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Pilot Evaluation of Sailplane Handling Qualities

A. G. Bennett, Jr.

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Pilot Evaluation of Sailplane Handling Qualities

A. G. Bennett, Jr.
Mississippi State University
Mississippi State, Mississippi

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1. INTRODUCTION

The performance of competition sailplanes as measured by maximum lift to drag ratio ($L/D_{\text{max}}$) or average cross-country speed has shown a steady improvement with time as shown in Figure 1 (Reference 1). This performance improvement has been due to the continual evolution of airfoils and of fiberglass and metal structures to achieve low drag and high aspect ratio wings. The quest for high performance has had a profound effect upon the handling qualities of sailplanes. The increased $L/D_{\text{max}}$ has increased the range of flight speeds. To minimize the trim drag, the static stability margin has been decreased which has increased control sensitivity and decreased pitch control force gradients. The very slender wing and fuselage structures have also introduced aeroelastic effects upon the sailplane control response characteristics.

There has been some concern voiced about the trends in high performance sailplane handling qualities. Poor handling qualities generally result in increased pilot workload which may compromise flight safety. Thus there is a strong interest in determining whether the current trends in sailplane performance improvement can continue while at the same time a high level of flight safety can be maintained.

The primary objective of this study was to make a qualitative evaluation of all aspects of high performance sailplane handling qualities and to define areas which require further study. To accomplish this objective at a modest cost, a round-robin flight evaluation of several sailplanes by several test pilots was conducted. The Cooper-Harper Rating Scale and pilots' comments
were to be used to evaluate the sailplane handling qualities. The specific objectives of this study were:

1. Using the Cooper-Harper Rating Scale and pilot comments investigate the handling qualities of high performance sailplanes.

2. Obtain pilot opinion of handling quality characteristics to assist the formulation of airworthiness standards.

3. Develop a data base of pilot opinion which would be of value in the design of future sailplanes.

4. Delineate areas which warrant more quantitative study.

The development of high performance sailplanes has evolved in discrete stages with several sailplanes vying for the market at each stage. Thus it was determined that if the sailplanes developed since the early 60's were arranged into groups, then one sailplane from each group should be chosen for the evaluation session. The sailplane grouping logic is given as follows:

- **Group 1:** Borderline between utility and racing class, \( L/D_{\text{max}} \) mid 30's.
- **Group 2:** First sailplanes to use fiberglass structures. Represents technology in the late 60's. Most have camber changing flaps and/or drag chute.
- **Group 3:** Sailplanes developed in early 70's. Most numerous class in USA today, hence important.
- **Group 4:** Sailplanes developed during mid 70's. Just becoming available in substantial numbers. Most have landing flaps.
- **Group 5:** Very high performance, \( L/D_{\text{max}} = 50 \). Effect of large span on handling can be established by this class.
- **Group 6:** High performance two place. Used in transition to high performance single place sailplanes.

Test pilots for the flight session were chosen from NASA, FAA and the soaring community to ensure that a wide range of pilot backgrounds would be brought to bear upon the sailplane handling quality evaluations.

The text which follows describes the evaluation session and presents the analysis of the pilot opinion data. Chapter 2 describes the sailplanes, pilots and the flight session. Chapter 3 presents the analysis of the pilot opinion data.
ratings and comments. The evaluation questionnaire, pilot ratings, and pilot comments are presented in the Appendices.

The sailplane owners are due a special thanks for lending their sailplanes for the flight test session. They were Mr. John Thompson, McCrory, Arkansas; Mr. Lanier Franz, Roanoke, Virginia; Mr. Dave Lawrence, Starkville, Mississippi; Mr. Marion Griffith, Dallas, Texas; Schweizer Aircraft Corporation, Elmira, New York; and the Air Force Flight Dynamics Laboratory, Dayton, Ohio. Many members of the Soaring Society of America gave this project unstinting support. Mr. Howard Ebersole, Associate Director of the Raspet Flight Research Laboratory, provided excellent organizational support in the sailplane preparation and in the flight session. The departmental staff support for this project was as usual, superb.
2. SAILPLANE FLIGHT TEST SESSION DESCRIPTION

2.1 Introduction

The flight test session had to satisfy several requirements and constraints. The round-robin evaluation format required that six sailplanes and seven test pilots must be on site simultaneously. To accommodate the pilots busy flight schedules, the flight session was organized to conduct the flight activities necessary to acquire the required data in a maximum of 7 days. The session was scheduled for the early May period to avoid conflicts with the soaring season, and yet to have the possibility of encountering soaring conditions. In all respects, the flight session was a complete success. There were no problems acquiring the sailplanes, the weather during the flight session was perfect, the test pilots were very enthusiastic, and cooperative, and all operations were conducted safely.

2.2 Evaluation Sailplanes

Within the previously mentioned groups of sailplanes, a ranking was made to determine which one had characteristics of most interest to this investigation. At the same time, only sailplanes with standard approved type certificates were considered. The soaring community was most cooperative in supporting the acquisition of the evaluation sailplanes.

Sailplane 1. This sailplane was chosen since it represents the transition to higher performance ships. It has a fixed horizontal stabilizer with a fairly large chord elevator. The fixed gear is ahead of the center of gravity. The sailplane is equipped with schemmp-Hirth type divebrakes.

Sailplane 2. This sailplane is equipped with camber changing flaps which are inter-connected with the ailerons. The landing gear is retractable and is ahead of the center of gravity. The sailplane has schemmp-Hirth type divebrakes, and a very short, straight control stick. The sailplane is placarded against intentional spins.

Sailplane 3. This sailplane was selected from Group 3. It has an all-moveable horizontal tail and a control stick which curves slightly toward the pilot. The ship is equipped with retractable landing gear ahead of the center
Table 1

Sailplane Dimensional Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing Span</td>
<td>m</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
<td>20.3</td>
<td>17.4</td>
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<tr>
<td>Wing Area</td>
<td>m²</td>
<td>12.40</td>
<td>9.48</td>
<td>10.00</td>
<td>9.64</td>
<td>14.40</td>
<td>16.72</td>
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<tr>
<td>Aspect Ratio</td>
<td></td>
<td>18.1</td>
<td>23.6</td>
<td>22.5</td>
<td>23.3</td>
<td>28.6</td>
<td>18.0</td>
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<tr>
<td>MAC</td>
<td>m</td>
<td>0.885</td>
<td>0.687</td>
<td>0.704</td>
<td>0.681</td>
<td>0.756</td>
<td>1.069</td>
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<tr>
<td>Max Weight</td>
<td>kg</td>
<td>299</td>
<td>300</td>
<td>300/390</td>
<td>299/422</td>
<td>445/580</td>
<td>649</td>
</tr>
<tr>
<td>Wing Loading</td>
<td>n/m²</td>
<td>234.6</td>
<td>311.2</td>
<td>325.6/383</td>
<td>306.4/430.9</td>
<td>301.6/392.6</td>
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<tr>
<td>Root Chord</td>
<td>m</td>
<td>1.232</td>
<td>0.940</td>
<td>0.955</td>
<td>0.914</td>
<td>0.980</td>
<td>1.483</td>
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<td>Tip Chord</td>
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<td>0.343</td>
<td>0.368</td>
<td>0.373</td>
<td>0.350</td>
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<td>Fuselage Width</td>
<td>m</td>
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<td>0.610</td>
<td>0.635</td>
<td>0.584</td>
<td>0.610</td>
<td>0.813</td>
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<td>Hor. Tail Area</td>
<td>m²</td>
<td>1.65</td>
<td>1.04</td>
<td>0.99</td>
<td>1.00</td>
<td>0.99</td>
<td>2.03</td>
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<tr>
<td>Hor. Tail Span</td>
<td>m</td>
<td>2.819</td>
<td>2.395</td>
<td>2.408</td>
<td>2.032</td>
<td>2.408</td>
<td>3.200</td>
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<tr>
<td>Elevator C₉/c</td>
<td></td>
<td>0.42</td>
<td>0.28</td>
<td>1.00</td>
<td>0.56</td>
<td>1.00</td>
<td>1.00</td>
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<tr>
<td>Vert. Tail Area</td>
<td>m²</td>
<td>1.13</td>
<td>1.06</td>
<td>0.84</td>
<td>0.78</td>
<td>---</td>
<td>1.43</td>
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<tr>
<td>L/D max (Handbook)</td>
<td></td>
<td>32</td>
<td>39</td>
<td>35.2</td>
<td>37</td>
<td>49</td>
<td>34</td>
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<tr>
<td>Fwd C.G.</td>
<td>% c</td>
<td>20</td>
<td>25</td>
<td>26</td>
<td>27.8</td>
<td>29</td>
<td>25</td>
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<tr>
<td>Aft C.G.</td>
<td>% c</td>
<td>40</td>
<td>52</td>
<td>47</td>
<td>38.2</td>
<td>45</td>
<td>38</td>
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<tr>
<td>I yy (Approx.)</td>
<td>kg m²</td>
<td>186</td>
<td>186</td>
<td>204</td>
<td>186</td>
<td>407</td>
<td>1178</td>
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</table>
Figure 2. Three View of Sailplane 1.
Figure 3. Three View of Sailplane 2.
Figure 4. Three View of Sailplane 3.
Figure 5. Three View of Sailplane 4.
Figure 6. Three View of Sailplane 5.
Figure 7. Three View of Sailplane 6.
of gravity, and has upper surface divebrakes. Intentional spins are prohibited with this sailplane.

Sailplane 4. This sailplane has a conventional fixed stabilizer and moveable elevator. The retractable landing gear is located slightly behind the center of gravity. The camber changing flaps, interconnected with the ailerons, can be positioned up to 90 degrees for landing.

Sailplane 5. This ship had the largest wing span among the evaluation sailplanes. The horizontal tail, control stick and landing gear arrangement was identical to that of sailplane 3. This ship is equipped with camber changing flaps interconnected with the ailerons, and with upper surface divebrakes.

Sailplane 6. This sailplane represented a typical, fairly high performance two seater. It features a fixed landing gear, an all moveable horizontal tail equipped with anti-servo tab and large counterbalanced dive brakes.

A three-view drawing of each sailplane is shown in Figures 2 through 7, and the principal geometric characteristics are presented in Table 1.

In general, each sailplane was in excellent mechanical condition. Since in some of the ships intentional spins were prohibited and/or some of the ships were not equipped with water ballast or drag chutes, the effect of these three factors on the overall sailplane handling qualities was not evaluated.

2.3 Evaluation Pilots

Each evaluation pilot is affiliated with one of the following organizations: Soaring Society of America, Inc., the Federal Aviation Administration and the National Aeronautics and Space Administration. Table 2 indicates the number of flight hours as pilot in command of each pilot. Two of the pilots were professional experimental test pilots and had considerable experience with the Cooper-Harper rating scale. Four of the seven pilots had considerable sailplane cross-country and competition flying experience. Preceding the flight test sessions, these four pilots were asked to describe to the rest of the group in detail what they conceive to be the flight role or mission of
a high-performance sailplane. Thus, all of the pilots had a clear understanding of the broad mission for which this class of aircraft is designed.

Table 2
Evaluation Pilot Flight Experience

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>1</th>
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<th>6</th>
<th>7</th>
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</thead>
<tbody>
<tr>
<td>Sailplane</td>
<td>6500</td>
<td>1500</td>
<td>700</td>
<td>30</td>
<td>20</td>
<td>1500</td>
<td>20</td>
</tr>
<tr>
<td>SEL</td>
<td>500</td>
<td>500</td>
<td>200</td>
<td>600</td>
<td>200</td>
<td>1000</td>
<td>2450</td>
</tr>
<tr>
<td>MEL</td>
<td>1800</td>
<td>2600</td>
<td>3800</td>
<td>5000</td>
<td>1250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jet Fighter</td>
<td>2500</td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td>1500</td>
<td></td>
</tr>
<tr>
<td>Jet Transport</td>
<td>450</td>
<td>7000</td>
<td>3500</td>
<td>4000</td>
<td>550</td>
<td></td>
<td></td>
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<tr>
<td>Helicopter</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>250</td>
</tr>
</tbody>
</table>

2.4 Flight Session Preparation

To achieve the objectives of the evaluation session, several tasks were conducted prior to the session. An overriding consideration was the round-robin format for the session which required six sailplanes and seven pilots to be brought together for a one week period. Since the pilots were available for a limited time, it was most important that the sailplanes be properly prepared in advance of the session. A constraint upon the session date was that it must occur early in the year so that the borrowed sailplanes would not be away from the owners during contest activities.

The session data was scheduled for May 1 thru May 6, 1976, so that University students could assist in the flight operations. With the grant awarded February 16, 1976, this session date would allow time for sailplane acquisition, pilot selection, sailplane checkout, instrumentation development and flight session planning. The schedule was tight but all objectives were accomplished.

The acquisition of the sailplanes was found to be much easier than anticipated. A few phone calls to members of the soaring community quickly revealed that the sailplanes of interest were available in the southeastern region of the U.S. The owners were most interested in assisting in this investigation.
Prior to the flight session, all sailplanes except 4 and 5 were acquired with sufficient time for a thorough inspection, airspeed calibration check, and weight and balance check. Sailplanes 4 and 5 were delivered by evaluation pilots and had prior checkout.

Sailplane 6 was acquired early and was used as a testbed for formulating the evaluation tasks and for the development of a simple sailplane data acquisition system. A battery powered signal conditioning unit was developed to give a digital display of either stick position or stick force to the pilot. It was found that small low friction potentiometers could be quickly attached to the sailplane control linkages, but the press of other flight activities and difficulties with pilot data recording limited the utility of quantitative data recording during the flight session. The stick forces were too low for the stick force balance borrowed from Dryden Flight Research Center and also the balance was too bulky for high performance sailplane control sticks.

2.5 Flight Session

The flight session was conducted May 1 through May 6, 1976. The weather was ideal throughout the session with a wide range of convection conditions present. The pilots were allowed to fly each of the ships as required to complete the evaluation questionnaires. Cassette recorders were used to record inflight comments to be used later during the evaluations. A maneuver list was supplied to further support the evaluation.

A total of ninety-eight flights were made for a total of 80 flying hours. The sailplane evaluation forms were completed during the session to maximize evaluation effectiveness. The pilots were most cooperative and willing to participate. The session was very flight intensive, yet all objectives were accomplished without any mechanical or safety problems.

2.6 Pilot Opinion Sampling Instruments and Data Presentation

The primary objectives of this study were to (1) obtain pilot opinion of the handling qualities of current high performance sailplanes, (2) to aid in the formulation of certification criteria, (3) to provide some guidance in future designs, and (4) to delineate areas which require further study. The most cost effective method to accomplish this task was to stage a round-robin
flight session in which seven test pilots evaluated six sailplanes representing distinct groups. The detailed sailplane handling quality pilot opinion data was obtained with a questionnaire which used the Cooper-Harper Rating Scale and pilot comments.

Questionnaire I (Appendix A) was designed to record the pilot's rating and comments of the sailplanes' handling qualities, design and cockpit layout. Each test pilot completed a questionnaire for each sailplane that he flew. The questionnaire was configured to evaluate the pilots' opinion of the sailplane handling qualities over the entire operating envelope from takeoff to landing. Specifically, each flight consisted of a tow to an altitude of 2700 or 3300 meters (AGL) depending on the pilot's preference. Evaluation tasks in smooth air were carried out before the flight reached lower altitudes (1000-1200 meters AGL) where convective conditions were usually encountered. On the average, the duration of each flight was 45 minutes, although some thermalling flight evaluations lasted as long as two hours. Evaluations were made in both smooth air and in thermalling flight to determine if there were any significant pilot opinion differences between the smooth air test conditions and the usual operational environment, that is under convective conditions. A set of maneuvers listed in Table 3 was flown by each pilot to provide a basis for the evaluations. The pilots made comments on cassette recorders during each flight and these comments were transcribed by the pilots to the questionnaires. The questionnaire included evaluations of the design and cockpit layout.

The Cooper-Harper Rating Scale (Reference 21), widely used in the evaluation of handling qualities of powered aircraft, was adopted for this questionnaire. The attractive feature of the Cooper-Harper Rating Scale, Figure 8, is the decision tree structure which guides the pilot to a number for his rating value. For this initial study, the interpretation of the rating scale was broadened to be used in the evaluation of such sailplane characteristics as ease of assembly, inspection, and cockpit layout. The key to this interpretation was the assumption that the pilots would compensate for deficiencies in the design as they would for deficiencies in flight stability and control. It should also be noted that only two of the seven pilots had extensive previous experience with the Cooper-Harper rating scale.
Table 3
Evaluation Flight Tasks

A. Smooth Air Maneuver List

1. Evaluate take-off roll.
2. Evaluate tow characteristics; box tow plane.
3. Release, slow flight, stall entry, general characteristics.
5. Evaluate return to trim at 60 and 90 kts IAS.
6. Evaluate stick free stability. Trim at 60 and 90 kts. Introduce 5 kts airspeed perturbation and release stick. Note rate of convergence or divergence, time period of oscillation.
7. Evaluate stick position and force gradients over speed range. Trim at 75 kts, decelerate slowly to near stall then accelerate to 100 kts.
8. Evaluate pitch altitude response to small stick pulses over speed range especially at high speed (may be combined with Item 7).
9. Evaluate stick forces during pull up from high speeds.
10. Time roll rate during turn reversal (from 45° to 45° bank) at min. sink speed and at 65 kts. Evaluate ease of maintaining constant airspeed and coordination (zero sideslip).
12. Evaluate constant g turn, 45° bank, 60 kts, L and R.
13. Evaluate constant g turn, 60° bank, 70 kts, L and R.
14. Evaluate flight path control system, pattern, flare characteristics, ease of touchdown control, landing roll.

B. Convective Flight Maneuver List

1. Evaluate takeoff, possibly crosswind effects, and tow characteristics in turbulence.
2. Evaluate stall/spin (incipient spin only) characteristics. Note onset of pre-stall buffet.
3. Thermalling characteristics
   a. Low speed turns
   b. Stall-spin susceptibility, recovery
   c. Control characteristics near other aircraft
4. Interthermal flight evaluation. Fly at max L/D speed plus 10 kts and at rough air airspeed or 100 kts IAS (whichever is lower).
5. Evaluate handling during secondary task.
6. Evaluate glide path control, touchdown and rollout characteristics in turbulence.
Figure 8. Cooper-Harper Rating Scale
Consequently, the other pilots had a tendency to use the Cooper-Harper Scale as a linear interval scale.

After the flight session was completed, the Cooper-Harper ratings and pilots' comments for each task of Questionnaire I were transcribed into a data file on the university mainframe computer to facilitate the analysis and presentation of the data. The Cooper-Harper Rating Scale, is not a linear scale, thus statistical techniques do not strictly apply. However, averages and standard deviations were computed to gain some measure of the consensus of pilot opinions. An average and standard deviation of all subtasks for each pilot were computed to allow correlation of the average of subtasks ratings with the major task rating. The pilots' responses to Questionnaire I are given in Appendix B. The format adopted was to group the responses of all pilots for all sailplanes covering a major area of interest such as longitudinal handling, etc. Extreme caution should be exercised in drawing conclusions from the numerically averaged ratings. As can be seen from the individual pilot ratings, different pilots used different standards of acceptance.
3. RESULTS AND DISCUSSION

3.1 Pilot Rating Summaries

The Cooper-Harper Rating Scale is a valuable tool in the evaluation of aircraft handling qualities. To provide a measure of the variability of the pilot's assignment of ratings, averages and standard deviations for each task were computed for each sailplane. Again, it must be emphasized that the Cooper-Harper Rating Scale is non-linear and thus statistical methods do not strictly apply. Table 4 presents a summary of the average and standard deviation of all pilot ratings of a task for each sailplane. These average readings should not be directly compared with the levels of acceptability shown on the Cooper-Harper scale, but are rather a gross indication. Average Cooper-Harper ratings greater than 3.5 (with no specific meaning attached) have been underlined to delineate areas where problems were noted by most of the pilots. The standard deviations are a measure of the variation in the pilot's rating of a particular task.

Pilot rating numbers without their accompanying pilot comments are of very little value. The individual pilot ratings and comments furnished in Appendix A are rather formidable in their volume and scope. The numerical summaries of Table 4, rather than being accepted by the reader at their Cooper-Harper rating scale face value, should be used as a guide to point out sections of particular interest in the appendix pilot rating information.

Sailplanes 4 and 6 received poor ratings in construction and rigging. Sailplanes 4 and 5 rated down in cockpit layout, sailplanes 3 and 5 in longitudinal handling qualities, and sailplane 6 in stall/spin characteristics. Sailplanes 3, 4, and 5 were given poor ratings in landing characteristics, and sailplane 6 in circling flight. Sailplane 1 received consistently higher ratings than all other aircraft, in every rating category, and was often cited as a benchmark of excellence for sailplane handling qualities. To gain more than this superficial information, the reader must refer to the individual pilot comments in the above areas, which provide an understanding of the reasons for the ratings.
### Table 4. Rating Summary for Sailplanes

<table>
<thead>
<tr>
<th>TASK</th>
<th>1</th>
<th>2</th>
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<th>6</th>
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<td>I. Design</td>
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<td>STDV</td>
<td>AVG</td>
<td>STDV</td>
<td>AVG</td>
<td>STDV</td>
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<td>A. Pilot Opin. of Const. Rigging</td>
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<td>1.00</td>
<td>1.37</td>
<td>.41</td>
<td>2.25</td>
<td>.43</td>
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<tr>
<td>1. Ease of Inspection</td>
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<td>.82</td>
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<td>.50</td>
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3.2 Pilot Evaluation of Ease of Assembly, Inspection and Cockpit Layout

Although these factors are generally not regarded as an essential part of handling qualities, as, say, longitudinal stability, all three characteristics do influence the ease and precision with which the pilot is able to perform tasks for the overall mission of the sailplane. In rating these characteristics, the pilots tended to disregard the dichotomous structure of the Cooper-Harper scale; instead, they were asked to rate these factors on a linear scale from one to ten. Also, three of the pilots did not rate the ease of assembly and inspection since the flight test session did not provide enough time for them to become familiar with these characteristics.

The pilots who rated the ease of assembly and ease of control system inspection generally gave better ratings to the newer machines. These pilot ratings also confirmed the fact that frequent assembly/disassembly is part of the high-performance sailplane role and the ease of assembly should be a very important design objective.

Pilot comments on the cockpit layout show that there were wide variations among the six evaluation sailplanes. The pilots found visibility was adequate in all ships. They singled out poor ventilation, the use of curved control sticks, confusing or unhandy secondary control handles (such as trim and flap handles), need for good pilot protection as areas of concern. The variety of adverse comments indicates the need of some sort of standardization for the location, shape and color of the secondary control handles.

3.3 Pilot Opinion of Longitudinal Characteristics

Takeoff. Average pilot ratings ranged from 1.8 for sailplanes 1 and 6 to 3.2 for sailplanes 2 and 5. Sailplanes 1 and 6 were generally the most stable, had the highest stick forces, and had strong damping of the short period pitching oscillation. Pilots commented that sailplane 2 was more sensitive in pitch than they liked, and that they tended to overcontrol in pitch during takeoff. On sailplane 5, pilots reported disliking the stick bobbing force and aft when rolling over bumps. One pilot felt it necessary to maintain greater ground clearance while he was airborne and waiting for the towplane to accelerate to takeoff speed than with other gliders and that wing flexing resulted in undesirable excursions in fuselage-to-ground...
clearance. Although he gave a pilot rating of 2, one pilot noted that on sailplane 4, the longitudinal stick feel-and-trim spring system had high and unsymmetric breakout forces which caused him to overcontrol.

**Tow.** Again, pilot ratings were best for sailplanes 1 and 6, averaging 1.4 for 1 and 1.5 for 6. The worst average rating was 3.5 for sailplane 5. Pilots strongly objected to inertially induced stick forces, and reported overcontrolling, and a feeling that a serious PIO could occur. When the tow speed was increased from the standard 70 knots to 80 knots, the overcontrol/PIO tendency was reported more severe. One pilot reported he was unwilling to fly left-handed while raising the landing gear on tow. Sailplane 2 was reported easily upset in rough air, requiring frequent small control corrections. It received several pilot ratings of 3. Sailplane 4 was reported sensitive and easy to overcontrol, receiving pilot ratings of 2 and 3.

**Establishing and Maintaining Airspeed.** Establishing and holding speed was rated satisfactory for all sailplanes. It was reported by one pilot to be difficult to make fine speed corrections in sailplane 4 due to high breakout forces (his pilot rating was 2 however). For sailplane 5, one pilot reported that a pitch correction tended to continue past the intended point and had to be arrested by a checking control input, (his pilot rating was 4).

**Longitudinal Trimming.** The trim system on sailplane 1 was rated unsatisfactory. Comments were that it was ineffective and inconvenient. The trim system of every sailplane was reported as inconvenient to use, but only sailplane 1 was rated unsatisfactory. Comments indicated that pilots were content to fly without trimming rather than use inconvenient trim devices, except in the case of sailplane 6 in which stick forces became excessive.

**Pitch Sensitivity.** Sailplanes 3 and 5 received some pilot ratings of 4 and 5 for oversensitivity. Sailplanes 2, 3, 4, and 5 were described as sensitive, but 2 and 4 did not receive poor pilot ratings for sensitivity.

**Stick Force Gradient, Stick Fixed Stability, and Stick Free Stability.**

These were not tasks, but requests for opinions on the suitability of the listed characteristics. In the absence of quantitative data and since the pilot comments were rather general, the responses to these three requests for pilot opinion are broadly summarized: sailplane 1 was well liked; numbers 2, 3, and 5 were characterized as having light stick forces, bordering on too
light, while sailplanes 4, and, even more so, 6, were judged to have too-heavy stick forces.

**Return to Trim.** The pilots were satisfied with the return-to-trim characteristics of all sailplanes, giving pilot ratings of 2 to 3. An exception to this was pilot 1 who apparently excited the phugoid mode on this test and rated phugoid damping. Two pilots felt the task had no relevance to their opinion of a sailplane's handling qualities. Early NACA flying qualities tests by Gilruth (Reference 3) also showed that the tendency to return to trim speed was relatively unimportant for visual flight.

**Maneuver Response.** Opinions diverged on the maneuvering responses of the six sailplanes. Sailplane 1, 4, and 6 were well liked by all pilots, receiving mostly 1 and 2 pilot ratings. Sailplane 2 received mostly 3 ratings and comments giving the impression it was more responsive than the pilots liked. Sailplanes 3 and 5 got mixed opinions. Sailplane 3 was rated 4 and sailplane 5 rated 5 due to low or nil stick-force-per-g by some pilots. Delayed g response due to the flexible wing was reported to cause difficulty in stabilizing rapidly applied g by one pilot.

**Phugoid Characteristics.** This was not a flying task susceptible to pilot rating. Nonetheless pilots expressed their opinions of the suitability of the characteristic. Pilots were satisfied with the lightly damped or neutral stick-free phugoids of sailplanes 1, 2, 4, and 6, while some pilots objected to the strongly divergent stick-free phugoids of sailplanes 3 and 5. The divergent motions appeared to be caused by a dynamical interaction between the sailplane phugoid mode and the pitch control system.

**Dive Recovery.** Sailplanes 1, 4, and 6 were regarded as satisfactory. Sailplane 2 was given satisfactory pilot ratings, but several comments suggested that it was more sensitive than desired. Sailplanes 3 and 5 were rated unsatisfactory by some pilots who commented that the stick forces were too light, and sometimes reversed during pull-outs.

**Ease of Centering Thermal, and Speed Control in Circling Flight.** All sailplanes were rated satisfactory for these tasks. Comments indicated that the high stick forces and heavy stability of sailplane 6 caused an undesirably high workload in circling at varying bank angles as is typically done in thermalling flight. On sailplane 3, comments noted that the very low or negative stick-force-per-g was very pleasant to fly and felt immediately
natural and comfortable during the thermalling task. On sailplane 5 the same comments were made, and additionally that in an established thermalling turn the stick could be moved as much as 7 cm aft without appreciably affecting the turn. This later characteristic was not felt objectionable.

Table 5
Sailplane Longitudinal Stability and Control Characteristics

<table>
<thead>
<tr>
<th>Sailplane</th>
<th>Control Forces</th>
<th>Trim</th>
<th>Static Longitudinal Stab.</th>
<th>Stick-Free Short Per. Damping</th>
<th>Stick Force Per G</th>
<th>Perceived Sensitivity</th>
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<td>Aerodynamic + Spring</td>
<td>Spring</td>
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<tr>
<td>2</td>
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<td>&quot;</td>
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<tr>
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<td>4</td>
<td>Aerodynamic + Spring</td>
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<td>6</td>
<td>Aerodynamic Tab</td>
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Table 6
Summary of Opinions on Longitudinal Handling Qualities

<table>
<thead>
<tr>
<th>Sailplane</th>
<th>Takeoff and Tow</th>
<th>Straight Flight</th>
<th>Maneuvering &amp; Dive Pull-Out</th>
<th>Thermalling</th>
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<td>Well Liked</td>
<td>Satisfactory</td>
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Table 5 summarizes the longitudinal stability and control characteristics of the sailplanes evaluated and Table 6 summarizes the pilot opinion of longitudinal handling qualities for primary flight tasks. Table 6 shows that longitudinal characteristics best liked for thermalling are less well liked for takeoff, tow, maneuvering, and dive pull-out. From Table 5 it appears that increased stability and reduced sensitivity are beneficial to the first three tasks while lower stability and greater sensitivity are desirable for the last task. Table 6 shows that all the sailplanes had satisfactory or better longitudinal handling qualities for normal flying and thermalling, and that all but one were also satisfactory for maneuvering and dive pull-out. This was not surprising since all of the evaluation sailplanes were commercially successful in series production.

3.4 Sailplane Lateral-Directional Handling Qualities

Sailplane performance growth has not influenced lateral-directional handling qualities as much as the longitudinal handling qualities, although both have been degraded. The only serious lateral-directional problem apparent in current high performance sailplanes is in takeoff and landing, where low roll control and rudder power can lead to loss of directional control, especially in crosswinds. One cause is the placement of the landing wheel ahead of the C.G., which increases weather cock tendencies. Another is a raised C.G. coupled with a further aft and lower placement of the tow line attach point, which introduces a significant rolling moment with sailplane heading/tow line misalignment. This problem warrants further study to better define controllability during takeoff and landing.

Although pilot comments did not reflect any serious inflight problems, improvement in lateral-directional handling qualities, such as roll response quickening, increased roll control power, and reduction in rudder coordination requirements, would enhance performance in soaring flight, due to the importance of quickly acquiring and centering the thermals and of reducing pilot workload. Informal discussions with the evaluation pilots, as well as reported pilot comments, support this conclusion. Pilot opinions were mostly in the "excellent" to "minor but annoying deficiencies" region (pilot ratings 1 to 4).
Sailplane 1 was "excellent" to "good" (pilot rating 1 to 2) in almost every area. Pilot comments emphasized the good control harmony between rudder and aileron and ease of rudder-aileron coordination. Spiral stability was neutral, which was noted as beneficial for thermalling flight.

Sailplane 2 pilot ratings ranged from 2 to 4, with many comments about high rudder coordination workload in maintaining ball-in-the-center flight, both in turns and turn entries as well as level flight. Inadequate rudder control power was cited, as evidenced by insufficient rudder to maintain balanced flight in moderate rate turn entries. Spiral stability was slightly negative in thermalling configuration, which increased rudder-aileron coordination problems. Lateral-directional characteristics for this sailplane could be summarized as distracting and irritating. One pilot commented negatively on pitchup with sideslip, which is peculiar to this sailplane.

Pilot ratings for sailplanes 3, 4, and 5 fell in the 1 to 4 range. In average overall pilot ratings, sailplane 3 was slightly better than sailplanes 4 and 5, but ratings for each sailplane showed different areas of emphasis, as indicated in the following paragraphs.

Sailplane 3 lateral-directional control harmony and coordination was good. Comments ranged from "no problem" to "pleasant". Comments showed, however, that sailplane 1 was better. A comment for sailplane 3 on aileron effectiveness was that ailerons remained very effective even below stall speed.

The only complaints for sailplane 4 were due to the requirement for considerable top aileron in turning flight and mild objection to coordination workload in lateral maneuvering.

Sailplane 5 received good to excellent ratings for its ease of control in maintaining desired bank angles in turning flight. Several pilots objected to its low maximum roll rate of about 15 deg/sec, about 5 deg/sec less than that of all the other sailplanes, though 2 pilots commented that roll rate was surprisingly good for a sailplane of this large a wing span. Other comments indicated that the rudder force gradient was too high and noted too wide a deadband around neutral for airplane response to rudder inputs.

Sailplane 6 was judged as a training sailplane, suitable for transitioning into high performance ships. In this context, it received very good ratings, except for ease of maintaining desired bank angles and for control near the stall. Concerning turning flight, pilots commented that rudder forces were
too high relative to longitudinal stick forces and that unintentional over-controlling in pitch produced frequent pre-stall airframe buffeting. Lateral control near stall was poor due to decaying roll control power with airspeed decrease.

Rudder overbalance, or "rudder lock" was a characteristic common to sailplanes 2, 3, and 5. The pilots did not find this unsafe or even annoying, except on sailplane 5; one pilot gave sideslips a rating of 4 due to this feature, noting that about 180 N pedal force was required to "unlock" the rudder and that large sideslip angles were possible. Control, however, remained good and very little buffeting occurred at the high sideslip angles. This is classified as a minor but annoying deficiency. Rudder overbalance on the other sailplanes required much less pedal force to unlock. It is concluded that although proportionally increasing rudder pedal force with rudder deflection is a desirable characteristic, rudder overbalance is not unsafe unless very high pedal forces or other overruling characteristics are involved. For instance, sailplane 2 encountered overbalance at about 1/2 rudder deflection and sailplanes 3 and 5 at about 3/4 deflection. These conditions were acceptable, but it might be that overbalance of significantly less rudder deflection would be unacceptable.

3.5 Sailplane Stall/Spin Characteristics

Cross-country soaring flight sometimes involves steep turns at low altitudes to take advantage of whatever lift may be available, avoiding landing unless absolutely necessary. Since optimum airspeed for thermalling flight is near the stall speed, stall and incipient spin characteristics are of prime importance in safety of flight.

Stall warning characteristics of the evaluation sailplanes were described as mild for sailplanes 1 through 5 and too much for sailplane 6. The airspeed stall warning band varied from 1 to 3 kts for the first 4 sailplanes, and were often in a form that could be masked by atmospheric turbulence. However, once the stall was recognized, recovery in most cases was easily and quickly effected by merely relaxing aft stick pressure and flying out of the stalled condition with little altitude loss. Sailplane 6, on the other hand, had a wide stall warning airspeed band of 10-12 kts, which caused stall buffet to
occur frequently at thermalling flight airspeeds. The pilots noted that this is an undesirable characteristic because familiarity with the stall warning buffet degrades its effectiveness and tends to cause the pilot to ignore the warning.

As to stall, incipient spin, and recovery characteristics, sailplanes 1, 2, 3, and 5 generally received good to excellent ratings with sailplane 1 being foremost. Good aileron control was noted, even below stall speed, and abused, cross-controlled stalls did not reveal undesirable qualities. Sailplane 4 recovered immediately with relaxation of aft stick force, but two pilots noted a definite autorotative (spin) tendency if recovery was not executed promptly with wing drop. Sailplane 6 showed a tendency to yaw and roll to the left and to pitch down from a cross-control stall and received lower ratings due to this characteristic toward spinning.

3.6 Sailplane Approach and Landing Characteristics

Once committed to landing, sailplanes cannot go up; it follows that one of the primary considerations in evaluating approach and landing characteristics is ease of glidepath control. Precision in touchdown control is paramount for landing in unprepared and restricted areas, a situation often encountered in cross-country soaring flight. It is therefore not surprising that most of the evaluation sailplanes were criticized for lack of spoiler, flap, or air-brake effectiveness and precision.

Sailplane 6 received the best ratings, in the fair to good category, largely because of the effectiveness of spoilers in controlling glidepath. For instance, one pilot noted that due to dive brake effectiveness, it was easy to make "difficult" landings. "Difficult" here means landings over obstructions into a limited landing area.

Sailplane 1 again received the best rating of all except sailplane 6, although it was noted that the divebrakes were somewhat ineffective. The same comment was made about sailplanes 2, 3, and 5. Sailplane 4 relied only on flaps for glidepath control. This concept was criticized on two points: large changes in pitch attitude with varying degrees of flap extension made precise glidepath control more difficult, and awkward placement, high force requirements, and complex flap control positioning requirements degraded precision of
glidepath control. Some pilots criticized the "suck-open" tendency of spoiler controls on the other sailplanes for the same reasons; the necessity to hold force to restrain spoiler control lever aft movement degraded precise control in pitch with light stick forces, especially if spoiler control forces were high.

It is concluded that more quantitative information should be gathered on primary glide path control capability and also interaction of glide path controls with primary flight controls.

3.7 Pilot Opinion and Certification Criteria

Pilot opinion specifies the characteristics pilots like in sailplanes. Certification criteria specify the characteristics thought by the certifying authority to be essential to their safe operation. There is no reason to expect that pilots will invariably prefer a safer characteristic to one less safe. The contribution to safety of a given characteristic sometimes being recognizable only by a complex analysis or demonstrated in accident patterns. However, in the absence of such analysis or evidence, it would seem sensible that criteria should conform in general to favorable pilot opinion.

General and specific examples of conflicting criteria and pilot opinion follow:

In general, pilots were willing to accept sailplanes that were somewhat more sensitive and less stable in pitch than they liked for take-off, tow, and dive recovery in order to get easy longitudinal maneuvering and low stick forces for soaring flight—the mission of a sailplane. In particular, the criteria specifying a return-to-trim within, say, 10 percent of trim speed was felt to be of no benefit, and when achieved through increased stick centering forces considered to be a harassment. In what way such a criterion is essential to safety is not clear.

The only undesirable characteristic exhibited by some of the high performance sailplanes was marginal control during takeoff and landing. Current certification requirements are vague in this area. A requirement of controllability during takeoff and landing in crosswinds up to a prescribed level would be appropriate.
The requirement that no rudder overbalance occur was considered by some pilots to be overly restrictive. They argued that the natural instinct to straighten out would be sufficient to cue the pilot to overcome the mild overbalance that commonly occurs on gliders at large sideslip angles.

The sailplanes flown illustrated the ways in which stalling behavior desirable for sailplanes differs from that desirable for power planes. First, pre-stall warning was found to be of little or no value because of the normal course of thermalling, the stall boundary is commonly exceeded—an alarm quickly loses its value when often sounded. In any case, regardless of the presence or absence of any pre-stall warning, the considerable loss of climb that would result from reacting to every momentary gust-induced stall warning is unacceptable to most sailplane pilots. They will maneuver as the thermal demands and accept brief occasional stalls. Because occasional stalls must be accepted, it is important that only the least reduction in angle-of-attack be sufficient to achieve an immediate unstall, and that very little loss in altitude and very minor upset accompany the stall. Fortunately, this was just the behavior observed for all the sailplanes except sailplane 6 which had considerable altitude loss and some roll and yaw upset. For deeper or more prolonged or abused stalls, traditional criteria appeared acceptable. Thus, a modification to the traditional criteria such that the initial stall replaced buffet as a warning, and the deeper or aggravated stall be treated as the stall for purposes of certification.

The drag modulation observed on the test sailplanes was felt to be generally insufficient and the operating forces for the drag devices were felt to be generally undesirable for both flaps and airbrakes. Additionally, the variation of divebrake or flap effectiveness during the flare, float and touchdown phase was felt to degrade the pilots' ability to control his landing accuracy. In view of the importance of accurate landings for sailplanes, it was felt that a rational basis should be established for future criteria.
4. CONCLUDING REMARKS

The handling qualities of six sailplanes were evaluated by seven pilots in a flight test session consisting of 98 flights. The term "handling qualities" was defined to be those broad characteristics or attributes which influence the ease and precision with which the pilot is able to perform tasks for the overall mission of the sailplane. In this context the evaluation pilots were instructed to regard cross-country flight under visual flight rules as the principal mission of the sailplane.

Sailplane characteristics were evaluated using the Cooper-Harper rating scale with additional comments. The pilot opinion data indicates the following:

1. The evaluation sailplanes were found generally deficient in the area of cockpit layout. Poor cockpit ventilation, the use of curved control stick, confusing secondary control handles and the need for better cockpit crashworthiness were cited as reasons for deficiency.

2. The pilots indicated general dissatisfaction with pitch sensitivity which in some cases was coupled with inertially induced stick forces. While all sailplanes were judged satisfactory for centering thermals and in the ease of speed control in circling flight, pilot opinions diverged on the maneuvering response, pull-out characteristics from a dive, and on phugoid damping. The pilots found that the tendency to return to trim airspeed is relatively unimportant for visual flight.

3. Lateral-directional control problems were noted mainly during takeoff and landing. Pilot comments indicate the desirability of overall improvements in roll response quickening, increasing roll control power and reduction in the rudder coordination requirement. Existing levels of rudder overbalance or "rudder lock" was not found unsafe or even annoying.

4. Five of the evaluation sailplanes had very narrow airspeed band in which perceptible stall warning buffet occurred. This was not objectionable, however, since stall recovery was easy. The pilots objected to the characteristics of wide airspeed band of stall warning followed
by a stall with yawing and rolling tendency and substantial loss of altitude during the stall.

5. Landing characteristics of the evaluation sailplanes were found generally objectionable. Ineffective divebrakes, and the necessity of exerting a force to restrain divebrake control lever were quoted by some of the pilots. Flap type glide path control was also rated deficient due to the large attitude changes accompanying flap deflections and to the excessive flap actuation forces.

The present study shows the need for a more quantitative investigation of the factors influencing pitch control sensitivity such as precise measurements of stick forces due to both the aerodynamic hinge moments and the bobweight effects arising from the different horizontal tail configurations. Further study is required of lateral-directional control during takeoff and landing. More quantitative information should be gathered also on the various glide path control systems and the interaction of glide path controls with primary flight controls.
REFERENCES


Appendix A
Pilots' Questionnaire
**SAILPLANE EVALUATION**

<table>
<thead>
<tr>
<th>Pilot</th>
<th>Sailplane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date: ___________________________  Flight No.: ___________________________

**I. Design.**

A. Pilot Opinion of Construction & Rigging.

1. Ease of Inspection.
2. Safety of Control System.
3. Ease of Assembly.
4. Comments: 

B. Pilot Opinion of Cockpit Layout.

1. Pilot Comfort.
2. Control System Arrangement.
3. Instrument Display.
4. Pilot Visibility.
5. Pilot Safety.
6. Comments: 

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39
II. Smooth Air Maneuvering.

A. Pilot Opinion of Initial Takeoff Roll.

1. Towline Hookup.

2. Control of Sailplane During Initial Roll.

3. Comments

B. Pilot Opinion of Tow.

1. Ease of Maintaining Position.

2. Aircraft Trim.

3. Control in Propwash.


5. Comments

C. Pilot Opinion of Longitudinal Handling.

1. Ease of Establishing and Maintaining a Constant Airspeed.

2. Sailplane Trim System Over Speed Range.


5. Stick Fixed Stability.
6. Stick Free Stability
7. Return to Trim
8. Maneuvering Response
9. Phugoid Characteristics
10. Dive Recovery

11. Comments

D. Pilot Opinion of Lateral Handling
1. Aileron Force Gradient
2. Rudder Force Gradient
3. Roll Rate Over Speed Range
4. Sideslip Characteristics
5. Ease of Turn Entry
6. Yaw Due to Aileron
7. Yaw Due to Roll
8. Ease of Maintaining 45° Bank Turn
9. Ease of Maintaining 60° Bank Turn

10. Comments
E. Pilot Opinion of Sailplane Stall-Spin Characteristics

1. Rudder and Aileron Effectiveness During Stall

2. Stall Warning

3. Aggravated Stall-Tendency to Spin

4. Stick Force Gradient

5. Stall Recovery, Altitude Loss

6. Spin Entry

7. Spin Recovery

8. Stall From Turn at Low Speed

9. Comments

F. Pilot Opinion of Sailplane Landing Characteristics

1. Pilot Visibility

2. Glide Slope Control

3. Airspeed Control, Airbrake Ease of Modulation

4. Ease of Landing at Intended Spot

5. Ease of Controlling Sink at Touchdown

6. Control During Rollout

7. Comments
III. Flight Characteristics in Convection.

A. Pilot Opinion of Tow.

1. Ease of Maintaining Position.
2. Response to Vertical Currents.
4. Comments

B. Pilot Opinion of Circling Flight.

1. Low Speed Handling.
2. Stall-Spin Susceptibility.
3. Ease of Centering Thermal.
4. Speed Control.
5. Comments

C. Pilot Opinion of Cruising Flight.

1. Ease of Controlling Airspeed.
2. Pull up into Thermal.
3. Ease of Performing Secondary Tasks.
4. Ride Quality

5. Ease of Maintaining Straight Flight

6. Comments
Appendix B
Cooper Harper Ratings and Pilots' Comments
### SAILPLANE 1 DATA

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**TASK PILOT**

**COMMENTS**

2 | 3 | NOT AS GOOD AS GLASS SHIPS
3 | 3 | HAVE TO REMOVE OVERWING FAIRING
4 | 4 | GOOD
5 | 6 | MODERATELY EASY
74 | 6 | AFTER ASSEMBLY, INSPECTION IS DIFFICULT AT ELEVATOR AND WING PINS

### SAILPLANE 2 DATA

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**TASK PILOT**

**COMMENTS**

74 | 3 | EXCELLENT
75 | 3 | APPEARS MECHANICALLY OF MARGINAL DURABILITY
76 | 4 | POSSIBLE TO GET AILERON MOVEMENT WITH DISCONNECTED PUSH RODS
77 | 4 | OUTSTANDING
78 | 4 | HAS POOR HISTORY FOR RUDDER ACTIVATION SYSTEM, ELEVATOR, AILERON
79 | 4 | AND FLAP SYSTEM IS EXCELLENT
74 | 6 | AILERONS CONTROL RODS END, CAN BE INSTALLED BUT NOT PINNED.
75 | 6 | OTHERWISE IT IS BY FAR THE BEST ASSEMBLY OF ANY SAIL-PLANE.

### SAILPLANE 3 DATA

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**TASK PILOT**

**COMMENTS**

74 | 1 | EXCELLENT
75 | 3 | NOT AS EASY AS SAILPLANE 2 OR 5
76 | 4 | UNABLE TO VISUALLY INSPECT AILERON CONNECTORS BEHIND SPAR
77 | 4 | GOOD
78 | 4 | EXCELLENT
79 | 4 | QUALITY OF CONSTRUCTION IS EXCELLENT--AILERON AND AIR BRAKE LINKAGES
# SAILPLANE 4 DATA

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### Comments

- **74** Less desirable than most good
- **74** Need bending of handle required for flap actuation objectionable
- **74** Canopy fits fairly badly before locking. Found trim and flap handle actuation characteristics objectionable.
- **74** Assembly not compatible with task, i.e., frequent assembly/disassembly in minimum time with 2-3 people.

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# SAILPLANE 5 DATA

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### Comments

- **74** Outstanding
- **74** Excellent-easier than some smaller ships
- **74** Excellent construction-fairly large freeplay was observed in horizontal tail surface attachment
- **74** Heavy but simple once technique is understood

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# SAILPLANE 6 DATA

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### Comments

- **74** Excellent
- **74** Good solid design; rigging is more difficult than most; good
- **74** Safe control system.
- **74** Ship is simply not designed for assembly/disassembly necessary for a sailplane.
## Sailplane 1 Data

### Pilot Comments

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### Pilot Comments

- **FAIR**
- **Very Uncomfortable**
- **Seat Too Low In A/C**
- **Rudder Pedals Undesirable Changing Type**
- **Stick Hits Leg With Full Aileron Throw**
- **FLI Instruments Good, however Compass Located Too Far Forward**
- **Need New Instrument Panel**
- **Visibility Down Marginal**
- **Sides Of Cockpit Too High Which Reduces Down Visibility**
- **Not Good Art Or Forward Down**
- **Light Wooden Structure**
- **Pilot Comfort Is Poor. Visibility Is Restricted Somewhat Insufficient**
- **Cockpit Too Small And Hand To See Numbers**
- **Seat Back Not Properly Designed. Head Through Fishbowl Gives Some Concern About Pilot Protection, Top Hinged Rudder Pedals Unsatisfactory.**
- **Poor Lateral, Downward And Forward Visibility Stick Too Far Forward**
- **Long Trim Control Too Far Forward**
- **Defective Safety**
- **Excessive Air Leaking In Cockpit Seal.**

## Sailplane 2 Data

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### Pilot Comments

- **Not Very Comfortable**
- **Arm Outstretched**
- **Trim Lever In Poor Location—Stick Too Far Fwd.**
- **Trimmer Too Far Back. Hard To Reach And Hard To Operate.**
- **Average**
- **Stick Too Far FWD.**
- **Factory Stick Is OK. Test Ship Had A Non-Standard Type.**
- **Electric Vario Inoperative**
- **Shortage Of Instrument/Radio Space.**
- **Very Good**
- **Inadequate Pilot Protection Due To Minimal Structure**
- **Very Light Structure**
- **Get A Strong Feeling Of This Glider**
- **Seat Belt Installation Was Such That Seat Belt Adjustment Was Very Difficult And Probably Impossible In Flight.**
- **Poor Protective Structure.**
- **Seat Belts Hard To Adjust.**
- **Short Non-Standard Stick Was Found Unpleasant.**
- **Give Brake Can Come Out Of Detent Even After Adjustment.**
- **Control Stick (Non-Slotted) Too Fwd F/D.**
- **Trim Location Poor. Difficult To Reach The Trim Lever Because Of Narrow Cockpit. Also, Trim Was From Detent To Detent.**
- **Deployment Of Detention Was Such That It Did Not Allow Trim A/S Adjustments. Rudder Adjustment Was Excellent.**
- **Good Rudder Adjustment.**
- **Safety—Additional Fiberglass Structure In The Form Of Keel Or Stringers Long. Would Improve Leg/foot Safety Of Nose Impact.**
- **Inadequate/Unusual**
- **Trip Control Placement Awkward To Use.**
## SAILPLANE 3 DATA

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<td>AVER. AND STD. DEV. OF SUBTASKS</td>
<td>6.00</td>
<td>1.00</td>
<td>2.00</td>
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### PILOT COMMENTS

<table>
<thead>
<tr>
<th>Task</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td>GOOD COCKPIT IS SMALL, MY HEAD ALMOST TOUCHES THE CANOPY WHICH CAN LEAD TO SOME BUMPS IN TURBULENCE. COMPLEX FLAP CONTROL AWKWARD FOR 1.596° RAD FLAP. FLAP UNHARMLESSY COMPRESSED, EXCESSIVE FORCES SUSCEPTIBLE TO MIS-US. FORCES ARE TOO HIGH AT MAX FLAP SPEEDS. FLAP CONTROL IS A LITTLE AWKWARD TO REACH, AND TO MOVE PRECISELY, THE TRIM CONTROL IS ONE AND TWO TIMES DIFFERENT TO PILOT APPLICATION. MINOR NEW FLAP LANDING FLAP POSITIONuggage NEAR AWKWARD PLACEMENT.</td>
</tr>
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### SAILPLANE 5 DATA

<table>
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<th>TASK</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1. PILOT COMFORT</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2. PILOT SAFETY</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3. PILOT VISIBLE</td>
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</tbody>
</table>

<table>
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<tr>
<th>PILOT</th>
<th>1</th>
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<th>STD DEV</th>
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<tr>
<td></td>
<td>2.50</td>
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<td>1.00</td>
<td>1.00</td>
<td>1.700</td>
<td>.600</td>
</tr>
</tbody>
</table>

**Comments:**
- **Very Large Comfortable Cockpit Generally Well Layed Out.**
- **Trimmer is hard to operate and highly annoying.**
- **Drag chute Knob susceptible to inadvertent operation.**
- **Excellent Cockpit Layout**
- **Elevator offset so as to give momentum to Up Elevator when you hit a positive LG.**
- **Trim Visibility Marginal during Tum**
- **Excellent**
- **View of Tension Line OK, but could be improved.**
- **Cockpit construction minimal in strength, not as safe as some.**
- **Excessive Ballast in Nose could be converted into Glass to Improve**
- **Excellent Cockpit comfort. Ventilation should be better. Vent Air exhaust should have been provided.**
- **Excellent Control Placement, Seat design and Visibility. Flap and speed brake controls are well located and convenient to use.**

### SAILPLANE 6 DATA

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION OF TASKS</th>
<th>PILOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1. PILOT COMFORT</td>
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<td>2</td>
<td>2. PILOT SAFETY</td>
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<td>3. PILOT VISIBLE</td>
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<th>AVER.</th>
<th>STD DEV</th>
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<tbody>
<tr>
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<td>2.2</td>
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<td>2.2</td>
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<td>2.0</td>
<td>.6</td>
<td>.0</td>
<td>.0</td>
<td>3.4</td>
</tr>
</tbody>
</table>

**Comments:**
- **Excellent**
- **Air Wheel Should be on Left**
- **Tow Wheel Located on Wrong Side of Cockpit**
- **Stick Too Far Fwd.**
- **Trim Wheel on Wrong Side**
- **Tow Release should be out to Left.**
- **Trim Control should be on Left Side of Cockpit.**
- **Stick Too far Fwd.**
- **At Most Fwd Position**
- **Fairly Poor on this Glider, should have compensated variometers**
- **Non Standard**
- **Excellent**
- **Very substantial Cockpit Structure**
- **Trim wrong side and hard to use**
- **Good, Safe Design Features in Cockpit. I would question some of the aerodynamic compromises made for the sake of roominess.**
- **Control Travel is much too extensive for Rudder, Aileron, elevator, and dive brakes.**
******** ZEROS INDICATE NO RATING BY PILOT ********

### SAILPLANE 1 DATA

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION OF TASKS</th>
<th>PILOT</th>
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<th>2</th>
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<th>4</th>
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<th>6</th>
<th>7</th>
<th>AVER.</th>
<th>STD DEV</th>
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<td>1. TOWLINE HOOKUP</td>
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<td>1.3</td>
<td>1.6</td>
<td>.97</td>
</tr>
</tbody>
</table>

### TASK PILOT COMMENTS

- **76 2**: Excellent characteristics in this phase of the flight.
- **76 5**: No problems in takeoff, including light crosswind 9kts, 45deg to runway.
- **76 7**: TOWPLANE WAS STILL ON GROUND. Probably should have released.

### SAILPLANE 2 DATA

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION OF TASKS</th>
<th>PILOT</th>
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<th>7</th>
<th>AVER.</th>
<th>STD DEV</th>
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<td>4.00</td>
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<td>.950</td>
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<td>13</td>
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<td>1.50</td>
<td>2.00</td>
<td>3.00</td>
<td>.50</td>
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<td>2.167</td>
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<tr>
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<td>2. CONTROL OF PLANE IN INIT. ROLL</td>
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<td>2.00</td>
<td>4.00</td>
<td>2.00</td>
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<td>3.990</td>
<td>.990</td>
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<tr>
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<td>1.5</td>
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<td>3.5</td>
<td>3.5</td>
<td>.99</td>
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### TASK PILOT COMMENTS

- **76 2**: Some tendency to drop wing at start. Don't like to have to move flaps during T/O. Roll (up at start) to neutral. Flap operating handle excellent.
- **76 3**: There is a tendency to drop a wing on rollout. Stick Location is inconvenient.
- **76 4**: Insufficient rudder. Location of control stick, control stick short, Travel, lack of control forces, and lack of sailplane 2 experience resulted in poor T/O control.
- **76 5**: Stick almost always dragged on initial roll. Felt like not enough rudder to stay lined up. Stick too far forward.
- **76 7**: Ailerons ineffective at first even with flaps in the negative. No problems in takeoff, including light crosswind 9kts, 45deg to runway.
### SAILPLANE 3 DATA

<table>
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<tr>
<th>TASK</th>
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<th>PILOT</th>
<th>PILOT</th>
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<th>PILOT</th>
<th>PILOT</th>
<th>AVER. STD DEVE</th>
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<tr>
<td>12</td>
<td>II. SMOOTH AIR MANEUVERING</td>
<td>3.00</td>
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<td>3.00</td>
<td>2.00</td>
<td>3.00</td>
<td>2.333 0.471</td>
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<tr>
<td>13</td>
<td>A. PILOT OPIN OF INITIAL TAKEOFF RLL</td>
<td>2.00</td>
<td>2.00</td>
<td>2.00</td>
<td>3.00</td>
<td>3.00</td>
<td>2.720</td>
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<tr>
<td>15</td>
<td>1. CONTROL OF PLANE IN INIT. PULL</td>
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<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
<td>2.720</td>
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76 AVER. AND STD. DEV. OF SUBTASKS: EX 1, 2, 3

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<th>PILOT</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>6</td>
<td>PILOT USUALLY PUMPS ELEVATOR</td>
</tr>
<tr>
<td>14</td>
<td>5</td>
<td>PULLED ON ROPE EXTENSION BECAUSE HANDLE TOO FAR FWD.</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>VISIBILITY AND DIRECTIONAL CONTROL LIMITED</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>CROSS WIND CAPABILITY MARGINAL</td>
</tr>
<tr>
<td>23</td>
<td>2</td>
<td>67/9 DIVERGES, TOO DANGEROUS, EXTREME</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>RUDDER WEAK DURING ROLL, EASY TO DROP WING TO GROUND</td>
</tr>
<tr>
<td>76</td>
<td>4</td>
<td>NO PROBLEM WITH INITIAL TAKEOFF ROLL</td>
</tr>
<tr>
<td>76</td>
<td>4</td>
<td>ON TAKEOFF ROLL WITH AIR VENT OPEN, SAND AND ROCKS WERE PLOWED THROUGH THE VENT INTO THE COCKPIT BY THE TOWPLANE.</td>
</tr>
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### TASK PILOT COMMENTS

#### SAILPLANE 4 DATA

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<tr>
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<th>AVER. STD DEVE</th>
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<td>12</td>
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<td>2.00</td>
<td>1.00</td>
<td>3.00</td>
<td>2.333 0.471</td>
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<tr>
<td>13</td>
<td>A. PILOT OPIN OF INITIAL TAKEOFF RLL</td>
<td>.00</td>
<td>.00</td>
<td>2.00</td>
<td>1.00</td>
<td>1.00</td>
<td>2.333 0.471</td>
</tr>
<tr>
<td>15</td>
<td>1. CONTROL OF PLANE IN INIT. PULL</td>
<td>.00</td>
<td>.00</td>
<td>2.00</td>
<td>1.00</td>
<td>1.00</td>
<td>2.333 0.471</td>
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76 AVER. AND STD. DEV. OF SUBTASKS: EX 1, 2, 3

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<th>PILOT</th>
<th>COMMENTS</th>
</tr>
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<tbody>
<tr>
<td>14</td>
<td>3</td>
<td>EXCELLENT AERODYNAMICALLY, CONFUSING FOR PILOT SINCE HE ALWAYS PULLS</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
<td>GOOD</td>
</tr>
<tr>
<td>16</td>
<td>2</td>
<td>REQUIREMENT TO START T.O. WITH FLAP UP; THEN PUT NEUTRAL IS UNDESIRABLE SOME TENDENCY TO DROP WING AT START OF ROLL</td>
</tr>
<tr>
<td>26</td>
<td>2</td>
<td>MOST SERIOUS DEFICIENCY I NOTE IS THE Sudden BLOW TO THE TAILWHEEL</td>
</tr>
<tr>
<td>28</td>
<td>2</td>
<td>WHEN THE TAILWHEEL BECOMES TAU</td>
</tr>
<tr>
<td>30</td>
<td>2</td>
<td>THERE IS ADEQUATE CONTROL DURING T.O. TO MAINTAIN WINGS LEVEL EVEN IN CROSSWINDS OF AT LEAST 10KTS</td>
</tr>
<tr>
<td>76</td>
<td>7</td>
<td>TO PULL THE FWD BREAKOUT FORCE IS RELATIVELY SO HEAVY THAT IT FEELS</td>
</tr>
<tr>
<td>76</td>
<td>7</td>
<td>AS IF A STOP HAS BEEN ENCOUNTERED. THIS UNBALANCED BREAKOUT FORCE</td>
</tr>
<tr>
<td>76</td>
<td>7</td>
<td>CAUSED ME TO OVERCONTROL IN PITCHDOWN ON ONE TAKEOFF, IT HAS BEEN</td>
</tr>
<tr>
<td>76</td>
<td>7</td>
<td>SUGGESTED(PILOT 4) THAT WITH LONG TIME CONTROL ALMOST FULL FWD.</td>
</tr>
<tr>
<td>76</td>
<td>7</td>
<td>THE FEEDBACK FROM THE BREAKOUT FORCES ARE UNBALANCED AFT AS AN</td>
</tr>
<tr>
<td>76</td>
<td>7</td>
<td>INHERENT CHARACTERISTIC OF THE FEEL SPRING MECHANISM.</td>
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### SAILPLANE 5 DATA

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<tr>
<th>TASK</th>
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<th>PILOT 4</th>
<th>PILOT 5</th>
<th>PILOT 6</th>
<th>PILOT 7</th>
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<th>STD. DEV.</th>
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<td>1.166</td>
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<td>13</td>
<td>A. PILOT SPIN OF INITIAL TAKEOFF RLL</td>
<td>3.00</td>
<td>5.00</td>
<td>3.00</td>
<td>1.00</td>
<td>8.00</td>
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<td>3.00</td>
<td>1.366</td>
<td>1.166</td>
</tr>
<tr>
<td>14</td>
<td>2. CONTROL PLANE IN INIT. ROLL</td>
<td>2.00</td>
<td>5.00</td>
<td>3.00</td>
<td>1.00</td>
<td>8.00</td>
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<td>3.00</td>
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<td>1.166</td>
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**76 AVER. AND STD. DEV. OF SUBTASKS: EX 1, 2, 3,**

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</tr>
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<tbody>
<tr>
<td>12</td>
<td>5</td>
<td>RUDDER INEFFECTIVE; FLAP/AILERON MOVEMENT NECESSARY TO CONTROL</td>
</tr>
<tr>
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<td>6</td>
<td>RUDDER INEFFECTIVE; FLAP/AILERON MOVEMENT NECESSARY TO CONTROL</td>
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### SAILPLANE 6 DATA

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<th>PILOT 5</th>
<th>PILOT 6</th>
<th>PILOT 7</th>
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<th>STD. DEV.</th>
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<td>3.00</td>
<td>2.00</td>
<td>1.00</td>
<td>1.250</td>
<td>1.333</td>
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<tr>
<td>13</td>
<td>A. PILOT SPIN OF INITIAL TAKEOFF RLL</td>
<td>0.00</td>
<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>3.00</td>
<td>2.00</td>
<td>1.00</td>
<td>1.250</td>
<td>1.333</td>
</tr>
<tr>
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<td>2. CONTROL PLANE IN INIT. ROLL</td>
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<td>1.00</td>
<td>1.00</td>
<td>0.00</td>
<td>3.00</td>
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<td>1.00</td>
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**76 AVER. AND STD. DEV. OF SUBTASKS: EX 1, 2, 3,**

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<td>12</td>
<td>5</td>
<td>FIGH STICK, ARM OUTSTRETCHED</td>
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<tr>
<td>13</td>
<td>6</td>
<td>TAIL HITS THEN NOSE SKID HITS WHEN PILOT OVERCONTROLS PITCH EVER</td>
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<td>14</td>
<td>7</td>
<td>EXCELLENT</td>
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SAILPLANE 1 DATA

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<th>AVER. STD DEV</th>
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<tr>
<td>16</td>
<td>8. PILOT OPTION OF TOW</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>17</td>
<td>1. EASE OF MAINTAINING POSITION</td>
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TASK PILOT COMMENTS

17  4  INSUFFICIENT ELEVATOR TRIM. REQUIRES ABOUT 13N CONSTANT PUSH FORCE
17  6  LEADING DOES NOT HUNT. EXCELLENT (FOLLOWING OF TOWPLANE).
18  7  TOO MUCH FORWARD STICK TO MAINTAIN POSITION
18  8  INEFFECTIVE-UNSATISFACTORY
19  9  MAX TRIM SPEED 45-50KTS; HOWEVER FORCES ARE LIGHT THROUGH SPEED RANGE
20  7  GOOD HARMONY--OUTSTANDING
20  8  GLIDER CANNOT BE TRIMMED ON TOW. WOULD BE TIRESOME AT A CROSS-COUNTRY TOW
27  7  BOXING SAILPLANE IS SIMPLE TASK. WINGS LEVEL (ADEQUATE RUDDER CONTROL)

SAILPLANE 2 DATA

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TASK PILOT COMMENTS

17  4  INSUFFICIENT RUDDER TO BOX TOWPLANE
17  6  EFFECTIVE BUT HARD TO OPERATE
17  8  FRICTION FORCE IS SUFICIENT
17  9  SUFFICIENT TRIM AVAILABLE HOWEVER EACH DETENT RESULTED IN AT LEAST 4K TRIM INCREMENTS
18  7  DIRECTIONAL COULD NOT BOX TOW. VERY WELL
18  8  FAIRLY LARGEAILERON DELECTIONS ARE REQUIRED.
18  9  ALWAYS NEED PUSH FORCES ON STICK
20  7  GOOD, QUIET
20  8  TOUGH IN DIRECTIONAL
20  9  SOME CONCENTRATION REQUIRED FOR DIRECTIONAL-LATERAL CONTROL
77  7  HANDLES EXCELLENTLY. EASILY UPSET BY BRAKES BUT EASILY RESTORED BY CONTROLS
77  8  PLEASANT; LIGHT RUDDER FORCES; GEAR RETRACTION FORCES ARE HEAVY
77  9  UNCOMFORTABLE. SLIGHT OVERSHOOT WHEN MOVING BACK TO CENTER FROM THE OUTSIDE. CURIOUS CLICKING NOISE COMING FROM THE BACK IN THE RUDDER CIRCUIT. UNPLEASANT STICK FORCES; EXCESSIVE FRICTION.
77  4  POOR VISIBLE
77  6  HARD TO FLY IN ROUGH AIR. HAD TO WORK TO RETURN TO CORRECT POSITION.
77  8  NON-STANDARD STICK TOO FORWARD RESULTING IN TROUBLE HOLDING NOSE DOWN AT HIGH TOW SPEEDS
77  9  ADEQUATE RUDDER CONTROL TO BOX TOWPLANE WITH WINGS LEVEL. SMALL BUT FREQUENT STICK AND RUDDER INPUTS REQUIRED IN NORMAL TOW.
******* ZEROS INDICATE NO RATING BY PILOT *******

SAILPLANE 3 DATA

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77 AVER. AND STD. DEV. OF SUBTASKS (EX 1 2 3 4 5 6 7) 1.7 0.8 2.0 0.1 2.5 0.5 2.5 0.1 1.7 0.4 2.2 0.6 2.2 1.6 1.7

** TASK PILOT COMMENTS **

17 1. EASY TO MAINTAIN POSITION.
17 2. FOLLOW VISIBILITY LIMITED.
17 3. THERE WAS SOME VERTICAL OSCILLATION EACH TIME THERE WAS A SLACK ROPE
17 4. AND THE TOWPLANE TOOK ON THE SLACK BUT THIS WAS MORE
17 5. PRONOUNCED BECAUSE OF TOW ROPE MOCKUP LOCATION
17 6. COULD NOT BOX TOWPLANE IN LOW POSITION DUE TO TOWLINE RUN ON FUSELAGE
17 7. BOTTOM
17 8. OVER SENSITIVE LONGITUDINAL CONTROL
17 9. IT CAN BE TRIMMED FOR LONG TOWS
17 10. ADEQUATE; HOWEVER, SOME DIFFICULTY IN ACTUATING TRIM LOCK.
17 11. CONTROL GOOD BUT TOWROPE RUBS SIDE OF FUSELAGE DUE TO LOCATION OF
17 12. RELEASE HOOK
17 13. NO PROBLEM
17 14. DID NOT CHECK BECAUSE OF TOW ROPE MOCKUP LOCATION
17 15. NOISE; CONTROL FORCES NEGLIGIBLE. WHEN PULLED UP AND PUSHED OVER.
17 16. ENCOUNTERED NEGATIVE G-LI, COULD BE CORRECTED BY THE PILOT BEING
17 17. ENSURE CLAMP ON THE CONTROLS OR BY ELIMINATING THE PULLUP-HOOK
17 18. PRIOR TO RELEASE.
17 19. NO COMMENTS, VERY GOOD
17 20. EASY TO OVERCONTROL IN PITCH
18 1. SOLID FEEL; SEAT TRIM MORE COMFORTABLE THAN SAILPLANE 2. TOW L
18 2. COMES UP SIDE OF FUSELAGE WHEN BOXING TOWPLANE.
18 3. SAILPLANE OFFSET TO RIGHT SO 1 WOULD CORRECT DUE TO SIDE OF GLARE SHIELD
18 4. AND TOWPLANE CENTERED; HAD TO FLY LOW TO SEE OVER SHIPS.
18 5. WITHOUT USE OF RUDDER, NOSE WANDERS ABOUT 3/4 TOWPLANE SPAN. NO PROB.

SAILPLANE 4 DATA

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77 AVER. AND STD. DEV. OF SUBTASKS (EX 1 2 3 4 5 6 7 8 9) 0.1 0.1 1.7 0.5 3.0 0.7 2.0 0.7 1.7 0.4 2.5 0.9 1.7 0.4 2.1 0.8

** TASK PILOT COMMENTS **

17 1. THIS SAILPLANE WAS EASY TO LOCK IN POSITION.
17 2. CENTERING SPRING IS ANNOYING.
17 3. ADEQUATE BUT DIFFICULT TO ACTUATE TRIM LEVER TO OBTAIN PRECISE
17 4. SETTINGS AND LEVER LOCATED TOO FAR FROM PILOT.
17 5. THE TRIM WAS VERY GOOD
17 6. EXCELLENT BUT NOISE
17 7. FELT SOLID; NOTED DURING TOW THAT NOSE UP BREAKOUT FORCE LESS THAN
17 8. NOSE DOWN. NOSE DOWN FELT LIKE A STOP.
17 9. HANDLING DURING TOW IS GOOD; ONLY ANNOYING CHARACTERISTIC IS NOISE
17 10. STRONG POSITIVE TRIM FORCE CAUSES UNWANTED PITCH CHANGES.
17 11. WHEN NOT ACTUATING, THE TOWPLANE IS NOTED.
17 12. RUDDER CONTROL MORE THAN ADEQUATE TO MAINTAIN WING SEMISPAAN LATERAL
17 13. OFFSET FROM TOWPLANE WITH WINGS LEVEL.
14. ** TASK PILOT COMMENTS **

17 1. THIS SAILPLANE WAS EASY TO LOCK IN POSITION.
17 2. CENTERING SPRING IS ANNOYING.
17 3. ADEQUATE BUT DIFFICULT TO ACTUATE TRIM LEVER TO OBTAIN PRECISE
17 4. SETTINGS AND LEVER LOCATED TOO FAR FROM PILOT.
17 5. HANDLING DURING TOW IS GOOD; ONLY ANNOYING CHARACTERISTIC IS NOISE
17 6. RUDDER CONTROL MORE THAN ADEQUATE TO MAINTAIN WING SEMISPAAN LATERAL
17 7. OFFSET FROM TOWPLANE WITH WINGS LEVEL.
17 8. ** TASK PILOT COMMENTS **
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<td>3. I FELT THAT IN TURBULENCE; I WAS CLOSE TO A SERIOUS PITCH CONTROL PROBLEM AT TIMES (PILOT INDUCED OSCILLATION). I WAS UNABLE (AND UNWILLING TO TRY A SECOND TIME) TO RAISE THE LANDING GEAR WITH THE RIGHT HAND WHILE FLYING WITH THE LEFT HAND; EVEN IN SMOOTH AIR, AS USUAL WITH A SENSITIVE PITCH CONTROL, I WAS CONCERNED THAT INPUTS AND CORRECTIONS MUST BE KEPT SMALL; THAT LARGE INPUTS WOULD BE UNPLEASANT, IF NOT DOWNRIGHT HAIRY.</td>
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<td>4. OPTIMUM 70 KTS, 60 KTS THE NEGATIVE STICK FORCE (SEE GIVE THE IMPRESSION OF HAVING A NEGATIVE UNSTABLE) STICK FORCE GRADIENT. THE STICK MUST BE RESTRAINED IN CENTER POSITION. MOST UNPLEASANT. ON TOW WHERE STEERING TASK IS TIGHTER, INITIAL TOW SPEED GOOKS. FELT MORE COMFORTABLE WITH ONE NOTCH DOWN FLAPS: NO BOXING OF TOWPLANE WAS ATTEMPTED. VERY EASY TO STAY IN POSITION. WIT(2000) FEET ON MUDER PEDALS, YAWS ABOUT ONE WING SPAN TO EITHER SIDE OF TOWPLANE. CONTROLLABLE WITH RUDDER. POOR HARMONY; VERY SENSITIVE ELEVATOR WITH RELATIVELY HEAVY, SLOWLY DISENGAGED, BOXING TO SIDE WITH FULL SPEED TOW. WINGS LEVEL ABOUT 1/2 SPAN FROM TOWPLANE</td>
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SAILPLANE 1 DATA

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78 AVER. AND STD. DEV. OF SUBTASKS (EX 1*2**.) 1.5 .6 1.6 1.3 1.6 .7 1.6 1.1 2.3 .6 1.5 1.0 2.1 .8 1.7 .96

### TASK PILOT COMMENTS

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**Comments**

- **Task PILOT**
  - **Aver.** and **Std. Dev.** of subtasks (Ex. 1-2...)
  - **2.7 1.3 1.9 0.2 8.6 2.3 0.2 6.7 0.7 2.6 0.89**

**Comments**

- **22** Poorer than some sailplanes
- **23** Difficult to obtain precise trim speeds
- **24** Trim good, but minimum increment too large
- **25** Trim was adequate if precise trim speeds are not required.
- **26** More sensitive than others
- **27** Very sensitive but lack of force gradient causes some difficulty
- **28** In obtaining precise pitch inputs
- **29** Wide friction band
- **30** Very light force gradient, almost neutral static long. stab.
- **31** Stable force but very light forces very low, but just perceptible
- **42** Rarely perceptible, gradient not checked
- **43** Not possible because of wide friction band
- **44** Very good when A/S was displaced to the high side. Very poor when A/S was displaced to the low side.
- **45** Does not return but works fine.
- **46** Vtrim 571AS DFLAP=0 LOW 49 HIGH 74, Vtrim 50 DFLAP=1, LOW 46 HIGH 60
- **47** Vtrim 50 DFLAP=0 LOW 56 HIGH 85
- **48** Flexible wing gives spongy feel
- **49** Sensitive, no force gradient
- **50** Have to work at coordination: rudder weak
- **51** Lightly damped phugoid
- **52** During 1st flight divergent at higher speed. 2nd flight, neutral to slightly positive at trim A/S 58 and 74KTS.
- **53** Unpredictable: long period dangerous sometimes, sometimes neutral
- **54** Slightly divergent
- **55** Vtrim 541AS Period 2.6sec, Vtrim 701AS Period 4.6sec Lightly damped
- **56** Very light approx. 4.5-9N/m
- **57** No force gradient
- **58** Accelerates very rapidly with nose down
- **59** 27/19 undesirable at most speeds because of divergence—neutral
- **60** Attitude changes, trim was set at 5th notch from near and left
- **61** There for most of flight
- **62** Very light stick forces—very light gradient—OK
### Sailplane 3 Data

#### Task Description of Tasks

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<tr>
<th>Task</th>
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<th>Pilot 3</th>
<th>Pilot 4</th>
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#### Pilot Comments

- **POOR OPERATION DEVICE**
  - During descent and trimming at 60125 and holding elevator control.
  - Fixed note: a +21 Kt oscillation. Speed variation was confirmed.
  - Noting slight a/c oscillation.
  - VTirm 50Kts friction band low 42 high 53 VTirm 50Kts low 48 high 68 VTirm 70Kts low 57 high 73.
  - Ship gathers speed quickly, easy to maintain speed.
  - 50 to 90 Kts.
  - This is funny, because it feels good, but can't take hand off for long enough speed. Trim stops about 80125.
  - Too sensitive.
  - Fairly sensitive.
  - Very sensitive, but lack of force gradient caused some difficulty.
  - In obtaining precise pitch inputs.
  - Easy to control at high speeds.
  - Sensitive but no over CG problems.
  - Light stick forces not unpleasant.
  - Gradient very light.
  - Barely perceptible.
  - Good in speed, poor in below trim speed.
  - Light but perceptible.
  - Insensitive at low speed.
  - Fairly good.
  - Speed vs. position good.
  - Nice.
  - Lower than most, low force gradient.
  - Very light, but perceptible.
  - Early perception.
  - Not checked.
  - No return to trim.
  - From high side (left trim) good, from low side (50-65) poor. Because of low force gradient.
  - Unsatisfactory.
  - Stick force/lge neutral.
  - Unfavorable.
  - AT 60125, PHUGOID quickly diverges. AT 60125 almost neutrally stable.
  - Trim 60125 neutral. Stick force/lge divergence.
  - Diversified vigorously after 12 cycle in pitch.
  - Divergence-Strongly-Period 16sec at 60125 50 Kts.
  - Unsatisfactory slightly negative stick force/lge.
  - No problems.
  - Stick up abruptly applied to control stick resulted in a very sharp pitch up. When force was released elevator control continued to move aft (like elevator over balance) resulting in zero pitch. I think full up elevator would have resulted if I had not restrained the stick movement. This condition is not good.
  - Can't even get 70125 off all diverge, not nearly as unpleasant in maneuvers as sailplane 5.
  - Control stick feels a little loose, very low force levels. When stick is tilted fore and aft at 60125, aileron nose seems to tick under. I believe it should be observed stick fixed.
  - I think it is a result of elevator floating PHUGOID.
  - Stick force/lge very light at 40 deg bank. Neutral at 60 deg bank.
  - Max trimmed speed 92 Kts. Control system friction very low (good).
### Sailplane 4 Data

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#### Comments

- **Task: PILOT SPIN OF LONG. HANDLING**
  - Occasional overshoot is experienced when changes are attempted.
  - IAS easy to obtain; however, it is difficult to activate trim lever.
  - For maintaining IAS, hard to adjust precisely.
  - Able to trim throughout req'd trim range.
  - Very good.

- **Task: EASE OF IAS & MAIN CON AIRSPEED**
  - Force gradient is the result of working against springs. This results in forces as high as 15-20N. During all maneuvers except T.L., the gradient is very light; forces would be more desirable.
  - Light but ok.
  - Non-linearity observed going from 75 to 80 degrees starting from 50.
  - Oscillation begins the same as stick fixed.
  - Positive stick force/gradient did not do.
  - Good.
  - Very pleasant if same trim speed is desired at end of maneuver.

- **Task: PILOT TUCK SPEED OVER SPEED RANGE**
  - Positive force gradient with IAS.
  - OK.
  - Neutral—approx. 16 sec period.
  - Vtrim 48ias 20 sec period moderately damped.
  - Light but no surprises.

- **Task: PITCH SENSITIVITY**
  - Good.
  - Positive force gradient with IAS.
  - Stick gives impression of light stability with stiff insensitive stick.
  - Quick light but consistent, pleasant to fly.

- **Task: STICK GRADIENT**
  - When returning from off trim condition, phugoid oscillation 45s.
  - Experienced in 2 of 3 cases.
  - Stick force per IAS too light. Stick force per displacement may be ok.
  - High stick force gradient in both IAS and maneuvering flight.

- **Task: STICK FIXED STABILITY**
  - In free flight, much of the required pitch control activity consists of small deflections around the strong centering spring demand.
  - The pilot is deprived of true anticipatory feel for airplane response to stick inputs by the artificial breakaway forces.
  - This is a problem previously encountered in research simulators; it does not seriously affect airplane control with possible exception of IAS.
  - Takeoff but it causes highly pilot workload in iterating small pitch inputs and is irritating.
## Sailplane 5 Data

### Description of Tasks

1. **Ease of Est & Main Controls Airspeed**
2. **Plane Trim System Over Speed Range**
3. **Pitch Sensitivity**
4. **Stick Force Sensitivity**
5. **Stick Fixed Stability**
6. **Stick Free Stability**
7. **Return to Trim**
8. **Maneuvering Response**
9. **Phugoid Characteristics**
10. **Dive Recovery**

### Pilot Comments

- **Pitch Response to Control Inputs**: The pitch response is like an acceleration command. Checking motion follows most stick inputs, too sensitive but not as bad as Sailplane 3.
- **Light Hand-Trimming**: Unable to trim to full speed. Trim capability stops at about 75-80 knots.
- **Light Stick Handling**: Too light. Not as sensitive as Sailplane 3.
- **Divergent Stick Forces**: Too extreme. Positive stick forces required to change speed.
- **High Divergent Gradient**: Extremely light gradient. Diverges too extreme.
- **Stick Response to Elevator Input**: Appreciably delayed, making tight pitch steering difficult.
- **Vibration Too Wide to Return Externally**: Vibration 60 knots low 53 high. Aft stick force at 47 knots is several dynes. Forward stick force at 90 knots is about 2.2 dynes. In combination with reversed stick forces, makes for poor maneuvering characteristics.
- **Phugoid Characteristics**: Exceeds. Divergent at high speed. Nodding divergent. Vibration 90 knots; strongly divergent. Did not let it complete a full cycle. No problems found.
- **Dive Recovery**: Negative roll. Recovering from dive (110-120 knots) after wingover is very unpleasant. Trajectory must be made by positively displacing the stick an estimated amount and holding it rigid. This ship cannot be flown by pressure or feel-only by stick position.
- **Phugoid Oscillations**: Somewhat better at 90 knots. Little slow on precise attitude changes. No unpleasant trim changes with flap setting.
- **Phugoid Divergent Control**: Strongly Divergent—Friction Very Low in System (Good).
| TASK | DESCRIPTION OF TASKS | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT |
|------|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 21   | 1. EASE OF EST & MAIN CON AIRSPEED | 0.00  | 1.00  | 2.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
|      | 2. PLANE TRIM SYS OVER SPEED RANGE | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 3. PITCH SENSITIVITY | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 4. STICK FORCE GRADIENT | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 5. STICK FREI STABILITY | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 6. PERFORMANCE RESPONSE | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 7. RETURN TO TRIM | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 8. MANEUVERING RESPONSE | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 9. PHUGIOID CHARACTERISTICS | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 10. DIVE RECOVERY | 0.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  | 2.00  |
|      | 78 AVER. AND STD. DEV. OF SUBTASKS (EX 1-2...) | 0.0  | 0.0  | 1.0  | 4.0  | 8.0  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  | 0.2  |
| TASK | PILOT | COMMENTS |
| 21   | VERY EASY WITHIN TRIM RANGE. STICK FORCES ARE ON HEAVY SIDE |
|      | POWERFUL AND POSITIVE |
|      | TOO STRONG A TENDENCY |
|      | VTRIM 59IAS 50 HIGH 54 VTRIM 65IAS LOW 58 HIGH 79 |
|      | GOOD-POSITIVE |
|      | SOMEWHAT SLOW |
|      | POSITIVE STICK FORCE/LOC |
|      | LIGHTLY DAMPED |
|      | UNSTABLE PHUGIOID AT 60KTS |
|      | NEUTRAL |
|      | VTRIM 52IAS 26 SEC PERIOD VTRIM 65IAS 26 SEC PERIOD |
|      | GOOD-A LITTLE LIGHT FOR TRAINER |
|      | NO DESIRABLE CHARACTERISTICS WERE NOTED |
|      | SHORT PERIOD HEAVILY DAMPED |
| 78   | STICK GRADIENTS ARE LITTLE TOO HEAVY. SOME BUFFETING WELL INTO |
|      | CRUISING SPEED RANGE. RAN OUT OF TRIM AROUND 76KTS. SOFTNESS IN |
|      | GENERAL ATTITUDE CHANGES |
|      | EXCELLENT CONTROL CHARACTERISTICS FOR TRAINING MISSION |
SAILPLANE 1 DATA

| TASK | DESCRIPTION OF TASKS | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT | PILOT |
|------|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 32   | D. PILOT OPINION OF LATERAL HANDLING | 1.00  | 1.00  | 1.00  | 0.00  | 0.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 33   | 1. ALERON FORCE GRADIENT | 1.00  | 1.00  | 1.00  | 2.00  | 2.00  | 2.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 35   | 2. RUDDER FORCE GRADIENT | 1.00  | 1.00  | 1.00  | 2.00  | 2.00  | 2.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 36   | 3. ROLL RATE OVER SPEED RANGE | 1.00  | 1.00  | 1.00  | 3.00  | 3.00  | 3.00  | 3.00  | 3.00  | 3.00  | 3.00  |
| 37   | 4. SIDESLIP CHARACTERISTICS | 1.00  | 1.00  | 1.00  | 2.00  | 2.00  | 2.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 38   | 5. EASE OF TURN INJURY | 1.00  | 1.00  | 1.00  | 2.00  | 2.00  | 2.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 39   | 6. YAW DUE TO ALERON | 2.00  | 3.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 40   | 7. YAW DUE TO ROLL | 2.00  | 3.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 41   | 8. ROLL RATE OF BANK TURN | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |
| 79   | 9. EASE OF MAIN 1.04 RAD BANK TURN | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |

**TASK** | **PILOT** | **COMMENTS**
--- | --- | ---
33 | 3 | VERY PLEASANT
34 | 4 | CONTROL HARMONY, VERY GOOD
35 | 5 | OCCASIONALLY TOO LIGHT
36 | 6 | EXCELLENT
37 | 7 | ABOUT 200 TO 262 RAD/SEC AT SPEEDS CHECKED
38 | 8 | 262 RAD/SEC AT 39 IAS, 262 RAD/SEC AT 27 IAS
39 | 9 | RUDDER FORCE REVERSED BUT GOOD OTHERWISE
40 | 10 | APPROX 262 RAD BANK REGD FOR MAX RUDDER DEFLECTION FOR CONSTANT HPADI
41 | 11 | POSITIVE STABILITY HOWEVER A/S BLANKS OUT WITH YAW
42 | 12 | RUDDER FORCE REVERSED
43 | 13 | STEADY HEADING SIDESLIP--RUDDER FORCE GRADIENT LIGHTENS AFTERR ABOUT 1/2 THROW, BUT NO REVERSAL, FULL RUDDER REQUIRES 262 RAD BANK--SLIGHT
44 | 14 | SPEED UP LIGHTLY POSITIVE DIHEDRAL EFFECT
45 | 15 | VERY EASY
46 | 16 | VERY LITTLE RUDDER REQUIRED FOR INITIAL ROLL, SLIGHTLY MORE FOR LATER
47 | 17 | X VERY NOTicable, BUT STILL IT IS POSSIBLE TO MAKE A GOOD TURN WITH
48 | 18 | ALLERONS ONE
49 | 19 | VERY EASY TO MAINTAIN COORDINATED CONTROL
50 | 20 | ABOUT 262 RAD RUDDER FIXED
51 | 21 | CAN PICK UP LOW WIND WITH RUDDER--262 RAD ROLL IN 5 SEC WITH FULL
52 | 22 | RUDDER AT 30 IAS
53 | 23 | ONE OF THE BEST
54 | 24 | GOOD--SLIGHT AMOUNT OF TOP STICK REQUIRED
55 | 25 | EXCELLENT
56 | 26 | SAME AS D.8
57 | 27 | VERY LIGHT AND RESPONSIVE
58 | 28 | SUPERB COMBINATION IN MANEUVERING FLIGHT
59 | 29 | EXCELLENT FOR IDLERASING
60 | 30 | DIAL STABILITY NEUTRAL--VERY GOOD--PITCH ROLL CONTROL AND RESPONSE
61 | 31 | HARMONY IS VERY GOOD
## SAILPLANE 2 DATA

### TASK DESCRIPTION OF TASKS
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<th>STD DEV</th>
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<td>TO WORK AT RUDDER TO COORDINATE</td>
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<td>VERY DIFFICULT TO KEEP YAW STRING CENTERED</td>
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<td>Rudder-uneffective at low speeds when executing rapidly</td>
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<td>FAIRLY DIFFICULT AT LOWER SPEEDS</td>
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### AVER. AND STD. DEV. OF SUBTASKS (EX 1, 2, 3, ...)

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### ZEROS INDICATE NO RATING BY PILOT
### Sailplane 3 Data

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**Average and Std. Dev. of Subtasks (ex: 1, 2, ...):**

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<th>1</th>
<th>2</th>
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**Comments:**
- Flexible wing on sailplane 5 makes it worse.
- Light, maybe too much so.
- Aileron-elevator force harmony—excellent.
- Took attention effort to coordinate.
- Overbalances at 3/4 deflection.
- No variation observed; adequate throughout.
- About 0.48rad/sec at speeds checked.
- VTR1: 10kts, 30kts, 60kts (3kts), 60kts; 09kts.
- Rudder weak.
- Pitching nose down moderately pleasant.
- Although force reversal occurs, rudder returns to neutral when wings are leveled.
- Positive at 60 IAS; pull rudder deflection will result in rudder lock; also a loss of airspeed.
- Rudder force lightened but never zero or reversed.
- Buffet/overbalance in rudder in both directions; pitch down with slip.
- Less rudder required than sailplane 2.
- Average adverse yaw.
- Tack attention to rudder.
- Seem pronounced, have to modulate rudder to coordinate.
- No problem.
- No problem.
- Rudder and stick; small gradient.
- Stick force force/col; pleasant in turns; above 2G turns will self.
- Tightened tail buffet with air brake on.
- Side slips are not objectionable.
- Pleasant lateral handling but falls short of sailplane 1 or 2.
- Roll coordination no problem—ailerons very effective below stall speed.
### SAILPLANE 4 DATA

**ZEROS INDICATE NO RATING BY PILOT**

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION OF TASKS</th>
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**COMMENTS**

- PLEASANT
- SLOWER WITH FLAPS DOWN, ROLL RATE IS ADEQUATE BUT NOT AS GOOD AS THE OTHER HIGH PERFORMANCE SAILPLANES
- ABOUT 3-5 SEC
- SUFFICIENT RUDDER TO BALANCE AILERON CONTROL
- WING ROCKS AT BUFFET ONSET: GOOD
- BECAUSE OF STICK BACK PRESSURE WORKING AGAINST CENTERING SPRING
- STRONGLY POSITIVE DIHEDRAL EFFECT, CONSIDERABLE TOP AILERON ROLL IN TURNS.
### Sailplane 5 Data

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**Task PILOT COMMENTS**

**32.1** PLEASANT, FAIRLY LARGE TOP AILERON REQUIRED; LITTLE TOO HIGH OUTSIDE THE DEADBAND; TOOT HEAVY (NOT ENOUGH MECHANICAL ADVANTAGE); SLOW BUT SURPRISINGLY GOOD.

**32.2** HEAVY, STABLE AILERON FORCES AND DISPLACEMENTS IN SIDESLIP, RUDDER OVERBALANCE AT 4/4 DEFLCTION. LARGE AILERON AND RUDDER INPUTS REQD. RUDDER SUFFICIENT TO BALANCE.

**32.3** CAN BE BALANCED WITH RUDDER AT THERMALLING SPEEDS.

**32.4** EXCELLENT.

**32.5** IF SIZE AND SPAN OF SHIP WERE TAKEN INTO CONSIDERATION THE 2 RATINGS WOULD BE BETTER.

**32.6** SUITABLY GOOD LATERALLY FOR ITS SIZE.

**32.7** RUDDER DEFLECTION EXCITED A WELL-DAMPED OSCILLATION OF THE FUSETAGE.
### Sailplane 6 Data

<table>
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<th>Task</th>
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### Pilot Comments

- **Task 32**: Feels better than pitch stick gradient
- **Task 33**: Too heavy
- **Task 34**: Good
- **Task 35**: High rudder force to coordinate
- **Task 36**: VR1M 521IAS, .314rad/sec, VR1M 781IAS, .454rad/sec
- **Task 37**: Slight pitch/roll coupling, also rudder a little weak
- **Task 38**: Lower sink rate than others
- **Task 39**: IJOS bank with full rudder for constant meaning slip--no rudder lock, with airspeed after approx. 349 rad yaw
- **Task 40**: Slight pitch down with sideslip, 785 rad bank for full rudder, slight dimedral effect at 514 rad, neutral at 781IAS
- **Task 41**: A little slow near stall
- **Task 42**: Very good
- **Task 43**: About average
- **Task 44**: Because of heavy rudder forces, approx. 89N in maintaining turn neutral low amplitude, long period
- **Task 45**: Stick force/CG approx. 9N
- **Task 46**: Very good
- **Task 47**: Rudder force/CG approx. 22N
- **Task 48**: Rudder force/CG approx. 9N
- **Task 49**: Excellent lateral-directional characteristics mixed somewhat by buffetting, good rudder response
- **Task 50**: Hard to coordinate rudder due to unharmonious force (only about 89N but seeks high relative to stick)
- **Task 51**: Very light resulting in overcontrolling elevators and getting stall
- **Task 52**: Rudder coordination good would not be acceptable in a powered airplane, but as sailplanes go....
## Sailplane 1 Data

### Task Description of Tasks

<table>
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<th>Task</th>
<th>Description of Tasks</th>
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**Aver. and Std. Dev. of Subtasks (Ex. 123...)**

1.3 2.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1

### Task Pilot Comments

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<tr>
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<td>Rudder Effective, Ailerons Ineffective, Rudder Will Not Pick Up. Bu will arrest further drop</td>
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<td>2</td>
<td>Adequate Aileron Entry Rate Very Slow but plenty of time to catch it</td>
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<td>Slightly Neutral Elevator; Slightly Opposite Rudder</td>
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<td>Stall-Spin Characteristics Are Good to Excellent. Lack of Slippage Associated With Glass Ship. (Probably Responsible for Good Stall Characteristics)</td>
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<td>46</td>
<td>5</td>
<td>All the above gave great confidence in ship to work weak lift at low altitude safety</td>
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<tr>
<td>47</td>
<td>6</td>
<td>Light Buffet at 515 M, Stall at 321 M (ice). Turning Stall, Crossed Controls; Airplane Practically Recovers by Itself. More Falls Than And Airplane Starts Flying Again. Excellent Characteristics—Very Saff</td>
</tr>
<tr>
<td>TASK</td>
<td>DESCRIPTION OF TASKS</td>
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**AVER. AND STD. DEV. OF SUBTASKS:**

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**COMMENTS:**

1. STALLS RUDDER POOR, AILERON FAIRLY GOOD.
   - ADEQUATE, SOME OF IT IS IN THE FORM OF CHANGING NOISE CHARACTER.
   - NO BUFFET WARNING-DIRECTIONAL STABILITY APPARENTLY DETERIORATES.
   - WANDERS IN YAW
   - ABOUT AVERAGE
   - 15M INCIPIENT SPIN FAIRLY MILD
   - EAST RECOVERY
   - JUST RELAX AFT STICK FORCE
   - NO PROBLEM
   - PRIOR TO STALL THERE IS A TENDENCY OF ROLL OSCILLATIONS.
   - EAST STALL RECOVERY FROM EITHER TURN DIRECTION.
   - VERY SLIGHT PRE-STALL WARNING AND SUDDEN BREAK MAKE SHIP UNDESIRABLE
   - FOR EXTENSIVE HEAT SOARING FOR A LOW TIME PILOT
   - VERY DOCILE STALLS; TURNING AND 1 EGG STICK CAN BE HELD FULL AFT
   - AND AIRPLANE CAN BE REVERSED IN BANK—CAN BE FLOWN INDEFINITELY
   - IF HELD
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**Zeros Indicate No Rating by Pilot**

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### Pilot Comments

- GOOD WARNING OCCURS APPROX. 2 KTS ABOVE STALL.
- NO-FLY BUFFET AT STALL V STALL 30 KTS FLAP 0
- WILL DROP WING UNCONTROLLABLY IF AGGRAVATED, BUT NOT ABDUCTION WING DROP
- SEEMED TO HAVE TENDENCY TO SPIN
- DEFINITE FEELING OF BEGINNING AUTOROTATION
- POSITIVE
- VERY POSITIVE GRADIENT
- 12 METERS
- NEGLECTABLE ALT LOSS
- LESS THAN 15M.
- ABOUT 20M IN HLS
- IMMEDIATE WITH RELEASE OF BACK PRESSURE
- UNABLE TO DO DUE TO LIMITED STICK TRAVEL.
- ALT LOSS ABOUT 61 METERS.
- GOOD
- NO OBJECTIONABLE CHARACTERISTICS
- WING DROP FOLLOWING ABUSED STALL IS UNCONTROLLABLE AND IS FOLLOWED BY AUTOROTATIVE TENDENCY.
**Zeros Indicate No Rating by Pilot**

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<tr>
<th>TASK</th>
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<th>PILOT OPINION OF PLANE STALL/SPIN CHARACTERISTICS</th>
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<td>BUFFET PROGRESSIVE WITH AFT STICK MOVEMENT</td>
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<td>2. Rudder/AILERON EFFECT DURING STALL</td>
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<td>3. RUDDER/AILERON EFFECT DURING STALL</td>
<td>VERTICAL LANDING FLAPS = LIGHT BUFFET JUST BEFORE STALL</td>
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<td>4. RUDDER/AILERON EFFECT DURING STALL</td>
<td>LARGE LONGITUDINAL STICK MOTIONS NEAR STALL. AT STICK POSITION</td>
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<td>5. RUDDER/AILERON EFFECT DURING STALL</td>
<td>WITHIN 5CM OF AFT STICK, SHIP KEEPS ENTER SPIN</td>
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<td>ABUSED STALL RESULTS IN EVENTUAL WING DROP BUT NO INCipient SPIN</td>
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<td>8. RUDDER/AILERON EFFECT DURING STALL</td>
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<td>9. RUDDER/AILERON EFFECT DURING STALL</td>
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<td>10. RUDDER/AILERON EFFECT DURING STALL</td>
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<td>11. RUDDER/AILERON EFFECT DURING STALL</td>
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<td>12. RUDDER/AILERON EFFECT DURING STALL</td>
<td>ABOUT 15M IF WING ALLOWED TO DROP</td>
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<td>13. RUDDER/AILERON EFFECT DURING STALL</td>
<td>RELATIVELY RESISTANT</td>
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<td>14. RUDDER/AILERON EFFECT DURING STALL</td>
<td>SLOW INCipient SPIN QUICKLY STOPPED SINCE AILERON REMAINS EFFECTIVE</td>
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<td>15. RUDDER/AILERON EFFECT DURING STALL</td>
<td>BEYOND THE STALL</td>
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<td>16. RUDDER/AILERON EFFECT DURING STALL</td>
<td>OK WITH STICK RELEASED; NOT INSTANT RECOVERY, BUT FAIRLY PROMPT</td>
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<td>17. RUDDER/AILERON EFFECT DURING STALL</td>
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<td>18. RUDDER/AILERON EFFECT DURING STALL</td>
<td>CONSIDERABLE LOSS OF STICK FORCE GRADIENT UNDER CGL.</td>
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<td>19. RUDDER/AILERON EFFECT DURING STALL</td>
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<td>TENDS TO JUST PICK UP SPEED AND FLY OFF</td>
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<td>21. RUDDER/AILERON EFFECT DURING STALL</td>
<td>NO TENDENCY TO FALL OFF TO EITHER SIDE AFTER STALL. STALL WARNING</td>
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<td>22. RUDDER/AILERON EFFECT DURING STALL</td>
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<td>23. RUDDER/AILERON EFFECT DURING STALL</td>
<td>AILERONS HAVE SLOW BUT POSITIVE EFFECTIVENESS THROUGH STALL—EXCELLENT</td>
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**Sailplane 5 Data**

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**COMMENTS**

WEAK JUST ABOVE STALL INEFFECTIVE AFTER STALL

GOOD

STALL WARNING CONSISTED OF AIRFRAME PUFFET THAT BECAME APPARENT

9-10% ABOVE STALL IF THERMALING IS CONDUCTED COMPANY AND THEN THE PILOT WILL IGNORE THE STALL BUFFET. NORMAL STALL BUFFET SHOULD NOT OCCUR ABOVE THERMAL STALL.

YES

RECOVERY IS GOOD

LEFT WING DROPS, TENDENCY TO SPIN

SAILPLANE WANTS TO COVER THE TOP FROM A RIGHT TURN AND DIG IN FURTHER TO THE LEFT FROM A LEFT TURN (FEET ON THE FLOOR) CROSS-CONTROLLED STALLS)

GOOD

NOT MEASURED BUT CONSIDERABLE

LESS THAN 61%

LESS THAN 61%

AGGRAVATED STALL 61-91%

moderate ENTRY RATE BUT POSITIVE ENTRY

FAIRLY QUICK

WELL

ADEQUATE STALL WARNING; ABRupt NOSE SLICE FOLLOWS SOME LATERAL

OCSTALLATIONS JUST PRIOR TO STALL

STICK FORCES DO NOT TELL YOU THAT YOU ARE ABOUT TO ENCOUNTER THE

MORE THAN 1.5 Gs. IT DOES NOT INCREASE NEAR THE STALL AT 2 Gs.

HAS A TENDENCY TO TAM, ROTATE AND FLY THE NOSE FROM A CROSS-

CONTROLLED; ABUSED STALL
### Sailplane 1 Data

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AVER. AND STD. DEV. OF SUBTASKS (EX 1, 2, 3, 4)

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**Comments**

- **EXCELLENT**
  - Air Brakes a little weak
  - Very low force gradient results in some porpoising prior to flare.

- **GOOD**
  - Very good control; just fast
  - Air brake has a tendency, after being unlocked, to float to approx. 2/3 extended position. I feel the air brake should have the capability of rapid movement but the air brake should remain in the selected position.
  - Light pitchdown with spoiler extension at 55 KTS.
  - Not as easy as some
  - Air brakes could be more effective
  - Easy to control in pitch in turbulence

- **FAIR**
  - Very low force gradient results in some vertical oscillation during the flare.
  - Rudder + ailerons fair

- **POOR**
  - Brake control awkward to apply without taking hand from control stick
  - Heavy full brake application resulted in only minor braking action.
  - Lost control during one of landings.
  - Minimum rudder and tailskid for directional control. A steerable tail wheel would help.
  - T1.4.5 could be improved with more powerful dive brake
  - Fair crosswind capability
  - Fairly easy to make good landing. Touches down at higher speeds than one would like
  - Limited yaw control on rollout.
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TASK PILOT COMMENTS

- EXCELLENT
- OK UNTIL FLARE THEN FLOATS IF SPEED IS TOO HIGH
- EXCELLENT
- SELECTION OF FLAPS FOR DRAG RESULTS IN LARGE PITCH ANGLES
- HARD TO MODULATE FLAPS; HANDLE UNHANDY
- NOT TRIED AT LOW SPEEDS; IT WOULD BE PROJECTIONAL
- AIR BRAKE(SLEPS) REQUIRE CONSTANT FORCE AND EFFORT TO SELECT AND MAINTAIN DESIRED POSITION; BECAUSE OF HANDLE LOCATION AND TRAVEL DIFFICULT TO OBTAIN MAX. FLAP TRAVEL. FORCES VERY HIGH AT MAX. FLAP SPEED.
- PRECISE SELECTION CONTROL REQUIRED AT FLARE ENTRY POINT IF DROP-IN OR LONG FLOAT ARE TO BE AVOIDED
- IN SUFFICIENT PRACTICE FOR OBJECTIVE EVALUATION OF THE FLAP SYSTEM
- FEEL THAT IT IS OK IN MOST SITUATIONS
- THE AIR BRAKE(SLEPS) IS VERY DIFFICULT TO MANIPULATE, I.E. TAKES LARGE FORCE TO PUT IT WHERE I WANT TO MAINTAIN LAYS. IN ADDITION, THE AIRPLANE ATTITUDE CHANGES DRASTICALLY TO WHERE I AM UNCERTAIN OF FLIGHT PATH.
- CHANGE OF TRIM FROM FLAPS - U TO LANDING BRAKE CAUSES HIGH STICK FORCES. FLAP CONTROL REQUIRES VERY HIGH FORCES TO DEPLOY AROUND 520 - 590 P.M.
- PHYSICALLY UNABLE TO SELECT 1.306 AND FLAPS IN FINAL STAGE OF APPROACH
- HAVE TO HOLD HIGH FORCE ON FLAP HANDLE WITH LEFT HAND AND MAKE SMALL, PRECISE STICK INPUTS WITH RIGHT HAND TO EXECUTE GLIDE PATH AND LOR ON THE FINAL LANDING. I MADE A HIGH BASE LEG AND SELECTED LANDING FLAPS THEN CONTROLLED FLIGHT PATH WITH PITCH ATTITUDE ONLY. ACCEPTING SPEED, WHEN MODERATE DURING FLARE. I CONSIDER THIS AN AWKWARD AND IMPRECISE METHOD. IT DOES NOT OFFER THE PRECISION IN FLIGHT PATH CONTROL WHICH IS AVAILABLE WITH THE METHOD OF CONTROLLING AIRSPEED WITH MODULATION OF A DRAG DEVICE THROUGHOUT THE APPROACH.
**SAILPLANE 5 DATA**

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81 AVER. AND STD. DEV. OF SUBTASKS (EX 1,2,...) | 0.0 | 1.6 | 1.7 | 1.0 | 1.0 | 1.5 | 1.7 | 1.4 | 1.0 | 0.60 |

**COMMENTS**

- **EXCELLENT**
  - Good due to dive brake effectiveness; it is easy to make difficult landing.
  - Good—poor if not greased well; very poor.
  - Excellent—very good except as noted.
  - Very good.
- **GOOD**
  - Poor if not greased well; very poor.
  - Excellent—very good except as noted.
  - Very good.
- **POOR**
  - Moderate force to close. Tendency to land hard if more than about 1/2" air brake used.
  - Ship has very good landing characteristics; large sink rates require definite pilot attention.
- **BAD**
  - Very good except airplane is not forgiving of letting airspeed decay below 17 knots on final approach.
- **HFB**
  - Very good except airspeed is not forgiving of letting airspeed decay below 17 knots on final approach.
- **BDF**
  - Very good except airspeed is not forgiving of letting airspeed decay below 17 knots on final approach.
**Zeros indicate no rating by pilot**

### Sailplane 1 Data

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**Task PILOT Comments**

- **5** Pitch primarily---lat/dir-2
- **7** Had to use slight forward stick force during tow---trim not adequate

### Sailplane 2 Data

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**Task PILOT Comments**

- **5** Got to stay with it, direction most obvious
- **1** I believe the ride is caused by wing flex

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**Task PILOT Comments**

- **3** Some tendency of nose to pounce
- **5** Some stick instability in turbulence
- **5** High workload in rudders and ailerons
### Sailplane 1 Data

**Task Description of Tasks**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description of Tasks</th>
<th>Pilot 1</th>
<th>Pilot 2</th>
<th>Pilot 3</th>
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**Task Pilot Comments**

- **Task 59**: No problem at all.
- **Task 60**: Noisy.
- **Task 61**: No significant difference from still air.

### Sailplane 2 Data

**Task Description of Tasks**

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</table>

**Task Pilot Comments**

- **Task 59**: OK at 70kts, at 80kts worse than in smooth air. Must fly with stick.
- **Task 60**: Rigid.
- **Task 61**: Cannot fly pitch by pressure. Must fly by position.
- **Task 62**: No rough air today.
- **Task 63**: Thermals.
- **Task 64**: Lateral positioning is an easy task; pitch is difficult due to overcontrol tendency.

### Sailplane 3 Data

**Task Description of Tasks**

<table>
<thead>
<tr>
<th>Task</th>
<th>Description of Tasks</th>
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<th>Pilot 3</th>
<th>Pilot 4</th>
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</table>

**Task Pilot Comments**

- **Task 59**: Not excessive.
- **Task 60**: Same as smooth air.
- **Task 61**: Airspeed bleed off quickly during pullup. Requires pilot attention.
- **Task 62**: Higher workload than in smooth air. Of course, but no unusual characteristics due to turbulence.
### Sailplane 1 Data

<table>
<thead>
<tr>
<th>Task</th>
<th>Description of Tasks</th>
<th>Pilot 1</th>
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### Aver. and Std. Dev. of Subtasks (Ex 1, 2, 3, ...) | 1.3 | 1.3 | 1.6 | 4.0 | 0.0 | 2.0 | 1.3 | 1.7 | 4.0 | .56 |

### Task Pilot Comments

- **63**
  - BEST THERMAL MANEUVERING OF ANY SAILPLANE—PERHAPS DUE TO POWERFUL RUDGER. AILERON ROLL RESPONSE IN THERMALS EASY TO MABLE GLIDER.
  - ARROD IN THERMAL QUALITIES EXCELLENT—VERY LOW WORKLOAD—LITTLE RUDGER AND RESPONSE.

### Sailplane 2 Data

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### Aver. and Std. Dev. of Subtasks (Ex 1, 2, 3, ...) | 1.5 | 1.5 | 1.5 | 2.7 | .0 | 3.2 | 2.7 | 1.7 | 3.0 | .7 2.4 | 1.11 |

### Task Pilot Comments

- **63**
  - HAS SOME UNDESIRABLE CHARACTERISTICS: RUFFETING 
  - FEELS PRECARIOUS DUE TO STICK POSITION AFT WITH LOW FORCE AND YAW STRING OSCILLATION 
  - MORE DIFFICULT THAN OTHERS
  - FAIRLY DIFFICULT

- **64**
  - 1ST RUDGER EFFECTIVENESS COULD BE IMPROVED. WILL SPIRAL HANDS
  - OFF FOR LONG PERIODS
  - LACK OF DIRECTIONAL STABILITY AND DIFFICULT TURN COORDINATION

- **65**
  - LOW RUDGER EFFECTIVENESS
  - HIGH WORKLOAD DUE TO RUDGER AND AILERON ACTIVITY TO KEEP SIDESLIP NEAR 2-40.GIVES IMPRESSION OF LOW DIRECTIONAL STABILITY.
### Sailplane 3 Data

<table>
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#### Task Pilot Comments

63

- Pleasant; although stick forces on the light side
- No stall-spin tendency observed while thermalling
- Comfortable
- Tendency to pitch in turbulent thermals
- Better than sailplane 2
- Will occasionally self-tighten during strong up-gusts. Can tighten itself into stall in strong gust
- One feels immediately at home in the ship
- Good control harmony at gong. But poor at higher speeds. Rudder coordination and airspeed control create fairly high workloads.

### Sailplane 4 Data

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#### Task Pilot Comments

63

- Good
- No undesirable characteristics noted
- Tended to overcontrol with rudder
- Not as good as sailplane 1
- I don't find trimmer objectionable. Wing-rock is bothersome
- Quite good in circling flight; though not as good as sailplane 1
- Gusts cause nose to change attitude up and down. This tendency must be flown by pilot to maintain thermal location.
- Excessive top aileron required.
### SAILPLANE 5 DATA

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#### PILOT OPINION OF CIRCLING FLIGHT

- Low stick force/feel rather nice for thermalling.
- Better than smaller span gliders.
- Stick cannot be released for more than a few seconds.
- In steeply banked circling flight, fairly large long stick inputs could be made without any change in speed or CG forces.
- Roll rate and yaw due to aileron make thermal centering difficult.
- Very stable in bank angle but attention required to control airspeed.

#### TASK PILOT COMMENTS

- Good except near stall.
- Good, buffering is annoying.
- Modest, off into incipient spin easily.
- Good.
- Excessive pitch force change with bank change.
- Excellent, but on heavy side.
- High workload, turbulence causes upsets in all three axes.
- Requiring lots of stick and rudder movement.

### SAILPLANE 6 DATA

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#### PILOT OPINION OF CIRCLING FLIGHT

- Good except near stall.
- Good, buffering is annoying.
- Moderate.
- Excessive pitch force change with bank change.
- Excellent, but on heavy side.
- High workload, turbulence causes upsets in all three axes.
- Requiring lots of stick and rudder movement.

#### TASK PILOT COMMENTS
### Sailplane 1 Data

<table>
<thead>
<tr>
<th>TASK</th>
<th>DESCRIPTION OF TASKS</th>
<th>PILOT</th>
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**AVG. AND STD. DEV. OF SUBTASKS**

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**AVG. AND STD. DEV. OF SUBTASKS**

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**COMMENTS**

- **Sailplane 1**
  - Very pleasant
  - Difficult
  - Good
  - No problem
  - Directionally loose
  - Nose wanders, but not so as to detract from mission
  - Bouncy because of wing flexing
  - Very easy to change speeds
  - Negative flaps result in quick airspeed changes (quicker than sailplane 5) with no attitude or sound changes
  - This feature may make ship difficult for transitioning

- **Sailplane 2**
  - Very pleasant
  - Difficult
  - Good
  - No problem
  - Directionally loose
  - Nose wanders, but not so as to detract from mission
  - Bouncy because of wing flexing
  - Very easy to change speeds
  - Negative flaps result in quick airspeed changes (quicker than sailplane 5) with no attitude or sound changes
  - This feature may make ship difficult for transitioning
SSAIPLANE 7 DATA

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**PILOT COMMENTS**

68: WORKING AGAINST SPRING IS ANNOYING
69: WORKING AGAINST SPRING IS ANNOYING
70: OCCASIONAL LACK OF COORDINATION NOTED WHILE WATCHING OTHER GLIDERS
71: WORSE THAN MOST
72: GOOD
73: MAINLY CONCERNED WITH WORKING AGAINST THE FEEL SPRING
74: PULLUP TENDS TO PITCH UP TOO HIGH, ROLL AT TOP OK, BUT IF YOU
75: OVERSHOOT, UNBANKING MAY BE DIFFICULT DUE TO LACK OF TOP AILERON
76: AT SPEEDS BELOW 40 KTS WITH FLAPS AT 13/4 RAO;
77: HOLDING HEADING AND SPEED WELL, SECONDARY TASKS CAN BE ATTENDED TO.
**Zeros Indicate No Rating by Pilot**

### Sailplane 5 Data

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<th>TASK</th>
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### Task Pilot Comments

- **TASK** 69: AT HIGH CRUISING SPEEDS, UNABLE TO PIN. POSITIVE LRG GIVES NOSE UP.
- **TASK** 69: INPUT TO STICK SPECTACULAR DUE TO LARGER KINETIC ENERGY OF GLIDER.
- **TASK** 69: MUST HOLD STICK RIGID, NOT UNPLEASANT IF CONTROL TASK IS VERY.
- **TASK** 69: OPEN LOOP.
- **TASK** 69: EXCELLENT.
- **TASK** 69: CAN'T LET GO OF STICK.
- **TASK** 69: IN TURBULENCE, IN THE APPROACH CONFIGURATION, FULL PILOT ATTENTION IS REQUIRED. SLOWER ROLL RATE IS NOTICEABLE; LOT OF RUDDER ACTIVITY.
- **TASK** 69: WAS needed in this phase of flight.
- **TASK** 69: AT 65-70 KG PENETRATION SPEED, QUIET EXCEPT FOR LIGHT RATTLE IN.
- **TASK** 69: WINGS ATTENTION TO AIRSPEED(PITCH) CONTROL LEAVES LITTLE TIME FOR.
- **TASK** 69: SECONDARY TASKS; TURBULENCE CAUSES CONTINUAL SMALL PITCH UPSETS.

### Sailplane 6 Data

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<tr>
<th>TASK</th>
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### Task Pilot Comments

- **TASK** 69: EXCELLENT.
- **TASK** 69: SHOULD BE VERY MOBILE IN THIS GLIDER.
- **TASK** 69: AIRSPEED DECREASES VERY RAPIDLY.
- **TASK** 69: QUICK, EASY BECAUSE OF LARGE STABILITY.
- **TASK** 69: NOT AS SOFT AS GLASS SHIPY NOISY.
- **TASK** 69: GOOD.
- **TASK** 69: LARGE ATTITUDE CHANGES WITH AIRSPEED; NOISY AT TIMES.
- **TASK** 69: SAME GENERAL COMMENTS AS FOR CIRCLING FLIGHT.
---|---
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4. Title and Subtitle | Pilot Evaluation of Sailplane Handling Qualities
5. Report Date | May 1978
7. Author(s) | A. G. Bennett, Jr.
9. Performing Organization Name and Address | Mississippi State University
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Mississippi State, MS 39762
10. Work Unit No. | NASA CR-2960
11. Contract or Grant No. | NSG-1284
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Washington, D.C. 20546
13. Type of Report and Period Covered | Contractor Report
15. Supplementary Notes | Langley technical monitor: Joseph Gera
Final report.
16. Abstract | Seven test pilots flew six sailplanes in a round-robin evaluation of sailplane handling qualities. An evaluation was made of the handling qualities over the sailplane operational envelope using the Cooper-Harper Rating Scale and pilot comments as the evaluation instrument. The sailplanes were chosen to represent the range of handling and performance characteristics of high performance sailplanes in current use.

The evaluation sailplanes were found generally deficient in the area of cockpit layout. The pilots indicated general dissatisfaction with high pitch sensitivity especially when coupled with inertially induced stick forces. While all sailplanes were judged satisfactory for centering thermals and in the ease of speed control in circling flight, pilot opinions diverged on the maneuvering response, pull-out characteristics from a dive, and on phugoid damping. Lateral-directional control problems were noted mainly during takeoff and landing for most sailplanes with the landing wheel ahead of center of gravity. Pilot opinion of in-flight lateral-directional stability and control was generally satisfactory. Five of the evaluation sailplanes exhibited a very narrow airspeed band in which perceptible stall warning buffet occurred. However, this characteristic was considered not objectionable when stall recovery was easy. The pilots objected to the characteristics of a wide airspeed band of stall warning followed by a stall with yawing and rolling tendency and substantial loss of altitude during the stall. Glide path control for the evaluation sailplanes was found to be generally objectionable.

17. Key Words (Suggested by Author(s)) | Handling Qualities, Stability and Control, Sailplane, Cooper-Harper Rating Scale, Pilot Ratings, Sailplane Certification
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