

RECEIVED IN REGISTRY  
R.A.A.F. COMMAND  
Date 30 AUG 1944

DETAIL No.: 401/29/14.

R.A.A.F. HEADQUARTERS

DIRECTORATE OF TECHNICAL SERVICES

SPECIAL DUTIES AND PERFORMANCE FLIGHT

REPORT

ON

"MEASUREMENT OF THE INCREASE OF PARASITE DRAG OF A P40N-20  
AIRCRAFT FITTED WITH EXTERNAL BOMBS AND RACKS."

Mr. G.J. DAILEY.

and

Flight Lieutenant I.R. KINROSS.

DATE OF ISSUE: August, 1944.

"This report is issued for information and advice only. It is not to be used by R.A.A.F. personnel as authority for demanding equipment components or for effecting modifications which are covered by the regular demand and modification procedure as laid down in various Air Force Orders."

## AERONAUTICAL SYMBOLS

### 1. FUNDAMENTAL AND DERIVED UNITS

	Symbol	Metric		English	
		Unit	Abbreviation	Unit	Abbreviation
Length	$l$	meter	m	foot (or mile)	ft (or mi)
Time	$t$	second	s	second (or hour)	sec (or hr)
Force	$F$	weight of 1 kilogram	kg	weight of 1 pound	lb
Power	$P$	horsepower (metric)		horsepower	hp
Speed	$V$	kilometers per hour	kph	miles per hour	mph
		meters per second	mps	feet per second	fps

### 2. GENERAL SYMBOLS

$W$	Weight = $mg$	$\nu$	Kinematic viscosity
$g$	Standard acceleration of gravity . 9.80665 m/s <sup>2</sup> or 32.1740 ft/sec <sup>2</sup>	$\rho$	Density (mass per unit volume)
$m$	Mass = $\frac{W}{g}$		Standard density of dry air, 0.12497 kg-m <sup>-3</sup> -s <sup>3</sup> at 15° C and 760 mm; or 0.002378 lb-ft <sup>-3</sup> sec <sup>3</sup>
$I$	Moment of inertia = $mk^2$ . (Indicate axis of radius of gyration $k$ by proper subscript.)		Specific weight of "standard" air, 1.2255 kg/m <sup>3</sup> or 0.07651 lb/cu ft
$\mu$	Coefficient of viscosity		

### 3. AERODYNAMIC SYMBOLS

$S$	Area	$i_w$	Angle of setting of wings (relative to thrust line)
$S_w$	Area of Wing	$i_t$	Angle of stabilizer setting (relative to thrust line)
$C$	Gap	$Q$	Resultant moment
$b$	Span	$\Omega$	Resultant angular velocity
$c$	Chord	$R$	Reynolds number $\rho \frac{V l}{\mu}$ where $l$ is a linear dimension (e.g., for an aerofoil of 1.0 ft chord, 100 mph, standard pressure at 15° C, the corresponding Reynolds number is 935,400; or for an aerofoil of 1.0 m chord, 100 mps, the corresponding Reynolds num- ber is 6,865,000)
$A$	Aspect ratio, $\frac{b^2}{S}$	$\alpha$	Angle of attack
$V$	True air speed	$\epsilon$	Angle of downwash
$q$	Dynamic pressure, $\frac{1}{2} \rho V^2$	$\alpha_0$	Angle of attack, infinite aspect ratio
$L$	Lift, absolute coefficient $C_L = \frac{L}{qS}$	$\alpha_i$	Angle of attack, induced
$D$	Drag, absolute coefficient, $C_D = \frac{D}{qS}$	$\alpha_a$	Angle of attack, absolute (measured from zero-lift position)
$D_0$	Profile drag, absolute coefficient $C_{D_0} = \frac{D_0}{qS}$	$\gamma$	Flight-path angle
$D_i$	Induced drag, absolute coefficient $C_{D_i} = \frac{D_i}{qS}$		
$D_p$	Parasite drag, absolute coefficient $C_{D_p} = \frac{D_p}{qS}$		
$C$	Cross-wind force, absolute coefficient $C_C = \frac{C}{qS}$		

MEASURE  
AIR  
Detail  
R.A.A.F.  
No. 1 A  
SUMMARY

1. IN  
bombs  
tested  
forman  
for th  
ion an  
Armane  
2. DE  
2.  
which



NO. 1 AIRCRAFT PERFORMANCE UNIT

LAVERTON

"MEASUREMENT OF THE INCREASE OF PARASITE DRAG OF A P40N-20  
AIRCRAFT FITTED WITH EXTERNAL BOMBS AND RACKS."

Detail No:- 401/29/14  
R.A.A.F. H.Q. File No:- 9/42/96.  
No. 1 A.P.U. File No:- A/6/29.

SUMMARY

During the flight tests on a Kittyhawk fitted with and without the wing bombs, measurements of the loss in speed were made from which the increase in basic drag,  $D_{100}$  was computed.

Loss in top speed at 5000 ft. was 10 m.p.h. with racks and braces only and 21 m.p.h. with racks, braces and bombs.

Increase in basic drag  $D_{100}$  figures are :

2 Racks	3 lb.
2 (Racks and Braces)	7 lb.
2 (Racks, Braces and Bombs).	15 lb.

1. INTRODUCTION.

A locally designed modification to fit 2-250 lb. bombs to the underside of the mainplanes of a P40N-20 was flight tested. This note covers the analysis of the level speed performance at 5000 feet, and gives the change in speed and drag for the various attachments. Serviceability of the modification and other aspects of the tests are reported separately in Armament Detail No. 281/29/10.

2. DESCRIPTION OF AIRCRAFT.

2.1 GENERAL.

Type : Curtiss P40N-20  
R.A.A.F. Serial No : A29-650  
Makers Serial No : AC43-23903.

The external details were similar to A29-418 which was reported in D.T.S. Report No. 115/29/9.



2.2 Engine.

Allison V1710-99 fitted with a "single lever" engine control for R.P.M. and manifold pressure.

2.3 Aircrew.

Curtiss Electric - 3 bladed, type C532-D-F84.

Blade Drawing No: 89303 - 24W.

Diameter: 11' - 0".

2.4 External Bombs and Racks.

The prototype installation tested was made in this Unit and a photograph of the complete fitment is attached to this report. It should be noted that the bomb is a single hook type but has been modified by the addition of two bands to fit on to the U.S. type double hook rack. Hence the parasite drag of the bomb will be rather higher than normal.

3. WEIGHT OF AIRCRAFT DURING TRIALS.

<u>Condition of Aircraft.</u>	<u>Take-Off Weight</u>	<u>Mesh Weight.</u>
Without bombs	7800 lbs.	7500 lbs.
With bombs	8300 lbs.	8000 lbs.

x Performance has been reduced to apply at this weight.

4. TESTS CARRIED OUT.

At four engine powers the aircraft was flown at 5000 feet in four conditions as below :-

- (a) Normal "clean" aircraft.
- (b) Condition (a) + bomb racks under each wing.
- (c) Condition (b) + sway braces to each rack.
- (d) Condition (c) + a 250 lb. G.P. bomb to each rack.

5. RESULTS OF TESTS.

The cruising performance of the aeroplane is summarised in the table below. Position Error Corrections have been taken from Ref. 1.



TABLE 1.

LEVEL SPEED PERFORMANCE OF A P40N-20 AIRCRAFT IN  
STANDARD ATMOSPHERE.

HEIGHT 5000 Feet.

R.P.M.	M.P.	Aircraft Condition							
		A (7500 lb)		B (7500 lb)		C (7500 lb)		D (8000 lb)	
		A.S.I.	T.A.S.	A.S.I.	T.A.S.	A.S.I.	T.A.S.	A.S.I.	T.A.S.
Ins.Hg.	m.p.h.	m.p.h.	m.p.h.	m.p.h.	m.p.h.	m.p.h.	m.p.h.	m.p.h.	
3000	44.3	277	309	273	306	268	299	257	288
2600	36.7	258	289	255	285	251	280	240	268
2300	31.4	234	261	231	257	226	252	217	241
2190	28.7	211	235	207	231	204	226	193	216

Note:

Gills were shut and cold carburettor air used. The "single engine control" level system was overridden in order to keep the various required engine R.P.M. and manifold pressure combinations constant on days of varying air temperature.

6. ANALYSIS OF FLIGHT TESTS.

The increases in parasite drag corresponding to the losses in speed given in Table 1, have been estimated from the relation given below, obtained by differentiating the Bailey Oswald<sup>2</sup> general performance equation.

$$\Delta D_{100} = \Delta V_i \left( \frac{10 \cdot B}{V_i^3} - \frac{3 \cdot D_{100}}{V_i} \right) \text{ in f.p.s. units.}$$

where  $\Delta D_{100}$  = change in parasite drag at 100 f.p.s. - lbs.

$\Delta V_i$  = Corresponding change in indicated airspeed - f.p.s.

$$B = \frac{29^2}{11.6 \cdot b^2 \cdot \rho_0} \text{ in standard N.A.C.A. nomenclature.}$$

$V_i$  = Indicated airspeed - f.p.s.

$D_{100}$  = Total aircraft parasite drag at 100 f.p.s. lbs.



4.

The accuracy of the relation is limited, but when applied in small steps as a series of approximations it is considered to be within the accuracy of the flight tests. The salient results of the analysis is given below.

TABLE 2.

VALUES OF INCREASED PARASITE DRAG DUE TO FITTING 2 BOMB RACKS AND 2 - 250 lb. BOMBS TO A P40N-20 AIRCRAFT.

Extra Items.

2 (Racks)	3 lb.	= 3 lbs. Total
2 (Racks + Braces)	3 lb. + 4 lb.	= 7 lbs. "
2 (Racks + Braces + Bombs)	(3 lb. + 4 lb.) + (8 lb.)	= 15 lbs. "

7. CONCLUSIONS.

The drag of this installation was considered acceptable for a fighter bomber, but nevertheless could be reduced by fairing the racks and braces. The loss in top speed at 5000 feet is 10 m.p.h. with complete racks and 21 m.p.h. with bombs fitted, whilst the decrease at a high cruising power was 11 m.p.h. and 19 m.p.h. respectively. The increase of the parasite drag at 100 ft. per sec. of the aeroplane was 7 lb. for the installation alone and 15 lb. when 2 - 250 lb. G.P. bombs were fitted.

REFERENCES.

1. "Performance of P40N-5 and P40N-1 Aircraft." D.T.S. Detail No. 115/29/9, April, 1944.
2. "General Formula and Charts for the Calculation of Airplane Performance." by W. Bailey Oswald. N.A.C.A. Report No. 408.



THIS PAGE IS REPRODUCED FROM A BADLY FADED OR ILLEGIBLE SOURCE.  
SCANNING THIS ITEM AT A HIGHER RESOLUTION WILL NOT IMPROVE ITS LEGIBILITY.

FIGURE 1.

MODIFIED BOMB RACK AND BRITISH TYPE  
BOMB FOR P40 AIRCRAFT.



SIDE VIEW.



THREE QUARTER FRONT VIEW.