Technical Report

Phase I and II Preliminary Evaluation of the Sequoia 300 Airplane

Final Report

by A. J. Aitken

March 15, 1993

Abstract. A Phase I and II Preliminary Evaluation was conducted to evaluate the flying qualities and suitability of the Sequoia 300 airplane for sport and limited aerobatics flying and to determine its suitability for Phase III performance testing. The builder of the test airplane did a superb job with exceptional craftsmanship, and the airplane was truly a pleasure to fly. The lack of positive directional control with the nose wheel on the ground and the routing of the aileron cables adjacent to and in direct contact with each other are Part I deficiencies. The exceedingly shallow longitudinal stick force gradient with the landing gear and flaps down, and the minimal brake effectiveness during high speed ground operation are Part II deficiencies. Nine other Part II deficiencies and five Part III deficiencies were also noted. Within the scope of this test, and due to the Part I deficiencies noted, the Sequoia 300 airplane has limited potential for sport and limited aerobatics flying. Upon correction of the Part I deficiencies, the Sequoia 300 will have excellent potential to serve as an enjoyable, safe and effective sport and limited aerobatics airplane. The Sequoia 300 airplane is suitable for Phase III performance testing.

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After the first flight of the Sequoia 300 prototype built by Jim Baugh, I asked Al Aitken if he would be interested in conducting a series of flight tests to evaluate the airplane and to make recommendations for improvements to the design. Al graciously agreed to do this, and in September 1992, he flew the aircraft and subsequently he has written the report which follows.

This extensive report follows the format used in the military, however we have made a number of minor changes to the presentation, formatting and terminology to make the document more readable. This type of report is ordinarily a closely guarded document within a company, however we are publishing and distributing this widely in the hopes that others will do the same.

Since the test flights in September, Jim Baugh has installed stronger springs in the nose wheel steering system and has eliminated some inadvertent toe-out in the main gear. Jim reports that the ground handling problems have been eliminated; however, this is not included in the report because it has occurred after the flight tests and this report only includes the observations and measurements of Al Aitken.

My sincere thanks go to Al Aitken for taking the time to produce this document as a volunteer effort.

Alfred P. Scott
President
Sequoia Aircraft Corporation

About the Author

Al Aitken has been flying for 30 years and has logged over 4200 hours of flight time in about 50 different types of aircraft ranging from civilian production and homebuilt airplanes to military jets and helicopters to commercial airliners. Al has a B. S. degree in aeronautical engineering from Cal Poly, San Luis Obispo, California, and he has recently retired from a career as a pilot in the U. S. Marines. He is a graduate of the Navy's Test Pilot School in Patuxent River, Maryland, and he later served as the Senior Fixed-Wing Flight Instructor at that school teaching other officers in the methods of airplane flying qualities and performance testing.

In the Marine Corps, Al was a test pilot for avionics systems for the F/A-18, which he also flew from carriers. Now retired from the Marine Corps, Al and Nancy Aitken live near Manassas, Virginia, where he flies for American Airlines—when he is not building his Sequoia Falco kitplane.

Author's Foreword

At the request of Alfred Scott of Sequoia Aircraft Corporation for an evaluation of the Sequoia 300 airplane, I conducted Phase I and II of an evaluation in accordance with the test plan I submitted in August, 1992. The flight tests were conducted at Felts Field in Spokane, WA using Sequoia 300 prototype N48BL built by Jim Baugh. This report concludes that evaluation.

For the benefit of any readers of this report, I am a homebuilt aircraft enthusiast, and I am currently building a Sequoia Falco from kits; my first airplane project was a Smyth Sidewinder. I have been a member of EAA for most of 23 years, and I have observed with great satisfaction the tremendous boom in homebuilt activity, innovation and technology. I think those involved in the homebuilt movement, from the garage tinkerers to the production kit manufacturers, should be justifiably proud of the advances they have pushed to the forefront of our country's aviation industry.

I am involved in this test work because I believe that we in EAA must be careful to protect our right to design, build and fly experimental aircraft. Toward that end, it would be prudent for us to seek independent and proper flight testing of the airplanes we design, especially those we intend to market on a wide scale. I respect the leadership of the EAA for sponsoring the CAFE Foundation to establish just such a program. The Society of Experimental Test Pilots has published an article recommending and offering their professional assistance in such an endeavor. I would recommend the scope and methodology found in this evaluation be used as a minimum guide.

I would like to mention the impressive accomplishment of the builder, Jim Baugh and of course the designer, Dave Thurston. By homebuilt, and even most other standards, the Sequoia 300 airplane is a very complex, large and powerful airplane. Not only was it a pleasure to fly in spite of the deficiencies that I report, it was built with superb craftsmanship and dedication over an eleven-year period of time. Testing it was an experience I was happy to have.

Some of the deficiencies I cite in this report may already have been corrected, such as the ground handling problems. All deficiencies cited should be addressed as recommended.

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Terminology

This report is an engineering document, and as such contains phrases and technical terminology which may be new to the non-engineer.

Deficiencies

Deficiencies are cited throughout this report. The citing of a deficiency is warranted when, in the view of the test pilot, a particular system, characteristic or flying quality increases the pilot's workload or degrades the performance of the airplane for its intended purpose. The following definitions of deficiencies cited in this report are in common use within the military flight test community and are also applicable to aircraft being evaluated for the homebuilt aircraft community.

Part I indicates a deficiency, the correction of which is necessary because it adversely affects:

a. Airworthiness of the aircraft.

b. The ability of the aircraft (or piece of equipment) to accomplish its primary or secondary intended purpose.

c. The effectiveness of the pilot as an essential subsystem.

d. The safety of the pilot or passengers or the integrity of an essential subsystem. In this regard, a real likelihood of injury or damage must exist. Remote possibilities or unlikely sequences of events shall not be used as a basis for safety items.

Part II indicates a deficiency of lesser severity than a Part I which does not substantially reduce the ability of the aircraft or piece of equipment to accomplish its primary or secondary intended use, but the correction of which will result in significant improvement in the effectiveness, reliability, maintainability or safety of the aircraft, its equipment or its pilot and passengers. A Part II deficiency is a deficiency which either degrades the capabilities of the aircraft or equipment, or requires significant pilot compensation to achieve the desired level of performance. However, the aircraft or equipment is still capable of accomplishing its intended purpose with an acceptable degree of safety and effectiveness.

Part III indicates a deficiency which is minor or slightly unpleasant or appears too impractical or uneconomical to correct in this model, but which should be avoided in future designs.

Handling Quality Ratings

Pilot evaluation still remains the only method of assessing the interactions between pilot-vehicle performance and total workload in determining the suitability of an airplane for its intended purpose. The Cooper-Harper Handling Qualities Rating Scale is a standardized, systematic means of denoting the quality of the pilot-vehicle combination in the accomplishment of the airplane's purpose. The scale is used by both the military and civilian flight test communities, and it provides a numerical rating which corresponds to a specific verbal description.

In this system, the handling qualities are assigned a number ranging from 1 to 10 and these pilot ratings are referred to as HQR-1, HQR-2, HQR-3, etc. HQR-1 is the top rating and denotes excellent and highly desirable handling qualities. HQR-10 is the lowest rating and denotes an uncontrollable situation.

The assignment of the ratings follows a decision tree built on three questions. The first question is "Is it is controllable?" If not, it is assigned HQR-10 and improvement is considered mandatory.

If it passes that test, then the question becomes "Is adequate performance attainable with a tolerable pilot workload?" If not, it is assigned an HQR-7, -8 or -9. These are major deficiences which require improvement.

If it passes that test, then the question becomes "Is it satisfactory without improvement?" If not, it is assigned an HQR-4, -5 or -6. These deficiences are further graded as minor, moderately objectionable, or very objectionable but tolerable. All of these deficiencies warrant improvement.

A summary of the Cooper-Harper Handling Qualities Rating Scale is:

Pilot Rating	**Aircraft Characteristics**	**Demands on the Pilot in Selected Task or Required Operation**
1	Excellent, highly desirable	Pilot compensation not a factor for desired performance
2	Good, negligible deficiencies	Pilot compensation not a factor for desired performance
3	Fair, some mildly unpleasant deficiencies	Minimal pilot compensation requred for desired performance
4	Minor but annoying deficiencies	Desired performance requires moderate pilot compensation
5	Moderately objectionable deficiencies	Adequate performance requires considerable pilot compensation
6	Very objectionable but tolerable deficiencies	Adequate performance requires extensive pilot compensation
7	Major deficiencies	Adequate performance not attainable with maximum tolerable pilot compensation, controllability not in question
8	Major deficiencies	Considerable pilot compensation is required for control
9	Major deficiencies	Intense pilot compensation is required to retain control
10	Major deficiencies	Control will be lost during some portion of required operation

To use the scale, the test pilot decides on a specific task to accomplish within certain tolerances. In our context, the task is devised to simulate maneuvers the sport pilot would commonly experience in the course of an average flight. For example, the sport pilot should reasonably expect to be able to easily and accurately rotate to a 10 deg nose-up attitude during takeoff. The test pilot then may design a task to rotate to 10 deg nose-up within ± 2 deg, evaluate his ability to accomplish that task, note whatever compensation was required of him to do so and then assign an HQR between 1 and 10 from the scale above that best describes his conclusions. For instance, an inability to achieve the 10 deg target pitch attitude without major overshoot and pilot induced oscillations where control of the airplane is a concern may prompt the test pilot to assign an HQR-8 or HQR-9. Quantitative data from static and dynamic longitudinal test procedures, such as the short period mode tests, would then be used to support the test pilot's qualitative findings.

In this manner, other pilots, designers and manufacturers alike can better understand the test pilot's description of a deficiency and more accurately pinpoint the needed corrective actions. The importance of the HQR scale lies in its repeatability. It would be counterproductive if one pilot's HQR-4 meant something different from another pilot's HQR-4 for the same airplane and intended purpose. Therefore, pilots involved in the evaluation of airplane handling qualities should be trained in the use of the HQR scale and the myriad of considerations that go into the formulation of specific HQR tasks and the resulting conclusions.

Test Configurations

Throughout the report, you will see "configuration TO", "configuration CR", etc. These test configurations are defined in Table 1, and describe the configuration of the aircraft for takeoff (TO), climb (CL), cruise (CR), power approach (PA) and land (L).

Glossary

ϕ	Bank angle. The Greek letter is Phi.
β	Sideslip angle. The horizontal angle between the relative wind and the longitudinal axis of the airplane. Commonly referred to as yaw but not exactly the same. For example, left yaw generates right sideslip or β. The Greek letter is Beta.
ϕ / β	Phi to Beta ratio. A description of the nature of the dutch roll mode of the airplane. A high ϕ / β dutch roll response exhibits a predominately wing rocking motion. A low ϕ / β describes a yawing or snakey dutch roll motion.
$\delta_{\mathbf{r}}$	Rudder displacement. The Greek letter is Delta. Usually measured in terms of rudder control pedal displacement.
Centering	Usually applied to the mechanical characteristics of the flight control system, centering is the tendency of a control device to return to the trim position when displaced and released. For example, when the control stick is pulled aft and released, the airplane is said to have positive longitudinal control centering if the control stick returns toward the trim position. If the control stick returns exactly to the trim position, centering is said to be positive and absolute. Lack of positive centering could be indicative of a binding or sloppy control and could have a profound effect on the handling qualities of the airplane.
Deadbeat	Refers to a type of response where a displaced body returns to its origin without overshoot or oscillation. For example, if pulling the control stick aft and releasing it results in the control stick returning to near the original position and stopping with no overshoot and no further oscillation, the motion would be described as deadbeat.
Directional	Refers to motion and stability characteristics about the vertical axis.
Doublet	A test technique consisting of a control input to excite an airplane response. For example, to excite the short-period mode of motion, the test pilot would displace the control stick forward from the trim position a small amount and then pull it aft an equal amount past the trim position and then return it to the trim position. The fore-and-aft input to the control stick is called a

doublet. Doublets are also used with the rudder pedals to excite the dutch roll mode.

Dutch Roll A coupled dynamic lateral and directional mode of motion. Usually consists to some degree of both roll and yaw motions.

Dynamic Stability Refers to the airplane's motion characteristics in a state of non-equilibrium. An airplane's dynamic longitudinal stability characteristics are the means by which the airplane responds to a change in equilibrium. The two dynamic longitudinal modes of motion for an airplane are the short period and the long period or phugoid. (See also Static Stability.)

F_a Aileron stick force. Usually measured at mid-stick grip with a hand-held force gauge held to the side of the stick grip.

F_r Rudder pedal force.

F_s Longitudinal stick force. Usually measured at mid-stick grip with a hand-held force gauge placed to the front or back of the stick grip.

Irreversible A flight control system where aerodynamic control forces on the control surfaces are not transmitted back to the pilot. Hydraulically operated control systems and fly-by-wire computer-controlled systems are typical irreversible control systems. These systems usually incorporate artificial feel devices such as springs to give the pilot an approximate sense of the airloads on the control surfaces. (See also Reversible.)

Lateral Airplane motion about the longitudinal axis or imaginary line running through the nose and tail of the airplane.

Longitudinal Airplane motion about the lateral axis or imaginary line running through the wingtips.

Long Period Often called phugoid, a dynamic longitudinal oscillatory mode of motion. Occurs after the short-period mode in response to a control input or external disturbance. Characterized by essentially constant angle of attack with airspeed and altitude deviations. (See also Short Period.)

N_o' Stick-free non-maneuvering neutral point. The CG location where the stick-free static longitudinal control force versus airspeed gradient is zero under stable, non-maneuvering (no pitch rate damping) conditions. An airplane at equilibrium in flight is balanced about the CG. The sum of all the pitching or restoring moments about the CG contributed by the fuselage, wing and tail is zero. If the airplane is positively stable and its angle of attack is increased, the sum of all the pitching moments changes and becomes positive or nose-down. The nose-down restoring moment returns the airplane to equilibrium. By far the largest contributor to positive restoring moment is the tail. Its contribution is dependent on its moment arm, or distance of its aerodynamic center from the CG of the airplane. As the CG moves aft, the tail's contribution to positive stability decreases. There comes a point when the sum of all the restoring moments is zero or neutral. At that point, the airplane is perfectly happy to be at any airspeed or angle of attack with no stick forces or trim required. For a reversible flight control system, that CG location is N_o' .

N_z Load factor in the vertical axis. Commonly referred to as G's.

PIO Pilot induced oscillations. For example, if the pilot makes a control input for a desired change in flight path and then is not immediately satisfied with the resulting change, he makes another control input. His series of control inputs may induce an oscillatory response from the airplane about the desired change in flight path. In this case, the pilot is driving the oscillation. The oscillation could be divergent, convergent or neutral. Often, all that is required to stop the oscillation is for the pilot to momentarily stop making control inputs.

Reversible A flight control system, usually mechanical in design, where aerodynamic forces on the control surfaces are transmitted, or reversed, back to the pilot. With a reversible system, the pilot is able to feel changes in the stick or rudder pedal forces as a result of the airloads on the control surfaces. (See also Irreversible.)

Short Period Initial response of an airplane to a longitudinal control input. The control input generates pitching moments which initially cause only changes in angle of attack. Airspeed is essentially constant for this mode of motion because the short time period does not allow speed changes. Major impact is on maneuvering tasks. (See also Long Period.)

Spiral A dynamic lateral-directional mode of motion. A non-oscillatory mode, it's a measure of the bank angle convergency or divergency after a bank angle disturbance from wings-level flight with the controls restrained in the position for wings-level flight.

Static Stability Handling qualities or characteristics of an airplane observed under conditions of equilibrium. The airplane's tendency to return or not return to its original condition. (See also Dynamic Stability.)

Stick-free A condition of static longitudinal stability usually attributed to reversible flight control systems. In a reversible flight control system, the elevator is free to respond, or float, to aerodynamic pressure changes caused by changes of angle of attack at the horizontal tail and changes of elevator deflection in relation to the tail. The pilot feels the float characteristics in the control stick. Generally, as airspeed is slowed from the trim speed, the angle of attack at the tail increases and the elevator tends to float up. This results in an apparent lessening of the stick force required to hold a given elevator deflection to keep the airplane at the airspeed slower than trim. Thus the stick-free static longitudinal stability is indicated by the variation of longitudinal control force with airspeed and for a reversible flight control system is usually less than the stick-fixed static longitudinal stability.

Stick-fixed Refers to static longitudinal stability as indicated by the variation of longitudinal control position with airspeed. Usually measured as the variation of longitudinal control stick (δ_s) position with airspeed. Of interest here is the absolute deflection of the longitudinal control surface and it is applicable to both reversible and irreversible flight control systems.

V_S Stall speed with the landing gear and flaps up.

V_{so} Stall speed with the landing gear and flaps down.

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Introduction

Background

In references 1 and 2, Appendix A, test pilot Al Aitken was requested to evaluate the Sequoia 300 airplane for the purpose of sport and limited aerobatics flying. Phase I and II of the evaluation was conducted to determine the flying qualities of the Sequoia 300 and its conformity to the generally accepted guidelines of reference 3, Appendix A. Phase I and II was conducted in accordance with reference 4, Appendix A during the period September 8-11, 1992 at Felts Field airport in Spokane, Washington.

Purpose

The purpose of this evaluation was to determine the potential suitability of the Sequoia 300 airplane as a homebuilt aircraft licensed in the Experimental category for sport flying in day/night and VFR/IFR conditions and for limited aerobatics flying. The objective was to determine gross deficiencies to allow for design corrections.

Description of Test Airplane

The Sequoia 300 is a high performance, two-place, dual control, VFR/IFR homebuilt experimental sport plane powered by a single Lycoming TIO-540-S1AD 300-horsepower turbocharged engine turning a Hartzell 2-blade, 80-inch, J blade constant-speed propeller. Prominent features of the Sequoia 300 include retractable landing gear, sliding bubble canopy, dual control sticks and conventional all-metal construction with fiberglass skin on the fuselage section aft of the firewall. The pitot-static system includes a standard heated pitot tube mounted under the right wing and dual static ports mounted one on each side of the aft fuselage.

The aerodynamic design is conventional with reversible, mechanically actuated flight control surfaces. Longitudinal trim is provided by two mechanically operated trim tabs, one on each elevator. The elevators and rudder are aerodynamically and mass balanced, and the ailerons are mass balanced only. The low-mounted wing incorporates slotted trailing edge flaps hinged from below and sculptured wing tips that curl upwards a few inches. A three-view drawing of the Sequoia 300 is presented in Appendix B.

The Sequoia 300 has provisions for night and instrument flight and is stressed for maneuvers in the Aerobatic Category. The test airplane, Serial No. 0019 (N48BL), is a prototype airplane built in accordance with Sequoia Aircraft Corporation's plans with no significant modifications. Empty weight without ballast was 2,172 lbs. Ballast consisting of 30 lbs. of lead at station 41.81 was required for the loaded airplane to fall within the design-predicted center of gravity range of 18-26% MAC. The builder attached the lead ballast to steel brackets which were fastened to available mounting pads on the front left and right sections of the engine crankcase. No automatic data collection system or any sensitive instrumentation was available for this evaluation. All data were taken from standard panel-mounted instruments, tape measures and a hand-held force gauge and were recorded on data cards and a portable tape recorder. For the purposes of this evaluation, Sequoia 300 N48BL was representative of homebuilt Sequoia 300 airplanes for flying qualities testing.

Scope of Tests

The Sequoia 300 airplane was evaluated as a homebuilt sport plane for day/night, VFR/IFR sport and limited aerobatics flying. Major emphasis was placed on flying qualities with a specific objective to determine the approximate location of the stick-free non-maneuvering neutral point (N_o'). However, cockpit layout and ground handling were also evaluated.

The first two phases of the evaluation consisted of four flights and 7.1 flight hours and were conducted during day VMC in the Spokane, Washington, area. Phase I consisted of one flight and was flown dual with builder/owner Jim Baugh to provide airplane and area familiarization for the test pilot. Cockpit layout, ground handling, control system mechanical characteristics and qualitative handling qualities in sample maneuvers were evaluated during this flight. Phase II consisted of three flights, solo and dual, to determine stall speeds and evaluate quantitative longitudinal and lateral-directional flying qualities at mid and aft CG locations. For determination of the approximate N_o', the static longitudinal stability characteristics about the trim airspeed as a function of CG, for either configuration, were assumed to be linear within the speed envelope of the Sequoia 300. Phase III will evaluate performance and stall and spin characteristics and will be described in a subsequent supplemental test plan.

Configuration	Landing Gear	Flaps	Power
Takeoff (TO)	Down	15 deg	36” Hg, 2650 rpm, wastegate full open
Climb (CL)	Up	Up	25” Hg, 2500 rpm
Cruise (CR)	Up	Up	75% (1)
Power Approach (PA)	Down	38 deg	PNA (2)
Land (L)	Down	38 deg	Idle

Notes: (1) Power as required for 160 mph at 7000 ft pressure altitude. Approximately 22” Hg, 2400 rpm
(2) Power for normal approach; 3 deg glideslope, prop full increase, approximately 20” Hg

Table I. Test Configurations

Flight test limitations adhered to during this evaluation are summarized in Appendix C. Planned CG variance was accomplished by varying the number of pilots and the amount of fuel at takeoff. The evaluation was conducted in a build-up fashion with quantitative data collected at mid-CG first followed by aft CG tests. Airplane test configurations are presented in Table I.

Method of Tests

Flying qualities test procedures were in accordance with References 5 and 6, Appendix A. Handling qualities ratings (HQR) were assigned in accordance with Reference 7, Appendix A.

Special instrumentation used during this evaluation consisted of:

a. Hand-held force gauge (0-50 lb. range—the only force gauge available at the time)

b. Hand-held digital stop watch (0.01 sec. accuracy)

c. Cockpit mounted tape measures (longitudinal and lateral)

d. Windshield mounted yarn tuft (to measure sideslip angle)

e. Floor-mounted rudder pedal travel indicator (1/4 δ_r increments)

All other data measurement requirements such as bank angle, normal acceleration (N_z) and airspeed were obtained from standard panel-mounted instruments. Cockpit evaluation data was based on the test pilot’s average 70” height and 185 lb weight with average sitting height and leg and arm reach measurements. Data were recorded on pilot’s kneeboard cards and a portable tape recorder. Flying qualities test conditions are summarized in Table II below.

Phase	**Test**	**Con-fig.**	**Trim IAS** (mph)	**Alti-tude** (ft AGL)	**Nbr of Pilots**	**Fuel** (gal)	**Gross Wt** (lbs)	**CG** (%)
I	Cockpit Layout	L	0	Airport Elev.	2	60	3000	25.4
	Ground Handling	L	1-60	Airport Elev.	2	60	3000	25.4
	Mechanical Characteristics Breakout including friction, freeplay, centering, control system oscillations.	CR	160	3000	2	60	3000	25.4
	HQR Sample Maneuvers Takeoff	TO	60	Airport Elev.	2	60	3000	25.4
	Climb	CL	110	0-3000	2	60	3000	25.4
	Level Off	CL	110-160	3000	2	60	3000	25.4
	Heading Changes	CR	160	3000	2	60	3000	25.4
		PA	100	3000	2	60	3000	25.4
	Stall Characteristics, Stall Warning,	CR	100-V_S	3000	2	60	2845	23.3
	Stall Speed	PA	90-V_{SO}	3000	2	60	2845	23.3
	Approach Glide Slope	PA	100	3000-2000	2	60	3000	25.4
	Flare	L	1.3 V_{SO}	Airport Elev.	2	60	3000	25.4
II	Static Longitudinal Stability Stick Fixed (δ_S vs IAS) Stick Free (F_S vs IAS)	CR	160	3000	1	77	2845	23.3
	Trim Speed Band	PA	100	3000	2	60	3000	25.4
	Flight Path Stability	PA	100	3000	2	60	3000	25.4
	Dynamic Longitudinal Stability,	CR	160	3000	1	77	2845	23.3
	Long Period (phugoid)	PA	100	3000	2	60	3000	25.4
	Dynamic Longitudinal Stability, Short Period	CR	160	3000	1	77	2845	23.3
					2	60	3000	25.4
	Maneuvering Longitudinal Stability, δ_S vs N_Z, F_S vs N_Z	CR	160	3000	1	20	2500	23.7
	Longitudinal Trim Changes & Trimmability	vari-ous	135 / 135	3000	2	60	3000	25.4
	Static Lateral-Directional Stability, directional stability, dihedral effect,	CR	160	3000	1	77	2845	23.3
	sideforce characteristics, adverse yaw	PA	100	3000	2	60	3000	25.4
	Roll Performance,	CR	160	3000	1	77	2845	23.3
	roll rate	PA	100	3000	2	60	3000	25.4
	Dynamic Lat-Dir Stability,	CR	160	3000	1	77	2845	23.3
	dutch roll mode, spiral mode	PA	100	3000	2	60	3000	25.4

Table II. Flying Qualities Test Conditions

Specification Conformity

As mentioned in the background paragraph and throughout this evaluation, comparison is made to the guidelines presented in the Federal Code of Regulations, Title 14, Part 23, hereinafter referred to as “the specification” (Reference 3, Appendix A). Although there is no legal requirement for a homebuilt aircraft, licensed under the Experimental category, to comply with or strictly meet the requirements in the specification, there is nevertheless a common-sense need to design and build aircraft that perform their intended purposes satisfactorily and safely. The specification was written to ensure that need is met for certified aircraft, and it should serve as a useful guideline for those designing, building and testing homebuilt aircraft as well. After all, it will always make sense that an airplane without computer-assisted flight controls should be positively stable longitudinally, no matter how hot a performer the aircraft was designed to be.

That said, not every aspect of the Sequoia 300 evaluation is covered by an applicable guideline in the specification. Not every tested aspect which did not conform to an applicable guideline was necessarily deficient in the view of the test pilot. Conversely, any tested aspect of the Sequoia 300 found deficient in the judgement of the test pilot was reported as such regardless of its conformity with applicable guidelines of the specification. The bottom line is that the test pilot’s judgement is over-riding and is based on his experience with the intended use of the airplane being evaluated.

Those involved in the rapidly expanding homebuilt industry need to preserve and protect our right to design and build the aircraft of our future. It is toward that end that the Sequoia 300 was evaluated for its ability to perform as a sport flying and limited aerobatics airplane with a concern for its conformity to the guidelines in the specification.

Chronology

The chronology of the evaluation was as follows:

a. Request for Evaluation received	July 7, 1992
b. Test Plan submitted	August 20, 1992
c. Test Plan Review completed	September 8, 1992
d. Test Pilot arrived Spokane, WA	September 8, 1992
e. Aircraft Preparation completed	September 8, 1992
f. Evaluation Flight Tests commenced	September 9, 1992
g. Evaluation Flight Tests completed	September 11, 1992
h. Test Pilot returned home	September 12, 1992
i. Data reduction and analysis completed	February 14, 1993
j. Final Report submitted	March 15, 1993

Results and Discussion

Cockpit Evaluation

Canopy

The bubble canopy was mounted on side rails and opening or closing it amounted to sliding it aft or forward respectively. Sliding the canopy forward required the pilot to tilt his head forward or to the side to clear the canopy bow as it passed. Once closed, the canopy was locked by latching a hook from the canopy to the windshield bow at the centerline and pulling aft and up on a cam-action handle to apply over-center locking tension to the hook. Unlocking was a reverse of that action.

Locking the canopy required approximately 30 lbs. of pull and lifting force on the handle which was not easily accomplished due to the lack of leverage with the pilot's arm stretched forward approximately 1.5 ft. The pilot was required to use both hands and squeeze the locking handle upward using the center canopy support frame for leverage. It appeared there were adjustment nuts provided to adjust the throw of the hook to lower the force required to lock the canopy with the locking handle. Appropriate adjustments and further testing are recommended.

Cockpit Entry/Egress

Entry into the cockpit was awkward and was gained by standing at the wing root leading edge, facing forward with the hands behind the pilot placed on the upper surface of the wing and hopping up to a sitting position on the upper wing root. From that position, holding on to the canopy sill stabilized the pilot as he stood up on the wing and stepped over the canopy sill into the cockpit. The canopy sill was high relative to the upper surface of the wing and required a noticeable effort to step over. Once over, stepping onto the protected upper surface of the spar and then slipping down into a seated position was accomplished with little effort. Egress was the reverse of the entry procedure.

According to the builder, insufficient structural support in the upper wing root skin aft of the spar required the awkward entry procedure across the wing in front of the spar. The sport pilot and his passenger may find the entry procedure too awkward or ungraceful and may resort to stepping up over the trailing edge of the wing which could result in minor wing skin denting. The insufficient wing skin structural support aft of the wing spar for use in entry and egress is a Part III deficiency which should be avoided in future designs.

Cockpit Accommodations and Restraint System

Two late-model MGB Roadster seats were installed on tracks just above the wing spar and just forward of the fuselage cockpit center cross bracing. The high back seats had integral headrests and were adjustable fore and aft through an adequate range. The pilot was able to adjust the seat to obtain full throw of the non-adjustable rudder pedals and toe brakes. No vertical adjustment was provided. The seat back angle was not adjustable due to the fuselage cockpit center cross bracing and was set at an angle too acute for long-term comfort. The first flight of the evaluation was 2.7 hours long and caused minor back discomfort due to the acute angle. The excessively acute angle of the seat back is a Part III deficiency which should be avoided in future designs.

The restraint system consisted of a military-style single-lever quick-release lap belt and shoulder harness arrangement for each occupant. No crotch strap was provided. The shoulder straps were attached to the airframe at the aft bulkhead of the cockpit as a single strap and separated into two straps just prior to the back of the seat headrest.

The shoulder straps were brought individually around the sides of the head rest and fastened to the lap belt. When the shoulder straps were tightened, the tension was taken against the back of the headrest at the point of strap separation rather than at the airframe bulkhead. The tension also caused the lap belt to ride up with no restraint from a crotch strap. When the pilot leaned inboard, the outside strap would ride up over the top of the headrest and result in an uncomfortable asymmetric restraint at the shoulders.

The sport pilot will need to frequently fidget with and readjust his shoulder harness to his desired tension and symmetry which will detract his attention from flying the airplane. In situations of negative G, the sport pilot may tend to float up away from the seat or may "submarine" under the lap belt in case of impact. The inadequate restraint system is a Part II deficiency which should be corrected as soon as practicable. The restraint system did not conform to the guidelines of paragraph 23.785 (e) of the specification in that negative G's would allow the pilot to float up which could prevent him from performing all functions necessary for flight operations.

External Field of View

The external field of view was evaluated on the ground and in the air with the pilot strapped into the left seat and with the seat positioned to enable full throw of the rudder pedals and toe brakes. The field-of-view perspective was from the assumed design eye position allowing for normal unstrained head and body twisting. External field-of-view ranges are depicted photographically in Figure 1.

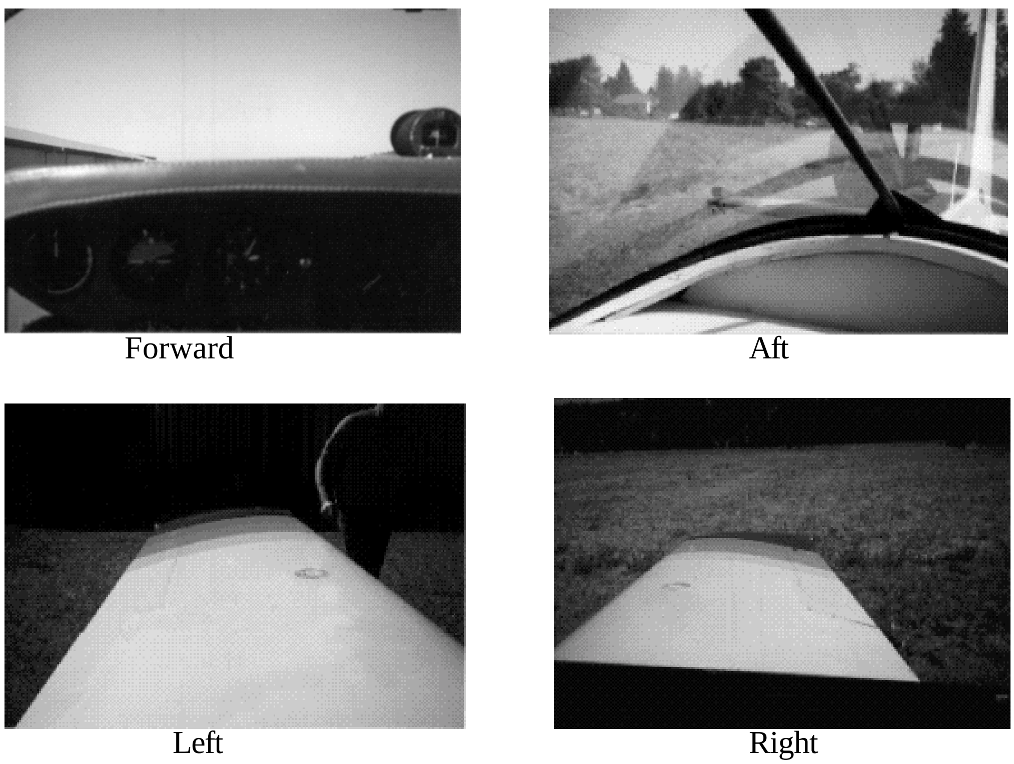


Figure 1. External Field of View

The external field of view upward, downward to the sides and rearward was excellent with only the wing interrupting a portion of the downward view. The vertical and horizontal tails were in full view with only minimal head and body twist. The external field of view forward over the nose was somewhat obstructed by the large cowling and instrument panel glareshield as viewed from the relatively low design eye position. The forward obstruction to external field of view became more pronounced as angle of attack was increased. During the landing flare and aerodynamic braking, the sport pilot will need to monitor his centerline tracking by looking up to 15 deg left and 20 deg right to reference the sides of the runway. The obstructed forward external field of view is a Part III deficiency which should be avoided in future designs. The external field of view appeared to conform to the applicable guidelines in the specification.

Cockpit Controls

Cockpit controls were evaluated to determine relative location and ease and logic of manipulation. All flight controls and system switches were easily reached and manipulated through their full range of travel by the pilot sitting erect in the left seat. Some circuit breakers and cabin air and heat controls mounted on the right side of the instrument panel were also within easy reach with minimal stretch of the pilot's right arm. All controls operated in the normal manner.

A single set of engine controls was provided at the center of the lower instrument panel. Engine controls were vernier and were color-coded for throttle (black), mixture (red) and propeller (blue), located left-to-right in that order. The turbocharger control (red), was also vernier and located just below the throttle. Landing gear, flap and trim controls were mounted on a vertical pedestal below the center instrument panel. The flap handle was obstructed from view from the design eye position by the right front corner of the pilot's seat. However, it was tactiley shaped like a flap and easily reached and actuated. Within the scope of these tests, the cockpit controls of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying. The cockpit controls did not conform to the guidelines of paragraph 23.777 (d) in that the left-to-right order of the engine controls was not throttle, propeller and mixture.

Cockpit Displays

An evaluation of the cockpit displays was conducted to determine the availability, accuracy, and ease of interpretation of all flight and systems information provided to the pilot. All cockpit displays were within the pilot's cockpit internal field of view and appeared accurate and easy to read. Primary flight instruments were arranged in the typical "T" fashion which facilitated an efficient instrument scan pattern. Primary engine instruments, consisting of rpm, manifold pressure and fuel pressure/fuel flow gauges, were arranged logically in the upper center instrument panel and were large and easily read.

An engine instrument cluster was positioned in the center of the right instrument panel and included fuel quantities (one for each fuel tank, left and right), ammeter, oil pressure, oil temperature and cylinder head temperature. Due to the depth of mounting in the instrument panel and the angle of view from the left seat, some parallax existed in reading those instruments.

A turn coordinator was mounted in the lower left corner of the standard flight instrument "T". With the aircraft sitting level on the ground, the inclinometer showed 1/8 ball to the left. The misaligned inclinometer was verified in flight with 1/8 ball left required for zero sideslip with the wings level. The sport pilot will be required to mentally adjust for the misaligned inclinometer in order to maintain zero sideslip and minimize drag. The misaligned inclinometer in the turn and bank indicator is a Part II deficiency which should be corrected as soon as practicable. The cockpit displays appeared to conform to the applicable guidelines of the specification.

Emergency Controls

An emergency hydraulic landing gear hand pump was installed on the left cabin side wall just above the pilot's left knee. A red-tipped telescoping handle was provided and was in prominent view and easily actuated to provide emergency hydraulic power to lower the landing gear. The sport pilot will have adequate emergency control available to lower the landing gear in the event of a primary system motor failure. Within the scope of these tests, the emergency controls of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying.

Airplane Systems

Engine System

The test airplane was powered by a single Lycoming TIO-540-S1AD 300-horsepower turbocharged engine turning a Hartzell 2-blade, 80-inch constant-speed propeller. Standard vernier engine controls were provided for throttle, mixture, propeller and turbocharger wastegate. Engine instruments were provided for RPM, manifold pressure and fuel flow, EGT, CHT, oil temperature and oil pressure. The digital EGT gauge was used for an approximate and conservative turbine inlet temperature indication.

The turbocharger control operated a manual wastegate which was selected full on (pushed in) for takeoff and landing. During climbout, manifold pressure was regulated to 25” Hg by turning the vernier turbocharger control out. After level off, manifold pressure setting for cruise (22” Hg/2400 rpm) required alternate adjustments of both the throttle and turbocharger controls. During approach for landing, again alternate adjustments of both the throttle and turbocharger controls were required to maintain a constant manifold pressure as the wastegate was fully opened for landing.

The engine idled as low as 800 rpm and operation was responsive and smooth at all power settings used throughout the tested flight envelope. Takeoff power was set at 36 in. manifold pressure and the propeller governor maintained 2650 rpm. As power was increased for takeoff, noticeable P-factor torque developed which was easily countered with approximately 1/4 right rudder pedal displacement. Within the scope of these tests the engine systems of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying. The engine system appeared to conform to the applicable guidelines of the specification.

Oil System

The engine oil system is a standard wet sump system which includes an oil cooler mounted within the cowling on the lower left side of the engine. No inverted oil system is provided. Ram air for oil cooling enters the cowling through a 3-inch diameter circular intake below the left engine cooling air intake. The oil cooling ram air is ducted down and to the left of the engine to meet the front face of the oil cooler. Air exhausting the aft face of the oil cooler is not directionalized but is free to mix with exhausted engine cooling air and air entering the bottom of the cowling through the open nose gear bay.

During climbing flight at 25” Hg, 2500 rpm and 110 mph with outside air temperature at approximately 63°F, engine oil temperature reached the red line (245°F) even with the cowl flaps full open. Oil temperatures improved slightly during flight at 160 mph in configuration CR with power set at 22” Hg and 2400 rpm and the cowl flaps closed. However, during level flight at 100 mph in configuration PA, oil temperature again reached the limit. The sport and limited aerobatics pilot will be restricted to cooler climates, higher-than-optimum climb speeds and lower-than-normal power settings in order to keep the oil temperature within limits. The inadequate engine oil cooling of the Sequoia 300 is a Part II deficiency which should be corrected as soon as practicable. The oil system did not conform to the guidelines of paragraph 23.1011 (a) of the specification in that it did not supply the engine with an appropriate quantity of oil at a temperature not above that for safe continuous operation.

Hydraulic System

An electrically driven self-contained hydraulic system was provided for actuation of the landing gear and flaps. An emergency hand pump was included for actuation of the landing gear in case of the hydraulic pump electric motor failure. The self-contained hydraulic unit included the electric motor, hydraulic pump, pump pressure regulator and reservoir. No hydraulic pressure or fluid quantity indications were provided in the cockpit.

An additional overflow reservoir was installed in close proximity to the self-contained unit. Hydraulic pump flow capacity was adequate to raise or lower the landing gear in approximately 18-20 seconds or the flaps in approximately 3-4 seconds. The flow capacity was insufficient to raise or lower the landing gear and flaps simultaneously. When attempting to lower the landing gear and flaps together, priority was given to the landing gear which continued to lower at a reduced rate while the flaps remained stationary until the gear lowering cycle was completed.

Slight venting of hydraulic fluid overboard occurred with repeated cycling of the landing gear and flaps during the evaluation and required refilling of the reservoirs on a frequent basis. The requirement for the sport pilot to frequently refill the hydraulic system will significantly increase the maintenance man-hours and operating cost per flight hour. Venting of the hydraulic fluid overboard with cycles of the landing gear is a Part II deficiency which should be corrected as soon as practicable. The hydraulic system did not conform to the guidelines of paragraph 23.1435 (a) of the specification in that no means to indicate the pressure in the hydraulic system, which supplies two or more primary functions, was provided to the pilot.

Fuel System

Fuel capacity was 77 gallons contained in two wet-wing fuel tanks forward of the main wing spar and spanning from the root to approximately 1/3 of the wing span. A fuel selector valve was provided with positions of left, off and right. The selector valve knob was easily accessible on the aft center console between the two seats. No inverted fuel system was provided. An electrically driven fuel boost pump was included and used for engine start, takeoff and landing.

Two fuel quantity gauges, one for each fuel tank, left and right, were provided but were inaccurate. A fuel sending unit consisting of a pivoting arm and float assembly was installed near the wing root in each tank. Due to the 3 deg dihedral of the wing, when the sending unit floated to the top with fuel filling the root area of the wing tank, much more capacity was still available farther out toward the wing tip. In level flight, when the fuel quantity needle began to decrease from the full mark, approximately less than half of the fuel in that tank remained. Any correlation between the gauge indications and actual fuel quantity came only from the builder's experience. The sport pilot will be unable to accurately detect his fuel status which will prevent him from determining his stall speeds or his gross weight for aerobatic maneuvers and will require him to significantly reduce his range capability in order to ensure sufficient reserves under IFR. The inaccurate fuel quantity indicating system is a Part II deficiency which should be corrected as soon as practicable. The fuel quantity indicating system did not conform to the guidelines of paragraph 23.1337 (b) of the specification in that it did not accurately indicate to the pilot the quantity of fuel in each tank during flight.

The internal volume of the wing fuel tanks were baffled only by the normal wing ribs with their lightening holes. Fuel was able to slosh spanwise to some extent. The fuel tank outlet line was installed near the lowest point in the fuel tank near the wing root. During the evaluation, steady-heading sideslips were conducted while operating from an approximately half full right fuel tank. When the pilot abruptly re-centered the rudder pedals from a maximum deflection right beta steady-heading sideslip, the engine quit momentarily until the pilot switched fuel tanks, pushed in the mixture control and turned on the electric fuel pump. During VFR approaches using slips to correct for an above-glideslope condition, the sport pilot may be faced with a momentary hesitation in power as he re-centers the ball to conclude his flare and landing. Engine hesitation or stoppage in abrupt yaw rate conditions is a Part II deficiency which should be corrected as soon as practicable. The fuel tanks appeared to conform to the applicable guidelines of the specification.

Brake System

Cleveland 6.00 x 6 wheels and brakes with single-puck calipers were installed on the main gear. The brakes were actuated from either seat by toe brake pedals through individual master cylinders with integral reservoirs. A parking brake selector valve was installed on the cabin right sidewall interior and was hard to reach from the left seat with the shoulder harness fastened. The parking brake was set by applying pressure to the toe brakes and then pulling upward on the red knob of the parking brake selector. Releasing the parking brake was accomplished by simply pushing down on the red knob. The parking brake was effective in holding the airplane during engine run-ups to 2000 rpm. During pre-takeoff checks, the sport pilot will need to unfasten his shoulder harness in order to engage and then disengage the parking brake. The placement of the parking brake selector valve on the right sidewall of the cabin interior is a Part III deficiency which should be avoided in future designs. The parking brake control did not conform to the guidelines of paragraph 23.777 (b) in that it was not located so that the pilot, when seated, had full and unrestricted movement of the control.

Preflight and Starting

Preflight and starting procedures were qualitatively evaluated throughout this evaluation period. The preflight procedure was straightforward and followed a logical sequence around the airplane. Fuel samples were taken at three points accessed from the bottom of the airplane wings and fuselage by using a bayonet-style fuel sample flask inserted into plunger-style fuel drains at the wing and fuselage low points.

Inspection of the hydraulic system reservoirs required opening a small 4-fastener access panel on the fuselage belly centerline. Inspection of the engine bay and accessories was from the lower aft opening of the cowling behind the nose gear as no hinged side cowling doors were provided. Full view of the engine compartment was difficult from this position. Checking the oil was facilitated by use of a small step ladder as the oil stick access panel was located on the top in the center of the cowling which made it difficult for the pilot to reach and check from ground level.

Cockpit preflight and engine starting procedures were also straightforward and logical for a fuel injected engine. Within the scope of these tests, the preflight and starting characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying. The cowling installation did not conform to the guidelines of paragraph 23.901 (c) of the specification in that the cowling was not easily removeable or openable by the pilot to provide easy access to and exposure of the engine compartment for preflight checks.

Ground Handling Characteristics

Ground handling characteristics were evaluated during taxi, takeoff and landing rollout. Wind conditions were essentially calm during ground handing evaluations. An idle power setting of 1000 rpm was sufficient to cause airplane movement on a level taxiway. Continued operation at 1000 rpm produced a moderate taxi speed of approximately 8-10 mph. A reduced power setting of 800 rpm resulted in a more comfortable taxi speed of approximately 5 mph. Brakes were effective at stopping the airplane from 5 mph in approximately 3-5 ft. From a faster taxi speed of 8-10 mph, moderate braking stopped the airplane in approximately 30 ft. Differential braking was effective for easily remaining within ± 2 ft. of the taxiway centerline with only mild applications of brake pedal pressure opposite to the direction of drift (HQR-2). Differential braking was also effective at generating a turn with an acceptable turn radius in non-congested ramp areas. Dragging the outside brake during turns using the nosewheel steering (NWS) was effective at controlling speed.

The NWS system was actuated by the rudder pedals through cables connected to the NWS actuating bar. Displacement of the bar would act against rollers on the NWS horn to angularly displace the nose gear strut and fork. Springs pre-loaded to 35 lbs. were installed in-line between the NWS cables and the actuating bar. As rudder pedals were displaced, tension would first be assumed in the springs before the actuating bar was displaced. Directional control during slow and moderate taxi speeds was good with the airplane tracking the taxiway centerline. To remain on the centerline within ± 2 ft., the pilot needed only to apply minimal rudder pedal inputs (δ_r) of less than 1/4 deflection (HQR-2). However, if the pilot allowed the airplane to deviate from the centerline, moderate δ_r of greater than 1/4 deflection were required to bring the airplane back to within ± 2 ft. and a noticeable pilot-induced oscillation (PIO) resulted (HQR-4).

During takeoff roll, directional control became more difficult with increasing speed. As power was increased for takeoff, P-factor required noticeable right rudder pedal displacement up to 1/4 δ_r to maintain runway centerline ± 2 ft. (HQR-3). As speed increased, the pilot was required to focus his attention on directional control using frequent moderate rudder pedal inputs of greater than 1/4 deflection. Quick anticipation of the need to remove the rudder pedal displacement was required in order to keep the airplane tracking within ± 2 ft. and avoid pilot induced oscillations (PIO) and a dramatic departure from the runway centerline (HQR-5). Directional control became somewhat easier as speed approached liftoff apparently due to increased rudder effectiveness. During rotation from the runway center, the pilot was able to maintain runway centerline ± 2 ft. and zero sideslip ± 1/8 ball with only a small increase in δ_r (HQR-2).

During landing rollout, directional control was manageable only with the nose wheel off the ground in aerodynamic flare. With the nose gear lowered to the ground, directional control became extremely difficult. Once deviated from the runway centerline, rudder pedal inputs required to return to centerline became excessive (greater then 1/2 deflection) and unpredictable. In attempting to regain centerline within ± 2 ft, a divergent PIO developed and the pilot was unable to recapture the centerline. The pilot was able to dampen the PIO only somewhat by use of differential braking (HQR-8). During landings in crosswind conditions or wet runway conditions, the sport pilot may have extreme difficulty maintaining directional control and may depart the runway resulting in airplane damage or personal injury. The lack of positive directional control with the nose wheel on the runway at high speed during takeoff or landing conditions is a Part I deficiency which must be corrected prior to operations in wet or crosswind conditions. The ground handling characteristics did not conform to the guidelines of paragraph 23.233 (b) of the specification in that the airplane was not satisfactorily controllable on the ground, without exceptional piloting skill and alertness, in power-off landings at normal landing speeds.

Braking action was tested during the landing rollout at Felts Field's elevation of 1,953 ft. Braking was minimally effective for stopping the airplane within 3,000 ft even considering the slightly higher true airspeed at touchdown due to field elevation. To improve deceleration and better maintain directional control, the pilot was required to aerodynamically brake as long as possible, then lower the nose and attempt maximum braking. At that point, maximum braking appeared ineffective and improved only with continued deceleration during the rollout. The sport pilot will be limited in selection of runway length, slope and tailwind conditions due to the ineffective braking capability during high speed abort or landing rollout events. The minimal brake effectiveness during high speed ground operation is a Part II deficiency which should be corrected as soon as practicable. The braking action did not conform to the guidelines of paragraph 23.735 (a) of the specification in that the kinetic energy capacity of the main wheel brakes appeared less than the kinetic energy absorption requirements based on a rational analysis of the sequence of events during landing.

Control System Mechanical Characteristics

The longitudinal control system consists of a single-piece elevator hinged to the trailing edge of a fixed horizontal stabilizer. The elevator is actuated through the control sticks by push-pull tubes, a bellcrank and cables. The builder modified the original mechanical trim system to incorporate a single, electrically actuated trim tab on the right side of the elevator. The lateral control system consists of ailerons actuated through the control sticks via control cables, pulleys, bellcranks and push-pull tubes. The aileron control cables to each wing are routed adjacent to each other in such a fashion that they make direct contact with each other and with their installed cable tension turnbuckles. As the control stick was moved laterally, the adjacent cables and turnbuckles rubbed against each other. The directional control system consists of a rudder actuated through twin sets of rudder pedals via cables, pulleys and a control horn. No lateral or directional trim is provided.

The mechanical characteristics of the Sequoia 300 airplane's longitudinal, lateral and directional control systems were measured in flight at 160 mph. Measurements were also made of the longitudinal and lateral control systems on the ground for verification. The mechanical characteristics measurements are presented in Table III below.

Control System	**Breakout Force** (1) (including friction) (lbs)	**Freeplay** (2) (in.)	**Centering**	**Control Oscillations**
Longitudinal	0.5/0.5	± 1/16	Positive & absolute	Deadbeat
Lateral	0.5 / 0.5 (3) 1.5 / 0.5 (4)	± 1/16	Positive within 1/4"	Deadbeat
Directional	< 5 / < 5	Negligible	Postive within 1/8 δ_r	Deadbeat

Notes: (1) Measured Fwd/Aft, Left/Right
(2) Measured at mid stick grip.
(3) In flight
(4) Static on the ground

Table III. Sequoia 300 Control System Mechanical Characteristics

The mild longitudinal breakout force, including friction, coupled with the very small freeplay provided the pilot with positive but smooth and predictable feel about longitudinal trim. The pilot was able to keep his hand on the control stick without concern for inadvertently displacing the control stick longitudinally. The pilot was able to easily maintain desired attitude within ± 2 deg or trim airspeed within ± 5 mph (HQR-2). Longitudinal centering was positive and absolute, and control system oscillations were deadbeat. The sport pilot will be able to rest his hand on the control stick with his forearm supported across his knee while attending to other cockpit duties without displacing his climb or cruise attitude. Within the scope of these tests, the mechanical characteristics of the Sequoia 300 airplane longitudinal flight control system are satisfactory for sport and limited aerobatics flying.

The light directional breakout force, including friction, and the negligible freeplay provided the pilot with smooth, predictable directional control feel. However, the non-absolute centering of the rudder pedals allowed inadvertent flight with mild sideslip. The lateral breakout force, including friction, in flight, which was less than that measured on the ground, provided the pilot with smooth predictable lateral control feel and contributed to very pleasing control harmony. Flight vibrations in the adjacently routed aileron control cables may have contributed to the reduction in apparent lateral breakout including friction compared to static ground measurments.

The higher lateral breakout including friction measured in static ground conditions was indicative of a rubbing or chaffing condition caused by the aileron cable routing arrangement, that over time could cause cable damage or binding of the lateral control system and resultant loss of control of the airplane. The routing of the aileron control cables adjacent to and in direct contact with each other is a Part I deficiency which must be corrected prior to further testing. The routing of the aileron control cables did not conform to the guidelines of paragraph 23.671 of the specification in that the aileron control did not operate easily and smoothly; or paragraph 23.685 of the specification in that each detail of the aileron control system was not designed or installed to prevent jamming or chaffing; or paragraph 23.689 (e) of the specification in that the aileron cable turnbuckles were not attached in a manner that positively prevented binding throughout the range of travel.

Longitudinal Flying Qualities

Static Longitudinal Stability

Static longitudinal stability, as indicated by the variation of longitudinal control force (F_S) and longitudinal control position (δ_S) with indicated airspeed, was evaluated at two different CG values in configurations CR and PA at 7,000 ft pressure altitude. The objectives were to evaluate the longitudinal stability characteristics and to determine the approximate N_o' in each configuration. Configuration CR static longitudinal stability test results at the mid and aft CG's tested are presented in Figures 2 and 3 respectively. Configuration PA static longitudinal stability test results at the mid and aft CG's tested are presented in Figures 4 and 5 respectively.

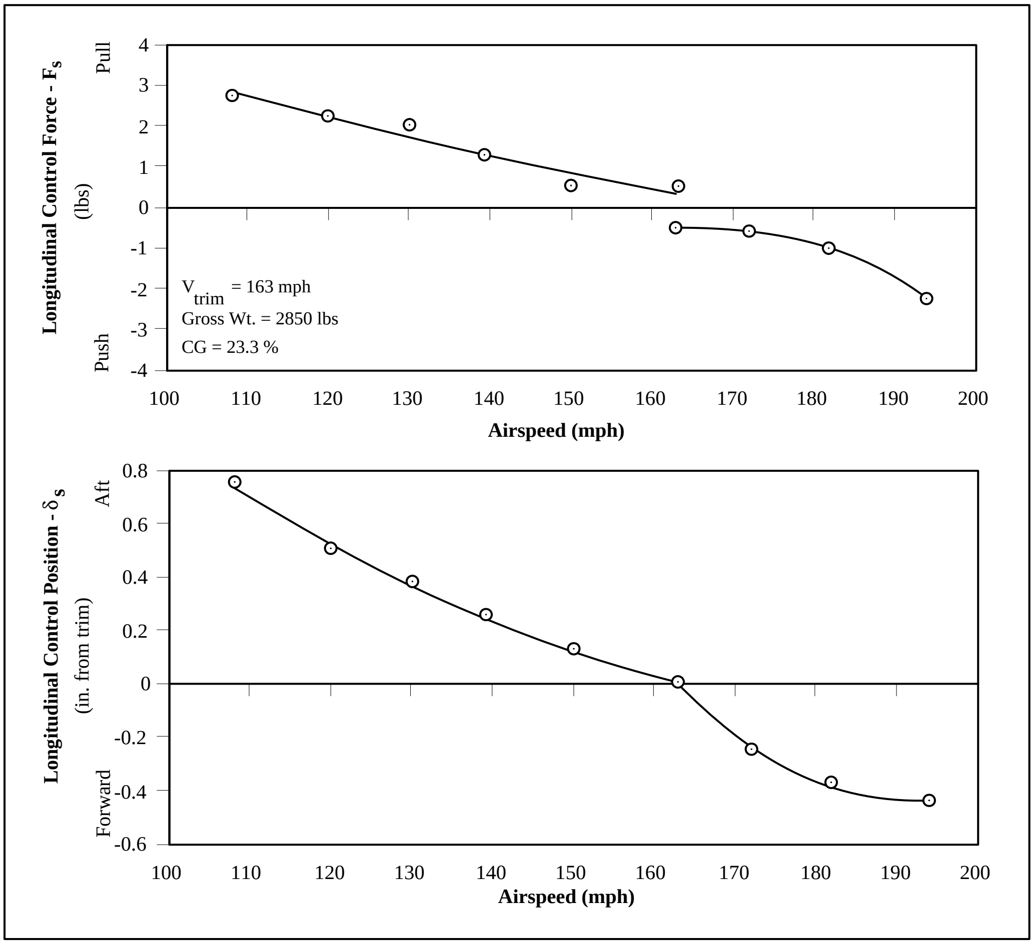


Figure 2. Sequoia 300 Static Longitudinal Stability Characteristics, Configuration CR—Mid CG

In configuration CR, the control force and position gradients were shallow but positive and smooth throughout the speed envelope tested. Changes in airspeed required very little change in longitudinal control force or trim. The pilot was able to make smooth accelerations and decelerations while easily maintaining altitude within ± 50 ft (HQR-2). The negligible friction band contributed to a relatively small trim speed band of only 5 mph. The shallow F_S gradient coupled with the small value of breakout including friction contributed to a light, responsive feel about the trim airspeed. Small trim requirements during speed changes in level cruise flight will allow the sport and aerobatic pilot to concentrate on navigation and aerobatic maneuver checkpoints which will enhance his overall enjoyment of sport flying. Within the scope of these tests, the static longitudinal stability characteristics of the Sequoia 300 airplane in configuration CR are satisfactory for sport and limited aerobatics flying.

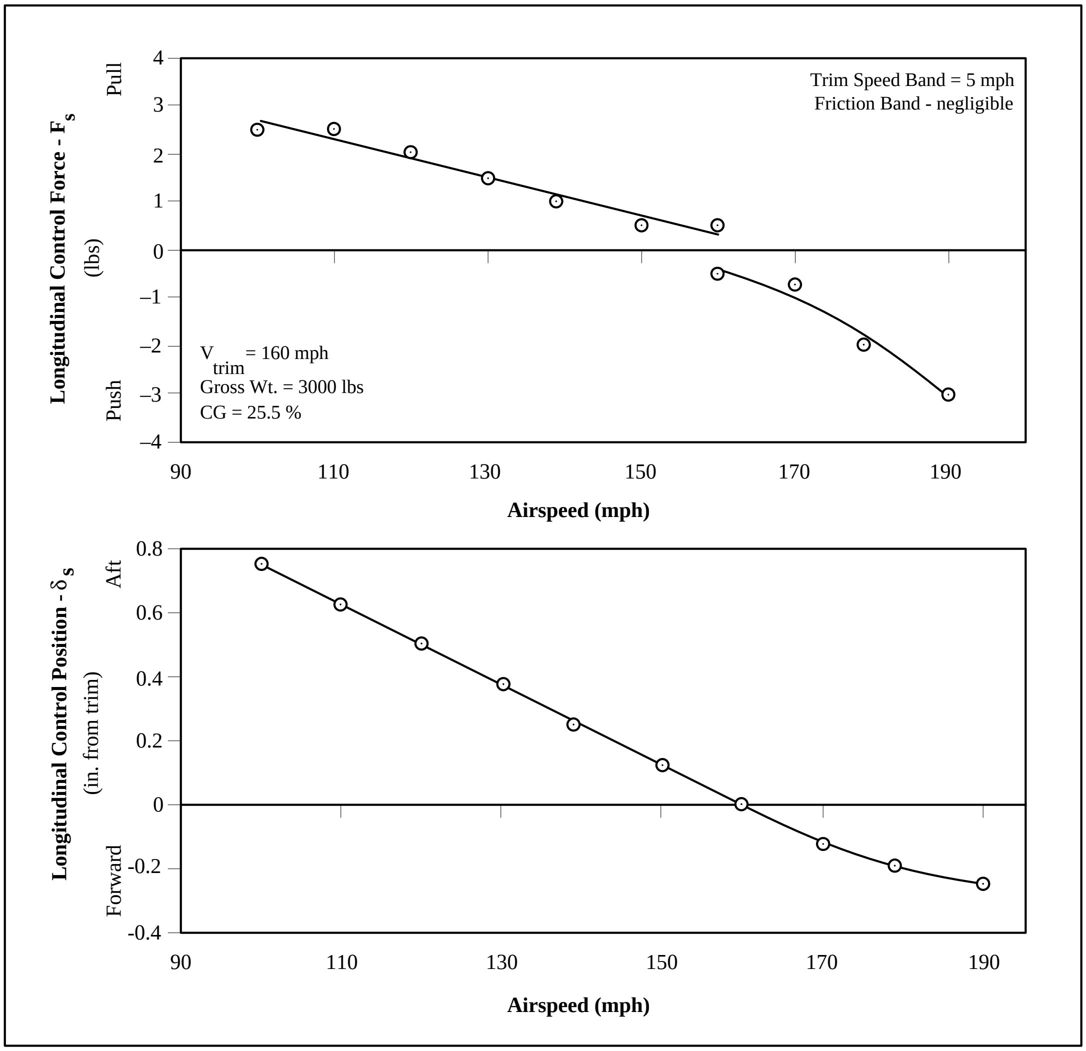


Figure 3. Sequoia 300 Static Longitudinal Stability Characteristics, Configuration CR—Aft CG

In configuration PA, the control force gradient was very shallow but still positive and smooth. The control position gradient was positive and smooth with a steeper gradient than that for configuration CR at the same CG. The longitudinal control force gradient was so shallow that F_S measurements were difficult to obtain with the 0-50 lb. force gauge. Accuracy of the F_S measurements in configuration PA was questionable as verified by the unexpectedly steeper F_S gradient at the aft CG condition compared to the mid CG condition.

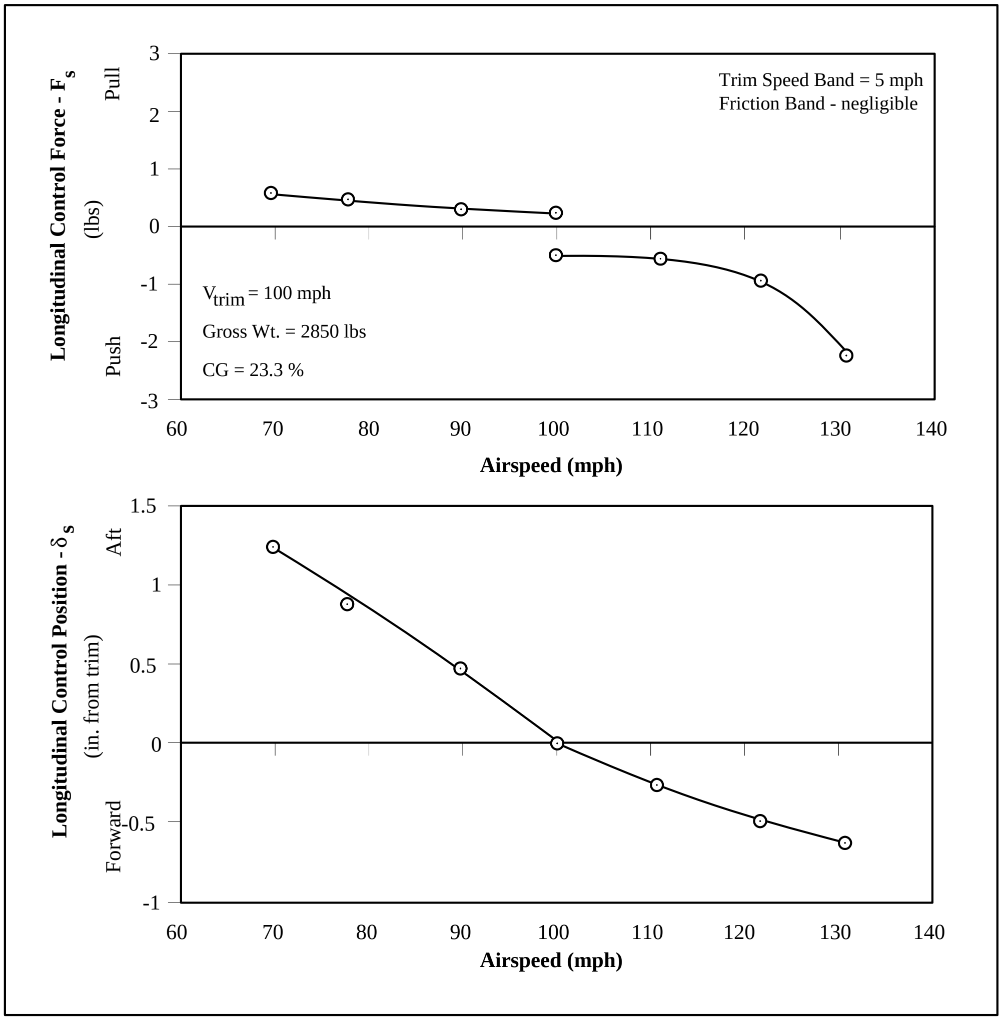


Figure 4. Sequoia 300 Longitudinal Stability Characteristics, Configuration PA—Mid CG

Trim requirements with speed changes away from trim were perceptible but required concentration to detect. The exceedingly shallow F_S gradients in configuration PA precluded the pilot from using longitudinal control feel as a cue in detecting airspeed deviations during simulated instrument approaches and required him to concentrate his attention on the airspeed indicator and the artificial horizon to help control his airspeed within ± 5 mph (HQR-4). During instrument approach conditions or normal VFR landings, the sport pilot will need to devote much of his attention to pitch attitude and airspeed control which will detract from his ability to control lineup and glideslope. The exceedingly shallow F_S gradient of the Sequoia 300 in configuration PA is a Part II deficiency which should be corrected as soon as practicable. The static longitudinal stability characteristics of the Sequoia 300 in configurations CR and PA conform to the applicable guidelines of the specification.

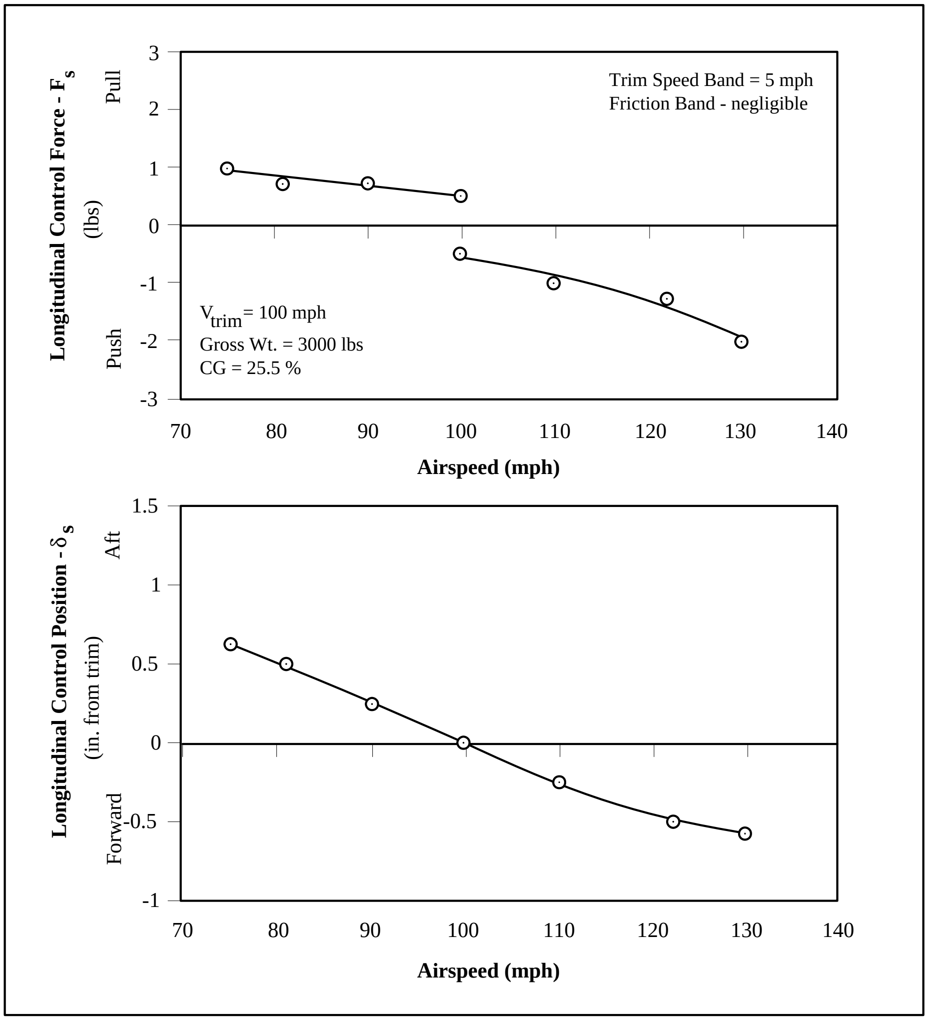


Figure 5. Sequoia 300 Longitudinal Stability Characteristics, Configuration PA—Aft CG

Stick-Free Non-Maneuvering Neutral Point (N_o')

For determination of the approximate N_o', the variation of the stick-free F_S stability gradients with CG at any given trim airspeed is considered to be linear. The variation in gradients of the stick-free stability curves in configuration CR as a function of CG is presented in Figure 6. The variation of stick-free stability gradients with CG in configuration PA is not presented because of the questionable nature of that data. Extrapolation of the curve in Figure 6 to the zero gradient line (X-axis) yields an approximate N_o' of 39.3% MAC in configuration CR.

The initial flight test envelope allowed a CG range of 18-26% MAC. Only two CG's were tested because of the inability to attain a CG farther forward than 23.3% without additional ballast. The accuracy of the extrapolation in Figure 6 would be enhanced with additional stability data obtained at a CG farther aft than the flight test limit. Calculation of the maximum aft CG required to accommodate the worst case loading, which would include the owner and his passenger, 100 lbs of baggage and zero fuel, yields a maximum aft CG limit of 29.1% MAC. Further testing is recommended at 29.5% MAC in configurations CR and PA to obtain maximum aft CG longitudinal stability data, enhance the accuracy of the extrapolation in Figure 6 and allow configuration PA N_o' data to be validated and presented. During the follow-on testing, additional data should be collected at the 23.3% and 25.5% CG conditions to verify the data presented in Figures 2 through 6. Follow-on testing should be performed using a 0-10 lb. force gauge to improve the F_S data accuracy.

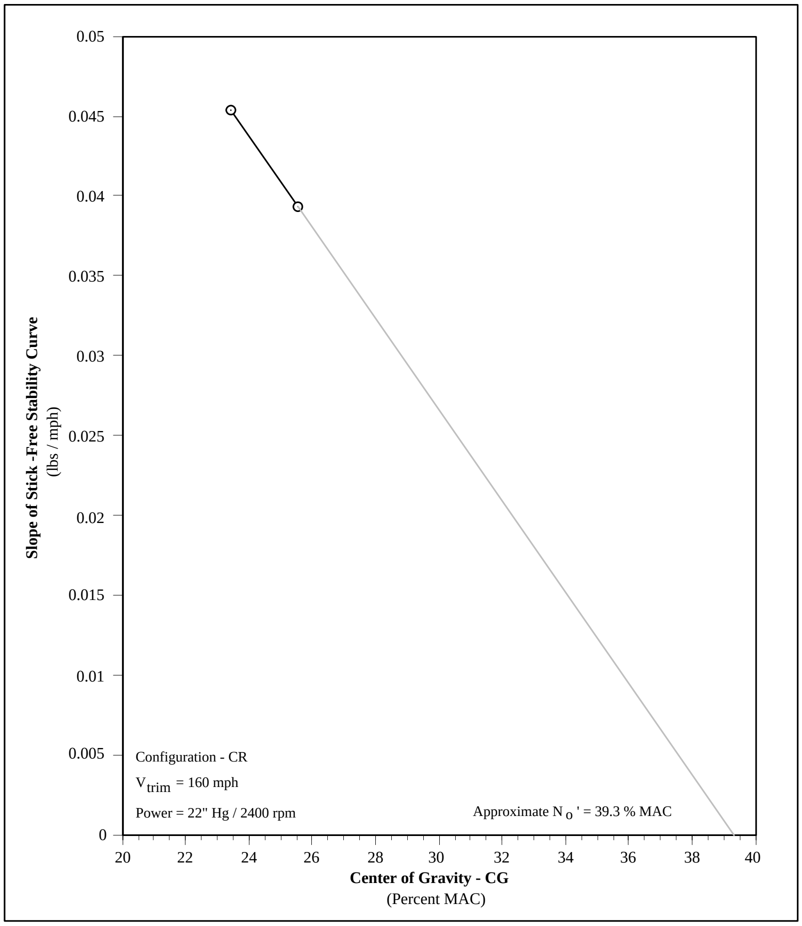


Figure 6. Sequoia 300 Stick-Free Non-Maneuvering Neutral Point—N_o'

Flight Path Stability

Stall speeds in configuration CR and PA were investigated subsequent to the longitudinal stability test flights and therefore V_{SO} had not yet been determined for use in the flight path stability tests. Therefore, flight path stability, as indicated by the variation of vertical velocity with indicated airspeed was qualitatively evaluated in configuration PA during one visual approach at approximately 90 mph (approximately 1.5 V_{SO}). At that speed, variations in airspeed about the trimmed approach speed resulted in predictable and controllable variations in flight path. The test pilot was able to easily control glide slope within ± 100 fpm using minor adjustments in pitch attitude and approach airspeed (HQR-2). Further testing is recommended to obtain flight path stability data in configuration PA at speeds about a trim airspeed of 1.3 V_{SO} (77 mph).

Dynamic Longitudinal Stability

Long Period Characteristics. The long period (phugoid) characteristics were quantitatively evaluated in configuration CR at 7,000 ft pressure altitude. Both a fast-start and a slow-start method was used. Test results are presented in Table IV below. In each case, the phugoid was heavily damped and not easily excited. Once excited during airspeed changes, the well-damped oscillations of the long period aided the pilot in easily establishing and maintaining his cruise airspeed within ± 5 mph (HQR-2). The long period characteristics were also qualitatively evaluated in configuration PA during slow flight and approaches and found to be similarly well damped. The well-damped long period characteristics will decrease the sport pilot's workload in trying to maintain airspeed while navigating the airways or correcting to the localizer during instrument approaches. Within the scope of these tests, the long period characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying. The long period characteristics of the Sequoia 300 airplane conform to the applicable guidelines of the specification.

Configuration	CG % MAC	Trim A/S (mph)	Press Alt (ft)	Gross Wt (lbs)	Period (sec)	Undamped Natural Frequency (rad/sec)	Damping Ratio
CR, Fast Start	23.3	160	7000	2850	61	0.013	0.26
CR, Slow Start	23.3	160	7000	2850	41	0.155	0.125

Table IV. Sequoia 300 Long Period Characteristics

Short Period Characteristics. The short period characteristics were quantitatively evaluated at mid CG in configuration CR at 7000 ft pressure altitude. The doublet method was used with initial application of forward stick. At completion of the doublet application, the stick was returned to and held at the trim position to obtain the stick-fixed response. The short period oscillation was essentially deadbeat with one small high frequency overshoot and complete damping within 0.8 seconds. No pilot-induced oscillation tendency was noted in either configuration.

The high frequency, highly damped short period made the airplane feel highly responsive and predictable. During steep turns and sample aerobatic maneuvers, the pilot was able to easily establish and maintain a desired normal load factor (N_Z) level within ± 0.5 G's (HQR-2). The short-period response was also qualitatively evaluated during takeoff in configuration TO and during approaches in configuration PA and found to be essentially deadbeat. During takeoff, the pilot was initially surprised at the quick response of the nose at rotation but was able to precisely establish the takeoff attitude at 10 deg ± 2 deg with one small bunt application of forward stick to stop the rotation (HQR-2). During approaches, the pilot was able to easily maintain precise glideslope and rate of descent within ± 100 fpm even with occasional short period excitation by gusts (HQR-2). The sport pilot will be able to smoothly and accurately establish pitch attitudes and N_Z levels in the execution of limited aerobatics maneuvers. Within the scope of these tests, the short period response characteristics of the Sequoia 300 airplane in configurations CR and PA are satisfactory for sport and limited aerobatics flying. The short period response characteristics of the Sequoia 300 airplane conform to the applicable guidelines of the specification.

Maneuvering Longitudinal Characteristics

Maneuvering longitudinal stability, as indicated by the variation of longitudinal control force with N_Z greater than one, was evaluated in configuration CR at 7,000 ft pressure altitude and a trim airspeed of 160 mph. Based on a clean stall speed of 74 mph at 2,850 lbs, found during the approach-to-stall tests, the accelerated stall N_Z limit was predicted at 4.9 G's. Wings-level steady pull-ups were therefore planned to 4.5 G's but only 3.0 G's were attained. Performing the steady pull-ups was difficult due to the extreme acceleration rate of the Sequoia 300 with its nose down. Sudden pull-ups to investigate N_Z overshoot tendency during abrupt maneuvers were not attempted. Maneuvering longitudinal stability test results are shown in Figure 7.

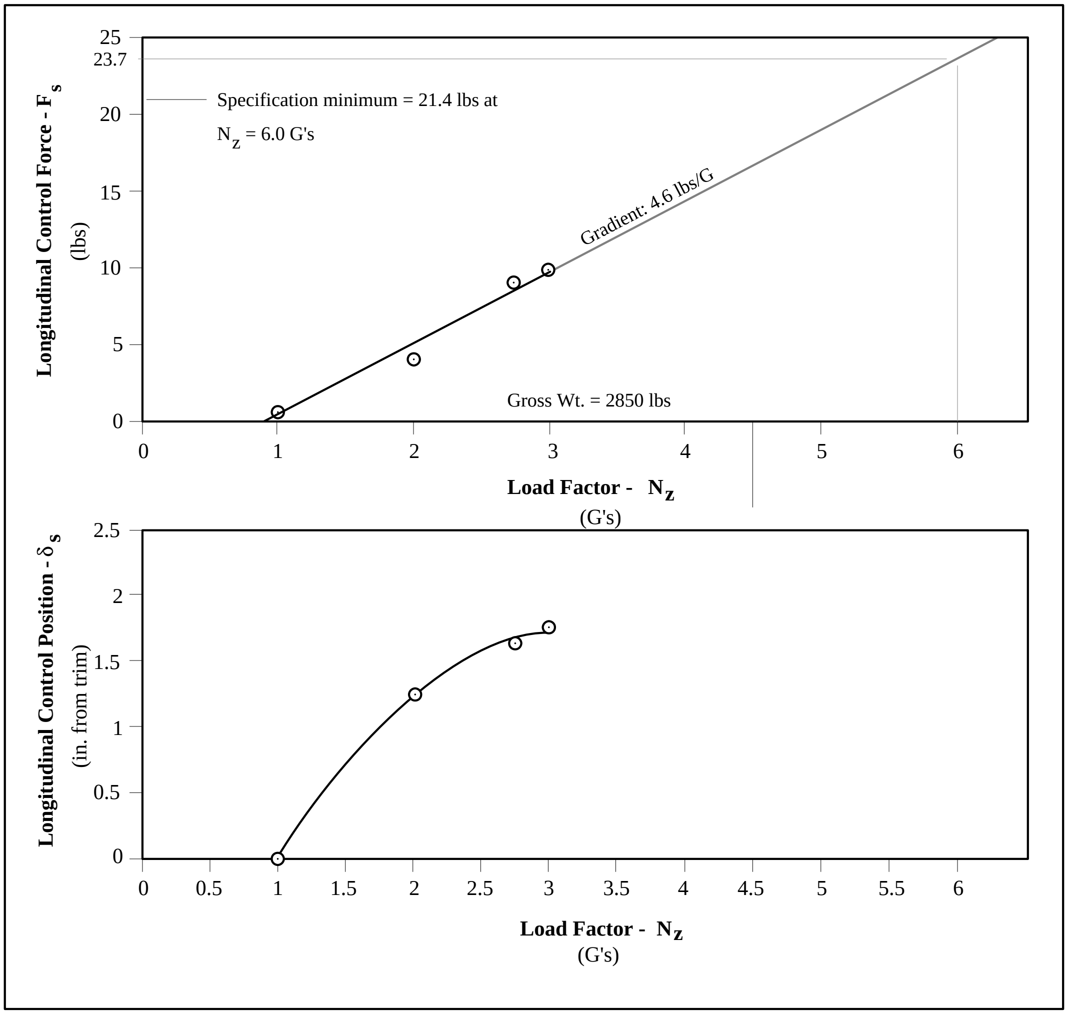


Figure 7. Sequoia 300 Maneuvering Longitudinal Stability Characteristics Configuration CR

The maneuvering longitudinal control force gradient was stable and essentially linear up to the N_Z attained with an average slope of 4.6 lbs/G. If assumed linear throughout the N_Z envelope, and extrapolated to the positive N_Z limit of the airplane (6.0 G's), that slope would yield a F_S requirement of 23.7 lbs. The longitudinal control position gradient with N_Z was also stable with some shallowing near the higher load factors.

The essentially linear and relatively shallow control force gradient provided the pilot with precise and predictable maneuvering control feel to establish and maintain desired load factors within ± 0.5 G's (HQR-2). The moderate control position gradient provided the pilot with additional noticeable cueing to assist in gauging control input to modulate N_Z. The aft longitudinal control forces required to maintain load factors approaching the accelerated stall were not fatiguing to the pilot. The limited aerobatics pilot will have adequate and predictable control force and position cues to precisely and smoothly establish his desired load factors during aerobatic maneuvers. Within the scope of these tests, the maneuvering longitudinal stability characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying. The maneuvering longitudinal stability characteristics of the Sequoia 300 airplane conform to the applicable guidelines of the specification.

Further testing is recommended at minimum gross weight to explore the F_S and δ_S versus N_Z characteristics and linearity at N_Z levels between 3.0 and 6.0.

Longitudinal Trim Changes

Longitudinal trim changes with various configuration and power changes were evaluated during Phase II. Pitch attitude was held constant during the configuration changes in order to determine the trim forces required. Initial longitudinal trim force requirements with power changes were qualitatively determined to be negligible. Test conditions and results are presented in Table V below. Peak longitudinal control forces during each tested configuration change were small and the pilot was able to easily maintain pitch attitude within ± 2 deg by countering the trim changes with small longitudinal control inputs (HQR-3).

Pressure Altitude (ft)	**Airspeed** (mph)	**Landing Gear**	**Flaps**	**Power**	**Configuration Change**	**Peak Longitudinal Force** (lbs)
7000	135	Up	Up	PLF (1)	Landing Gear Down	2 Pull
7000	135	Down	Up	PLF	Flaps to 38 deg (2)	5 Pull

Notes: (1) Power for level flight. Approximately 18" Hg and 2500 rpm.
(2) Full landing flaps.

Table V. Sequoia 300 Longitudinal Trim Changes

Pitch attitude was allowed to change during one test while lowering the landing gear. During this test the initial response was a momentary nose bob of 3 deg nose-up as the landing gear moved out of the wheel wells. The sport pilot will be able to maintain pattern altitude or glideslope during approaches while configuring the airplane for landing. Within the scope of these tests, the longitudinal trim change characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying.

Longitudinal Trimmability

Longitudinal trimmability was qualitatively evaluated throughout these tests. The original mechanical trim system as built had too much play and was redesigned by the builder to be an electrically operated system with only one moveable trim tab mounted on the right side of the elevator. The trim was actuated with a rocker switch mounted on the center pedestal.

The longitudinal trim system was very sensitive and the trim rate was exceptionally high. Although trim requirements during speed and configuration changes were not a major concern, any attempt to trim out the light longitudinal control forces resulted in a tendency to overshoot the trim position slightly and required the pilot to use several alternating trim input pulses to stabilize at the proper trim setting for zero longitudinal control force ± 0.5 lb (HQR-4). During pattern entry or on glideslope while slowing and reconfiguring for landing, the sport pilot will experience an increased workload if he attempts to re-trim the airplane. The excessively sensitive longitudinal trim system of the Sequoia 300 airplane is a Part II deficiency which should be corrected as soon as practicable. The longitudinal trimmability of the Sequoia 300 airplane failed to conform to the guidelines of paragraph 23.677 (a) of the specification in that the longitudinal trim tab operation was rapid, abrupt and oversensitive.

Trim System Failure

The ability of the pilot to control the airplane longitudinally with a runaway longitudinal trim failure was not evaluated. In view of the oversensitive longitudinal trim system, and the normally light longitudinal control force requirements with speed and configuration changes, determination of the peak longitudinal control force requirements with a runaway trim condition would be prudent. Therefore, further testing is recommended to determine the controllability of the Sequoia 300 airplane with a runaway longitudinal trim system failure.

Lateral-Directional Flying Qualities

Static Lateral-Directional Stability

General. Static lateral-directional stability was evaluated using steady-heading sideslips and single-control turns in configuration CR at a pressure altitude of 7,000 ft and a trim airspeed of 160 mph. In configuration PA, static lateral-directional stability was qualitatively evaluated during single-control turns at 7,000 ft and a trim airspeed of 100 mph, and during visual landings and simulated instrument approaches. Test results for configuration CR are presented in Figures 8 through 10.

The test airplane had been instrumented for determining sideslip angles (β) by placing a yarn tuft and narrow tape strips on the exterior centerline of the windscreen near the canopy bow. The tape strips were placed at graduations of 10 deg arc either side of the fuselage centerline. During the first flight, the maximum β was determined to be approximately 10 deg, so the tape strips were essentially useless. Therefore approximate sideslip angles were determined by holding a steady-heading sideslip and then quickly releasing rudder pedal pressure to read the heading difference on the directional gyro. Indicated airspeed errors and longitudinal trim changes in all sideslip angles tested were negligible.

The flaps had been rigged by holding a yardstick on the hangar floor and adjusting the zero-flap setting using equal measurements on the yardstick. A control surface rigging tool was not used. Throughout the evaluation period, the airplane exhibited a noticeably heavy right wing in configuration CR and a slightly heavier right wing in configuration PA. The heavy right wing was correctable with small but noticeable lateral stick force (F_a) inputs of less than 1 lb. to hold the wings level within $\pm$ 2 deg bank (HQR-4). During long distance cruise, the sport pilot will become fatigued by holding constant pressure laterally on the control stick. The heavy right wing of the Sequoia 300 airplane in configurations CR and PA is a Part II deficiency which should be corrected as soon as practicable.

Directional Stability. Static directional stability in configuration CR, as indicated by the variation of rudder control force (F_r) and δ_r with β up to full rudder deflection was positive. Test results are presented in Figure 8.

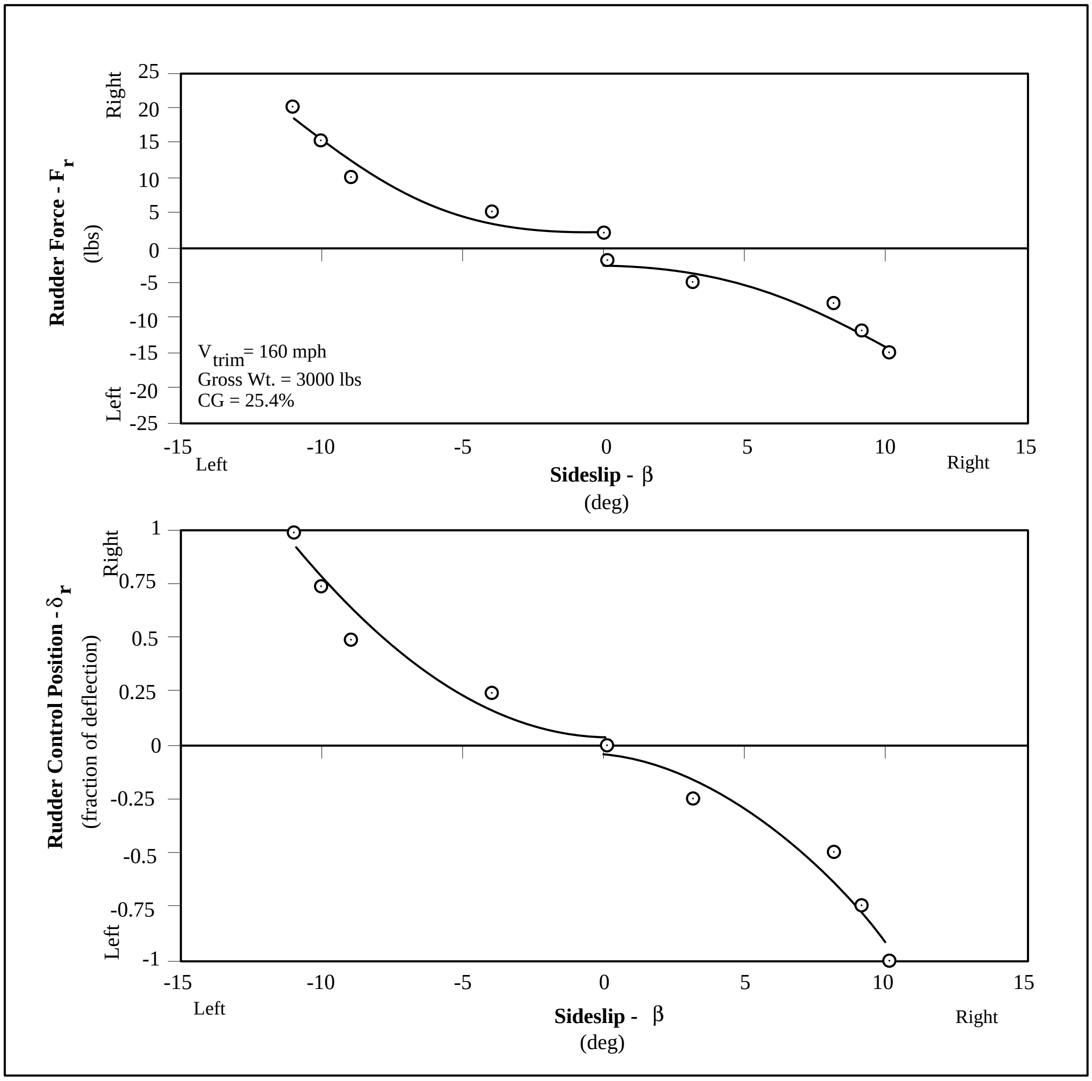


Figure 8. Sequoia 300 Directional Stability Configuration CR—Aft CG

The gradients of the static directional stability curves were smooth. Near the zero sideslip condition, the F_r gradient was quite shallow. The pilot was able to maintain the zero β condition ± 1/8 ball with frequent reference to the slip indicator and occasional applications of rudder pedal input up to 1/4 δ_r to re-center the ball (HQR-4). In configuration PA, the directional stability qualitatively appeared to be positive and smooth. In both configurations, the airplane felt moderately stiff directionally at sideslip angles beyond a few degrees from zero. During slips and crosswind landings where significant and precise amounts of sideslip may be desirable, the sport pilot will be able to smoothly and predictably establish and maintain the desired sideslip. Within the scope of these tests, the static directional stability characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatic flying. The static directional stability characteristics of the Sequoia 300 airplane conform to the applicable guidelines of the specification.

Dihedral Effect. Qualitative assessment of the dihedral effect characteristics was accomplished in configurations CR and PA during rudder-only turns at 7,000 ft pressure altitude. Dihedral effect was quantitatively evaluated during steady-heading sideslips in configuration CR. Configuration CR dihedral effect characteristics are presented in Figure 9.

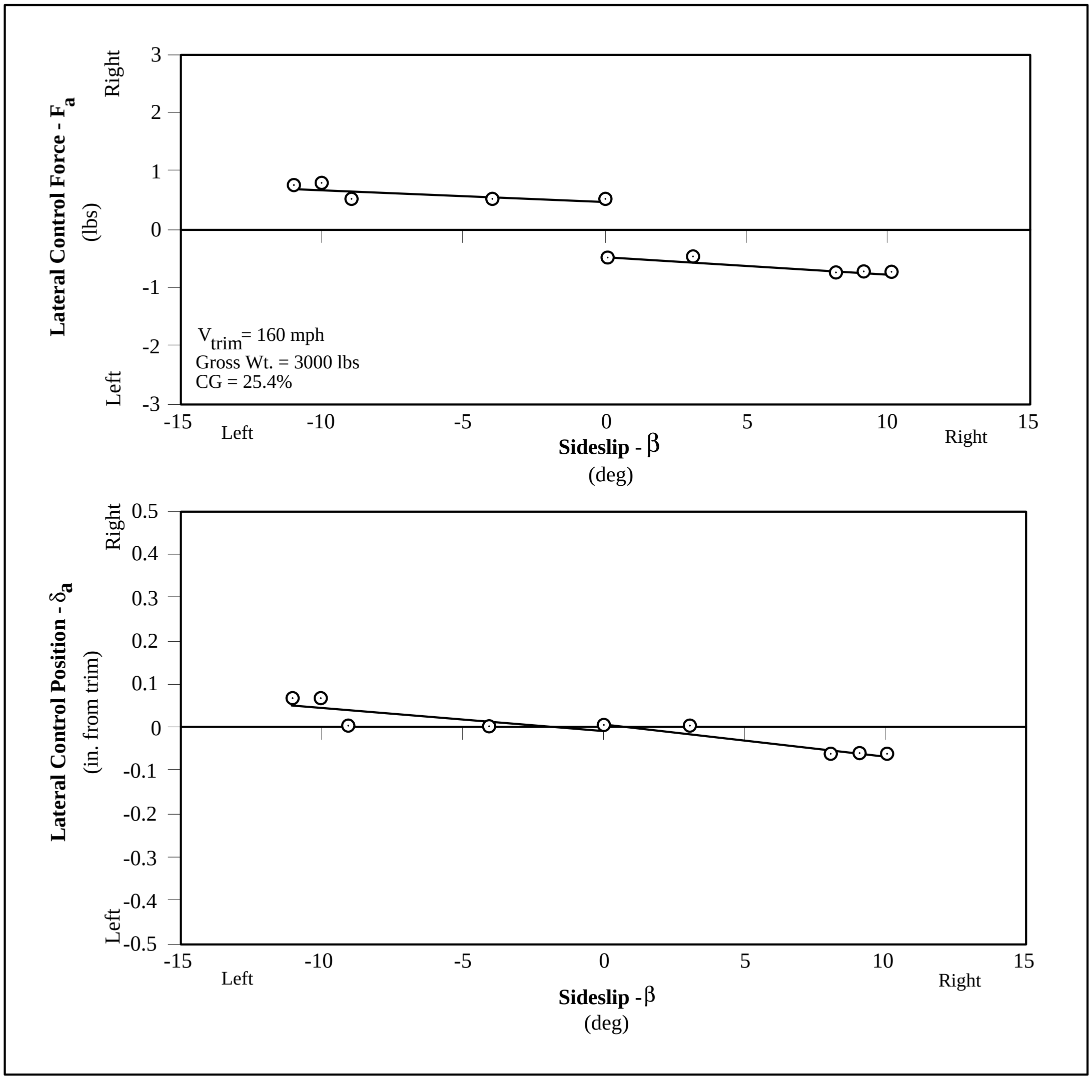


Figure 9. Sequoia 300 Dihedral Effect Characteristics Configuration CR—Aft CG

The F_a and aileron control position (δ_a) gradients in configuration CR were essentially linear throughout the attainable sideslip range and indicated positive but apparently weak dihedral effect. During rudder-only turns in configuration CR, slightly more than 1/4 right rudder pedal deflection was required to generate roll rate to the right. Once generated, a comfortable rate of roll was attained using between 1/4 and 1/2 δ_r. The pilot was able to easily achieve and maintain a 20 deg ± 2 deg bank angle by simply centering the rudder pedals (HQR-2). To the left, from a wings-level condition, virtually no roll rate was generated even with full left rudder pedal displacement. The airplane simply held a wings-level skidding turn to the left.

In configuration PA, right roll rates were again easily generated, but the pilot could not stop the roll rate even with full left rudder and was unable to achieve a desired bank angle of 20 deg ± 2 deg

(HQR-8). The airplane simply continued to roll further, and the pilot had to use ailerons to regain control. Again, to the left in configuration PA, no roll rate was generated with full left rudder.

During instrument approaches, the sport pilot will be unable to use rudder for bank-angle control while using his hands to manage cockpit tasks such as frequency changes, finding approach plates and completing checklists. The weak dihedral effect characteristics of the Sequoia 300 airplane are a Part II deficiency which should be corrected as soon as practicable. The dihedral effect characteristics of the Sequoia 300 airplane failed to conform to the guidelines of paragraph 23.177 of the specification in that the tendency to raise the low wing using a slip was not positive for all gear and flap configurations. Further testing is recommended, after proper rigging of the flaps and ailerons is verified, to determine if any improvement is gained in the apparent dihedral effect characteristics.

Sideforce Characteristics. Sideforce characteristics, as indicated by the variation of bank angle (ϕ) with sideslip, were positive in both configurations. Right bank angle was required for right sideslips; left bank angle was required for left sideslips. Sideforce characteristics in configuration CR are presented in Figure 10.

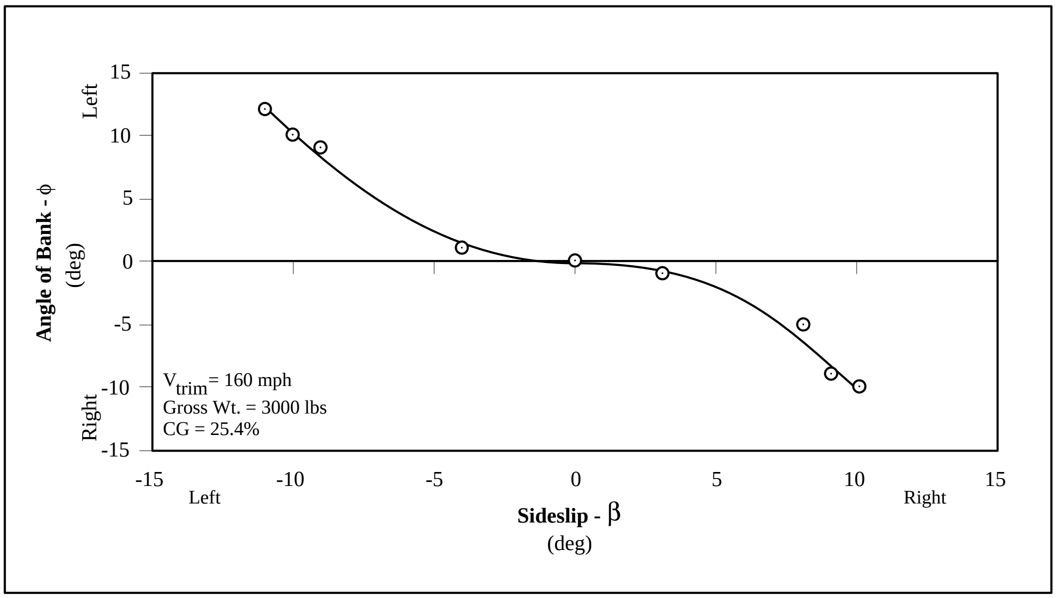


Figure 10. Sequoia 300 Sideforce Characteristics Configuration CR—Aft CG

The bank angle gradient was near zero between 2 deg left sideslip and 2 deg right sideslip but became significantly steeper with larger sideslips. Aileron control authority was sufficient to achieve the required bank angles in both configurations and both directions. At a constant heading, bank angle information provided the pilot with an immediate and ample cue that sideslip variations of greater than 2 deg existed. During long range cruise, the sport pilot will be aided by the sideforce characteristics in maintaining near zero sideslip for minimal drag and improved range performance. Within the scope of these tests, the sideforce characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatic flying.

Adverse Yaw. The adverse yaw characteristics were evaluated during aileron-only turns at a pressure altitude of 7,000 ft in configurations CR and PA. In both configurations, adverse yaw was minimal and only slightly more apparent in configuration PA than in configuration CR.

In configuration CR at 160 mph, the pilot was able to easily roll out on a given heading within ± 2 deg with moderately brisk aileron only input (HQR-2). In configuration PA at 100 mph, the adverse yaw was slightly more pronounced and required minimal coordination of rudder input with ailerons to achieve a given heading within ± 2 deg (HQR-3). Aileron step inputs in configuration PA tended to excite the dutch roll mode. Minimal adverse yaw will allow the sport pilot to fly precise maneuvers at altitude and reduce his workload during lineup corrections on visual and instrument landing approaches. Within the scope of these tests, the adverse yaw characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying.

Dynamic Lateral-Directional Stability

Dutch Roll Mode. The dutch roll mode characteristics were qualitatively evaluated in configurations CR and PA using rudder doublets. The nature of the dutch roll response in terms of ϕ and β was also assessed. In configuration CR, the dutch roll mode, although not easily excited, had a moderately high frequency and was lightly damped. In configuration PA, the dutch roll mode was easily excited by gusts and adverse yaw and also displayed high frequency, lightly damped characteristics. In both configurations, the roll-to-yaw (ϕ/β) ratio was very low which resulted in a pronounced snakey mode of motion.

In preparation for the visual landing pattern, a decending entry to a modified base was made over rising terrain. Thermals over the ridgeline created gusts which excited the continuously snakey dutch roll mode. On final approach, the mild adverse yaw generated from aileron inputs for lineup corrections also excited the snakiness. Although annoying, the dutch roll did not significantly affect control of heading or lineup, and the pilot was able to remain on the extended runway centerline within ± 1 deg with normal aileron and rudder inputs (HQR-3).

The sport pilot will find the snakey dutch roll mode characteristics to be unpleasant and somewhat bothersome in the landing configuration. The high frequency, lightly damped and low ϕ/β ratio nature of the dutch roll mode is a Part III deficiency which should be avoided in future designs. The dutch roll mode of the Sequoia 300 airplane did not conform to paragraph 23.181 of the specification in that the dutch roll did not appear to damp to 1/10 amplitude within 7 cycles with the primary control (rudder) fixed.

Spiral Mode. The spiral mode characteristics were evaluated in configuration CR at a pressure altitude of 7,000 ft and a trim airspeed of 160 mph. Test results are presented in Figure 11. Lateral balance and flap rigging may have affected the data. To compensate for the earlier heavy right wing, fuel was burned out of the right wing to improve lateral balance. Because of the inaccuracy of the fuel gauges, the degree of lateral balance was not accurately established prior to conducting this spiral mode test.

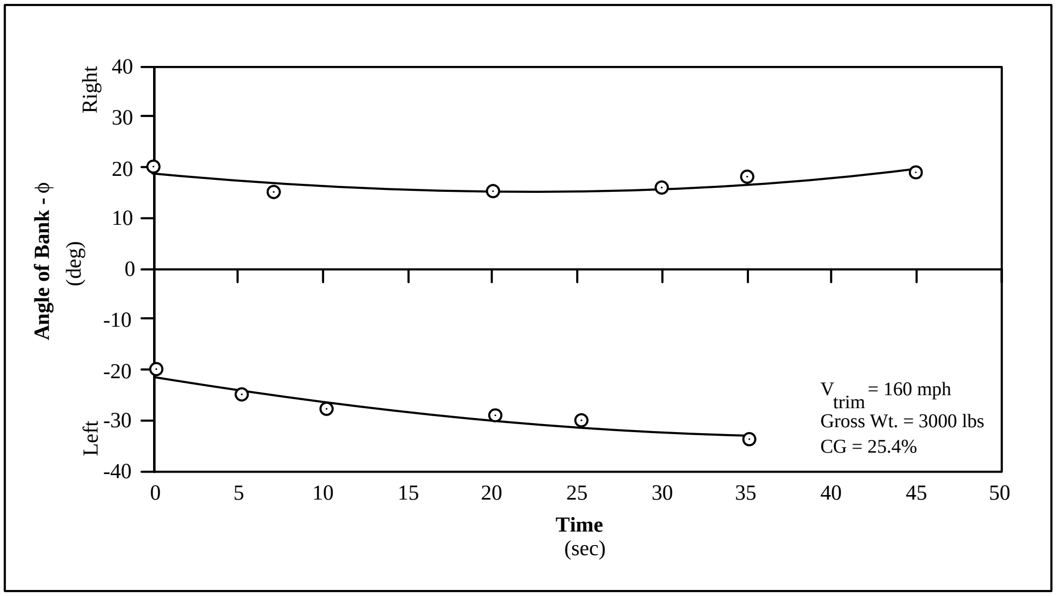


Figure 11. Sequoia 300 Spiral Mode Configuration CR—Aft CG

The spiral mode appeared to be either essentially neutral to the right or very slightly divergent to the left. The pilot was able to easily maintain a given left bank angle within ± 2 deg by maintaining slight (less than 2 lbs) aileron control force to the right to maintain the constant left bank angle. No continued aileron control force was required to maintain a constant right bank angle. The rate of bank angle change to the left with no aileron control force applied was only 0.4 deg/sec. During instrument flight, the sport pilot will be able to divert his attention from bank angle control for brief periods of time to arrange instrument publications or operate navigation equipment while confident that his bank angle will not change significantly. Within the scope of these tests, the spiral mode characteristics of the Sequoia 300 airplane in configuration CR are satisfactory for sport and limited aerobatics flying. Further testing is recommended to determine the affect on the spiral mode from changes in lateral balance. Such further testing should be accomplished after proper rigging of the flaps and ailerons is verified and the inaccuracy of the fuel quantity indicating system is corrected.

Roll Performance

Roll performance was evaluated in configuration CR at 7000 ft and a trim airspeed of 160 mph using full deflection aileron rolls at 1.0 G. Rolls were timed from 45 deg of bank in one direction to 45 deg of bank in the opposite direction. Both left and right rolls were conducted. Full 360 deg aileron rolls were also conducted to determine any axis-coupling tendencies. Rolls in configuration PA were qualitatively evaluated. Due to the absence of any automated data recording system, the roll mode time constant, a measurement of the time to achieve steady state roll rate, was evaluated in both directions only qualitatively. Test results are presented in Table VI below.

Direction of Roll	**Trim Airspeed** (mph)	**Aileron Deflection**	**Time to Roll 90 deg** (1) (sec)	**Estimated Roll Mode Time Constant** (sec)
Left	160	Full	1.18	> .5
Right	160	Full	1.21	> .5

Notes: (1) Average time between attempts.

Table VI. Sequoia 300 Roll Performance, Configuration CR

Slight adverse yaw occurred during the full-deflection aileron rolls in both directions. No other pitch or yaw coupling tendencies were noticed even during the 360 deg rolls. The steady-state roll rate was moderate at an average of only 76.5 deg/sec in either direction. The roll mode time constant, which affects the lateral feel and responsiveness of the airplane, appeared to be only moderate, giving the airplane a slightly sluggish feel in the initial few degrees of roll. Rolls conducted in configuration PA during the landing pattern indicated similar roll performance. The sport and limited aerobatics pilot will have adequate roll rate and lateral feel at his disposal to conduct a variety of limited aerobatic and landing pattern maneuvers. Within the scope of these tests, the roll performance of the Sequoia 300 airplane is satisfactory for sport and limited aerobatics flying. The roll performance of the Sequoia 300 airplane conforms to the applicable guidelines of the specification.

Approach-to-Stall Characteristics

Stalls were conducted in configurations CR and PA primarily to determine stall speeds for use in landing approach and static longitudinal stability tests. The approach to stall, stall speed, stall definition and recovery characteristics were evaluated in both configurations. Turning flight and accelerated stalls were not evaluated in this phase, nor was any attempt made to evaluate post-stall gyrations, incipient spins or fully developed spin characteristics. Approach-to-stall test results are presented in Table VII below. Wings-level stall speeds as a function of gross weight were determined empirically from flight test data and are presented in Figure 12.

Configuration	**Trim Airspeed** (mph)	**Stall Warning Speed** (mph)	**Type of Warning**	**Stall Airspeed** (mph)	**Type of Stall**
CR	160	75	Mild nose bob	74	Heavy nose bob
PA	100	64	Mild nose bob	59	Sharp left wing drop

Notes: (1) Gross Wt. = 2845 lbs.

Table VII. Sequoia 300 Approach-to-Stall Characteristics, Configurations CR & PA

During the approach to stall, no wing drop tendency was noted and the pilot was able to easily maintain wings level ± 2 deg with normal aileron control alone (HQR-2). As the airplane was decelerated from trim at less than 2 mph/sec using idle power, up to 1/4 left rudder pedal input was required to keep the ball centered. Near stall in each configuration, nose attitude was relatively high.

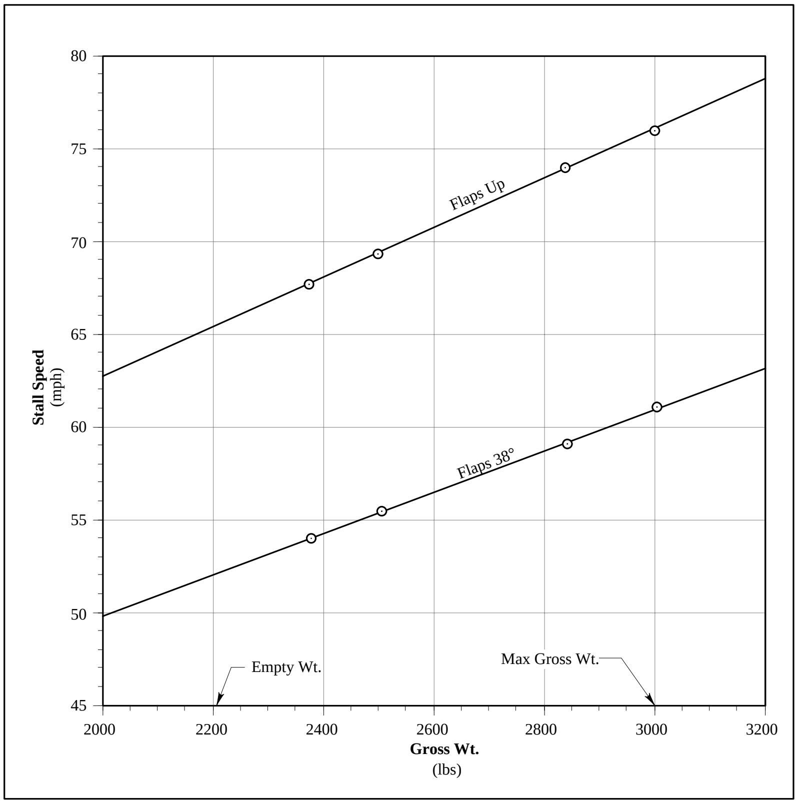


Figure 12. Sequoia 300 Stall Speeds
Configurations CR and PA

In configuration CR at 2,840 lbs gross weight, stall warning occurred at 75 mph and consisted of initiation of very mild nose bobbing. Stall warning progressed quickly to pronounced heavy nose bob at 74 mph at which point the pilot recovered from the stall by simply relaxing back stick pressure and adding power. The approach to stall was not allowed to progress to an uncontrollable nose-down pitch but rather, stall was defined as uncontrollable heavy nose bob. Stall recovery was instantaneous and controls about all three axes were effective immediately after releasing back stick pressure.

In configuration PA at 2,840 lbs gross weight, stall warning again was a light nose bob occurring this time at 64 mph. The stall warning progressed to slightly more pronounced nose bob when, to the pilot's surprise, stall abruptly occurred at 59 mph. Stall was defined as a sharp left wing drop-off to about 60 deg bank which resulted in a quick heading change of about 15 deg and a nose-down attitude of about 20 deg. The pilot recovered by quickly releasing back stick pressure, rolling wings level, adding power and pulling out from the dive. Again stall recovery was instantaneous. At the point when the pilot released back stick pressure, control about all three axes was immediately regained. Approximately 300 ft was lost in the stall recovery to a positive rate of climb.

The sport pilot, during normal decelerations, will have adequate warning of and will be able to prevent an impending stall. Should a stall inadvertantly occur, the sport pilot will have ample control for a quick and safe recovery and spin avoidance. Within the scope of these tests, the approach to stall characteristics of the Sequoia 300 airplane are satisfactory for sport and limited aerobatics flying. The approach-to-stall characteristics of the Sequoia 300 airplane in configuration PA conform to the applicable guidelines of the specification. Further testing is recommended in Phase III to determine if deceleration below 74 mph in configuration CR would result in continued stall warning and eventual uncontrollable nose-down pitch. Further testing would also allow a check of specification conformity in configuration CR.

Conclusions

General

Within the scope of these tests, the Sequoia 300 airplane has limited potential to perform its intended purpose of sport and limited aerobatics flying. Upon correction of the Part I deficiencies listed in the following paragraphs, the Sequoia 300 airplane will have excellent potential to safely perform as a sport and limited aerobatics airplane. The Sequoia 300 airplane is suitable for Phase III of this evaluation.

Part I Deficiencies

- The lack of positive directional control with the nose wheel on the runway at high speed during takeoff or landing conditions.
- The routing of the aileron control cables adjacent to and in direct contact with each other.

Part II Deficiencies

- The inadequate restraint system.
- The misaligned inclinometer in the turn and bank indicator.
- The inadequate engine oil cooling.
- Venting of the hydraulic fluid overboard with cycles of the landing gear.
- The inaccurate fuel quantity indicating system.
- Engine hesitation or stoppage in abrupt yaw rate conditions.
- The minimal brake effectiveness during high speed ground operation.
- The exceedingly shallow stick force gradient in configuration PA.
- The excessively sensitive longitudinal trim system.
- The heavy right wing in configurations CR and PA.
- The weak dihedral effect characteristics.

Part III Deficiencies

- The insufficient wing skin structural support aft of the wing spar for use in entry and egress.
- The excessively acute angle of the seat backs.
- The obstructed forward external field of view.
- The placement of the parking brake selector valve on the right sidewall of the cabin interior.
- The high frequency, lightly damped and low roll-to-yaw (ϕ/β) ratio of the dutch roll mode.

FAR Part 23 Specification Conformity

The Sequoia 300 conformed in general to the guidelines in the specification against which it was compared with the following exceptions:

- Paragraph 23.785 (e) in that negative G's would allow the pilot to float up which could prevent him from performing all functions necessary for flight operations.
- Paragraph 23.777 (d) in that the left-to-right order of the engine controls was not throttle, propeller and mixture.
- Paragraph 23.1011 (a) in that the oil system did not supply the engine with an appropriate quantity of oil at a temperature not above that for safe continuous operation.

- Paragraph 23.1435 (a) in that no means to indicate the pressure in the hydraulic system, which supplies two or more primary functions, was provided to the pilot.
- Paragraph 23.1337 (b) in that the fuel quantity indicating system did not accurately indicate to the pilot the quantity of fuel in each tank during flight.
- Paragraph 23.777 (b) in that the parking brake control was not located so that the pilot, when seated, had full and unrestricted movement of it.
- Paragraph 23.901 (c) in that the cowling was not easily removeable or openable by the pilot to provide easy access to and exposure of the engine compartment for preflight checks.
- Paragraph 23.233 (b) in that the airplane was not satisfactorily controllable on the ground, without exceptional piloting skill and alertness, in power-off landings at normal landing speeds.
- Paragraph 23.735 (a) in that the kinetic energy capacity of the main wheel brakes appeared less than the kinetic energy absorption requirements based on a rational analysis of the sequence of events during landing.
- Paragraph 23.671 in that the aileron controls did not operate easily and smoothly.
- Paragraph 23.685 in that each detail of the aileron control system was not designed or installed to prevent jamming or chaffing.
- Paragraph 23.689 (e) in that the aileron cable turnbuckles were not attached in a manner that positively prevented binding throughout the range of travel.
- Paragraph 23.677 (a) in that the longitudinal trim tab operation was rapid, abrupt and oversensitive.
- Paragraph 23.177 in that the tendency to raise the low wing using a slip was not positive for all gear and flap configurations.
- Paragraph 23.181 in that the dutch roll did not appear todamp to 1/10 amplitude within 7 cycles with the primary control (rudder) fixed.

Recommendations

General

- Correct the lack of positive directional control with the nosewheel on the runway during high-speed takeoff or landing conditions prior to operation in wet or crosswind conditions (Part I deficiency).
- Correct the routing of the aileron cables adjacent to and in direct contact with each other prior to further testing (Part I deficiency).
- Correct the Part II deficiencies as soon as practicable.
- The Part III deficiencies should be avoided in future designs.

Specific

- Adjust the throw of the canopy lock latching hook, and conduct further testing to evaluate the improved ease of locking the canopy.
- Conduct further testing at CG's as far aft as 29.5% MAC in configurations CR and PA to evaluate static longitudinal stability characteristics at the worst case loading and to collect additional data to validate previous test results for approximate N_o'. Use a 0-10 lb force gauge to conduct the follow-on testing.
- Conduct further testing to obtain flight path stability data in configuration PA at speeds about a trim airspeed of 1.3 V_{so} (77 mph).
- Conduct further testing at minimal gross weight to explore the F_s and δ_s versus N_z characteristics at N_z levels between 3.0 and 6.0.
- Conduct further testing to determine the controllability of the Sequoia 300 airplane with a runaway longitudinal trim system failure.
- Conduct further testing, after proper rigging of the ailerons and flaps, to determine any improvement in the apparent dihedral effect characteristics.
- Conduct further testing, after properly rigging the flaps, to determine the effect of lateral balance on the spiral mode.
- Conduct further testing in Phase III to determine if deceleration below 74 mph in configuration CR would result in continued stall warning and eventual uncontrollable nose-down pitch and to determine specification conformity for stalls in configuration CR.

Appendix A
References

1. Phone conversation, Alfred Scott, President Sequoia Aircraft Corp., and A. J. Aitken on July 7, 1992.

2. Phone conversation, Jim Baugh, Builder of Sequoia 300 airplane N48BL, and A. J. Aitken on July 16, 1992.

3. Code of Federal Regulations, Title 14, Part 23, Airworthiness Standards: Normal, Utility, Acrobatic and Commuter Category Airplanes, as revised January 1, 1992.

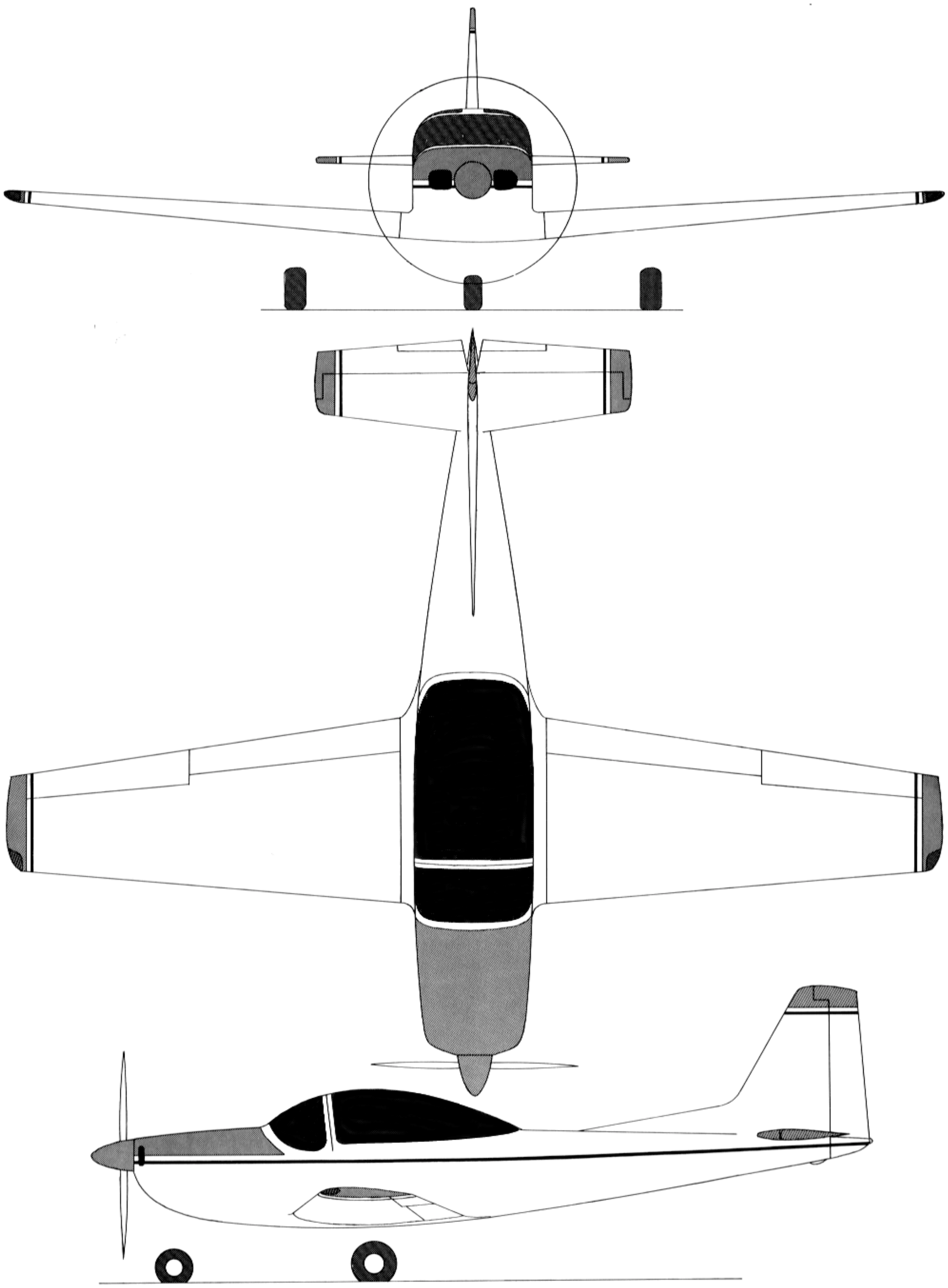
4. Test Plan, Phase I and II, Sequoia 300 Airplane, by A. J. Aitken, of August 20, 1992.

5. U.S. Navy Test Pilot School Flight Test Manual, USNTPS-FTM-No. 103, Fixed Wing Stability and Control Theory and Flight Test Techniques, of January 1, 1975, revised November 1, 1981.

6. U.S. Navy Test Pilot School Textbook, USNTPS-T-No. 5, An Introduction to Dynamics, of June 1974.

7. NASA Technical Note D-5153, The Use of Pilot Rating in the Evaluation of Aircraft Handling Qualities, of April 1969.

Appendix B
Sequoia 300 Three-View



Appendix C
Flight Test Limitations

1. Maximum Gross Weight .... 3000 lbs.

2. Center of Gravity .... 109.7” - 114.0” (18 - 26% MAC)

3. Airspeed (IAS)
   - Landing Gear in Transit (V_l) .... 135 mph
   - Landing Gear Extended (V_{le}) .... 150 mph
   - Landing Gear (emergency lowering) .... 135 mph
   - Maximum Flap Speed (V_f) .... 150 mph
   - Never Exceed Speed (V_{ne}) .... 280 mph
   - Design Maneuvering Speed (V_a) .... 200 mph
   - Computed Clean Stall Speed at 3000 lb (V_s) .... 89 mph
   - Computed Landing Configuration Stall Speed at 3000 lb (V_{so}) .... 72 mph

4. Engine Limitations
   - Maximum Manifold Pressure .... 41 in Hg
   - Maximum RPM .... 2650 rpm
   - Maximum Turbine Inlet Temp (TIT) .... 1650°F
   - Cylinder Head Temp (CHT) .... 475°F > 75%
     .... 435°F < 75%
   - Oil Pressure .... idle: 25 psi min.
     .... normal: 55 to 90 psi
     .... cold start: 100 psi max
   - Maximum Oil Temp .... 245°F
   - Fuel Pressure .... –6 to 65 psi

5. Acceleration Limits (N_z)
   - 3000 lbs. Gross Weight .... +4.8 to –2.4 G’s
   - 2500 lbs. .... +5.5 to –2.8 G’s
   - 2400 lbs. .... +6.0 to –3.0 G’s