SECRET

~~RESTRICTED.~~ 4th Part of Report No. A.& A.E.E./824.

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AIRCRAFT AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

AVIA 18/1113

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 & action by the Ministry of Aircraft Production.

Fury Mk.I. NX.798
(Centaurus 12 SM)

Brief handling trials with larger tail plane and modified wing root fairings.

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Period of tests: 2nd May - June 6th, 1945.

Progress of issue of report

Report No.	Title
1st Part of A.& A.E.E./824.	Hawker F 2/43. NX.798 - Weights and loading data.
2nd do.	do. - Brief handling trials. (Stages of development at October 1944).
3rd do.	do. - Carbon monoxide contamination tests.

Contents

Subject	Paragraph	Page	Figure
Summary		1	
Introduction	1	1	
Condition of aircraft	2	2	
Tests made	3	2	
Results of tests	4	3	
Conclusions	5	7	
Plan of tail plane			1
Manoeuvrability tests			2

Routine 4-view photographs at end of Report, and photograph showing cowl gill fairings at wing root.

Summary

Further handling trials to those reported in the 2nd part of this Report have been made on the prototype Fury Mk.I. NX.798. For these tests the aircraft was modified in that a larger tail plane and elevator had been fitted, the oil cooler changed to the port wing and fairings had been fitted beneath the cooling gills and exhausts.

General handling tests with special reference to longitudinal behaviour and stalling characteristics, were made at two loadings covering the forward and aft practical c.g. positions. Some stick force and accelerometer readings during manoeuvres were also recorded.

The modifications made to the aircraft since it was previously tested here were considered to have made appreciable improvements to the longitudinal stability and the stalling characteristics. In its modified form the aircraft was statically stable over most of its speed range over its practical c.g. range and the previous marked tendency to drop a wing on landing was no longer apparent.

Some criticisms of the flying characteristics were made and it was considered that if some attention were paid to meeting these, the aircraft would be most pleasant to fly, being outstanding among existing fighter types.

1. Introduction.

Brief handling trials with special reference to longitudinal stability and stalling characteristics have been made on Fury Mk.I. NX.798, the prototype F2/43.

It was the second visit this aircraft had paid to this Establishment and had been modified since its previous tests here (see 2nd part of this Report) by the fitting of a larger tailplane, the removal of the oil cooler to the port wing

/and the

and the addition of gill and exhaust fairings at the wing roots. tions were incorporated as a result of Contractor's trials to improve longitudinal stability and stalling characteristics which were adversely on in the above mentioned report.

Preliminary results of the present tests here have been forwarded to M... letter dated 24th May, 1945.

2. Condition of aircraft relevant to tests.

2.1 General. The aircraft was in a similar condition to that described in the 2nd part of this Report except for the following alterations:

(i) Addition of gill and exhaust fairings at the wing roots, the two lower exhaust pipes being led through the under fuselage panel. (See photograph at end of Report).

(ii) Oil cooler transferred to a similar position on the port wing.

(iii) Fitting of a larger tail plane and elevator (see Fig.1 at end of the Report).

(iv) Trimming mechanism incorporated in the rudder spring tab.

The engine was still rigidly mounted, the flexible mounting not yet being available for this aircraft.

The gills and oil cooler flap were manually controlled.

Routine 4-view photographs of the aircraft as tested are given at the end of this Report.

2.2 Airspeed indicator system. All airspeeds quoted in the text of this Report are those obtained from an airspeed indicator connected across the pitot and static sides of the Mk.VIII strut mounted leading edge pressure head.

2.3 Loading. The aircraft was flown at the following two loadings representing the practical aft and forward c.g. positions.

Loading	Condition	Weight lb.	Centre of gravity position			
			U/c down		U/c up	
			Ins. fwd.	S.M.C.	Ins. fwd.	S.M.C.
A	Take-off- full fuel ammo. & equipment	11230	16.0	0.260	14.9	0.273
B	Take-off - main tank only full & 20 galls in interspar, no ammunition.	10530	17.7	0.241	16.6	0.254
	As above with interspar fuel used up.	10380	18.0	0.238	16.9	0.250
	As above all fuel consumed.	9690	18.5	0.232	17.3	0.246

The practical aftmost c.g. position which occurs at take-off with full fighter load, is about 0.5 inches further aft than the similar loading with the aircraft in its previous condition (see 1st and 2nd parts of this Report). This 0.5 inch shift of the c.g. is accounted for by the additional weight of the larger tail plane.

3. Tests made.

General qualitative handling tests were made at loadings A and B with special reference to the assessment of the stalling characteristics and the longitudinal stability.

Some quantitative measurements were made at both these loadings with an R.A.E. type stick force indicator and a Watt type accelerometer. These tests consisted of the measurement of elevator stick forces in out-of-trim flight and during manoeuvres together with accelerometer readings in recovery from dives

/and in

...ht turns. The quantitative tests were made at two basic heights of ... and 20,000 ft.

Results of tests.

4.1 Handling at loading 'A' (practical aft loading).

4.11 Take-off. The take-off was normal and straightforward with exception of the directional control. The aircraft tended to swing to the right on opening up the engine and if 25° degrees of flap were used, full left rudder was required to check the swing even when taking off dead into wind. If the take-off was made out of wind the rudder was not sufficiently powerful to check the swing. During take-off the foot loads on the rudder control were light.

4.12 Climb. The longitudinal behaviour on the climb at normal climbing power at a speed of 180 mph ASI was satisfactory. The aircraft was statically stable and the phugoid stability was satisfactory, the aircraft returning to its trimmed speed after three or four slow oscillations.

The rudder trimmer was not powerful enough to give zero pedal force at 180 mph ASI and a light left foot load was required to maintain a straight course. The minimum speed for zero pedal force with full left bias was 190 mph ASI. At 150 mph ASI, full left rudder was required to maintain direction and the aircraft also tended to roll to the right. Throughout the climb, even at 190 mph ASI, when using normal climbing power the aircraft tended to fly right wing low and this required a continual light aileron stick force to counteract.

4.13 Level flight. The longitudinal behaviour of the aircraft throughout the level speed range was generally satisfactory, although there was an appreciable decrease of phugoid stability with increase in altitude. At 25,000 ft. when trimmed for cruising at 260 mph ASI, a disturbance resulted in a phugoid of increasing amplitude which necessitated taking over the controls to avoid a stall.

At 5000 ft. the aircraft was longitudinally statically stable throughout its speed range but at 20,000 ft. it appeared to become neutrally stable at speeds above 300 mph ASI.

It was noted that in nearly all conditions of level flight a certain amount of left rudder was carried, i.e. the left rudder pedal was always forward of the right.

4.14 Stalls.

4.141 Flaps and undercarriage up and gills closed. If speed was reduced when trimmed for the glide with engine off at 160 mph ASI, slight buffeting on the elevator was apparent at 110 mph ASI. As speed was further reduced this buffeting increased and was accompanied by aileron twitching together with a tendency to drop either wing. At 103 mph ASI the aircraft stalled; lateral control was lost and at the same time the nose started to fall away rapidly. The elevator force to stall the aircraft was light and the control column could be held fully back at the stall. The recovery was straightforward on easing the control column forward.

4.142 Flaps and undercarriage down and gills closed. In this condition the elevator buffeting and aileron twitching became apparent at 96 mph ASI with engine off. These characteristics increased in intensity until the stall occurred at about 90 mph ASI. At the stall lateral control was lost, the left wing dropping followed smartly by the nose. The elevator force to stall the aircraft was light, the position of the control column at the stall being about half way back. The recovery was immediate on easing the control column forward.

With engine on as for an engine assisted approach, the aircraft could be flown comfortably at 92 mph ASI, but if the speed was reduced, the aileron twitch started and the right wing dropped at 86 mph ASI.

/4.143

4.143 General stalling characteristics. It was co[illegible] the stalling characteristics had been appreciably improved since the [illegible] previous visit, but the stalling speeds were difficult to measure accur[illegible] to the aileron twitch and the subsequent loss of lateral control which w[illegible] considered adverse features particularly for a Naval aircraft.

Opening the gills fully had the effect of raising the stalling speeds by about 5 mph ASI.

If the aircraft was stalled in a turn under 'g' the aileron twitch was followed immediately by a roll or flick of 40° to 60° in either direction. The following dynamic stall figures were obtained:

Height	ASI	'g' (acc. reading)
5000'	280	5
5000'	245	4
28000'	200	2.5

4.15 Dives. The general behaviour of the aircraft at high speeds was satisfactory. The aircraft gained speed rapidly in the dive which was smooth and free from disturbance up to the maximum speed reached of 480 mph ASI at 8000 ft.

A series of dives was made from trimmed level flight at 28000 ft. During these dives a maximum Mach No. of about 0.79 was reached at 23,000 ft. and at these conditions the stick force to hold the aircraft in the dive decreased from about 10 lb. to zero. The aircraft was immediately pulled out of the dive with a light pull force and without any difficulty, but it was considered that it was on the verge of compressibility trouble.

The quantitative measurements of stick forces and accelerations during the diving tests are given in Fig.2 at the end of this Report and discussed in a later paragraph under manoeuvrability. (See para. 4.18).

4.16 Approach and landing. The best approach speed with flaps and undercarriage down and engine off was considered to be 110 mph ASI. There was sufficient elevator trim to trim for hands off flight at this speed. If disturbed from the trimmed speed the aircraft carried out a series of slow continuous oscillations of small amplitude about a speed slightly higher than the trimmed speed.

Gliding turns up to rate 3 could be safely made at 110 mph ASI but the aileron control on the approach was spongy and although adequate was not considered very effective.

The touch down was satisfactory and no difficulty was experienced in carrying out a three point landing and no marked tendency to drop a wing was apparent.

4.17 Baulked landing. Opening up the engine and going round again after a baulked landing was straightforward and satisfactory. The changes of trim were moderate on opening up and raising the flaps to the maximum lift position, and could easily be held on the control column whilst retrimming.

4.18 Manoeuvrability. As will be seen from Fig.2, the manoeuvrability of the aircraft increased appreciably with altitude; that is, the stick force to produce a given value of normal acceleration decreased with altitude.

In tight turns at 5000 ft. the stick force to produce a 5'g' accelerometer reading was moderate at speeds up to 350 mph ASI, becoming heavy at speeds above 400 mph ASI. At 27000 ft., however, the stick force in turns was light, a pull of 4 lb. at 250 mph ASI producing a 3'g' accelerometer reading and at 4'g' the aircraft would continue in the turn with zero stick force.

The values of stick force per increment of 'g' accelerometer reading obtained on recoveries from dives at a 5'g' accelerometer reading varied appreciably with speed and with altitude from 2 lb/'g' at low speed at 20,000 ft. to 9 lb/'g' at high speed at 5000 ft. (See Fig.2). The lower value was considered too low as it is below the AP.970 requirements for new type fighters, whilst the higher value is on the top limit of these requirements.

/The stick

[illegible] [stick] force to hold the aircraft into the dive when trimmed for level [illegible] maximum climbing power was moderate up to the maximum speed measured [illegible] mph ASI (See Fig.2). It was considered, however, that if the diving speed [illegible] raised from the present maximum reached by the contractor of 480 mph ASI, the [stick] forces in untrimmed dives to these higher speeds might be excessive. The accelerometer readings on releasing the control column in the out of trim dives were well within the requirements, the maximum recorded being 3.2'g'accelerometer reading at 5000 ft. at 460 mph ASI.

4.2 Handling at loading 'B' (practical forward loading).

4.21 Take-off. The take-off characteristics were similar to those at the aft loading 'A' (para. 4.11).

4.22 Climb. In general the handling of the aircraft on the climb at normal climbing power and at a speed of 190 mph ASI were similar to those at the aft loading 'A'.

In the phugoid stability tests the aircraft appeared slightly more stable in that it returned to the trimmed speed after a slightly lesser number of oscillations of smaller amplitude.

4.23 Level flight. The forward shift of the c.g. did not have any marked effect on the general behaviour of the aircraft in level flight over its speed range.

The longitudinal stability both static and phugoid was satisfactory at low and high altitudes. The tendency for the aircraft to become neutrally statically stable at speeds above 300 mph ASI at 20,000 ft. as in loading 'A' was not apparent at this loading.

4.24 Stalls. The stalling speeds and the aircraft's behaviour at and near the stall were unaffected by the change of loading.

4.25 Dives. The general behaviour of the aircraft at high speeds was not appreciably effected by the change of loading.

The quantitative measurements of stick forces and accelerations made during the diving tests at this loading are given in Fig.2., and are discussed in a later paragraph under manoeuvrability (see para. 4.28).

4.26 Approach and landing. At this forward loading it was only just possible to trim the aircraft longitudinally at the best approach speed of 110 mph ASI with engine off, flaps and undercarriage down. Under the above conditions the elevator trimmer control had to be wound fully 'nose up' against the stop.

In order to make a three point landing engine off, it was found necessary at this loading to check the 'holding off' period with a decisive rearward movement of the control column to bring the tail down.

4.27 Baulked landing. The handling of the aircraft in carrying out a simulated baulked landing when trimmed for the approach as in para. 4.26 above was satisfactory and similar to that at the aft loading. Opening up the engine caused the aircraft to become tail heavy to a small degree which was enough however to enable the pilot to retrim and move the elevator trimmer control away from the fully 'nose down' position.

4.28 Manoeuvrability. In tight turns at 5000 ft. the stick force (although not measured) to produce 5'g'accelerometer reading had appreciably increased when compared with the aft loading case and at speeds above 400 mph ASI it was considered too heavy. There was no tendency for the aircraft to tighten in the turn even at altitudes up to 28,000 ft.

As will be seen from Fig.2 the manoeuvrability of the aircraft in terms of stick force to produce a given accelerometer reading was noticeably effected by the change of loading.

/The values

The values of stick force per increment of g accelerometer re... on recoveries from trimmed dives at 5'g'accelerometer reading varied ... and altitude from a minimum measured of 5.2 lb/'g'at low speed at 20,00... maximum of 10.2 lb/'g'at high speed at 5000 ft. (see Fig.2) The higher ... above the top limit of the AP.970 requirements for a new type ...

The stick forces to hold the aircraft into the dive when trimmed for level flight at maximum climbing power were satisfactory up to the maximum speed reached of 450 mph ASI at this loading. The accelerometer readings on the release of the control column in the out of trim dives were low, the maximum recorded being 2.3'g'accelerometer reading.

4.3 Assessment of controls.

4.31 Longitudinal control. In general it was considered that the longitudinal behaviour at both loadings tested was satisfactory and a considerable improvement over that obtaining during the aircraft's previous visit to this Establishment.

The degree of static stability was satisfactory at all conditions of flight at both loadings, but the elevator was considered slightly too heavy for manoeuvres especially at high speeds at the forward loading. The pronounced increase of manoeuvrability with altitude was undesirable in that the elevator control became too light in manoeuvres at high altitude at the aft loading at low speeds.

There was a noticeable lack of 'nose up' trimmer range for an engine off landing at the forward loading.

4.32 Lateral and directional control. The aileron control, was considered very pleasant to handle throughout the speed range except at speeds below about 150 mph ASI where they felt spongy and became ineffective as the stall was reached.

The initial response to aileron movement at cruising speeds and above was sharp but the rate of roll did not appear to increase in proportion to angular displacement. The peak rate of roll was considered to occur at around 300 mph ASI at 10,000 ft. where it reached the value of about 85° per second when maximum aileron stick force was applied with one hand. No aileron overbalance was apparent up to the maximum speed reached of 480 mph ASI but the aileron twitching at and near the stall was considered a bad feature especially as it was accompanied by a loss of lateral control as the stall occurred.

The rudder was light over small movements, becoming slightly heavier for larger displacements. The effectiveness of the rudder was good at high speeds becoming less with decrease of speed until, at conditions of take-off across wind, it was barely adequate to counteract the swing which could occur. The rudder trimmer functioned satisfactorily but there was insufficient left trimmer range to fly "feet off" on the climb at what was considered to be about the best climbing speed. It was noted that a certain amount of left rudder was carried continually in most conditions of flight in order to maintain a constant heading.

4.33 Changes of trim with speed and power. The longitudinal change of trim with speed was in the correct sense, i.e. nose up with increase of speed throughout the aircraft's speed range at both loadings. The elevator stick forces to hold out of trim flight were considered slightly too heavy for a fighter especially at the high end of the aircraft's speed range. The longitudinal change of trim with power was:- increase power, aircraft noses up; decrease power, aircraft noses down. This was in the correct sense and was conveniently small in magnitude.

The lateral change of trim with speed was negligible, but at low speeds there was an appreciable tendency to fly right wing low at full climbing power, due, presumably, to the torque reaction.

The directional change of trim with speed was such that with increase of speed, the aircraft tended to yaw to the right. With increase of power the aircraft also tended to yaw to the right. In all cases the change in directional trim could be held on the rudder.

/The effect

effect of yaw on pitch and vice versa was very small on this aircraft. was considered a very desirable characteristic from the point of view of gunnery.

4.4 Engine installation. As stated in para. 2.1, the engine was rigidly mounted and in this respect was similar to that obtaining on the aircraft's first visit to this Establishment (see 2nd part of this Report). In consequence the engine vibration was very bad and exceptionally unpleasant. This feature is understood to be fully realised by the Contractors who are taking action to fit rubber mountings on the production aircraft.

Very high oil inlet temperatures were experienced especially on the climb. The high temperatures were not considered due to oil congealing in the cooler but rather to inadequate provision for cooling.

5. Conclusions.

In general it was considered that the handling qualities of the Fury as tested were satisfactory, the aircraft having some good features. The improvements effected since the aircraft's previous visit to this Establishment were considered to have rendered the longitudinal stability satisfactory up to 25000 ft., and the behaviour on landing was no longer considered dangerous.

Some recommendations on improvements which were considered necessary are given below:

(i) The aileron control at low speeds should be more effective as regards response and maintainance of lateral control down to the stall.

(ii) A more powerful rudder is required at low speeds to counteract swing especially in the case of taking-off across wind when using flaps.

(iii) The range of left rudder trimmer should be increased to cover the climb at speeds down to about 160 mph ASI.

The following features were also noted, and attention to these points, although not a necessity, would considerably improve the manoeuvring qualities of the aircraft:

(i) The change of longitudinal trim in terms of stick force to hold out of trim flight should be decreased.

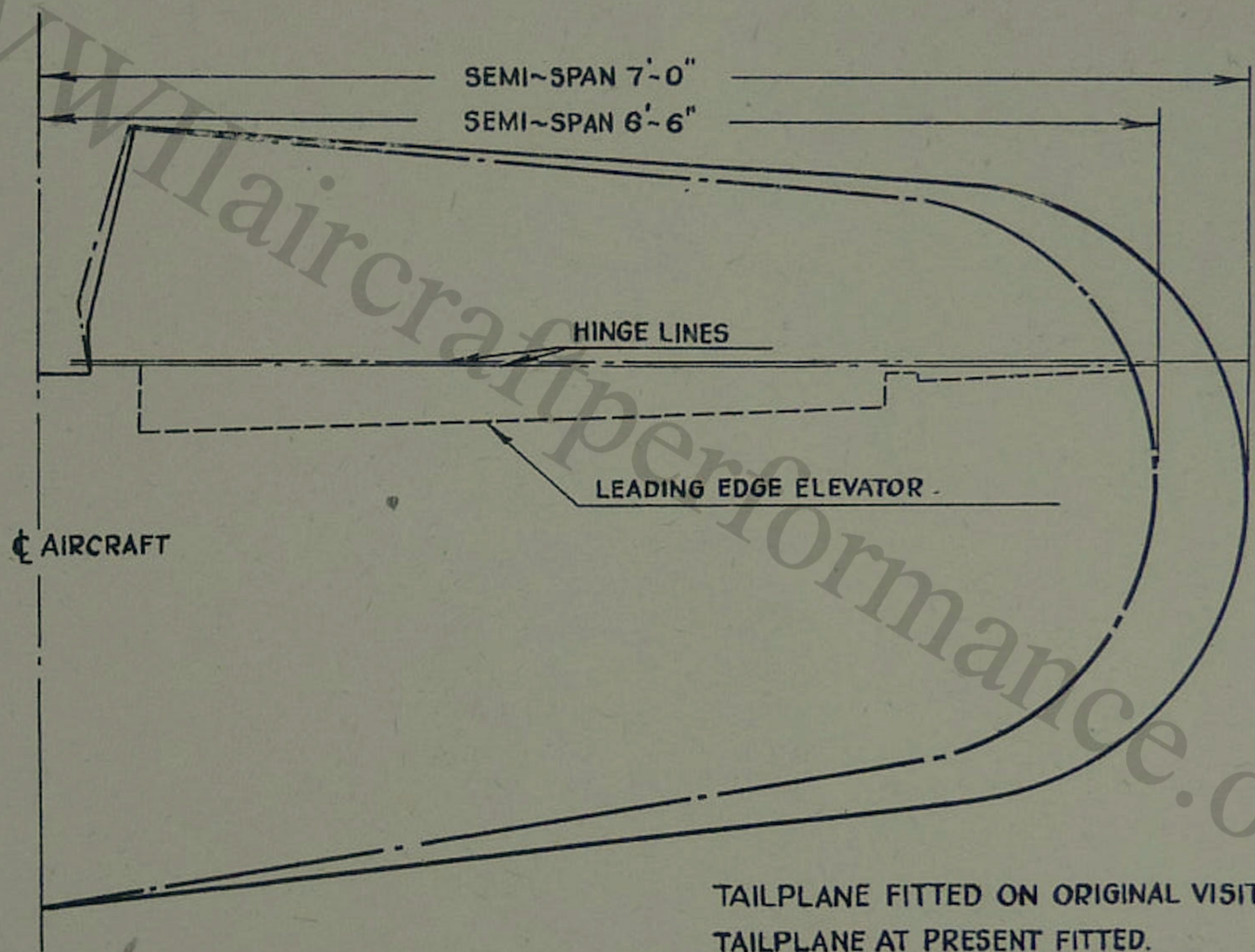
(ii) The manoeuvrability in terms of stick force per 'g' should be decreased to give a slightly smaller value at high speeds at low altitude and increased to give a higher value at low speeds at high altitude.

It should be noted that the level of engine vibration cannot be over-stressed, as this bad feature tends to detract from the otherwise pleasant impressions gained from flying this aircraft. It is understood however that this is fully realised and that suitable action is being taken to provide rubber engine mountings.

The oil cooling appeared to be inadequate to a degree that it seems to require urgent attention.

SKETCH Nº 3076	4TH PART OF REPORT Nº A.&A.E.E/824	FURY I NX 798	TR. I.M.P.	CH [illegible]	APP. [illegible] for S. of P.	1...

COMPARISON OF TAILPLANES.



TAILPLANE FITTED ON ORIGINAL VISIT —·—

TAILPLANE AT PRESENT FITTED. ———

NOTE ~ ELEVATOR LEADING EDGE SHAPE IS THE SAME FOR BOTH.

SCALE 1" TO 1'-0"

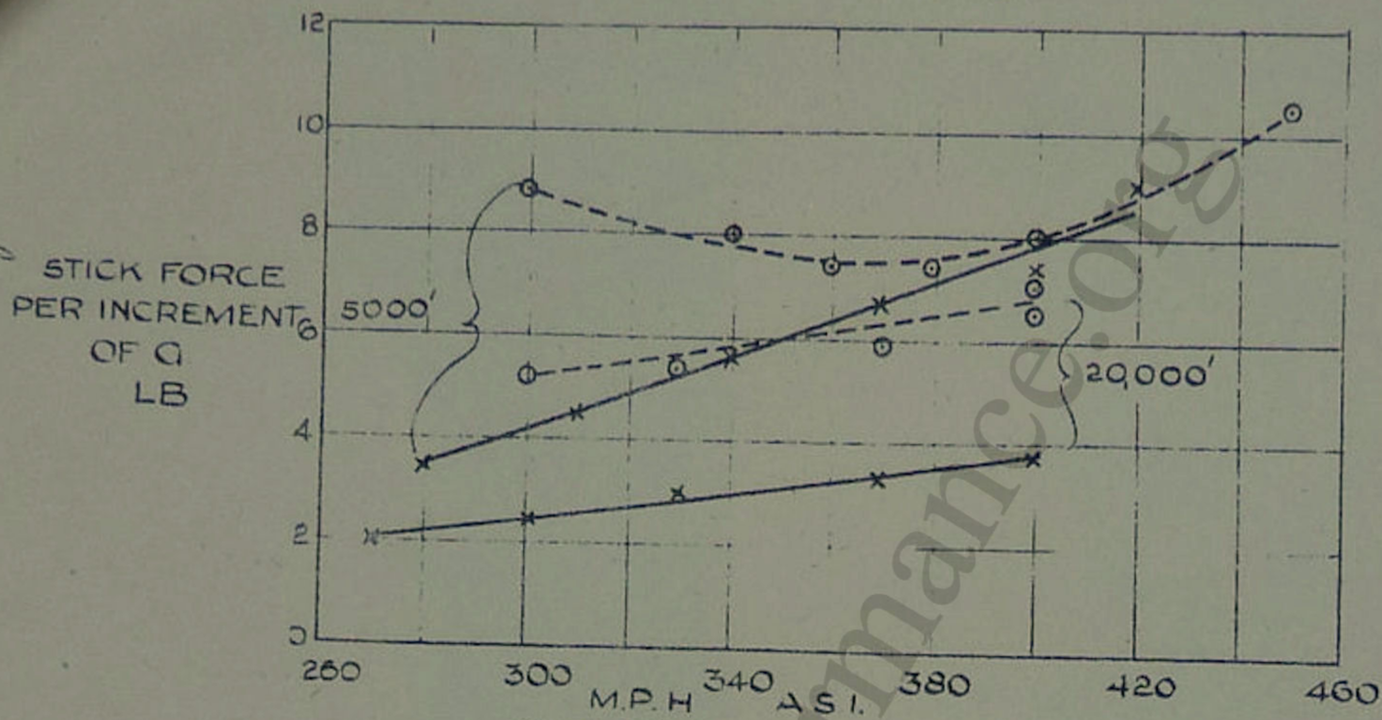
FIG.1

…OEUVRABILITY TESTS FIG.2.

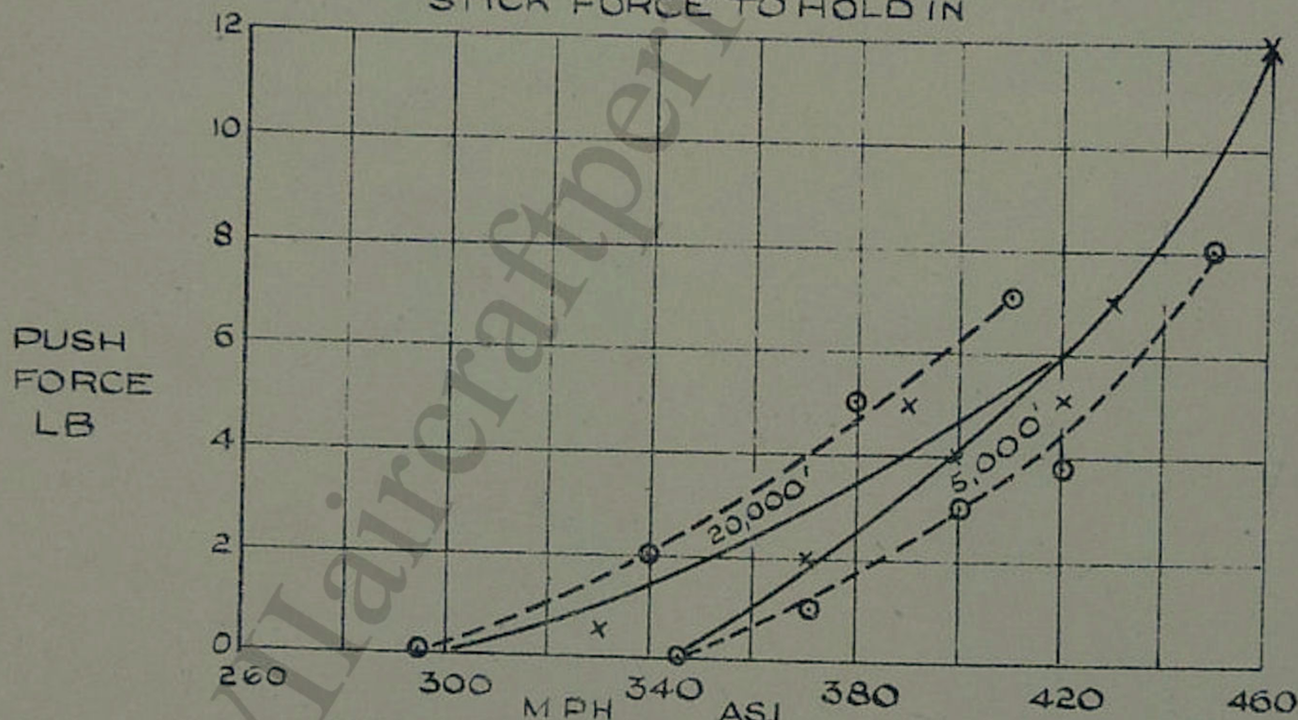
GILLS CLOSED 2400 R.P.M. +6 LB/□" BOOST

×——— AFT LOADING 'A' ⊙- - - - - FORWARD LOADING 'B'

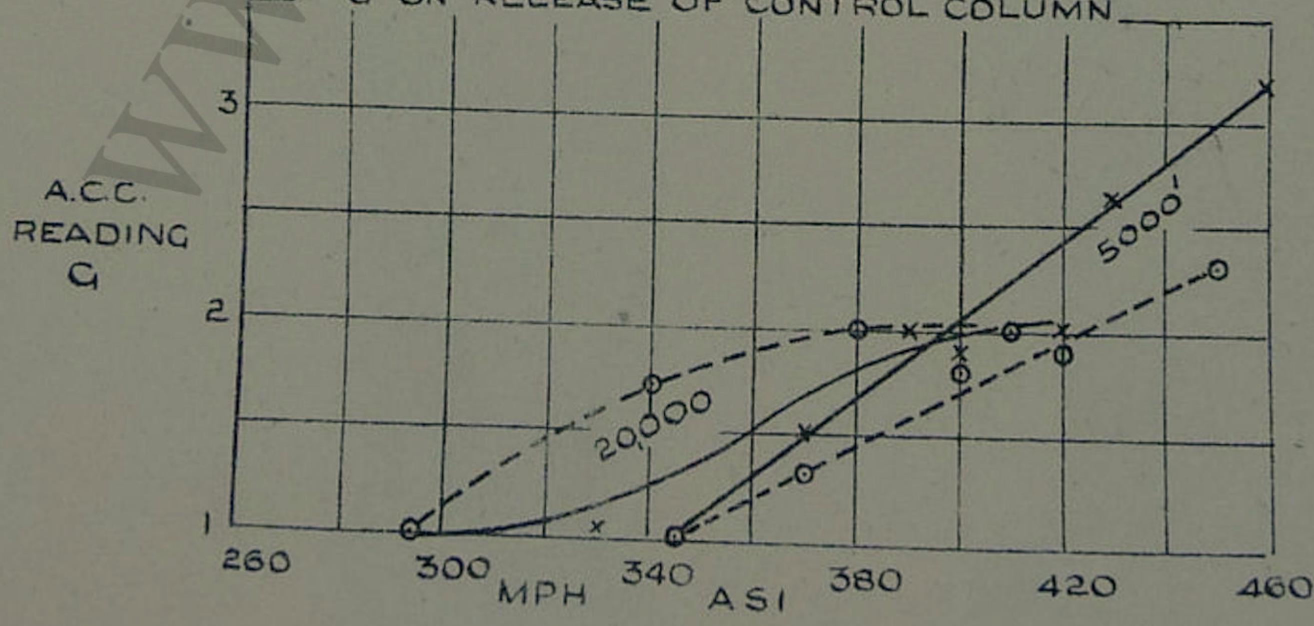
TRIMMED DIVES
STICK FORCE PER INCREMENT OF 'G' TO RECOVER AT 5 G ACC READING



OUT OF TRIM DIVES
TRIMMED FOR LEVEL FLIGHT
STICK FORCE TO HOLD IN



'G' ON RELEASE OF CONTROL COLUMN




A.M. NEG Nº 15144. A.


B.


C.


D.