Performance, brief handling and pressure cabin tests

A. & A.E.E, ref:- GTO/AM/O1/25.
M.A.E.E ref:- SB34338/ROU 1(b)/H
Period of tests:- 6th September - 1st October 1943

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 follows:

Climb. Maximum rate of climb in MS gear (2650 RPM, +12 lb/in² boost)

FS: 1,360 ft/min at 14000 ft.

Maximum all-out level speed in MS gear (5000 RPM, +18 lb/in² boost)

FS: 385 mph at 15000 ft.

Maximum cruising speeds. MS gear (2650 RPM, +7 lb/in² boost)

FS: 352 mph at 16000 ft.

These results agree with those of Mosquito (B) Mk IX LR 486, as Part of Report No. A & A.E.E, 1943. After making due allowance 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 removable 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. 152 mph I.A.S.
Flaps 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 RD I(b) (IAF) in a letter of 1st October 1943.

Courtesy of Neil Stirling
2. Condition of aircraft relevant to tests.

2.1. External details. (See photographs)

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

2.1.2. The pressure hood is in the usual position for Mosquito aircraft, i.e. near the top of the fin. Two RAE prototype 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 hood 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./787. 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-camer'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 control 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-camer'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 Kollman altimeter was used to obtain cabin "altitude".

2.3. Engine details, limitations etc.

2.3.1. Engines.

Merlin 73
Part No. 160248/446935,
Starboard No. 160249/446937.

The limitations are as follows:

<table>
<thead>
<tr>
<th>Condition</th>
<th>RPM</th>
<th>Boost</th>
<th>Coolant</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take-off (5 mins)</td>
<td>3000</td>
<td>4.12</td>
<td>135</td>
<td>105</td>
</tr>
<tr>
<td>Climb normal (1 hour)</td>
<td>2650</td>
<td>4.12</td>
<td>125</td>
<td>95</td>
</tr>
<tr>
<td>Climb combat (5 mins)</td>
<td>3000</td>
<td>4.18</td>
<td>135</td>
<td>105</td>
</tr>
<tr>
<td>All-out level</td>
<td>3000</td>
<td>4.18</td>
<td>135</td>
<td>105</td>
</tr>
<tr>
<td>Cruise</td>
<td>2650</td>
<td>4.17</td>
<td>105</td>
<td>95</td>
</tr>
<tr>
<td>Dive</td>
<td>3150</td>
<td>4.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.32. Propellers.

Type. DeH. hydrostatic, Type A6/147; 3 blades 12 ft diameter. Rotation right hand.
Serial Nos. Fort NK 22099 Starboard NK 22111

2.4. Loading. The aircraft was flown at the maximum permissible weight of 22340 lb, with the C of G at 18.1 in, 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 jettisoning, 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 climb of Mosquito Mk VIII and IX. The E.E. 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 anemoid 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 variations 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.


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

4.2.2. 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:

<table>
<thead>
<tr>
<th>Mach Number</th>
<th>Actual air (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(based on standard conditions)</td>
<td>temp on test.</td>
</tr>
<tr>
<td>MS gear, 13000 ft</td>
<td>0.91</td>
</tr>
<tr>
<td>FS gear, 25500 ft</td>
<td>0.97</td>
</tr>
<tr>
<td>FS gear, 36000 ft</td>
<td>0.98</td>
</tr>
</tbody>
</table>

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 496 which gives similar results.

4.2.3. 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 15000 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 wasteland 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/sq.in. 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/sq.in. cabin pressure is held at all engine RPM above 2300. The pressure increases from 2.0 lb/sq.in. at 2500 RPM to 2.05 lb/sq.in. at 3000 RPM. The cabin pressure at 2100 RPM falls to 1.97 lb/sq.in., 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 supervisory 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 84000 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 taxiing and at low altitude the cabin was uncomfortably warm, even with "cold air", unless 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 severely 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 sway 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 swaying.

6.2. **Climb.** At the best climbing speed, 170 mph, I.A.S., the aircraft is neutrally stable, phugoids of constant amplitude (about 1 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 ±50 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.

/ 6.6. }
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 1/3 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 lighter push force was required up to 400 mph I.A.S., above which speed it increased slightly to reach 433 mph. During recovery loss of push force was required then — 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 150 mph I.A.S. with the flaps and undercarriage up, and at 135 mph, all down. On displacing the speed 110 mph from the trimmed state the aircraft executes stable phugoids.

6.7. Banked 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 the 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 buffetting 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 buffetting 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 cockpits, 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 IR 495, when a correction is applied for difference in weight. (see 4th Part of report No. A & A.E./787/1).
7.21 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 (loc.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, c), the speeds of BZ 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 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.

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Rate of Climb (ft/min)</th>
<th>Time to Height (min)</th>
<th>A&amp;I (mph)</th>
<th>Mean Boost (lb/in²)</th>
<th>REM</th>
<th>S/C Gear</th>
<th>Cabin &quot;Height&quot; (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1910</td>
<td>0</td>
<td>170</td>
<td>+12.0</td>
<td>2850</td>
<td>MS</td>
<td>-</td>
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<tr>
<td>4000</td>
<td>1325</td>
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<td></td>
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<td>3100</td>
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<td>8000</td>
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<td></td>
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<td>16000</td>
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</tr>
</tbody>
</table>

* Full throttle heights.

Estimated absolute ceiling 35700 feet

Greatest height reached 35000 feet

Courtesy of Neil Stirling
TABLE II
ALL-OUT LEVEL SPEEDS
Corrected to 21250 lb = 95% take-off weight.

<table>
<thead>
<tr>
<th>Height (FT)</th>
<th>T.A.S. (mph)</th>
<th>I.A.S. (mph)</th>
<th>Corrections</th>
<th>Mean Boost (lb/in²)</th>
<th>RPM</th>
<th>S/C Gear</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>342</td>
<td>331</td>
<td>+2</td>
<td>4</td>
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<td>350</td>
<td>329</td>
<td>+2</td>
<td>2</td>
<td>14.4</td>
<td>16.8</td>
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<tr>
<td>6000</td>
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<td>328</td>
<td>+1</td>
<td>2</td>
<td>12.2</td>
<td>16.8</td>
</tr>
<tr>
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<td>325</td>
<td>+1</td>
<td>2</td>
<td>10.2</td>
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</tr>
<tr>
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<td>11.8</td>
</tr>
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</table>

* Full throttle heights.

TABLE III
CRUISING SPEEDS.
Corrected to 21250 lb = 95% take-off weight.

<table>
<thead>
<tr>
<th>Height (FT)</th>
<th>T.A.S. (mph)</th>
<th>I.A.S. (mph)</th>
<th>Corrections</th>
<th>Mean Boost (lb/in²)</th>
<th>RPM</th>
<th>S/C Gear</th>
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<tbody>
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<td>30000</td>
<td>366</td>
<td>227</td>
<td>+0</td>
<td>1</td>
<td>5.8</td>
<td>2550</td>
</tr>
<tr>
<td>32000</td>
<td>360</td>
<td>227</td>
<td>+0</td>
<td>1</td>
<td>5.8</td>
<td>2550</td>
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<tr>
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<td>192</td>
<td>+0</td>
<td>1</td>
<td>2.7</td>
<td>2550</td>
</tr>
</tbody>
</table>

* Full throttle heights.

Courtesy of Neil Stirling
Type of Pressure Head.

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) 9 3/4"  
D Nose of Head to Supporting Strut 6 2"  
Z " " Chord Line of T.P. 6'-1 1/2"  
X " " T.P. Leading Edge (parallel to Chord) 1'-4"  
E Distance of Static Vents (mean) to Strut 3 3/16"  
C Length of Chord of T.P (at Root) 5'-6"  
M Major Axis of Strut 1 3/8 dia.  
N Minor " " 1 3/8 dia.  
Distance from Plane of Symmetry NIL  
Position. LEADING EDGE OF FIN ON 4 A/C  
Semi- Span. 10'-5"
LOCATION OF STATIC VENTS

PORT STATIC VENT 1/2" DIA
STB STATIC VENT 1/2" DIA

6'-9.8" 6'-2"

1'-6.2" STBD 1'-8.2" PORT

DATUM POINT
FUSELAGE DATUM LINE

SECTION ON "BB"
SECTION ON "AA"

STATIC VENTS R.A.E TYPE (FLAT PLATE)
CORRECTION TO ALTIMETER WHEN CONNECTED TO STATIC VENTS.

MEAN WEIGHT ~ 21,600 lb.

[Graph showing correction to altimeter with various speed and altitude values.]
LEVEL SPEEDS
CORRECTED TO 21250 LB = 95% TAKE-OFF WEIGHT.
TWO EXTERNAL 50-GAL. FUEL TANKS FITTED
RADIATOR FLAPS SHUT
ESTIMATED CURVE.
PRESSURE CABIN TRIALS

CABIN PRESSURE AT 32,000FT

DIFF PRESS LB/IN
2.1
2.0

ENGINE ~ R.P.M.
19
2000 2200 2400 2600 2800 3000

CABIN PRESSURE ON CLIMB.

DIFF PRESS.

THOUSANDS OF FEET
24
20
16
12
8
4
0

THOUSANDS OF FEET

DIFFERENTIAL PRESSURE ~ LB/IN
0
0.4
0.8
1.2
1.6
2.0
2.4

CABIN HEIGHT ~ THOUSANDS OF FEET.