AD NUMBER
AD020265
CLASSIFICATION CHANGES
TO: unclassified
FROM: restricted
LIMITATION CHANGES
TO: Approved for public release, distribution unlimited
FROM: Distribution authorized to DoD only; Foreign Government Information; 18 AUG 1953. Other requests shall be referred to British Embassy, 3100 Massachusetts Avenue, NW, Washington, DC 20008.
AUTHORITY
DSTL, AV 18/3676, 29 Jul 2008; DSTL, AV 18/3676, 29 Jul 2008

The following ESPIONAGE NOTICE can be disregarded unless this document is plainly marked RESTRICTED, CONFIDENTIAL, or SECRET.

NOTICE: THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 and 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

11th Part of AAEE/853/2

MINISTRY OF SUPPLY

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT

BOSCOMBE DOWN

WYVERN S. MK.4 VW. 884
(PYTHON 3)

LATERAL AND DIRECTIONAL HANDLING TRIALS WITH TAILPLANE FINS FITTED AND HALF AREA RUDDER TRIM TAB

AAEE Form 1.

ENCLOSURE 13 TO ASTIA 26453

(A638) Wt.23897/1179. 40M. 2. 10/51. H.E.S. Gp.818

AIR ATTACHE LONDON

11th Part of Report No. AAEE/853/2

AEROPLANE AND ARMAMENT EXPERIMENTAL ESTABLISHMENT
BOSCOMBE DOWN

18. AUG. 1953

Wyvern S. Mk.4 VW. 884
(Python 3)

Lateral and directional handling trials with tailplane fins fitted and half area rudder trim tab

A. & A.E.E. Ref: 5720,h/11/THJH
M. O. S. Ref: 7/Acft/5909/RDN1
Period of Test : January to March, 1953

Progress of issue of Report

Report No.	Title
6th Part AAEE/853/2	VW. 884 Night flying appraisal.
7th - do -	VW. 884 Airfield landing assessment.
8th - do -	VW. 884 Brief directional handling tests with interim rudder state.
9th - do -	VW. 884 Altimeter and ASI static pressure error corrections.
10th - do -	VW. 884 Qualitative longitudinal and lateral handling trials up to 20,000 ft., including stalls.

Summary

The tailplane fins improved directional characteristics in that overbalance was no longer present in sideslip tests even at the maximum rudder angle, (14° in flight); slight lightening of foot forces was encountered occasionally near the maximum rudder angle but was not considered serious.

The greater rudder angle (14½° compared with 11° of the proposed interim scheme) improved directional control in crosswind take-offs and landings.

The fins also appeared to make the 'jinking' motion in rough air, previously criticised, more gentle but trials would be needed to determine the effect of the motion on aiming.

The half area rudder trim tab made trimming easier and satisfactory throughout the speed range.

This Report is issued with the authority of

Air Commodore
Commanding A. & A.E.E.

1. Introduction

The 3rd part of this Report gave the results of a preliminary directional handling assessment in which rudder overbalance was observed in straight sideslip tests on the climb at 165 knots I.A.S., and an account of some fruitless measures taken in attempts to cure the overbalance. Development continued and the 8th part of this Report gave an account of tests directed towards attaining a suitable 'interim' rudder state which would allow a small number of aircraft to go into Service without delay, albeit in a restricted manner. However, at about this time, tests at the firm on a Wyvern with subsidiary fins fitted on the tailplane were showing promise, and it was decided to fit a pair of fins to VW. 884. Tests made in this configuration are reported here together with tests of a half-area rudder trimmer tab which was fitted to overcome earlier A. & A.E.E. criticisms of the too-rapid operation of the trimmer.

2. Condition of aircraft relevant to tests

2.1 General. VW. 884 was a Mk.4 Wyvern, differing at first from the earlier (Mk.2) version in having a 10° dihedral tailplane, cut-back engine cowl, lockable tailwheel and a "horn-balanced' rudder. Other changes were made in the course of developing the Mk.4 to a standard acceptable for Service use and those relevant to directional handling are given in later paragraphs.

2.2 Loading. The tests were made at the design aft c.g. position of 6.0 ins. aft of datum (21.2% S.M.C.) undercarriage down, with the aircraft loaded to a weight at take-off of 20,730 lb.

2.3 Airframe limitations. The maximum permissible indicated airspeed was 435 knots I.A.S.

From structural considerations the maximum allowable angles of sideslip, based on a safety factor of 2, were 25° at speeds up to 170 knots I.A.S. (this was also the calculated fin stalling angle) 12° at 250 knots I.A.S., 5½° at 350 knots I.A.S. and 3½° at 435 knots I.A.S. (Ref. RTO's letter 2040/Wyv/01, dated 22nd January, 1953).

2.4 Central fin and rudder details. The fin and rudder were basically as fitted for the first series of tests (3rd part of this report) and relevant details are as follows.

The leading edge of the rudder above the top hinge was extended forward to form a 'horn balance'. The rest of the rudder leading edge, between the top and bottom hinges was shrouded by rearward extension of the fin skinning but for these tests the shroud trailing edge strips (about ⅜" wide) were removed. The gap between the fin and the rudder nose was open (i.e. rubberised fabric seal removed. This was the condition in which the tests were made by the firm and appeared promising).

Gross fin and rudder area	50.2 sq.ft.
Gross rudder area	17.1 " "
Rudder area aft of hinge line	13.3 " "
'Horn balance' area above top hinge and forward of hinge line	0.97 " "
Rudder travel (each way)	14½° ∅
Rudder tab area	0.77 sq. ft. (1.59 sq.ft. originally)

The reduction in tab area made during the course of the tests was effected by reducing the height of the tab, maintaining the original chord. The upper part of the trimmer then became an integral part of the rudder proper.

The tab was adjusted to give zero balance action.

∅ The original rudder travel of the Mk.4 was ± 15°. Since preliminary A.& A.E.E. tests with the fins fitted showed some lightening towards full travel, the firm proposed a rudder movement of 14° each way, with +½°, - 0° tolerance; for the remainder of the A. & A.E.E. tests the rudder movement was set to the top limit as shown.

2.5 Tailplane fins. One fin was fitted on each side of and normal to the tailplane (see Figs. 4 and 5). The gross area of each fin was $5\frac{3}{4}$ sq.ft., divided equally above and below the tailplane.

2.6 Instrumentation. A Hussenot A.20 continuous trace recorder was used to record rudder pedal force, rudder angle, height and indicated airspeed. A sideslip vane was fitted on a pole on the starboard wing tip and was connected to a desynn indicator in the cockpit.

3. Scope of tests

The tests were in three parts:

3.1 Sideslip tests to port and starboard

(a) On the climb at 165 kts. I.A.S. (intermediate power) at about 14,000 ft.
(b) In level flight at operational necessity power (giving about 290 kts. I.A.S. at the test height)
(c) In the dive at 420 kts. I.A.S. at max. continuous power.
(d) On the glide at 130 kts. I.A.S. with the flaps and undercarriage down and the throttle at the flight idle gate.

Tests (b), (c) and (d) were made between 8000 ft. and 10,000 ft.

3.2 Assessment of the half area trimmer tab.

3.3 General directional assessment, including changes of trim with speed and power and turns on one control.

4. Results of tests

4.1 Sideslips. The results are summarised in the following table. Foot forces quoted are nett values (i.e. port minus starboard or vice-versa) from the Hussenot records, samples of which are given in Fig.1. Fig.2 gives a plot of rudder angle against sideslip angle for the climb test, and Fig.3 gives, again for the climb test, a plot of rudder force against rudder angle together with some typical values for the unmodified aircraft.

Figures quoted in brackets in this table are sideslip angles.

Condition	Sideslip to port	Sideslip to starboard
Climb ϕ 165 kts. I.A.S.	Foot force increased progressively to 290 lb. at 13.8° stbd. rudder (16°) at which point the rudder pedals appeared to be at full travel. Between $\frac{1}{3}$ and $\frac{1}{2}$ aileron used to maintain straight sideslip.	Similar to test to port, 310 lb. at 14° ($17\frac{1}{2}$°).
Level 290 kts. I.A.S.	Heavy foot force (about 280 - 290 lb.) limited the rudder angle to 5.8° ($7\frac{1}{2}$°).	Heavy foot force (about 300 lb.) limited the rudder angle to 5°($5\frac{1}{2}$°)
Dive 420 kts. I.A.S.	As for level flight, max rudder angle 2° (2°).	As to port.
Glide, flaps & u/c down. 130 kts. I.A.S.	Pedal force increased progressively, becoming prohibitively heavy (about 290 lb.) at the same time as the pedals appeared to be at full travel with a rudder angle of 14° (7°).	As to port, about 300 lb. at 13.8° ($8\frac{1}{2}$°).

ϕ Occasionally during the climb tests there appeared to be very slight lightening of the pedal forces just before full travel was reached.

/4.2....

4.2 Assessment of trim tab. The half area trim tab overcame earlier A. & A.E.E. criticisms of too-rapid operation. Directional trimming was now much smoother. Whereas on previous Wyverns it was not possible to trim the aircraft accurately for straight flight, the present 'fine-action' trimmer enabled the aircraft to be trimmed with precision up to 435 kts. I.A.S.

4.3 General directional assessment. Pilots considered the rudder, although heavier than in previous configurations, to be a pleasant control for all normal flight conditions; it was moderately light and responsive.

The increased rudder movement now available (± 14½° compared with ± 11° of the "interim" scheme, see 7th and 8th parts of this Report) gave better directional control in cross-wind take-offs and landings in winds of up to 20 knots (the maximum value during the trials) from either side.

The directional change of trim with power was insignificant (e.g. on throttling to the flight idle gate when trimmed for level flight at operational necessity power, 290 kts. and about 250 lb/sq.in. torquemeter reading). The change of trim with speed was also small; trimmed on the climb at 165 kts. I.A.S. a right rudder bar force of 40 lb. was required to maintain straight flight at 435 kts. I.A.S.

Turns on one control were made. On rudder only, there was no appreciable rate of turn, and only moderate amounts of slip. On aileron, with the rudder fixed, satisfactory turns could be made without noticeable slip or skid; it was possible to exceed rate 4 (the maximum value on the pilot's instrument) in turns made at 165 kts. I.A.S. on the climb and at 305 kts. I.A.S., approximately the maximum speed in level flight.

Earlier reports on Wyvern aircraft criticised the directional 'jinking' at high speeds in rough air. The fins altered this characteristic in that the motion was smoother and of longer period. Pilots were of the opinion that there was a slight amount of roll now present, such that the motion was almost a gentle 'wallow'.

Aerobatics were accomplished without difficulty. Rolls and half-rolls from the tops of loops were made with no signs of rudder locking.

5. Discussion

5.1 General. The tests made with the tailplane fins fitted have shown that the rudder locking has been overcome. From this aspect the directional characteristics are considered to be of a standard acceptable in Service use, but the jinking in disturbed air may affect aiming, and specialist armament trials will be required to assess this.

It should be noted that the fins were tested in conjunction with the removal of the fin-to-rudder seal and the shroud trailing edge strips. The seal had been removed in earlier tests (8th part of this Report) and was still out when the aircraft returned to this Establishment after having the fins fitted. It was decided not to refit the seal since it appeared to have helped in the earlier tests. With the seal out, some tests were made with the shroud trailing edge strips refitted, but these increased the lightening of the foot forces (see next para.) although no reversal of foot force was encountered even at full travel.

It was found on a few occasions in straight sideslip tests, that with the present configuration there appeared to be some lightening of the foot forces towards full rudder travel, but it was not serious and the rudder would always centralise when the foot force was released.

Although the maximum rudder travel was ± 14½° and this could be obtained on the ground, the maximum rudder angle which could be obtained in flight with the pedals at full travel was 14°, indicating slight distortion somewhere in the circuit.

/5.2.....

5.2 Possible action of fins. It will be noted that, in comparison with the results quoted in the 3rd part of this Report, the ratio of rudder angle to sideslip angle had been increased slightly due to fitting the fins (e.g. about 0.88 :1 compared with about 0.75 :1) but the increase was by no means adequate to prevent an angle of sideslip of about 10° (the critical value in the original tests) being reached.

The most likely explanation of the effect of the fins is as follows.

It appears probable on this aircraft that while b_2 remained correctly negative with increasing sideslip, b_1 became progressively negative so that, at a given sideslip angle, the sum of the two main hinge moment terms was zero i.e., ignoring b_0 and b_3 effects, $C_H = b_1\psi + b_2\zeta = 0$, (a positive ζ giving rise, in accordance with convention to a negative ψ). The foot force would then be zero also, giving symptoms of overbalance. Increase in the rudder angle/sideslip angle ratio would, at a given sideslip angle, increase the $b_2\zeta$ term and therefore delay the sideslip angle at which the sum of the terms becomes zero, there being no reason for any change in the $b_1\psi$ term. When the plot of $b_1\psi$ against sideslip is non-linear, only a small increase in the slope of the $b_2\psi$ plot might be needed to give a marked increase in the sideslip angle for zero hinge moment.

It was thought that the change in b_1 with sideslip might be due to partial fin stalling, and in this connection it is interesting to note that RAE flight tests with wool tufts on the fin have shown break-away of the flow at the top of the fin in sideslips.

5.3 Lateral and directional derivatives. From the results of tests in which turns were made on aileron alone, the yawing moment with sideslip (n_v) appeared satisfactory. This is confirmed by the general directional steadiness, the jinking movement referred to in para. 4.3 being more of a sideways displacement (Y_v effect).

Between $\frac{1}{3}$ and $\frac{1}{2}$ aileron with about 10-15 lb. force was used to maintain the 16° sideslip on the climb. This would appear to indicate a satisfactory value of l_v, this opinion being supported by the only moderate amounts of skid apparent in turns on rudder alone.

Tests made with the aircraft in the original condition (no fins) had shown that oscillatory stability was satisfactory, the aircraft returned to the trimmed state within 2 or 3 oscillations when the controls were released after applying about 5° of sideslip. The fins would increase the damping and oscillatory stability may be considered good.

Although no specific tests were made to investigate spiral stability, it does not appear that the increase in n_v due to the fins has made the aircraft noticeably unstable and pilots did not complain of spiral instability.

5.4 A.P. 970 requirement for sideslip. Chapter 601, para. 8.3 states inter alia, that "the angle of sideslip corresponding to a rudder control force of 150 lb., or to full rudder if this can be produced with a lesser force, shall be within the design limit (for sideslip) and shall not be greater than 67% of the angle at which the fin stalls." These requirements are met easily on the Wyvern, where foot forces approximately double the quoted value were used without achieving the design sideslip angle. It is felt however that 150 lb. is rather a low figure and that a higher figure (say 250 lb.) would be more realistic. It will be recalled from the 8th part of this Report that deliberate heavying of the rudder was one of the lines of attack to prevent overbalance.

6. Conclusions

The fitting of tailplane fins has overcome rudder locking on this aircraft, foot forces now being progressive with sideslip and rudder angle, any lightening being very slight and occurring only at extreme angles.

/It........

It appeared also that the fins had affected the 'jinking' motion in rough air, criticised earlier, in that it was now more gentle and seemed to be associated with very slight rolling. Specialist tests will be needed to determine the effect of this motion on aiming.

The greater rudder angle available with this configuration ($\pm 14\frac{1}{2}^{\circ}$ compared with $\pm 11^{\circ}$ in the proposed interim scheme) has improved directional control in crosswind take-offs and landings.

The half area rudder trim tab has made directional trimming easier and satisfactory, thus overcoming one criticism levelled at the Wyvern throughout its development life.

7. Further developments

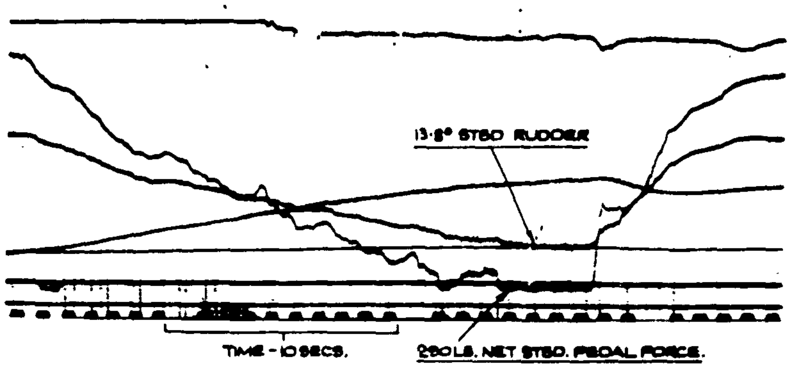
Tests have been completed to determine the effect of the end fins on longitudinal characteristics, and these tests will be reported later.

Circulation List

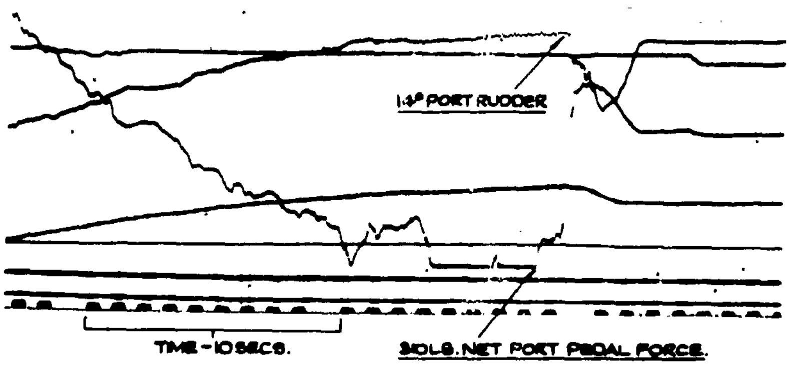
A.D.R.D.N.	2 Copies	1 for Action
A.R.D. (Projects)	1 Copy	
T.P.A.3/T.I.B.1c	75 Copies	
O.C. Handling Sqdn.	1 Copy	
R.T.O. Westlands	2 Copies	

FIG.1.

CLIMB AT 165KTS. I.A.S.
14,000FT. APPROX.
TAILPLANE FINS ON, ±14½° RUDDER MOVEMENT.
ZERO BALANCE ON TAB, FIN TO RUDDER SEAL OUT.
SHROUD T.E. STRIPS OFF.



(i) SIDESLIP TO PORT.



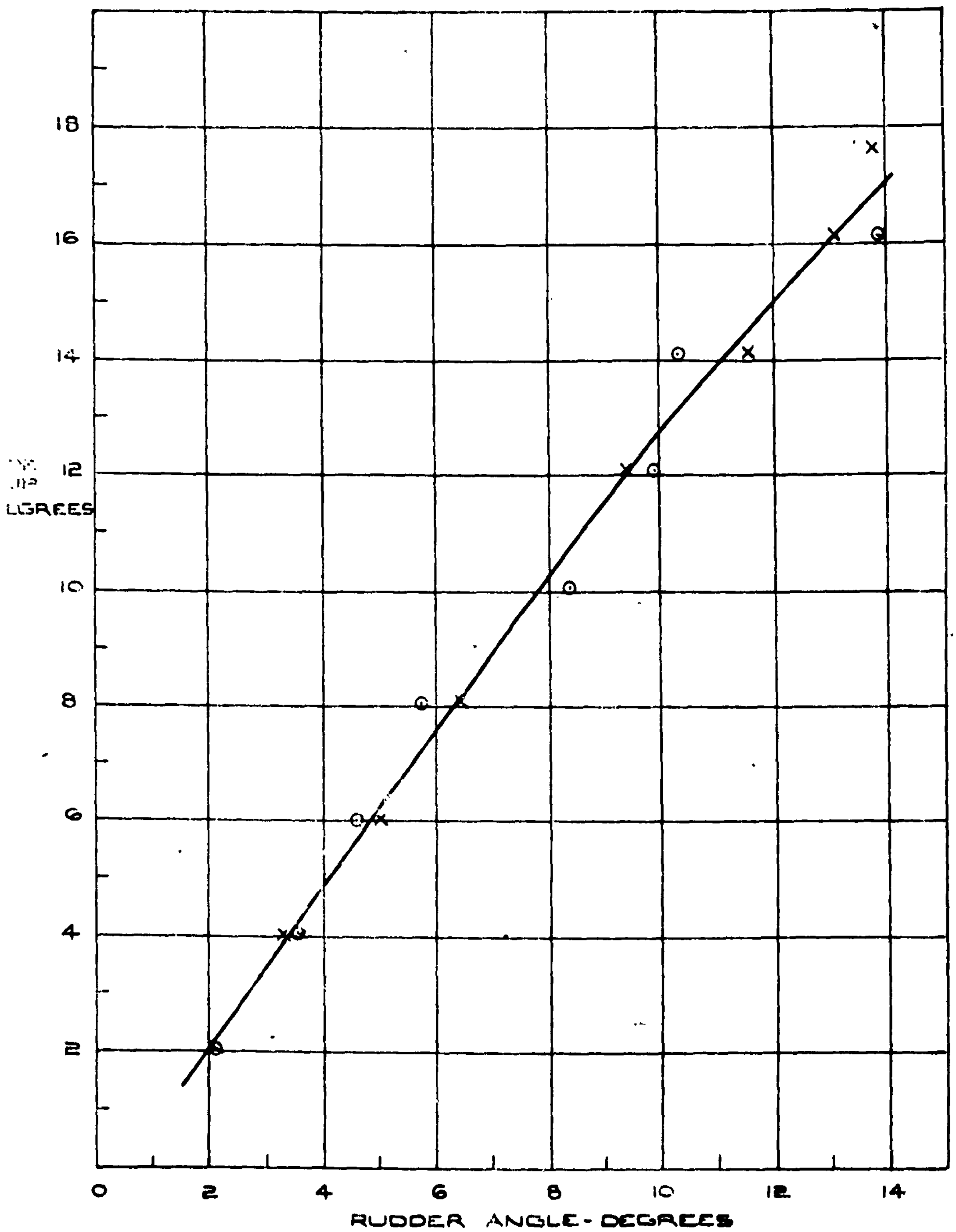
(ii) SIDESLIP TO STARBOARD.

SAMPLE HUSSENOT RECORDS OF STRAIGHT SIDESLIPS.

A. & A.E.E. NEG. No. 1593.

FIG. 2

CLIMB AT 165 KTS. I.A.S. APPROXIMATELY 15,000 FT.
± 14½° RUDDER TRAVEL
TAILPLANE FINS ON
ZERO BALANCE TAB
FIN-TO-RUDDER SEAL OUT
SHROUD T.E. STRIPS OFF
X APPLYING LEFT RUDDER
⊙ APPLYING RIGHT RUDDER



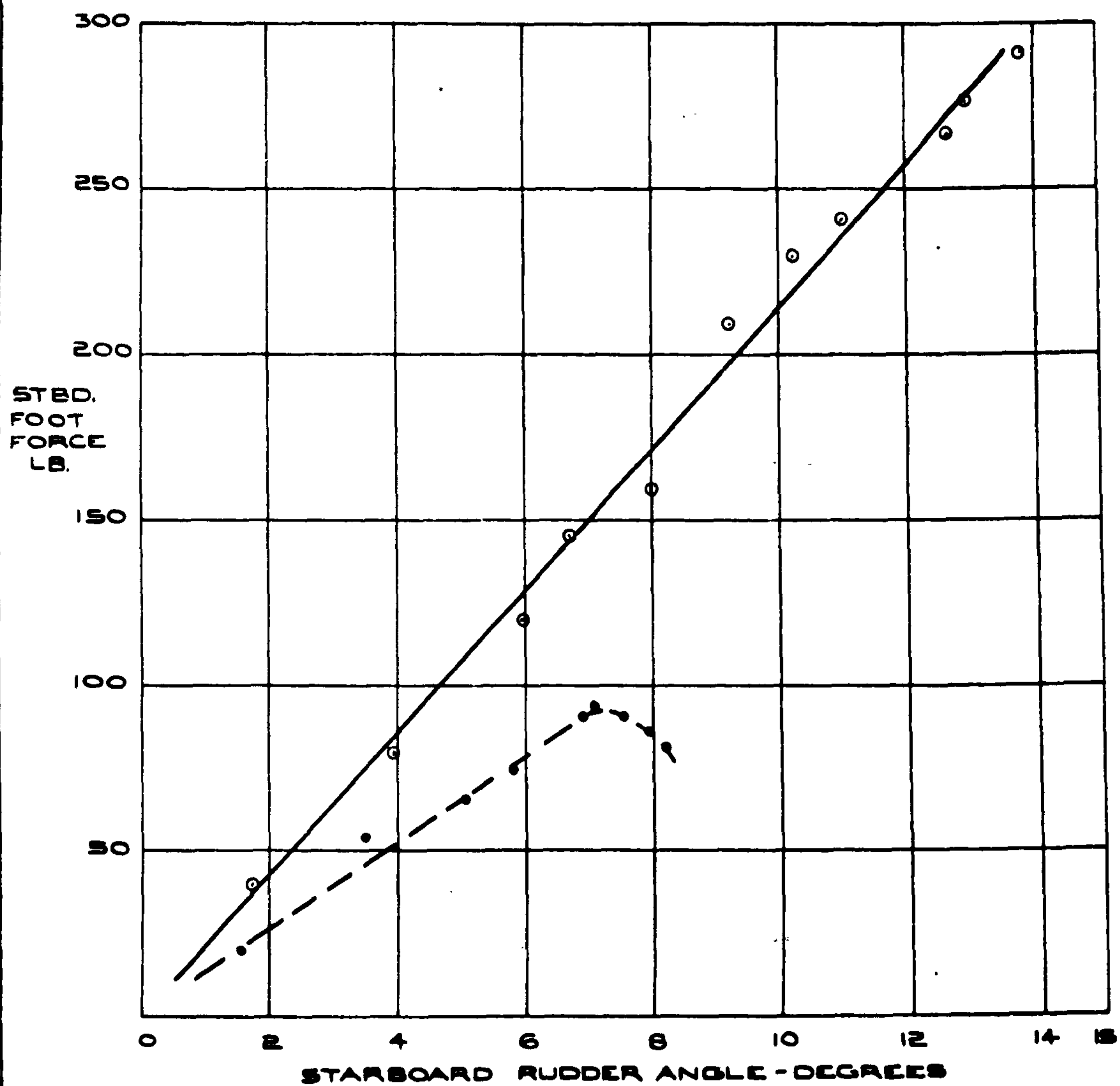
RUDDER ANGLE - SIDESLIP ANGLE.

SK.Nº A4759 | REPORT NO A.&A.E.E./853/2 | WYVERN 5 MK.4 VW 881 | CH. T.HEFFERNAN | APP.

FIG. 3

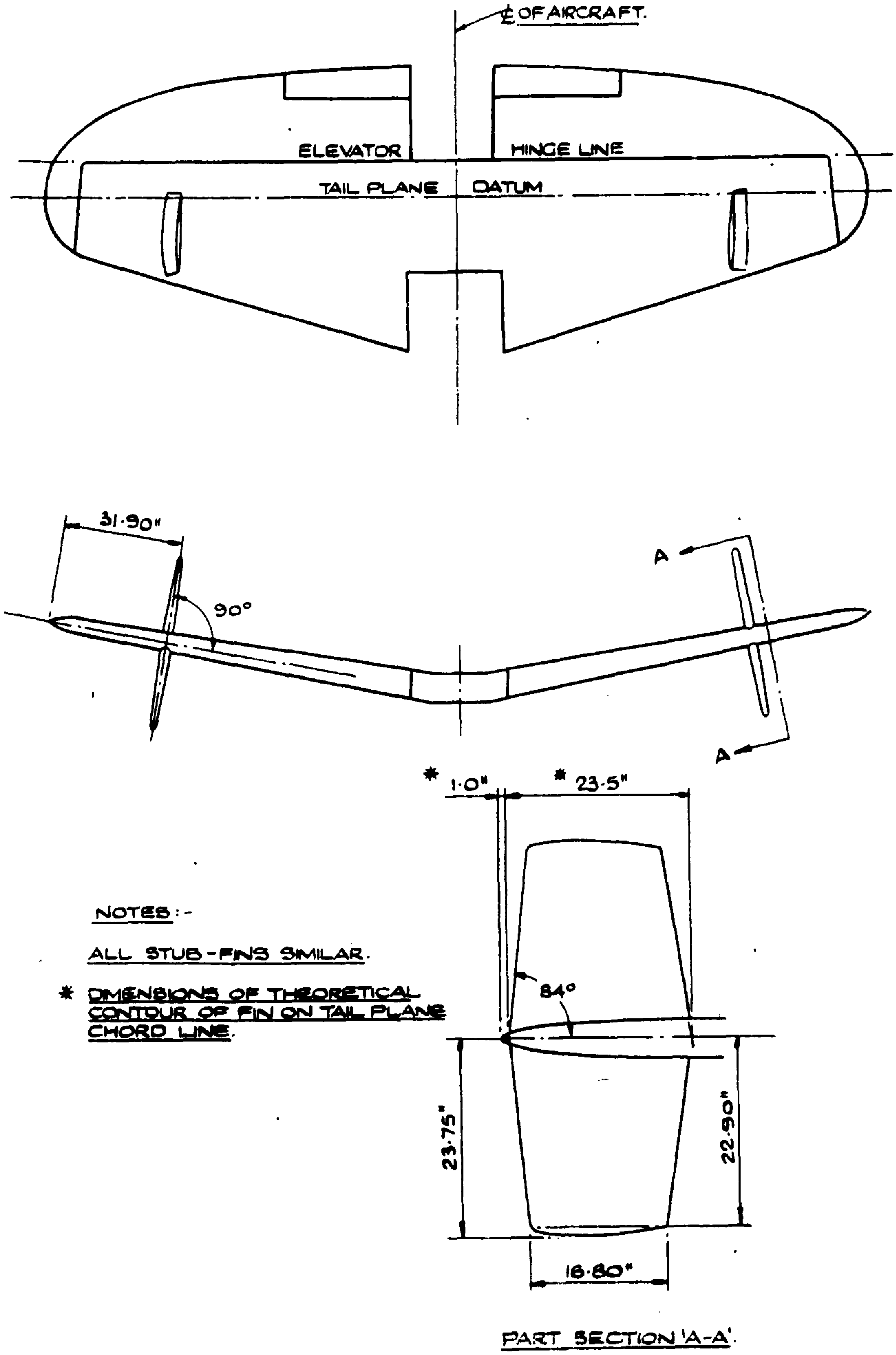
TYPICAL VALUES FROM STRAIGHT
SIDESLIPS ON CLIMB AT 165 KTS. I.A.S.
PORT SIDESLIPS ONLY SHOWN FOR CLARITY

• NO FINS (TYPICAL RESULT FROM STAGE 2 OF 3RD PART OF REPORT, TAB AT ZERO BALANCE)
⊙ FINAL CONFIGURATION, FINS, NO SEAL ETC.



RUDDER ANGLE - FOOT FORCE.

FIG.4.



TAIL PLANE SUBSIDIARY FIN DETAILS

SK. No. A 4840 | REPORT No. A.&A.E.E./853/2 | WYVERN 5 MK.4. VW 834 | S.M. | J.T. HEFFERNAN. | APP. | for Sof P | 13.8.53.

A. & A.E.E. NEG. No. 15932.

[dstl]

Information Centre
Knowledge Services
[dstl] Porton Down,
Salisbury
Wilts
SP4 0JQ
22060-6218
Tel: 01980-613753
Fax 01980-613970

Defense Technical Information Center (DTIC)
8725 John J. Kingman Road, Suit 0944
Fort Belvoir, VA 22060-6218
U.S.A.

AD#: AD020265

Date of Search: 29 July 2008

Record Summary: AVIA 18/3676
Title: Wyvern S Mk 4 VW.884 (Python 3): lateral and directional handling trials with tailplane fins fitted and half area rudder trim tab
Availability Open Document, Open Description, Normal Closure before FOI Act: 30 years
Former reference (Department) 853/2 Pt 11
Held by The National Archives, Kew

This document is now available at the National Archives, Kew, Surrey, United Kingdom.

DTIC has checked the National Archives Catalogue website (http://www.nationalarchives.gov.uk) and found the document is available and releasable to the public.

Access to UK public records is governed by statute, namely the Public Records Act, 1958, and the Public Records Act, 1967.
The document has been released under the 30 year rule.
(The vast majority of records selected for permanent preservation are made available to the public when they are 30 years old. This is commonly referred to as the 30 year rule and was established by the Public Records Act of 1967).

This document may be treated as <u>UNLIMITED</u>.