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MEASUREMENT OF FLYING QUALITIES OF A DEHAVILLAND MOSQUITO F-8 AIRPLANE (AAF NO. 43-334960)

II - LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS

By H. L. Crane, D. H. Talmage, and W. E. Gray, Jr.

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Langley Field, Va.

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MR No. L5G11

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

for the

Air Technical Service Command, Army Air Forces

MEASUREMENT OF FLYING QUALITIES OF A DEHAVILLAND MOSQUITO F-8 AIRPLANE (AAF NO. 43-334960)

II - LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS

By H. L. Crane, D. B. Talmage, and W. E. Gray, Jr.

SUMMARY

This report presents the results of tests to determine the longitudinal stability and control characteristics and the stalling characteristics of a DeHavilland Mosquito F-8 airplane. This report has no bearing on the performance characteristics, which were not measured, but which were considered to be exceptionally good. Some desirable features of the longitudinal handling qualities of the F-8 airplane were:

1. The control forces in accelerated flight were within the 7 to 38 pound per g range specified as satisfactory over the test center-of-gravity range (33.4 to 38.1 percent mean aerodynamic chord).

2. The elevator control was adequate for longitudinal control during take-off and landing and to reach the stall in straight or turning flight.

3. The trim changes due to flaps, power, and landing gear were not excessive and the power of the elevator trimming tabs was adequate.

4. The stalling characteristics were very good with adequate warning in the form of buffeting and pitching. Lateral control could be maintained after the buffeting and pitching occurred. Recovery was easily accomplished by application of down elevator.

Some undesirable features of the longitudinal handling qualities were:

1. The airplane was slightly unstable stick fixed in the rated-power clean, gliding, landing, approach, wave-off, and cruising conditions with the normal center-of-gravity position.

2. The airplane was neutrally stable or slightly unstable stick free in the rated-power clean, landing, approach, and wave-off conditions with the normal center-of-gravity position.

3. Although stable stick free the airplane was unstable stick fixed in high-speed turns with the normal center-of-gravity position.

INTRODUCTION

Flight tests have been made to determine the flying qualities of a DeHavilland Mosquito F-8 airplane. This report presents the results of the tests to determine the longitudinal stability and control characteristics and the stalling characteristics. The results of the tests to determine the lateral and directional stability and control characteristics have been presented in part I (reference 1).

DESCRIPTION

The version of the Mosquito tested was a Canadian built, camera-equipped F-8 airplane. A three-view drawing of the airplane is given in figure 1. A description, the general specifications, and several photographs of the airplane were presented in reference 1. All the control surfaces were metal-covered. The ailerons were of the Frise balance type and the elevator and rudder had horn balances. There was a bobweight in the elevator system which required a pull force on the control wheel of approximately 10 pounds per g. The ailerons and the elevators were equipped with balancing tabs and the rudder with a spring tab. Cross sections of the wing and of the horizontal and vertical tail surfaces are given in figure 2. Figure 3 shows the variation of elevator position with position of the control column and figure 4 the

variation of the elevator balancing tab angle with the elevator deflection. The stretch in the elevator system amounted to 1° per 25 pounds of control force. Elevator deflections were measured with respect to the stabilizer. The stabilizer incidence was 1.2° leading edge up and the wing incidence was 1.5°.

INSTRUMENTATION

The instrumentation of the airplane for the flying-qualities tests has been described in reference 1. The control surface angles were measured at the inboard ends of the surfaces. Elevator control column and rudder pedal positions were measured in the cockpit. To measure the control-wheel forces, the service wheel was replaced with one on which strain gages were mounted.

Service indicated airspeed as used herein corresponds to the reading of a standard A-N type meter connected to a pitot-static system that is free from position error and is defined by the formula:

$$V_i = 45.08 f_o \sqrt{q_c}$$

where V_i is in miles per hour, f_o is the compressibility correction factor at sea level, and q_c is the correct difference between total and static pressures in inches of water. Static pressure was measured with a swiveling static head mounted 1 chord length ahead of and slightly below the right wing tip. The static head was calibrated for position error by means of a trailing airspeed bomb. Total pressure was measured with a shielded total head mounted at the right wing tip.

TESTS, RESULTS, AND DISCUSSION

The results of the tests are evaluated in terms of the specifications of reference 2.

A. Longitudinal Stability and Control Characteristics

1-A. Dynamic longitudinal stability

Short period oscillations were induced in the clean condition with engines idling and with rated power at 150 and 250 miles per hour at an altitude of approximately 8000 feet. The procedure used was to trim the airplane, then abruptly pull up to approximately 2g and release the control column. Time histories of two of these pull-ups are presented in figure 5. Oscillations of the elevator occurred which did not disappear immediately although they damped out in 2 cycles or less. The period of the oscillation was short enough that the response of the airplane was small, as shown by the records of normal acceleration. There was a tendency for the airplane to oscillate longitudinally in rough air which the pilot noticed as a bouncing of the stick. It seems likely that this tendency was caused by the bobweight.

2-A. Static longitudinal stability

The static longitudinal stability was measured at three center-of-gravity positions, approximately 33.5, 36.5, and 38 percent mean aerodynamic chord with landing gear up. The forward shift of the center of gravity due to lowering the landing gear was approximately 1.5 percent mean aerodynamic chord. The weight of the airplane at take-off varied from 19,300 to 19,800 pounds. In the presentation of data, account has been taken of the effect of fuel consumption on weight and center-of-gravity position. The conditions in which the airplane was tested and the figures showing the data obtained for the three center-of-gravity positions are indicated in the following table:

Condition	Power setting	Flaps	Landing gear	Shutters	Approximate trim speed (mph)	Figure
Rated power clean	2650 rpm 7 psi boost	Up	Up	Closed	280	6
Gliding	Engines idling	Up	Up	Closed	Same tab setting as rated power clean	7,10
Landing	Engines idling	Down	Down	Open	130	8
Wave off	2650 rpm 7 psi boost	Down	Down	Open	130	8
Approach	2650 rpm 0 boost	Down	Down	Open	120	9
Cruising, maximum range	2650 rpm 4 psi boost	Up	Up	Open	180	9

Figures 6 to 9 contain plots of the variation of elevator position, elevator control force, sideslip angle, and angle of bank in straight flight against indicated airspeed. The variation of the elevator angle with normal-force coefficient and the variation of elevator force divided by the dynamic pressure F_e/q_c with normal-force coefficient are presented in figure 10 for the gliding condition. The stick-fixed and stick-free neutral points were determined from the slopes of curves of this type. The neutral points for a given lift coefficient are defined as the center-of-gravity positions at which the slopes $\frac{d\delta_e}{dC_N}$ and $\frac{d\frac{F_e}{q_c}}{dC_N}$ are zero. The determination of the neutral points in the clean rated-power, gliding, landing, and wave-off conditions for several normal-force coefficients is shown in figures 11 through 14. Figure 15 shows the variation of stick-fixed and stick-free neutral points with normal-force coefficient.

The requirements of reference 2 state that with the center of gravity at its rearward limit, the variation of elevator angle with speed must have a stable slope within the speed range specified for a given flight condition and the variatio of the elevator stick force with speed shall be such that the forces are zero only at trim speed and that push forces are required to increase speed from trim and pull forces to decrease speed. Information received from the British Air Commission indicated that the permissible aft center-of-gravity limit was at 36 percent mean aerodynamic chord. It was assumed that this limit was with the landing gear down and would therefore be 37.5 percent mean aerodynamic chord with the landing gear retracted. The normal center-of-gravity position for the test airplane at take-off was at approximately 35.5 percent mean aerodynamic chord with the landing gear down. The only substantial variation beside that due to the landing gear was due to fuel consumption which could cause forward shifts of the center-of-gravity position of as much as 4 percent mean aerodynamic chord. Since the normal center-of-gravity position was close to the rearward limit, the longitudinal stability is discussed in terms of the normal center-of-gravity position. Slightly further aft loadings would occur if the long-range tanks were replaced with four 500-pound bombs.

The following conclusions were reached regarding the static longitudinal stability of the F-8 airplane from examination of figures 6 to 9 and 15:

1. Rated-power, clean condition

Above 150 miles per hour the airplane was unstable stick fixed and neutrally stable stick free with the normal center-of-gravity position, 37 percent mean aerodynamic chord, when trimmed for level flight (280 miles per hour).

2. Gliding condition

Above 150 miles per hour the airplane was unstable stick fixed, but was stable stick free with the normal center-of-gravity position throughout the speed range. There was some indication of decreasing stick-free stability above 300 miles per hour. The trimming tab settings were the same as in the rated-power clean condition. Note: The preceding conditions correspond to the diving condition of reference 2 but only extend to 80 percent of the maximum diving speed.

3. Landing condition

With the normal center-of-gravity position, 35.5 percent mean aerodynamic chord, the airplane was slightly unstable stick fixed and stick free except at the stalling speed when trimmed at 130 miles per hour.

4. Wave-off condition

With the normal center-of-gravity position the airplane was unstable stick fixed and stick free when trimmed at 130 miles per hour.

5. Approach condition

With the normal center-of-gravity position, 35.5 percent mean aerodynamic chord, the airplane would be unstable stick fixed and stick free for a trim speed of 120 miles per hour.

6. Cruising maximum-range condition

The airplane would be neutrally stable both stick fixed and stick free with the center of gravity at 37 percent mean aerodynamic chord when trimmed for level flight at 180 miles per hour.

7. Cruising condition

The stability in the cruising condition was estimated by analysis of the data for the rated-power, clean, and gliding conditions. Except below approximately 150 miles per hour the airplane would be unstable stick fixed. The airplane would be stable stick free with the normal center-of-gravity position, 37 percent mean aerodynamic chord.

8. General

The static longitudinal stability requirements of reference 2 were not satisfied in any case except that stick-free stability existed in the cruising and gliding conditions. The gradient of control force with indicated airspeed whether stable or unstable was small except near the stall. Both stick-fixed and stick-free stability increased near the stall in all conditions except wave off.

3-A Longitudinal control

1. Longitudinal control in accelerated flight

a. Turns

The longitudinal stability and control characteristics in accelerated flight were investigated in turns made in the rated-power, clean condition at an altitude of approximately 10,000 feet. A time history of a 3g, 180° left turn at 280 miles per hour is presented in figure 16. Spot records were obtained in steady turns at 170, 230, and 290 miles per hour at various accelerations. Figure 17 presents curves of the variation of elevator control force with normal acceleration at each speed for four center-of-gravity positions. Figure 18 shows the variation of elevator position with airplane normal-force coefficient in the turns.

The stick-fixed maneuver points were determined for a normal-force coefficient at the middle of the range covered for each speed as the center-of-gravity positions where values of the slope $d\delta_e/dC_N$ are zero in figure 19. The stick-fixed maneuver point was at approximately 34 percent mean aerodynamic chord at an indicated airspeed of 290 miles per hour and a normal-force coefficient of 0.4 and moved aft with decreasing speed or increasing normal-force coefficient.

The approximate change in elevator control force in turns at 2g and 3g with change in indicated airspeed, shown in figure 20 at the four test center-of-gravity positions, was determined by cross-plotting the data of figure 17. The stick-free maneuver points were determined from figure 17 for an acceleration at the middle of the range covered at each speed. The stick-free maneuver points are the center-of-gravity positions where values of the slope dF_e/dn are zero in figure 19. The symbol n represents normal acceleration in gravitational units. The stick-free maneuver point for a 2g turn at 290 miles per hour was at approximately 39 percent mean aerodynamic chord and moved aft as the speed decreased.

With the center of gravity at the normal position, approximately 37 percent mean aerodynamic chord with the landing gear retracted, the F-8 airplane was stable stick fixed for low-speed turns at rated power. The stability decreased with speed until it became negative at 230 miles per hour for lift coefficients below 0.65 and at 290 miles per hour throughout the test range of lift coefficients. However, the dangerous aft center-of-gravity limit, defined as the point where the force per g becomes zero, was always aft of 39 percent mean aerodynamic chord. The pilot noticed that the stick-fixed stability in turns was approximately neutral but did not consider it to be objectionable since the force was always in the right direction.

b. Abrupt pull-ups

The elevator control force and response to elevator control were investigated in abrupt pull-ups in the clean condition with power for level flight at 200 miles per hour in which the elevator was deflected rapidly and returned to neutral and fixed. The elapsed time required to deflect and return the elevator was varied. This type of maneuver has been used in some previous tests to investigate undesirable control force characteristics observed to occur in rapid maneuvers with closely balanced elevators. Time histories of typical abrupt pull-ups are given in figure 21. The variation of the gradient of stick force per unit acceleration F_e/n with the elapsed time to deflect and return the elevator is presented in figure 22. The increase in force for a given acceleration with the rapidity of the maneuver is approximately proportional to the increase in elevator deflection required. This is an exploratory test for which no definite requirements have been set up. However, the increase of the force per g with the rapidity of the maneuver was considered to be satisfactory and no undesirable characteristics in rapid maneuvers were noted.

c. Acceleration due to cooling shutters

An investigation was made at moderate speeds of the effectiveness of the cooling shutters as dive recovery flaps. The shutters are shown in figure 1. The shutters extended from the fuselage

to the nacelle on the forward part of the under surface of the wing and had a chord of 8.5 inches. The deflection between closed and open position under no load was 13.5°. Time histories of normal acceleration and of the position of the free elevator produced by opening the shutters after the airplane had been trimmed at 200, 250, and 300 miles per hour in the clean condition with power for level flight are presented in figure 23. The resulting normal acceleration increased steadily with speed and was approximately 2.2g at 300 miles per hour. This limited investigation indicates the possibility that radiator shutters of this type could also be made to serve as dive recovery flaps.

2. Longitudinal control in landing

The longitudinal control in landing was satisfactory. With the center of gravity at 35 percent landing gear down, about 12° of up-elevator deflection or about one-half of that available was required to land. The corresponding control force required in landing when the force had been trimmed to zero at 125 miles per hour in the landing condition was approximately 50 pounds, pull. This force was equal to the maximum considered satisfactory by the standards of reference 2. A time history of a typical landing was presented in reference 1.

In connection with the landing tests rough measurements were made of the rate of descent of the F-8 at a wing loading of 42 pounds per square foot with two flap settings in the landing condition (landing gear down, engines idling). Figure 24 presents plots of rate of descent as a function of indicated airspeed at an altitude of approximately 8000 feet and at sea level for the two flap settings. The rate of descent at an indicated airspeed of 120 miles per hour (120 percent of the stalling speed) at sea level was about 33 feet per second with the flaps fully deflected or about 25 feet per second with the flaps half deflected. It was indicated in reference 3, in the case of the B-26 airplane, that 25 feet per second was the maximum rate of descent which the pilot considered to be acceptable. Landings of the Mosquito were usually made with some power to reduce the rate of descent somewhat.

3. Longitudinal control in take-off

The power of the elevator to control the longitudinal attitude during take-off was easily adequate. However, due to the poor directional control, which was discussed in reference 1, raising the tail at low speeds was likely to result in violent yawing tendencies. A time history of a take-off in which the tail was raised at approximately 45 miles per hour with the center-of-gravity at 35.5 percent mean aerodynamic chord using 8° or about one-third down elevator deflection was presented in reference 1.

4. Longitudinal trimming control

The variation with speed of the power of the elevator trimming tab in terms of pounds of control force per degree of tab deflection is presented in figure 25 for the four principal flight conditions. The tabs on both elevators acted as both trimming and balancing tabs. The change in elevator hinge moment coefficient per degree of trimming tab deflection was about 0.004 except in the rated-power, clean condition at low speeds where the value approached 0.006. It was possible to trim the elevator control forces to zero throughout the test center-of-gravity range in any condition from the highest speed reached to within a few percent of the stalling speed.

5. Trim changes due to flaps and power

The longitudinal trim changes due to flaps, landing gear, and power with the center of gravity at 32 percent mean aerodynamic chord (landing gear down) and with the elevator trimming tab set 4.9° up from the elevator at 130 miles per hour were measured to be as follows:

Position of		Power setting	Approximate elevator control force (lb)
Flaps	Landing gear		
Down	Down	Level flight (2650 rpm, -4 psi)	1 pull
Down	Down	Engines idling	7.5 pull
Down	Down	Rated (2650 rpm, 7 psi)	5 push
Down	Up	Rated (2650 rpm, 7 psi)	18 push
Up	Up	Rated (2650 rpm, 7 psi)	18.5 pull
Up	Up	2650 rpm, -4 psi	27 pull
Up	Up	Engines idling	18.5 pull

The trim changes were not excessive by the standards of reference 1, but the nosing-up tendency due to lowering the flaps was considered to be objectionable.

6. Pitching moment due to sideslip

The pitching moment due to sideslip has been discussed in reference 1. In power-on conditions of flight an undesirable pitching moment due to sideslip and due to yawing velocity existed which made it difficult to trim the airplane in rough air.

CONTROL FRICTION

The friction in the elevator, rudder, and aileron systems was measured on the ground at about 70° F in terms of control forces. As shown below the aileron friction requirement of reference 2 was not quite satisfied on the test airplane.

Control	Friction at neutral deflection (lb)	Maximum allowable friction at neutral deflection (lb)
Elevator	±5	±7
Rudder	±5	±20
Aileron	±4	±3.5

STALLING CHARACTERISTICS

Time histories of a stall approach and stall in the rated-power, clean, gliding, landing, and wave-off conditions are given in figures 26 through 29. The stalling characteristics were good in all conditions. Stall warning consisted of mild to severe buffeting accompanied by pitching oscillations. Marked up-elevator motion and an increase in pull force occurred near the stall except in the wave-off condition, where the warning was less noticeable. Lateral control could be maintained with the ailerons after the buffeting and pitching occurred. At the stall there was a snatching of the ailerons and the airplane rolled off usually to the left. To recover from the stall a downward movement of the elevator was all that was required.

A time history of a 2g right windup turn to the stall made in the rated-power, clean condition is shown in figure 30. Near the stall there was an increase of pull force and up-elevator deflection and some buffeting of the rudder.

From the data of the stall tests an approximate determination of maximum normal-force coefficient was made. In the calculations account has been taken of the effect of fuel consumption on the weight and of variation in normal acceleration from 1g. Three stall runs were available in each condition. The maximum scatter in the results was about ±0.1. The following table presents average values of maximum normal-force coefficient and the corresponding indicated airspeeds:

Condition	V_i	$C_{N_{max}}$
Rated power clean	90	1.6
Gliding	115	1.25
Landing	100	1.55
Wave off	80	2.45
Approach	82	2.3

CONCLUSIONS

The results of the tests to determine the longitudinal stability and control characteristics of an F-8 airplane (AAF No. 43-334690) may be summarized as follows:

1. Short-period longitudinal oscillations were satisfactorily damped. However, there was a tendency for the stick to bounce in rough air.

2. At the normal center-of-gravity position, 37 percent mean aerodynamic chord with the landing gear up, the airplane was slightly unstable stick fixed and stick free in all conditions except that there was positive stability, stick free in the gliding and cruising maximum-range conditions, and also neutral stability stick fixed in the cruising maximum-range condition.

3. At the normal center-of-gravity position 37 percent mean aerodynamic chord during turns in the rated-power, clean condition the airplane was unstable stick fixed at 230 miles per hour for lift coefficients below 0.65 and at 290 miles per hour throughout the test range of lift coefficients. The stick-free stability was positive over the test range of speeds and lift coefficients. The range of force per g values encountered in the tests was between 7 and 35 pounds per g. Both of these values are within the range specified for the F-8 airplane. The dangerous aft center-of-gravity limit was at 39 percent mean aerodynamic chord where the force per g became zero. The control forces required for abrupt elevator motions were satisfactorily large.

4. There was always sufficient elevator deflection for longitudinal control during take-off and landing or to reach the stall in straight or turning flight.

5. The power of the elevator trimming tabs was adequate and the trim changes due to flaps, power, and landing gear were not excessive. However, the direction of the trim change due to lowering the flaps, a nosing-up tendency, was considered to be objectionable.

6. The stalling characteristics were very good. There was adequate stall warning in the form of buffeting and a marked increase in stability near the stall. The stall warning was less pronounced in the wave-off condition. As the stall developed a pitching oscillation usually ensued followed by a roll off to the left. Control could be maintained beyond the stall and recovery was accomplished by simply pushing the wheel forward.

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2. Anon.: Stability and Control Requirements for Airplanes. AAF Specification No. C-1815, August 31, 1943.

3. Gustafson, F. B., and O'Sullivan, William J., Jr.: The Effect of High Wing Loading on Landing Technique and Distance, with Experimental Data for the B-26 Airplane. NACA ARR No. L4K07, 1945.

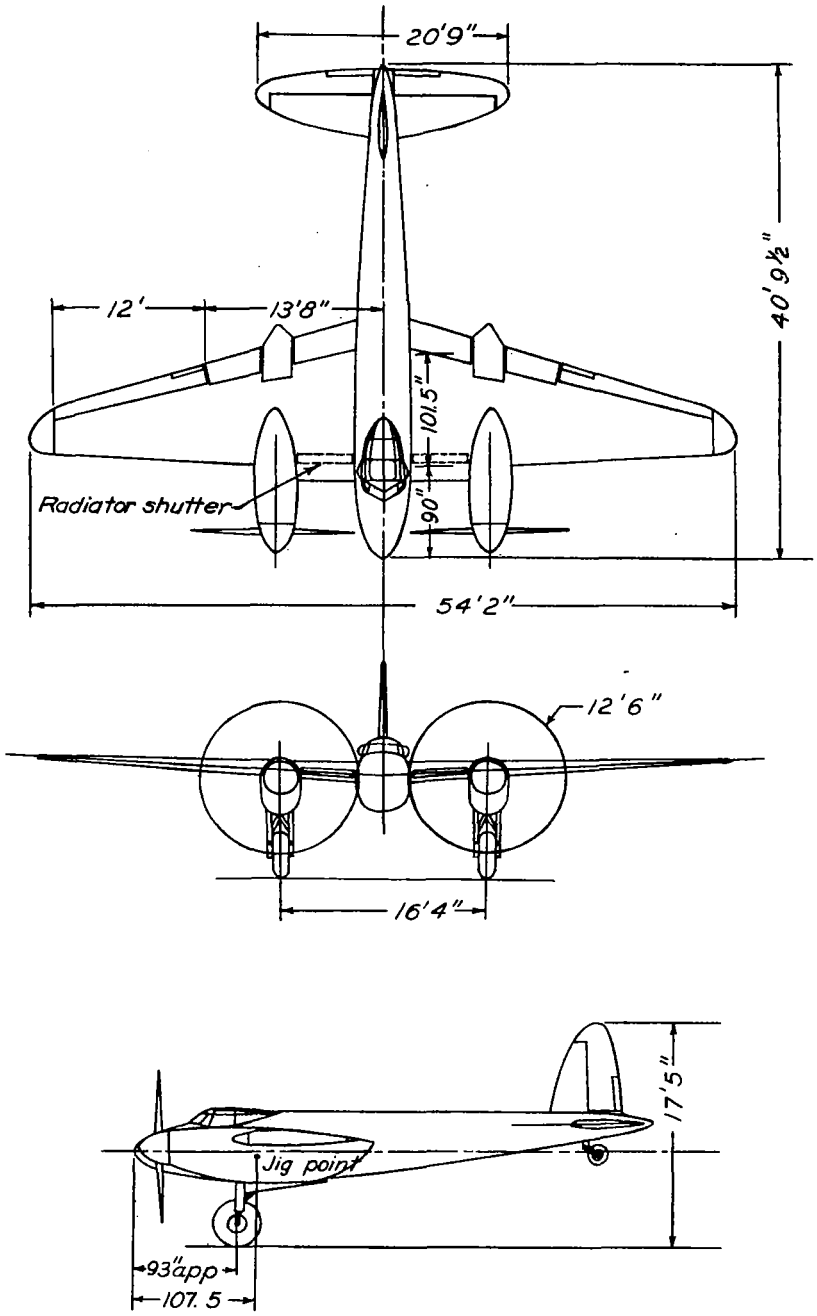

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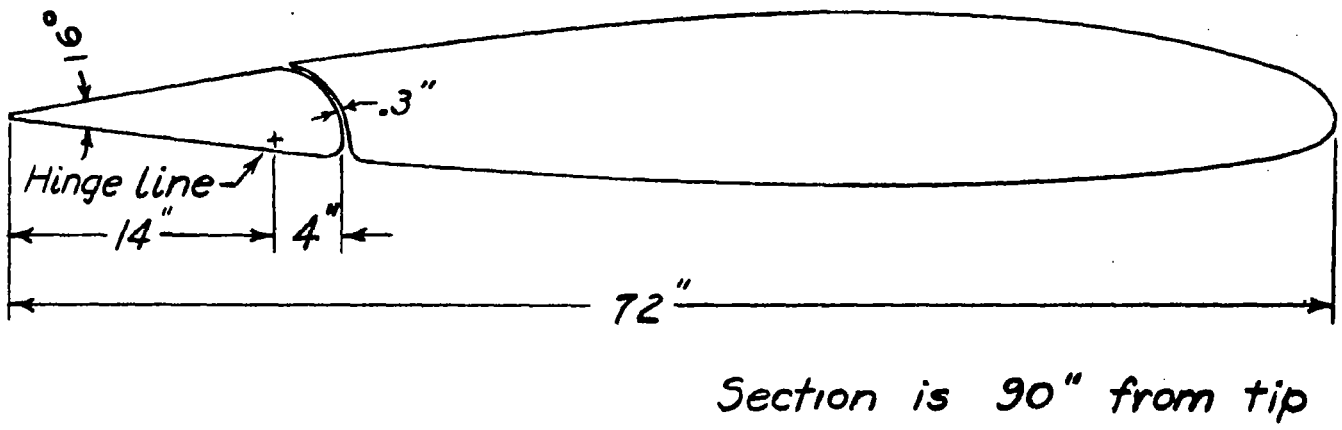
Figure 1. - Three-view drawing of DeHavilland Mosquito F-5 airplane.



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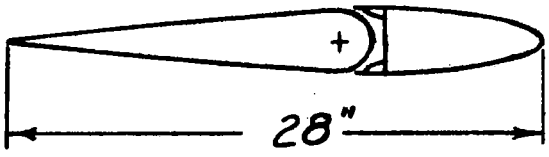
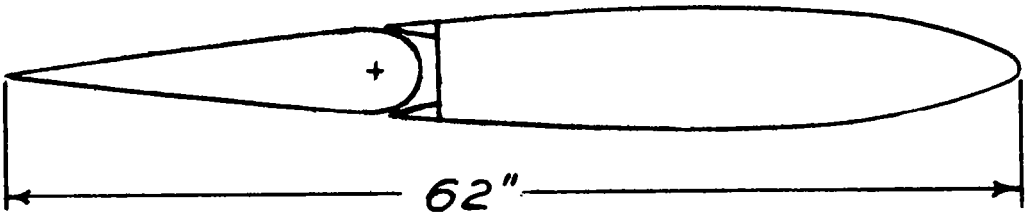
(a) Wing and aileron

Figure 2. - Section views of control surfaces. De-Havilland Mosquito F-8 airplane.



Vertical tail at tip of fin



Horizontal tail 26" from centerline

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(b) Horizontal and vertical surfaces
Figure 2. - Concluded.

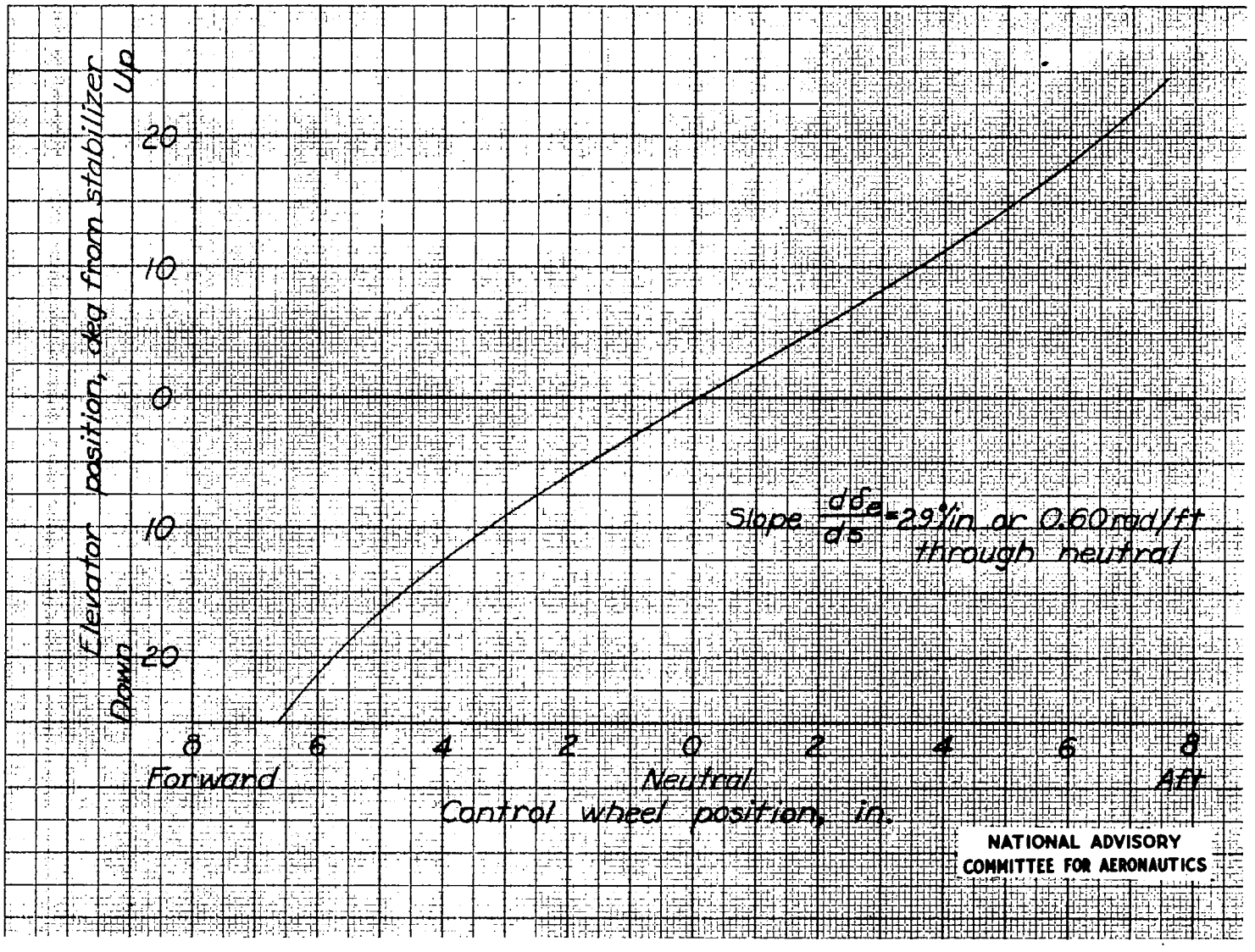


Figure 3. - Linkage of control wheel and elevator, DeHavilland Mosquito F-8 airplane.

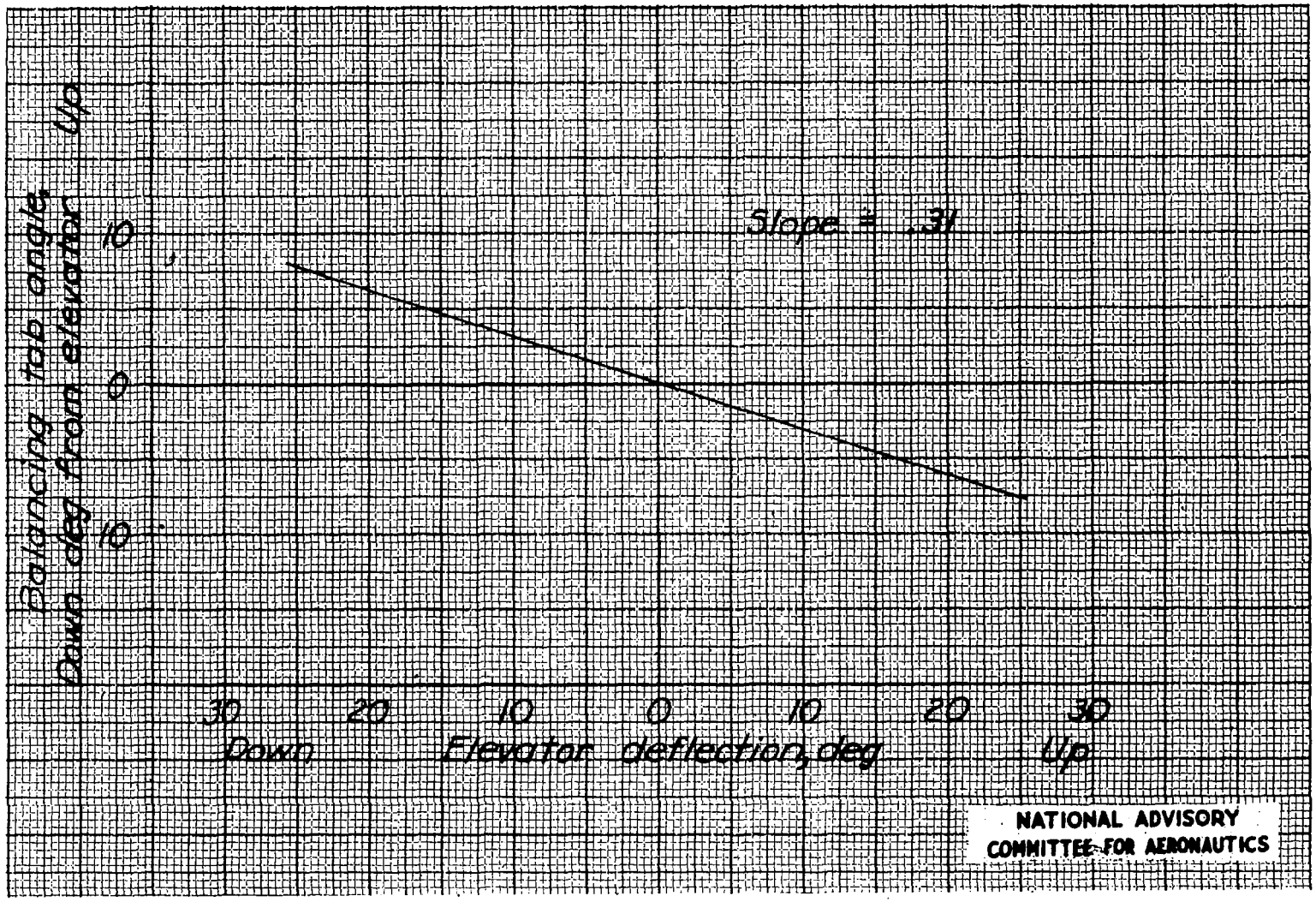
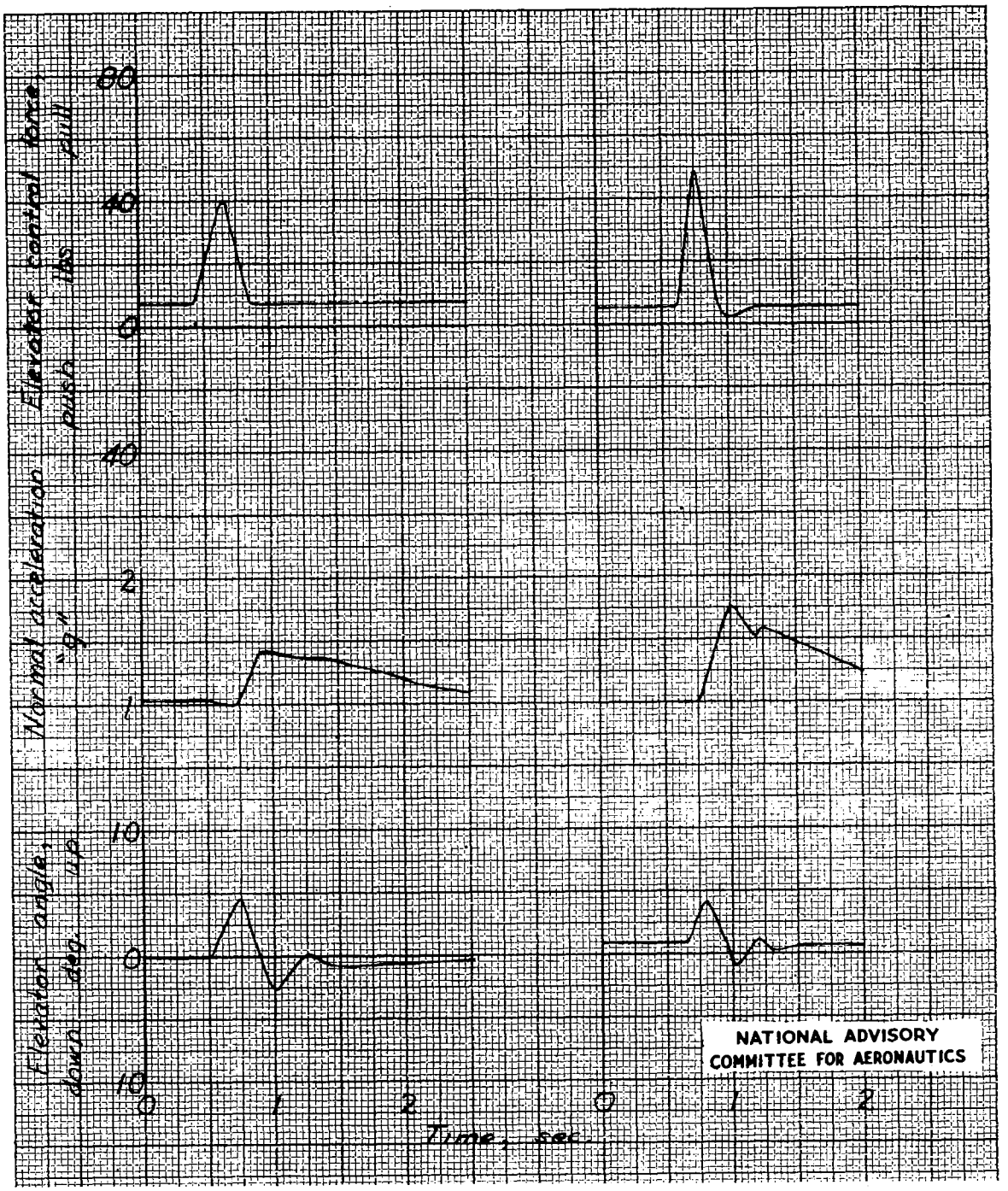


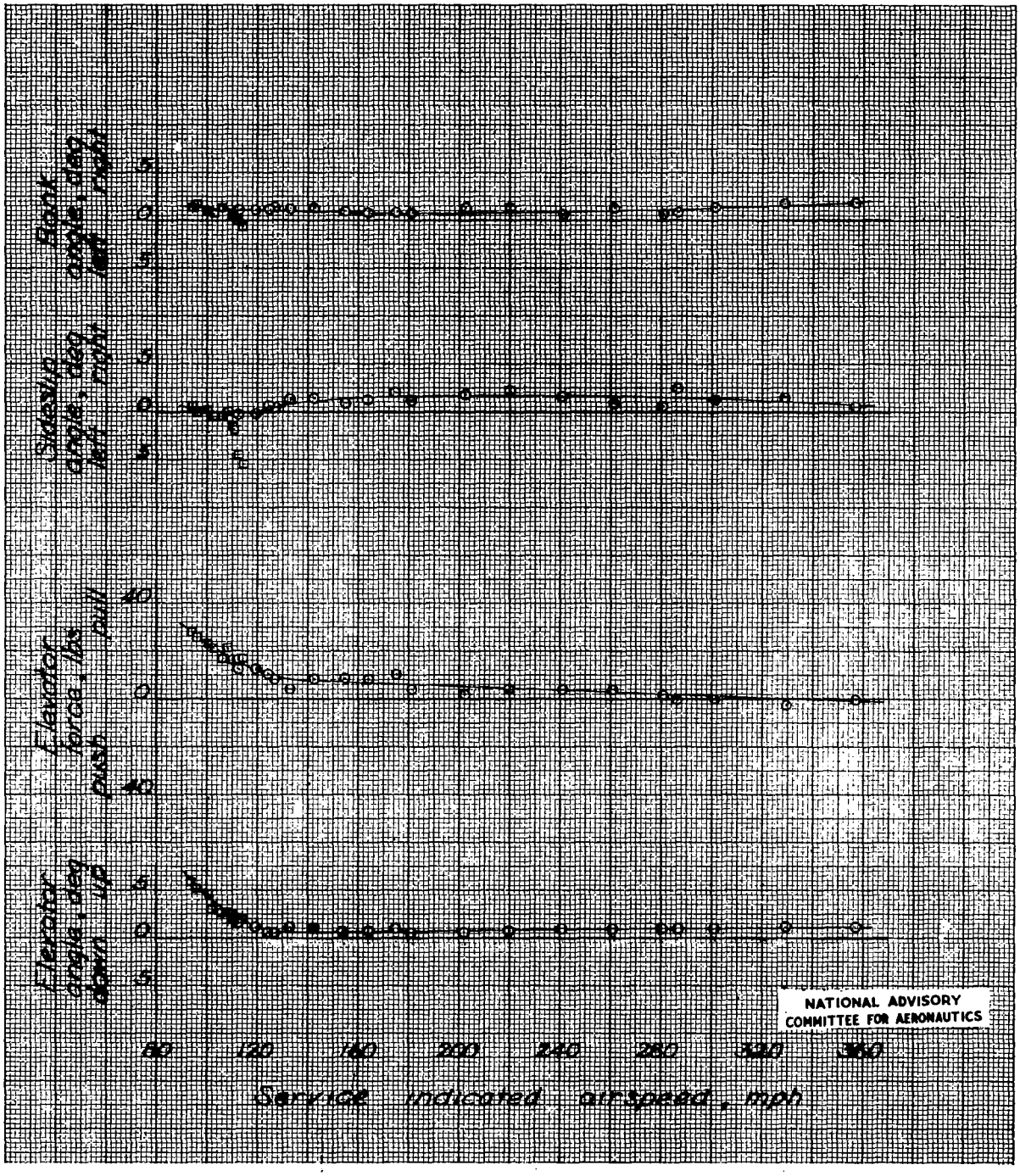
Figure 4. - Elevator balancing tab linkage, De-Havilland Mosquito F-8 airplane. (Tabs on each elevator are both trimming and balancing tabs)



(a). V_i = 150 miles per hour, rated power.

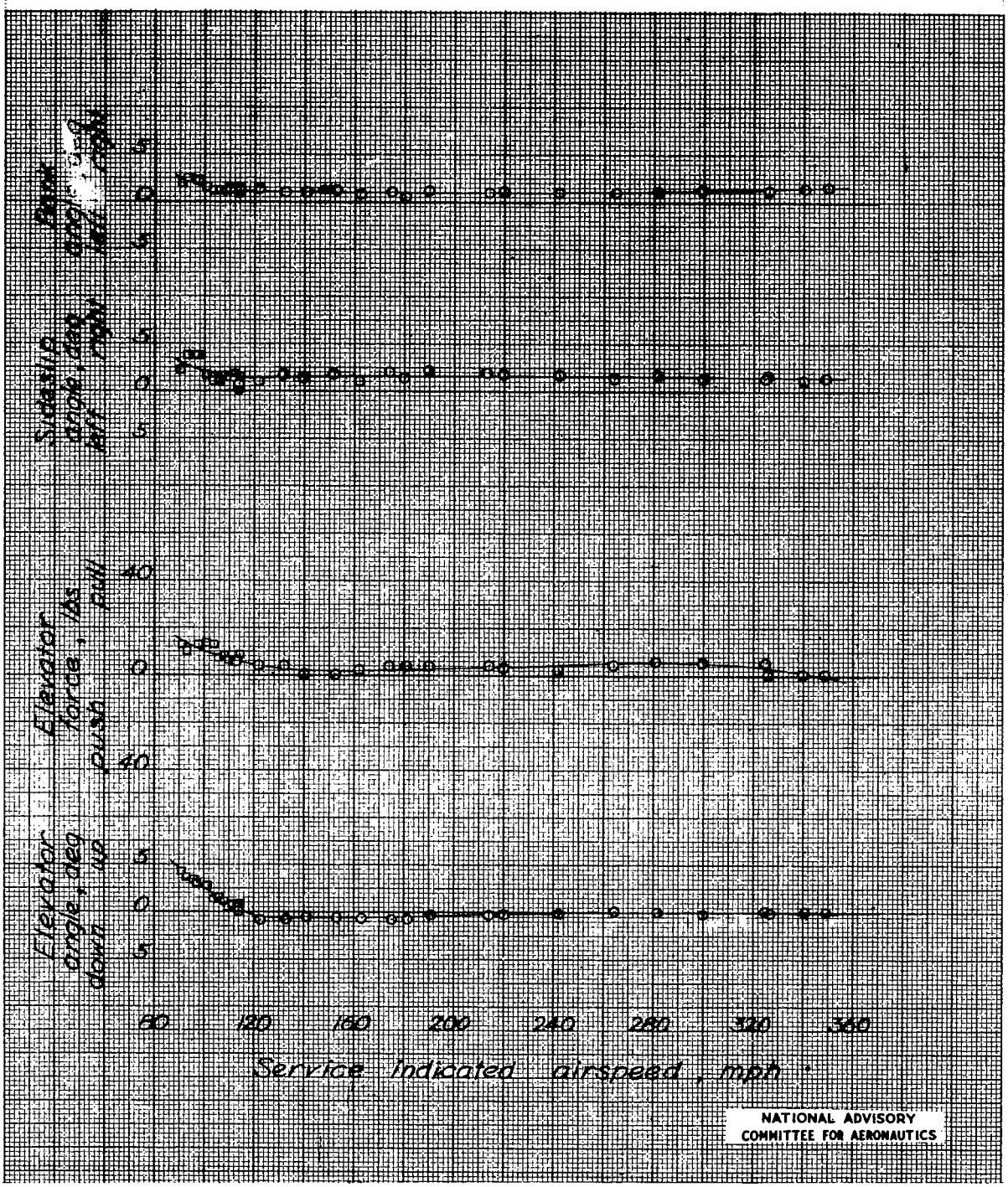
(b). V_i = 250 miles per hour, engines idling.

Figure 5. - Short period longitudinal oscillations in the clean condition with the center of gravity at 36 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.



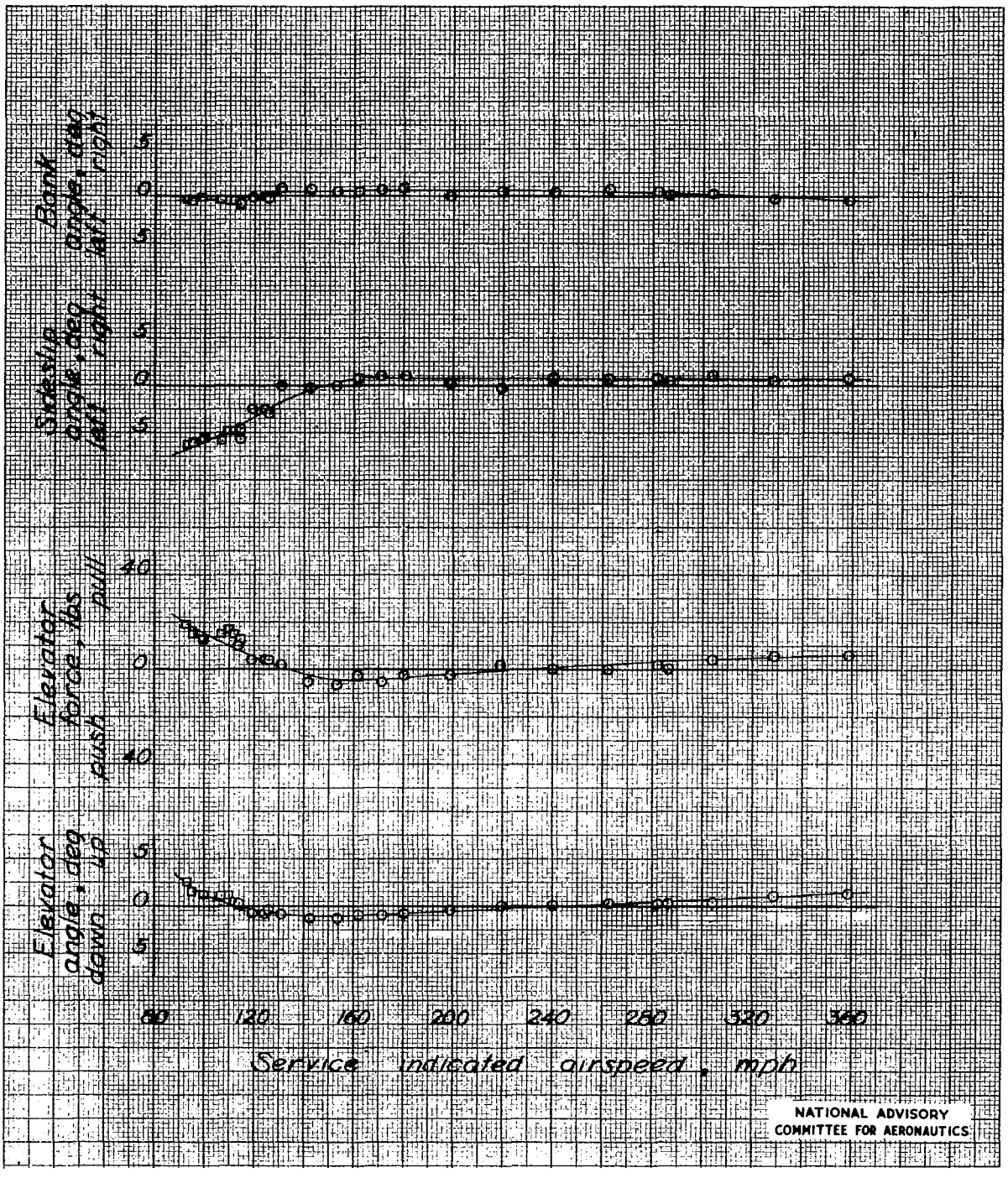
(a). Center of gravity at 33.4 percent mean aerodynamic chord, elevator trimming tabs 1.8 degrees up from the elevator.

Figure 6. - Static longitudinal stability characteristics in the rated-power clean condition (2650 rpm, 7 psi boost at 6,000 to 10,000 feet, shutters closed, flaps up, landing gear up), DeHavilland Mosquito F-8 airplane.



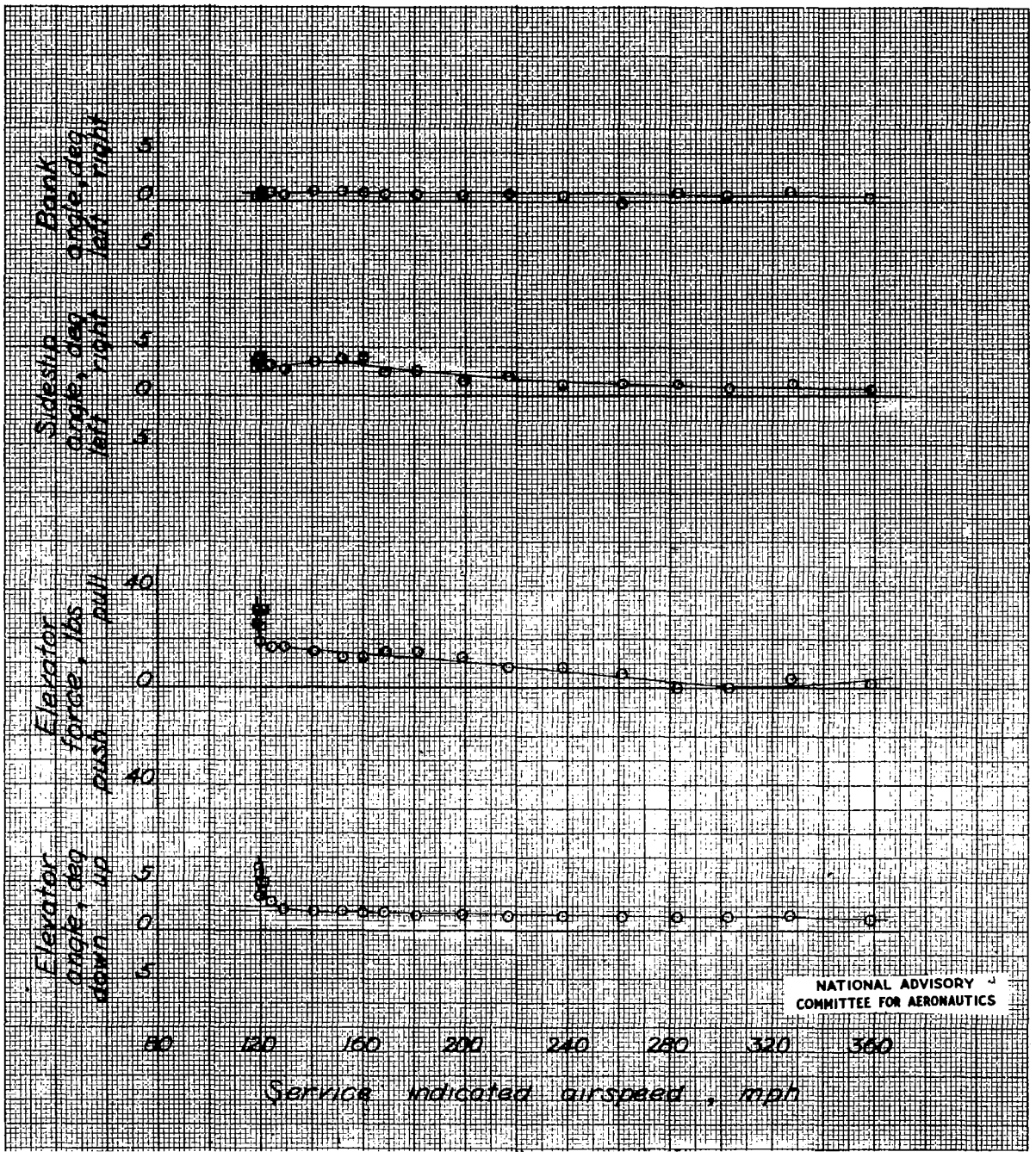
(b). Center of gravity at 36.8 percent mean aerodynamic chord, elevator trimming tabs 1.9 degrees up.

Figure 6. - Continued.



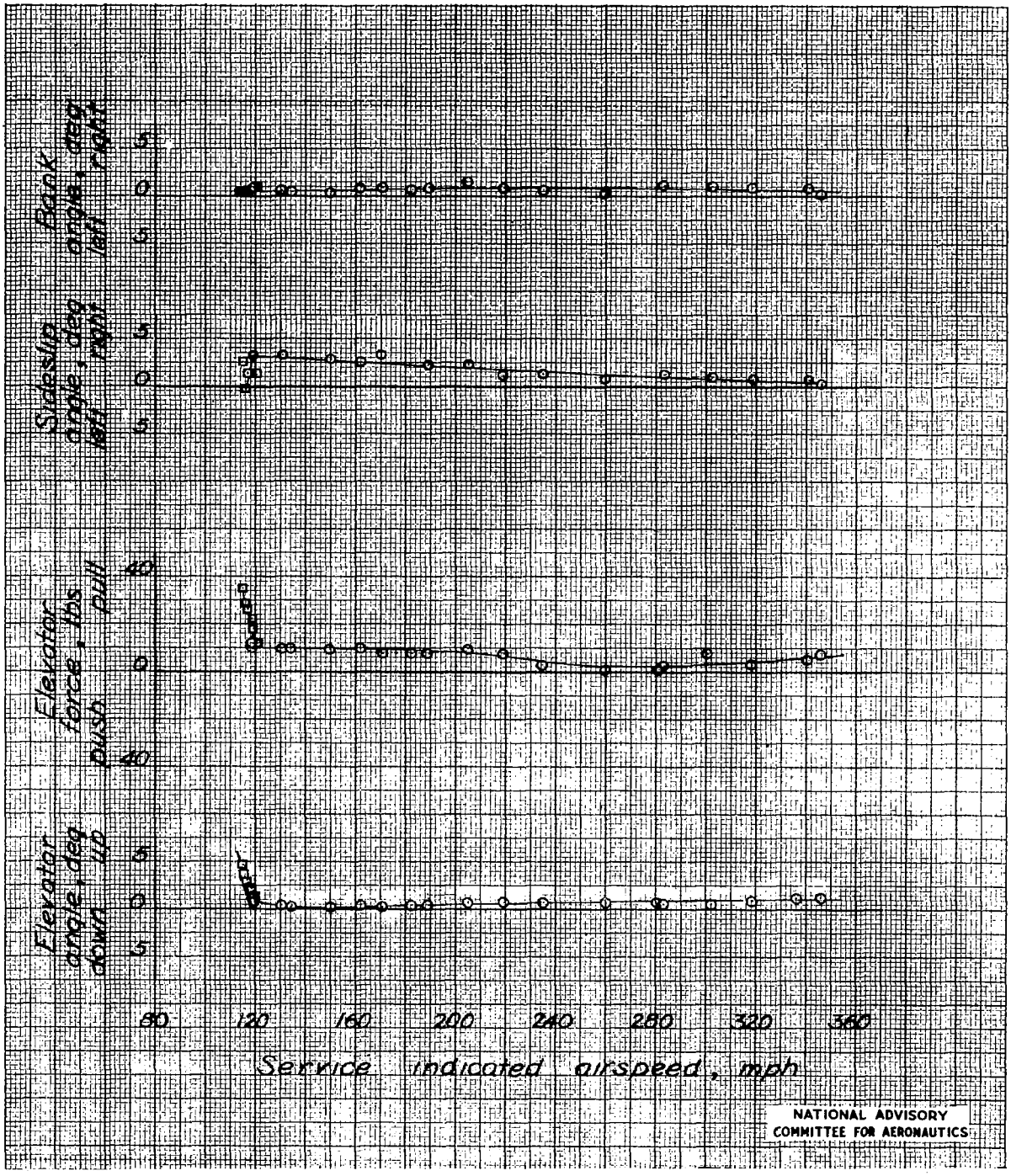
(c). Center of gravity at 38.2 percent mean aerodynamic chord, elevator trimming tabs 2.3 degrees up.

Figure 6. - Concluded.



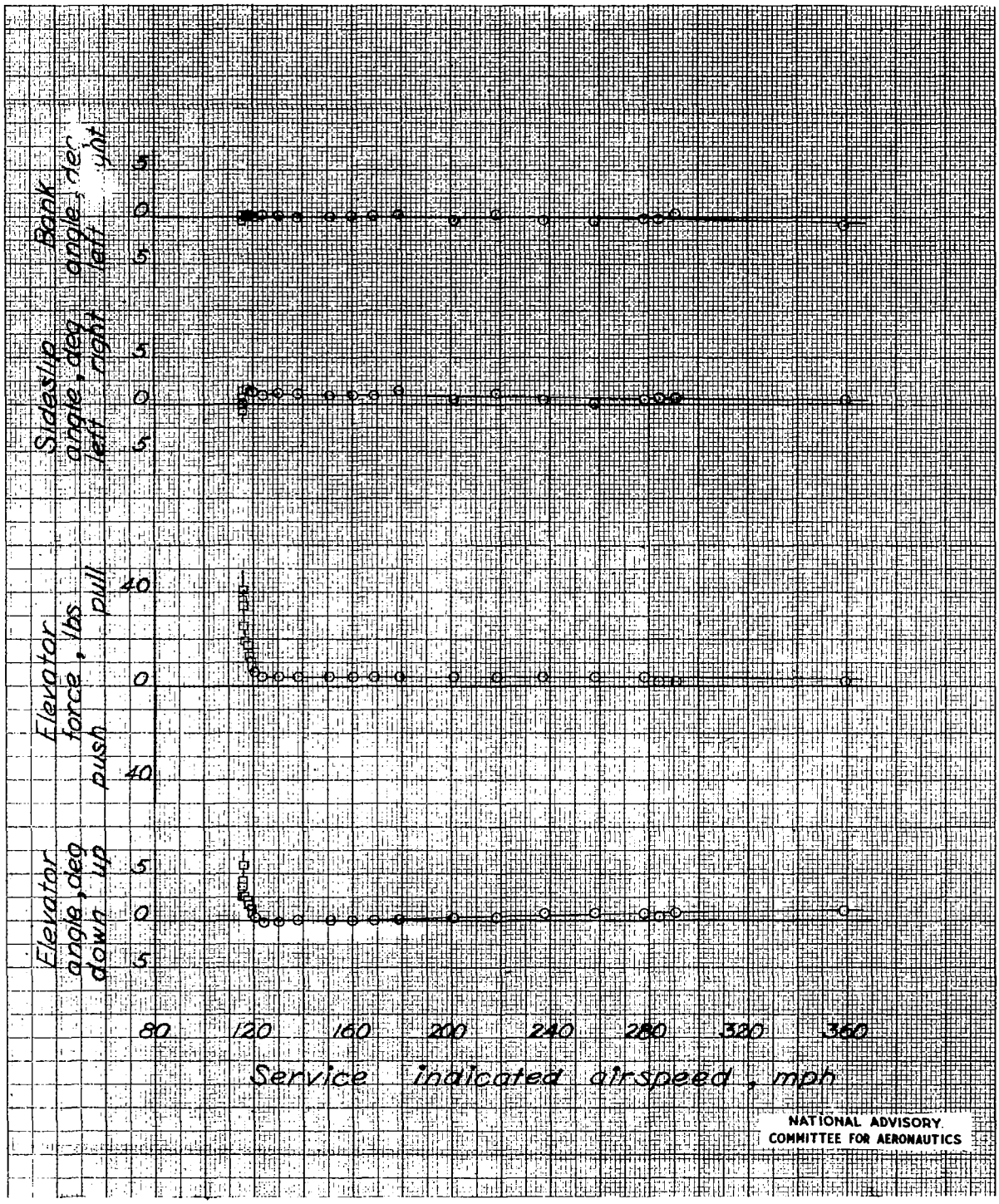
(a) Center of gravity at 33.2 percent mean aerodynamic chord, elevator trimming tabs 1.2 degrees up.

Figure 7. - Static longitudinal stability characteristics in the gliding condition (engines idling, at 6,000 to 10,000 feet, shutters closed, flaps up, landing gear up) De-Havilland Mosquito F-8 airplane.



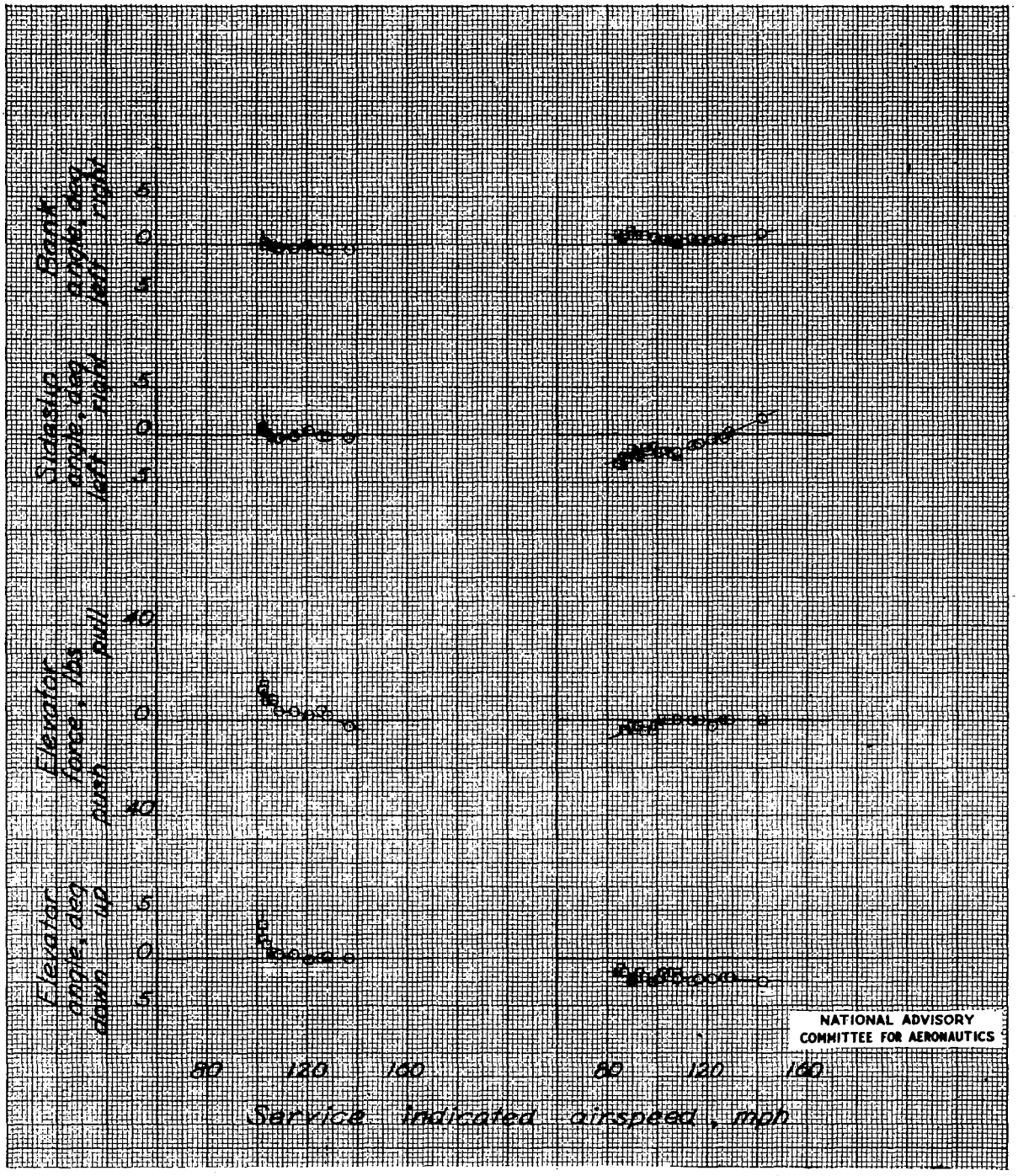
(b). Center of gravity at 36.4 percent mean aerodynamic chord, elevator trimming tabs 2.0 degrees up.

Figure 7. - Continued.



(c). Center of gravity at 38.0 percent mean aerodynamic chord, elevator trimming tabs 2.1 degrees up.

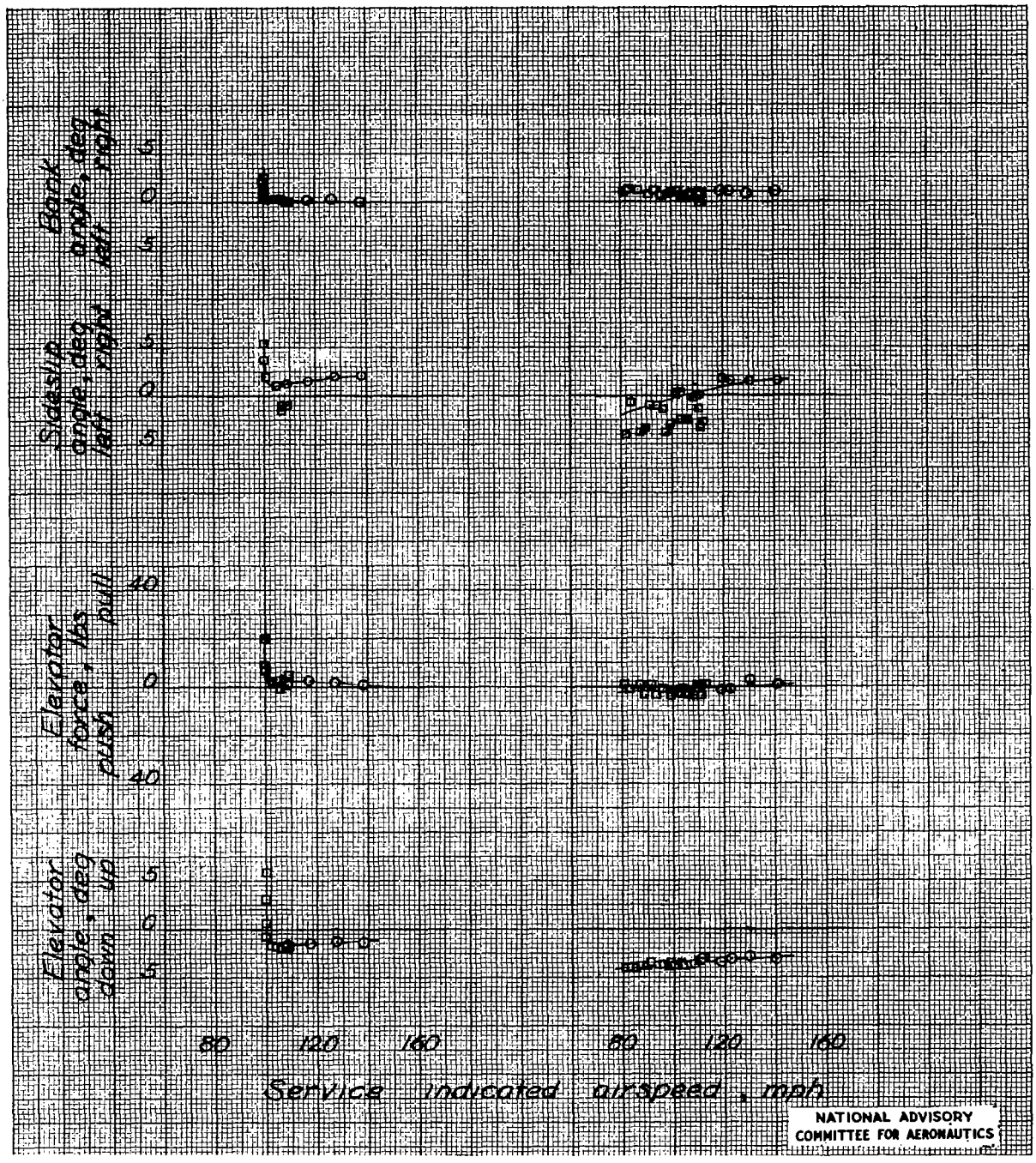
Figure 7. - Concluded.



(a). Landing condition, engines idling, center of gravity at 32.0 percent mean aerodynamic chord, elevator trimming tabs 2.6 degrees up

(b). Wave-off condition, rated power (2650 rpm, 7 psi boost), center of gravity at 31.9 percent mean aerodynamic chord, elevator trimming tabs 5.6 degrees up.

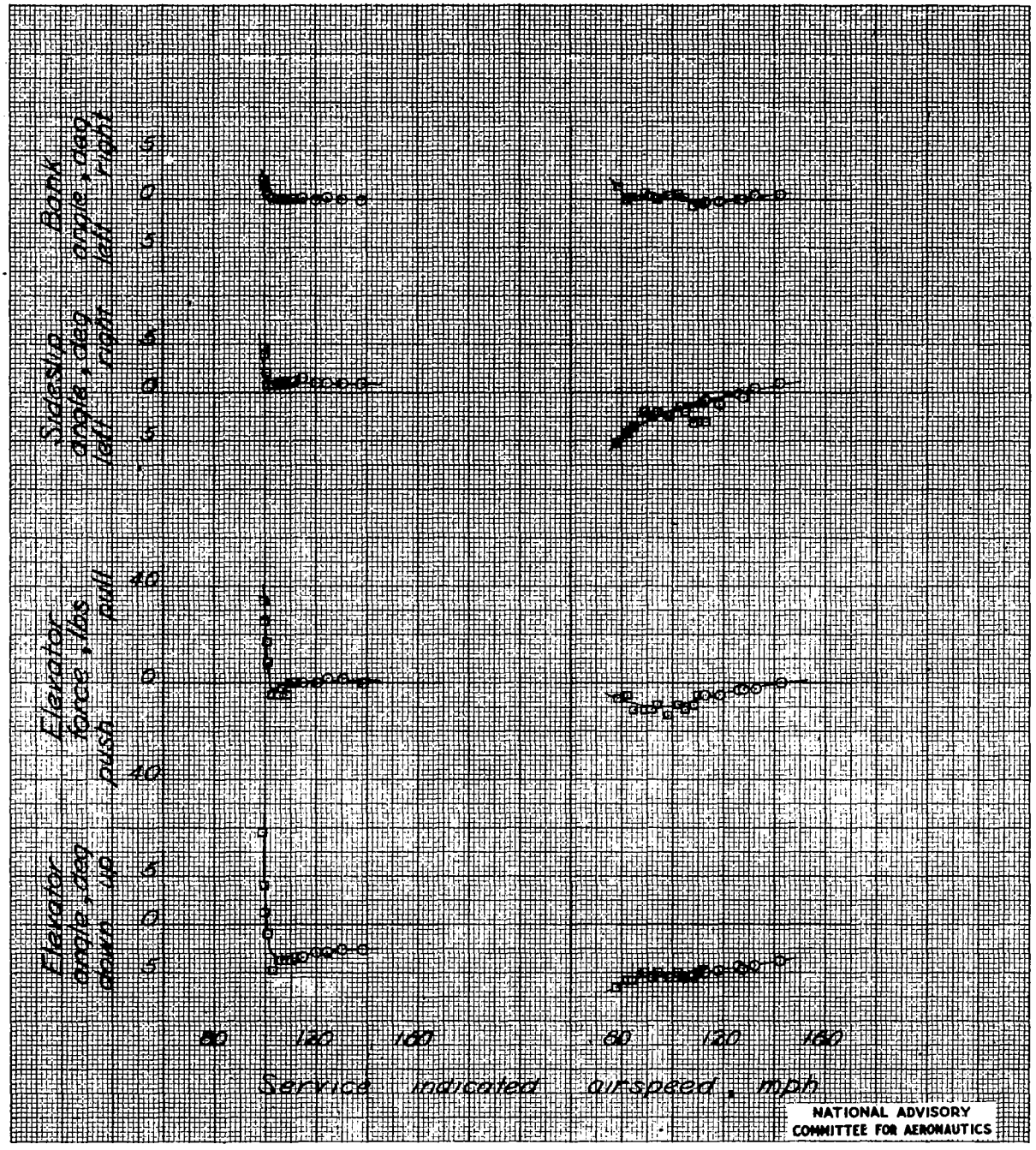
Figure 8. - Static longitudinal stability characteristics with the flaps and landing gear down, at 6,000 to 10,000 feet, shutters open. DeHavilland Mosquito F-8 airplane.



(c). Landing condition, center of gravity at 34.6 percent mean aerodynamic chord, elevator trimming tabs 3.8 degrees up.

(d). Wave-off condition, center of gravity at 34.4 percent mean aerodynamic chord, elevator trimming tabs 7.2 degrees up.

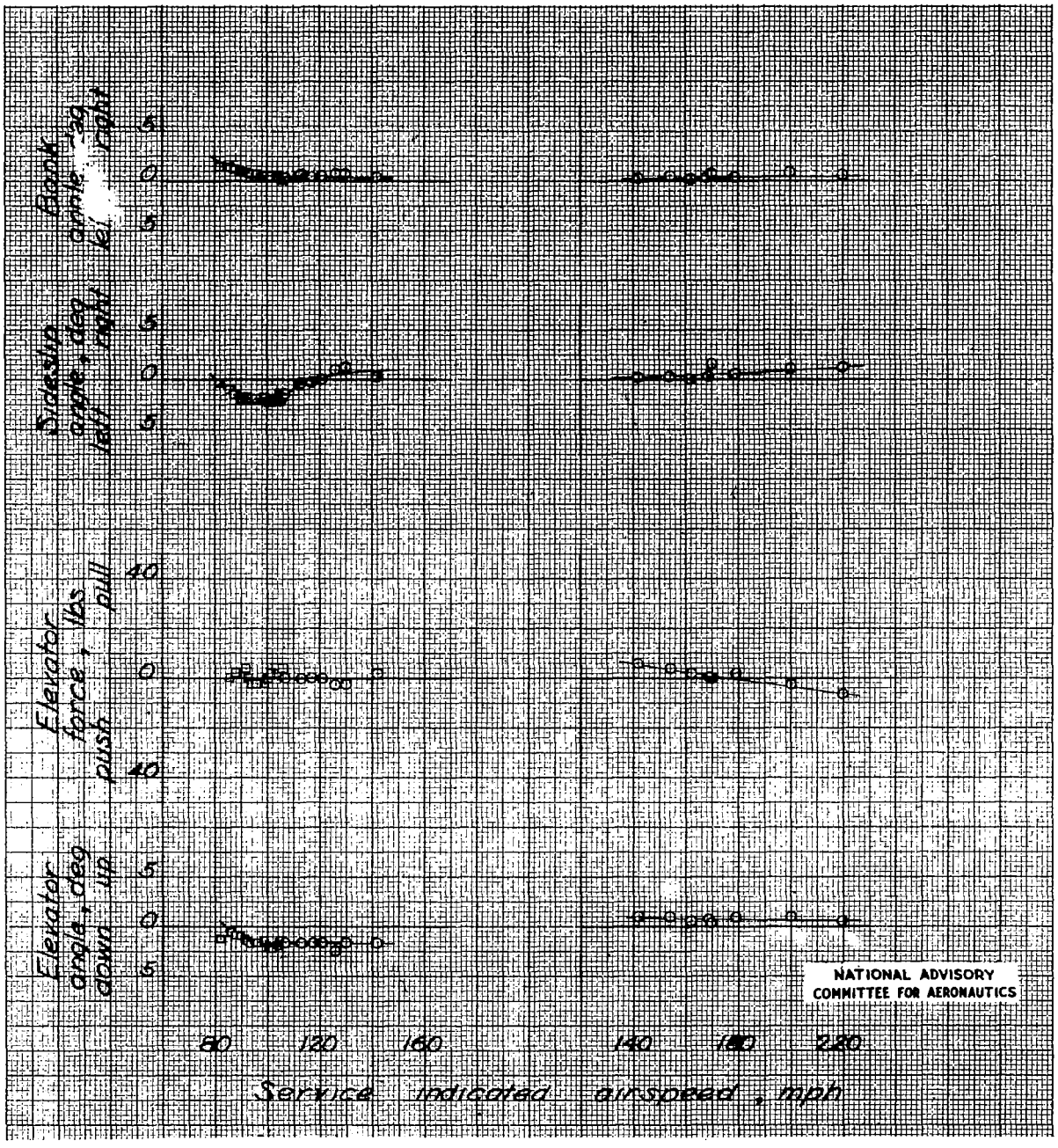
Figure 8. - Continued.



(e) Landing condition, center of gravity at 36.1 percent mean aerodynamic chord, elevator trimming tabs 7.2 degrees up.

(f). Wave-off condition, center of gravity at 36.2 percent mean aerodynamic chord, elevator trimming tabs 7.2 degrees up.

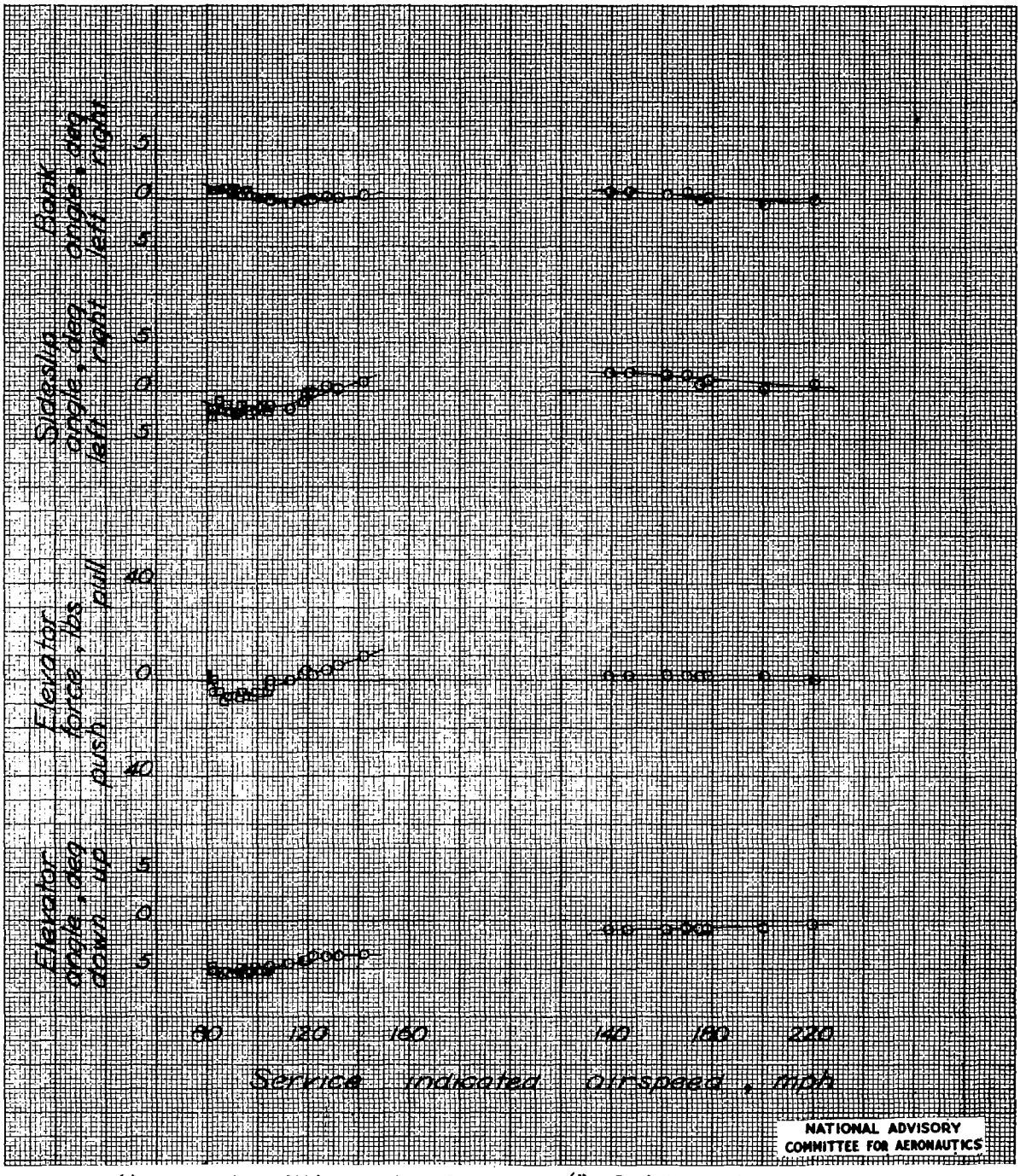
Figure 8. - Concluded.



(a). Approach condition, (flaps down, landing gear down, 2650 rpm, 0 boost, shutters open), center of gravity at 31.8 percent mean aerodynamic chord, elevator trimming tabs 5.1 degrees up.

(b). Cruising, maximum range conditions (flaps up, landing gear up, 2650 rpm, 4 psi boost, shutters open), center of gravity at 33.3 percent mean aerodynamic chord, elevator trimming tabs 1.8 degrees up.

Figure 9. - Static longitudinal stability characteristics at 6,000 to 10,000 feet, DeHavilland Mosquito F-8 airplane.



(c). Approach condition, center of gravity at 36.0 percent mean aerodynamic chord, elevator trimming tabs 7.2 degrees up.

(d). Cruising maximum-range condition, center of gravity at 37.5 percent mean aerodynamic chord, elevator trimming tabs 2.8 degrees up.

Figure 9. Concluded.

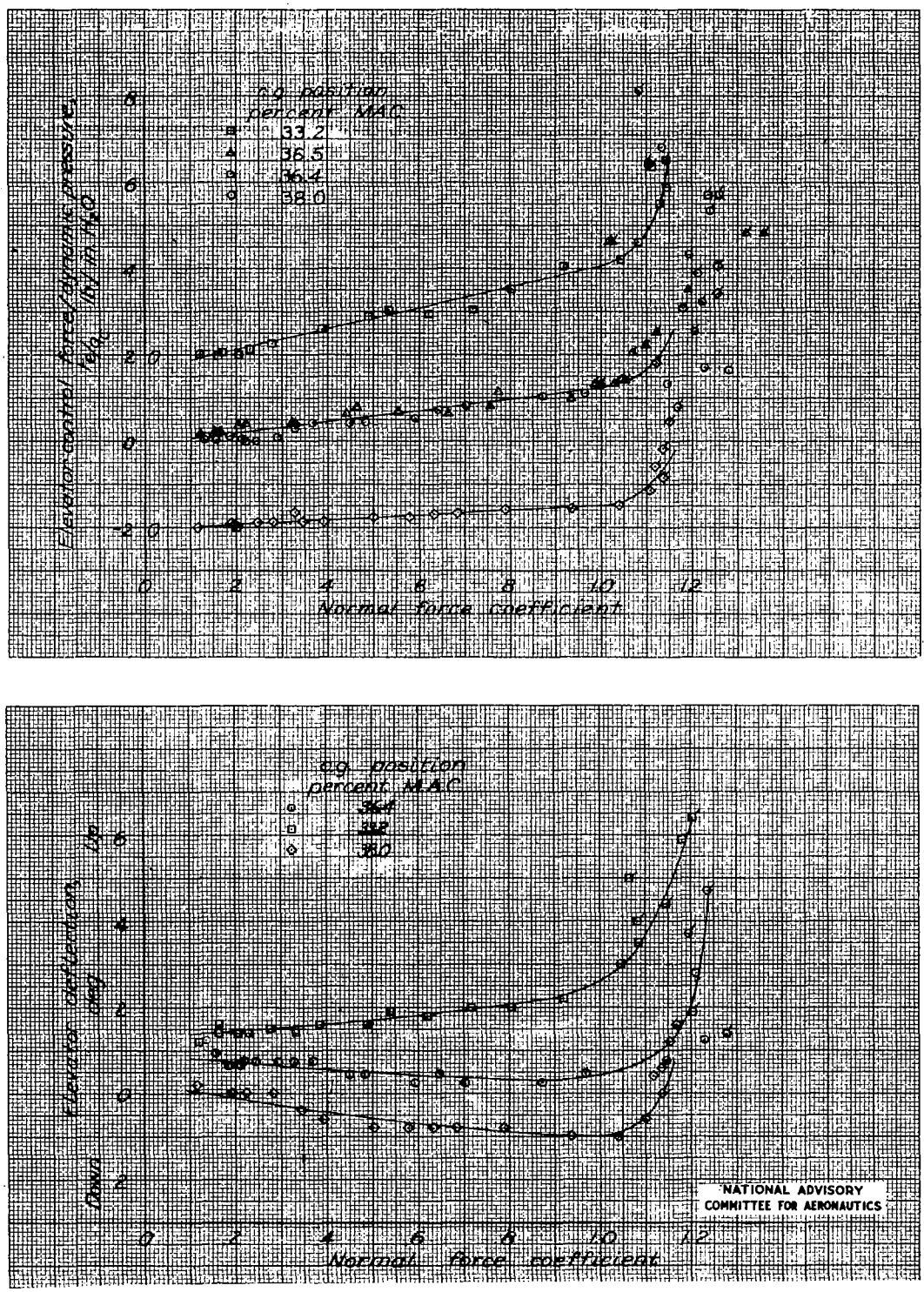


Figure 10. - Variation of elevator deflection and elevator force divided by dynamic pressure with normal force coefficient for the gliding condition, DeHavilland Mosquito F-8 airplane.

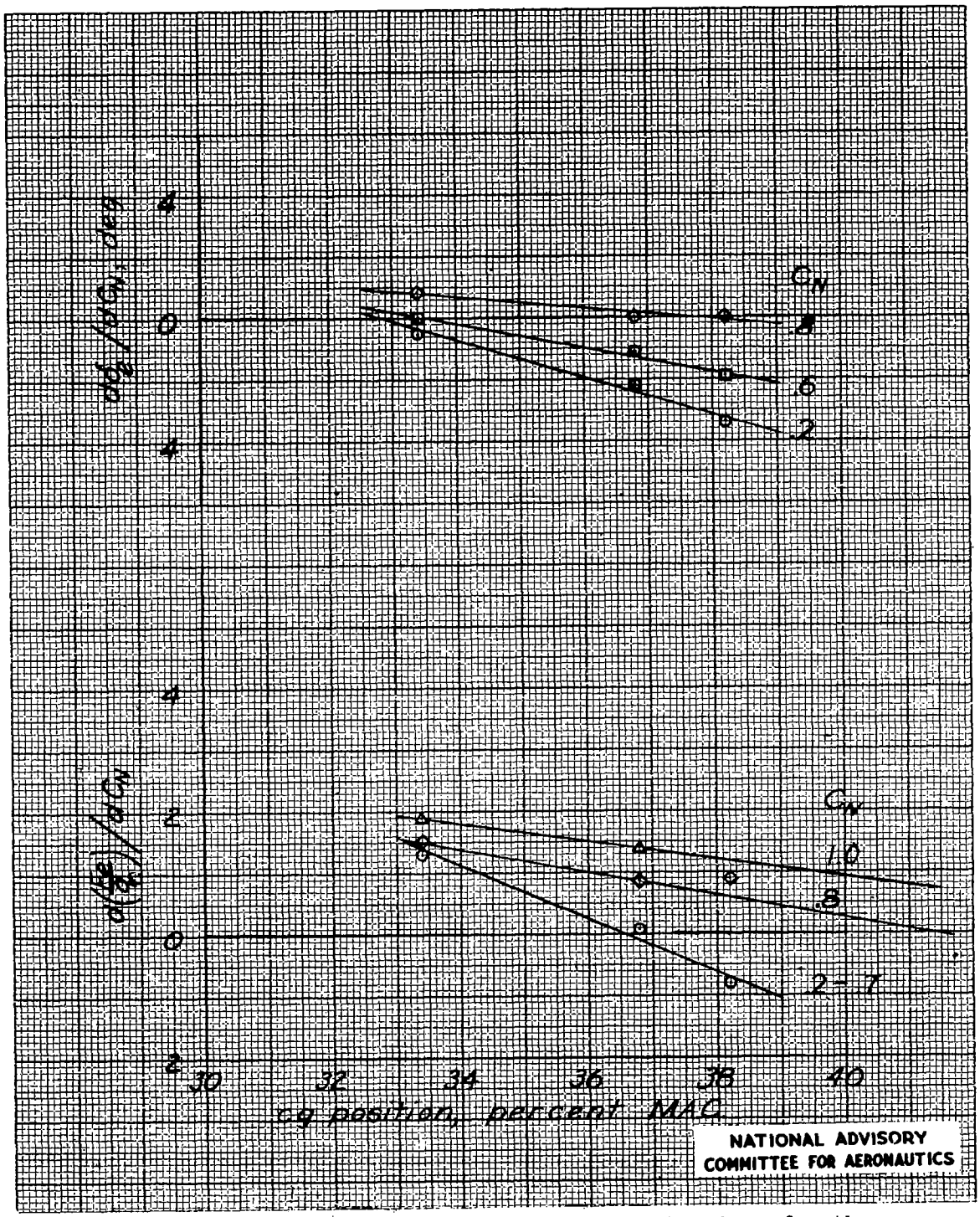


Figure 11. - Determination of neutral points for the rated-power clean condition, De-Havilland Mosquito F-8 airplane.

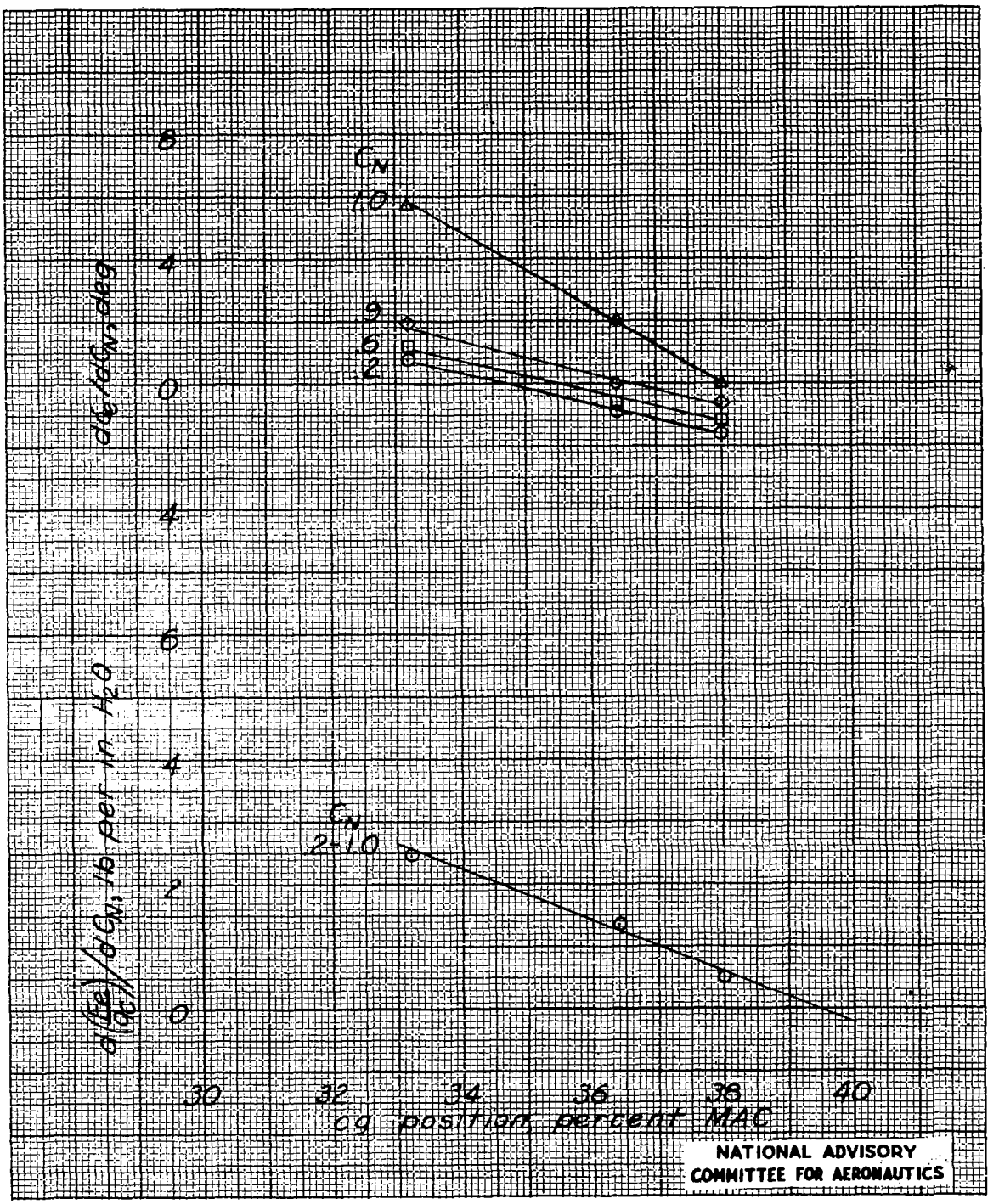


Figure 12. - Determination of neutral points for the gliding condition, DeHavilland Mosquito F-8 airplane.

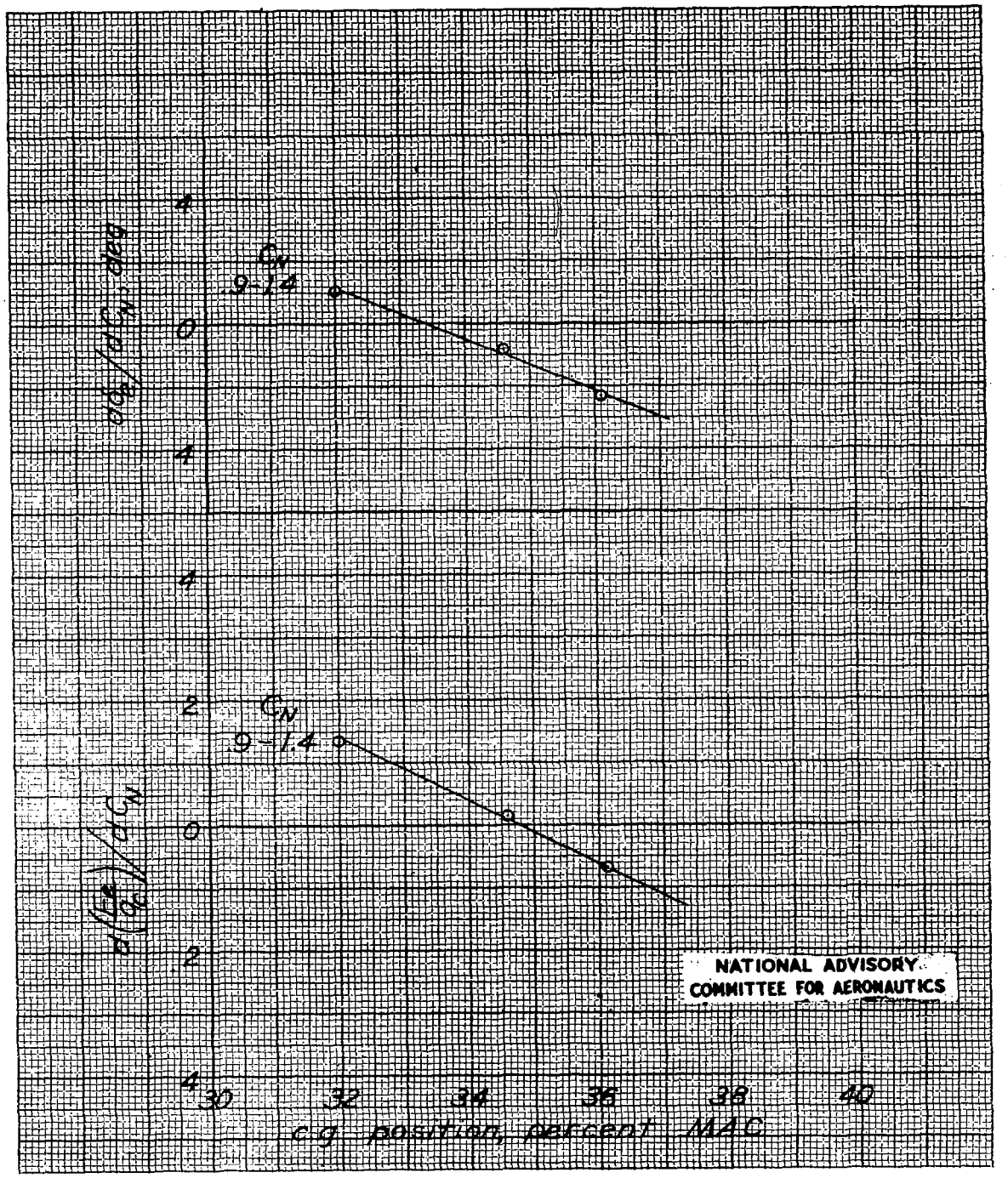


Figure 13. - Determination of neutral points for the landing condition, DeHavilland Mosquito F-8 airplane.

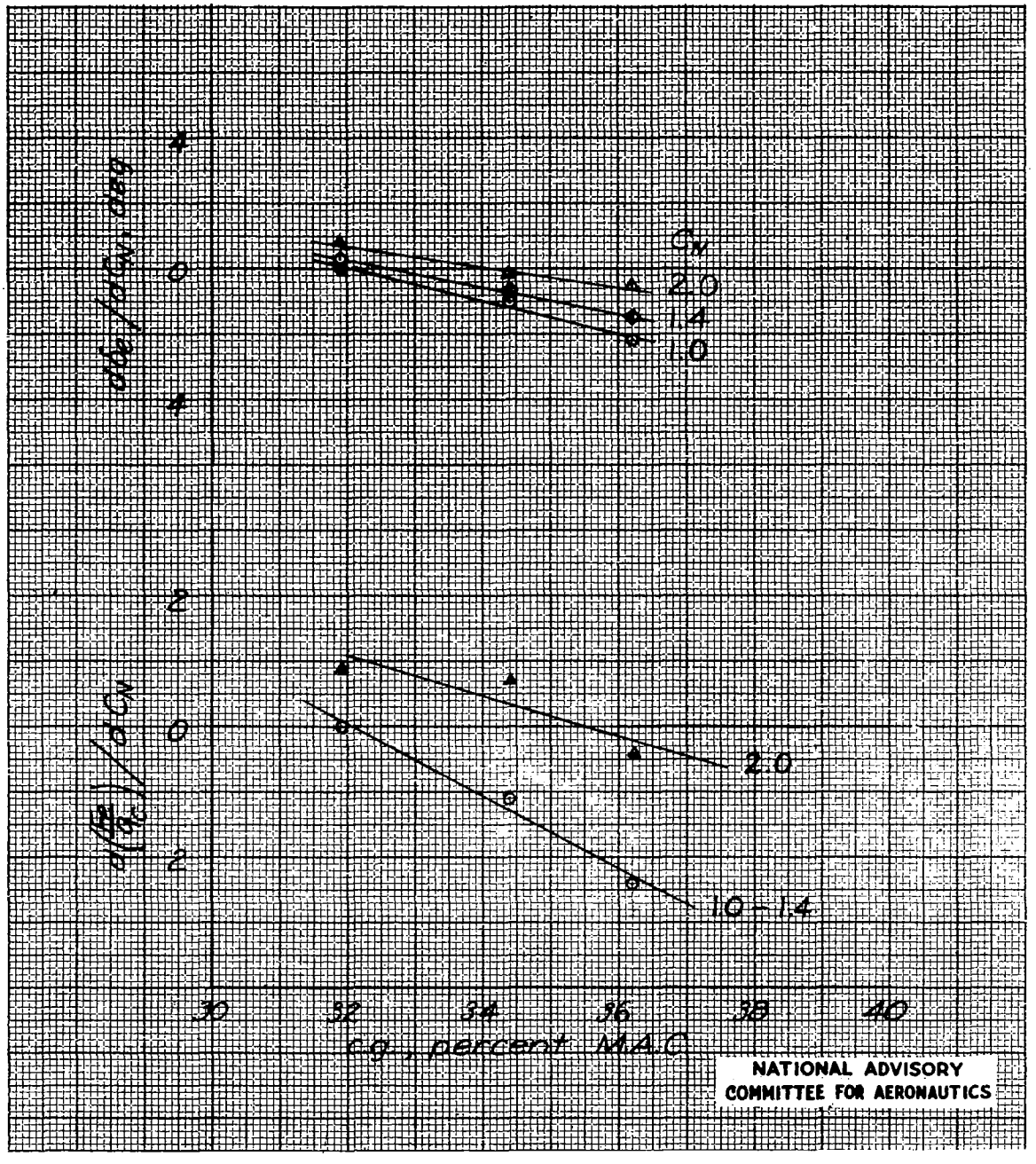


Figure 14. - Determination of neutral points for the wave-off condition, DeHavilland Mosquito F-8 airplane.

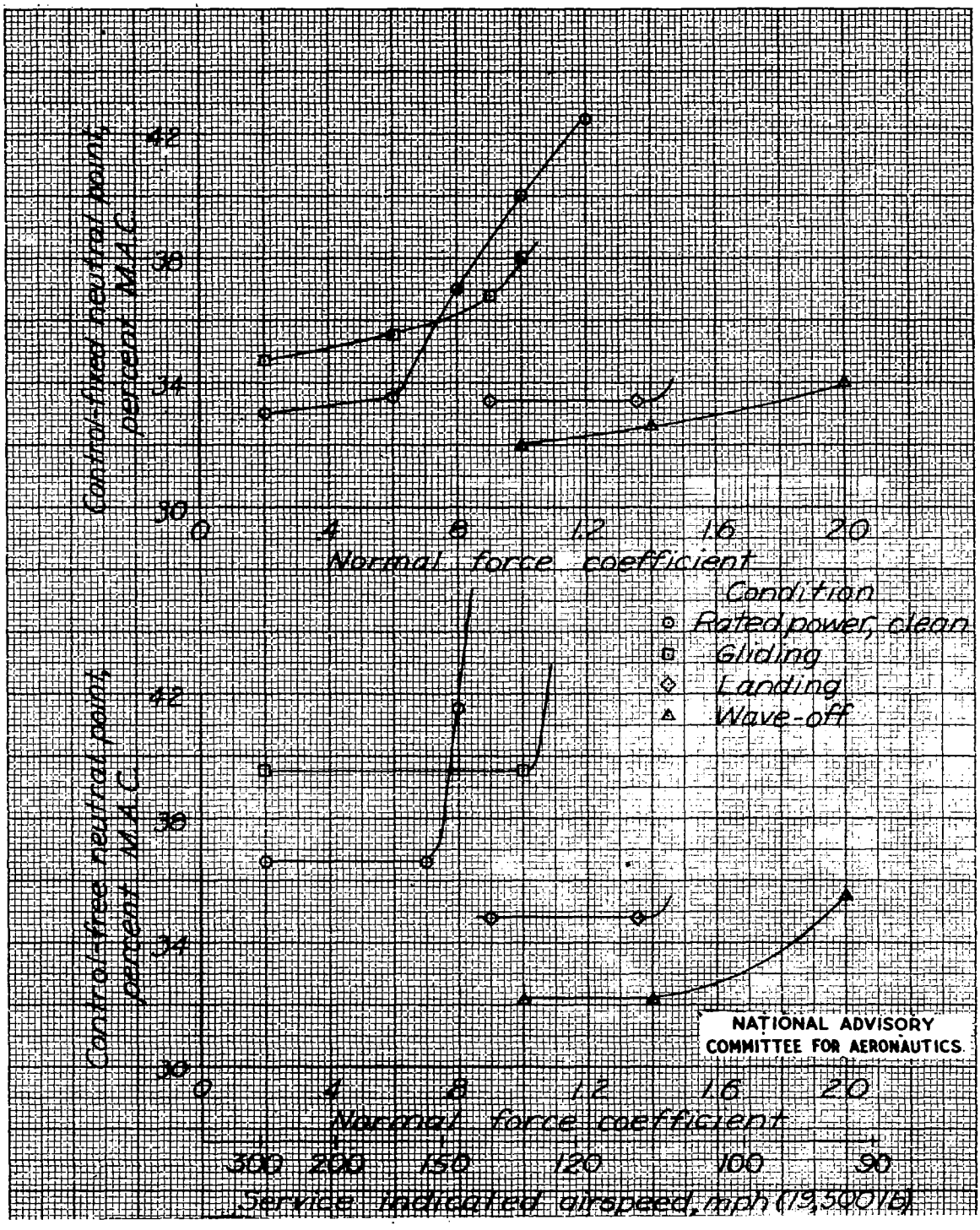


Figure 15. - Summary plot of the variation of the neutral points with normal force coefficient, De-Havilland Mosquito F-8 airplane.

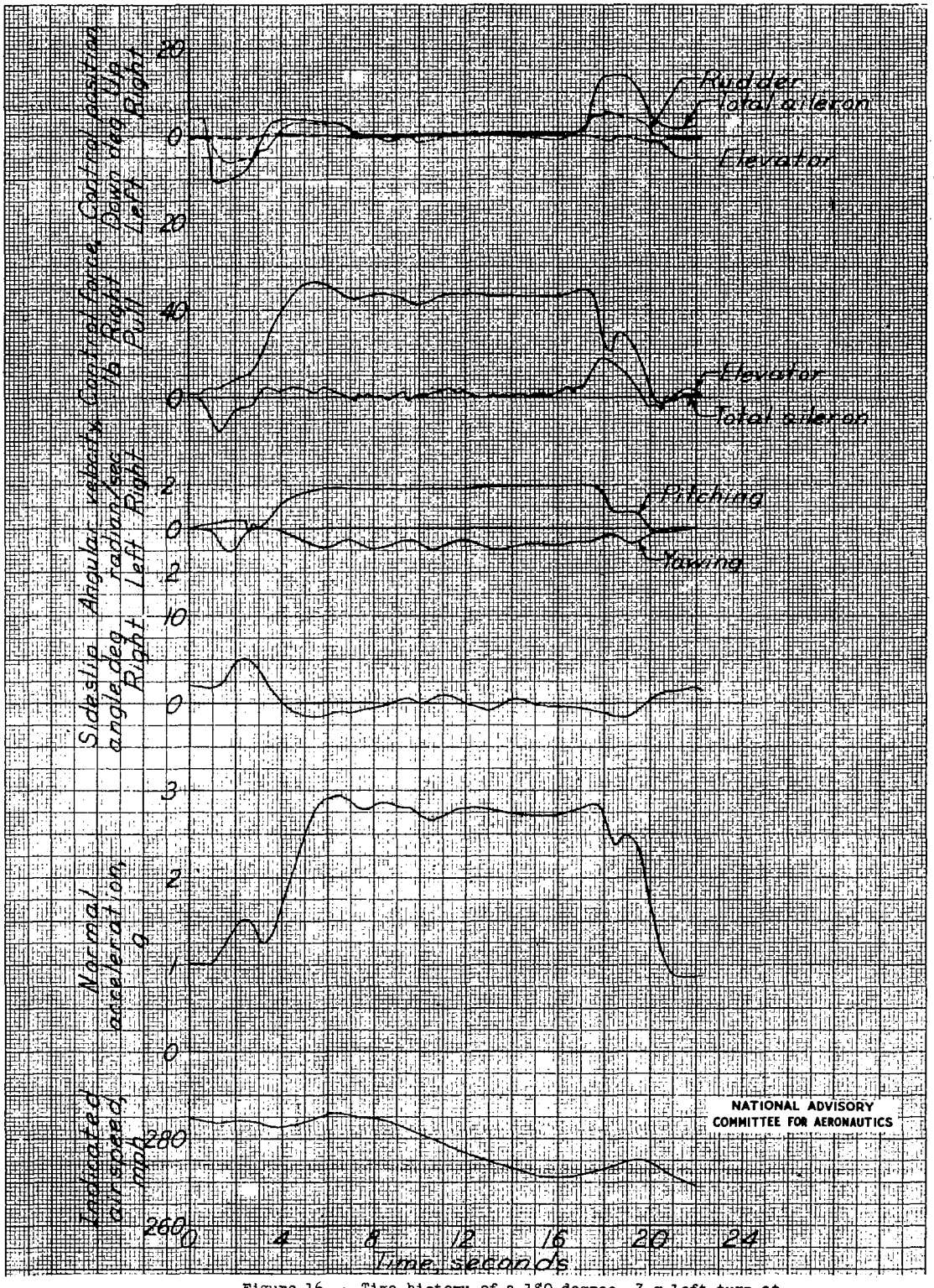


Figure 16. - Time history of a 180 degree, 3 g left turn at 280 miles per hour, center of gravity at 33.2 percent, DeHavilland Mosquito F-8 airplane.

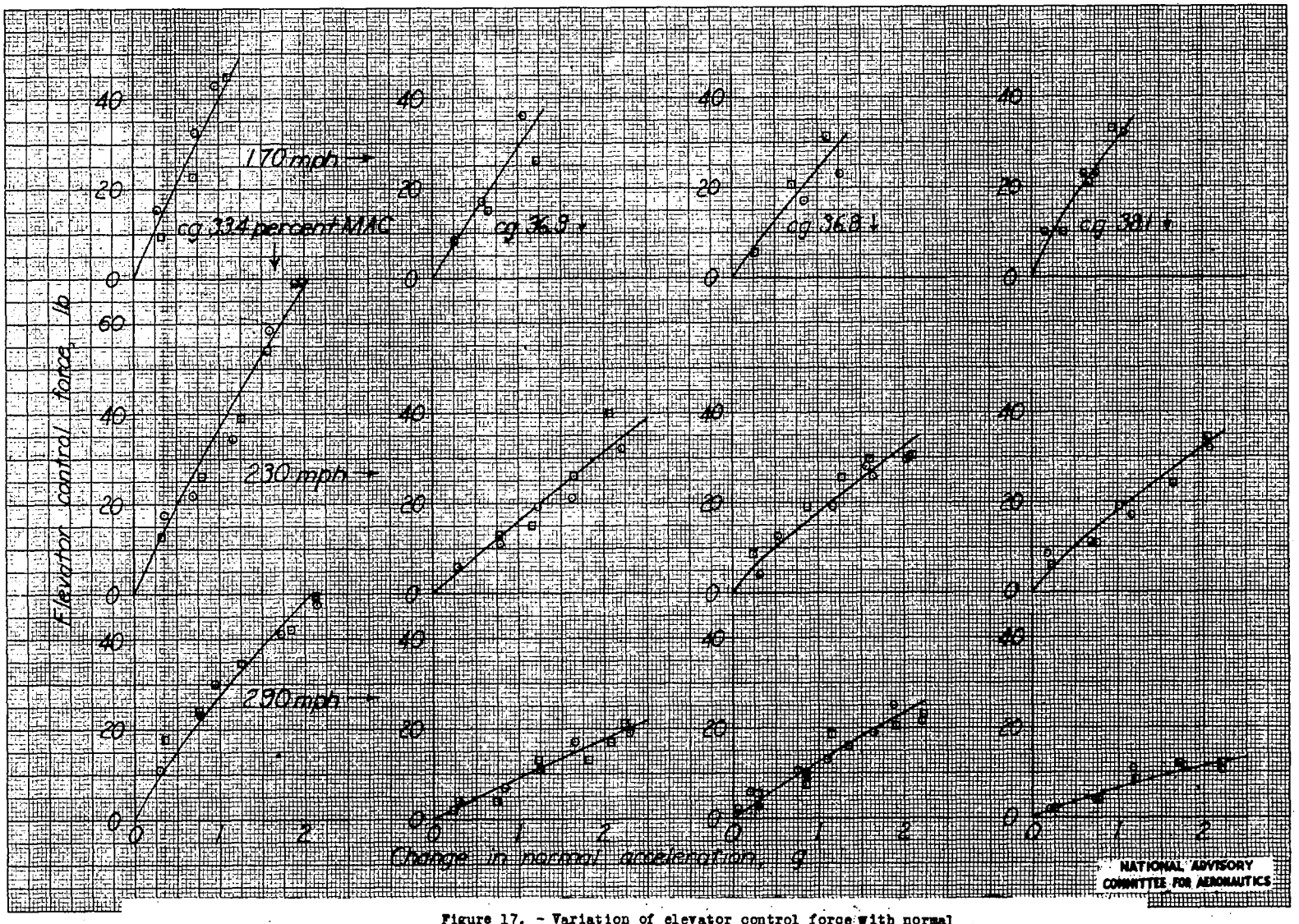


Figure 17. - Variation of elevator control force with normal acceleration, indicated airspeed constant, DeHavilland Mosquito F-8 airplane.

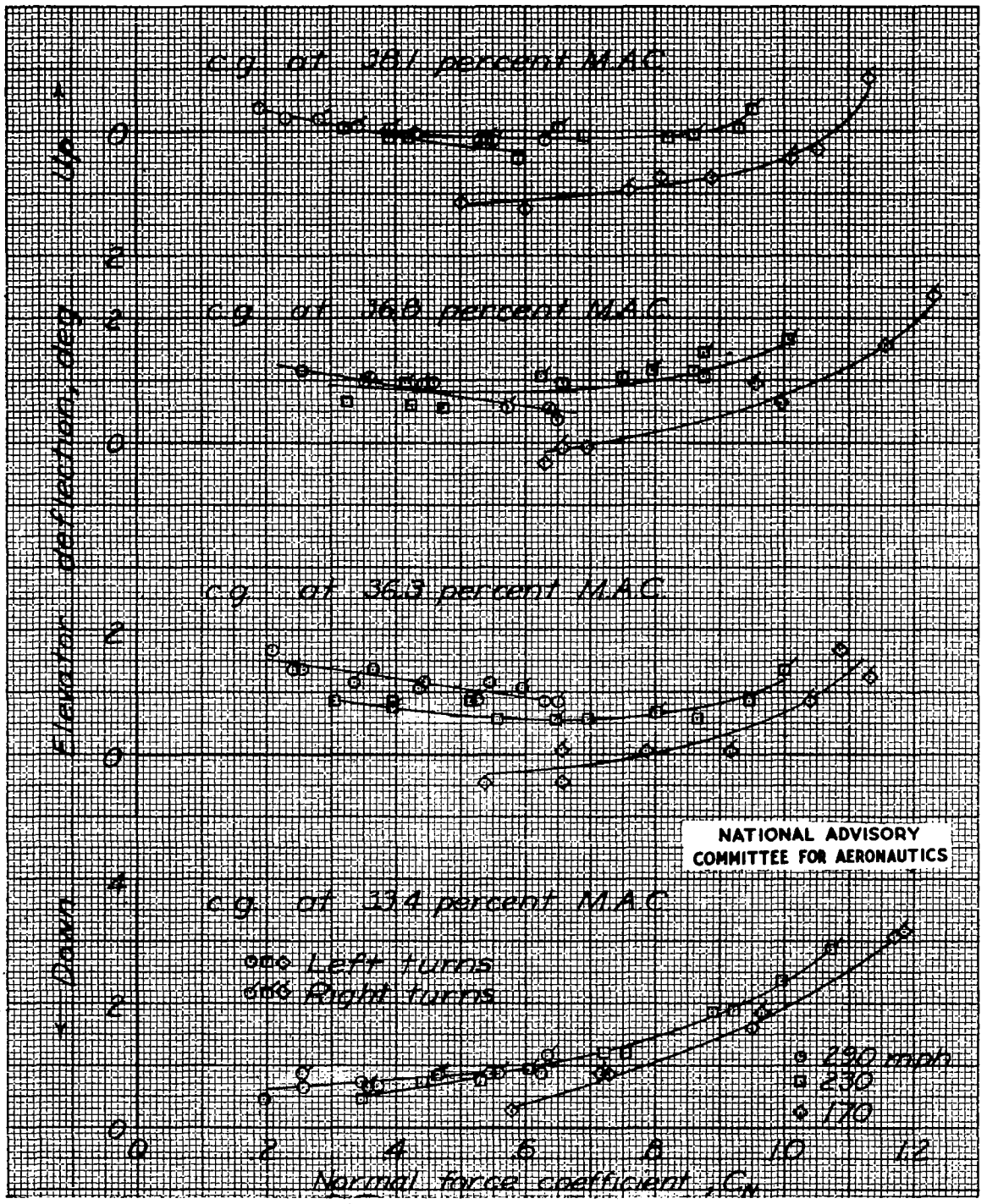


Figure 18. - Variation of elevator deflection with normal force coefficient in constant speed turns, DeHavilland Mosquito F-8 airplane.

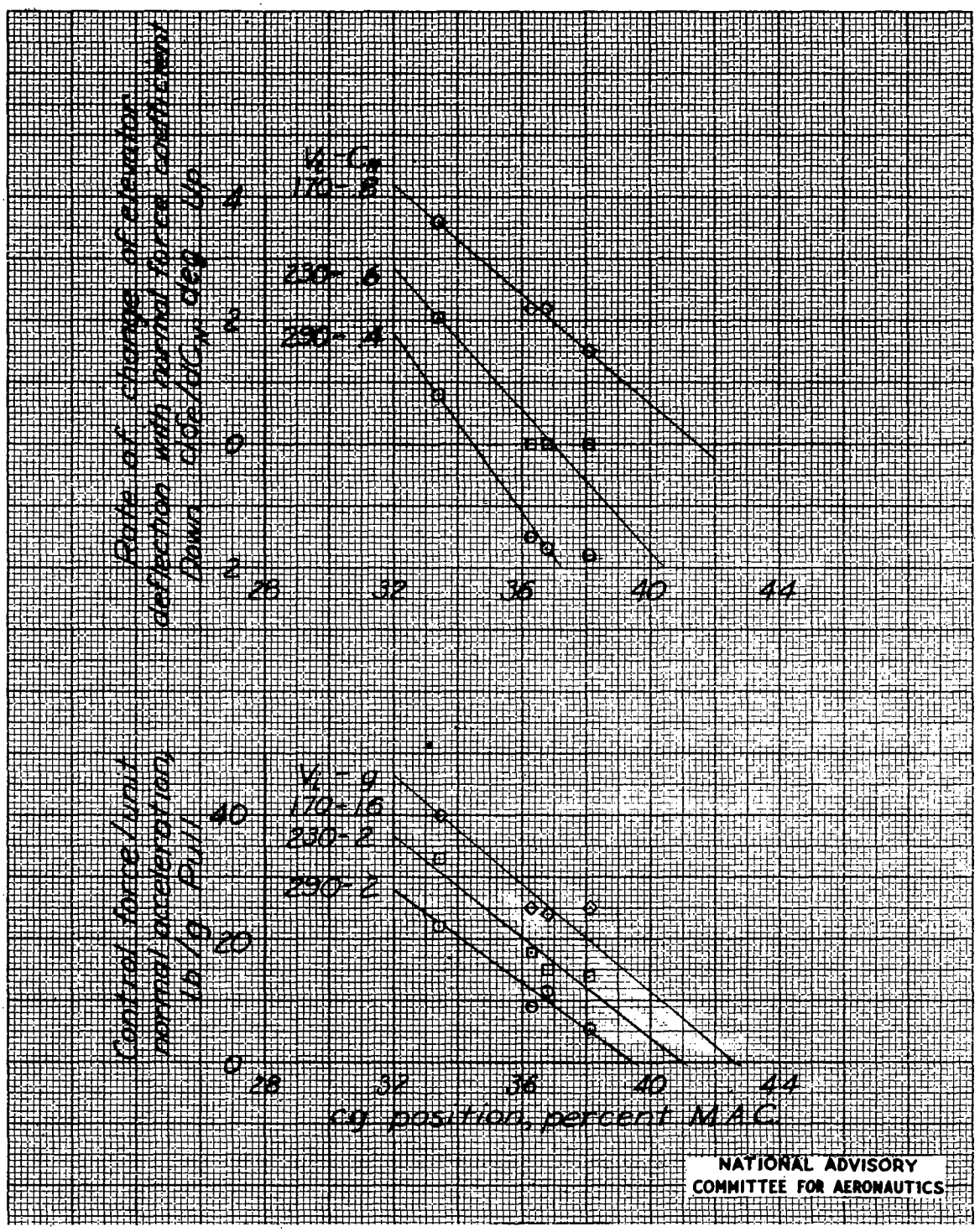


Figure 19. - Determination of maneuver points for the rated-power clean condition, DeHavilland Mosquito F-8 airplane.

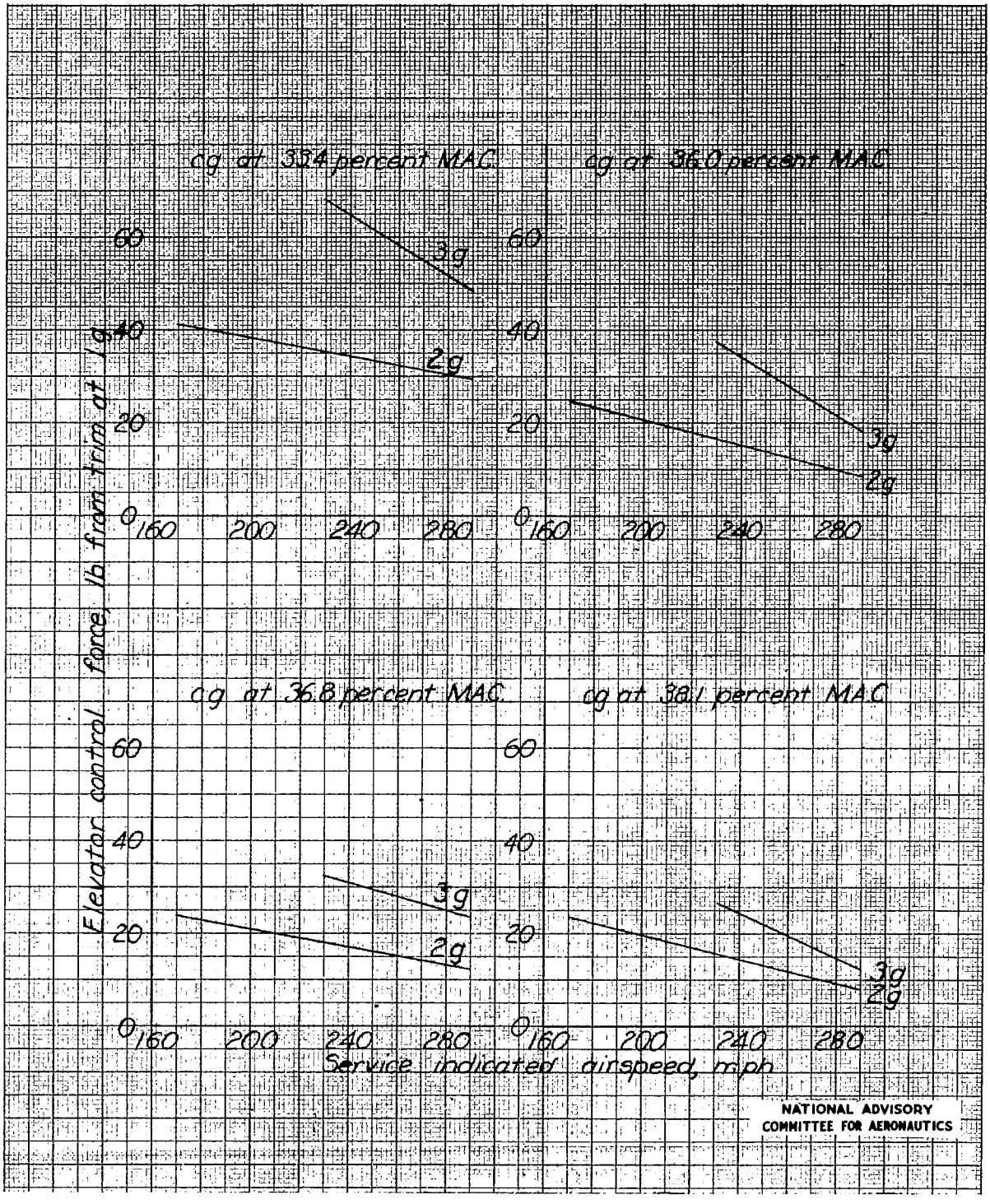


Figure 20. - Approximate variation of elevator control force with airspeed in turns, acceleration constant, DeHavilland Mosquito F-8 airplane.

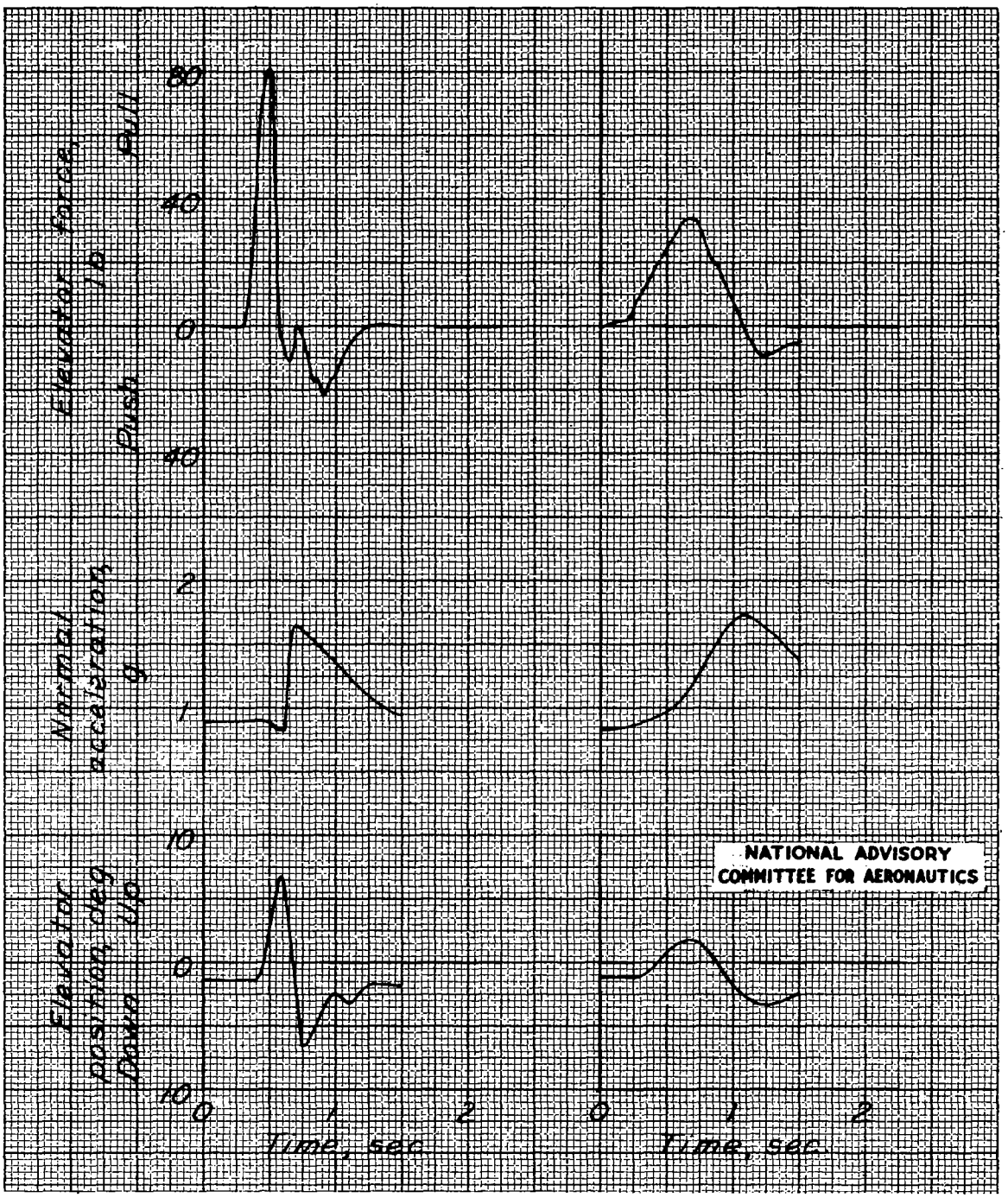


Figure 21. - Time histories of rapid pull-ups at 200 miles per hour in the clean condition with power for level flight (2650 rpm, 0 boost, center of gravity at 33 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.

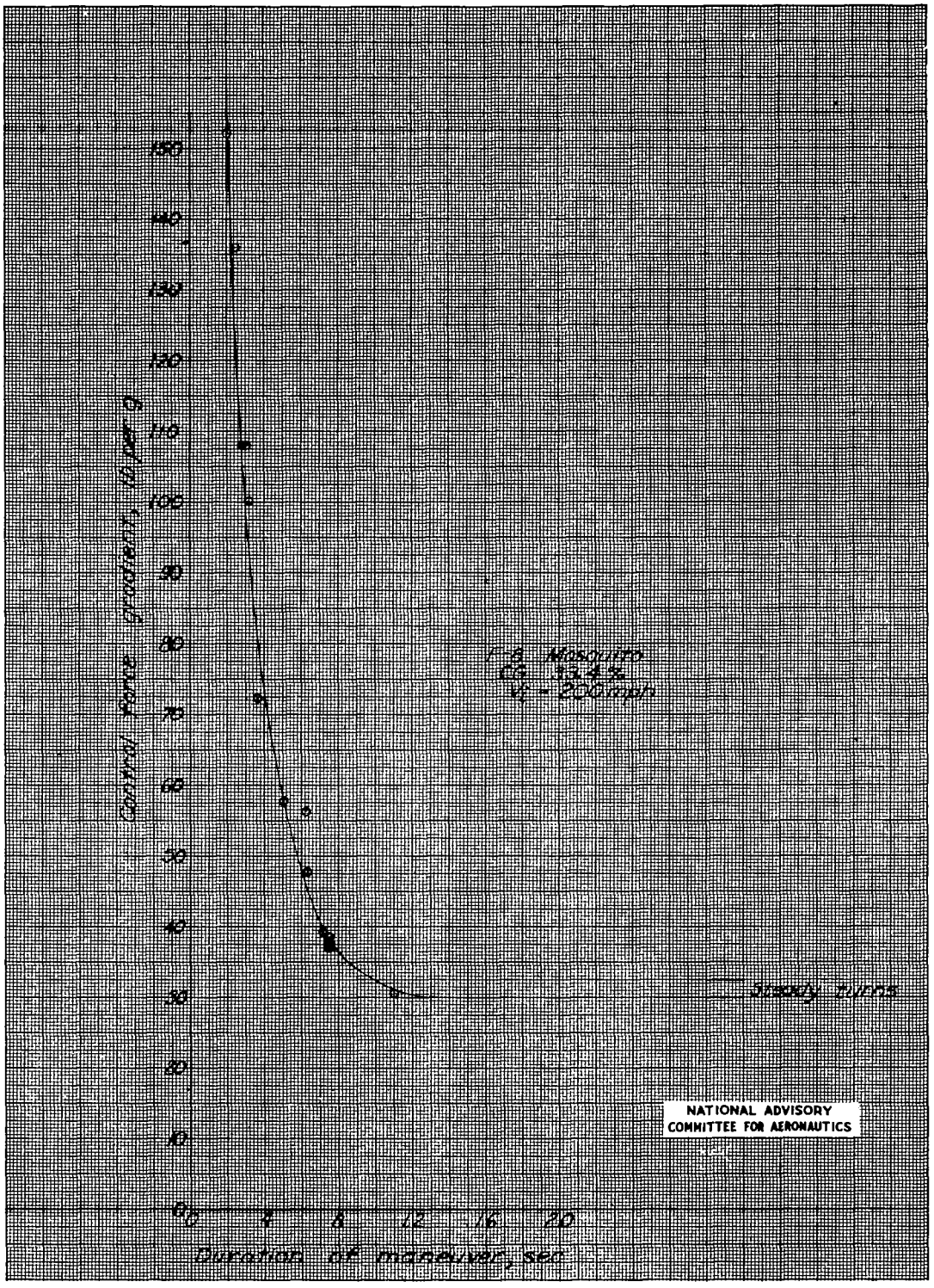


Figure 22. - Variation of elevator control force per g with the rapidity of the maneuver, clean condition with power for level flight at 200 miles per hour, center of gravity at 33 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.

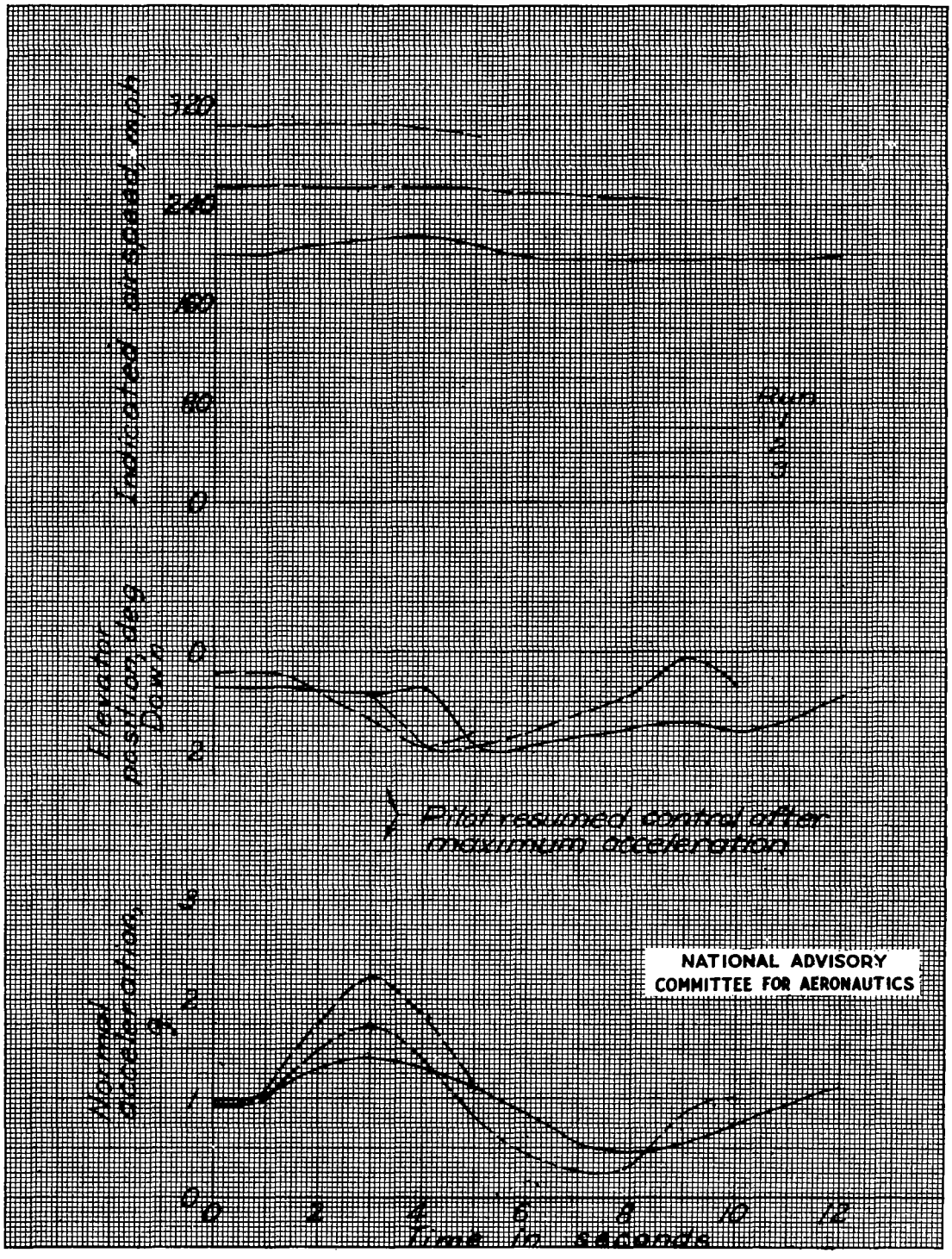


Figure 23. - Time histories of normal acceleration, elevator position and indicated airspeed caused by opening the cooling shutters while trimmed in the power on, clean condition, with elevator free, center of gravity at 32 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.

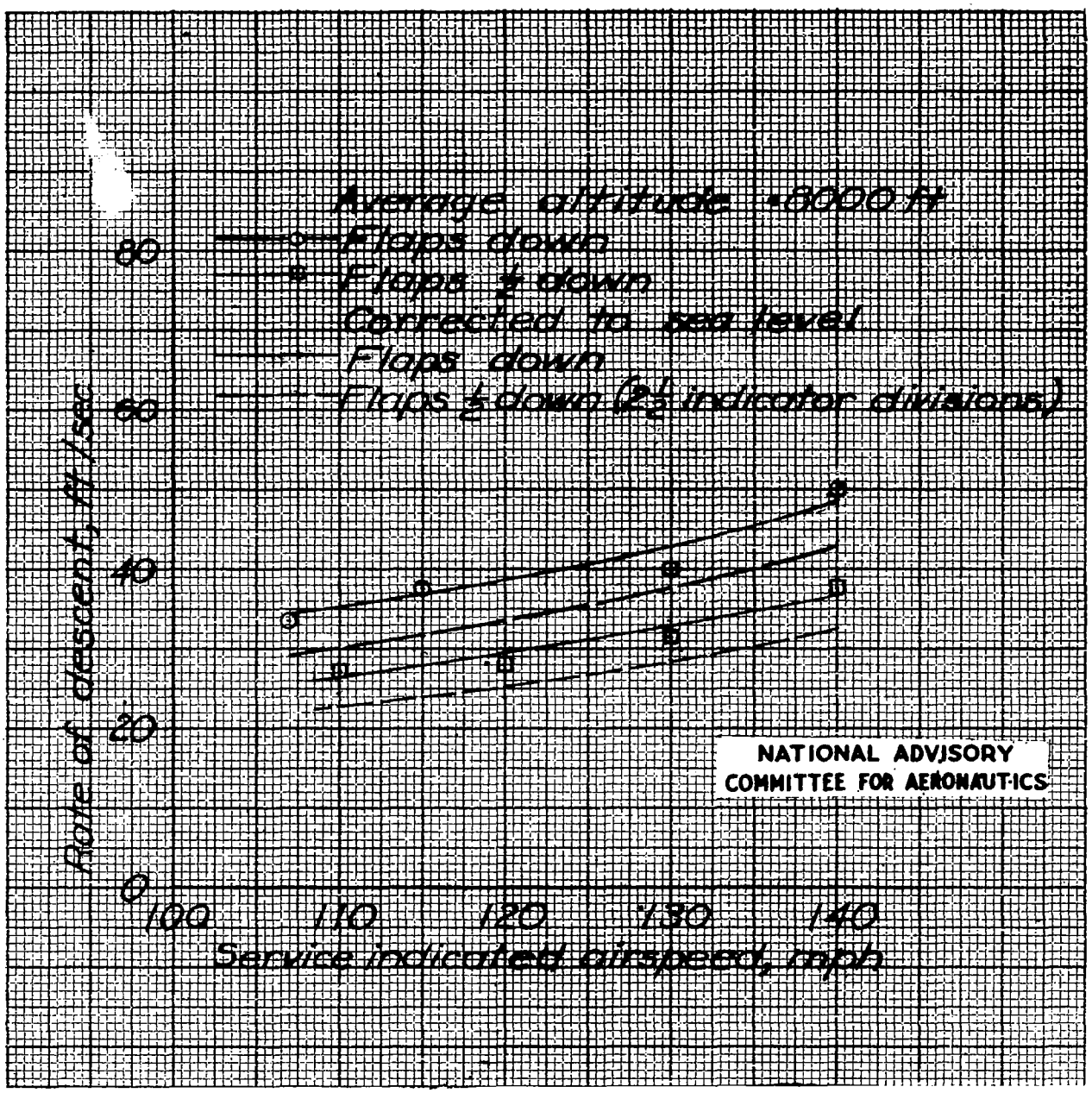


Figure 24. - Rate of descent in the landing condition (landing gear down, engines idling) at a wing loading of 42 pounds per square foot, DeHavilland Mosquito F-8 airplane.

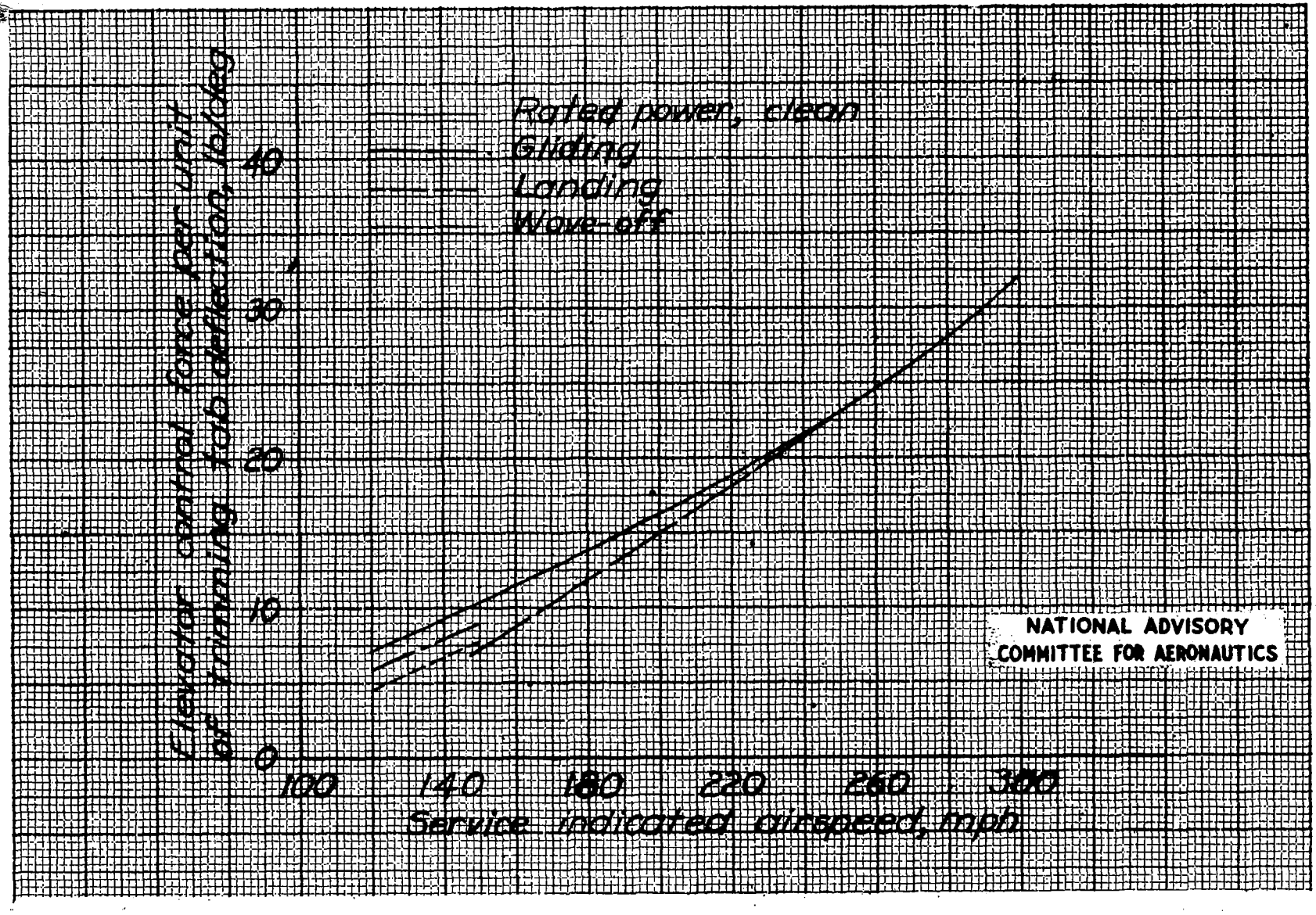


Figure 25. - Approximate power of elevator trimming tabs, DeHavilland Mosquito F-8 airplane.

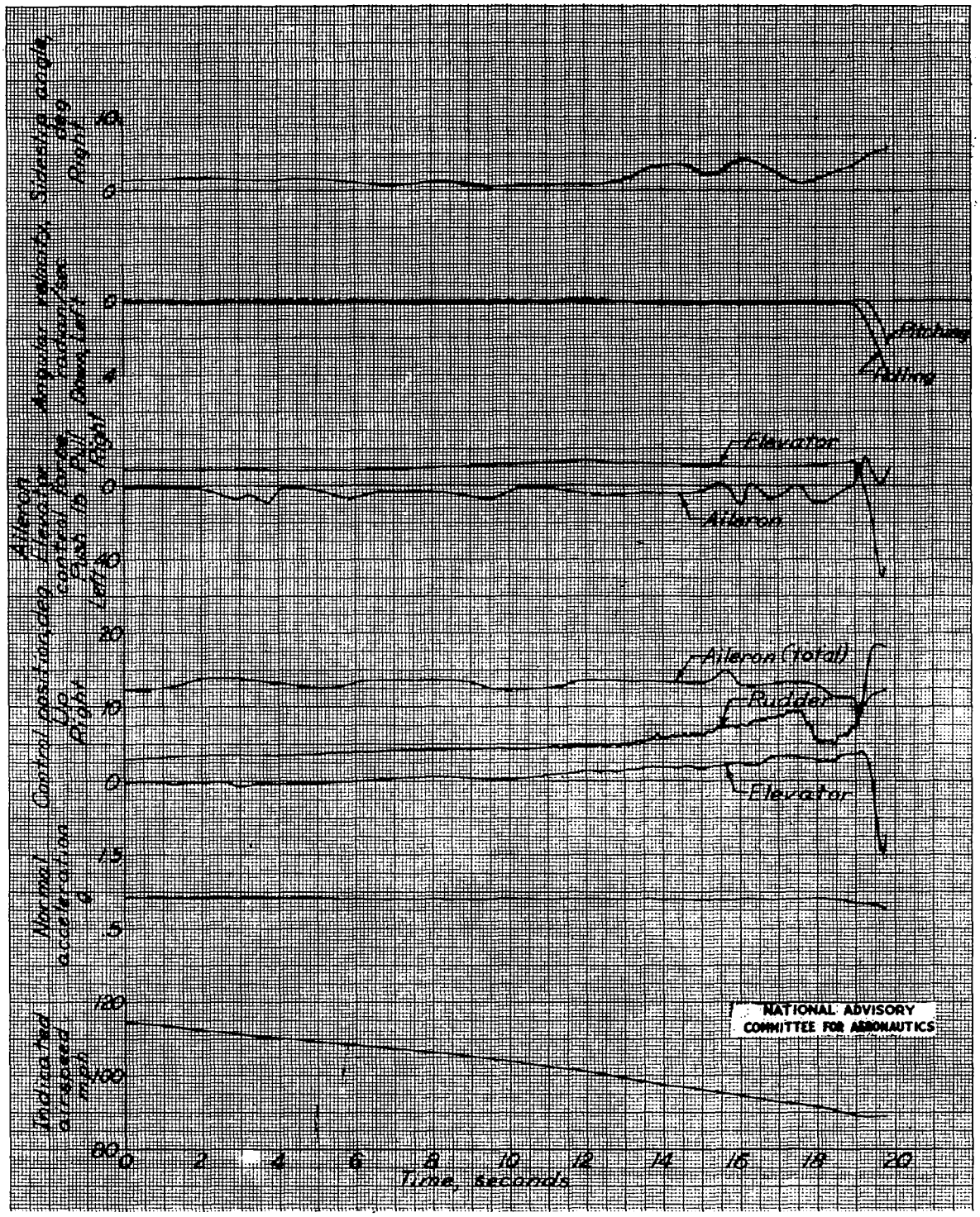


Figure 26. - Time history of a stall in the rated-power clean condition, center of gravity at 36.8 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.

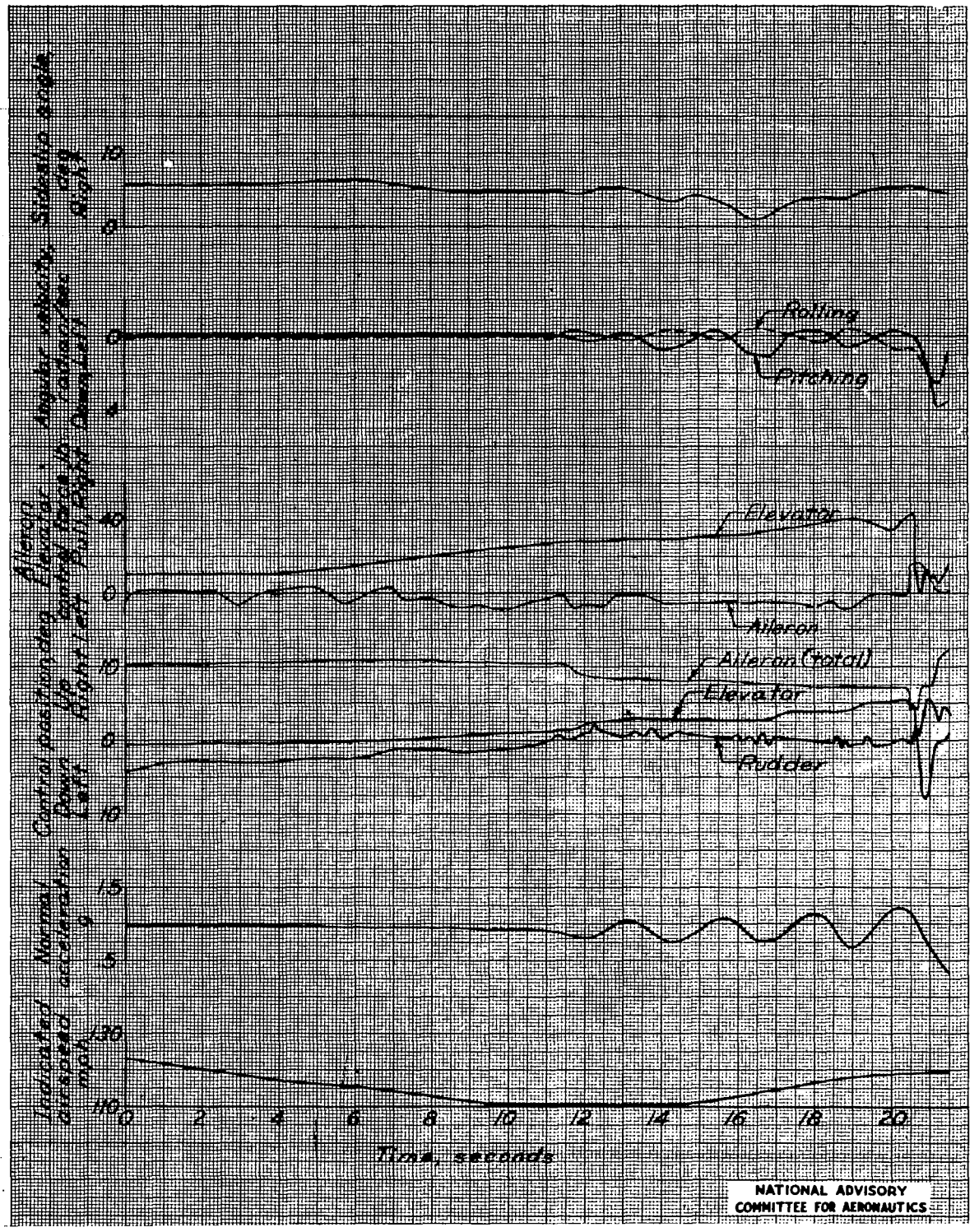


Figure 27. - Time history of a stall in the gliding condition, center of gravity at 36.4 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.

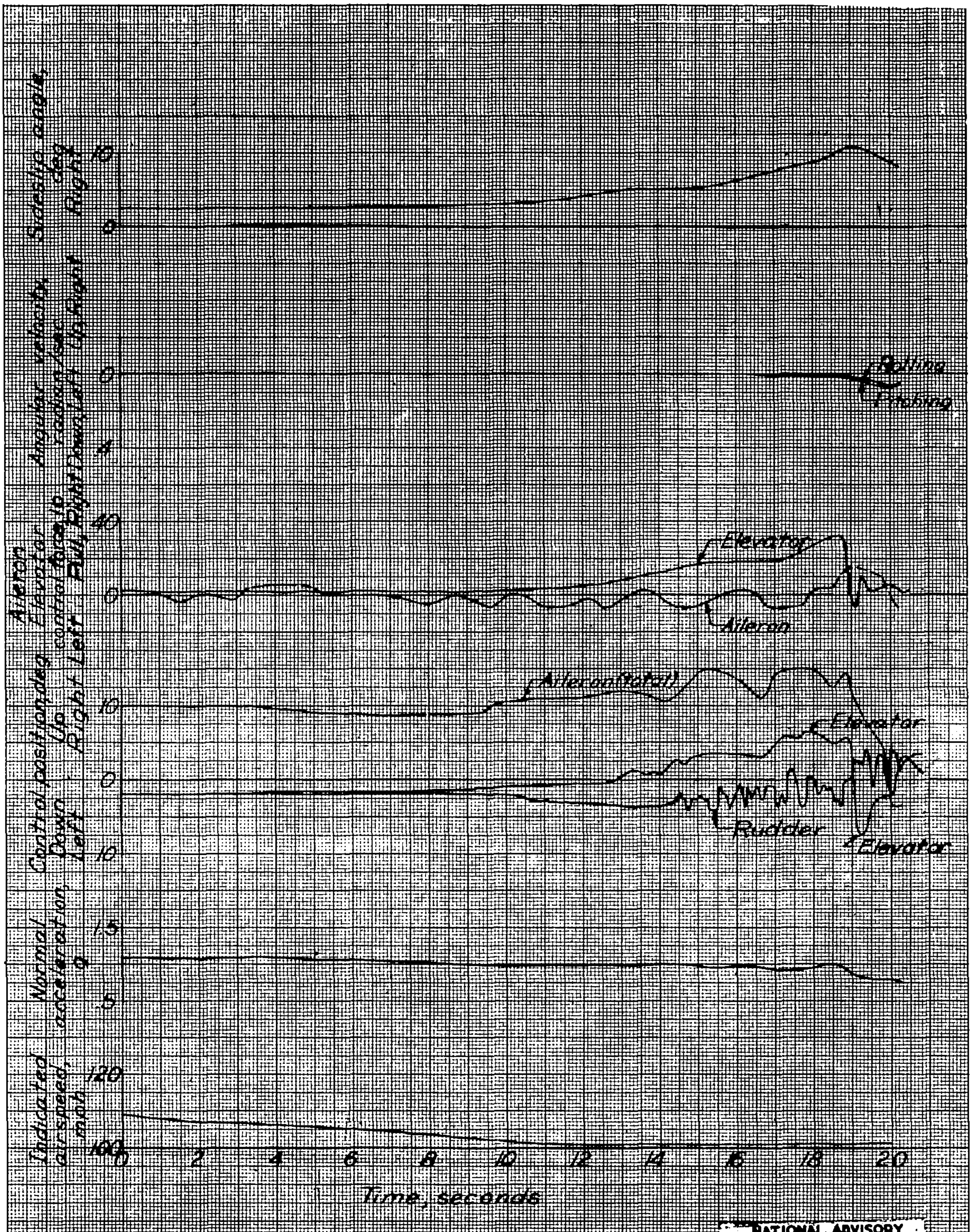


Figure 28. - Time history of a stall in the landing condition, center of gravity at 34.6 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.

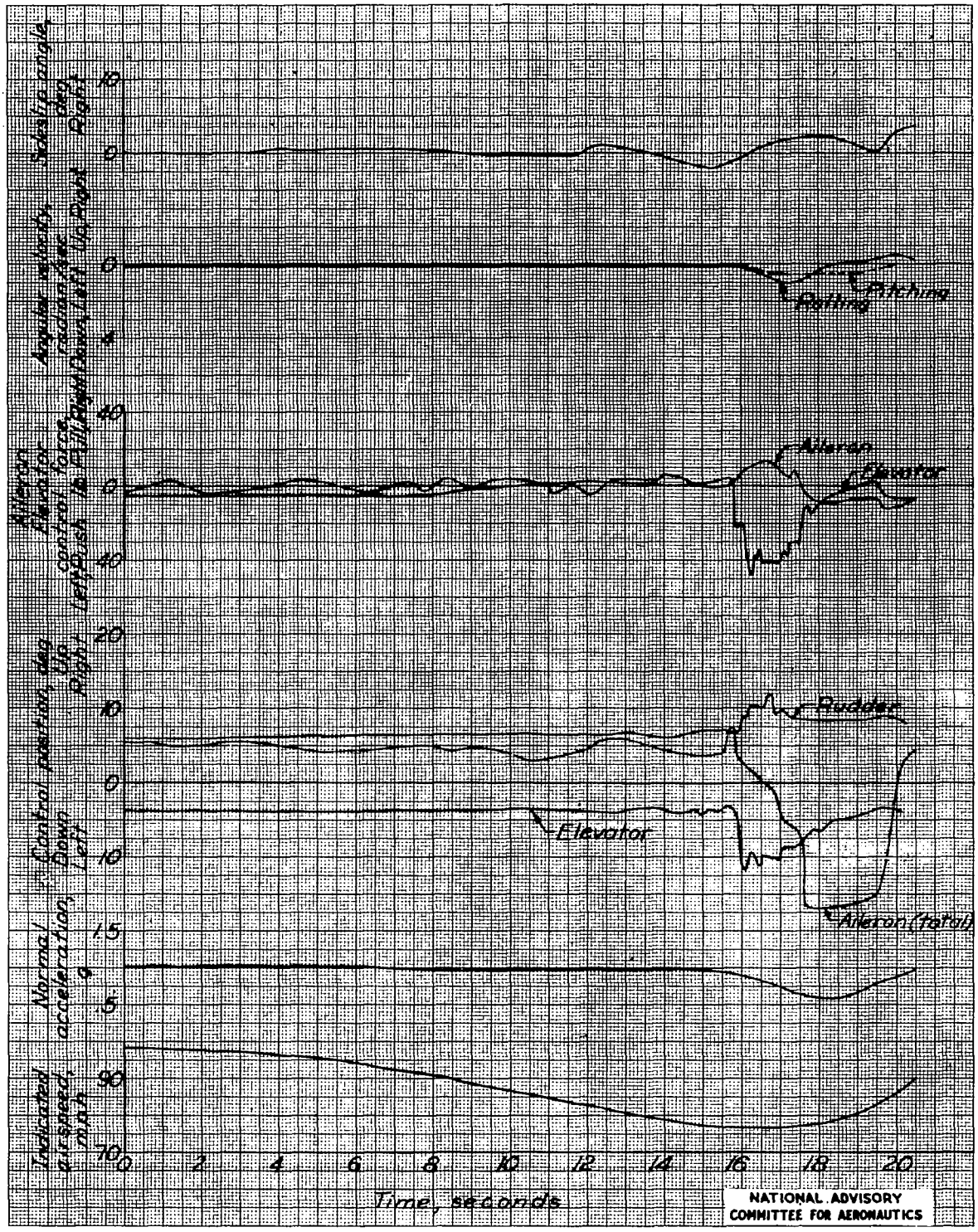


Figure 29. - Time history of a stall in the wave-off condition, center of gravity at 34.4 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.

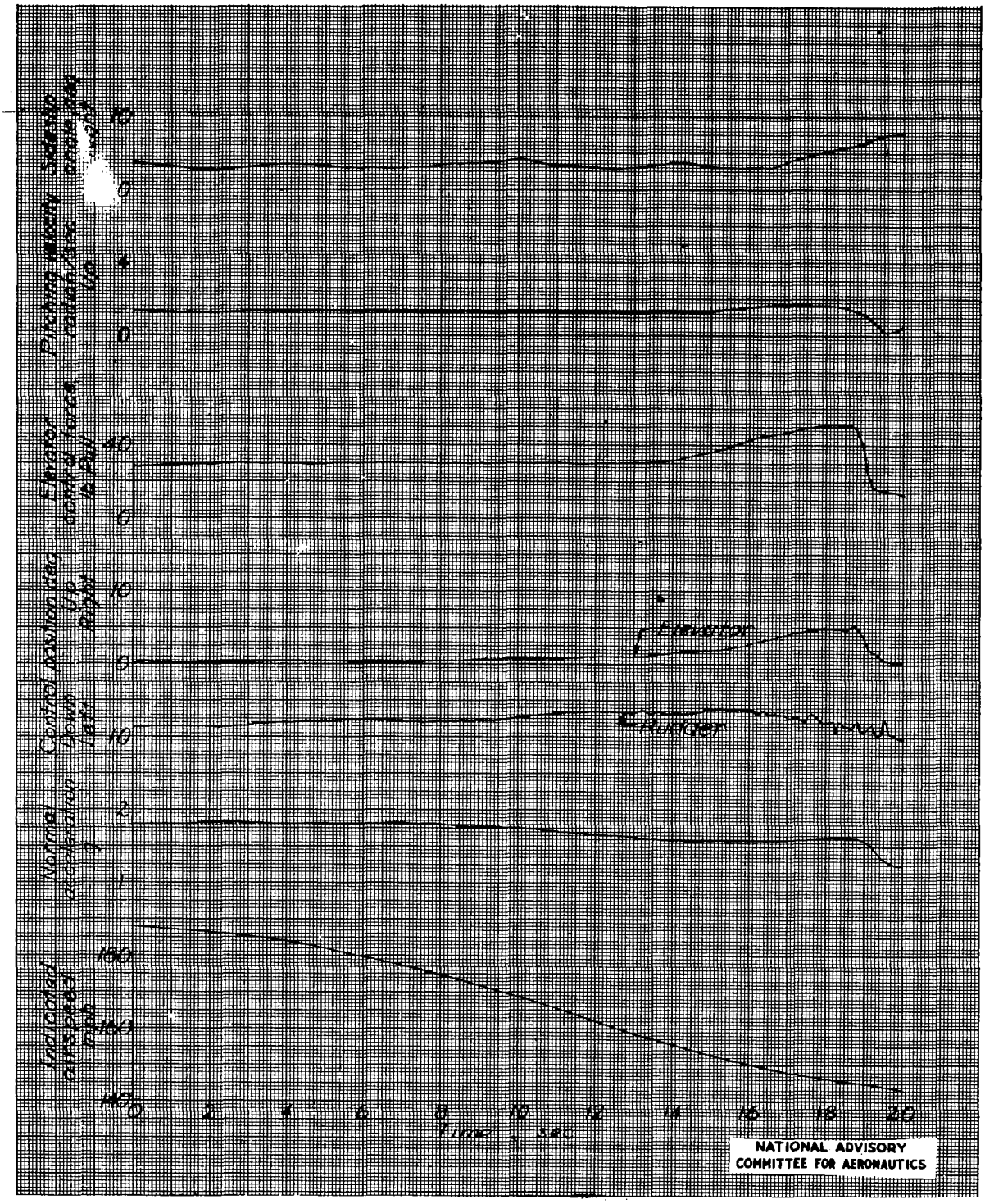


Figure 30. - Time History of a 2 g windup turn from 200 miles per hour to the stall warning in the rated-power clean condition, center of gravity at 33.2 percent mean aerodynamic chord, DeHavilland Mosquito F-8 airplane.