2nd Part of Report No. A.& A.E.E./785,a.

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

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 Ministry of Aircraft Production.

Seafire IIc. M.A.970
(Merlin 46)

Climb and level speed performance with and without a 30 gallon external fuel tank fitted.

A.& A.E.E.ref:- 4493/64 - A.S.77/2.
M.A.P.ref:- Res.Air.2321/D.D./R.D.N.
Period of tests:- October, 1942.

Progress of issue of report

Report No.	Title
1st Part of A.& A.E.E./785,a.	M.A.970 - Weights and loading data.

Summary

Performance on the climb and in level flight has been measured on this aeroplane with and without a 30 gallon under-fuselage fuel tank of the type that can be dropped when empty. A 4-blade Rotol propeller was fitted.

A summary of the results obtained follows:-

	Without 30 gal. tank.	With 30 gal. tank
Take-off weight - lb.	7145	7425
Max. rate of climb - ft/min.	2380 at 16,000 ft.	2200 at 16,000 ft.
Time to reach 10,000 ft.	4.25 mins.	4.6 mins.
" " " 20,000 "	8.55 "	9.35 "
" " " 30,000 "	15.65 "	17.5 "
Service ceiling @ 3000 r.p.m.	37,500 ft.	36,300 ft.
Estimated absolute ceiling @ 3000 r.p.m.	38,400 ft.	37,200 ft.
Max. true airspeed in m.p.h.	342 @ 20,700 ft.	332 @ 20,700 ft.

Partial climb tests gave a best climbing speed of 150 m.p.h. to 16,000 ft. reducing 2 m.p.h. per 1,000 ft. thereafter.

Engine r.p.m. was changed on the climb from 2850 to 3000 at 25,000 ft.

1. Introduction.

Performance on climb and in level flight were required on this aeroplane both with and without a 30 gallon fuel tank fitted beneath the fuselage. These tests were made with a temperate air intake and it was intended to make comparative trials with a tropical intake fitted; however, due to the aeroplane being required elsewhere urgently, the latter tests could not be made.

Preliminary results of the performance tests have been forwarded to M.A.P. by letter dated 30th October, 1942.

2. Condition of aeroplane relevant to tests made.

2.1. General. The following were fitted:-

A Merlin 46 engine.
A 4-blade, 10'9" diameter Rotol propeller, type XH54H/RN/5S(R5/4F5/4).
A temperate air intake with an ice guard.
Triple ejector exhausts with fishtails and heater tubes.
Universal wings with 4 x 20 mm. Hispano guns with their muzzles sealed and their ejector chutes open.
The 4 leading edge .303" gun ports sealed, and the ejector chutes open.
An arrestor hook and external catapult spools.
Two slinging lugs on either side of the fuselage just aft of the engine bulkhead.

/A

A rectangular rear view mirror above the bullet-proof windscreen.
A W/T aerial from the aerial mast to the top of the rudder.
I.F.F. aerials from the tail plane tips to the sides of the fuselage.
A V.H.F. aerial rod extending from the under surface of the starboard wing.

For the latter half of the tests a 30 gallon under-fuselage fuel tank which could be dropped in flight, was fitted on fixing attachments protruding from the undersurface of the fuselage.

2.2. Engine limitations. The limitations of the Merlin 46 engine obtaining at the time of test were:-

	R.P.M.	Boost lb/sq.in.	
Max. for take-off	3000	+12	
Max. for climb	2850	+9	Normal rating.
" " " above 25,000 ft.	3000	+9	Normal rating.
Max. for all-out level flight (5 min. limit)	3000	+9	

2.3. Loading. The aeroplane was flown at two loadings i.e. with and without the 30 gallon fuel tank. These were:-

	Take-off wt.	C.G.position
Without 30 gallon fuel tank	7145 lb.	7.5" aft of datum
With 30 gallon fuel tank full	7425 lb.	8.0" aft of datum

The design limits of the centre of gravity range are 5.0" and 8.2" aft of the datum point including the aft extension.

The centre of gravity positions quoted are with undercarriage down.

3. Scope of tests.

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

Performance on the climb with the radiator flap fully open at normal max. climb rating was measured both with and without the 30 gallon tank fitted. On the climbs the engine r.p.m. was increased from 2850 to 3000 at 25,000 ft.

Maximum level speeds were measured between 16,000 ft. and 26,000 ft. with the radiator flap in the minimum drag position, both with and without the 30 gallon tank fitted.

4. Results of tests.

4.1. The performance measurements were corrected to standard atmospheric conditions by the method given in A.& A.E.E. memorandum dated 27.8.42. The level speed measurements were corrected to 95% of the respective take-off weights. The position error correction was taken from the measurement made on Spitfire Vc. A.A.878 which was fitted with the same type of wing and armament, and had its pressure head at the same position and setting.

4.2. The results of the performance on climb and in level flight are given in detail in Tables I to IV and Figures 1 and 2; briefly they are:-

	Without 30 gal. tank.	With 30 gal. tank.
Max. rate of climb - ft/min.	2380 at 16,000 ft.	2200 at 16,000 ft.
Time to reach 10,000 ft.	4.25 mins.	4.6 mins.
" " " 20,000 "	8.55 "	9.35 "
" " " 30,000 "	15.65 "	17.5 "
Service ceiling @ 3000 r.p.m.	37,500 ft.	36,300 ft.
Estimated absolute ceiling @ 3000 r.p.m.	38,400 ft.	37,200 ft.
Max. true airspeed in m.p.h.	342 at 20,700 ft.	332 at 20,700 ft.

The results of the partial climb tests show that the best climbing speed is 150 m.p.h. A.S.I. up to 16,000 ft., reducing 2 m.p.h. per 1,000 ft. thereafter.

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5. Discussion of results.

It will be seen from the results that the effect of fitting the 30 gallon fuel tank lowers the maximum rate of climb by 180 ft/min., the service ceiling by 1,200 ft., and the maximum true air speed by 10 m.p.h.

The 24th Part of Report No. A.& A.E.E./692i dealt with similar tests of effect on performance of fitting a 90 gallon external tank to a Spitfire Vb. The changes in performance obtained now and on these previous tests are approximately in the expected proportion.

It is estimated from recent tests on a Spitfire Vc aeroplane, (results of which are about to be issued) that the fitting to a universal wing of 2 x 20 mm. Hispano guns and 4 x .303" machine guns instead of the 4 x 20 mm. Hispano guns as fitted in this case, would give an increase in speed of approximately 3 m.p.h. true air speed.

There is not sufficient evidence available to enable the reduction in performance due to fitting a tropical air intake with air cleaners to be estimated accurately.

The increase in performance obtainable by using combat rating (+16 lb/sq.in. boost; 3000 r.p.m.) on a Spitfire Vc is given in the 38th Part of Report No. A.& A.E.E./692i, and this increase will approximately apply equally to the Seafire.

TABLE I.

Performance on climb without 30 gallon fuel tank fitted.

Take-off Weight 7145 lb.
Radiator flap open.

R.P.M. changed at 25,000 ft.

Standard Height Feet	Time in Mins.	Rate of climb ft/min.	True air speed m.p.h.	A.S.I. m.p.h.	Corrections m.p.h.		R.P.M.	Boost lb/sq.in.
					P.E.	C.E.		
0	0	-	-	-	-	-	-	-
2000	0.85	2345	157	150	+2.2	0	2850	+9
4000	1.7	2350	161½			-.1		
6000	2.55	2355	166			-.2		
8000	3.4	2360	171½			-.3		
10000	4.25	2365	177			-.4		
12000	5.1	2370	182½			-.4		
14000	5.85	2375	188			-.5		
16000*	6.7	2380	194		↓	-.6		↓
18000	7.55	2160	195½	146	+2.5	-.7		+7.6
20000	8.55	1950	197½	142	+2.8	-.8		+6.2
22000	9.6	1730	198½	138	+3.2	-.9		+4.8
24000	10.85	1510	200	134	+3.6	-.9	↓	+3.5
26000	12.25	1410	202	130	+4.0	-1.0	3000	+3.3
28000	13.75	1180	204	126	+4.3	-1.0		+2.0
30000	15.65	960	205½	122	+4.7	-1.1		+0.8
32000	18.05	730	207	118	+5.0	-1.1		-0.5
33000	19.5	620	208	116	+5.3	-1.1		-1.1
34000	21.3	500	208½	114	+5.5	-1.2		-1.7
35000	23.55	390	209½	112	+5.7	-1.2		-2.2
36000	26.6	280	210	110	+5.9	-1.2	↓	-2.8

* Full throttle height.
Service ceiling = 37,500 ft.
Estimated absolute ceiling = 38,400 ft.

TABLE II

Performance on climb with 30 gallon fuel tank fitted.

Take-off Weight 7425 lb.
Radiator flap open.

R.P.M. changed at 25,000 ft.

Standard Height Feet	Time in Mins	Rate of climb ft/min.	True air speed m.p.h.	A.S.I. m.p.h	Corrections m.p.h. P.E.	Corrections m.p.h. C.E.	R.P.M.	Boost lb/sq.in.
0	0	-	-	-	-	-	-	-
2000	.9	2165	157	150	+2.2	0	2850	+9
4000	1.85	2170	161½			-.1		
6000	2.75	2175	166			-.2		
8000	3.7	2180	171½			-.3		
10000	4.6	2185	177			-.4		
12000	5.5	2190	182½			-.4		
14000	6.45	2195	188			-.5		
16000*	7.35	2200	194			-.6		
18000	8.3	1990	195½	146	+2.5	-.7		+7.6
20000	9.35	1780	197½	142	+2.8	-.8		+6.2
22000	10.55	1570	198½	138	+3.2	-.9		+4.8
24000	11.95	1360	200	134	+3.6	-.9		+3.5
26000	13.5	1250	202	130	+4.0	-1.0	3000	+3.3
28000	15.3	1020	204	126	+4.3	-1.0		+2.0
30000	17.5	800	205½	122	+4.7	-1.1		+0.8
32000	20.45	570	207	118	+5.0	-1.1		-0.5
33000	22.35	460	208	116	+5.3	-1.1		-1.1
34000	24.85	350	208½	114	+5.5	-1.2		-1.7
35000	28.3	240	209½	112	+5.7	-1.2		-2.2
36000	33.75	130	210	110	+5.9	-1.2		-2.8

* Full throttle height.
Service ceiling = 36,300 ft.
Estimated absolute ceiling = 37,200 ft.

TABLE III

Level speeds without 30 gallon fuel tank fitted.

Results corrected to 95% of the take-off weight i.e. 6780 lb.
Radiator flap in minimum drag position.

Standard Height Feet	True air speed m.p.h.	A.S.I. m.p.h.	Corrections m.p.h. P.E.	Corrections m.p.h. C.E.	R.P.M.	Boost lb/sq.in.
16,000	321½	260½	-6.7	-2.8	3000	+9.0
18,000	330½	259½	-6.7	-3.4		+9.0
20,000	339	258	-6.6	-3.9		+9.0
20,700*	342	257½	-6.5	-4.1		+7.8
22,000	340	250	-6.0	-4.1		+6.0
24,000	336	238½	-5.3	-4.1		+4.4
26,000	331	226½	-4.2	-4.1		

* Full throttle height.

/Table IV

TABLE IV.

Level speeds with 30 gallon fuel tank fitted.

Results corrected to 95% of the take-off weight i.e. 7050 lb.
Radiator flap in minimum drag position.

Standard Height Feet	True air speed m.p.h.	A.S.I. m.p.h.	Corrections m.p.h.		R.P.M.	Boost lb/sq.in.
			P.E.	C.E.		
16,000	311½	252	-6.1	-2.7	3000	+9.0
18,000	320½	251	-6.1	-3.1	↓	+9.0
20,000	329	249½	-6.0	-3.6		+9.0
20,700*	332	249	-5.9	-3.7		+9.0
22,000	330½	242	-5.4	-3.8		+7.8
24,000	327	231½	-4.7	-3.8		+6.0
26,000	321½	219	-3.7	-3.8		+4.4

* Full throttle height.

CIRCULATION LIST.

C.R.D.
D.C.R.D.
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D.T.D.
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SEAFIRE IIc MA 970

FIG.1.

(MERLIN 46)

RATE OF CLIMB, TIME TO HEIGHT AND BOOST

——— WITHOUT 30 GALLON FUEL TANK TAKE OFF WEIGHT = 7145 LB

- - - - - - WITH " " " " " " " = 7425 LB

RADIATOR FLAP OPEN

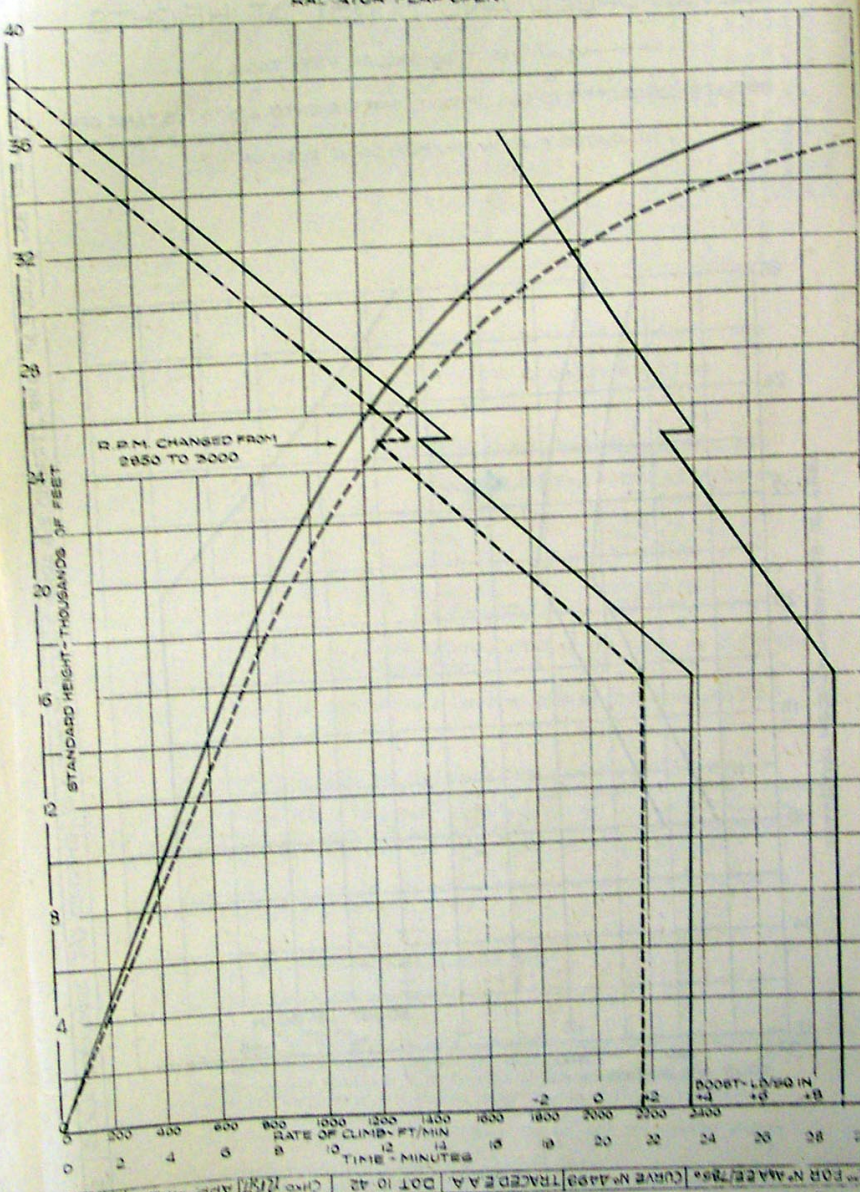


FIG.2 SEAFIRE IIc M.A 970

(MERLIN 46)

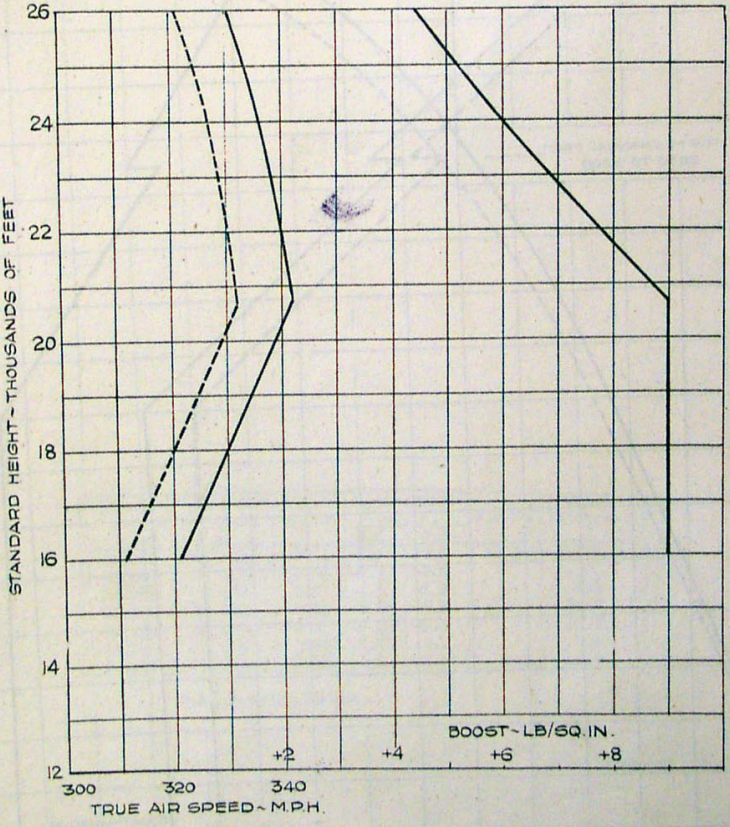
LEVEL SPEED AND BOOST AT HEIGHTS

——— WITHOUT 30 GALLON FUEL TANK

– – – – – – WITH " " " "

RESULTS CORRECTED TO 95% OF TAKE OFF WEIGHTS i.e. (6780 LB. TANK OFF / 7050 LB TANK ON)

RADIATOR FLAP IN MINIMUM DRAG POSITION



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