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Kittyhawk I AK 751
Allison V.1710 F.3R.
Handling and performance with a Hydulignum propeller.

A.& A.E.E. Ref:- 4484/1 - A.S.76/5.
M.A.P.:- 801130/38/R.D.A.1.

RESTRICTED

This report deals with the aircraft (or equipment) as tested. Action to remedy defects or decisions to accept items not in strict compliance with the specification are matters for decision and action by the M.A.P.

Progress of issue of report

Report No.	Title
11th Part of A.& A.E.E/783.	A.L.229. Take-off and landing trials with and without overload fuel tank.
12th do.	A.K.572) A.L.229) Engine Cooling trials.
13th do.	A.L.229 Gun heating tests.
14th do.	A.L.229. Level speed measurements with flame damping exhausts fitted.
15th do.	A.L.229. Weights and loading data.

SUMMARY

Brief performance and handling trials have been made on a Kittyhawk I fitted with a Hydulignum bladed propeller. The results of the performance trials are summarised below:

Maximum rate of climb = 1350 ft/min. at 12,000 feet.
Time to reach 10,000 ft. = 7.9 mins.
" " " 20,000 ft. = 17.25 "
Service ceiling = 28,600 feet.
Maximum true airspeed = 331 m.p.h. at 14,000 feet.

These performance figures have been reduced on the $p^{\frac{1}{2}} \sigma^{\frac{1}{2}}$ basis. Compared with a standard Kittyhawk I the top speed is unchanged, but the maximum rate of climb is reduced by 290 ft/min. The ceiling is about the same.

The handling characteristics have deteriorated with change of propeller. There is now a marked change of directional trim with change of speed. On the climb at low airspeeds, full starboard rudder bias is necessary to fly feet off, but in the dive the aircraft has to be re-trimmed in the opposite direction. The aircraft has also to be re-trimmed in level flight for varying throttle positions. This change of trim with speed would be a serious handicap to the pilot during combat and considerably reduces the usefulness of the aircraft as a fighter. Apart from this, the general handling characteristics are similar to a normal Kittyhawk I.

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1. **Introduction:**

Brief performance and handling trials were required on a Kittyhawk I aircraft fitted with a Curtiss electric propeller incorporating hydulignum blades. A summary of the results obtained has been reported to M.A.P. in our letter ref. A.& A.E.E/4484/1-A.S.76/5, dated 6th September 1942.

The tests were made in August and September 1942.

2. **Condition of aircraft relevant to tests made.**

2.1. **External details.** The aircraft was fitted with the following during the tests:

A 10'6" diameter Curtiss electric propeller fitted with Hydulignum blades. (Details given in Appendix, Table I).
6 x 0.5" machine guns in the wings. Their muzzles were covered with fabric held in position with adhesive tape. The ejector chutes were also sealed with fabric.
Rearward facing, individual stub exhausts.
A stone guard over the carburettor air intake.
A camera gun fairing under the starboard wing.
A ring and a bead sight in front of the windscreen.

/An internal

An internal bullet-proof windscreen.
A rear view mirror in a fairing above the pilot's hood.
An aerial mast behind the pilot's hood, and aerials extending from the fin - each wing tip with a lead in to the fuselage from the fin.
I.F.F. aerials extending from both tail plane tips to the fuselage.

2.2. Loading. The aircraft was flown throughout the tests at a take-off weight of 8420 lb. with the centre of gravity 27.1" aft of the datum (under-carriage down). This is the typical service load giving the aftmost centre of gravity position.

When fitted with this hydulignum propeller the limits of the centre of gravity range due to dissipation of loads are 21.6 ins. and 27.3 ins. aft of the datum.

2.3. The operational limitations of an Allison V1710 F.3.R. engine which obtained at the time of the tests were:-

	R.P.M.	Manifold pressure - ins. of Hg.
Take-off (5 mins.)	3000	44½
Maximum for climb (30 mins.)	2600	37
Maximum for all-out level flight (5 min)	3000	42
Maximum rich mixture cruising	2600	37
" weak " "	2300	30½

3. Scope of tests.

Partial climbs were made at two heights to determine the best climbing speed.

Performance was measured on two maximum power climbs to 27,000 feet with the radiator exit duct gills open.

Level speed performance was measured between 8000 and 18,000 ft. with the radiator exit duct gills in the neutral position.

Handling tests at the typical service load (quoted in para. 2.3), including dives to 420 m.p.h. A.S.I. and brief stalling tests were made.

4. Results of performance tests.

The results of the partial climb tests show that the best climbing speed is 160 m.p.h. A.S.I. up to 12,000 feet, reducing 3 m.p.h. per 1000 feet thereafter.

The performance measurements taken on the climb and in level flight reduced on the $p^{\frac{1}{2}}\sigma^{\frac{1}{2}}$ basis, are given in detail in Tables II and III and in Figures 1 and 2. The results obtained are summarised in the table below:

Maximum rate of climb	=	1350 ft/min. at 12,000 feet.
Time to reach 10,000 ft.	=	7.9 mins.
" " " 20,000 ft.	=	17.25 "
Service ceiling	=	28,600 feet.
Maximum true airspeed	=	331 m.p.h. at 14,000 feet.

Comparing these results with those obtained on a Kittyhawk I with a standard Curtiss electric propeller (reported in 8th and 10th parts of report No. A.& A.E.E./783), shows that the maximum true airspeed has not substantially changed, but that the performance on the climb has deteriorated. The maximum rate of climb is 290 ft/min. slower, the times to 10,000 and 20,000 ft. are 1.65 and 3.0 minutes longer, but the service ceiling is about the same.

Reducing the results by the methods of A.& A.E.E. memorandum dated 27/8/42 makes no appreciable difference to the climb performance, but the maximum true airspeed is increased by 5 m.p.h. at 14,000 ft.

5. Handling.

5.1. Take-off. With 1 division starboard rudder bias the take-off is steady and normal for a Kittyhawk I. Any tendency to develop a swing can easily be controlled by the use of rudder.

5.2. Climb. The initial climb after take-off using take-off power is normal,

/but

but when the maximum climbing conditions of 2600 r.p.m., 37" Hg boost, and 160 m.p.h. A.S.I. are selected, the aircraft starts to yaw to the left. The aircraft can be trimmed to fly feet off with 4½ divisions of starboard rudder bias in this condition, but if this speed is reduced the yaw becomes increasingly difficult to check until at 120 m.p.h. A.S.I., full starboard rudder bias is insufficient to trim the aircraft on the climb.

5.3. Level flight. At 2400 r.p.m. and 27" Hg. boost, the aircraft is trimmed directionally with the rudder bias in the neutral position. If the throttle setting is suddenly increased, the nose swings away to starboard quite severely; similarly if the throttle is closed the nose swings away to port. This characteristic is very disturbing and necessitates re-trimming for any speed change as the force on the rudder pedals due to these changes is heavy.

5.4. Stalling speeds and characteristics. The stalling speeds are 83 m.p.h. A.S.I. flaps and undercarriage up and 79 m.p.h. A.S.I. flaps and undercarriage down.

The stalls were straightforward and substantially the same as on a normal Kittyhawk I. The nose drops away to starboard in both cases and there is a slight extra tendency for a spin to develop unless immediate action to check this is taken. Except for this, the recovery from the stall is normal.

5.5. Approach and landing. The approach and landing remain unaffected by the change of propeller.

6. Dives.

The aeroplane was dived to 420 m.p.h. A.S.I. It was very steady in the dive, but at this speed the rudder bias was set at 3½ divisions to port to give zero load on the rudder pedals. It will be seen from this that to change from a climb to dive or vice versa necessitates a large alteration in directional trim.

The pitching movement when yaw was applied was more marked than on a standard Kittyhawk, but was not excessive.

7. Conclusions.

Comparison with a standard Kittyhawk I shows that fitting this hydulignum bladed propeller has little affect on the top speed performance, but reduces the maximum rate of climb by 290 ft/min. The ceiling is about the same.

This propeller causes a very marked change in directional trim with change in speed and power. The constant retrimming that is consequently necessary would be a serious handicap and reduces the usefulness of the aircraft as a fighter. Apart from this, the general handling characteristics are similar to those of a standard aircraft.

It is understood that in view of the adverse characteristics with this propeller its production for the Kittyhawk will not be continued.

APPENDIX

TABLE I

Propeller details

Type of propeller: Curtiss Electric C53155-C10 (Hydulignum blades manufactured by Horden-Richmond).

Serial No:- 9265
Diameter:- 10'-6"
No. of blades:- 3
Direction of rotation:- R.H.
Serial No. Blade No.1:- 14977
" " " " 2:- 15004
" " " " 3:- 15012
Pitch range:- 25°
Coarse pitch setting:- 50° - 30'
Fine " " 25° - 30'
Blade material:- Hydulignum.

/TABLE II.

TABLE II
PERFORMANCE ON CLIMB
RADIATOR GILLS FULLY OPEN

Standard Height in feet	Time from start. mins.	Rate of climb. Ft/min.	T.A.S. m.p.h.	A.S.I. m.p.h.	Correction m.p.h. P.E.	Correction m.p.h. C.E.	R.P.M.	Boost ins. of Hg.
Sea level	0	-	-	-	-	-		
2,000	1.65	1240	167	160	+2.5	0	2600	36.6
4,000	3.25	1260	172½			-.1		
6,000	4.80	1280	177½			-.2		
8,000	6.35	1300	183			-.3		
10,000	7.90	1320	188½			-.4		
12,000*	9.35	1350	195			-.5		
14,000	10.95	1200	193	154	+1.9	-.6		33.5
16,000	12.75	1040	190½	148	+1.2	-.6		30.9
18,000	14.80	900	188	142	+.6	-.6		28.6
20,000	17.25	750	185½	136	0	-.6		26.5
22,000	20.20	600	182	130	-.7	-.6		24.6
24,000	24.10	440	178½	124	-1.5	-.6		22.7
26,000	29.55	300	175	118	-2.3	-.6		21.0
27,000	33.40	220	172½	115	-3.0	-.6		20.1

* Full throttle height. Greatest height reached = 27,000 ft.
Estimated Service ceiling = 28,600 feet.

TABLE III
LEVEL SPEED PERFORMANCE
RADIATOR GILLS IN NEUTRAL POSITION

Standard Height Feet.	T.A.S. M.P.H.	A.S.I. M.P.H.	Correction m.p.h. P.E.	Correction m.p.h. C.E.	R.P.M.	Boost Ins. of Hg.
8,000	309	266	+9.5	-1.3	3000	41.7
10,000	316	264½	+9.5	-2.2		
12,000	323½	261	+9.4	-2.1		
14,000 *	331	260	+9.3	-2.4		
16,000	328	250	+8.9	-2.7		38.5
18,000	322	237½	+8.4	-2.7		35.3

* Full throttle height.

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KITTYHAWK.I AK 751

FIG.1

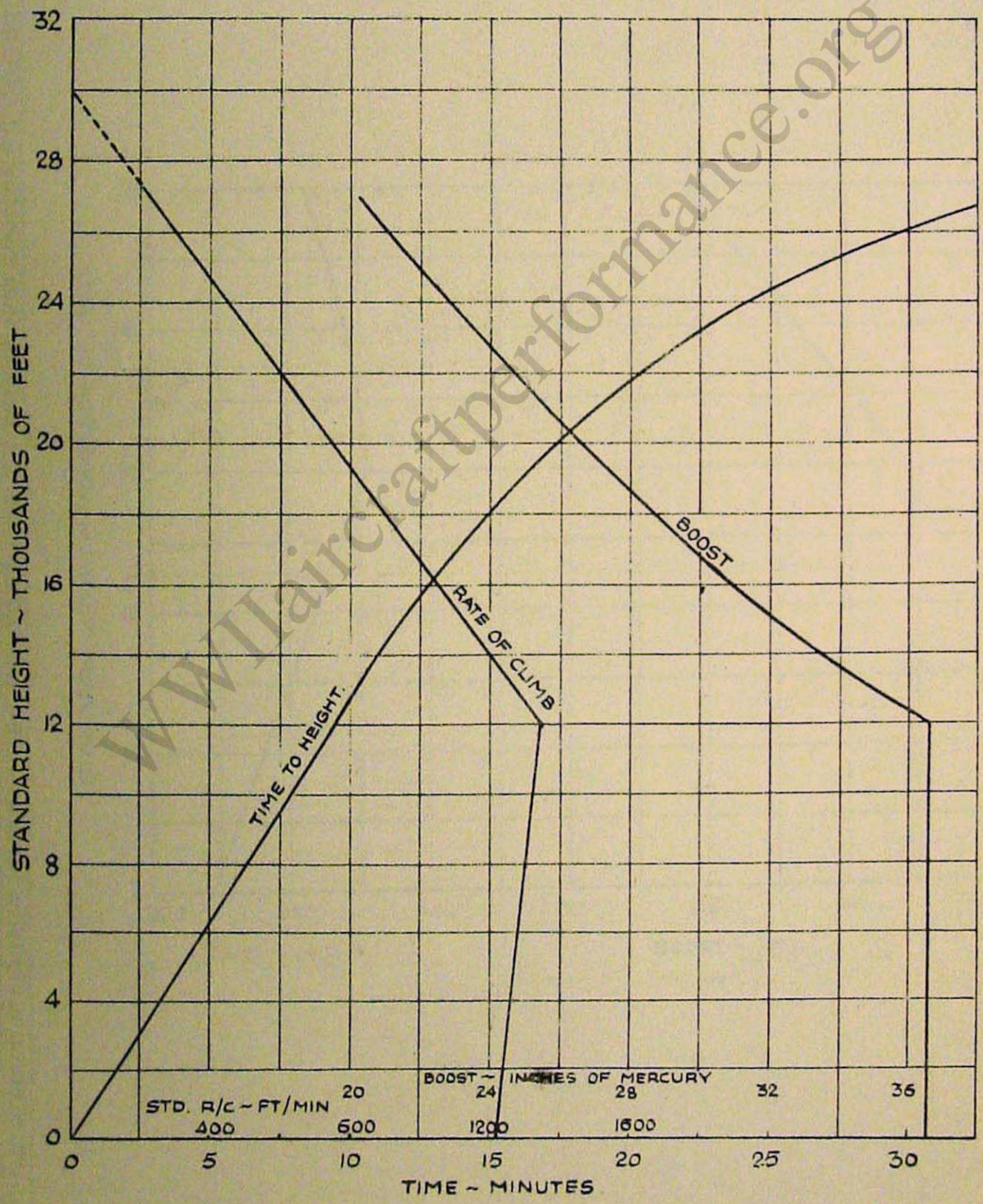
ALLISON V 1710 F-3-R

RATE OF CLIMB, TIME TO HEIGHT, AND BOOST.

HYDULIGNUM PROPELLER FITTED

TAKE OFF WEIGHT ~ 8420 LB

RADIATOR EXIT DUCT GILLS OPEN



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KITTYHAWK I AK 751. FIG.2.

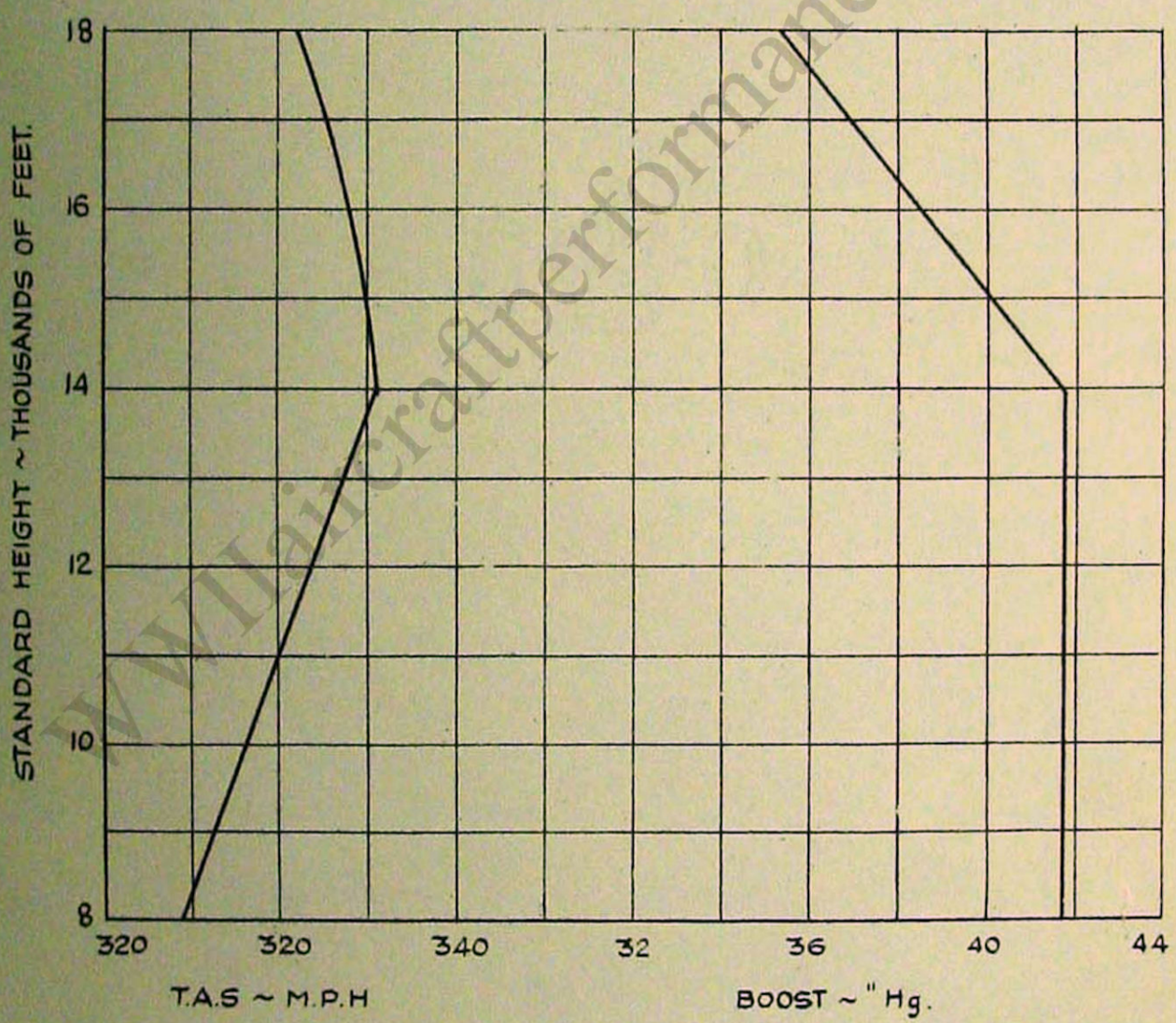
ALLISON V 1710 - F - 3 - R

LEVEL SPEEDS AND BOOSTS AT HEIGHTS

WEIGHT ~ 8420 LB.

HYDULIGNUM PROPELLER FITTED

RADIATOR EXIT DUCT. GILLS IN NEUTRAL POSITION.



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