND FULL SPIN BEHAVIOUR E.G. EASE OF ENTRY, MAINTAINING SPIN AND RECOVERY.
3. EVALUATE STICK FREE STABILITY. TRIM AT 60 AND 90 KTS. INTRODUCE 5 KT INCREASE OR DECREASE IN AIRSPEED AND RELEASE STICK NOTING SUBSEQUENT MOTION.
4. NOTE TRIM EFFECT OF OPERATING UNDERCARRIAGE, AIRBRAKES AND FLAPS.
5. MEASURE STICK POISITION OVER SPEED RANGE AND NOTE STICK FORCE.
6. TIME ROLL RATE FOR 45 DEGREE AND 60 DEGREE BANK TURNS AT 60 AND 90 KTS.
7. EVALUATE HANDLING IN THERMALS (IF AVAILABLE).

D. LANDING
1. EVALUATE EASE OF CONTROLLING GLIDE SLOPE.
2. EVALUATE FLARE CHARACTERISTICS AND TOUCHDOWN.

TABLE 5 CONTROL STICK POSITION

(mm FROM FULL BACK STOP)

SPEED KTS.	GLIDER 1	GLIDER 2	GLIDER 3	GLIDER 4*
40	166/141	—, 45	36, 48, 52	—, —, 53, —, 78, 60
45	—	94, —	—	—, —, —, 54, —, —
50	189/161	110, 95	50, 60, 82	88, 113, 93, 72, 84, 95
60	201/170	125, 130	58, 67, 92	103, 128, 110, 92, 93, 117
70	—/178	132, 140	61, 69, 99	108, 135, 119, 102, 97, 124
80	—/181	136, 148	63, —, 102	112, 139, 124, 105, 102, 129
90	—/184	138, 155	—, —, 104	114, 142, 128, 110, —, 132
100	—	—, 161	—	—
FWD. STOP	303/272	230/234	144, 146, —	173, 218, 217, 168, 149, 219

NOTES: FLAP SETTING ZERO UNLESS NOTED.

a/b : FRONT STICK/REAR STICK POSITION

— : NOT RECORDED.

a,b,c : PILOT COMBINATIONS a, b, c, ETC.

* : SIXTH PILOT HAD PLUS 6° FLAP APPLIED.