Title:- **Flight Test Report –** Certification Compliance Testing of Sherwood Ranger ST Microlight Aircraft G-TLAC

Written ………………… ……... Chris Taylor

ISSUE RECORD

ISSUE	DATE	REASON FOR RE-ISSUE	WRTN	
1	17 Nov 17	Initial issue.	CT	

Note. This document is updated as a whole and not as individual pages.

1 INTRODUCTION

The Sherwood Ranger was originally designed by Russ Light (allegedly named after a Retford, Notts inn) and first flew in 1992. Several versions of the Ranger have been built, with different maximum take-off weights (MTOW) and engines. The early aircraft were built as the LW variant, with a MTOW of 390 kg (860 lb) and with engines in the 37-49 kW (50-65 hp) power range. Engines fitted include the 48 kW (64 hp) Rotax 532, the similar 48 kW (64 hp) Rotax 582 two cylinder two stroke engine and the 64 kW (85 hp) Jabiru 2200 flat four.] Some were later built as, or upgraded to, an MTOW of 450 kg (992 lb), the ST variant standard. Some of these use the Rotax 582 or Jabiru engines and one is fitted with a BMW RS1100. The LW is no longer offered but the ST is available for building from plans, kit or quick build kit. The XP variant has short span wing (7.07 m; 23 ft 0 in) to provide aerobatic capability and can be fitted with engines rated up to 75 kW (100 hp)

Twelve Sherwood Ranger kits were produced by TCD until the death of Russ Light, after which the company ceased to trade. TLAC acquired the rights in 2007and flew their first prototype on 31 July 2009. Some confusion had arisen over previous testing particularly with regard to centre of gravity calculations. Additionally only minimal inadvertent spin recovery testing had been completed. The aim of this test programme was to complete a complete professional certification test programme for submission to both the Light Aircraft Association (LAA) and the British Microlight Association (BMAA).

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2 ABBREVIATIONS USED

AC	Advisory Circular
agl	above ground level
AMC	Acceptable Means of Compliance
ATSU	Air Traffic Service Unit
BMAA	British Microlight Aircraft Association
CAA	UK Civil Aviation Authority
C of g	Centre of Gravity
CS	Certification Specifications
EASA	European Aviation Safety Agency
ETPS	Empire Test Pilots School
FAA	Federal Aviation Administration
FBS	Full Back Stick
FTP	Flight Test Plan
FTS	Flight Test Schedule
HQ	Handling Qualities
LSS	Longitudinal Static stability
NTPS	National Test Pilot School
PFLF	Power for Level Flight
SHSS	Steady Heading Sideslip
VMC	Visual Meteorological Conditions
Vs	Stall Speed
Vs0	Stall Speed Landing Config
Vs1	Stall Speed other than Vs0

3 AIRCRAFT & MODIFICATION DESCRIPTION

The Sherwood Ranger was a relatively conventional biplane not dissimilar to a scaled down Tiger Moth. Its wings had 3.83° of sweepback and 3° of dihedral on the lower wing alone but no stagger. The wings were of constant chord and were of mixed construction, with single aluminium spars and drag struts, plywood covered D-box leading edges, ply and spruce ribs and fabric covering. There were externally interconnected Frise ailerons on both upper and lower wings. The wings were foldable for transport.

The fuselage of the Sherwood Ranger was of an aluminium tube structure, with ply formers and spruce stringers, and was fabric covered apart from glass fibre mouldings in the engine and cockpit areas and forming the rear decking. The nose was quite slender; the separate open cockpits were in tandem with the forward one a little behind the leading edge of the wing and the other under the trailing edge, where a slight upper wing cut-out improved the pilot's view. The fin was integral with the fuselage structure and carried a deep, rounded rudder which extended to the lower fuselage. The fixed conventional undercarriage had mainwheels, fitted with heel operated brakes, on split axles mounted from a bungee sprung compression frame below the central fuselage and hinged by faired, V-form legs to its lower longerons. There was a bungee sprung, tailwheel with limited breakout.

Flying controls were conventional with an elevator trimmer operated by cable and lever on the right hand side of the cockpit. There were no flaps.

The aircraft was fitted with a Rotax 582 Two stroke engine driving a 3 bladed (ground adjustable) prop.

4 PURPOSE

The flight testing was to complete formal certification compliance testing. Testing was conducted against

- CAP 482 British Civil Airworthiness Requirements - Section S - Small Light Aeroplanes Issue 6 dated:31 May 2013.

5 CATEGORY OF FLIGHT TEST

A national rather than EASA flight test programme however this flight trial was determined to be a Category 1 Flight Test.

6 STATEMENTS

The aircraft tested was:

A/C Reg : G-TLAC PFA 237B-13895

7 PHILOSOPHY

7.1 Objective

The objective of the Flight Test Programme was to conduct a standard certification flight test programme gathering the required data to demonstrate compliance with BCAR Section S Issue 6.

7.2 Philosophy of Flight Testing

Generally the flight testing of the modified aircraft fell into three categories

- Handling Qualities/Stability and Control
- Performance including stalling
- Ballast was added to obtain a c of g at the required c of g envelope limit.

7.3 Test Criteria

Handling Qualities/Stability and Control: Testing was conducted 100-5000ft Hp.

Performance: Performance testing was predominantly conducted 100-5000ft Hp. Stall speeds and climb performance was obtained at full forward c of g and as close to MAUW as possible.

Test Envelope: The aircraft was tested at up to 5,000 ft Hp and up to the forward and aft limits of c of g.

7.4 HQ and Performance Assessment Methodology

No novel test techniques were required. Performance testing was conducted where relevant iaw CAP 1038 CAA Check Flight Handbook and AC 23-8C Flight Test Guide for the Certification of Part 23 Airplanes. Handling Qualities testing was conducted iaw the above documents and ETPS standard test techniques as previously employed by the CAA Flight Test Department. Pressure Error data was gathered using the 3 leg (Triangle Method) provided by NTPS or by flying into and downwind legs at the same altitude and noting ground speed. Additionally the company had previously gathered PE data and used the BMAA technical procedure to analyse the results.

7.5 Data Analysis

Climb performance data was gathered using reciprocal climbs and the data averaged to provide a mean ROC. Weight effects were negligible as the climbs were conducted within 1-2 kg of each other. The loss of performance resulting in testing not being conducted at Sea Level will not be factored and will be used to provide conservatism in the results. PE data was analysed using the NTPS spreadsheet where relevant. Stick force per g has been plotted.

8 FLIGHT TESTS

8.1 Test Instrumentation

Forces were measured using a hand held force gauge from ETPS. GPS Navigation devices including Garmin & IPad were used to provide GPS ground speed and track.

8.2 Objective

The objective of the Flight Test Programme was to complete a full section S certification programme but was to specifically address specific concerns raised during previous flight testing achieved to date. Those concerns related to minimalist spin recovery testing. The objective was to ensure these aspects of the aircraft comply with the certification requirement and conduct sufficient further testing to demonstrate that the aircraft remains compliant with BCAR Section S.

8.3 Section S requirements

In combination with previous and subsequent testing the following Section S requirements are being assessed:

S 21	Proof of Compliance
S23	Load Distribution Limits
S45	Performance General
S49	Stalling Speed
S51	Take-off
S65	Climb
S71	Rate of Descent
S75	Landing
S143	Controllability and manoeuvrability
S145	Longitudinal Control
S147	Lateral and Directional Control
S155	Pitch Force in manoeuvres
S161	Trim
S171	Stability General
S173	Static longitudinal stability
S175	Demonstration of static longitudinal stability
S177	Static directional stability
S181	Dynamic Stability
S201	Stalls
S203	Turning Flight Stalls
S207	Recovery From the Stall
S221	Spinning
S233	Directional Stability & Control
S235	Take-off in Cross Winds
S251	Vibration and buffeting

Flight Test Programme

An initial shakedown and data gathering flight was flown with mid c of g followed by both full aft and full forward c of g flights. Testing was conducted out of Little Snoring Airfield(Norfolk) on 13 & 14 November in suitable weather conditions which included a very light wind day which allowed good take-off and landing performance data to be gathered.

Pressure Error data had been gathered previously however this was revalidated at 3 airspeeds indicating an over-reading of the ASI at slow speed of 3 MPH

Ranger Testing								
Serial	Date	T/O	Ldg	Time	T/OAUW	CG mm AoD	Fuel	Ldg Fuel
1	13/11/17	1530	1615	0:45	341 Kg	118 mm Mid	40 Lts	
2	14/11/17	1100	1200	1:00	353	197 Aft	21	10
3	14/11/17	1245	1300	0:15	450	Mid	40	35
4	14/11/17	1330	1400	0:30	390	55-60mm Fwd	40	20
5	14/11/17	1415	1445	0:30	450	160mm	30	20
6	14/11/17	1515	1600	0:45	353	197 Aft	21	10
			Total	3:45				
NOTE: no PFR for Sortie 3 which was simply a famil flight in the front cockpit with safety pilot in the rear. To test at full forward cg aircraft had to be flown from front cockpit with just 50kg ballast on rear seat.								

Results

The flight test results presented in this report are to support an application for certification against BCAR Section S. This report aims to address the requirements of Sub-Section B Flight Paras S21 –S251. A cockpit assessment was completed which allowed aspects of Sub-Section F Equipment to be addressed.

Sub-Section F

The cockpit of the aircraft was simple but functional. The seat had no adjustment. Rudder pedals were fixed. The joystick was conventional and fitted with a radio PTT switch. The instrument panel was functional with all fitted gauges being easy to read and all switches easy to reach and operate. Brakes were heel operated.

The aircraft complied with Section S as follows:

S1301 Function and Installation

1. Each item of equipment fitted in the cockpit was of a kind/design appropriate to its intended function.

Complied with S1301.a. 1

S1301 a) 3. The installed equipment functioned properly throughout the test programme. Ambient temperatures of -5℃ to +12℃ were experienced without difficulty. The aircraft was tested in light rain.

Complied with S1301.a. 3

S1301 b) The instruments and other equipment did not constitute a hazard to the safe operation of the aircraft throughout the test programme.

Complied with S1301.b

S1303 1 & 2

The aircraft was fitted with fully functioning ASI calibrated to read in MPH and an altimeter with a Hp/Mb subscale.

Complied with S 1303 1&2

S1305 a) Powerplant Instruments

The aircraft was fitted with conventional analogue gauges which allowed the engine manufacturer's limitations to be complied with.

S1305 b)

The aircraft was fitted with a digital fuel contents gauge which appeared to be sufficiently accurate for this class of aircraft. Satisfactory

S1305 c)

The a/c engine was conventional Rotax 582 with oil tank dip stick.

Complied with S 1305

S1307 a/b Safety Harness

The aircraft was fitted with a 4 point harness with a quick release mechanism. The lap straps gave good torso restraint. The harness was assessed as fit for purpose in that it gave good occupant restraint when tight.

The harness was not sufficiently long to contact the propeller even when unsecured.

Complied with S1307.

S1321 Instruments Arrangement and Visibility

The flight instruments (Slip ball) were clearly visible to the pilot and easy to read.

Complied with S1321

S1323 Airspeed Indicator

a) The ASI was calibrated by TLAC.
   Complied with S1323.

Sub Section B – Flight

General

S21 Proof of Compliance

a) The aircraft was tested with a full forward c of g by flying the aircraft from the front cockpit with the rear cockpit empty. It was tested at an extreme aft c of g by adding ballast under the pilot's seat in the rear cockpit. The aircraft was tested at 450 Kg with 2 POB for the heavy test points, and tested as light as possible with 1 POB and minimal fuel.
b) The aircraft was tested in all possible configurations. With fixed gear and a fixed pitch prop and no flaps there was a single configuration tested.

Complied with S21

S23 Load Distribution Limits

The ranges of c of g have been selected to be the worst possible fwd and aft c of g possibilities likely to be encountered.

Complied with S23

Weight Limits

The maximum weight had been established as 450 kg which was the highest weight selected by the applicant and was below the design maximum weight. 450 kg was more than (not less than) the weight of the a/c + 86 kg. And was more than a/c weight + 86 kg + max fuel.

Complied with S25

S29 Empty Weight and Corresponding c.g.

The empty weight of the test a/c was determined by weighing with fixed ballast, min equipment, unusable fuel, max oil.

Summary of CG Limits and Test Points

The aircraft was designed to have a MAUW of 450 KG with a cg range of 55 mm – 197 mm aft of datum. The aircraft was tested at MAUW from 340 Kg – 450 Kg and c of g from 55-197mm.

Performance

S45 General

All performance testing was done out of Little Snoring at 196 ft above Sea Level. Temperatures for submitted performance data was only slightly below ISA.

Complied with S45

Summary of Design Speeds

	V_{s0}	V_{s1}	Vx (Best angle)		Vy (Best climb)	
Kn CAS (calibrated)	40	40	55		55	
	V_A	Vh	V_{ne}	Vd		
Kn CAS (calibrated)			100	111		

S49 Stalling Speed

a) Vso was tested predominantly with idle power set (throttle closed). The landing configuration was as per the cruise with no fitted flaps. Testing was conducted at 340-450 kg (MAUW)
b) Vs1 was tested predominantly with idle power set (throttle closed). Testing was conducted at 340-450 kg (MAUW)
c) The procedure from S201 was used.
d) Testing with a full forward c of g stall speeds were as below.

Vs1/Vso Clean = 40 MPH

PE testing indicated that the PE was 3 MPH at the stall giving a Vso of 37 MPH (32kts).

Complied with S 49

S51 Take-Off

Good take off performance – 100 m

Complied with S51

S65 Climb

Previous testing had concluded the best rate of climb speed was 55 MPH. Two reciprocal 5 minute climbs were then conducted at MAUW at 55 MPH. The aircraft was established at full throttle at the targeted airspeed and climbed for a full 5 mins with the height noted every 30 seconds. The results were then plotted graphically. Approx 445 ft/min was achieved each time. The best rate of climb reduced with increasing altitude but was always consistently better than 250 ft/min at Sea Level allowing a climb to 1000 ft to be achieved in less than 4 mins. No temperature limits were exceeded.

Complied with S65

S71 Rate of Descent

The best glide speed was 55 MPH but 60 MPH was used to give better penetration into headwinds. 60 MPH was a good initial speed for forced landing profiles.
Complied with S71

S75 Landing

A series of landings were flown to the grass & concrete runway 27 at Little Snoring and Runway 25 Grass. The initial approach was flown maintaining 60 MPH. Once at 15m/50 ft agl power was progressively reduced to idle and speed reduced to 50 MPH. At approx. 1-2m the aircraft was gently flared using up to full back stick eventually to plant the aircraft onto the ground in tail low or the 3 point (stalled) attitude. Landing distances were short considering no flaps were fitted.

Complied with S75

Controllability and Manoeuvrability

S143 General

a) The aeroplane was safely controllable and manoeuvrable during a max power take-off, climbs, level flight, descents, landing power on & off and following throttle chops to simulate engine failure.
b) It was easy to make smooth transitions between all tested flight conditions with no more than average piloting skill. No unsafe flight conditions were experienced during testing. Tests were conducted at all permissible/possible power settings.
c) No unusual flying characteristics were observed during testing. Flight in light rain/drizzle was assessed and was satisfactory.
d) No marginal conditions existed with regard to pilot limits.

Complied with S143.

S145 Longitudinal Control

a) It was possible at any speed below 1.3Vs1 to pitch the nose downwards so that a speed equal to Vs1 could be reached promptly. All configurations were tested at all power settings at fwd and aft c.g.
b) There was only one configuration tested as no flaps were fitted.
c) Vdf was tested at fwd and aft c.g and recoveries flown with idle power and up to max rpm applied. It was easy to pitch the nose up and recover from the Vdf dive.

Complied with S145.

S147 Lateral and Directional Control

Tested in same conditions as LSS = sat.

Complied with S147.

S155 Pitch Control Force

The Pitch control force during turns/when recovering from manoeuvres was tested at forward and full aft c of g using wind up turns and pull ups. In both turns to the left and right 6daN was pulled at approx. 2.0 g and 7 daN reached at less than 2.5g. It was very hard to get close to 3 g as the speed washed off quickly and large aft stick input was required. Stick forcer per g was very benign with good force & tactile cues throughout.

Complied with S155.

S161 Trim

Longitudinal trim could be adjusted to cope with speed and power changes and even at Idle power with full flap a trim condition was achieved.

Complied with S161.

Stability

S171 General

The aeroplane was tested and met S173 to 181 Inclusive. In addition throughout the flight test programme the aircraft showed suitable stability and control "feel" and no additional condition was expected to be encountered in service.

Complied with S171

S173 Static Longitudinal Stability

Throughout the LSS testing at speeds from 1.4 Vs1 to Vne the slope of the curve of control force versus speed was consistently positive and any significant speed change introduced a variation in control force that was always plainly perceptible to the pilot. Additionally where the aircraft could be trimmed to a given speed it tended to return to within 10% of that speed after being disturbed from the condition.

Complied with S173

S175 Demonstration of Static Longitudinal Stability (LSS)

LSS was tested in the conditions required as follows:

a) Climb – The full power climb at 55 MPH was stable. As speed was increased the stability became more positive. Holding a given airspeed was easy and the aircraft demonstrated positive stability at the recommended climb speed of 55 MPH.

b) Cruise –Positive static stability in all required configurations 5000 Rpm Max Continuous power used. Static stability assessed up to Vdf.

c) Approach The recommended approach speed was 60 MPH with normal approach power being defined as 4000 rpm. Again positive stability was evident.

Complied with S175

S177 Lateral and Directional Stability

With the aeroplane in steady flight and when the roll and yaw controls were gradually applied in opposite directions any increase in sideslip angle corresponded to an increased deflection in joystick. In all sideslips the lateral stick force increased progressively with the amount of sideslip and did not reverse. It was noted that directional stability was weak and that maintaining ball centred flight required attention.

Complied with S177

S181 Dynamic Stability

The following requirements were met with the engine running at Idle, Cruise PFLF and full power.

a) Short Period Oscillations between Vs and Vne were heavily damped with the controls fixed and free.

b) The Lateral Directional Oscillations (LDO) were damped.

c) The phugoid was well damped and did not cause an unacceptable increase in pilot workload or otherwise endanger the aeroplane. When the conditions of S175 were tested and the controls released from the trim speed by 15% the response of the aircraft was benign and not excessive in relation to the magnitude of the control force released.
Complied with S181

S201 Stalls

Stalling behaviour was investigated at full fwd and full aft c.g and at MAUW and as light as possible with 1 POB and minimal fuel.

a) Stalls were conducted by reducing the speed at approx. 1 MPH per second from Straight and Level flight until a stall was noted by a downward pitching moment and/or full back stick. At idle power the stall was defined by full back stick. No uncontrollable rolling motion was observed and roll and yaw could be produced with unreversed use of the controls until the stall occurred.
b) There was no tendency to spin at the stall as long as the recovery was not delayed. Minimal wing drop was sometimes evident but with a very gentle roll rate allowing the drop to be contained within 20° AOB with normal use of the controls.
c) The loss of altitude from the beginning of the stall to regaining level flight by applying normal procedures and the max nose down pitch attitude below the horizon was noted. The typical height loss was approx. 50 ft and no more than 10-15 degrees nose down was required for recovery.
d) Testing was conducted, trimmed at 1.4 Vs and with Idle power and at the throttle setting for 5000 rpm in the cruise.

Complied with S201

S203 Turning Flight Stalls

a) When stalled during a co-ordinated 30°AOB turn it was possible to regain normal level flight without encountering uncontrollable rolling or spinning tendencies. On each occasion the aircraft naturally rolled off angle of bank at the stall.
b) The loss of altitude from the beginning of the stall until regaining level flight by applying normal procedures was determined and found to be approx. 50 ft. The testing was conducted with power idle and at the throttle setting for 5000 rpm in the cruise.

Complied with S203

S207 recovery from the Stall

a) It was possible to control the roll attitude of the aircraft up to the stall using the joystick alone and any tendency for excessive wing drop at the stall could be prevented.

b) The aircraft met the requirement of S207 in that with the rudder and ailerons fixed neutral no appreciable wing drop occurred. Additionally – although there was no obvious pre-stall buffet the open cockpit environment gave very clear audio, vibration, and wind speed indications to the flight allied with sloppy controls that a slow speed condition was being approached. It would not be possible to reach the stall without very clear indications to the pilot that he was flying slowly. The stall itself was then defined by full aft stick – any relaxation of this condition allowed the aircraft to be flown normally.

Complied with S207

S221 Spinning

A typical Part 23 spin matrix was conducted at mid, forward and aft c of g. There was only a single configuration as no flaps were fitted. Spins were entered with idle, full power or 5000 rpm selected at 5-10 MPH above the 40 MPH stall speed by selecting full aft stick and full rudder simultaneously. The spinning was incrementally progressed to allow an initial entry turn to be followed by a fully developed turn before spin recovery was initiated.

With full forward c of g a spin could not be entered without power as the aircraft fell instantly into a spiral dive. With power a spin could be entered but the aircraft recovered as soon as the throttle was closed. Forward c of g spinning was considered very benign.

With a mid c of g a spin could be entered in each direction at idle power and recovery could be achieved by applying opposite rudder alone.

With a full aft c of g the aircraft exhibited conventional spin characteristics reminiscent of a Tiger Moth type of aircraft. For all spins the aircraft recovered with full opposite rudder followed by easing the stick forward off the back stop by an inch or two. The aircraft recovered into a steep nose down dive. After a single 1 turn erect spin the aircraft could be recovered in no more than one additional turn by closing the throttle and centring the controls (Incipient Spin Recovery). As usual into spin aileron tended to steepen and quicken the spin with out of turn aileron having the opposite effect. Once fully established in the spin after 2 turns moving the stick forward with full pro-spin rudder applied (reverse recovery) resulted in a higher rotational rate – however this resulting high speed spin could then be recovered conventionally.

In summary – Spin recovery of the aircraft was conventional and compliant with S221.

Ground Handling Characteristics

S233 Directional Stability and Control

Testing was conducted on dry and wet grass and concrete with wind speeds to 10-12 kts. There was no uncontrollable ground-loop tendency at any speed at which the aeroplane could be expected to operate on the ground and it had adequate directional control during taxiing. The brakes were effective in stopping the aircraft quickly although the heel operation required some attention.

Complied with S 233

S235 Take-Off and Landing in Cross Winds

During the period of testing cross wind components up to and including 10 kts were experienced. The take –off was flown conventionally with into wind aileron applied at the start of the take-off roll. The landing could be accomplished using either the “kick off for drift” or “wing down” technique. The latter was used due to personal preference by the test pilot but both techniques allowed safe and controllable landings. The aircraft coped well with the cross wind.

S251 Vibration and Buffeting

There was no excessive vibration at all airspeeds up to and including Vdf, nor was there any buffeting severe enough to interfere with the satisfactory control of the aeroplane, cause fatigue to the crew or result in structural damage. The testing included the engine running at all powers from idle to full throttle and included start up and shut down.

Conclusion

The Ranger was a very pleasant small aeroplane to fly similar to a scaled down Tiger Moth. It had a simple but well laid out cockpit with the minimal instrumentation being easy to read and use. The flying controls were well harmonised and it demonstrated appropriate static and dynamic stability. The performance for such a small engine was good. The aircraft was satisfactory to manoeuvre on the ground and the take-off and landings were all easy to fly with short take-off and landing distances evident. The aircraft fully met the requirements of BCAR Section S Issue 6.

9 TEST DATA

Flight Number / Configuration	Sortie 1 – Mid c of g
Date	13 November 2017
Overview	Shakedown flight – Pressure Errors – Qualitative Assessment of LSS, Lat Dir & Stick Force/g plus Phugoid & Dutch Roll. Idle Power Stalls Engine & prop handling – and flight to V_{DF} Take-off & landings Spinning at Mid cg
Handling Pilot/P1	Chris Taylor
Safety Pilot P2	N/A
FTE	N/A
AUW	341kg
cg	mid
Fuel T/O	Full 40 lts = 28.8kg
Fuel Ldg	20kg
ZFW	227.5 kg

Airfield Altitude	196	ft	QFE	1008	mb
Wind	10-15	knots	OAT	3	°C
Weather (test area)	Good – Nil cloud minimal turbulence – Cold!				

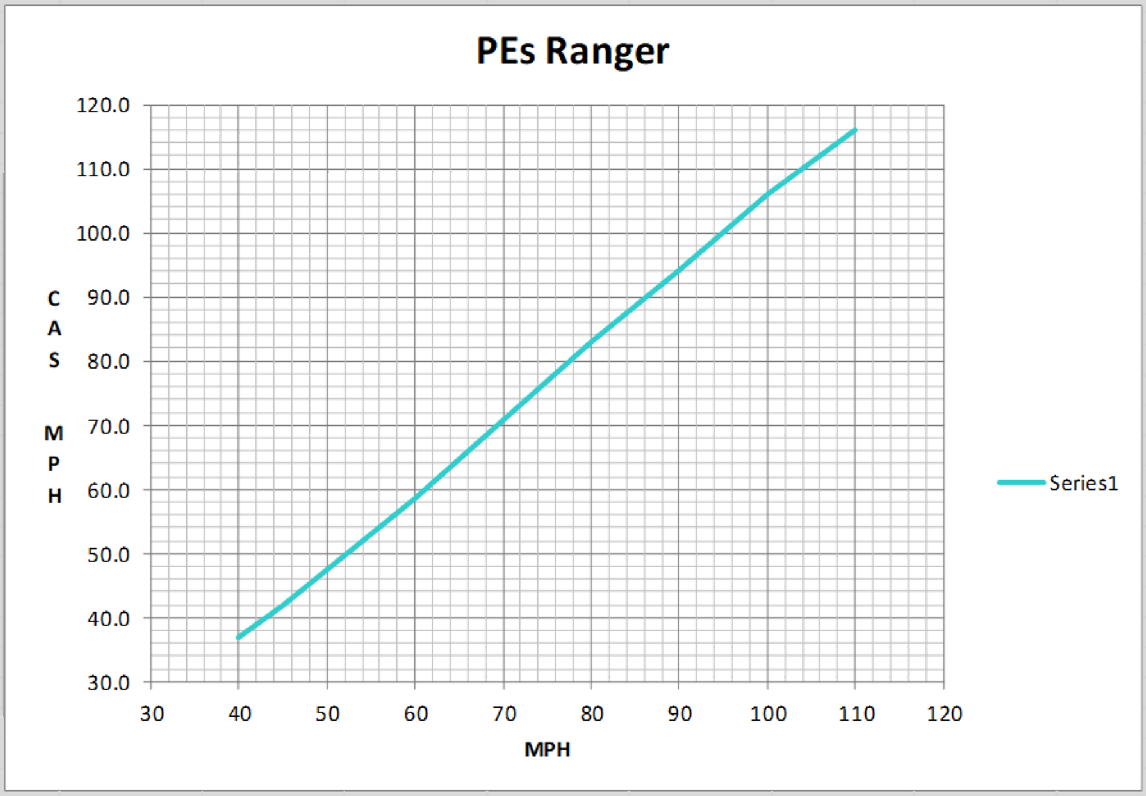
Test Timings			
Off Chocks	1520	Landing	1615
Take-Off	1530	On Chocks	1620
Flying Time	0:45	Chock Time	1:00

Ground Handling						
Test	Fuel	Wt				
Start	Full	450				
End	20kg	449				

All OK – Brakes worked well –Could 180 turn easily by braking inner wheel. Tail wheel connected to rudder – rudder without brake could be used for normal taxi and aircraft could be kept straight – Brakes heel operated – nowhere to place the heel apart form on the brake or "aloft" care required on landing. = sat

Pressure Error Testing – Level Flight PFLF

	Vg 1 (kts)	Track 1 (deg)	Vg 2 (kts)	Track 2 (deg)	Vg 3 (kts)	Track 3 (deg)	Vwind (kts)	Wind dir (deg)	1500/12C root Sigma		CAS	Vtrue (kts)
35												
40												
45	26	27	53	135	43	205	16.5	326.9	0.9900		36.7	37.1
60	41	15	68	129	52	214	16.7	315.2	0.9900		50.9	51.4
80	60	10	88	125	75	225	16.5	328.0	0.9900		72.4	73.1
90							#DIV/0!	#DIV/0!	0.9900		#DIV/0!	#DIV/0!
100							#DIV/0!	#DIV/0!	0.9900		#DIV/0!	#DIV/0!
110							#DIV/0!	#DIV/0!	0.9900		#DIV/0!	#DIV/0!



Basic/idle Stalling
49 Stall speed
201 Stall demonstration Wings Level
203 Stall characteristics Turning Flight
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0	Full	340	1545	Idle	55	Nil	40 MPH	10 degrees – slow roll rate – full back stick

Controllability and Manoeuvrability
143 General

S 143 General
a) The aeroplane must be safely controllable and manoeuvrable during;
1) take-off at maximum take-off power;
2) any steady climb condition;
3) level flight;
4) descent;
5) landing, power on and off; and
6) with sudden engine failure.
b) It must be possible to make a smooth transition from one flight condition to another (including turns, reversal of turns and slips) with no more than average piloting skill, alertness or strength, and without danger of exceeding the limit load factor, under any probable operating condition, with the engine running at all allowable power settings, including the effect of power changes and sudden engine failure. Modest departures from any recommended techniques must not cause unsafe flight conditions
c) Any unusual flying characteristics observed during the flight tests required to determine compliance with the flight requirements and any significant variations in flight characteristics caused by rain must be determined with the engine running at all allowable powers.
d) If marginal conditions exist with regard to pilot effort the 'pilot effort' limits must be shown by quantitative tests for a minimum weight pilot. In no case may the limits exceed those prescribed in the table shown in S.143. This requirement must be met with the engine running at all allowable powers. Values in pounds of force as applied to the control wheel or rudder pedals.

(a) For temporary application:	P	R	Y
Stick----------------	20	10	--------
Wheel (applied to rim)-------------------	25	20	--------
Rudder Pedal--------	-------	-------	40
(b) For prolonged application.	2	1.5	10

Amdt 23-0 & Amdt. 23-14, Eff. 12/20/73

Condition of Note	Comment
	All sat including response to throttle chop on climb out – gentle nose drop

S 161 Trim The speeds to achieve lateral, longitudinal and directional trim must lie within 1.3 VS1 and 2.0 VS1 at all engine powers and the extreme c.g. positions.						
Test	Fuel	Wt	Time	MPH	Pwr	Considerations
Flap Up		340		1.3Vs1	PFLF	Assess Long & Directional Trim
Flap Up				2.0 Vs1	PFLF	Assess Long & Directional Trim
Flap Up				1.3Vs1	Idle	Assess Long & Directional Trim
Flap Up				2.0 Vs1	Idle	Assess Long & Directional Trim
Flap Up				1.3Vs1	Full	Assess Long & Directional Trim
Flap Up				2.0 Vs1	Full	Assess Long & Directional Trim
Flap Full				1.3Vs1	PFLF	Assess Long & Directional Trim
Flap Full				2.0 Vs1	PFLF	Assess Long & Directional Trim
Flap Full				1.3Vs1	Idle	Assess Long & Directional Trim
Flap Full				2.0 Vs1	Idle	Assess Long & Directional Trim
Flap Full				1.3Vs1	Full	Assess Long & Directional Trim
Flap Full				2.0 Vs1	Full	Assess Long & Directional Trim
All satisfactory – no concerns regarding future test points.						

Stick Force per G

S 155 Pitch control force in manoeuvres
The pitch control force during turns or when recovering from manoeuvres must be such that at a constant speed an increase in load factor is associated with an increase in control force. In addition:
a) For conventional control systems the minimum value of this force to apply to the aeroplane a normal acceleration which would impose limit load on the structure must not be less than 7 daN from a trimmed 1 g condition at all speeds up to VNE at which the required normal acceleration can be achieved without stalling, with wing-flaps and, where applicable, landing gear retracted.

Test	Fuel	Wt	Time	MPH	Pwr	Considerations
The wind Up turns to 3G						
L	27	339		80	MCP	
R				80	MCP	
L				Vne	MCP	
R				Vne	MCP	
Large control throw to pull g with speed quickly washing off – difficult to reach 2g -2.5g max reached – no concerns regarding further data gathering						

Spinning – The spins were initiated with the throttle set as required to give idle power, 5000rpm or full power and the nose raised to slow down until 45-50MPH was reached when full back stick and full rudder was applied. Recoveries were commenced after ¼ ½ ¾ 1 or 1½ or 2 complete turns. With a mid cg the aircraft tended to recover as soon as the into spin rudder was neutralised or opposed. There was only one configuration as no flaps were fitted

Normal recovery was to close the throttle – apply full opposite rudder to the spin direction – then move the stick centrally forward progressively until the spin stopped.

Turns	Left/Right	Abuse	Recovery	Comment
¼	L	Normal	Opposite Rudder	
¼	R	Normal		
½	L	Normal		
½	R	Normal		
1	L	Normal		
1	R	Normal		
1-2	L	Power at 5000 rpm	Normal	
1-2	L	Full Power	Normal	
Spinning with Mid cg was benign. Recoveries were easy with the aircraft tending to recover as soon as rudder was applied. As a result the spin matrix with mid cg was reduced.				

75 Normal Landing – Power Off						
Test	CG	Wt	Ht	MPH	Pwr	Considerations
	Mid	335Kg		60	Idle	(1) A steady gliding approach with a calibrated airspeed of at least [1.3] V_{S1} must be maintained down to the 50 foot height. (2) The landing may not require exceptional piloting skill or exceptionally favourable conditions. (3) The landing must be made without excessive vertical acceleration or tendency to bounce, nose over, ground loop, porpoise, or water loop.
Satisfactory – easy to round out – Undercarriage very forgiving – landed tail low – subsequently 3 point						

75 Simulated Emergency Condition Flapless Landing – Touch & Go						
Test	CG	Wt	Ht	KIAS	Pwr	Considerations
4	A	L		55	Idle	Note change in pitch attitude at touch down
Easy – could land on main wheels or three point - satisfactory						

51 Flapless Take-Off – from Touch & Go						
Test	CG	Wt	Ht	KIAS	Pwr	Considerations
5	A	L			Idle	Note change in pitch attitude at rotate
Easy – tail could be raised by forward movement of the stick – aircraft flying off at 40-45 MPH.						

75 Vref-5 Landing –						
Test	CG	Wt	Ht	KIAS	Pwr	Considerations
6	A	L		45	Idle	
A 55MPH approach still gave a good margin above the stall and for a very short field landing 45-50 MPH could be used over the threshold – easy to round out – good elevator control power.						

Flight Number / Configuration	Sortie 2 – Full Aft c of g
Date	14 November 2017
Overview	Full Aft cg = HQ –LSS, Lat Dir & Stick Force/g plus Phugoid & Dutch Roll. Stalls– and flight toV_{DF} Take-off & landings
Handling Pilot/P1	Chris Taylor
Safety Pilot P2	None
FTE	None
AUW	353 kg
cg	197mm aft (full aft)
Fuel T/O	21 lts = 15.5 kg
Fuel Ldg	10 lts
ZFW	337 kg (25 kg ballast on P1 seat)

Airfield Altitude	196	ft	QFE	1010	mb
Wind	180/5	knots	OAT	10	°C
Weather (test area)	Excellent – light southerly winds no turbulence				

Test Timings			
Off Chocks	1050	Landing	1200
Take-Off	1100	On Chocks	1205
Flying Time	1:00	Chock Time	1:15

Ground Handling						
Test	Fuel	Wt				
Start	15kg	353				
End						
Satisfactory – Aft cg introduced no issues – easy to steer and brakes efficient						

Basic/idle Stalling
49 Stall speed
201 Stall demonstration Wings Level
203 Stall characteristics Turning Flight
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

Straight (thrust levers closed). Trim the aeroplane above 3000 ft AGL in the required configuration at 1.4 Vs with the throttle closed. Approach the stall in straight flight while decreasing speed at 1 knot/second. Recovery is to be completed by 3000 ft agl.

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0	14kg	352	1105	Idle	55	minimal	38 Full Back Stick FBS	Gentle (slow roll rate) wing drop if ball not centred at stall – could be prevented and was easily stopped in stall recovery = benign

Advanced Stalling
49 Stall speed
201 Stall demonstration Wings Level
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

4) Power :
i) Engine idling; and
ii) Maximum continuous power, or, if the power-to-weight ratio at maximum continuous power results in extreme nose-up attitudes, demonstration may be carried out with the power not less than that required for level flight in the landing configuration at maximum landing weight and a speed of 1·4 VS0, except that the power may not be less than 75% maximum continuous power.
Max rpm in level flight was 6100 rpm. 5000 rpm was used for power on stalls

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0	13kg	351	1110	5000rpm		Light	30	No

Advanced Stalling
49 Stall speed
203 Stall characteristics Turning Flight
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

4) Power :
i) Engine idling; and
ii) Maximum continuous power, or, if the power-to-weight ratio at maximum continuous power results in extreme nose-up attitudes, demonstration may be carried out with the power not less than that required for level flight in the landing configuration at maximum landing weight and a speed of 1·4 VS0, except that the power may not be less than 75% maximum continuous power.
Max rpm in level flight was 6100 rpm. 5000 rpm was used for power on stalls

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0 Left	12kg	350	1115	Idle	50	Light	40	Wings Levelled
Flaps 0 Right				Idle	50	Light	40	Wings Levelled
Flaps 0 Left				5000rpm	50	Light	35	Wings Levelled
Flaps 0 Right				5000rpm	50	Light	35	Wings Levelled

Controllability and Manoeuvrability
143 General

S 143 General
a) The aeroplane must be safely controllable and manoeuvrable during;
1) take-off at maximum take-off power;
2) any steady climb condition;
3) level flight;
4) descent;
5) landing, power on and off; and
6) with sudden engine failure.
b) It must be possible to make a smooth transition from one flight condition to another (including turns, reversal of turns and slips) with no more than average piloting skill, alertness or strength, and without danger of exceeding the limit load factor, under any probable operating condition, with the engine running at all allowable power settings, including the effect of power changes and sudden engine failure. Modest departures from any recommended techniques must not cause unsafe flight conditions
c) Any unusual flying characteristics observed during the flight tests required to determine compliance with the flight requirements and any significant variations in flight characteristics caused by rain must be determined with the engine running at all allowable powers.
d) If marginal conditions exist with regard to pilot effort the 'pilot effort' limits must be shown by quantitative tests for a minimum weight pilot. In no case may the limits exceed those prescribed in the table shown in S.143. This requirement must be met with the engine running at all allowable powers. Values in pounds of force as applied to the control wheel or rudder pedals.

(a) For temporary application:	P	R	Y
Stick----------------	20	10	--------
Wheel (applied to rim)-------------------	25	20	--------
Rudder Pedal--------	-------	-------	40
(b) For prolonged application.	2	1.5	10

Amdt 23-0 & Amdt. 23-14, Eff. 12/20/73

Condition of Note	Comment
None	All sat

S 161 Trim
The speeds to achieve lateral, longitudinal and directional trim must lie within 1.3 VS1 and 2.0 VS1 at all engine powers and the extreme c.g. positions.

Test	Fuel	Wt	Time	MPH	Pwr	Considerations
Flap Up	11kg	349	1120	1.3Vs1	PFLF	Assess Long & Directional Trim
Flap Up				2.0 Vs1	PFLF	Assess Long & Directional Trim
Flap Up				1.3Vs1	Idle	Assess Long & Directional Trim
Flap Up				2.0 Vs1	Idle	Assess Long & Directional Trim
Flap Up				1.3Vs1	Full	Assess Long & Directional Trim
Flap Up				2.0 Vs1	Full	Assess Long & Directional Trim

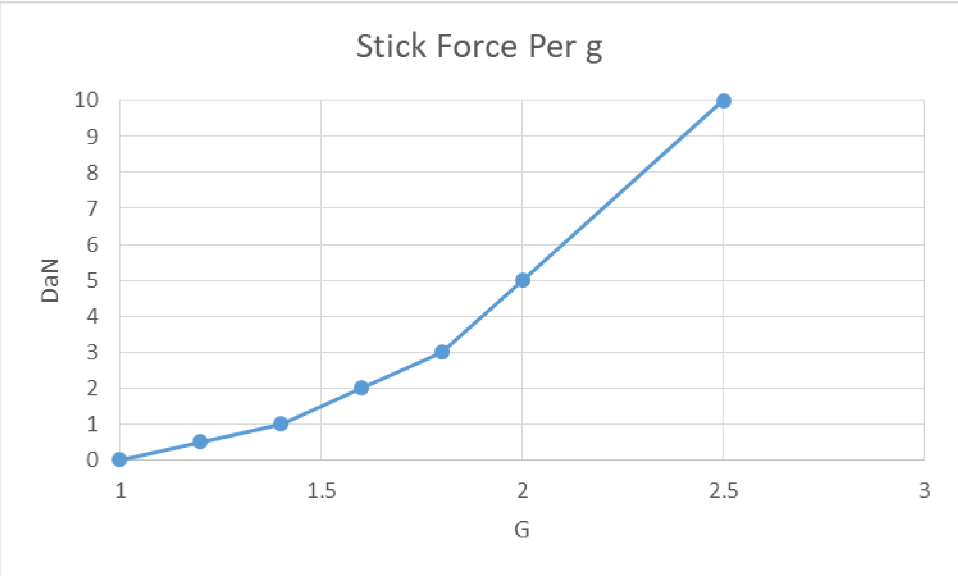
All sat – no issues

Test	Fuel	Wt	Time	Pwr	Considerations
Flap Up	11 kg	349	1125	Idle	Apply Full Power – maintain speed
Only one (Flap up – no flap) config to test – effect of power conventional but attitude easily held with power changes.					

S 147 Lateral and directional control a) Using an appropriate combination of controls, it must be possible to roll the aeroplane from a steady 30° banked turn through an angle of 60°, so as to reverse the direction of the turn within 5 seconds when the turns are made at speeds of 1.3 VS1 and at VNE. b) N/A - (Applicable only if control is effected by weight shift c) The tests required by a) and b) must be performed: 1) where applicable, with the landing gear and wing-flaps retracted and with the landing gear and wing-flaps extended; 2) without encountering uncontrollable rolling tendencies or uncommanded high roll rates; and 3) with any uncommanded pitching during the manoeuvre being readily controllable.						
Test	Fuel	Wt	Time	MPH	Pwr	Time to Roll
Flap Up	10kg	348	1130	1.3Vs1	PFLF	4 secs L-R
Flap Up				1.3Vs1	PFLF	4 secs R-L
Flap Up				Vne	5500	3 secs L-R
Flap Up				Vne	5500	3 secs R-L
At low speed the aircraft felt sluggish in roll despite having large connected ailerons on both upper and lower wings. In practice roll control was more than sufficient for landing and take-off even in cross winds. At higher airspeed the roll control became conventionally crisp and effective.						

Stick Force per G S 155 Pitch control force in manoeuvres The pitch control force during turns or when recovering from manoeuvres must be such that at a constant speed an increase in load factor is associated with an increase in control force. In addition: a) For conventional control systems the minimum value of this force to apply to the aeroplane a normal acceleration which would impose limit load on the structure must not be less than 7 daN from a trimmed 1 g condition at all speeds up to VNE at which the required normal acceleration can be achieved without stalling, with wing-flaps and, where applicable, landing gear retracted.						
Test	Fuel	Wt	Time	MPH	G	DaN
The wind Up turns to 3G						
	10kg	348	1135	80-100	1	0
					1.1	0.5

					1.4	1
					2	5-6
					2.5	10
Note – Turns left and right at MCP at 80 MPH and Vne 100 MPH – speed washed off very quickly – large aft stick displacement required – very obvious tactile cues – forces left and right the same – 7daN reached at approx. 2.2 g – well below 4g limit – compliant with Section S & satisfactory						



23.251 Vibration and buffeting 23.253 High speed characteristics Dive to Vdf						
Test	Fuel	Wt	Time	MPH	Pwr	Considerations
Clean	9kg	347	1145	111	55-6000	

NOTE: This test must not be carried out in turbulent conditions.

Start Altitude	3000 ft	IOAT	7 ºC	Scheduled Vdf	111 MPH
End Altitude	2000 ft	PEs	5	Vdf KIAS Achieved?	111 MPH

Left	Right

Any buffet or unusual vibrations ACC
Weight and Response of flying Controls ACC
Engine/Propeller behavior ACC

It must be possible to recover from an overspeed condition at Vd using the primary longitudinal control alone

Assess LSS = Very Stable

Assess LDO = Heavily damped

As with all open cockpit aircraft high speed flight is never comfortable but the aircraft continued to accelerate above Vne with no discernible problems – compliant with Section S

S 173 Static longitudinal stability
a) Under the conditions and throughout the speed range specified in S 175 the slope of the curve, control force versus speed, must be positive and have a value such that any significant speed change will cause a variation in control force plainly perceptible to the pilot.
b) 1) Where the aeroplane can be trimmed longitudinally the airspeed must return to within 10% of the original trim speed when the aeroplane is disturbed from the trimmed condition.
2) Where the aeroplane has no longitudinal trimmer the airspeed must return to within 10% of the trim speed required by S 161 in each configuration, when the aeroplane is disturbed from the trimmed condition.

S 175 **Demonstration of static longitudinal stability** The control force/speed curve must have a stable slope in the following conditions:
a) Climb:
1) At 1.4 VS1;
2) Landing gear retracted;
3) Wing-flaps in the position for climb; and
4) Maximum power.
b) Cruise:
1) At maximum level flight speed and VDF;
2) Landing gear retracted;
3) Wing-flaps retracted.
c) Approach:
1) At the recommended approach speed;
2) Wing-flaps in the landing position;
3) Landing gear extended; and
4) Engine at normal approach power and with engine off.

Test	Fuel	Wt	Time	Power	OAT	-20kts	Trim Speed	+20kts
Climb 1.4Vs1	9kg	347	1150	Full	8		60	
Cruise				MCP	8		80	
Vdf				MCP	8		111	XXXXXXX
App Full Flap				App	8		60	
App Full Flap				Idle	8		60	

Aircraft – positive static stability in all cases – weak in full power climb as typical

S 177 Lateral and directional stability a) With the aeroplane in straight steady flight, and when the roll and yaw controls are gradually applied in opposite directions, any increase in sideslip angle must correspond to an increased deflection of the lateral control. This behaviour need not follow a linear law. b) In a sideslip any control force must increase progressively with sideslip; it need not be linear but must not reverse.								
Test	Fuel	Wt	Time	Power	OAT	-10°	Trim	+10°
	9kg	347	1150					
Cruise 0.9Vh				PFLF	13			
Tested in cruise & same conditions as LSS – directionally and laterally stable throughout – weak directional stability – needed to pay attention to slip ball								

S 181 Dynamic stability a) Any short period oscillations not including combined lateral-directional oscillations occurring between the stalling speed and VDF must be heavily damped with the primary controls: 1) Free; 2) Fixed. b) Any combined lateral-directional oscillations occurring between the stalling speed and VDF must be damped with the primary controls: 1) Free; 2) Fixed. c) Any long period oscillation of the flight path (phugoid) must not be so unstable as to cause an unacceptable increase in pilot workload or otherwise endanger the aeroplane. When, in the conditions of S 175, the longitudinal control force required to maintain speeds differing from the trimmed speed by at least ±15% is suddenly released, the response of the aeroplane must not exhibit any dangerous characteristics nor be excessive in relation to the magnitude of the control force released. These requirements must be met with the engine running at all allowable powers								
Test	Fuel	Wt	Ht Hp	Power	OAT	LDO		Phugoid
Climb Vyi	8kg	346	3000	Full	6	Well damped		20 secs
Cruise 0.9Hh				MCP				24 secs
Slow Cruise				PFLF				22 secs
App				Idle				20 secs

75 Normal Landing – Power Off						
Test	CG	Wt		MPH	Pwr	Considerations
2	A	L		60	Idle	(1) A steady gliding approach with a calibrated airspeed of at least [1.3] V_{S1} must be maintained down to the 50 foot height. (2) The landing may not require exceptional piloting skill or exceptionally favourable conditions. (3) The landing must be made without excessive vertical acceleration or tendency to bounce, nose over, ground loop, porpoise, or water loop.
Easy to land – good elevator control response						

Flapless Landing – Touch & Go						
Test	CG	Wt	Ht	MPH	Pwr	Considerations
4	A	L		60	Idle	Note change in pitch attitude at touch down
Sat – no issues						

51 Flapless Take-Off – from Touch & Go						
Test	CG	Wt	Ht	MPH	Pwr	Considerations
5	A	L		60	Idle	Note change in pitch attitude at rotate
Sat – no issues – easy to pick tail up with full forward stick						

75 Vref-5 Landing –						
Test	CG	Wt	Ht	MPH	Pwr	Considerations
6	A	L		50-55	Idle	
All OK						

Flight Test Report

Flight Number / Configuration	Sortie 4 – Full Forward c of g
Date	14 November 17
Overview	Forward c of g = performance Climbs,. Idle Power Stalls and flight toV_{DF} Take-off & landings Spinning
Handling Pilot/P1	Chris Taylor (flown from front seat)
Safety Pilot P2	None
FTE	None
AUW	391 kg
cg	55-60 mm
Fuel T/O	40 lts
Fuel Ldg	30 lts
ZFW	362 kg (50 kg Ballast on P1 seat)

Airfield Altitude	196	ft	QFE	1010	mb
Wind	180/3kts	knots	OAT	12	°C
Weather (test area)	Overcast – light winds from south at altitude – no sig turbulence –				

Test Timings			
Off Chocks	1315	Landing	1400
Take-Off	1330	On Chocks	1405
Flying Time	0:30	Chock Time	0:45

Ground Handling						
Test	Fuel	Wt				
Start	28kg	391				
End	70	450				
Satisfactory – no issues						

Basic/idle Stalling
49 Stall speed
201 Stall demonstration Wings Level
203 Stall characteristics Turning Flight
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

Straight (thrust levers closed). Trim the aeroplane above 3000 ft AGL in the required configuration at 1.4 Vs with the throttle closed. Approach the stall in straight flight while decreasing speed at 1 knot/second. Recovery is to be completed by 3000 ft agl.

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0	28kg	391	1335	Idle	55	Light	38	Nil

Advanced Stalling Forward C of G & Heavy
49 Stall speed
201 Stall demonstration Wings Level
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

4) Power :
i) Engine idling; and
ii) Maximum continuous power, or, if the power-to-weight ratio at maximum continuous power results in extreme nose-up attitudes, demonstration may be carried out with the power not less than that required for level flight in the landing configuration at maximum landing weight and a speed of 1·4 VS0, except that the power may not be less than 75% maximum continuous power.
Note 5000 rpm used to give 75% of MCP

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0	28	391	1335	5000	50	Light	35	No

Advanced Stalling
49 Stall speed
203 Stall characteristics Turning Flight
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

4) Power :
i) Engine idling; and
ii) Maximum continuous power, or, if the power-to-weight ratio at maximum continuous power results in extreme nose-up attitudes, demonstration may be carried out with the power not less than that required for level flight in the landing configuration at maximum landing weight and a speed of 1·4 VS0, except that the power may not be less than 75% maximum continuous power.

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0 Left	27	390	1335	Idle	50	Light	38	Rolled level
Flaps 0 Right				Idle	50	Light	40	Rolled level
Flaps 0 Left				4800	50	Light	34	Rolled level
Flaps 0 Right				4800	50	Light	35	Rolled level

Controllability and Manoeuvrability
143 General

S 143 General
a) The aeroplane must be safely controllable and manoeuvrable during;
1) take-off at maximum take-off power;
2) any steady climb condition;
3) level flight;
4) descent;
5) landing, power on and off; and
6) with sudden engine failure.
b) It must be possible to make a smooth transition from one flight condition to another (including turns, reversal of turns and slips) with no more than average piloting skill, alertness or strength, and without danger of exceeding the limit load factor, under any probable operating condition, with the engine running at all allowable power settings, including the effect of power changes and sudden engine failure. Modest departures from any recommended techniques must not cause unsafe flight conditions
c) Any unusual flying characteristics observed during the flight tests required to determine compliance with the flight requirements and any significant variations in flight characteristics caused by rain must be determined with the engine running at all allowable powers.
d) If marginal conditions exist with regard to pilot effort the 'pilot effort' limits must be shown by quantitative tests for a minimum weight pilot. In no case may the limits exceed those prescribed in the table shown in S.143. This requirement must be met with the engine running at all allowable powers. Values in pounds of force as applied to the control wheel or rudder pedals.

(a) For temporary application:	P	R	Y
Stick----------------	20	10	--------
Wheel (applied to rim)-------------------	25	20	--------
Rudder Pedal--------	-------	-------	40
(b) For prolonged application.	2	1.5	10

Amdt 23-0 & Amdt. 23-14, Eff. 12/20/73

Condition of Note	Comment
Nil	All sat – Throttle chop on take-off benign – Gentle pitch nose down.

S 161 Trim
The speeds to achieve lateral, longitudinal and directional trim must lie within 1.3 VS1 and 2.0 VS1 at all engine powers and the extreme c.g. positions.

Test	Fuel	Wt	Time	KIAS	Pwr	Considerations
Flap Up	26	389	1340	1.3Vs1	PFLF	Assess Long & Directional Trim
Flap Up				2.0 Vs1	PFLF	Assess Long & Directional Trim

Flap Up				1.3Vs1	Idle	Assess Long & Directional Trim
Flap Up				2.0 Vs1	Idle	Assess Long & Directional Trim
Flap Up				1.3Vs1	Full	Assess Long & Directional Trim
Flap Up				2.0 Vs1	Full	Assess Long & Directional Trim
All satisfactory – aircraft could easily be trimmed in all required conditions –						

Longitudinal Control
S 145 Longitudinal Control
a) It must be possible at any speed below 1.3 VS1 to pitch the nose downwards so that a speed equal to 1.3 VS1 can be reached promptly.
1) **Test conditions.** All possible configurations and engine powers when trimmed at 1.3 VS1 (where trim control is fitted).
b) It must be possible throughout the appropriate flight envelope to change the configuration (landing gear, wing flaps etc.) without exceptional piloting skill and without exceeding the control forces defined in S 143 d).
c) It must be possible to raise the nose at VDF at all permitted c.g. positions and engine powers.

Test	Fuel	Wt	Time		Pwr	Considerations
Flap Up	26	389	1340	50	Full	Apply Full Power – maintain speed
All satisfactory – all test points easy to fly – easy to maintain level flight						

S 147 Lateral and directional control
a) Using an appropriate combination of controls, it must be possible to roll the aeroplane from a steady 30° banked turn through an angle of 60°, so as to reverse the direction of the turn within 5 seconds when the turns are made at speeds of 1.3 VS1 and at VNE.
b) N/A - (Applicable only if control is effected by weight shift
c) The tests required by a) and b) must be performed:
1) where applicable, with the landing gear and wing-flaps retracted and with the landing gear and wing-flaps extended;
2) without encountering uncontrollable rolling tendencies or uncommanded high roll rates; and
3) with any uncommanded pitching during the manoeuvre being readily controllable.

Test	Fuel	Wt	Time	MPH	Pwr	Time to Roll
Flap Up	26	389	1340	1.3Vs1	5000	4 secs L-R

Flap Up				1.3Vs1	5000	4 secs R-L
Flap Up				Vne	5500	3 secs L-R
Flap Up				Vne	5500	3 secs R-L

Stick Force per G

S 155 Pitch control force in manoeuvres
The pitch control force during turns or when recovering from manoeuvres must be such that at a constant speed an increase in load factor is associated with an increase in control force. In addition:
a) For conventional control systems the minimum value of this force to apply to the aeroplane a normal acceleration which would impose limit load on the structure must not be less than 7 daN from a trimmed 1 g condition at all speeds up to VNE at which the required normal acceleration can be achieved without stalling, with wing-flaps and, where applicable, landing gear retracted.

Test	Fuel	Wt	Time	KIAS	Pwr	Considerations

Stick Force per g evidently higher than at full aft cg which was determined to be the more critical case. Large linear and predictable aft stick in puts required to reach 2g.

23.251 Vibration and buffeting
23.253 High speed characteristics
Dive to Vdf

Test	Fuel	Wt	Time	MPH	Pwr	Considerations
Clean	25	388	1345	111	MCP	

NOTE: This test must not be carried out in turbulent conditions.

Start Altitude	3000 ft	IOAT	7 ºC	Scheduled Vdf	111 MPH
End Altitude	2000 ft	PEs	5	Vdf KIAS Achieved?	111 MPH

Any buffet or unusual vibrations ACC
Weight and Response of flying Controls ACC
Engine/Propeller behavior ACC

It must be possible to recover from an overspeed condition at Vd using the primary longitudinal control alone

Assess LSS = Very Stable

Assess LDO = Heavily damped

As with all open cockpit aircraft high speed flight is never comfortable but the aircraft continued to accelerate above Vne with no discernible problems – compliant with Section S

S 181 Dynamic stability
a) Any short period oscillations not including combined lateral-directional oscillations occurring between the stalling speed and VDF must be heavily damped with the primary controls:
1) Free;
2) Fixed.
b) Any combined lateral-directional oscillations occurring between the stalling speed and VDF must be damped with the primary controls:
1) Free;
2) Fixed.
c) Any long period oscillation of the flight path (phugoid) must not be so unstable as to cause an unacceptable increase in pilot workload or otherwise endanger the aeroplane. When, in the conditions of S 175, the longitudinal control force required to maintain speeds differing from the trimmed speed by at least ±15% is suddenly released, the response of the aeroplane must not exhibit any dangerous characteristics nor be excessive in relation to the magnitude of the control force released. These requirements must be met with the engine running at all allowable powers

Test	Fuel	Wt	Ht Hp	Power	OAT	LDO		Phugoid
Climb Vyi	25	388	3000	Full	11	Well damped		
Cruise 0.9Hh				MCP		Well damped		
Slow Cruise				PFLF		Well damped		
App				Idle		Well damped		

Spinning – The spins were initiated with the throttle set as required to give idle power, 5000rpm or full power and the nose raised to slow down until 45-50MPH was reached when full back stick and full rudder was applied. Recoveries were commenced after ¼ ½ ¾ 1 or 1½ or 2 complete turns. With a forward cg the aircraft tended to enter a spiral dive on each occaision – however with power applied the aircraft entered a spin – but as soon as the throttle was closed the aircraft tended to fall into a spiral dive – therefore recovery was generally achieved within approx. ½ a further turn unless annotated as such. There was only one configuration as no flaps were fitted

Normal recovery was to close the throttle – apply full opposite rudder to the spin direction – then move the stick centrally forward progressively until the spin stopped.

Turns	Left/Right	Abuse	Recovery	Comment
¼	L	Normal	Spiral Dive	
¼	R	Normal		
½	L	Normal		
½	R	Normal		
1	L	Normal		
1	R	Normal		
1	L	Normal		
1	R	Normal		
2	L	Power at 5000 rpm	Normal	Aircraft enterd a spin with power & high nose up – however as the throttle was closed the aircraft fell out of thew spin into a spiral dive
2	L	Full Power	Normal	

Spinning with forward cg was difficult to achieve unless the aircraft was forced into it. Recoveries were easy with the aircraft tending to recover itself. As a result the spin matrix with forward cg was reduced to concentrate on aft cg spinning.

75 Normal Landing – Power Off

Test	CG	Wt	Ht	KIAS	Pwr	Considerations
	Fwd	386			Idle	(1) A steady gliding approach with a calibrated airspeed of at least [1.3] V_{S1} must be maintained down to the 50 foot height. (2) The landing may not require exceptional piloting skill or exceptionally favourable conditions. (3) The landing must be made without excessive vertical acceleration or tendency to bounce, nose over, ground loop, porpoise, or water loop.

Easy to fly – 60 MPH approach – 50 MPH over threshold – good elevator authority – full back stick not reached/required

75 Simulated Emergency Condition Flapless Landing – Touch & Go						
Test	CG	Wt	Ht	KIAS	Pwr	Considerations
4	F	386			Idle	Note change in pitch attitude at touch down
Sat – no issues						

51 Flapless Take-Off – from Touch & Go						
Test	CG	Wt	Ht	KIAS	Pwr	Considerations
5	F	386			Idle	Note change in pitch attitude at rotate
Easy – no issues						

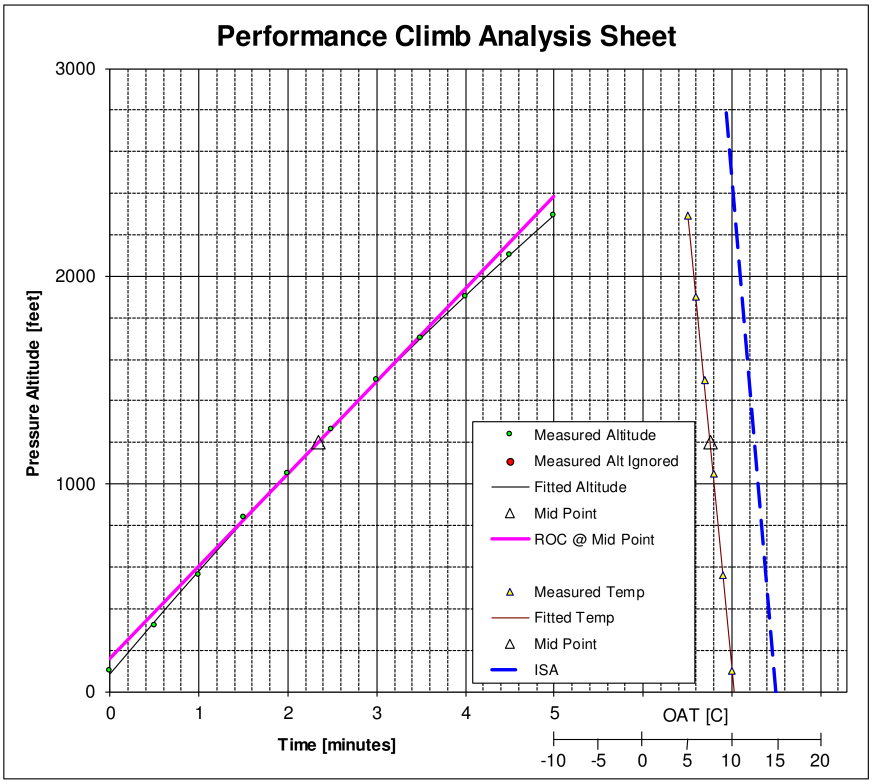
75 Vref-5 Landing –						
Test	CG	Wt	Ht	KIAS	Pwr	Considerations
6	F	386			Idle	
Short field technique 45 MPH at threshold – good control – good elevator authority – good field of view - sat						

Flight Number / Configuration	Sortie 5 – MAUW
Date	14 November 17
Overview	Forward c of g = performance Climbs,. Idle Power Stalls Take-off & landings
Handling Pilot/P1	Chris Taylor
Safety Pilot P2	James Milne
FTE	None
AUW	456 kg (on taxi)
cg	160 mm
Fuel T/O	30 lts
Fuel Ldg	20 lts
ZFW	435 kg (2 POB)

Airfield Altitude	196	ft	QFE	1010	mb
Wind	180/3kts	knots	OAT	12	°C
Weather (test area)	Overcast – light winds from south at altitude – no sig turbulence –				

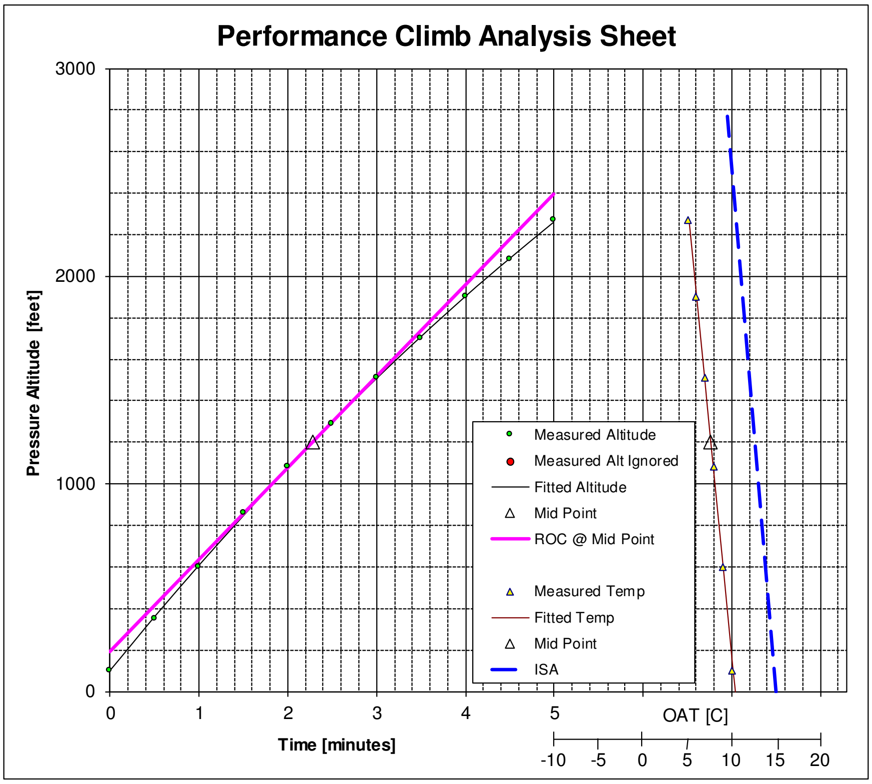
Test Timings			
Off Chocks	1410	Landing	1445
Take-Off	1415	On Chocks	1455
Flying Time	0:30	Chock Time	0:45

Climb data							
	ht	T			ht	T	Remarks
Time (mins)		℃		Time (mins)		℃	
0.0	100	10		0.0	100	10	
0.5	320			0.5	350		
1.0	560	9		1.0	600	9	
1.5	840			1.5	860		
2.0	1050	8		2.0	1080	8	
2.5	1260			2.5	1290		
3.0	1500	7		3.0	1510	7	
3.5	1700			3.5	1700		
4.0	1900	6		4.0	1900	6	
4.5	2100			4.5	2080		
5.0	2290	5		5.0	2270	5	



Aircraft Type	
Ranger	
Registration	
G-TLAC	
Date of Test	
14 Nov 2017	
Mean Weight	**Kg/Lbs**
450 Kg	
Mid Altitude	**[feet]**
1200	
Mid OAT	**[C]**
7.6	
(ISA -5)	
Scheduled ROC	**[ft/min]**
Basic	
Correction	0
Correction	0
Final SROC	
Observed ROC	**[ft/min]**
445	
Difference	**[ft/min]**
445	
(Observed ROC - Final SROC)	

 Curve Fit Quality: 99



Aircraft Type	
Ranger 2	
Registration	
G-TLAC	
Date of Test	
14 Nov 2017	
Mean Weight	**Kg/Lbs**
450 Kg	
Mid Altitude	**[feet]**
1200	
Mid OAT	**[C]**
7.6	
(ISA -5)	
Scheduled ROC	**[ft/min]**
Basic	
Correction	0
Correction	0
Final SROC	
Observed ROC	**[ft/min]**
440	
Difference	**[ft/min]**
440	
(Observed ROC - Final SROC)	

 Curve Fit Quality: 100

Basic/idle Stalling
49 Stall speed
201 Stall demonstration Wings Level
203 Stall characteristics Turning Flight
207 Stall Recovery & warning
NB: Full back Stick 2 secs, G Break

Straight (thrust levers closed). Trim the aeroplane above 3000 ft AGL in the required configuration at 1.4 Vs with the throttle closed. Approach the stall in straight flight while decreasing speed at 1 knot/second. Recovery is to be completed by 3000 ft agl.

Test	Fuel	Wt	Time	Pwr	Trim	Buffet	Stall	Wing Drop
Flaps 0	28	450		Idle	55	Light	38	Nil

Numerous Take-Off and landings were carried out during the formal evaluation. At light weight the aircraft's take-off roll was minimal with the aircraft leaping into the air. At MAUW with 2 POB take-offs were Tiger Moth like with full forward stick being applied once rolling to lift the tail – which was progressively brought to the rear to keep the aircraft level. The aircraft flew off at around 45 MPH. Testing was conducted on soft and damp grass – Runway 27 parallel to the taxiway at Little Snoring – wind was very light and directly across the strip with no headwind component.

	Direction	Distance	Comment
Take-Off	270	100	
Landing	270	105	
Take-Off	270	95	
Landing	270	100	
Take-Off	270	100	
Landing	270	90	
Take-Off	270	100	
Landing	270	105	
Take-Off	270	95	
Landing	270	100	
Take-Off	270	100	
Landing	270	90	

The take-off and land was accomplished in approx. 100 m – Recommend min of 130m be quoted in the AFM

Flight Number / Configuration	Sortie 6 – Full Aft c of g
Date	14 November 2017
Overview	Full Aft cg = spinning
Handling Pilot/P1	Chris Taylor
Safety Pilot P2	None
FTE	None
AUW	353 kg
cg	197 mm
Fuel T/O	21 lts
Fuel Ldg	10 lts
ZFW	338

Airfield Altitude	196	ft	QFE	1010	mb
Wind	180/2	knots	OAT	5	℃
Weather (test area)	Excellent – light southerly winds no turbulence				

Test Timings			
Off Chocks	1505	Landing	1600
Take-Off	1515	On Chocks	1605
Flying Time	0:45	Chocks Time	1:00

Spinning – The spins were initiated with the throttle set as required to give idle power, 5000rpm or full power and the nose raised to slow down until 45-50MPH was reached when full back stick and full rudder was applied. Recoveries were commenced after ¼ ½ ¾ 1 or 1½ or 2 complete turns. Recovery was generally achieved within approx. ½ a further turn unless annotated as such. There was only one configuration as no flaps were fitted

Normal recovery was to close the throttle – apply full opposite rudder to the spin direction – then move the stick centrally forward progressively until the spin stopped. In practice with an aft cg this was usually of the order of 1-2 inches of movement forward.

The incipient recovery was tested after the first turn by centralising the controls – the aircraft spin stopped almost immediately

Turns	Left/Right	Abuse	Recovery	Comment
¼	L	Normal	Normal	
¼	R	Normal	Normal	
½	L	Normal	Normal	
½	R	Normal	Normal	
1	L	Normal	Incipient Recovery	
1	R	Normal	Incipient Recovery	
1	L	Normal	Normal	
1	R	Normal	Normal	
2	L	Normal	Normal	
2	R	Normal	Normal	
2	L	In Spin Aileron	Normal	Sped Up
2	L	Out Spin Aileron	Normal	
2	R	In Spin Aileron	Normal	Sped Up
2	R	Out Spin Aileron	Normal	
2	L	Power at 5000 rpm	Normal	
2	L	Full Power	Normal	
2	L	In Spin Aileron	In Spin Aileron	
2	L	Out Spin Aileron	Out Spin Aileron	
2	L	Normal	Reverse	With full rudder applied if the stick was moved forward off the stop the spin rotational rate increased. However spin recovery was achieved normally by applying full opposite rudder with the stick initially moved aft then forward. The aircraft commenced recovery as soon as the stick was moved forward but due to the higher spin rate took just over a full turn to stop
2	R	Normal	Reverse	