3rd Part of Report No. A & A.E.E./767,j

AIRCRAFT AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

Mosquito PR Mk XVI DZ 540
(2 Merlin 73s)

Performance, brief handling and pressure cabin tests

A. & A.E.E. ref:- CTO/AM/01/25.
M.A.P. ref:- SB 34318/RDL 1(b)/HD
Period of tests:- 6th September - 1st October 1943.

Progress of issue of report

Report No.	Title
1st Part of A & AEE/767,j	DZ 540 - Weights and loading data.
2nd -do-	DZ 540 - Carbon monoxide contamination tests.

Summary

Brief handling and performance trials and tests of the pressure cabin installation have been made on this aircraft, which is the prototype Mosquito PR Mk XVI. The tests were done at the maximum permissible weight of 22340 lb. The principal results are as follow:-

Climb. Maximum rate of climb in MS gear (2850 RPM, +12 lb/in² boost)
= 1,960 ft/min at 14000 ft.
" " " " " FS " (2850 RPM, + 12 lb/in² boost)
= 1,150 ft/min up to 26100 ft.
Service ceiling (FS gear, 3000 RPM) = 36000 ft.
Absolute " (" " " ") = 36700 ft.

Maximum all-out level speed in MS gear (3000 RPM, +18 lb/in² boost)
= 385 mph at 13000 ft.
" " " " " " FS " (3000 RPM, +18 lb/in² boost)
= 401 mph at 25200 ft.

Maximum cruising speeds. MS gear (2650 RPM +7 lb/in² boost)
= 352 mph at 18800 ft.
FS gear (2650 RPM, +7 lb/in² boost)
= 366 mph at 30,600 ft.

These results agree with those of Mosquito (B) Mk IX LR 495, (4th Part of Report No. A & A.E.E./767h) after making due allowances for difference in weight, external equipment, and engine full throttle heights etc.

The pressure cabin functioned satisfactorily and no misting occurred on the double layer portions of the cockpit canopy and nose. The single layer transparent material became frosted internally at high altitude, but this was easily removeable by using the jet of warm air from the flexible supply tube.

Handling qualities are satisfactory at the maximum permissible loading, though care must be taken in recovery from out of trim dives as high accelerations are easily reached.

The stalling speeds are:-
Flaps and undercarriage up. 132 mph I.A.S.
" " " down. 118 mph I.A.S.

1. Introduction.

1.1. This aircraft is the prototype PR Mk XVI version of the Mosquito, which is essentially the same as the Mk IX with the exception of the pressure cabin. This report gives the results of brief handling and performance trials and tests of the functioning of the pressure cabin. The provisional performance results were forwarded to RDL 1(b) (MAP) in a letter of 1st October 1943.

2. Condition of aircraft relevant to tests.

2.1. External details. ~~(See photographs)~~

2.11. The aircraft is equipped for photographic reconnaissance duties with two camera "eyes" in the bomb doors and three more in the underside of the fuselage.

Other features are two faired 50 gallon fuel tanks, one under each wing, an aerial mast and W/T aerial but no IFF aerials, trailing aerial fairlead, fuel cooler radiator and small cabin ventilator intake. The air intakes are fitted with iceguards, and multi-stub ejector exhaust manifolds are used. Improved rearward view is obtained by having bulged sides to the cockpit canopy.

2.12. The pressure head is in the usual position for Mosquito aircraft, i.e. near the top of the fin. Two RAE plate type static vents are fitted, one on each side of the nose and these are interconnected to form the static of the airspeed system. Details of the pressure head and static vents are given in figures 1 and 2 respectively.

2.2. Internal details. (see figure 3) The layout of the pressure cabin is similar to that of Mosquito XV MP 469, which was described in the 1st Part of report No. A. & A.E.E./767g. The following are the details which differ from the above installation:-

(i) There is no forward bulkhead, the cabin being extended to include the bomb-aimer's compartment in the nose.

(ii) The cabin pressure supply enters through two fish-tailed tubes, one of which is fixed, and the other flexible, so that a stream of warm air may be directed to any part of the cockpit canopy which becomes misted or frosted internally.

(iii) The cabin pressure and heating control lever moves transversely in the cockpit instead of longitudinally.

(iv) The emergency pressure release control is situated behind the pilot.

(v) The double layer windows which include the bomb-aimer's elliptical panel in the nose, are kept dry by connection to a single large reservoir of silica gel situated in the nose. The direct vision panels are of single thickness material.

For test purposes a Kollsman altimeter was used to obtain cabin "altitude".

2.3. Engine details, limitations etc.

2.31. Engines.

Merlin 73
Port No. 160249/A446935.
Starboard No. 160253/A446937.

The limitations are as follows:-

	RPM	Boost lb/in^2	Coolant °C	Oil °C
Take-off (5 mins)	3000	+12	135	105
Climb normal (1 hour)	2850	+12	125	90
Climb combat (5 mins)	3000	+18	135	105
All-out level	3000	+18	135	105
Cruise	2650	+7	105	90
Dive	3150	+18	-	-

/2.32

2.32. Propellers.

Type. De.H. hydromatic, Type A5/147; 3 blades 12 ft diameter.
Rotation right hand.
Serial Nos. Port NK 22099
Starboard NK 23111

2.4. Loading. The aircraft was flown at the maximum permissible weight of 22340 lb, with the C. of G. at 16.1 ins. aft of datum. This corresponds to photographic reconnaissance loading with overload tanks in the bomb bay and external wing tanks, making the total fuel capacity 760 gallons. Some of the tests were made with bombs in place of the overload tanks, so that jettisonning, to lighten the aircraft for emergency landing was possible. This did not alter the loading appreciably.

3. Scope of tests.

3.1. Climbs were done at best climbing speed based on partial climbs of Mosquitoes Mk VIII and IX. The RPM was increased from 2850 to 3000 at 30,000 ft, and the supercharger gear changed automatically at 21000 ft.

3.2. The position error correction was measured by the aneroid method in level flight with flaps and undercarriage up.

3.3. Level speeds were measured from 2000 ft to ceiling at all-out level and cruising power conditions.

3.4. The functioning of the pressure cabin was tested during the performance climbs, and in level flight at 32000 ft, the former to check the efficiency of the Westland valve, and the latter to determine the variation of cabin pressure with engine revolutions.

3.5. A brief check of stability and general handling was made.

4. Results of position error performance test.

4.1. Position error (Fig. 4). The P.E.C. varies linearly from +2 mph at 340 mph ASI to -1.4 mph at 120 mph ASI, its value being zero at 210 mph. The value of the P.E.C. is smaller and more nearly constant than that obtained on other Mosquito aircraft and the experimental scatter was much less than usual. This aircraft is the first Mosquito to be fitted with twin static vents, and this, together with the use of RAE type vent plates, may be a contributory factor to the improvement.

4.2. Performance. These results are reduced by the methods given in report No. A. & A.E.E./Res/170. The compressibility correction is based on the methods given in addendum to report No. A & A.E.E./Res/147.

4.21. Climb. Figure 6 gives curves of rate of climb, time to height and boost. Details are given in Table I.

4.22. Level speeds. Figure 7 gives curves of all-out & cruising speeds & boost. Details are given in Tables II & III.

Propeller tip Mach Nos at all out level conditions exceed 0.9 over most of the height range. The values are:-

	Mach Number (based on standard conditions).	Actual air temp on test.
MS gear, 13000 ft	0.91	-7°C to -15°C
FS gear, 25200 ft	0.97	-31°C to -43°C
FS gear, 36000 ft	0.98	-54°C

No opportunity arose for testing the effect of these high tip-speeds on level speed but it is proposed to investigate it on Mosquito Mk IX LR 495 which gives similar results.

4.23. In climbing and all-out level flight the supercharger gear is

/changed

changed automatically but at too high an altitude for optimum performance. best heights are 19500 ft on the climb and 18500 ft for all-out level flight. However, if it is desired to reach a compromise with the best change-over height for cruising conditions 21000 ft is fairly reasonable.

5. Results of functioning test of pressure cabin. (Fig 8).

5.1. Climb. There was about 0.4 lb/sq.in. back pressure in the cabin up to 16000 ft, when the Westland valve began operating. From this height the pressure increased roughly linearly, becoming 2 lb/sq.in. at 30,700 ft; it increased to a maximum of 2.14 lb/in^2 at 34000 ft, above which height the pressure fell off slightly.

5.2. High altitude level. At 32000 ft, the nominal figure of 2 lb/in^2 cabin pressure is held at all engine RPM above 2300 . The pressure increases from 2.0 lb/in^2 at 2300 RPM to 2.05 lb/in^2 at 3000 RPM. The cabin pressure at 2100 RPM falls to 1.97 lb/in^2 but the aircraft cannot maintain height at maximum power at this RPM.

During these levels the cabin height varied by 100 to 300 ft. due to slight cabin supercharger surge which increased with RPM.

5.3. Misting. No internal misting was encountered but some frosting occurred. This was on the single thickness portions of the cockpit canopy and nose and was present above about 23000 ft on most occasions (maximum air temperature - 25°C). The double layer transparent panels in the cabin, namely the windscreen, bulged side windows, upper front panels of the canopy, and the elliptical nose window remained completely clear on all occasions with the exception that this particular sandwich windscreen has become opaque at the edges. At 26000 ft (outside air temperature - 37°C), the utility of the flexible air supply pipe was tried. Light frost which formed on the roof of the cockpit was immediately cleared by application of the air jet.

5.4. General. The cabin was comfortably warm at high altitude with the control lever at cold air, as the air supply was quite warm; using "hot air" the temperature did not rise excessively at 34000 ft. During taxying and at low altitude the cabin was uncomfortably warm, even with "cold air", unless the air was spilled and the ventilator used. Noise from the cabin supercharger and piping generally was not considered excessive, but it was found that the whine was scarcely audible if the fixed air supply opening, behind the pilot, was covered with the hand.

6. Results of handling test.

6.1. Take-off.

A slight swing to port may be corrected by use of rudder alone if the throttles are opened carefully. Use of 15° of flap makes little difference to the swing.

6.2. Climb. At the best climbing speed, 170 mph, I.A.S., the aircraft is neutrally stable, phugoids of constant amplitude (about ± 10 mph) being executed on displacing the aircraft ±10 mph from the trimmed state.

6.3. Level flight. The aircraft is longitudinally unstable at maximum power conditions, tending to stall after two or three divergent phugoids when the aircraft is displaced ± 10 mph from the trimmed state.

In cruising flight the aircraft is just unstable longitudinally, tending to stall after three or four divergent phugoids, when displaced ±10 mph from the trimmed speed.

6.4. Tight turns. Tight turns may be made in either direction at speeds down to 200 mph I.A.S. with no tendency to tighten. A light pull force only is necessary on the control column to maintain the turn.

/ 6.5.

6.5. Dive.

6.51. At full throttle. The aircraft was trimmed at 21000 ft for 3000 RPM, +18 lb/in² boost, 281 mph I.A.S., the trimmer being at ¾ division nose down. The push force in the dive was light up to 330 mph after which it increased to a maximum at 380 mph when it was considered moderately heavy; this decreased slightly on continuing the dive to the limiting speed of 433 mph. Recovery is initiated by partly relaxing the control column load but a very heavy push force is required almost immediately afterwards in order to restrict the normal acceleration to less than about 4g.

6.52. At 1/3 throttle opening. With the same trimmer setting as for the full throttle dive, a light push force was required up to 400 mph I.A.S. above which speed it was increased slightly to reach 433 mph. During recovery less push force was required than - in the full throttle dive. There was no buffeting during these dives, both of which were done between 21000 and 8000 ft in calm atmospheric conditions. The aircraft was yawed in the dive by application of rudder. On release of the rudder the normal diving position was resumed immediately.

6.6. Glide. The aircraft remains in the trimmed state (1 division nose heavy) at 160 mph IAS with the flaps and undercarriage up, and at 135 mph, all down. On displacing the speed ±10 mph from the trimmed state the aircraft executes stable phugoids.

6.7. Baulked landing. When trimmed 1 division nose heavy in the glide at 135 mph I.A.S. with flaps and undercarriage down, a very heavy push force is required to overcome tail heaviness on opening the throttles to about +6 lb/in² boost, 3000 rpm. With the trimmer fully forward, the push force required is moderate. Retraction of the undercarriage causes a further tail heavy moment but retraction of flaps gives the opposite effect.

6.8. Stalls.

6.81. Flaps and undercarriage up, radiator flaps closed.

Stalling speed:- 132 mph I.A.S.

The stall is very indefinite, warning being given at about 138 mph by slight elevator buffeting and a longitudinal pitching motion. The nose drops very gently at 132 mph and there is no tendency for either wing to drop. Recovery is easy.

6.82. Flaps and undercarriage down, radiator flaps open.

Stalling speed:- 118 mph I.A.S.

Tail buffeting and pitching occurs at 122 mph and at the stall the nose drops rather more sharply than in the "all up" case but neither wing tends to drop.

In both of these stalls the position of the control column is 1/3 back from neutral and the force is considered light. In either the all up or all down case the starboard wing drops if the control column is pulled right back.

6.9. General. This particular aircraft is left wing low during retraction of the undercarriage, due presumably to unequal speed of retraction of the two legs.

The controls are not considered heavier than on other Mosquito aircraft without pressure cabins, in fact the ailerons are lighter than average.

7. Discussion of results.

7.1. The performance of this aircraft on the climb is about the same as that of Mosquito B Mk IX LR 495, when a correction is applied for difference in weight. (see 4th Part of report No. A & A.E.E./767h).

/6.2.

7.2. The all-out level speed performance is about 9 mph lower in MS gear and 4 mph in FS gear than that of LR 495 (loco.cit.), but the full throttle heights of the engines on the latter aircraft are 800 and 500 feet higher in MS and FS gear respectively. Including this, an allowance of 1 mph of the 2% difference in weights, and 6 mph for the loss due to the external fuel tanks (estimated for the results on Mosquito FB Mk VI HJ 679, 7th Part of Report A & A.E.E./767,e), the speeds of DZ 540 and LR 495 agree to within about 2-3 mph.

8. Conclusions.

8.1. The performance of this aircraft is about the same as that of Mosquito B Mk IX LR 495, when due allowance is made for small differences between the two aircraft.

8.2. The pressure cabin functions satisfactorily in all conditions of flight. Internal misting is confined to the single layer portions of the transparent parts of the cabin; the double layer portions remain clear up to 35000 feet.

8.3. The handling qualities are satisfactory and the controls are free at all heights.

Care must be taken in recovery from out-of-trim dives as a large push force is required to prevent excessive normal acceleration.

TABLE I

CLIMB

Weight 22,340 lb

Radiator flaps fully open.

Height ft.	Rate of Climb ft/min.	Time to height mins	ASI mph	Mean Boost lb/in^2	RPM	S/C Gear	Cabin "Height"ft.
0	1910	0	170	+12.0	2850	MS	-
4000	1925	2.05					3100
8000	1940	4.10					7000
12000	1955	6.15					10900
*14000	1960	7.20		↓			12800
16000	1650	8.35		+10.2			14800
18000	1350	9.70		+8.4			16200
20000	1050	11.35		+ 6.5		↓	17400
21000	910/1150	12.30		+5.6/+12.0		FS	17900
24000	1150	15.00		+12.0			19200
*26100	1150	16.80	↓	+12.0			20200
28000	930	18.65	166	+10.4	↓		20900
30000	700/930	21.05	163	+8.7/+10.3	3000		21700
31000	800	22.15	162	+ 9.4			22000
32000	660	23.55	161	+ 8.4			22500
33000	540	25.20	160	+ 7.5			23000
34000	390	27.25	159	+ 6.5			23600
35000	250	30.40	158	+ 5.6			24500
36000	100	36.00	157	+ 4.8	↓	↓	-

* Full throttle heights.
Estimated absolute ceiling 36700 feet
Greatest height reached 35000 feet

/Table II

TABLE II

ALL-OUT LEVEL SPEEDS

Corrected to 21250 lb = 95% take-off weight.

Radiator flaps shut

Height FT	T.A.S. mph.	I.A.S. mph.	Corrections P.E.mph	Corrections C.E.mph	Mean Boost lb/in^2	RPM	S/C Gear
2000	342	331	+2	-¾	+18.0	3000	MS
4000	350	329	+2	-1½			
6000	358	328	+1¾	-2			
8000	366	325	+1½	-2½			
10000	374	323	+1¼	-3¼			
*13000	385	318	+1¼	-4¼			
14000	384	313	+1¼	-4¾	+16.8		
16000	382	302	+1¼	-5	+14.4		
18000	380	291	+1¼	-5¼	+12.2		
20000	378	280	+1	-5¼	+10.2		
21000	377	275	+1	-5¼	+9.1		
21000	388	283	+1	-5¼	+18.0		FS
24000	397	276	+1	-6½			
*25200	401	273	+1	-6¾			
26000	398	268	+¾	-6¾	+16.8		
28000	391	254	+¾	-6½	+14.2		
30000	384	240	+½	-6½	+11.8		
32000	377	228	+¼	-6	+9.8		
34000	369	215	0	-5¾	+7.6		
36000	360	202	-¼	-5¼	+5.9		

* Full throttle heights.

TABLE III

CRUISING SPEEDS.

Corrected to 21250 lb = 95% take-off weight.

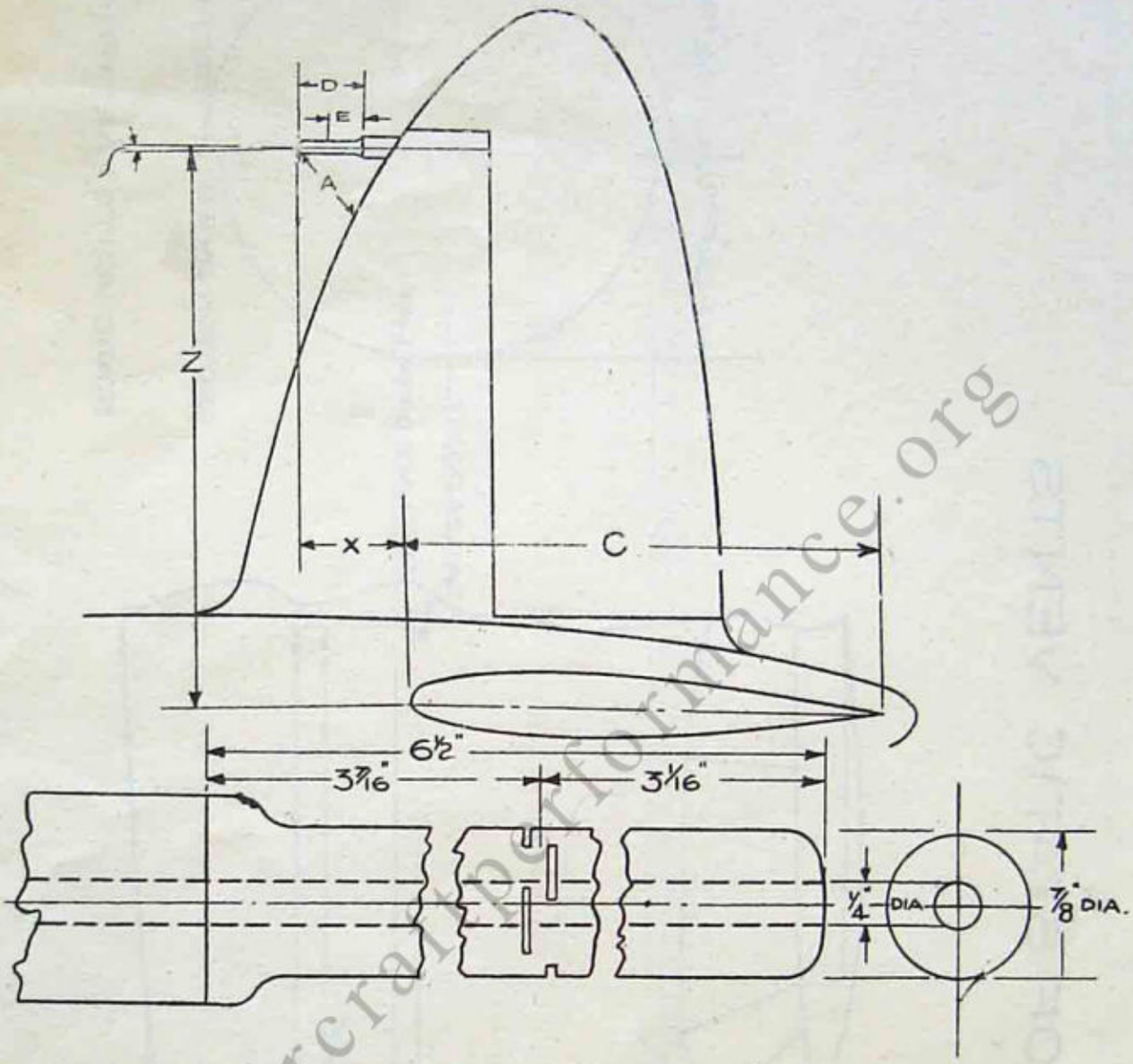
Radiator Flaps Shut

Height Ft	T.A.S. mph.	I.A.S. mph.	Corrections P.E.mph	Corrections C.E.mph	Mean Boost lb/in^2	RPM	S/C Gear
4000	292	275	+1	-1	+7	2650	MS
8000	308	274	+1	-1½			
12000	324	271	+1	-2¼			
16000	340	268	+1	-3¼			
*18800	352	265	+1	-4			
21000	349	254	+½	-4½	4.8		
21000	336	244	+½	-3½	+7		FS
24000	345	239	+½	-4			
28000	358	232	+½	-5			
*30600	366	227	0	-5½			
32000	360	217	0	-5	5.8		
36000	343	192	-½	-4½	2.7		

* Full throttle heights.

FIG 1

PRESSURE HEAD POSITION

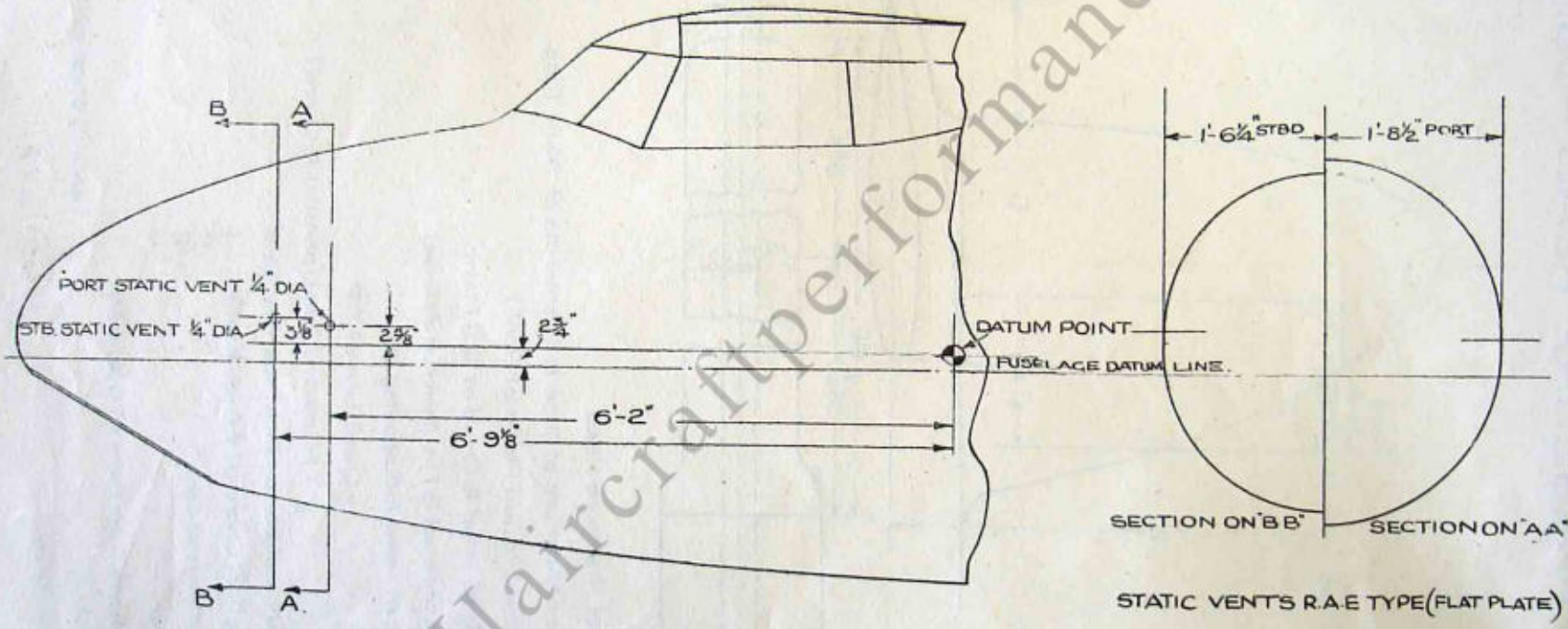


	Type of Pressure Head.	NOT STATED.
	Ratio of Aperture of Tube to External dia of Static Tube.	28·6%
	Incidence of Tail Plane (at Root)	+0°-20'
a	Angle of Head to Chord of Tail Plane.	+0°-30'
A	Nose of Head to Fin. (minimum distance)	9¾"
D	Nose of Head to Supporting Strut.	6½"
Z	" " " " Chord Line of T.P.	6'-1½"
X	" " " " T.P. Leading Edge (parallel to Chord)	1'-4"
E	Distance of Static Vents (mean) to Strut.	3 7/16"
C	Length of Chord of T.P (at Root)	5'-6
M	Major Axis of Strut	1⅜ dia.
N	Minor " " "	1⅜ dia
	Distance from Plane of Symmetry	NIL
	Position.	LEADING EDGE OF FIN ON ℄ A/C
	Semi-Span.	10'-5"

PART No A&AEE/7679 | MOSQUITO P.R. MK XVI DZ 540 | SKETCH No 2687 | DWN. - F. H. | TCD - [illegible] | DATE - 3-9-43 | CKD - [illegible] APPROVED

LOCATION OF STATIC VENTS

FIG 2

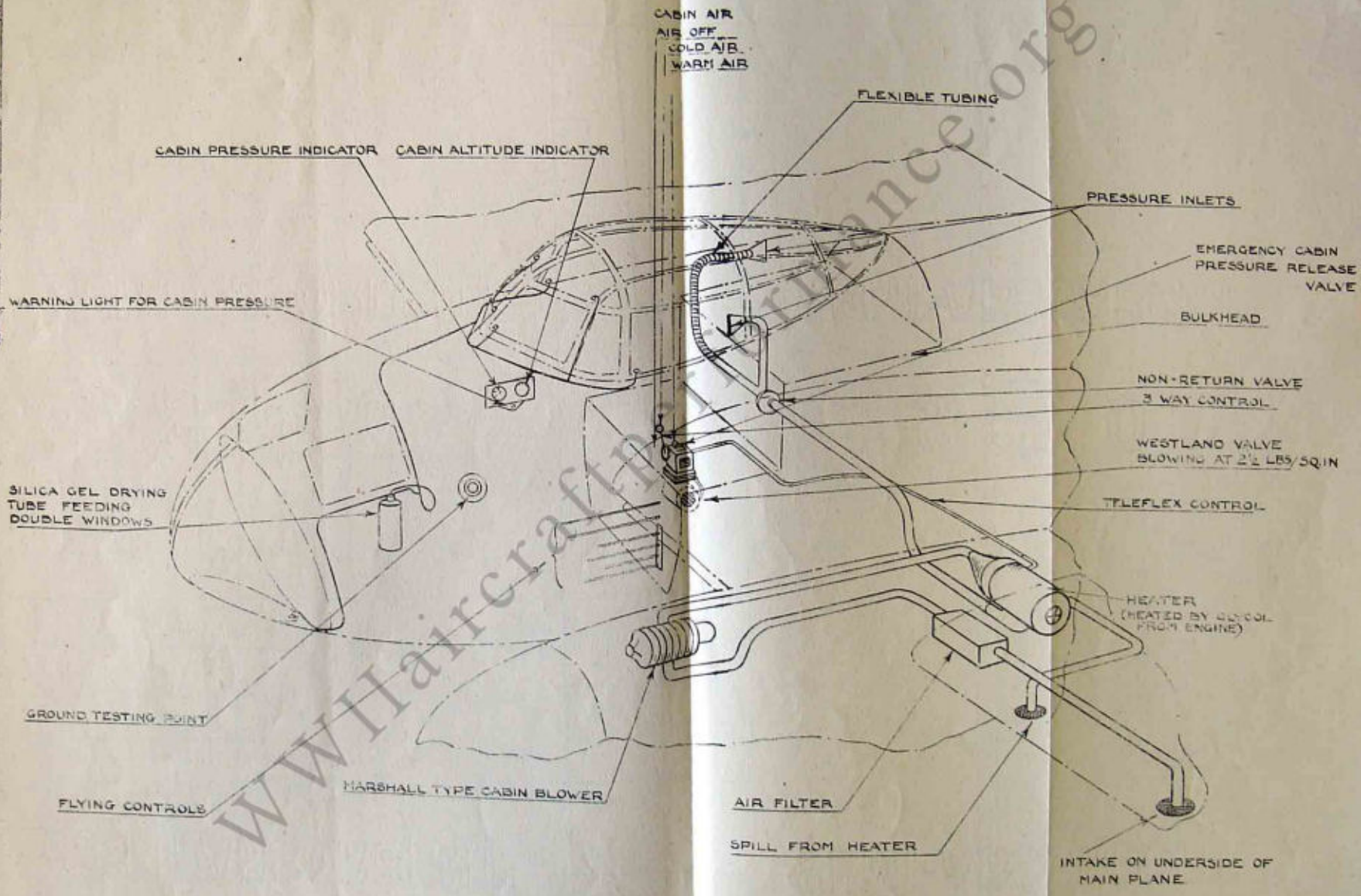


STATIC VENTS R.A.E TYPE (FLAT PLATE)

FIG 3

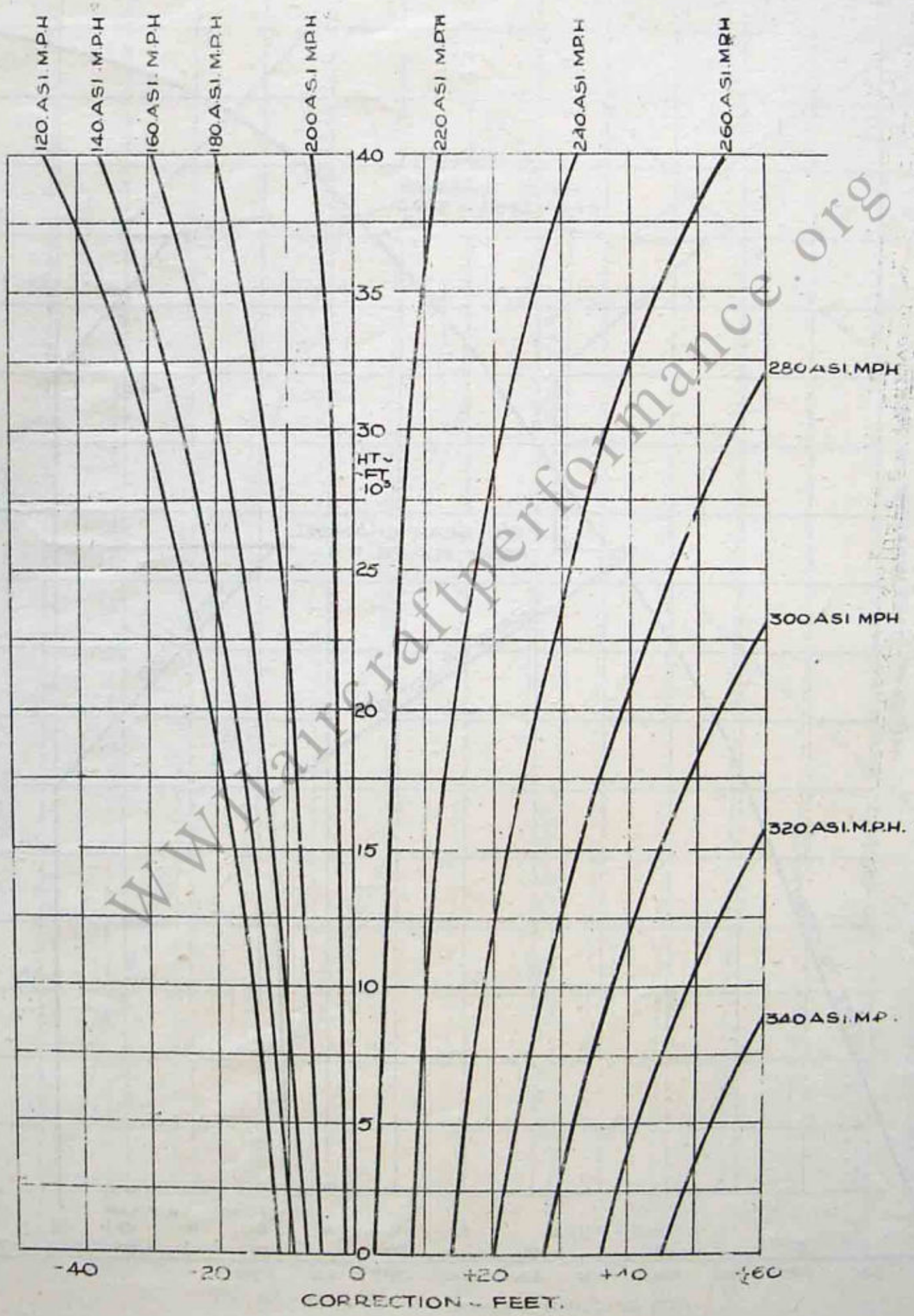
G.A. OF PRESSURE CABIN.

Fig. 3



CORRECTION TO ALTIMETER WHEN CONNECTED TO STATIC VENTS.

MEAN WEIGHT ~ 21,600 lb.



PART OF REPORT No. A&AEE/767 | MOSQUITO. P.R. MK XVI. DZ. 540 | CURVE No. 5809 | TRACED ~ [illegible] | DATE ~ 6-11-43 | CKD ~ ASH. | APPROVED ~ [illegible] | 19

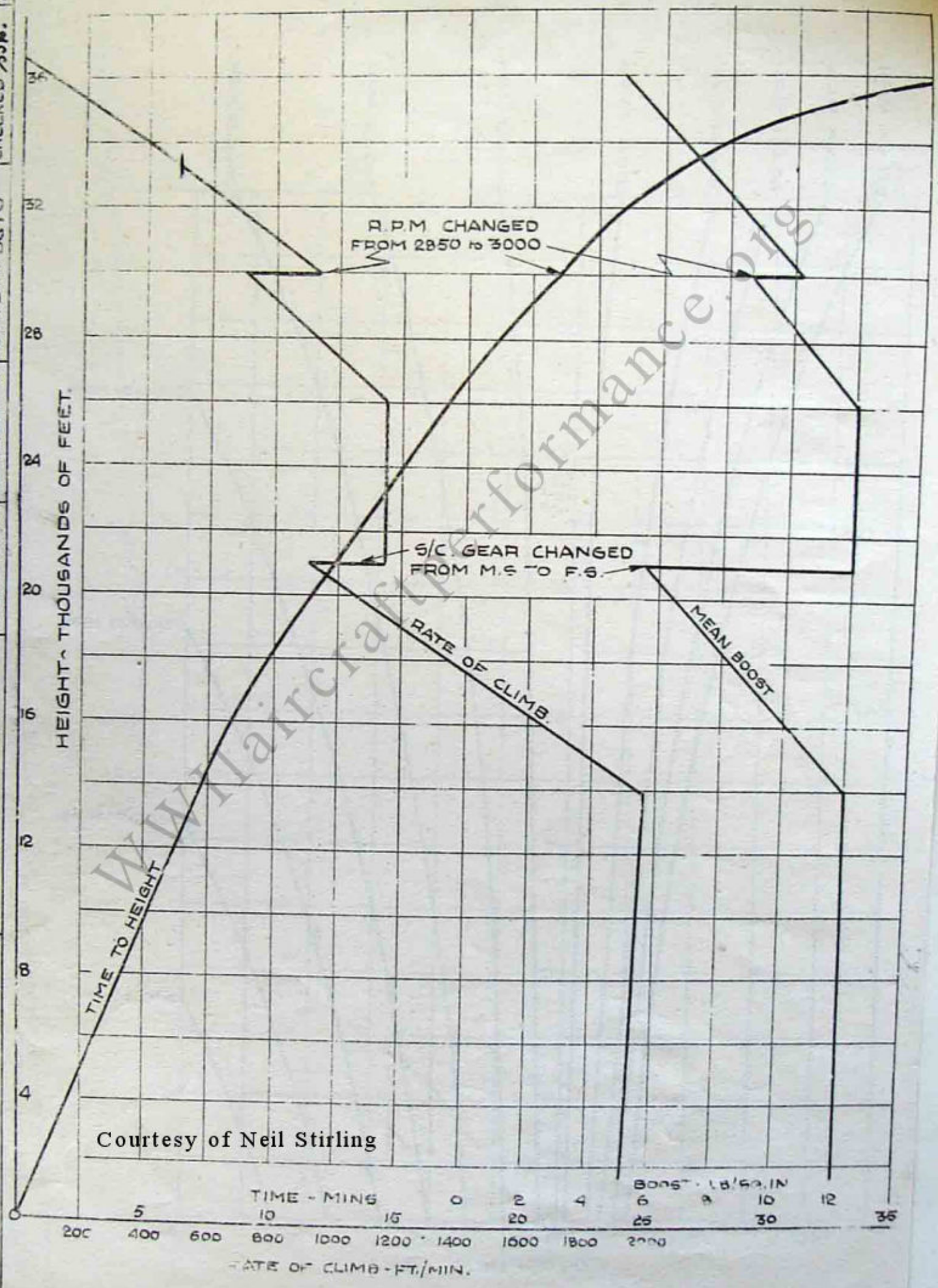
PERFORMANCE ON CLIMB

TAKE OFF WEIGHT - 22,340 LB.

RADIATOR FLAPS FULLY OPEN.

CORRECTED FOR TWO

3rd PART OF REPORT No. A&A.E.E/767j	MOSQUITO P.R. Mk XVI DZ 540	TRACED. A.A	DATE. 6-11-43	CURVE No. SB 10	CHECKED ASH.	APPROVED. M.G.	D.O.



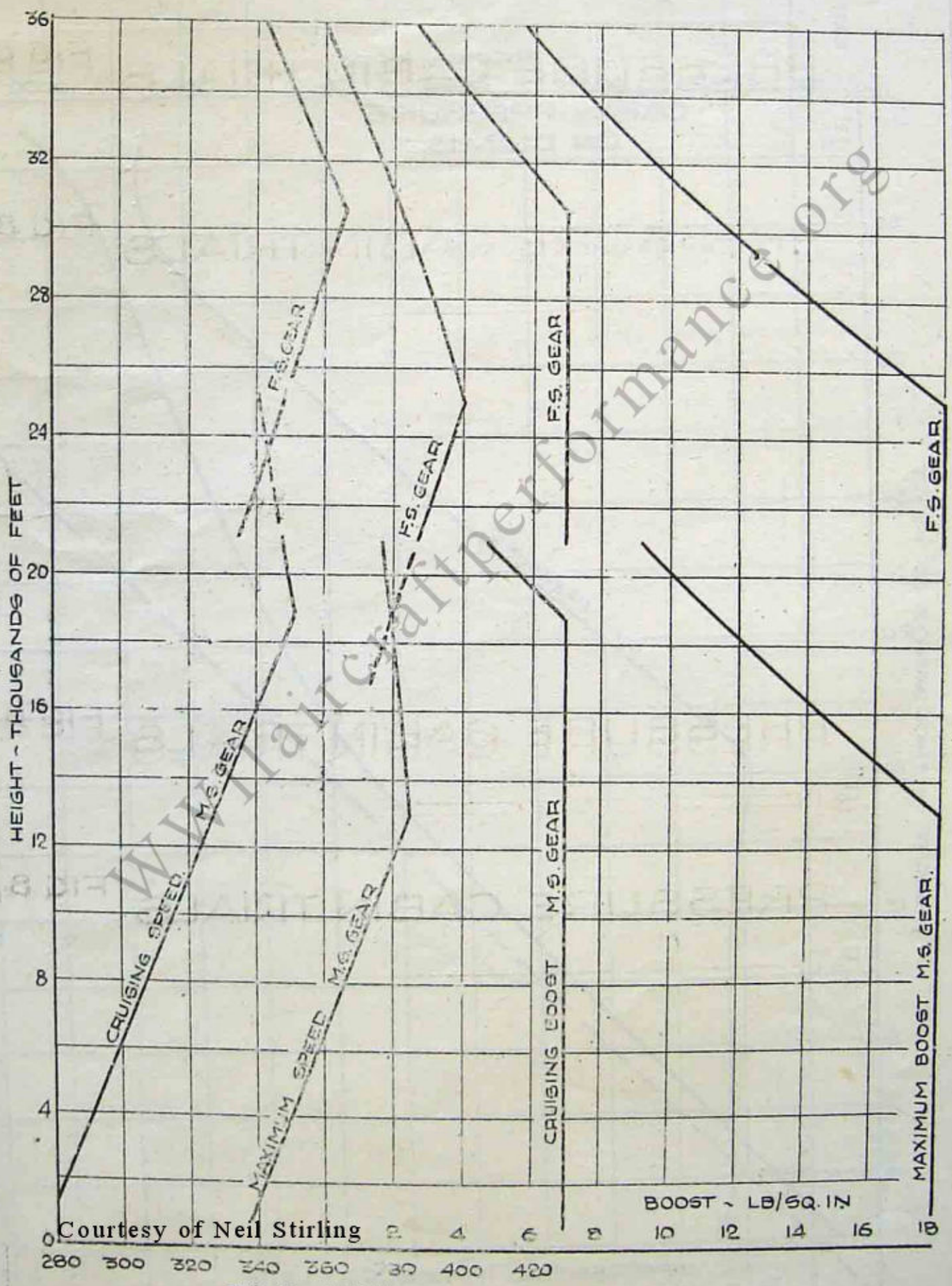
LEVEL SPEEDS

CORRECTED TO 21250 LB. = 95% TAKE-OFF WEIGHT.

TWO EXTERNAL 50-GAL. FUEL TANKS FITTED

RADIATOR FLAPS SHUT

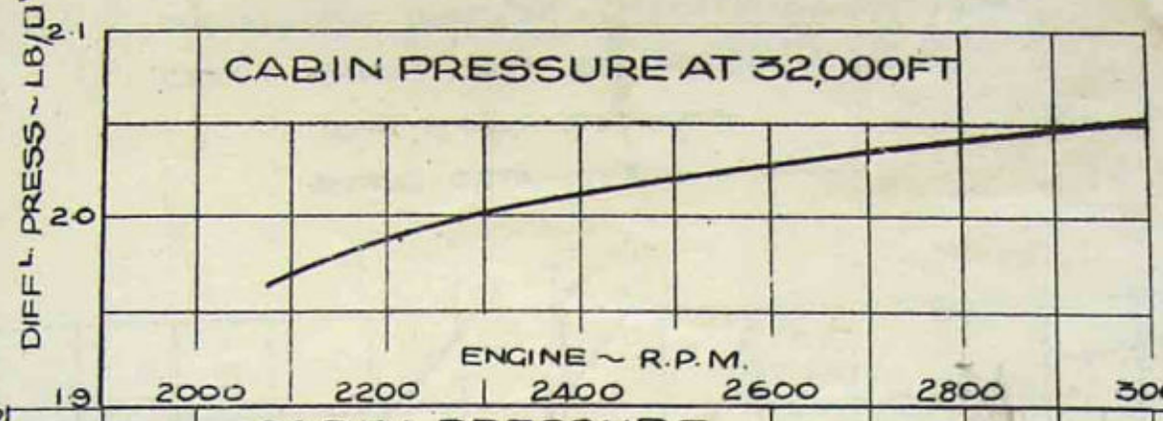
---------- ESTIMATED CURVE

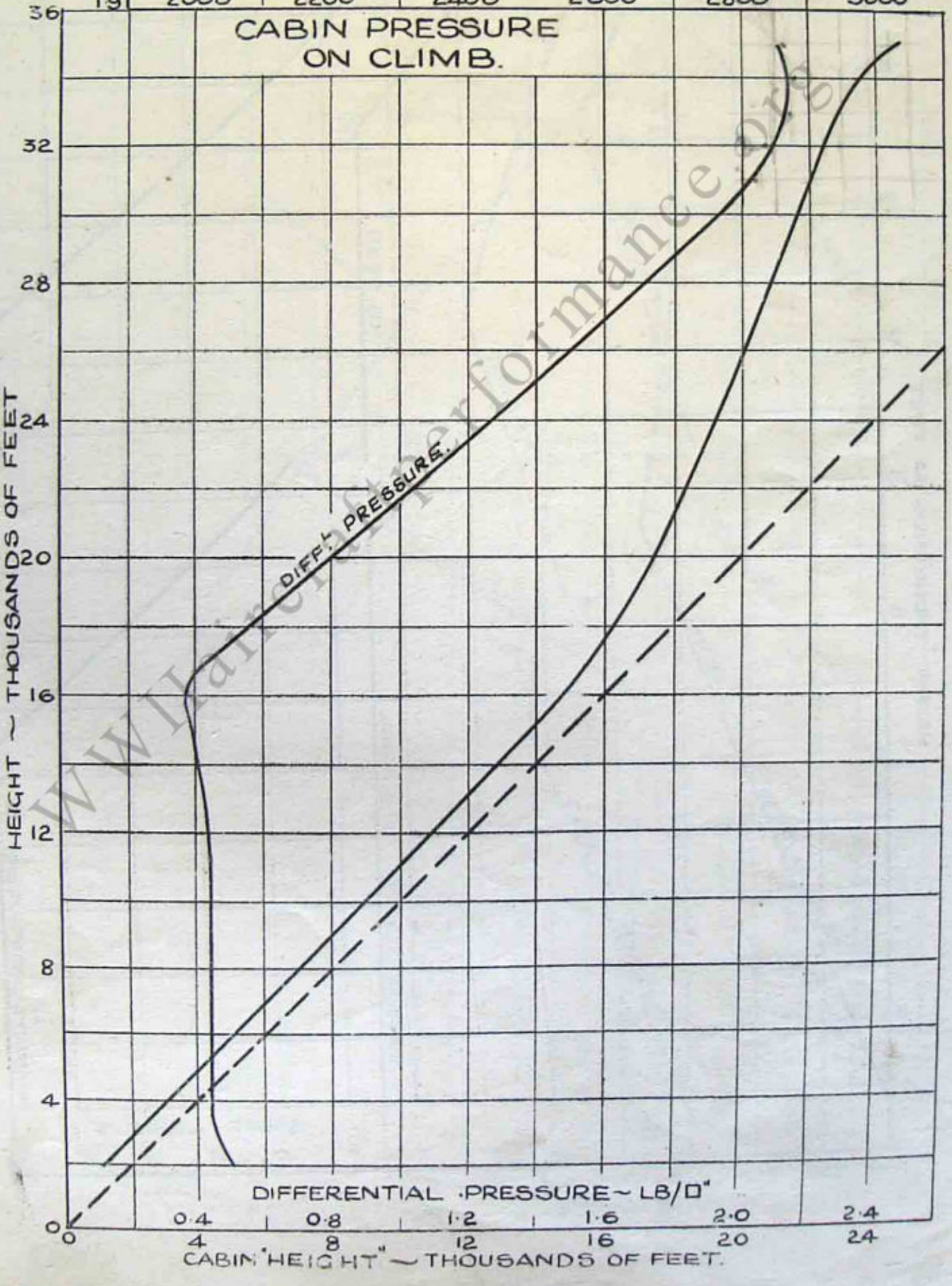


3RD. PART OF REPORT No. A&AEE/767 | MOSQUITO P.R. MK. XVI DZ.640 | CURVE No. 5811 | TRACED A.A | DATE 8.44 | CHECKED | APPROVED | D.O.

PRESSURE CABIN TRIALS

FIG 8





3rd PART OF REPORT No. A&AEE/767 | MOSQUITO P.R. MK XVI. DZ 540 | CURVE No. 5812 | TRACED ~ A.L.Wood | DATE ~ 6-11-43 | CHKD ~ ASW. | APPROVED ~ C.F.C.G. | 12