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# NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE 2899

MEASUREMENTS OF FLYING QUALITIES OF AN F-47D-30 AIRPLANE TO DETERMINE LONGITUDINAL STABILITY AND CONTROL AND STALLING CHARACTERISTICS

By Christopher C. Kraft, Jr., R. Fabian Goranson, and John P. Reeder

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# MEASUREMENTS OF FLYING QUALITIES OF AN F-47D-30 AIRPLANE TO DETERMINE LONGITUDINAL STABILITY AND CONTROL AND STALLING CHARACTERISTICS[1]

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## SUMMARY

Flight tests have been made to determine the longitudinal stability and control and stalling characteristics of an F-47D-30 airplane. The results of these tests show the airplane to be unstable with stick free in any power-on condition even at the most forward center-of-gravity position tested. At the rearward center-of-gravity position tested the airplane also had neutral to negative stick-fixed stability with power on. The characteristics in accelerated flight were acceptable at the forward center-of-gravity position at low and high altitudes except at high speed where the control-force variations with acceleration were high. At the rearward center-of-gravity position, elevator-force reversals were experienced in turns at low speeds, and the elevator-force variations with acceleration were low at all the other speeds tested. Ample stall warning was afforded in all the conditions tested and the stalling characteristics were satisfactory except in the approach and wave-off conditions.

## INTRODUCTION

This paper presents an investigation of the flying qualities of the F-47D-30 airplane. Many flying-qualities investigations have been conducted by the National Advisory Committee for Aeronautics with various types of airplanes and this paper is intended to supplement this information. By correlation of these data with pilot opinions of these airplanes, it has been possible to establish quantitative requirements for satisfactory flying qualities such as those presented in reference 1.

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[1]Supersedes the recently declassified NACA RM SL8A06 for the Air Materiel Command, Army Air Forces, "Flight Measurements of Flying Qualities of a P-47D-30 Airplane (AAF No. 43-3441) to Determine Longitudinal Stability and Control and Stalling Characteristics" by Christopher C. Kraft, Jr., R. Fabian Goranson, and John P. Reeder, 1948.

Additional information is continually being obtained, however, to determine whether the existing requirements are adequate or whether they should be modified in order to provide for conditions encountered with airplanes of later design. This paper includes the results of the tests of the longitudinal stability and control and stalling characteristics of the F-47D-30 airplane. The results of the investigation of the lateral and directional stability and control characteristics of this airplane have been presented in reference 2.

## AIRPLANE, INSTRUMENTATION, AND TESTS

The F-47D-30 is a low-wing fighter-type airplane. This model incorporates an R-2800-59 engine, a dorsal fin, dive-recovery flaps, round-nose ailerons, and a bubble canopy. A three-view drawing of the airplane is shown in figure 1 and additional data describing the airplane are presented in table I. Photographs of the test airplane are shown in figure 2. The airplane was flown at two center-of-gravity positions. The forward center-of-gravity position of approximately 26.4 percent mean aerodynamic chord (landing gear down) with the gross weight varying from 12,810 pounds at take-off to 11,870 pounds was obtained by attaching 200 pounds of lead to the propeller-reduction-gear box and flying the airplane with the fuselage auxiliary tank empty. Photographs of this ballast installation are shown in figure 3. The lead ballast was more than sufficient to balance the moment rearward of the center of gravity brought about by the installation of instruments in the baggage compartment. The instrument installation caused a rearward center-of-gravity shift of approximately 0.2 percent mean aerodynamic chord and the lead ballast caused a forward center-of-gravity shift of approximately 1 percent. The airplane manual gives the service center-of-gravity range for this airplane as between 24.75 and 31.0 percent mean aerodynamic chord with landing gear down. The forward center-of-gravity position of 24.75 percent of the mean aerodynamic chord could not be obtained on the test airplane with any normal loading. The rearward center-of-gravity position at which the airplane was flown was approximately 29.1 percent of the mean aerodynamic chord with gross weight ranging from 13,200 pounds to 12,400 pounds. This center-of-gravity position was obtained by using the same configuration as above and flying the airplane with the fuselage auxiliary tank filled. Raising the landing gear caused the center of gravity to shift forward 0.4 percent of the mean aerodynamic chord.

The friction and travel of the elevator, aileron, and rudder control systems are shown in figures 4 to 7. The amount of friction in all the control systems except that of the rudder was small and well within the requirements of reference 3. A more complete description of the characteristics of the rudder control system is presented in reference 2.

Tests were carried out at low altitude in the conditions shown in the following table:

| Condition | Power setting | Flaps | Landing gear | Canopy |
|---|---|---|---|---|
| Approach | 21 in. Hg at 2,550 rpm | Down | Down | Open |
| Glide | Off | Up | Up | Closed |
| Landing | Off | Down | Down | Open |
| Power-on clean | 42.5 in. Hg at 2,550 rpm | Up | Up | Closed |
| Wave-off | 42.5 in. Hg at 2,550 rpm | Down | Down | Open |
| Dive | 15 in. Hg at 2,550 rpm | Up | Up | Closed |

Tests were also carried out at high altitude in the power-on clean, glide, and dive conditions. The data were obtained by both the steady and continuous record methods. In the steady method, the pilot either dived or climbed the airplane to a given speed and, when the airplane reached a steady condition, a record was taken of the required values. In the continuous method, the airplane was flown through the speed range with gradually changing speed and the required values were recorded throughout the entire period. The data obtained by the continuous method are indicated by flagged symbols. Standard NACA photographic recording instruments were used to obtain the data. A description of this instrumentation is given in reference 2.

## DISCUSSION AND RESULTS

### LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS

#### Dynamic Longitudinal Stability

The short-period oscillation of normal acceleration and elevator angle was investigated in the power-on clean, glide, and landing conditions by abruptly deflecting and releasing the elevator at various speeds throughout the speed range. Typical time histories of these attempted oscillations are shown in figure 8. There was no oscillation of the elevator, but the airplane diverged longitudinally, sometimes violently, at low speeds in the power-on clean condition. (See fig. 8(a).) This unstable condition is in all probability due to the static longitudinal instability of the airplane.

## Static Longitudinal Stability

The static longitudinal stability was measured throughout the speed range for the configurations shown in the preceding table at two center-of-gravity positions of approximately 26 and 29 percent of the mean aerodynamic chord. The variations of elevator force and elevator angle with speed are presented in figures 9 to 14 and show the static longitudinal stability characteristics. The elevator tab angle $\delta_{e_{tab}}$ was also measured and is given for most of the tests made.

The evaluation of the stick-free and stick-fixed neutral points is shown in figures 15 to 20. The variations of the elevator angle $\delta_e$ and elevator force divided by dynamic pressure $F_e/q$ with airplane normal-force coefficient $C_N$ are plotted and the stick-fixed and stick-free neutral points are determined from the slopes of these curves. For a given normal-force coefficient the neutral points are at the center-of-gravity positions at which the slopes $\frac{d\delta_e}{dC_N}$ and $\frac{d(F_e/q)}{dC_N}$ are zero. The neutral points as determined by the above procedure for each flight condition are shown in figure 21.

The following discussion of the static longitudinal stability characteristics is based on the requirements of reference 3.

<u>Power-on clean condition (fig. 9)</u>.- The curves of elevator angle and elevator force as a function of speed show characteristics which do not meet the requirements of reference 3. The data show the airplane to be unstable with stick free at both center-of-gravity positions and to have neutral to negative stability with stick fixed. The same conditions existed at low and high altitude.

<u>Dive condition (fig. 10)</u>.- The airplane failed to meet the requirements in this condition. The data show the airplane to be unstable with stick free at speeds above approximately 260 mph and neutral to unstable stick fixed above approximately 300 mph. The same conditions existed at low and high altitude.

<u>Glide condition (fig. 11)</u>.- The airplane was stable with stick fixed and stick free at both center-of-gravity positions except at high speeds at the rearward center-of-gravity position where the airplane became slightly unstable with stick free. At high altitude the airplane was neutrally stable with stick free at the rearward center-of-gravity position. The airplane did not meet the requirements in this condition.

<u>Approach condition (fig. 12)</u>.- The curve of elevator force against speed had a stable slope at the forward center-of-gravity position but

the slope became unstable above approximately 125 mph at the rearward center-of-gravity position. The stick-fixed stability was neutral at the rearward center-of-gravity position at speeds above approximately 130 mph. The requirement of reference 3 was not satisfied. It should be noted that the flaps on the F-47D-30 are of the blow-up type; that is, the flap deflection varies with decreasing airspeed until a speed is reached where the flaps remain full down. The variation of flap deflection with airspeed is shown in figure 12.

Landing condition (fig. 13).- The requirement was satisfied as the airplane was stable both with stick fixed and with stick free throughout the permissible speed range at both the center-of-gravity positions tested.

Wave-off condition (fig. 14).- The airplane was unstable with stick fixed and with stick free in this condition and the requirement of reference 3 was not satisfied.

Neutral points (figs. 15 to 21).- The data shown in figures 15 to 20 illustrate the method used in obtaining the neutral points shown in figure 21. Since only two center-of-gravity positions were tested, the actual numerical values of the neutral points may not be entirely accurate, but they do give a general picture of the stick-fixed and stick-free stability. In the power-on clean condition, the stability parameter $\frac{d\left(F_e/q\right)}{dC_N}$ is always negative (see figs. 19 and 20); this fact indicates that the center-of-gravity position required to make the airplane stable could not be obtained with any normal loading of the airplane. These data also indicate that it would be useless to test the airplane at a more rearward center-of-gravity position since it is already known that the airplane will be unstable. The same condition existed in the wave-off condition. In the approach condition a more accurate determination of the neutral point was possible since data were obtained with the center of gravity both forward and rearward of the neutral point. In the glide and landing conditions the airplane was stable throughout the speed range except at low normal-force coefficients in the glide condition where the stick-free neutral points were slightly forward of the rearmost center-of-gravity position tested. The neutral points would have been better defined had a more rearward center-of-gravity position been tested in these two conditions but the significance of these data did not warrant the tests.

It can be seen from the above discussion that the application of power had a definite destabilizing effect on both the stick-fixed and stick-free stability. The adverse effect of rearward center-of-gravity position is markedly shown and it should be noted that center-of-gravity positions rearward of the rearmost test center-of-gravity position may be obtained with normal loadings of the airplane.

## Longitudinal Control

Longitudinal control in accelerated flight.- The longitudinal stability characteristics in accelerated flight were investigated by making steady turns at constant speed and acceleration at both high and low altitude and at the two center-of-gravity positions. The changes in elevator control force and elevator angle with change in acceleration at the different speeds tested are shown in figures 22 to 24. In figure 25 the variations of elevator angle with normal-force coefficient in the aforementioned turns are plotted. The stick-free and stick-fixed maneuver points were evaluated by plotting the slope of the curve of elevator angle plotted against normal-force coefficient $d\delta_e/dC_N$ (fig. 26) and the stick force per g (fig. 27) as a function of center-of-gravity position. The maneuver points are the center-of-gravity positions at which these slopes are zero.

At the forward center-of-gravity position of 26 percent of the mean aerodynamic chord and low altitude, the elevator-control-force increment per unit acceleration in left turns was 7.5 pounds per g at 200 mph and 11.0 pounds per g at 350 mph. (See fig. 27(a).) This value was approximately 1 or 2 pounds per g higher in right turns. The requirement given in reference 3 is 3 to 8 pounds per g. The effect of altitude was to decrease the force per g at the lower speeds. (See fig. 27(b).) However, at 350 mph or a Mach number $M$ of approximately 0.6, the force per g reached a value of 14.2 pounds per g in right turns. This fact indicates that some form of breakdown of flow was taking place. The plot of force per g against Mach number shown in figure 28 shows that the force per g increases with increase in Mach number to a maximum at a Mach number of about 0.6. Beyond a Mach number of 0.6, the force per g decreases until the maximum test Mach number of 0.7 is reached.

At the rearward center-of-gravity position tested, 29 percent of the mean aerodynamic chord, the stick-force gradient varied from 2 to 7 pounds per g (fig. 23(a)). At 200 mph, elevator-force reversal occurred in both left and right turns. At high altitude, push forces were required with increasing acceleration at 200 mph in both left and right turns and in left turns at 250 mph. (See fig. 23(b).) At the higher speeds at high altitude, the curves of force against acceleration show that pull forces were required but that these forces were dangerously low.

In figure 29 the data at 200 mph are plotted as a graph showing the center-of-gravity range and altitude at which desirable stick forces, according to the requirements of reference 3, can be obtained. The center-of-gravity range for desirable stick forces shown in figure 29 is only approximate because the stick-force variation with acceleration at 200 mph was nonlinear. The tests at 200 mph were used because this condition was the most critical one tested and indicated the smallest center-of-gravity range for desirable stick forces.

From the above discussion, it can be seen that the airplane did not completely satisfy the requirements of reference 3. The values of force per g at the forward center-of-gravity position were in general within the required limits of 3 to 8 pounds per g. The airplane did not meet the requirements at the rearward center-of-gravity position because of the force reversal experienced at low speeds, especially at high altitude.

The most forward stick-fixed maneuver point was found to be 29.7 percent mean aerodynamic chord at 300 mph at high altitude, and the most forward stick-free maneuver point, at 27.4 percent mean aerodynamic chord at 200 mph at high altitude. The data obtained show the airplane, in general, to have higher stick force per g in right turns. Part of this difference was probably due to the gyroscopic moment of the propeller, but the results are not consistent and the gyroscopic moment does not account for the entire difference.

<u>Longitudinal control in landing</u>.- The elevator deflection used in landing is shown as a function of speed in figure 30. These data show the elevator deflection to be adequate at all the speeds tested and at both center-of-gravity positions. The elevator angles shown were not necessarily the minimum elevator angles required to land. The elevator force required during landing did not exceed the 35-pound limit of the requirements of reference 3. (See time histories of stall approaches in the approach and landing conditions in figs. 36(b) and 37(b).) The pilot thought that the characteristics of the airplane in landing with power off were unsatisfactory because of the very high rate of descent, approximately 50 fps. (This value was obtained from the pilot's readings of the instruments in the cockpit.) The application of a small amount of power corrected this undesirable characteristic but brought about the static instability previously discussed relative to the power-on approach condition. This instability was also considered undesirable by the pilot. After the airplane reached the ground, the pilot considered the airplane to be easy to control.

Tests were made to determine the change in trim caused by the lowering of the landing flaps. The tests were made with the controls held fixed and repeated with the controls used to correct the ensuing motion. Typical time histories are shown in figure 31. The results showed that the two flaps did not lower at the same rate, the left leading the right, so that a slight rolling tendency resulted and had to be corrected by use of small deflections of the ailerons and rudder.

<u>Longitudinal control in take-off</u>.- With the center of gravity in the most rearward position tested, it was possible to hold the tail of the airplane off the ground at any attitude up to thrust-axis level by use of the elevator at approximately 80 mph. (This speed was obtained from the pilot's readings of the instruments in the cockpit.) The pilot considered the airplane satisfactory under all conditions during take-off.

Longitudinal trimming control.- It was possible to trim the airplane to zero elevator force by use of the elevator trim tab in all conditions and at all the speeds between the stall and the maximum speed tested. The requirement of reference 3 is therefore satisfied.

Trim changes due to flaps and power.- The trim changes due to flaps and power are shown in table II. The tests were made according to the specifications of the requirements in reference 3. The elevator force required to trim the airplane due to flap deflection or power change was usually small, 0 to 5 pounds, and well below the limits set by the requirements. The change in rudder force required when the power was changed was large. (See ref. 2.)

### Dive-Recovery-Flap Investigation

The dive-recovery flaps of the F-47D-30 were tested at both center-of-gravity positions at high and low altitude. The tests were conducted by deflecting the dive flaps when the airplane was trimmed to zero control forces and the controls were free. The results are presented in figure 32 as the variation of the change in normal acceleration with speed and Mach number to illustrate the dive-flap effectiveness.

The dive flaps reached maximum effectiveness in high-altitude tests at approximately 3g at the forward center-of-gravity position and 3.5g at the rearward center-of-gravity position. At low altitude, however, the maximum effectiveness could not be obtained at either center-of-gravity position. Accelerations as high as 4.6g at a Mach number of 0.66 were obtained, but there was no evidence of a change in slope at this Mach number. These data are in fair agreement with those obtained in the wind-tunnel tests of reference 4.

The dive flaps were considered effective at all speeds and altitudes tested and the dive recovery was considered satisfactory.

## STALLING CHARACTERISTICS

The stalling characteristics of the airplane were investigated in the various configurations by making stall approaches, starting a few miles an hour above the stall and extending into the stall region. These stalls were performed in two ways: first, by using the controls to overcome the motions of the airplane brought about by the stall and, second, by holding all but the elevator control fixed and allowing the airplane to roll off. Time histories of typical stalls performed by both of these methods are shown in figures 33 to 40. The stalling characteristics may be summarized as follows:

(a) In the power-on clean condition (figs. 33 and 35) stall warning was afforded by mild buffeting about 4 mph above the stall. As the stall was reached, an initial tendency to roll to the right was experienced, followed by a roll to the left. This rolling tendency could be controlled by normal use of the controls but with a little difficulty. During the actual stall a strong buffeting occurred. The stall warning and characteristics during the stall were considered satisfactory.

(b) In the glide condition (figs. 34 and 35) ample warning of the stall was provided in the form of buffeting about 5 mph above the stall. At the stall there was a mild roll to the left which could be easily controlled by normal use of the controls. The stalling characteristics in this condition were considered satisfactory.

(c) In the approach condition (fig. 36) the stall was preceded by mild buffeting about 3 mph above the stall. The aileron and rudder forces required to hold the airplane level were slightly high and irregular, and maximum rudder deflection was reached before the stall. Although there was a buffet warning, the stalling characteristics were considered unsatisfactory. In tests in which the airplane was pulled further into the stall than those shown in the time histories, there was a rapid roll which could not be controlled by either the ailerons or the rudder, or both.

(d) In the landing condition (fig. 37) no buffeting preceded the stall, but the positive stability in this condition affords ample stall warning because of increased stick forces or rearward movement of the stick. At the stall the airplane rolled generally to the left but occasionally to the right. The roll could be easily controlled by normal use of the controls. The stalling characteristics in this condition were considered satisfactory.

(e) In the wave-off condition (fig. 38) the airplane was not carried to the complete stall because of the instability in this condition. Rudder control was lost before the stall and almost complete aileron deflection had to be used. The nose-high attitude of the airplane was also uncomfortable to the pilot. Mild buffeting preceded the stall and there appeared to be a tendency to roll right. The stalling characteristics were considered unsatisfactory because the airplane was unstable in this condition.

(f) The stall in accelerated flight in the power-on clean and landing conditions (figs. 39 and 40) was preceded by buffeting. At the stall mild lateral instability existed which could be easily controlled with the ailerons. The stalling characteristics for this condition were considered satisfactory.

## CONCLUSIONS

Flight tests made to determine the longitudinal stability and control and stalling characteristics of an F-47D-30 airplane led to the following conclusions:

1. An abrupt deflection and release of the elevator produced no oscillation of the elevator, but the airplane itself diverged longitudinally in the low-speed, power-on clean condition, sometimes violently.

2. The airplane did not satisfy the Air Force handling-qualities requirements for stick-free stability at either center-of-gravity position for any power-on condition with flaps and landing gear up or down. The airplane had satisfactory stick-fixed stability in the glide and approach conditions; the other conditions tested showed the airplane to have neutral or negative stick-fixed stability for some part of the speed range at either of the center-of-gravity positions.

3. At the forward center-of-gravity position of 26 percent mean aerodynamic chord, the increment of elevator control force per unit acceleration was within the limits of the Air Force requirements except at 350 mph at low altitude. At the rearward center-of-gravity position of approximately 29 percent mean aerodynamic chord and at low altitude, the force per g was low and force reversal occurred at the low speeds. At high altitude force reversal occurred at speeds below 250 mph and the force per g above these speeds was dangerously low. Over the speed range and altitudes tested the force per g was higher in right turns than in left turns. The most forward stick-free maneuver point was at 27.4 percent mean aerodynamic chord.

4. The elevator control for landing met the Air Force requirements, but, because of the longitudinal instability in the power-on approach condition with the small amount of power applied, the pilot thought the landing approach was unsatisfactory. On the ground during take-off and landing the airplane had satisfactory handling qualities.

5. The power of the elevator trimming tab was sufficient to trim the control forces to zero throughout the speed range at both the center-of-gravity positions tested.

6. The elevator-trim-force changes due to power and flaps were small and satisfactory.

7. The performance of the dive-recovery flaps was satisfactory throughout the speed range and altitudes tested.

8. The stalling characteristics of the F-47D-30 airplane were considered satisfactory except in the approach and wave-off conditions. In all cases there was sufficient stall warning several miles per hour above the stall in the form of mild buffeting, increased stick forces, or by rearward movement of the stick.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., February 18, 1948.

## REFERENCES

1. Gilruth, R. R.: Requirements for Satisfactory Flying Qualities of Airplanes. NACA Rep. 755, 1943. (Supersedes NACA ACR, Apr. 1941.)

2. Goranson, R. Fabian, and Kraft, Christopher C., Jr.: Measurements of Flying Qualities of an F-47D-30 Airplane To Determine Lateral and Directional Stability and Control Characteristics. NACA TN 2675, 1952. (Supersedes NACA RM L6L31.)

3. Anon.: Specification for Stability and Control Characteristics of Airplanes. SR-119A, Bur. Aero., April 7, 1945.

4. Hamilton, William T., and Boddy, Lee E.: High-Speed Wind-Tunnel Tests of Dive-Recovery Flaps on a 0.3-Scale Model of the P-47D Airplane. NACA ACR 5D19, 1945.

TABLE I.- PERTINENT DIMENSIONS OF THE F-47D-30 AIRPLANE

| | |
|---|---|
| Engine | Pratt & Whitney R-2800-59 |
| Propeller | (four blades) Curtiss Dwg. No. SPA-5 |
| Total wing area, sq ft | 300 |
| Total aileron area, sq ft | 25.7 |
| Aileron-trim-tab area (left aileron), sq ft | 0.89 |
| Stabilizer area, sq ft | 33.0 |
| Elevator area, sq ft | 22.0 |
| Elevator-trim-tab area, sq ft | 0.94 |
| Fin area, sq ft | 13.9 |
| Rudder area, sq ft | 11.9 |
| Rudder-trim-tab area, sq ft | 0.87 |

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TABLE II.- TRIM CHANGES OF F-47D-30 DUE TO FLAPS AND POWER

(a) Center of gravity, 0.291 mean aerodynamic chord, gear retracted

| Indicated airspeed, mph | Power | Flaps | Gear | Control force, lb | | | Change in sideslip angle, deg |
|---|---|---|---|---|---|---|---|
| | | | | Elevator pull | Rudder | Aileron | |
| 164 | 50 percent | Up | Up | 0 | 0 | 0 | 0 |
| 164 | 50 percent | Up | Down | 5.4 | 1 left | 0 | .1 left |
| 164 | 50 percent | Down | Down | .8 | 9 left | .6 right | .5 right |
| 166 | Off | Down | Down | 5.4 | 33 left | 0 | .2 right |
| 139 | 50 percent | Down | Down | 0 | 0 | 0 | 0 |
| 139 | Off | Down | Down | 3.9 | 62 left | .6 right | 2.7 right |
| 162 | Off | Up | Up | 0 | 0 | 0 | 0 |
| 163 | Off | Up | Down | 3.9 | 1 left | .6 left | 0 |
| 165 | Off | Down | Down | 1.1 | 7 left | 1.0 left | 1.1 left |
| 139 | Off | Down | Down | 0 | 0 | 0 | 0 |
| 138 | Normal rated | Down | Down | -8.5 | 98 right | 0 | 2.2 left |
| 139 | Normal rated | Down | Down | 0 | 2 right | 0 | 2.5 left |
| 138 | Normal rated | Down | Up | -3.8 | 14 right | .6 left | 3.1 left |
| 138 | Normal rated | Up | Up | -3.8 | 3 right | .6 left | 4.7 left |
| 117 | Normal rated | Up | Down | 0 | 0 | 0 | 0 |
| 117 | Normal rated | Up | Up | -3.8 | 19 right | 0 | .1 left |

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TABLE II.- TRIM CHANGES OF F-47D-30 DUE TO FLAPS AND POWER - Concluded

(b) Center of gravity, 0.263 mean aerodynamic chord, gear retracted

| Indicated airspeed, mph | Power | Flaps | Gear | Control force, lb | | | Change in sideslip angle, deg |
|---|---|---|---|---|---|---|---|
| | | | | Elevator pull | Rudder | Aileron | |
| 164 | 50 percent | Up | Up | 0 | 0 | 0 | 0 |
| 165 | 50 percent | Up | Down | 4.6 | 14 left | .8 right | .5 right |
| 165 | 50 percent | Down | Down | 1.5 | 18 left | .8 right | .7 right |
| 163 | Off | Down | Down | 4.6 | 44 left | .8 right | 1.2 right |
| 137 | 50 percent | Down | Down | 0 | 0 | 0 | 0 |
| 138 | Off | Down | Down | 6.3 | 30 left | 0 | 2.0 right |
| 164 | Off | Up | Up | 0 | 0 | 0 | 0 |
| 165 | Off | Up | Down | 5.3 | 2 left | 4.8 left | .1 left |
| 164 | Off | Down | Down | 3.1 | 27 left | 6.0 left | .2 right |
| 138 | Off | Down | Down | 0 | 0 | 0 | 0 |
| 140 | Normal rated | Down | Down | -18.5 | 96 right | 0 | 2.9 left |
| 139 | Normal rated | Down | Down | 0 | 0 | 0 | 0 |
| 138 | Normal rated | Down | Up | -3.8 | 1 right | 0 | .2 right |
| 137 | Normal rated | Up | Up | -4.7 | 3 left | 0 | 1.2 left |
| 120 | Normal rated | Up | Down | 0 | 0 | 0 | 0 |
| 118 | Normal rated | Up | Up | -4.7 | 5 right | 0 | .7 left |

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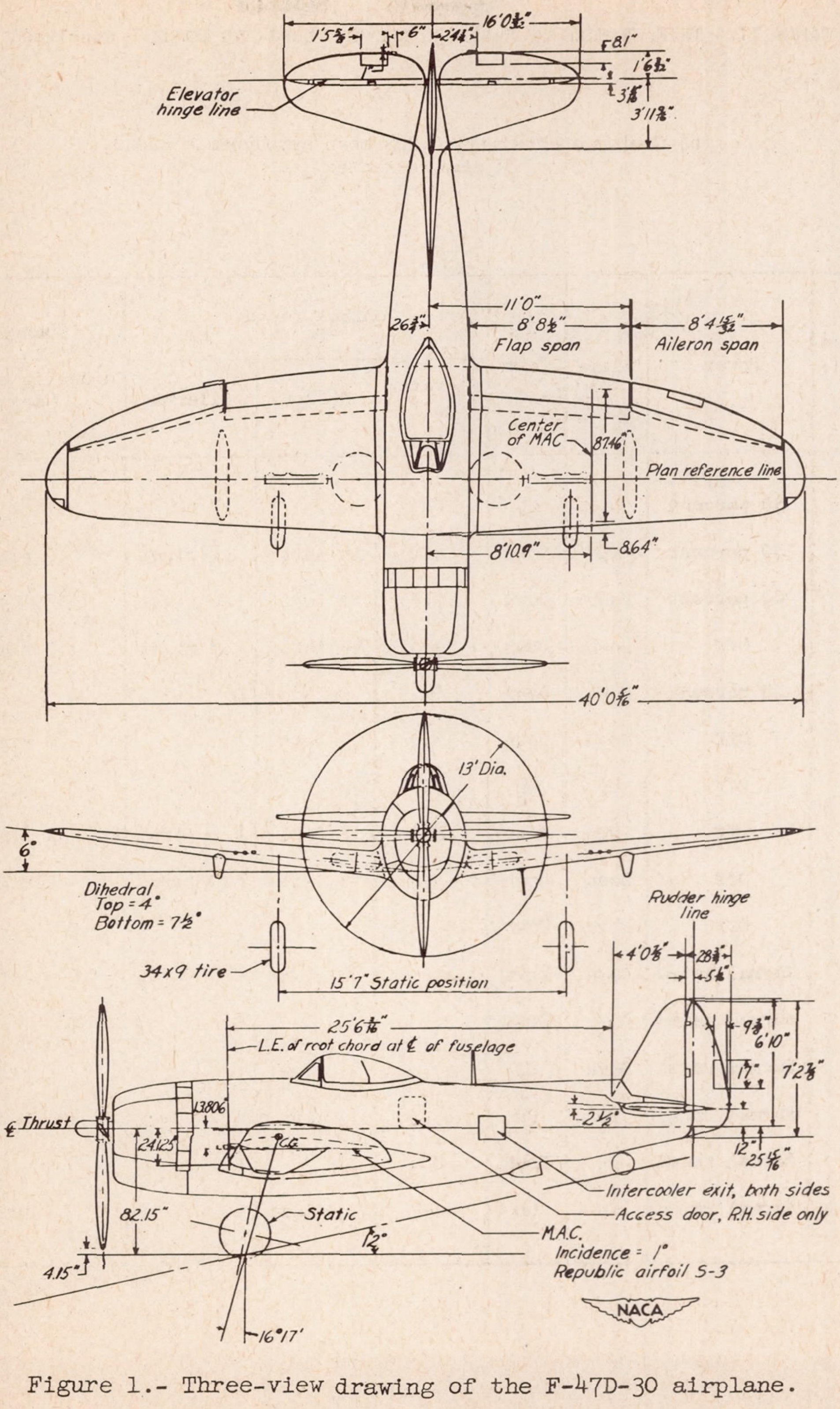


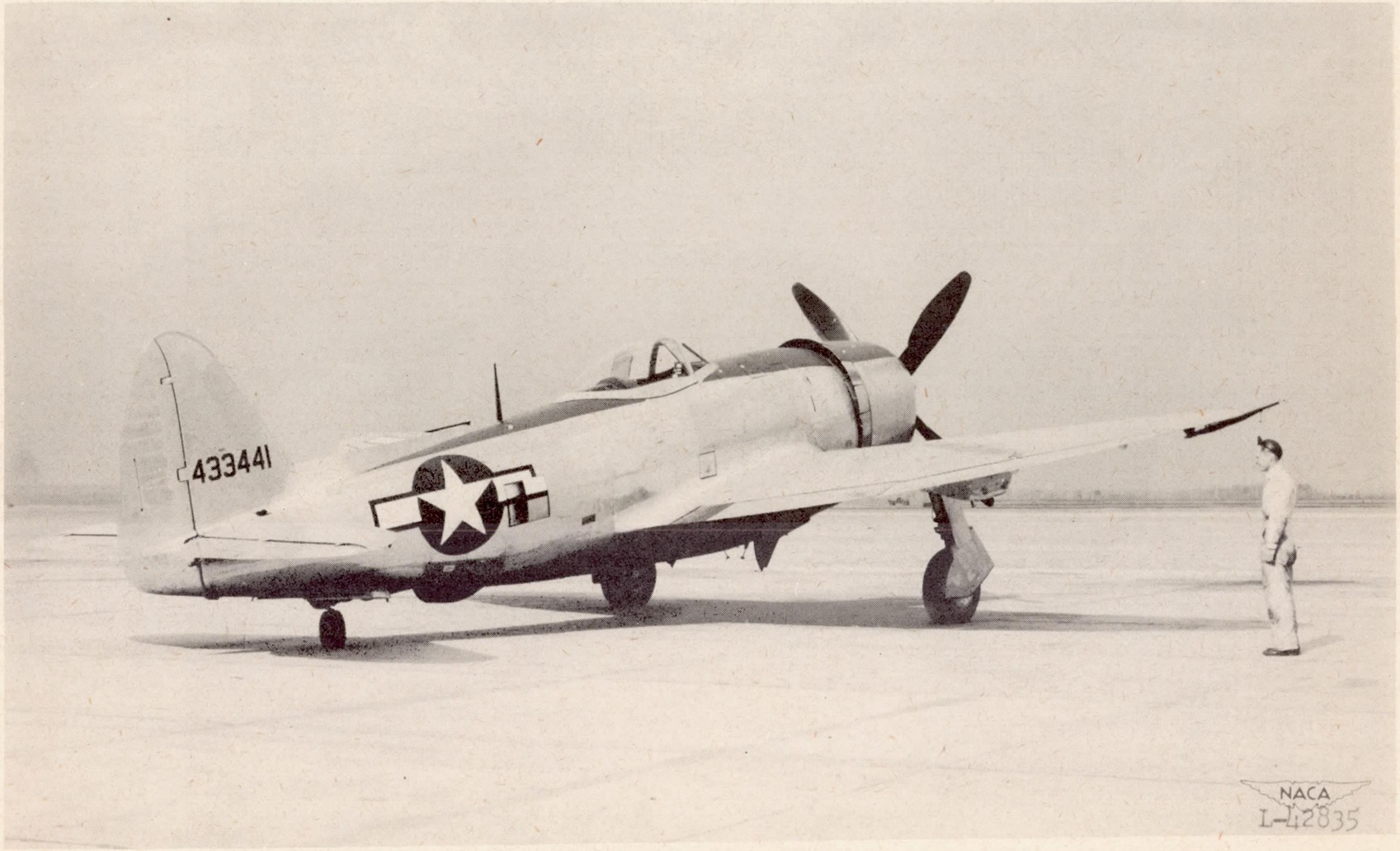

Figure 1.- Three-view drawing of the F-47D-30 airplane.


(a) Three-quarter front view.

Figure 2.- F-47D-30 test airplane.

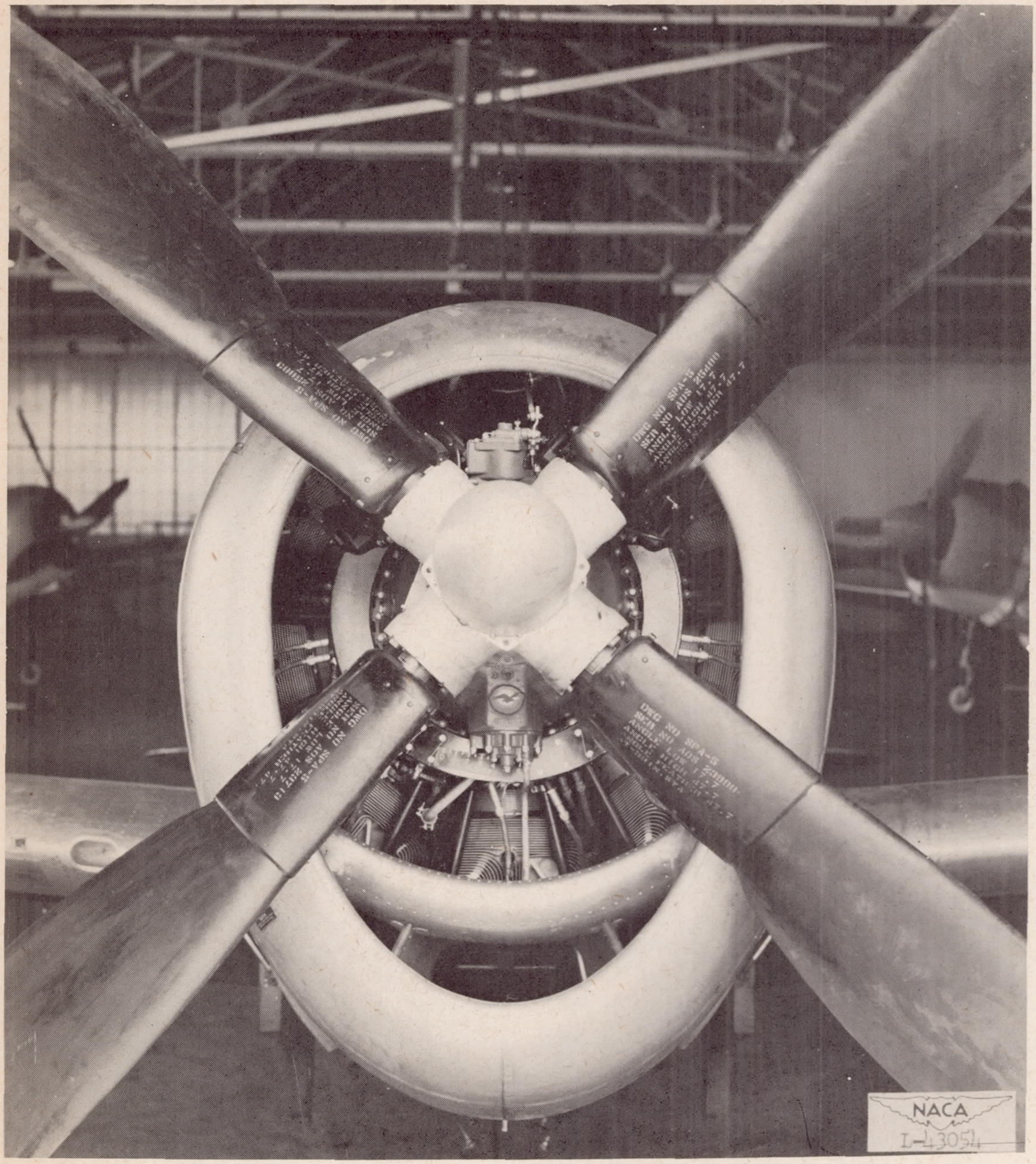

(b) Side view.

Figure 2.- Continued.



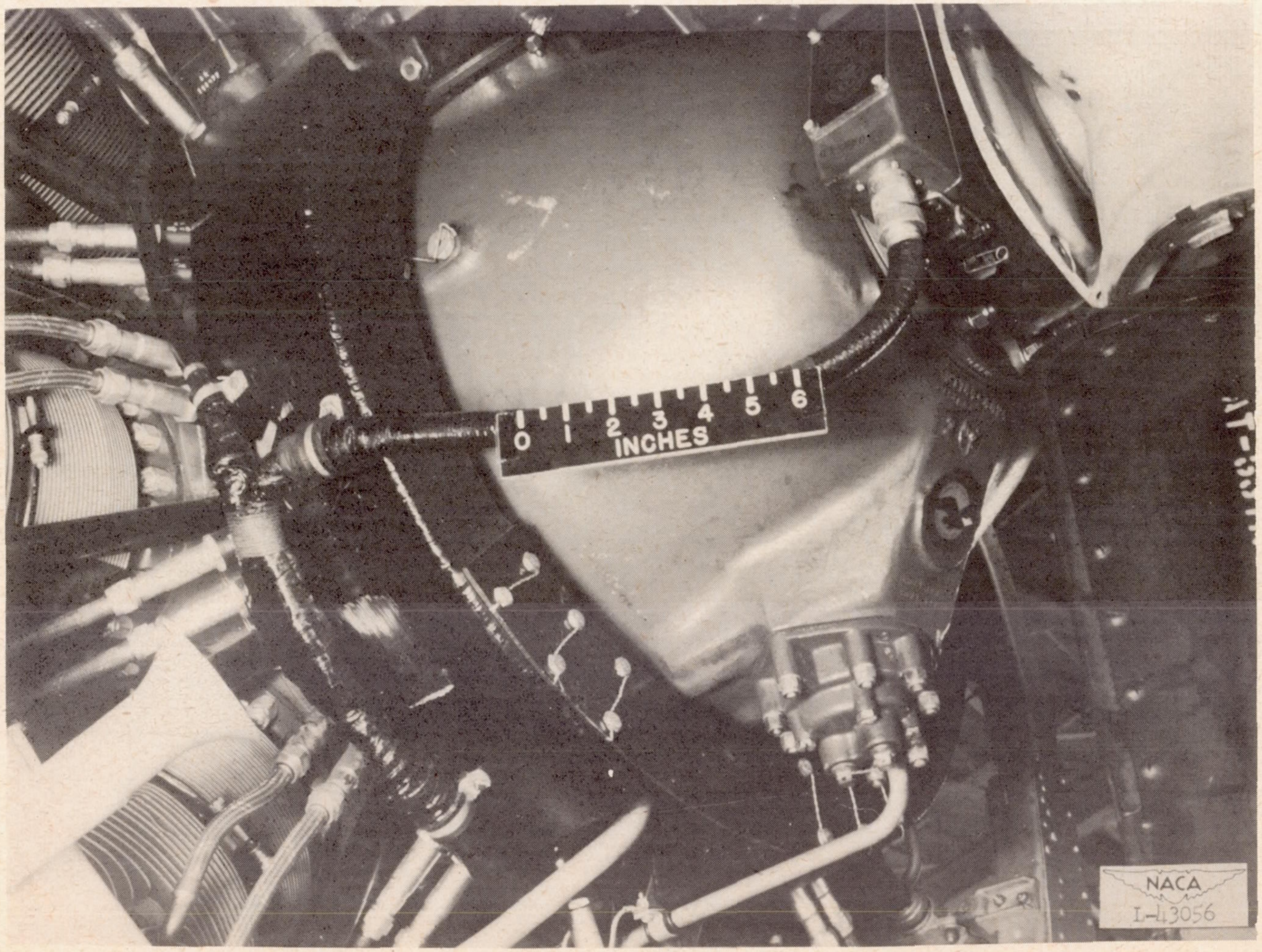

(c) Three-quarter rear view.

Figure 2.- Concluded.




(a) Front view of engine showing lead ballast ring mounted on gear box.

Figure 3.- Photographs of ballast installed on F-47D-30 test airplane.




(b) Details of lead ring mounted on reduction-gear housing.

Figure 3.- Concluded.

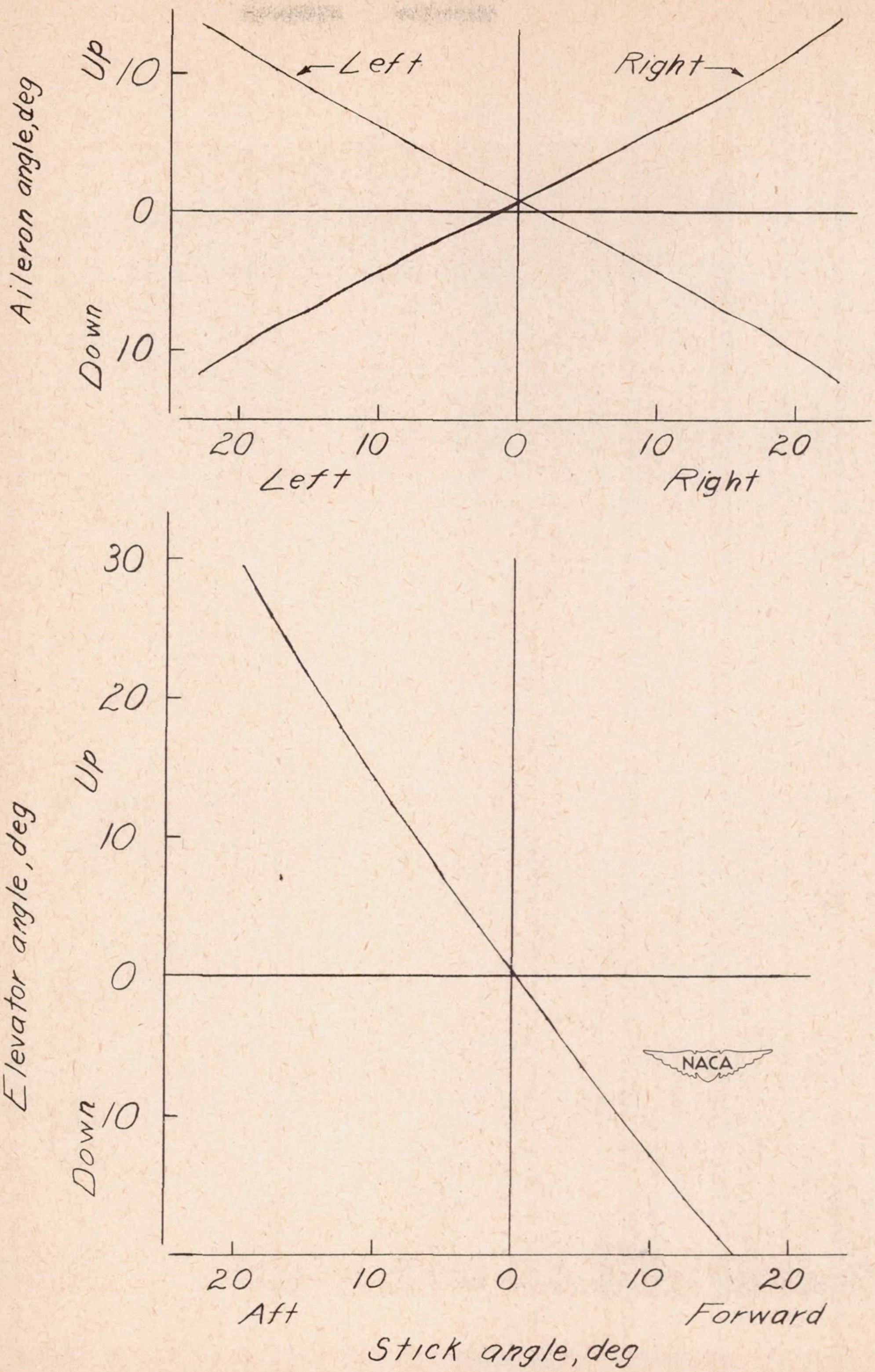



Figure 4.- Variation of aileron and elevator deflection with stick position. F-47D-30 airplane.

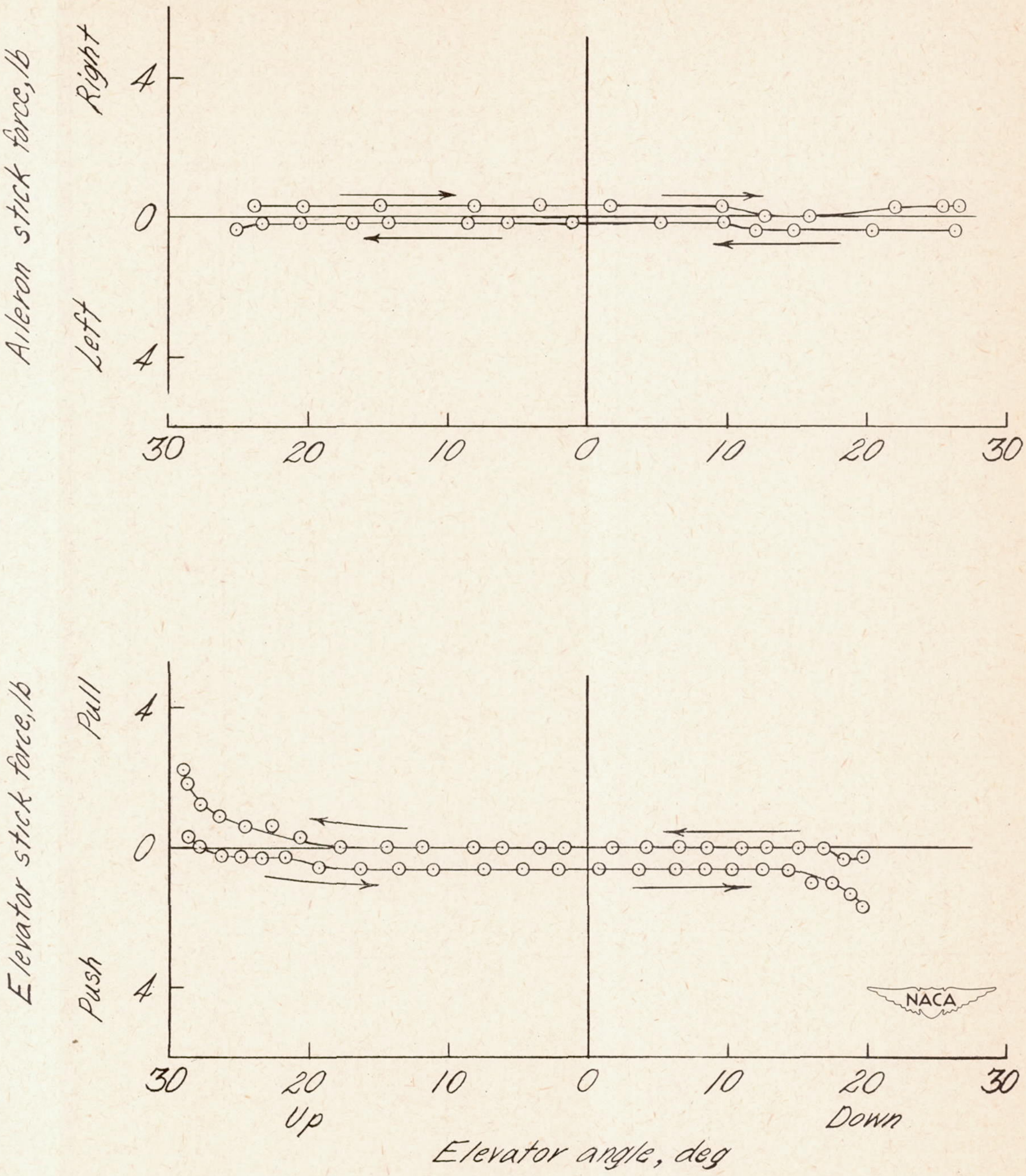



Figure 5.- Aileron and elevator stick force due to friction as measured on the ground with no load on the ailerons or elevator. F-47D-30 airplane.

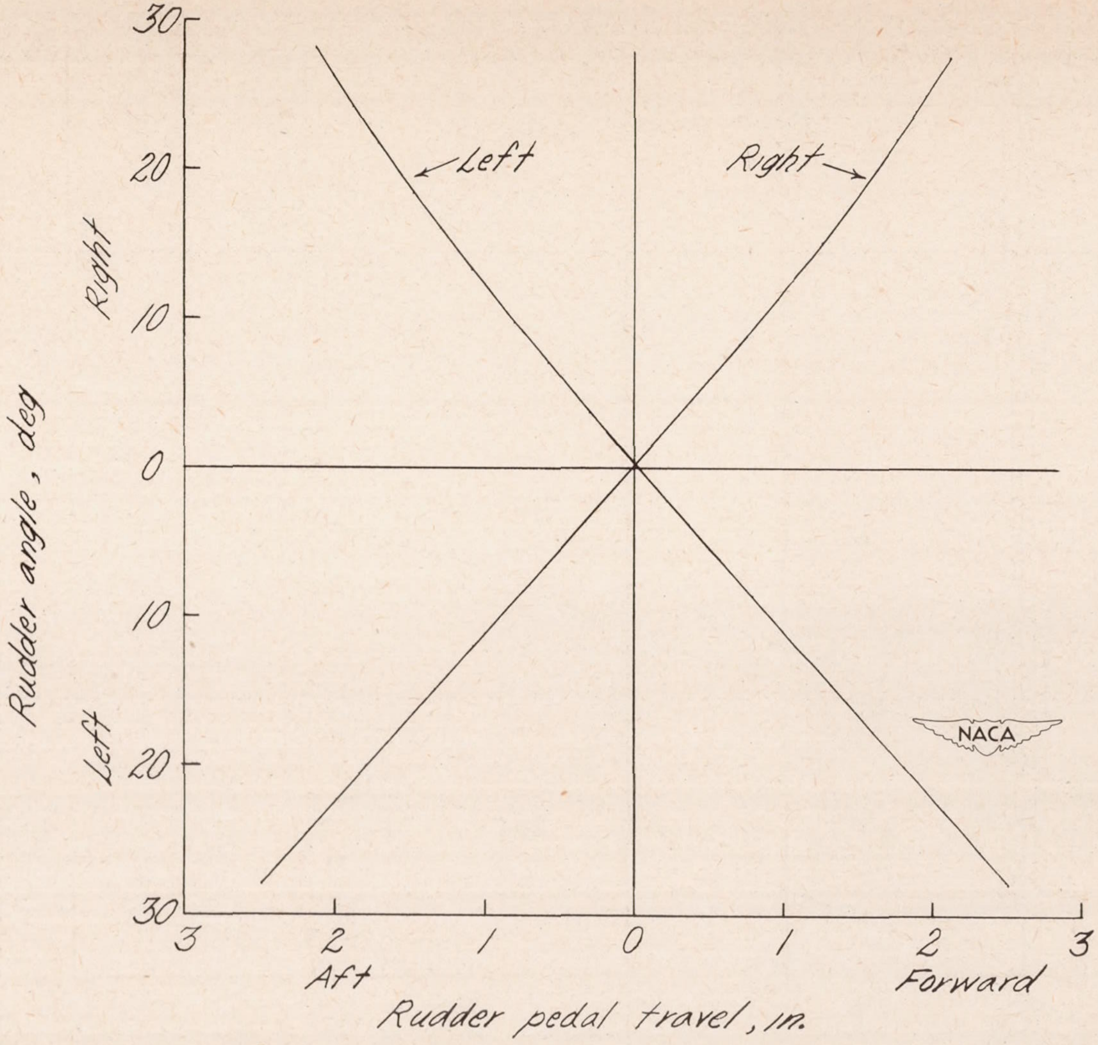



Figure 6.- Variation of rudder angle with rudder-pedal position as measured on the ground with no rudder load.

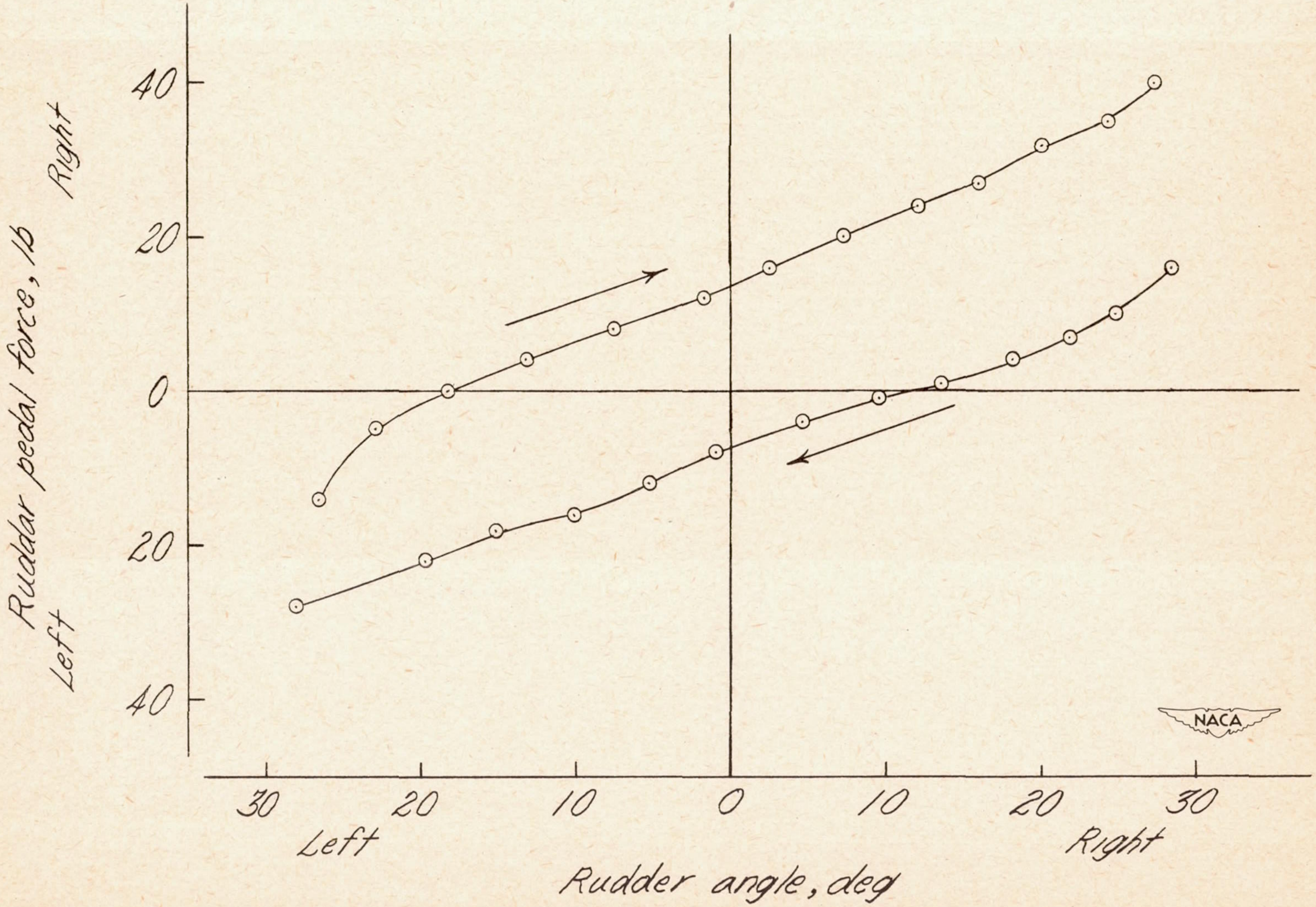
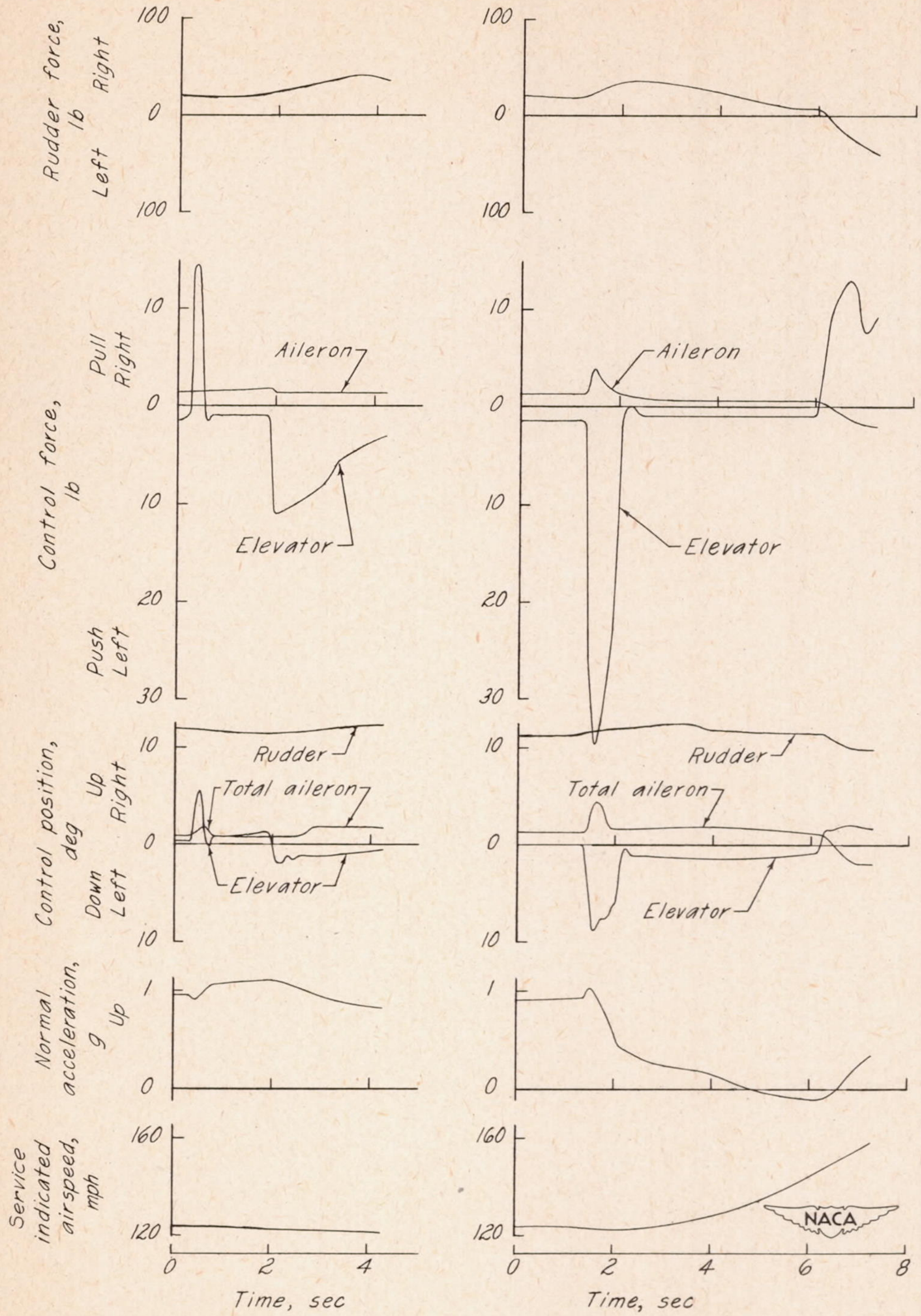
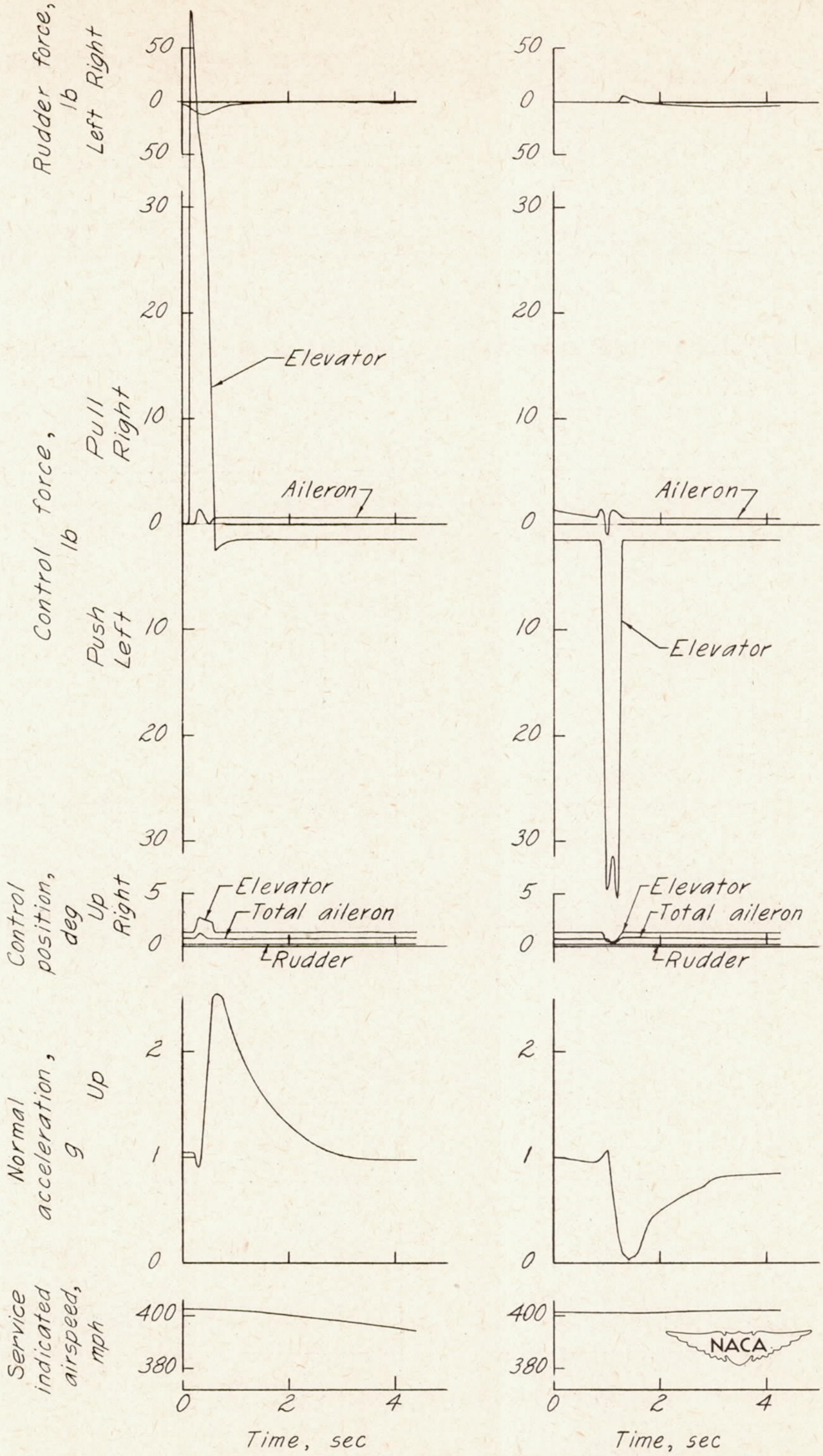



Figure 7.- Rudder-pedal forces due to friction in the rudder control system as measured on the ground with no rudder load. Free-air temperature, 70° F.



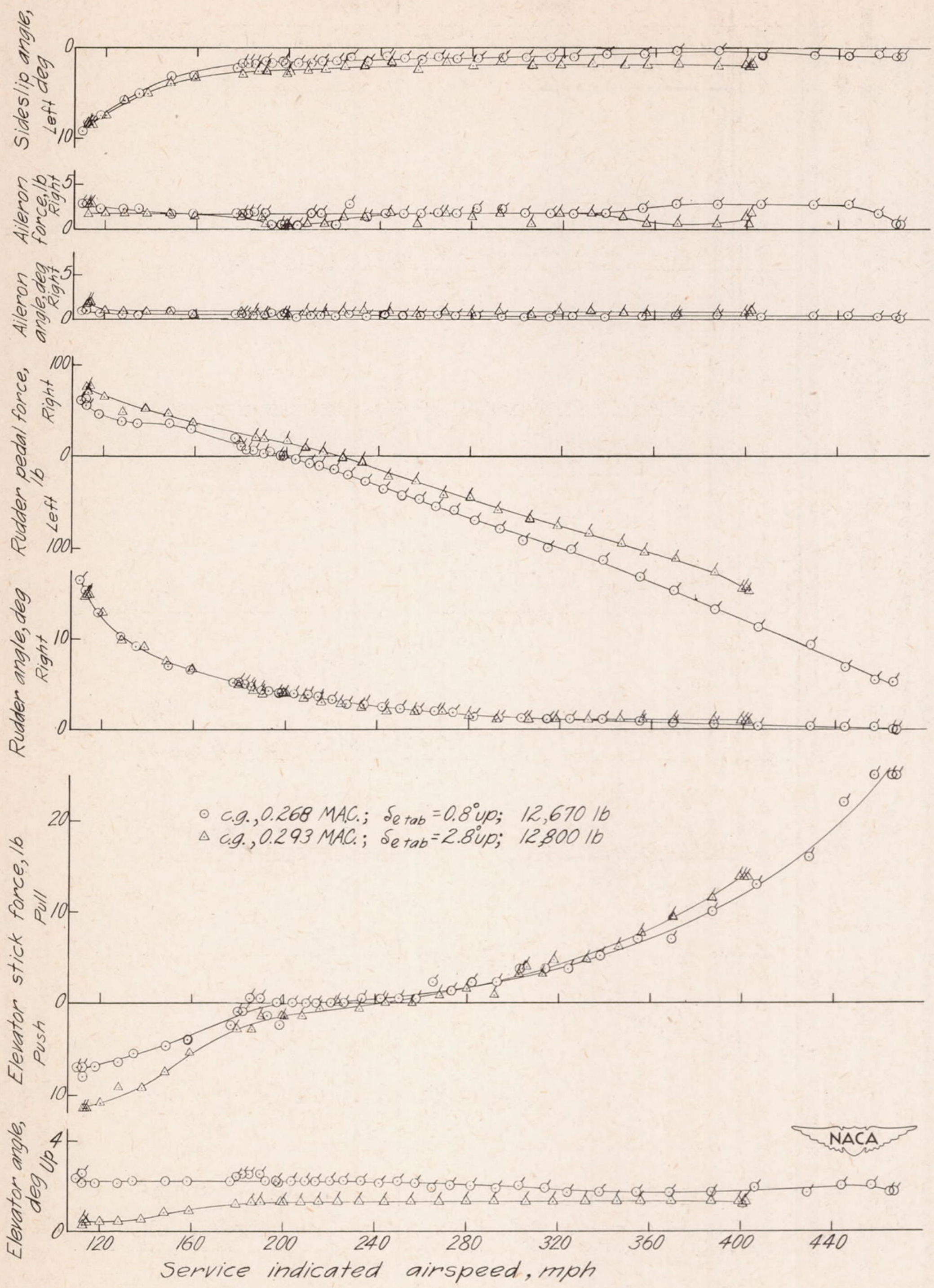

(a) Airspeed, 120 mph.

Figure 8.- Time histories of short-period oscillations induced by a rapid deflection and release of the elevator. Power-on clean condition; center of gravity at 29.0 percent of the mean aerodynamic chord.



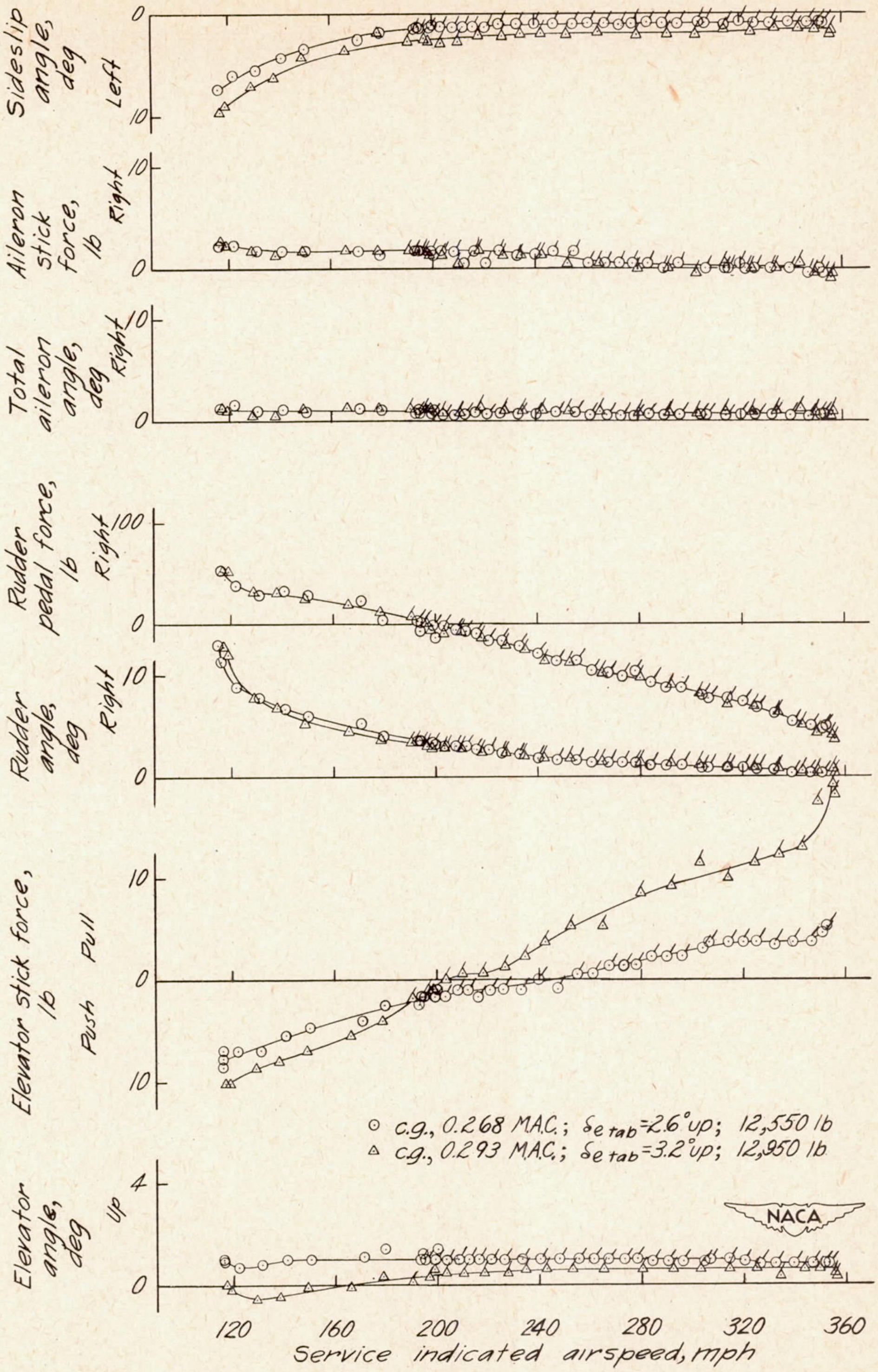

(b) Airspeed, 400 mph.

Figure 8.- Concluded.



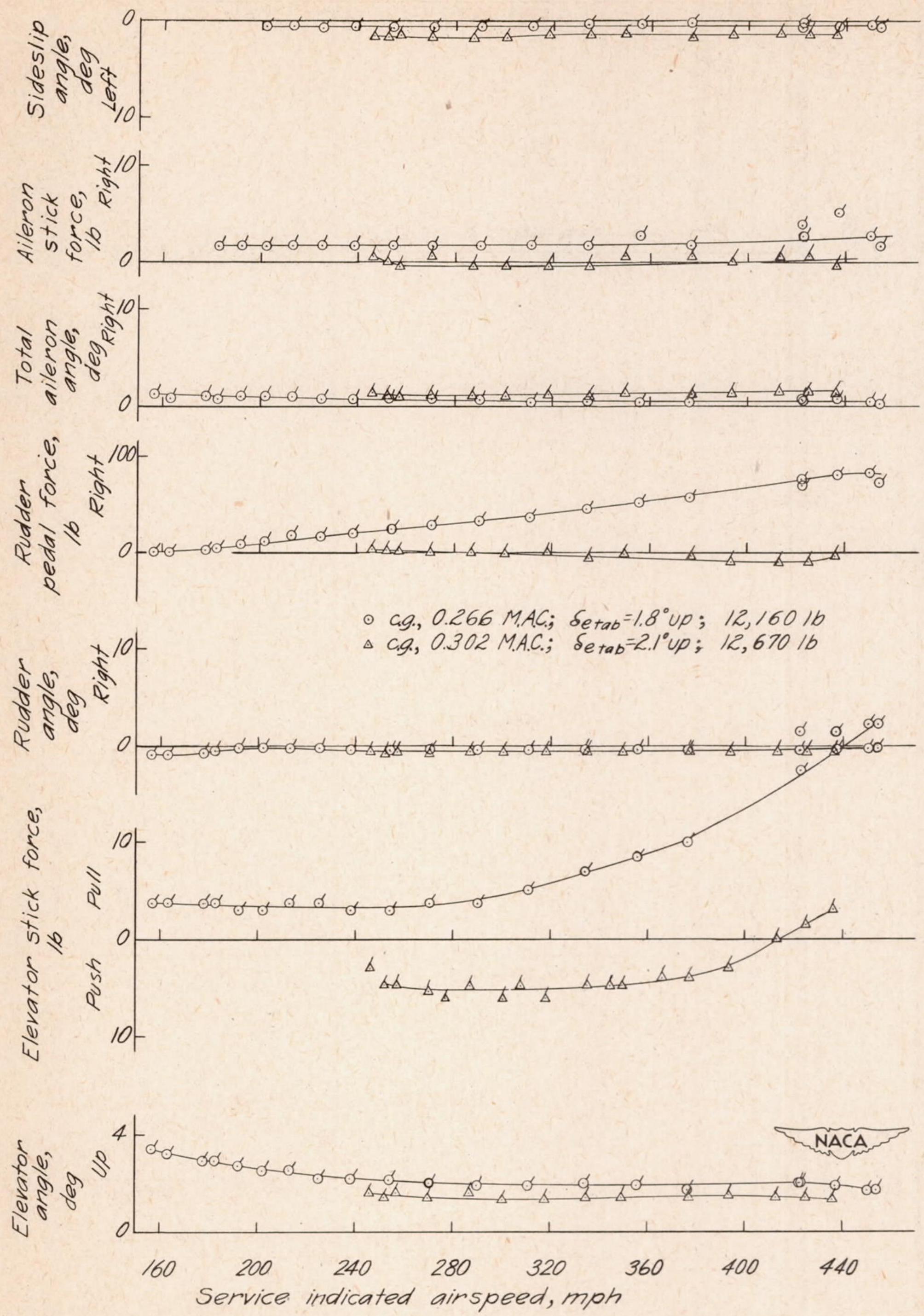

(a) Altitude, approximately 5,000 feet.

Figure 9.- Longitudinal stability characteristics of the F-47D-30 airplane in the power-on clean condition.



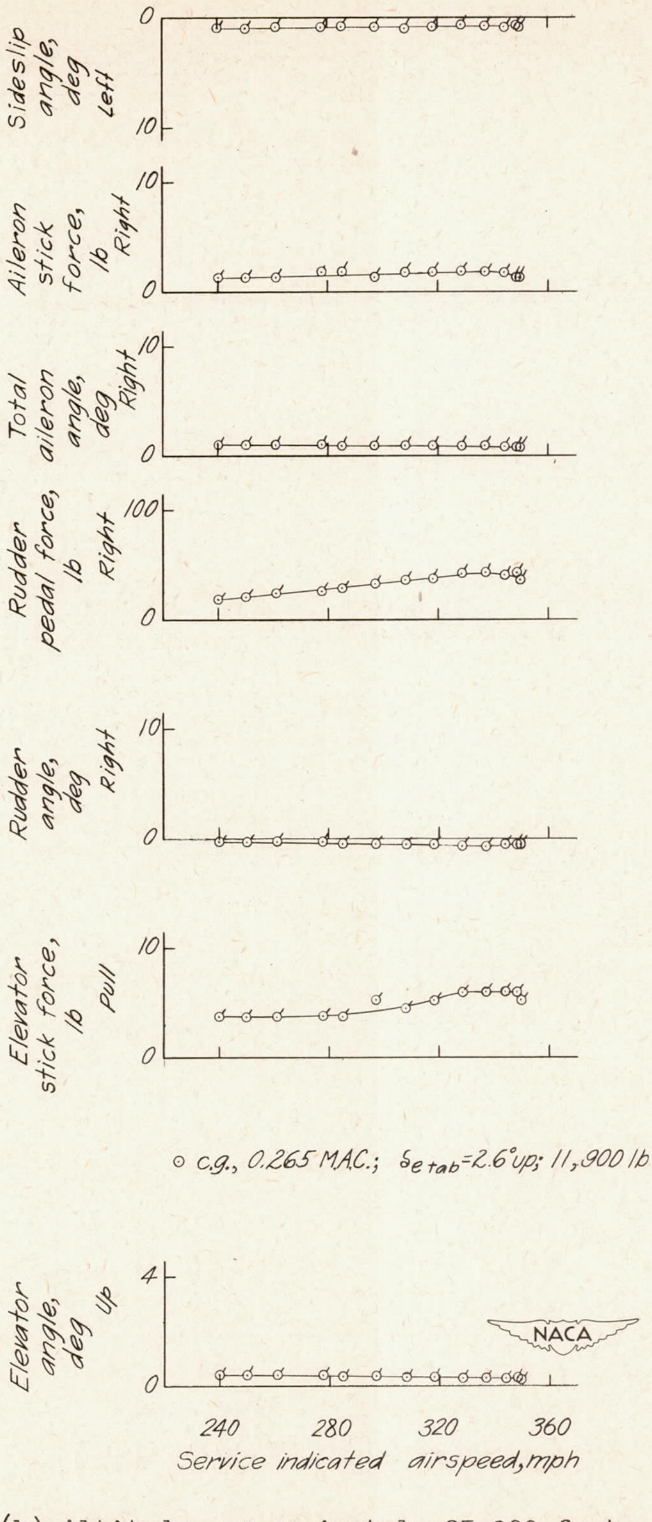

(b) Altitude, approximately 25,000 feet.

Figure 9.- Concluded.



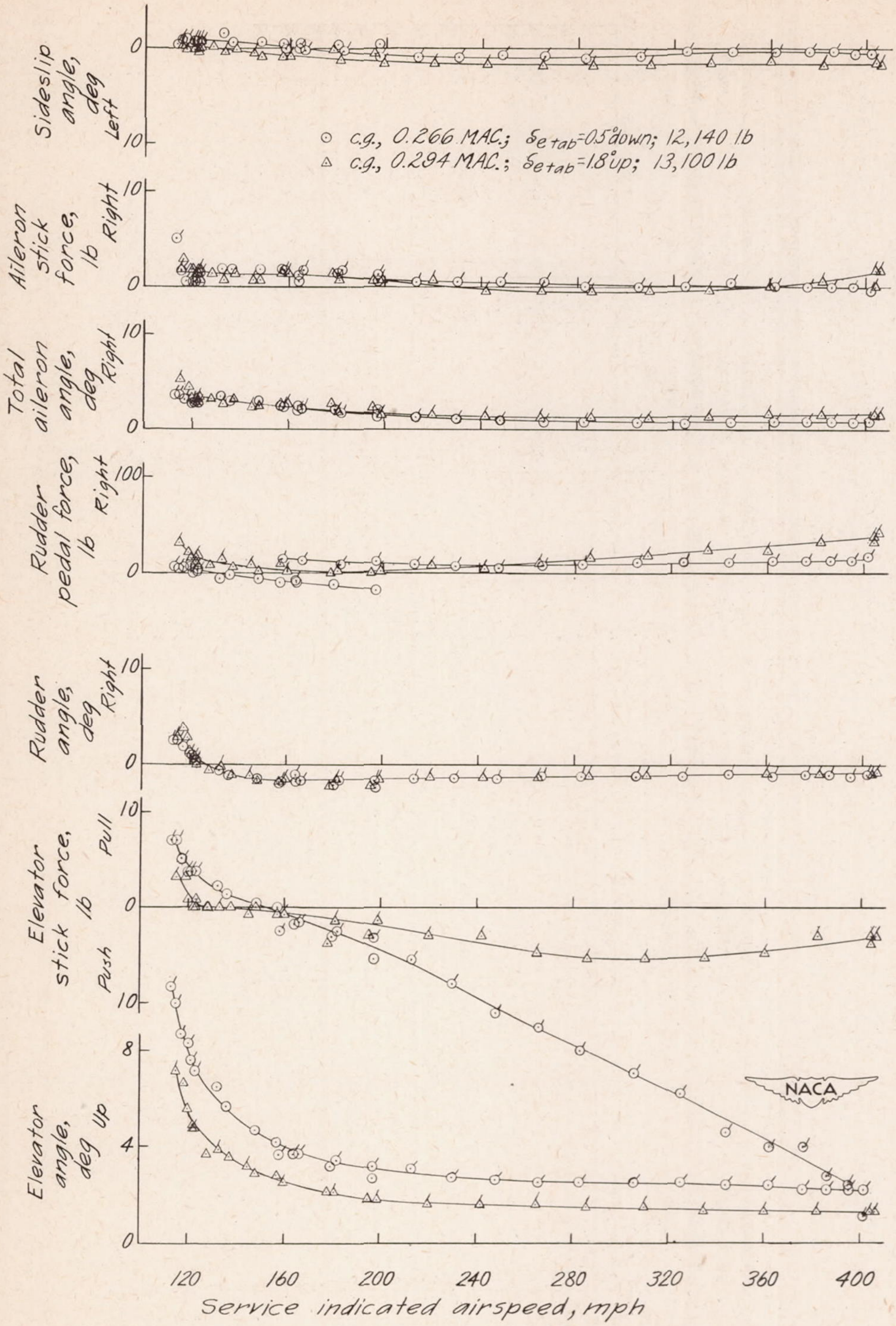

(a) Altitude, approximately 5,000 feet.

Figure 10.- Longitudinal stability characteristics of the F-47D-30 airplane in the dive condition.



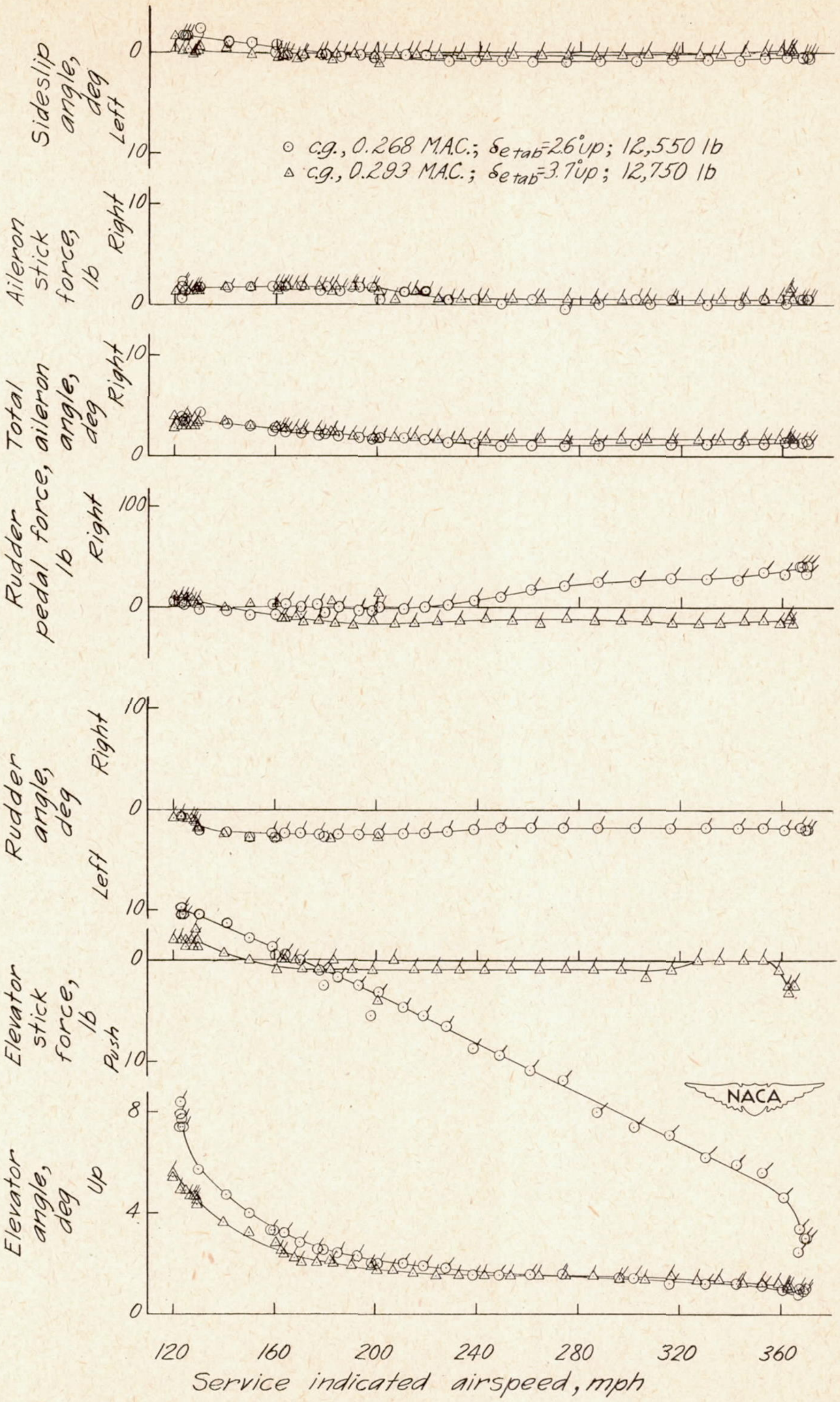

(b) Altitude, approximately 25,000 feet.

Figure 10.- Concluded.




(a) Altitude, approximately 7,000 feet.

Figure 11.- Longitudinal stability characteristics of the F-47D-30 airplane in the glide condition.




(b) Altitude, approximately 22,000 feet.

Figure 11.- Concluded.

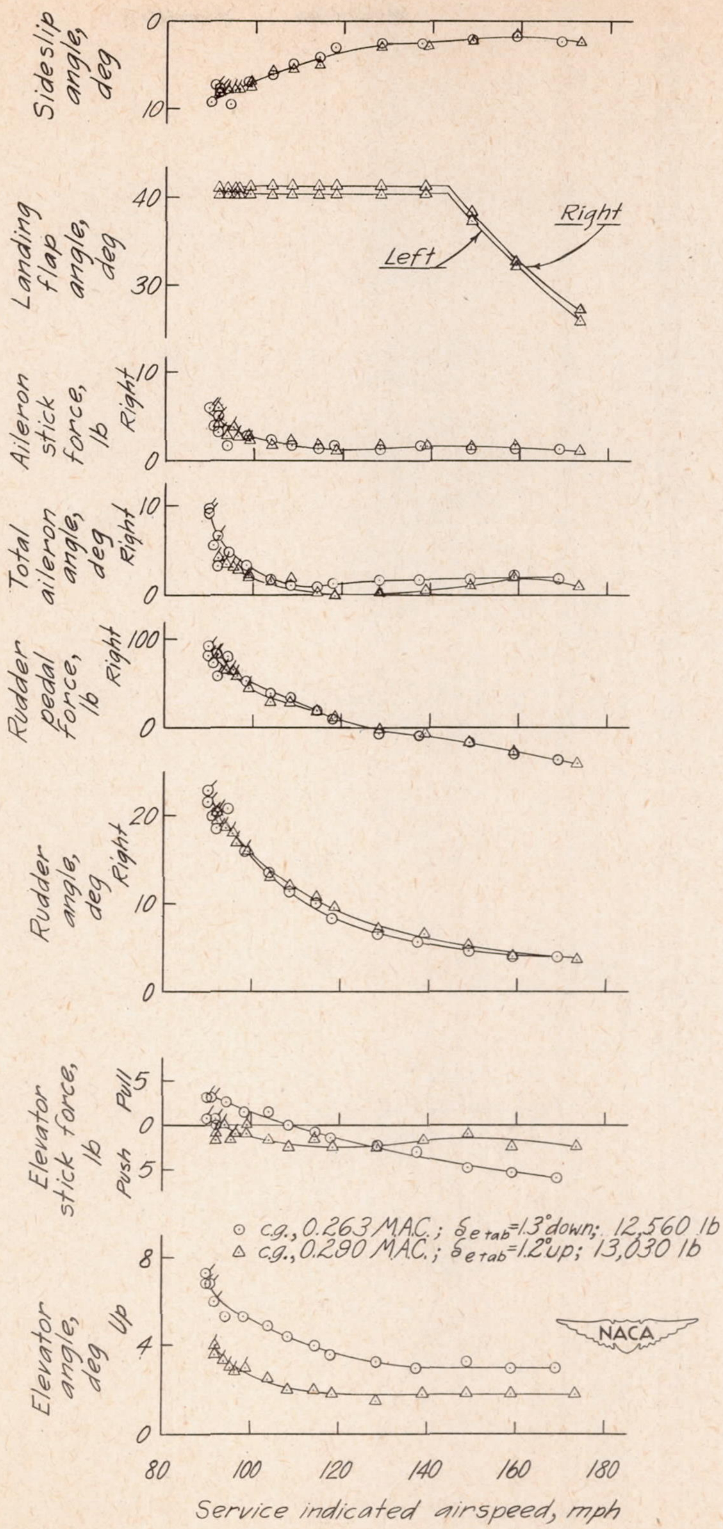



Figure 12.- Longitudinal stability characteristics of the F-47D-30 airplane in the approach condition at an altitude of approximately 5,000 feet.

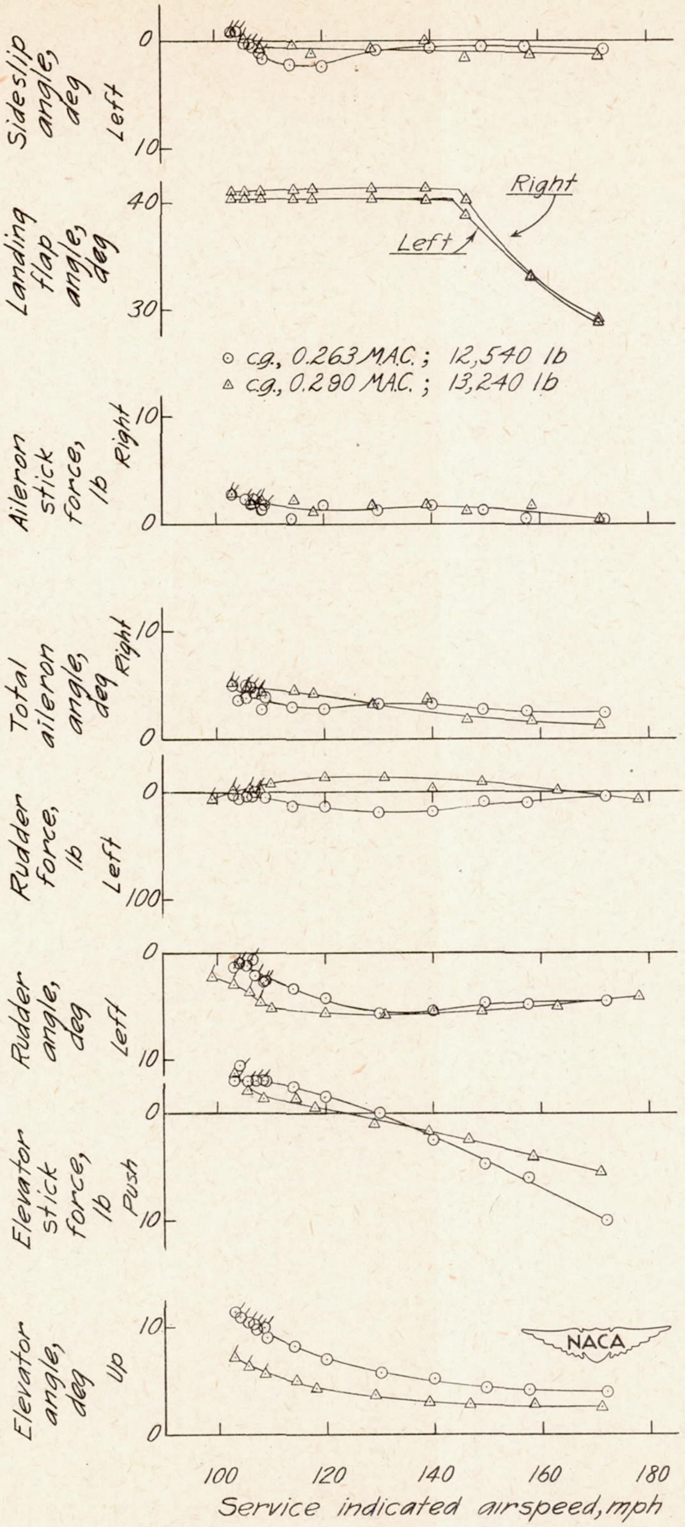



Figure 13.- Longitudinal stability characteristics of the F-47D-30 airplane in the landing condition at an altitude of approximately 5,000 feet.

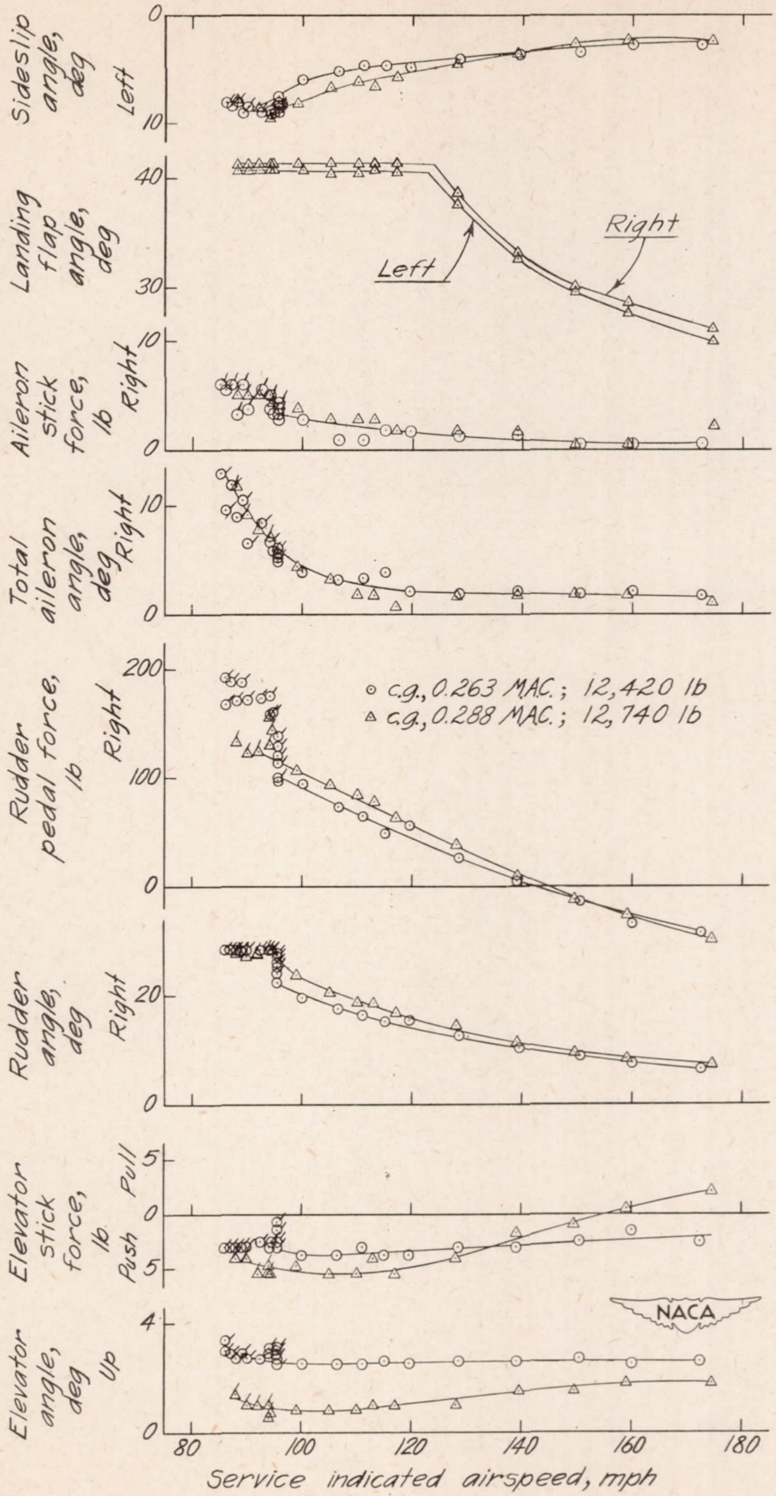
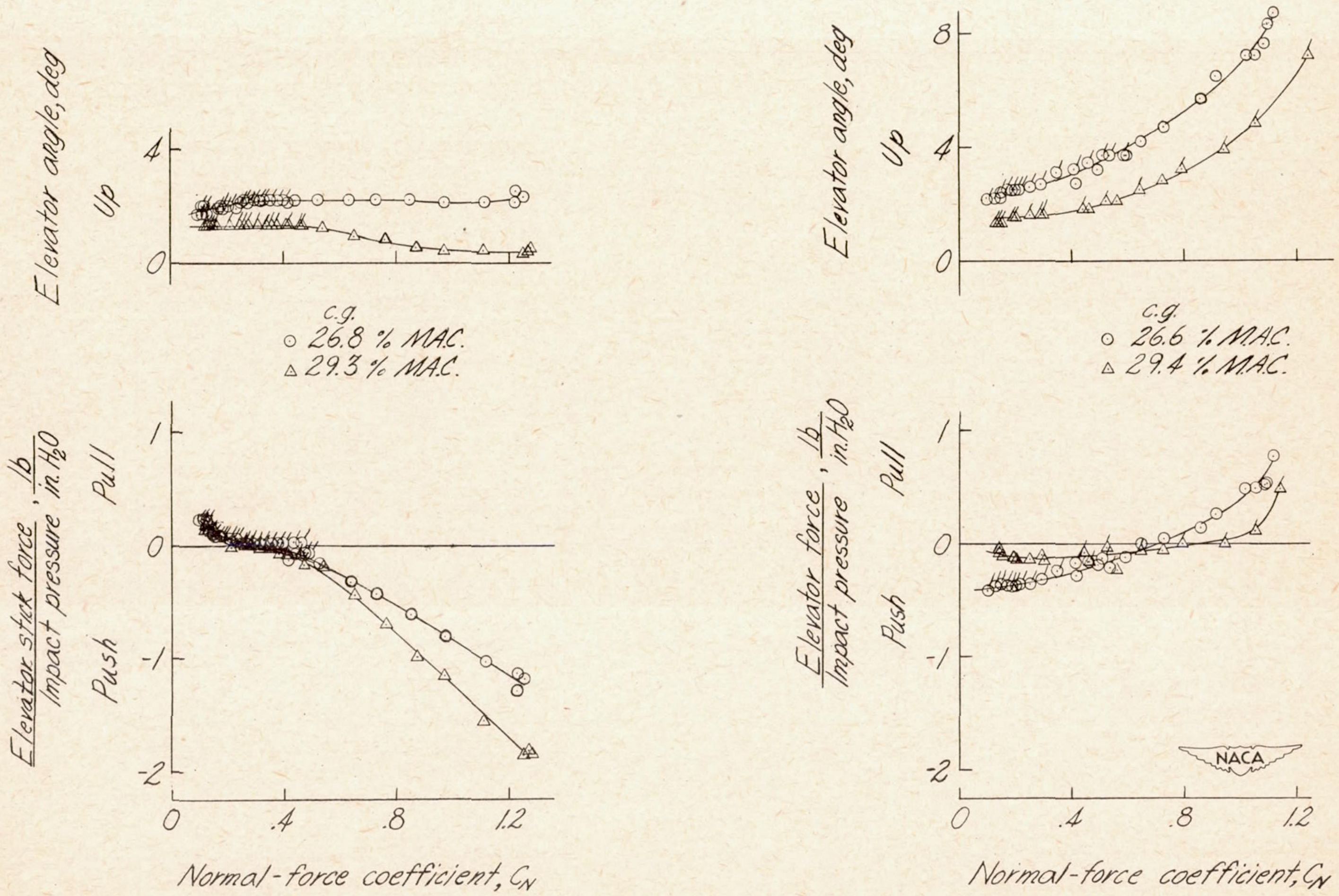


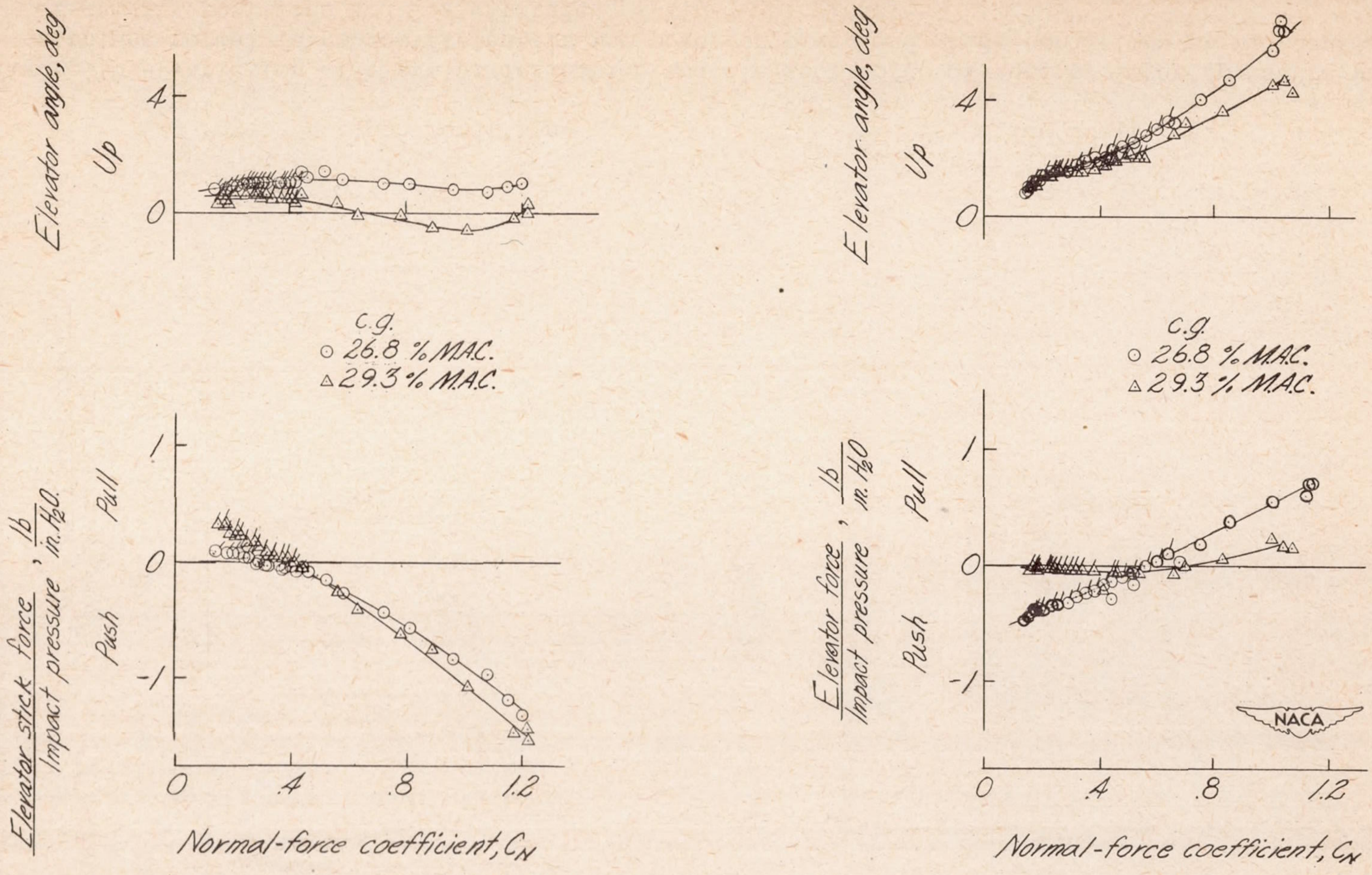

Figure 14.- Longitudinal stability characteristics of the F-47D-30 airplane in the wave-off condition at an altitude of approximately 5,000 feet.




(a) Power-on clean condition.

(b) Glide condition.

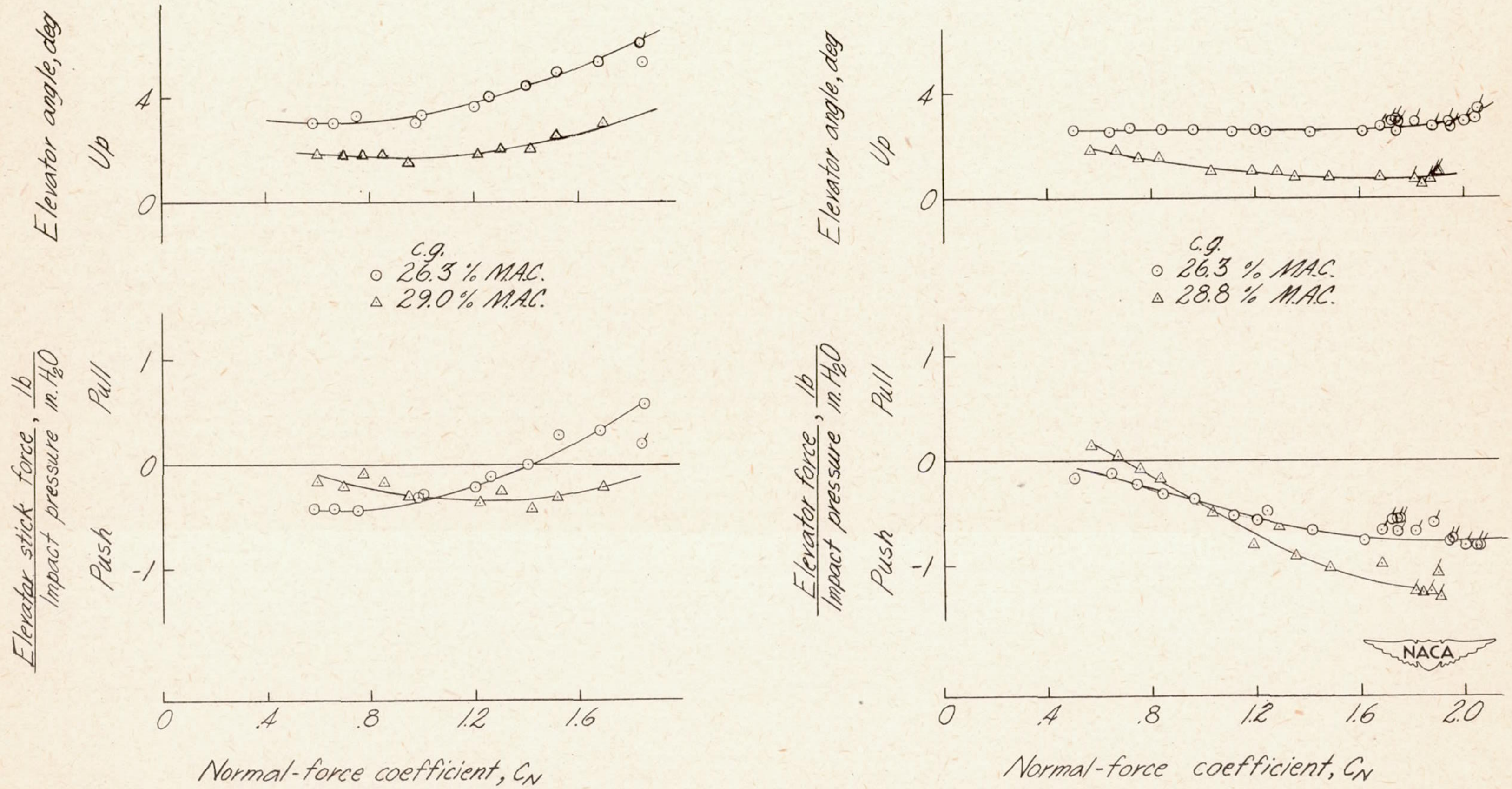
Figure 15.- Variation of elevator deflection and elevator force divided by impact pressure with airplane normal-force coefficient in the power-on clean and glide conditions at two center-of-gravity positions and low altitude. F-47D-30 airplane.




(a) Power-on clean condition.

(b) Glide condition.

Figure 16.- Variation of elevator deflection and elevator force divided by impact pressure with airplane normal-force coefficient in the power-on clean and glide conditions at two center-of-gravity positions and high altitude. F-47D-30 airplane.




(a) Approach condition.

(b) Wave-off condition.

Figure 17.- Variation of elevator deflection and elevator force divided by impact pressure with airplane normal-force coefficient in the approach and wave-off conditions at two center-of-gravity positions. F-47D-30 airplane.

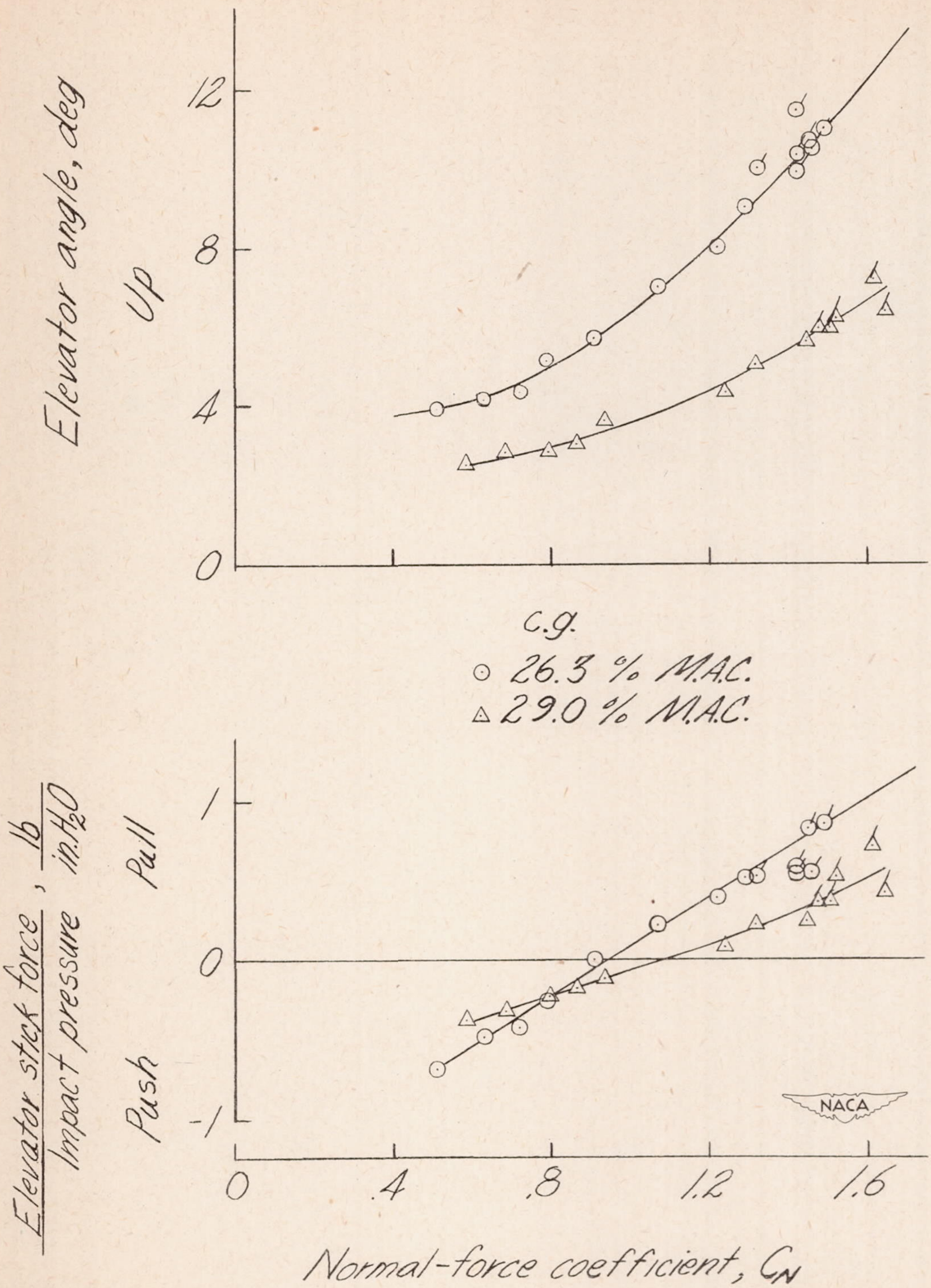
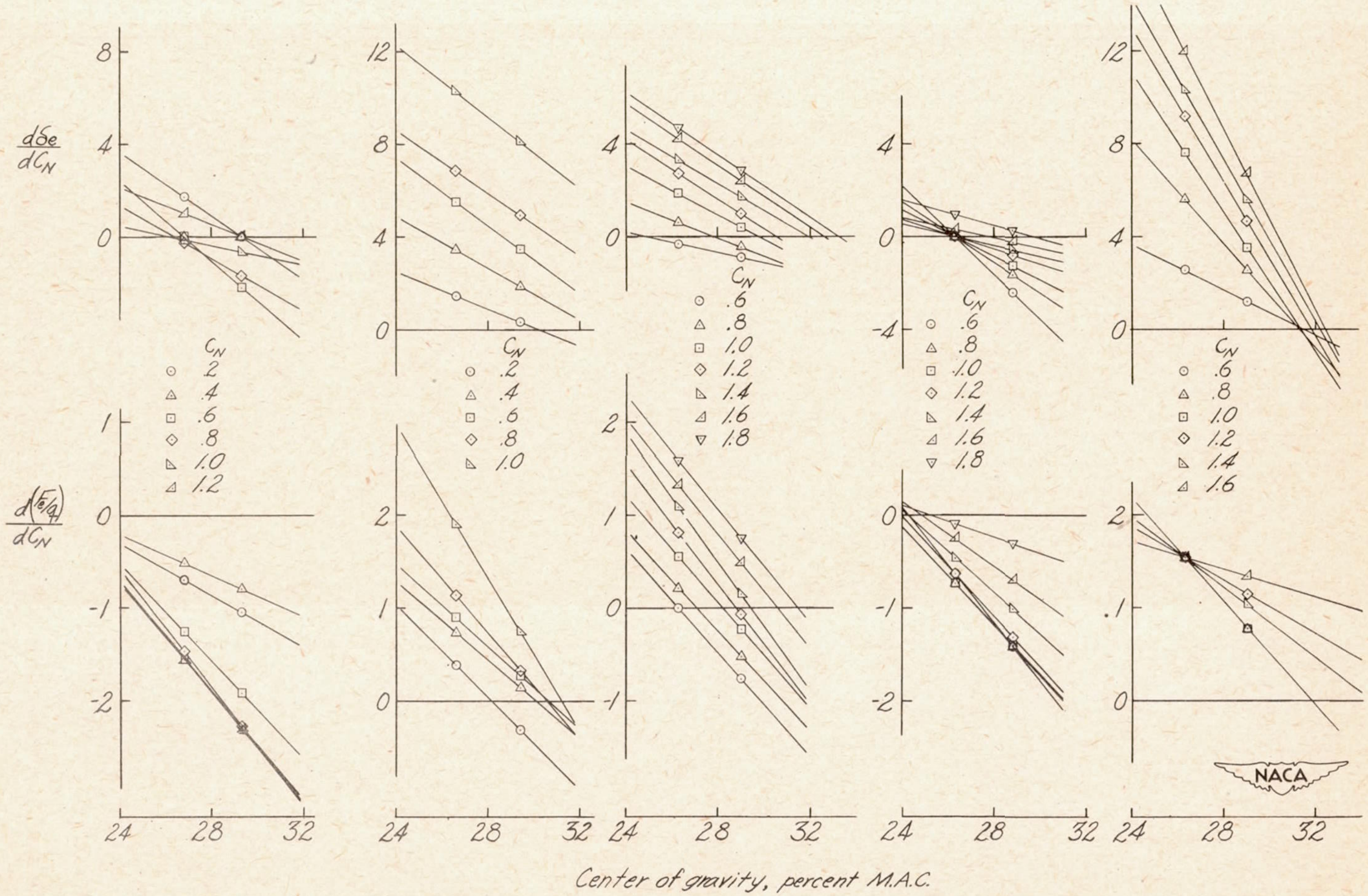
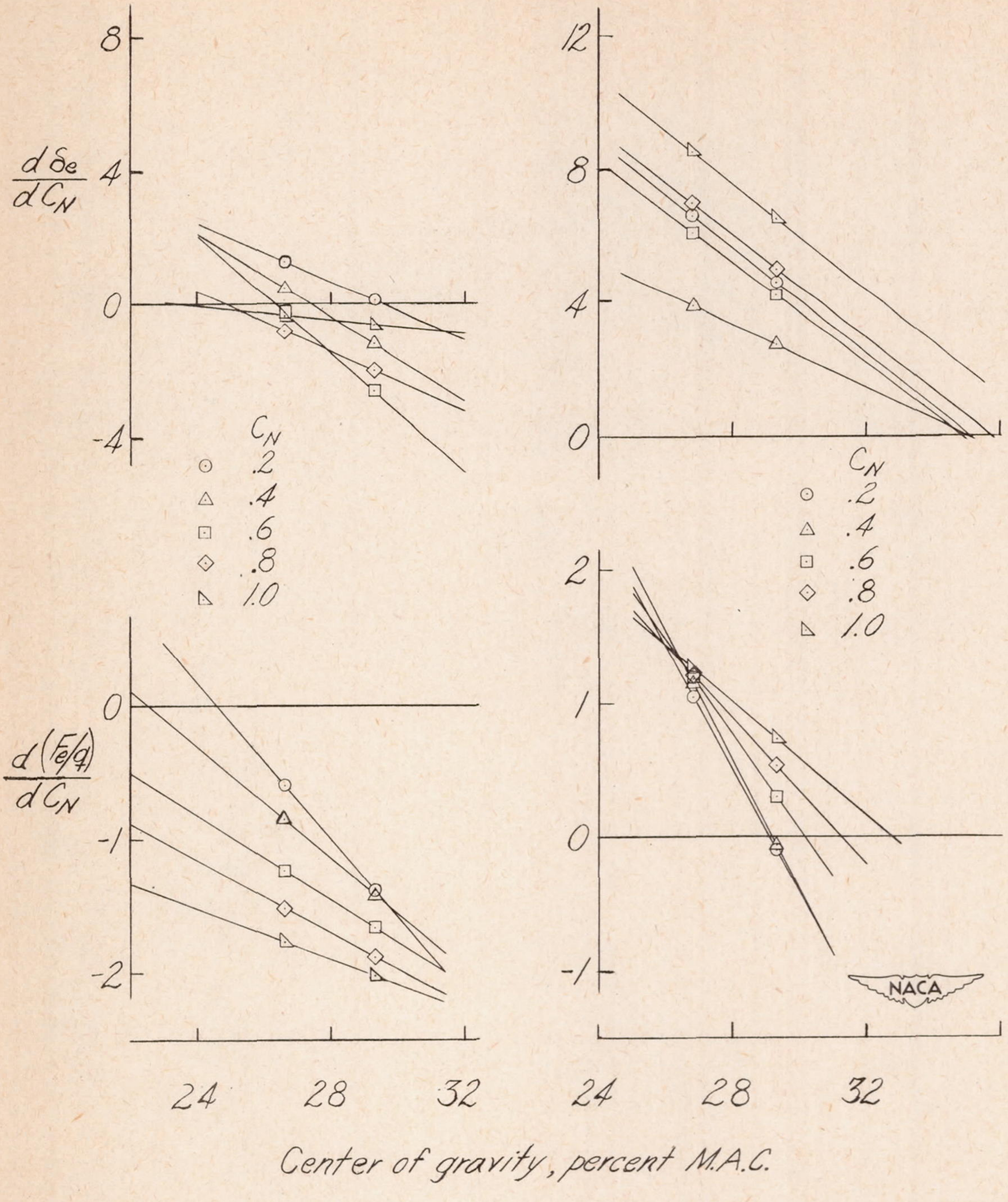



Figure 18.- Variation of elevator deflection and elevator force divided by impact pressure with airplane normal-force coefficient in the landing condition at two center-of-gravity positions. F-47D-30 airplane.



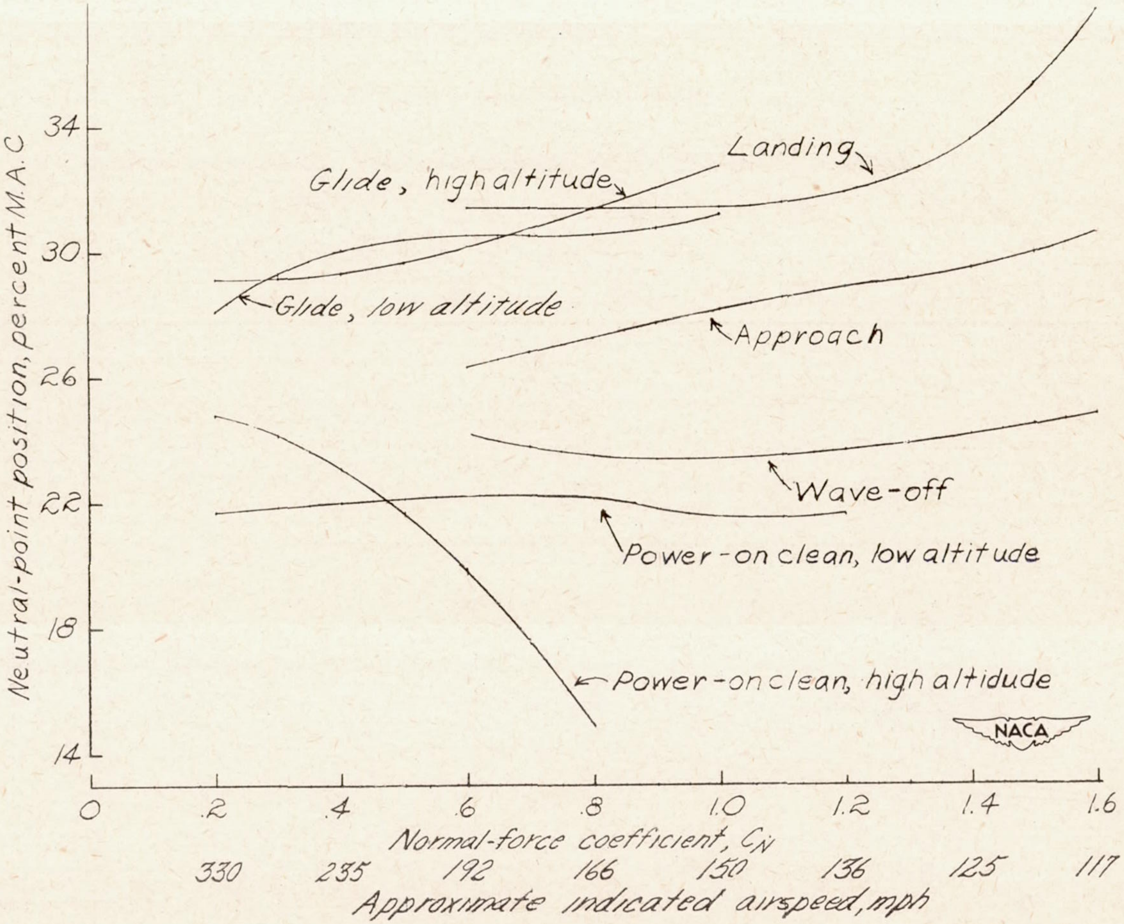

(a) Power-on clean condition. (b) Glide conditions. (c) Approach condition. (d) Wave-off condition. (e) Landing condition.

Figure 19.- Determination of neutral points for the various conditions at low altitude. F-47D-30 airplane.



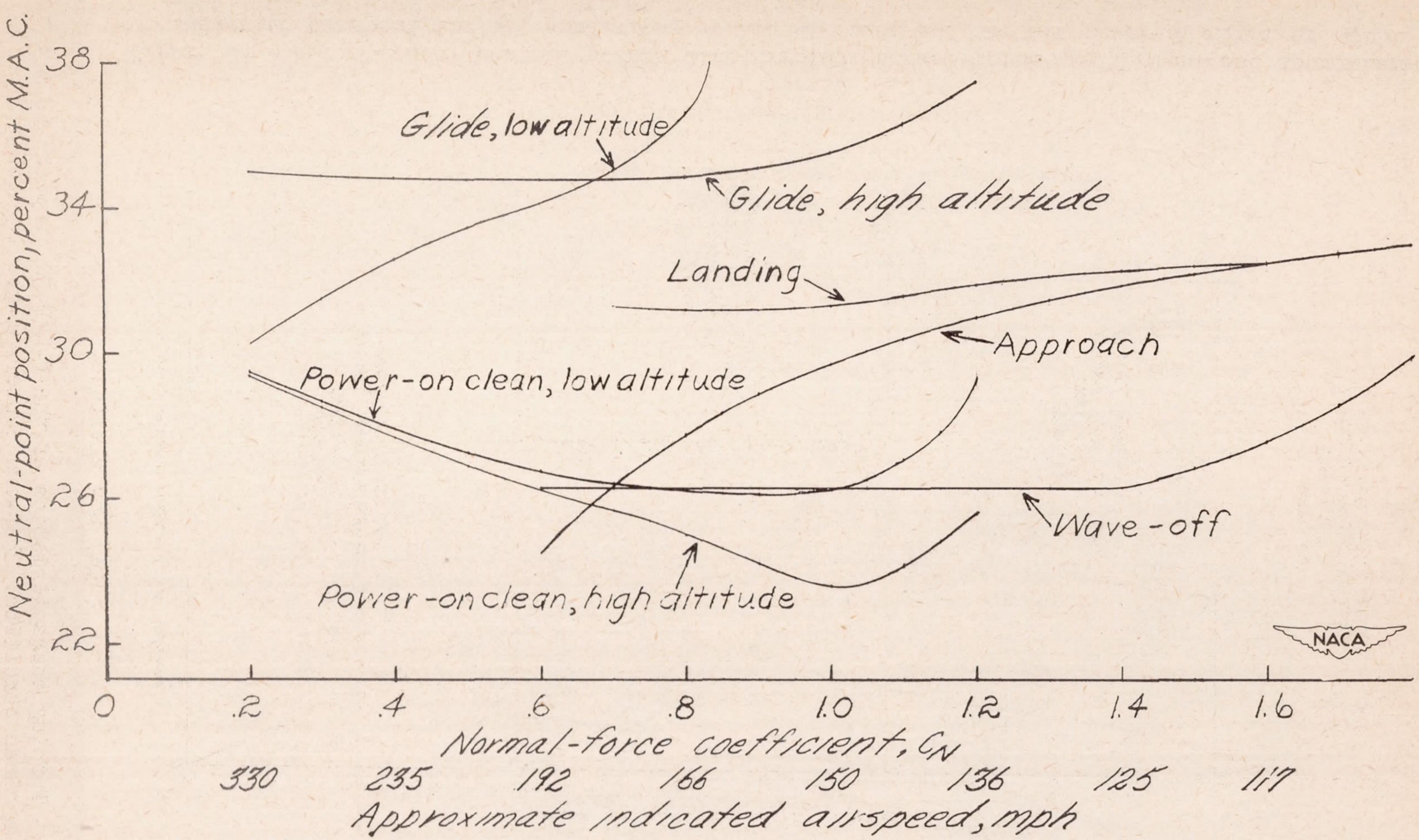

(a) Power-on clean condition. (b) Glide condition.

Figure 20.- Determination of neutral points for the power-on clean and glide conditions at high altitude. F-47D-30 airplane.



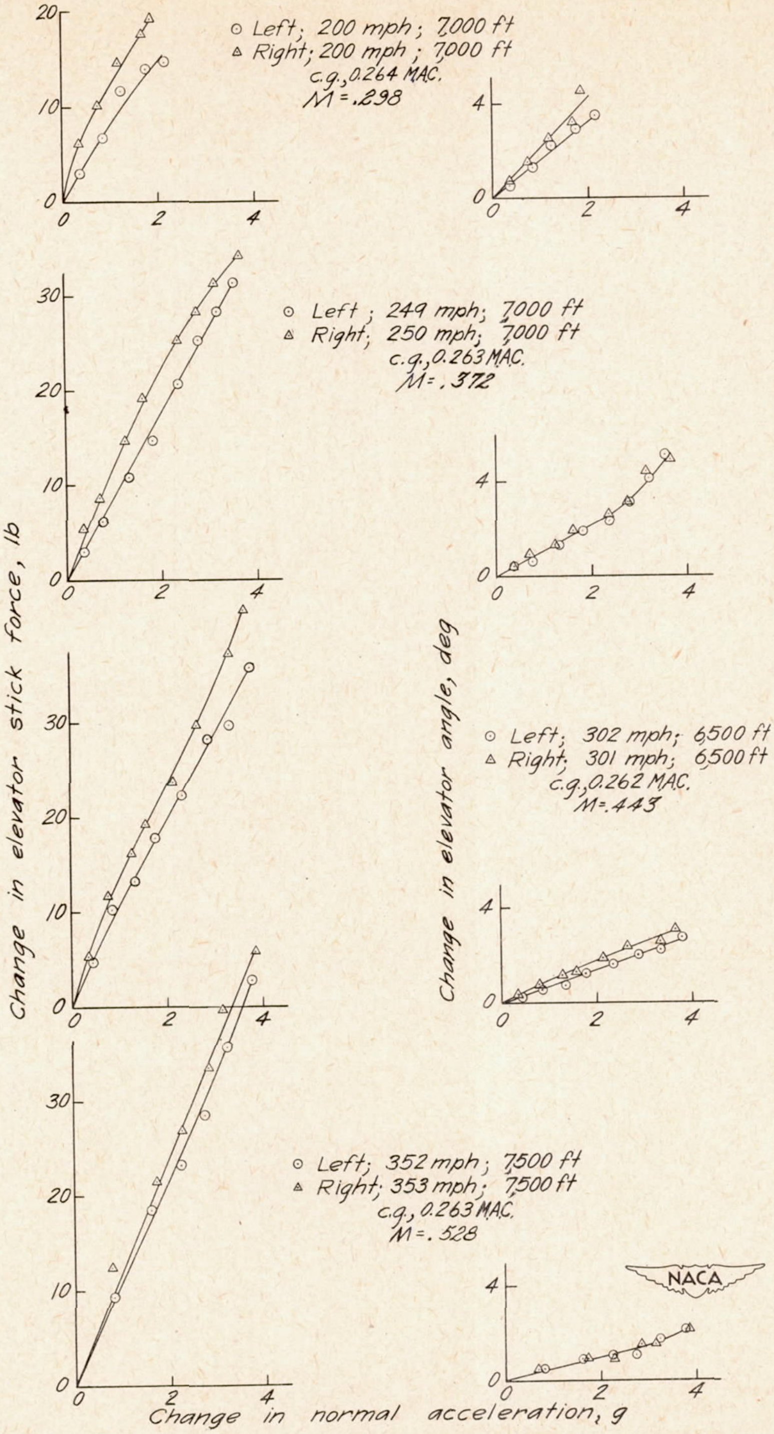

(a) Stick-free neutral points.

Figure 21.- Variation of neutral points with airplane normal-force coefficient and approximate indicated airspeed for all conditions at low altitude and for the power-on clean and glide conditions at high altitude. F-47D-30 airplane.



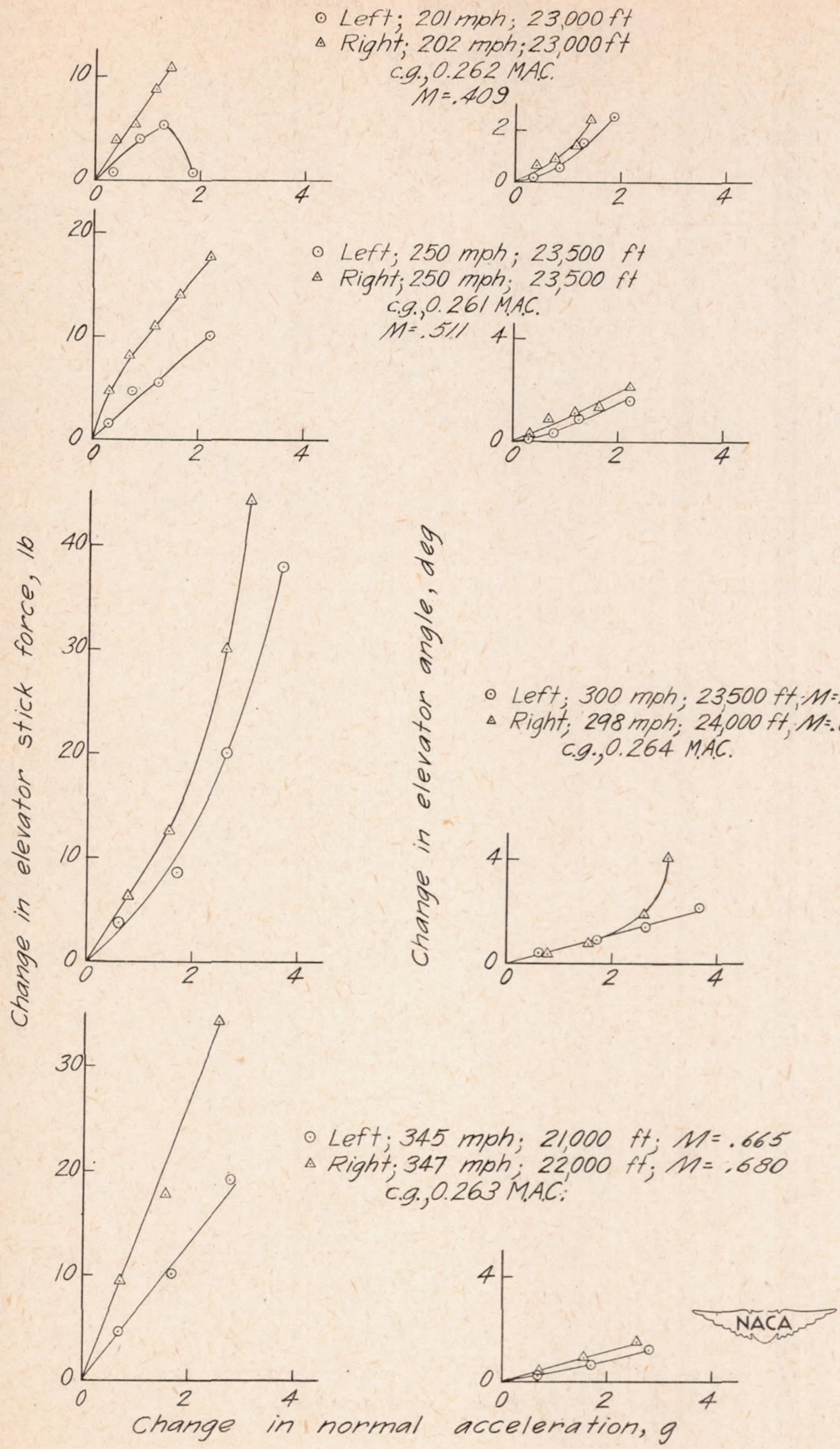

(b) Stick-fixed neutral points.

Figure 21.- Concluded.



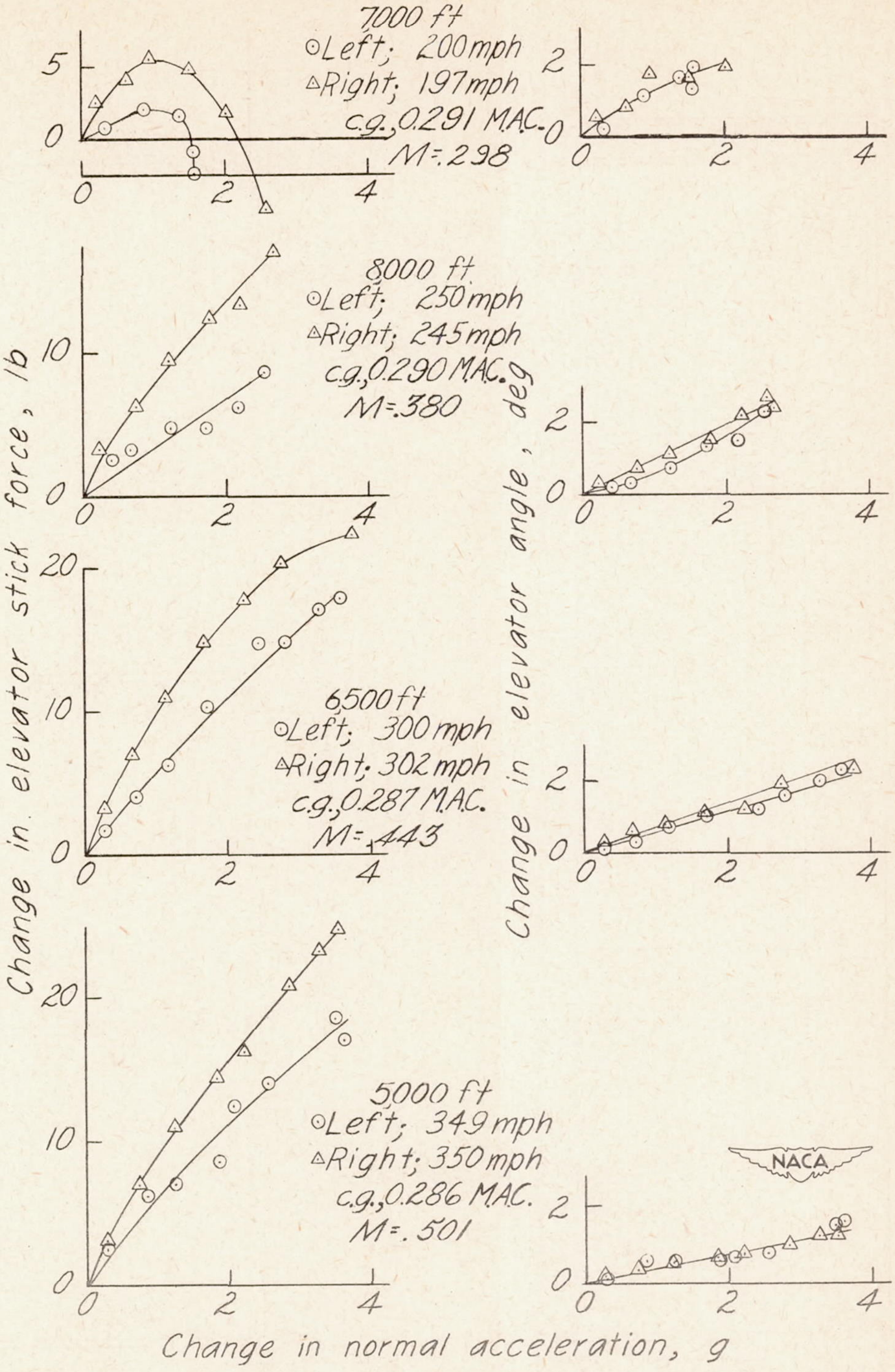

(a) Low altitude.

Figure 22.- Turning characteristics of the F-47D-30 airplane in the power-on clean condition. Forward center-of-gravity position.



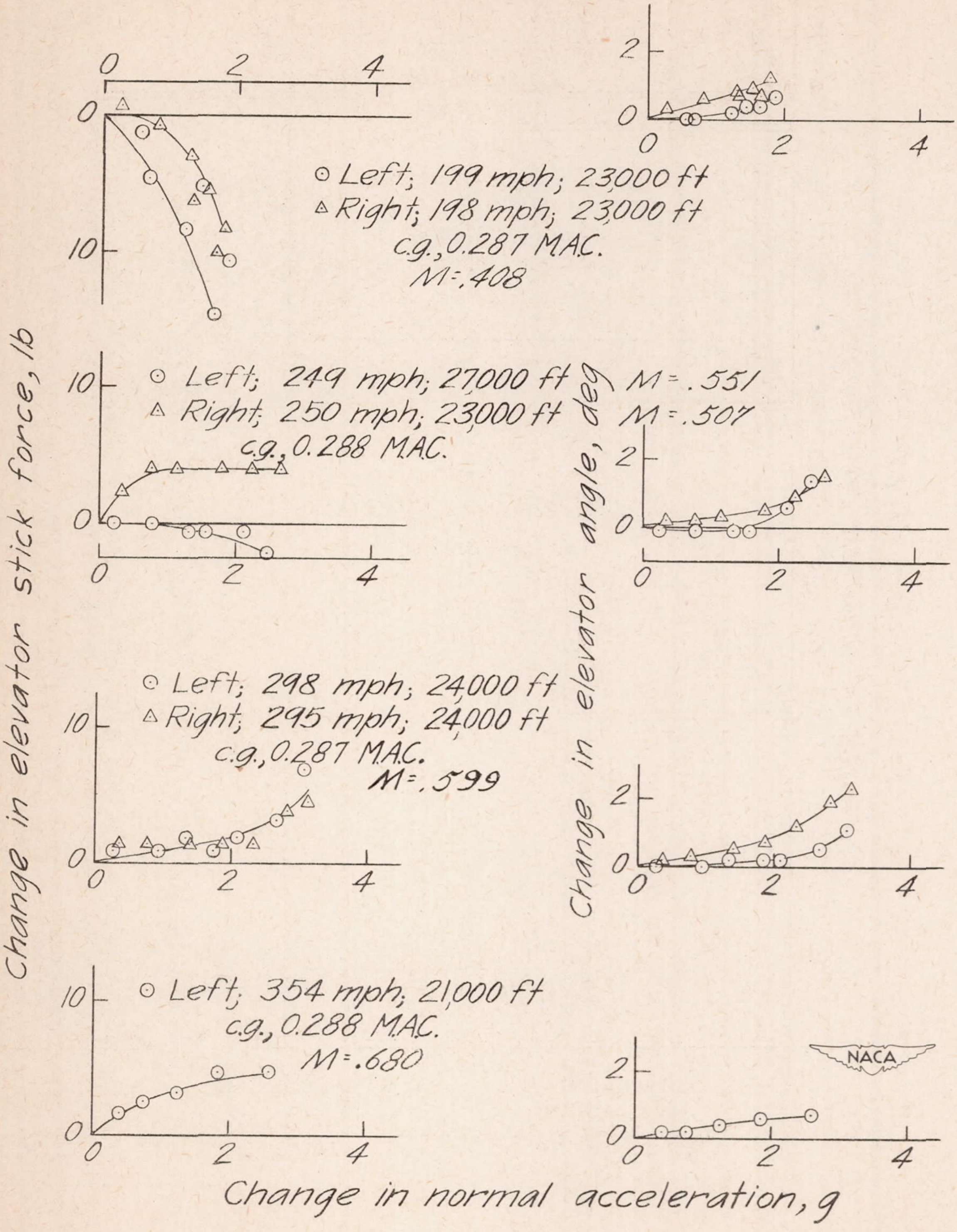

(b) High altitude.

Figure 22.- Concluded.




(a) Low altitude.

Figure 23.- Turning characteristics of the F-47D-30 airplane in the power-on clean condition. Rearward center-of-gravity position.




(b) High altitude.

Figure 23.- Concluded.

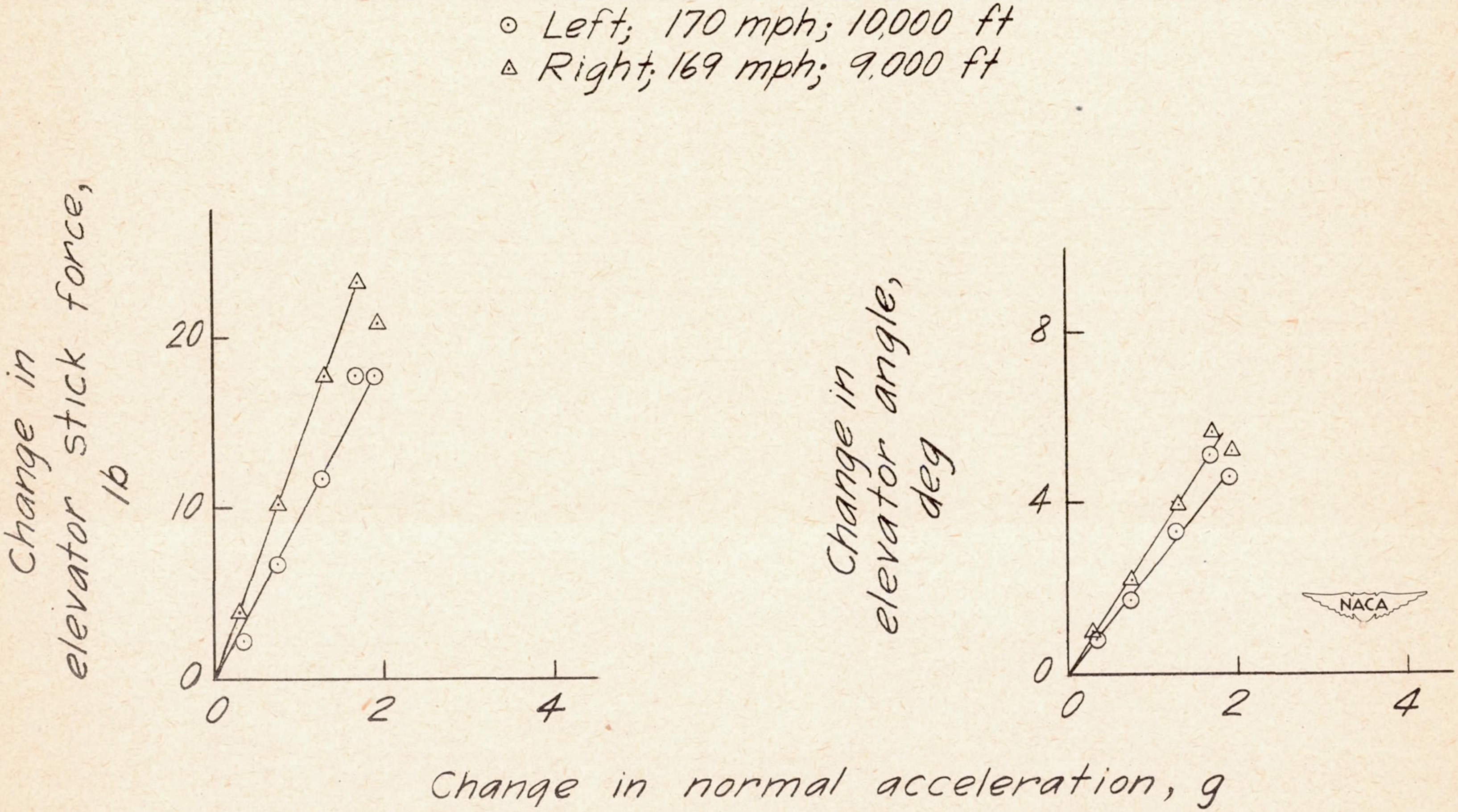
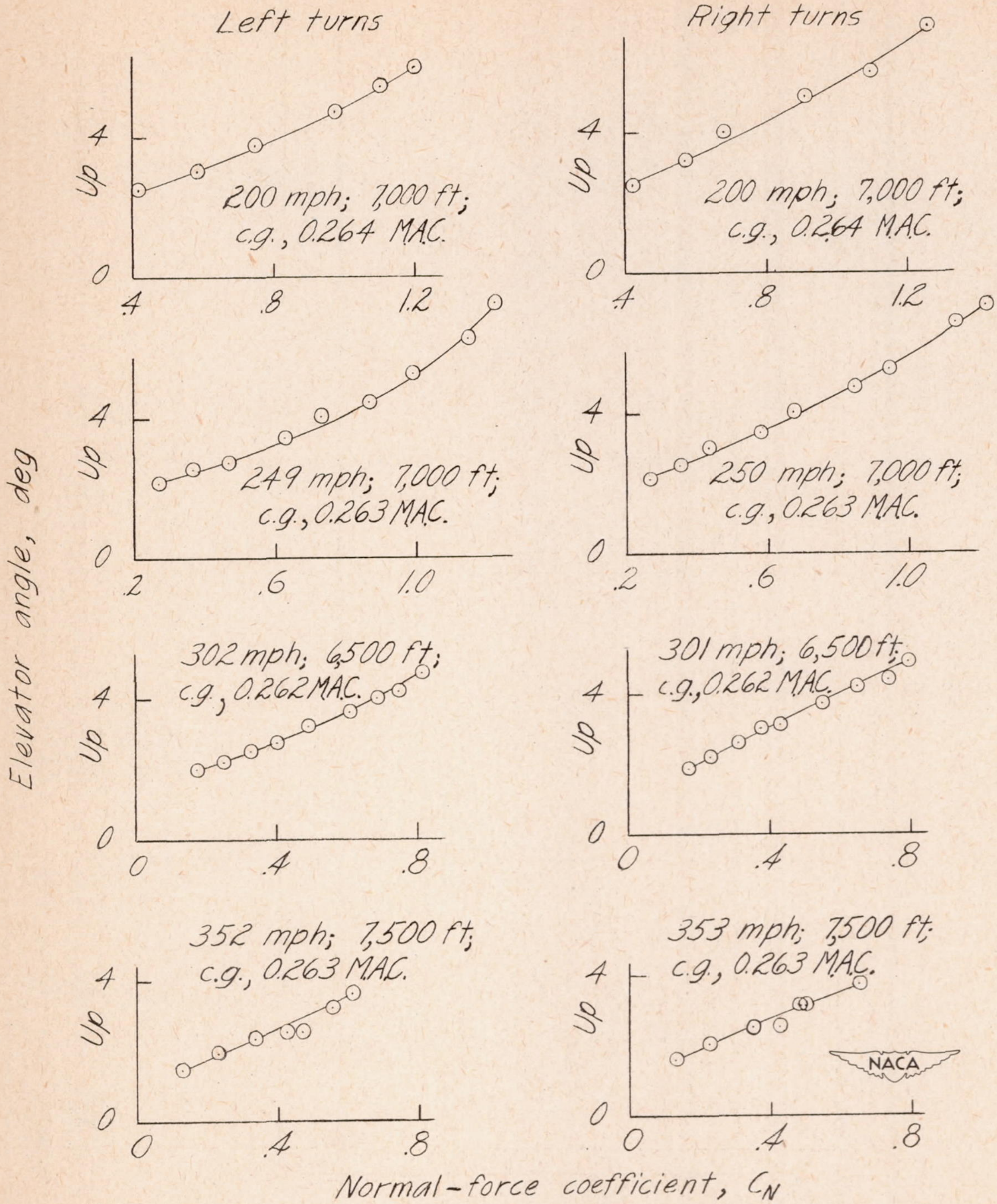
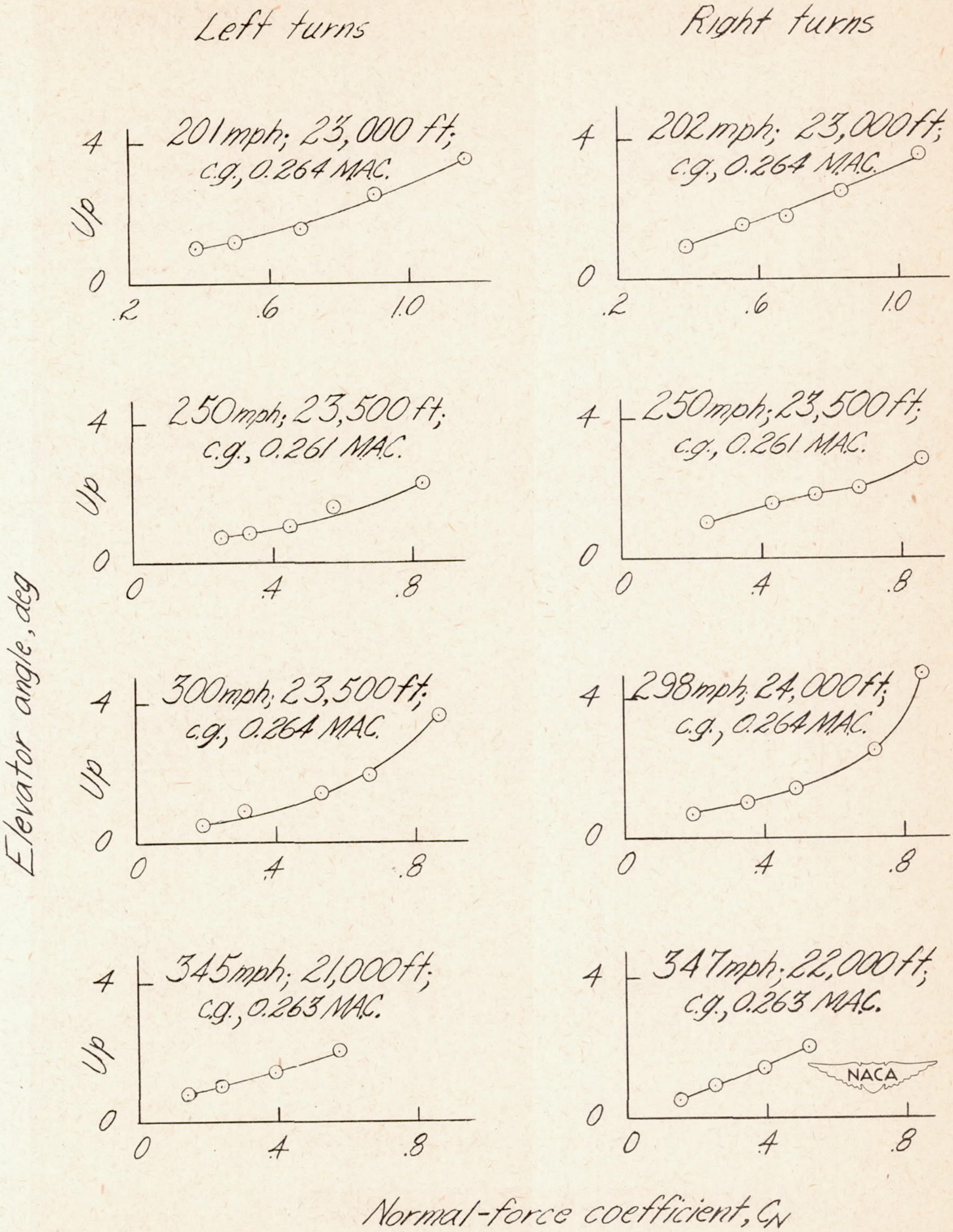



Figure 24.- Turning characteristics of the F-47D-30 airplane in the landing condition: landing flaps and gear down, canopy closed, power for level flight at 170 miles per hour. Forward center-of-gravity position.



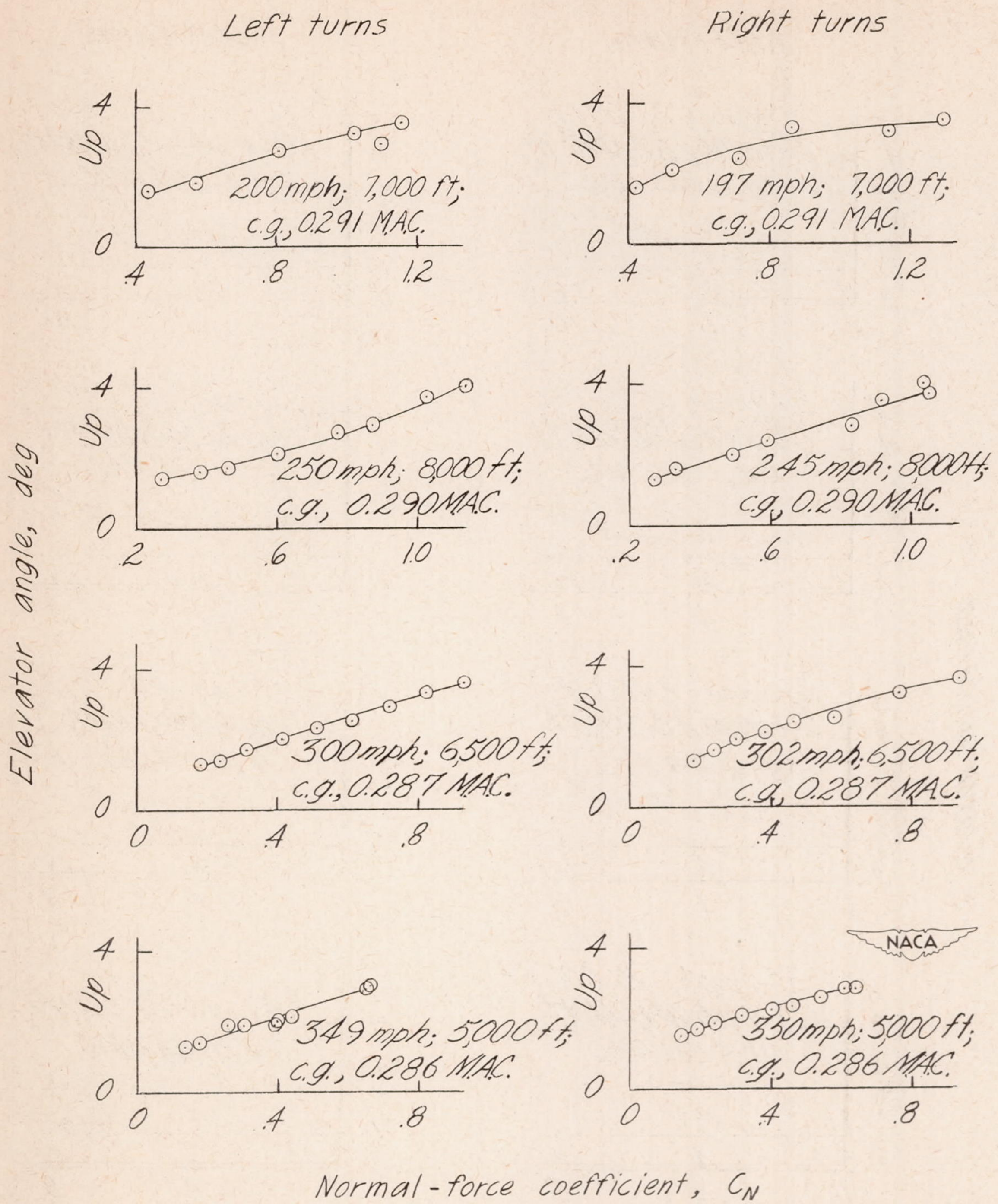

(a) Low altitude and forward center-of-gravity position.

Figure 25.- Variation of elevator angle with airplane normal-force coefficient in turning flight, power-on clean condition. F-47D-30 airplane.



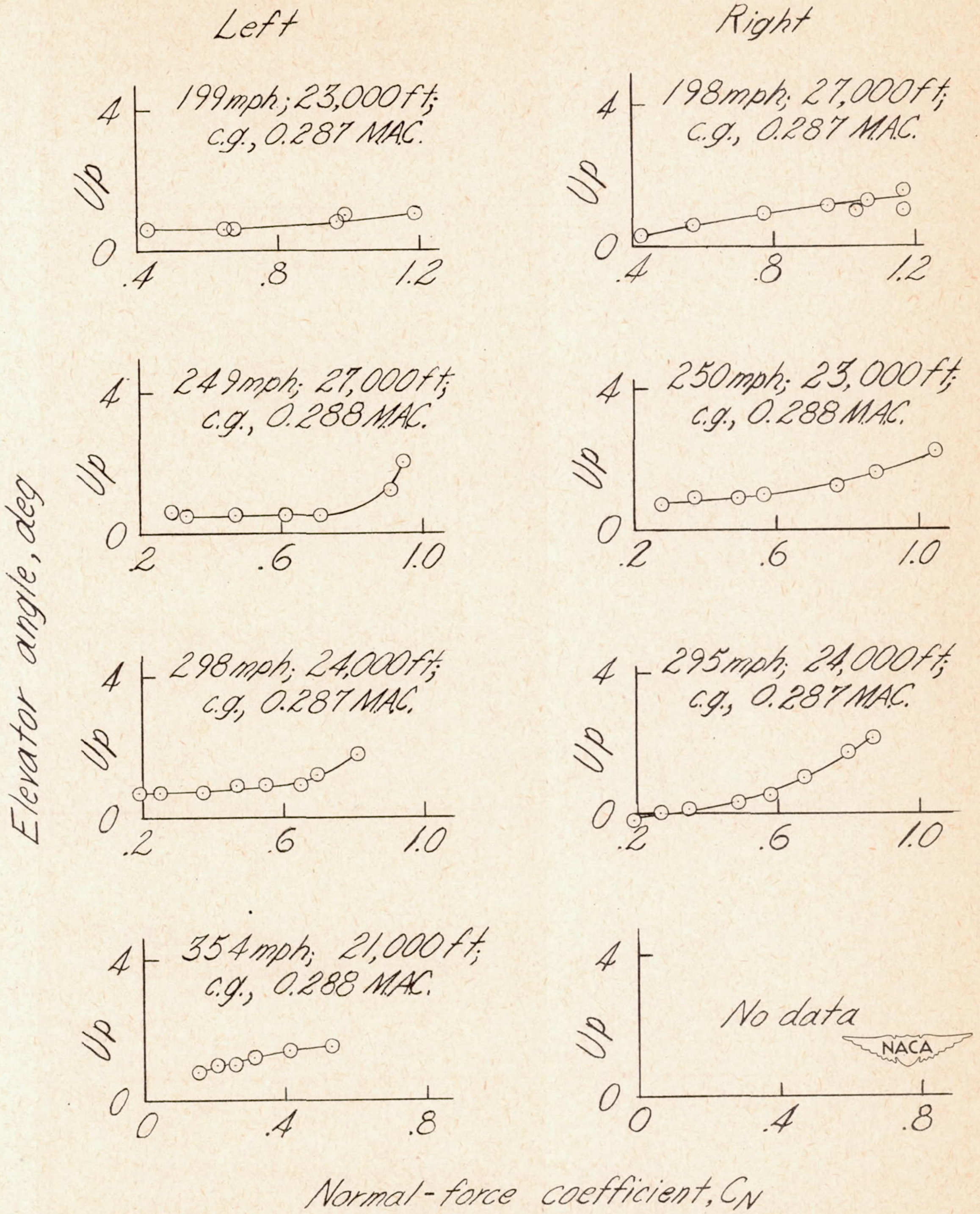

(b) High altitude and forward center-of-gravity position.

Figure 25.- Continued.



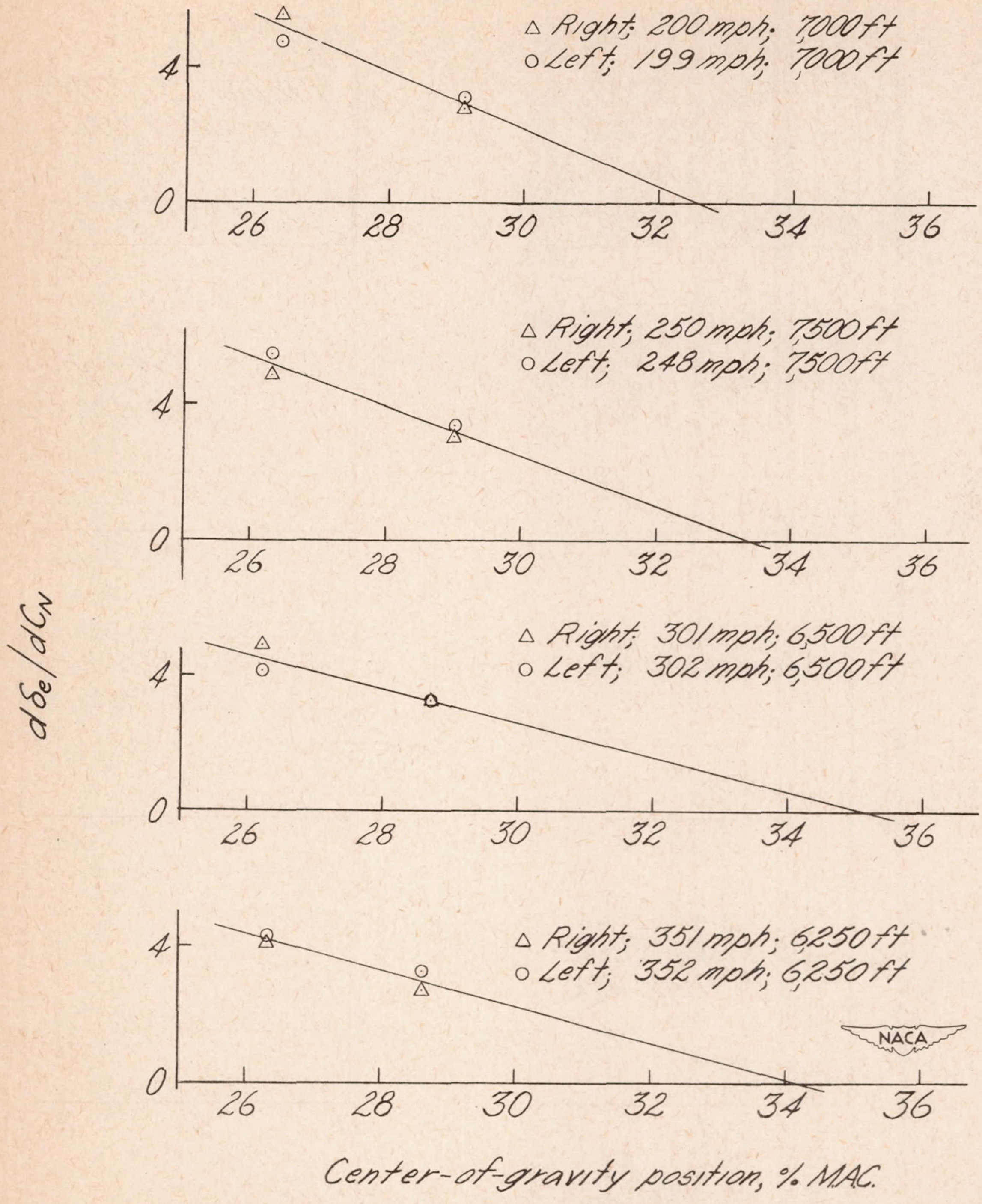

(c) Low altitude and rearward center-of-gravity position.

Figure 25.- Continued.



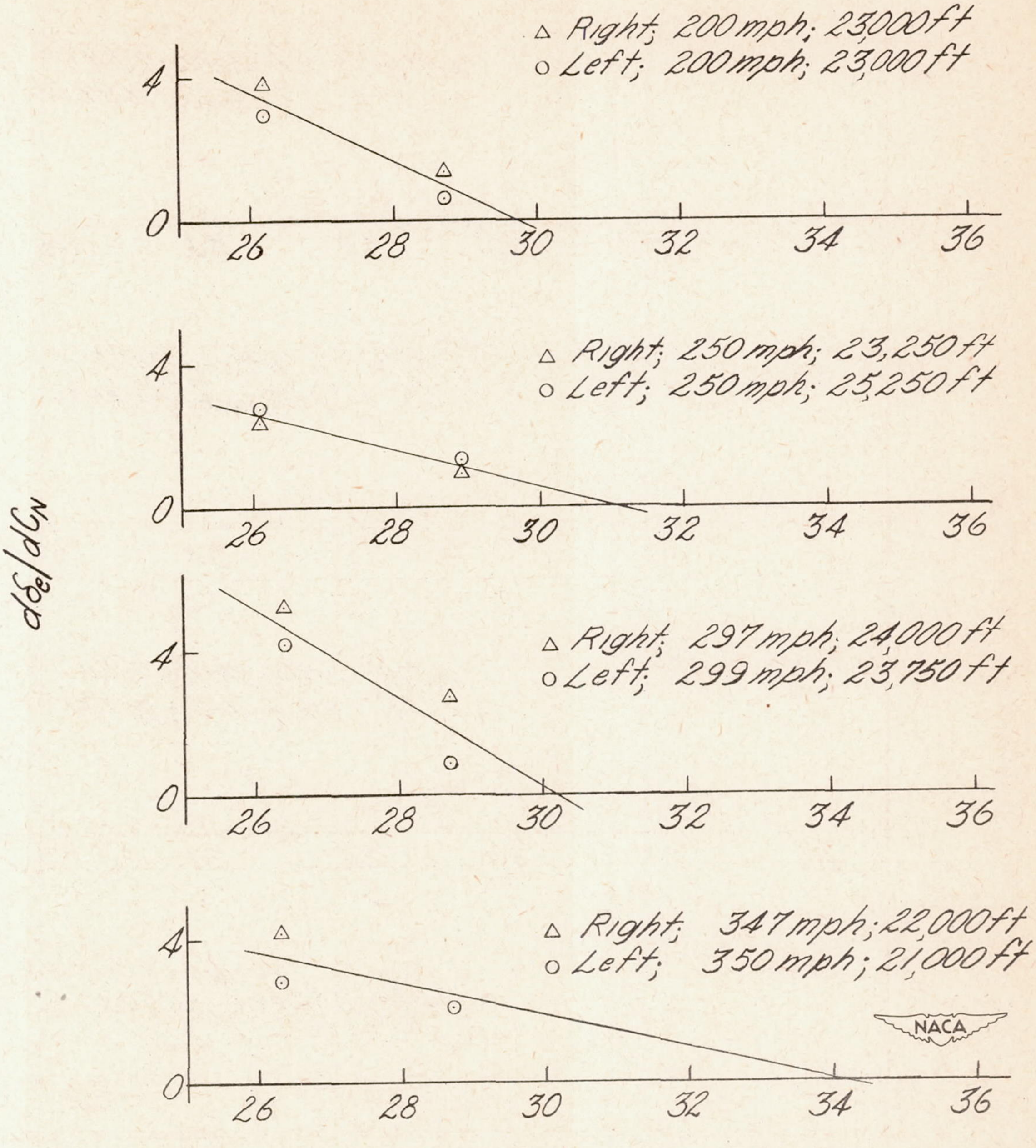

(d) High altitude and rearward center-of-gravity position.

Figure 25.- Concluded.



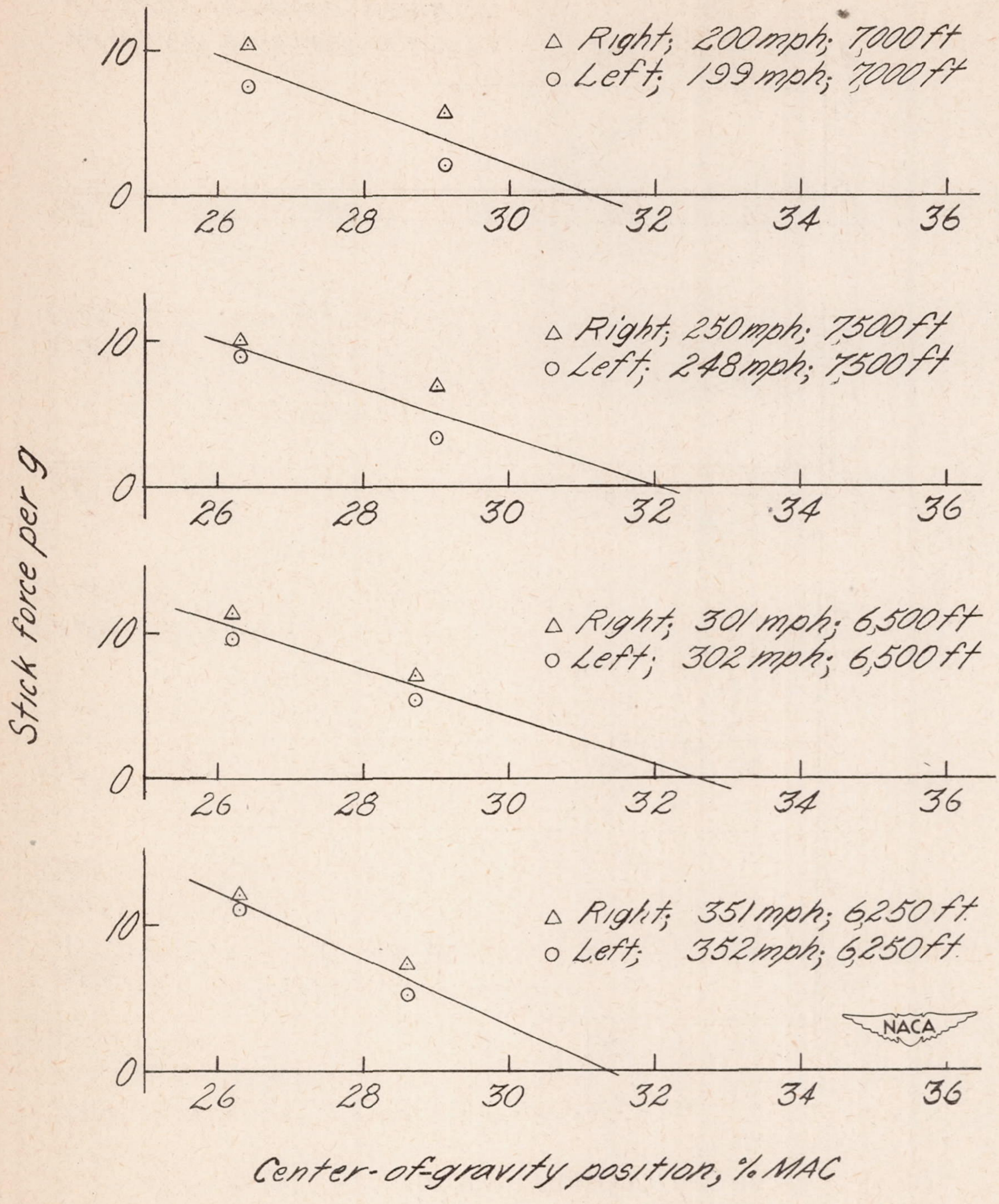

(a) Low altitude.

Figure 26.- Determination of the stick-fixed maneuver points of F-47D-30 airplane.



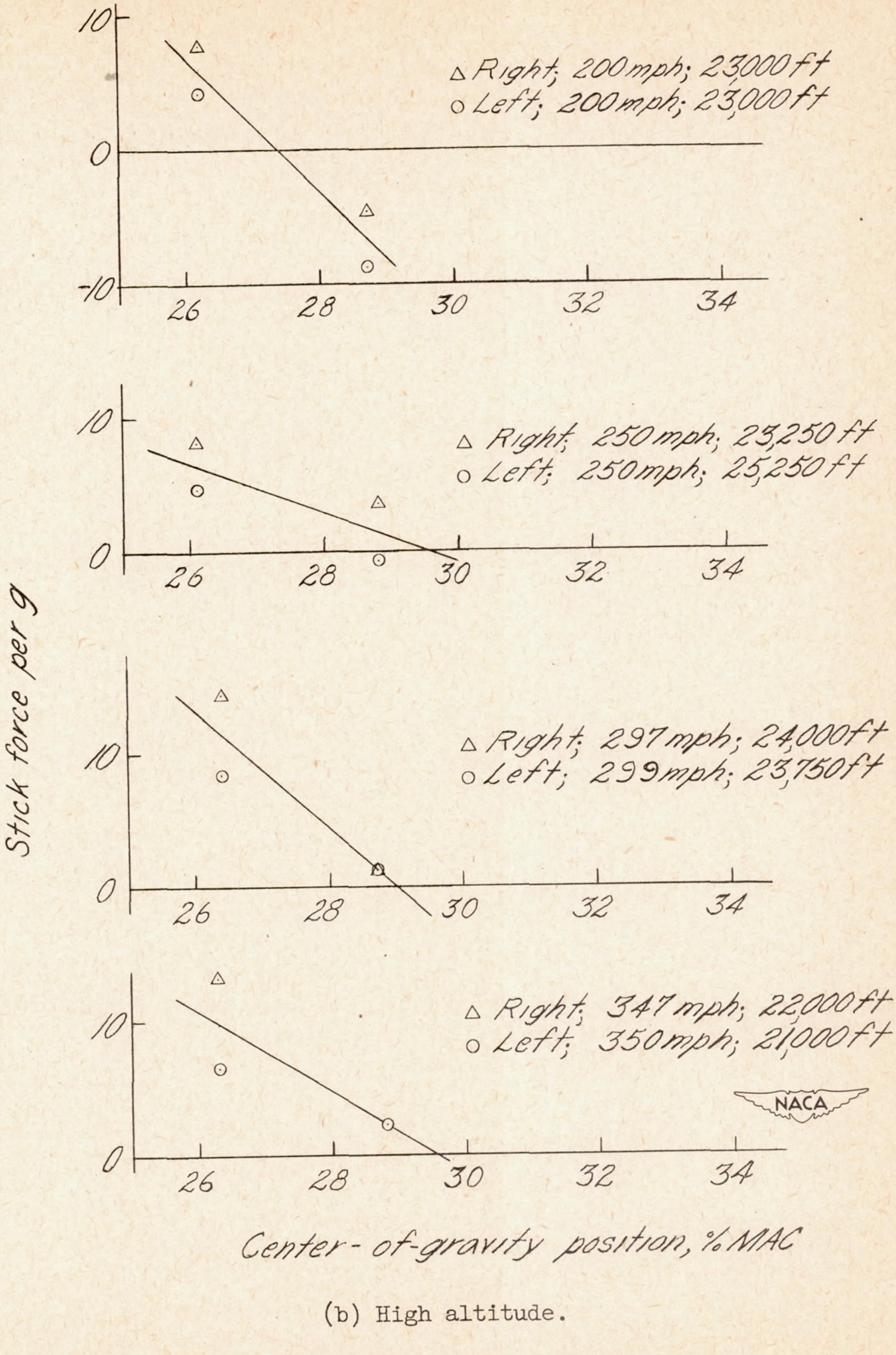

(b) High altitude.

Figure 26.- Concluded.




(a) Low altitude.

Figure 27.- Determination of the stick-free maneuver points of F-47D-30 airplane.




(b) High altitude.

Figure 27.- Concluded.

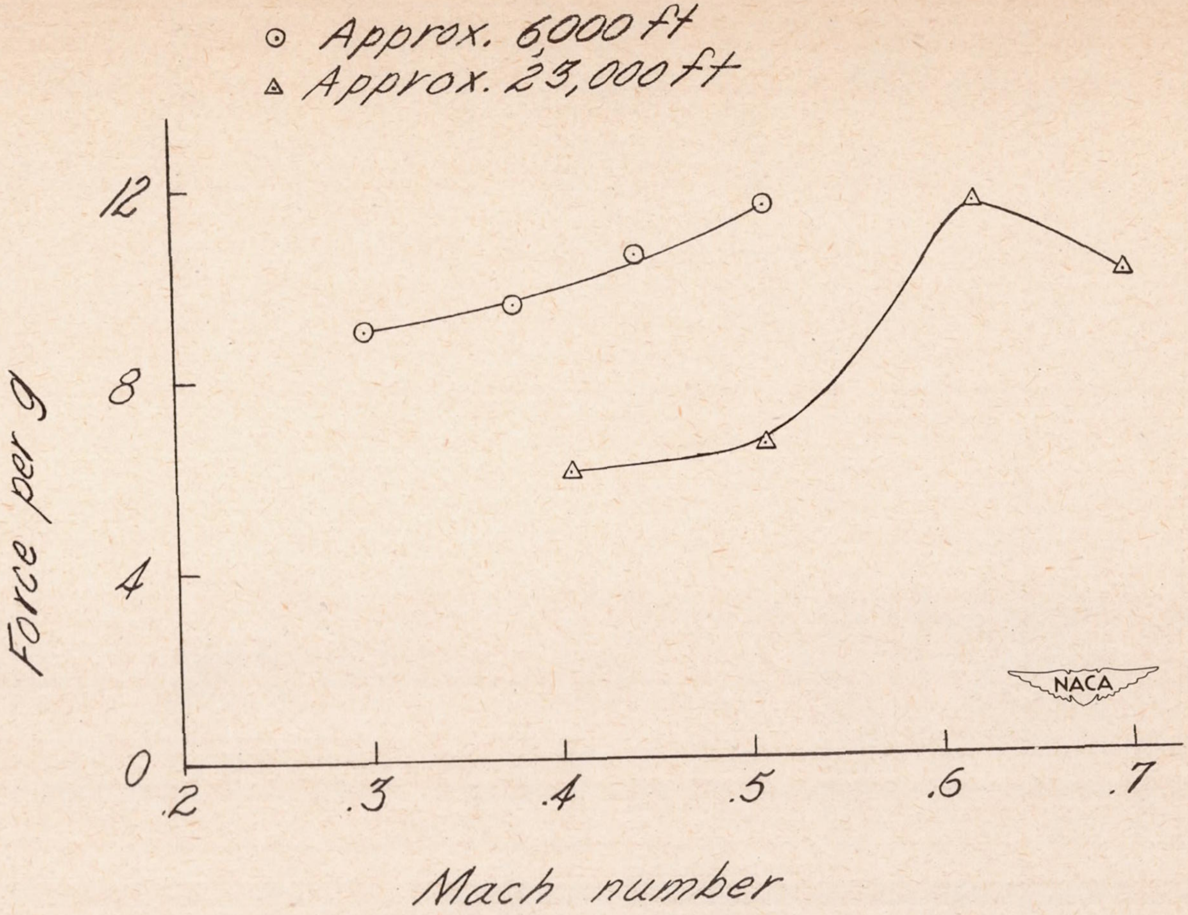



Figure 28.- Variation of force per g with Mach number at low and high altitude at the forward center-of-gravity position. F-47D-30 airplane. Data shown are averages of the force per g in left and right turns at the forward center-of-gravity position of 26.3 percent of the mean aerodynamic chord.

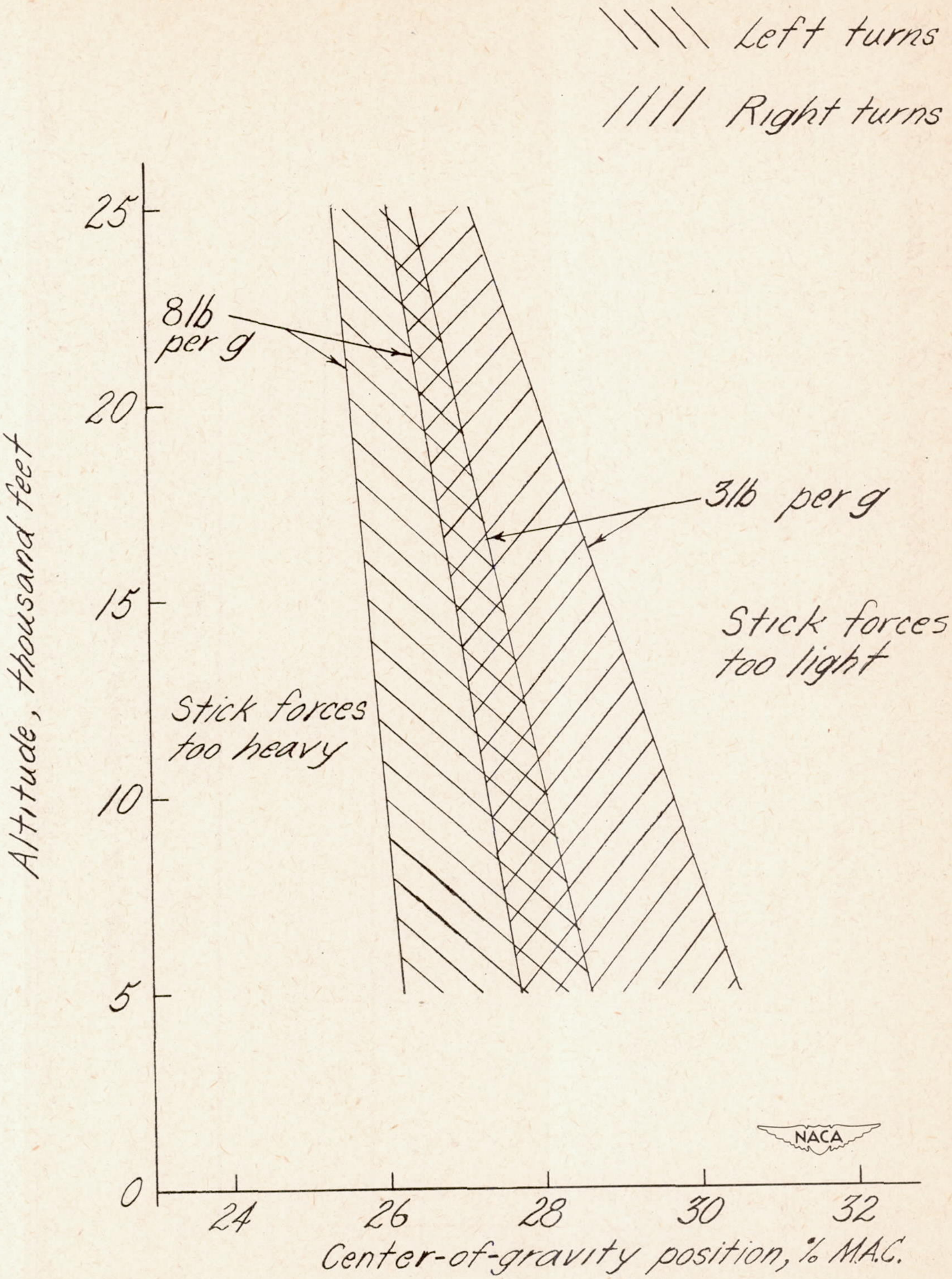



Figure 29.- Variation with altitude of the center-of-gravity range for desirable stick force per g in left and right turns at 200 miles per hour. F-47D-30 airplane.

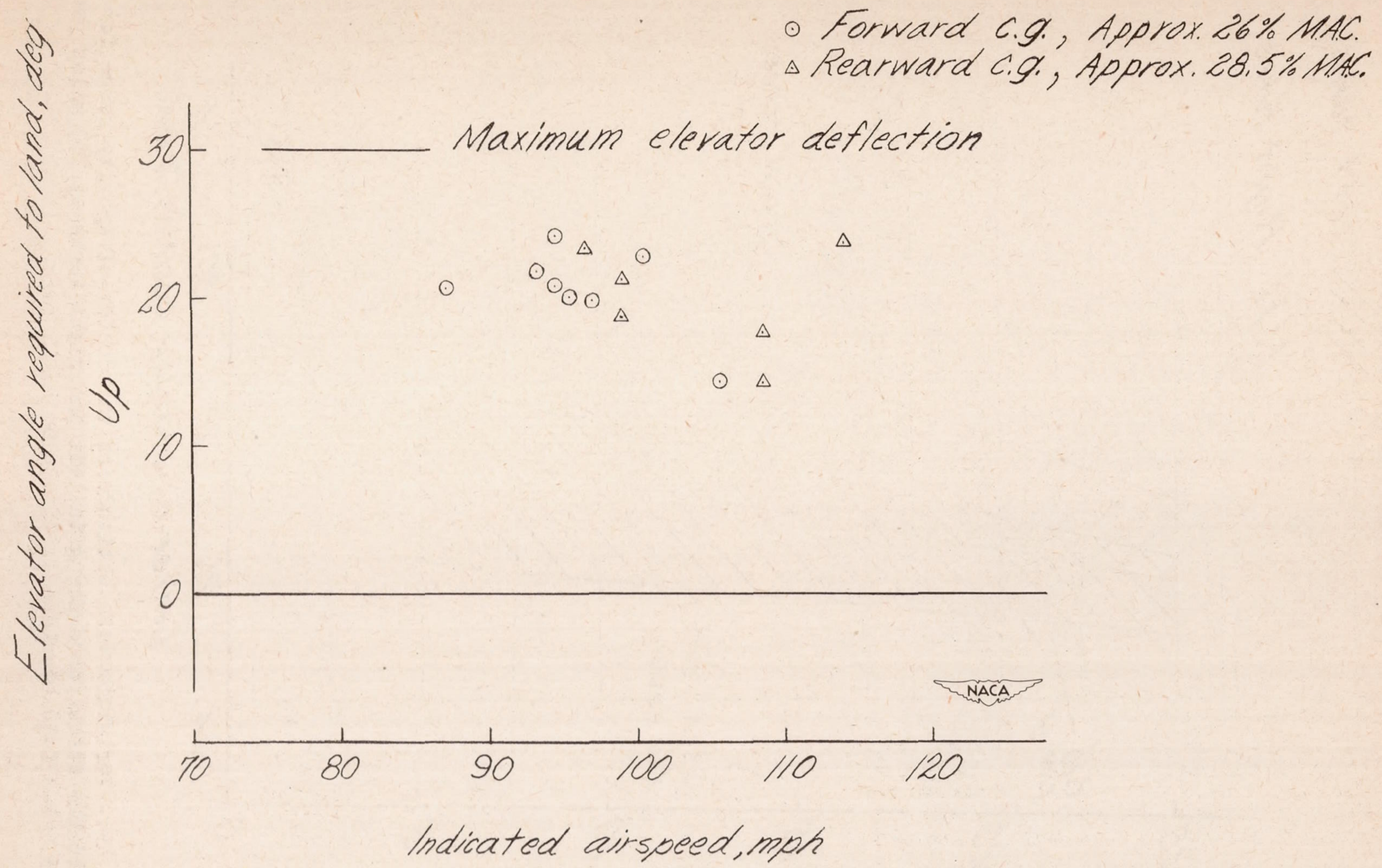
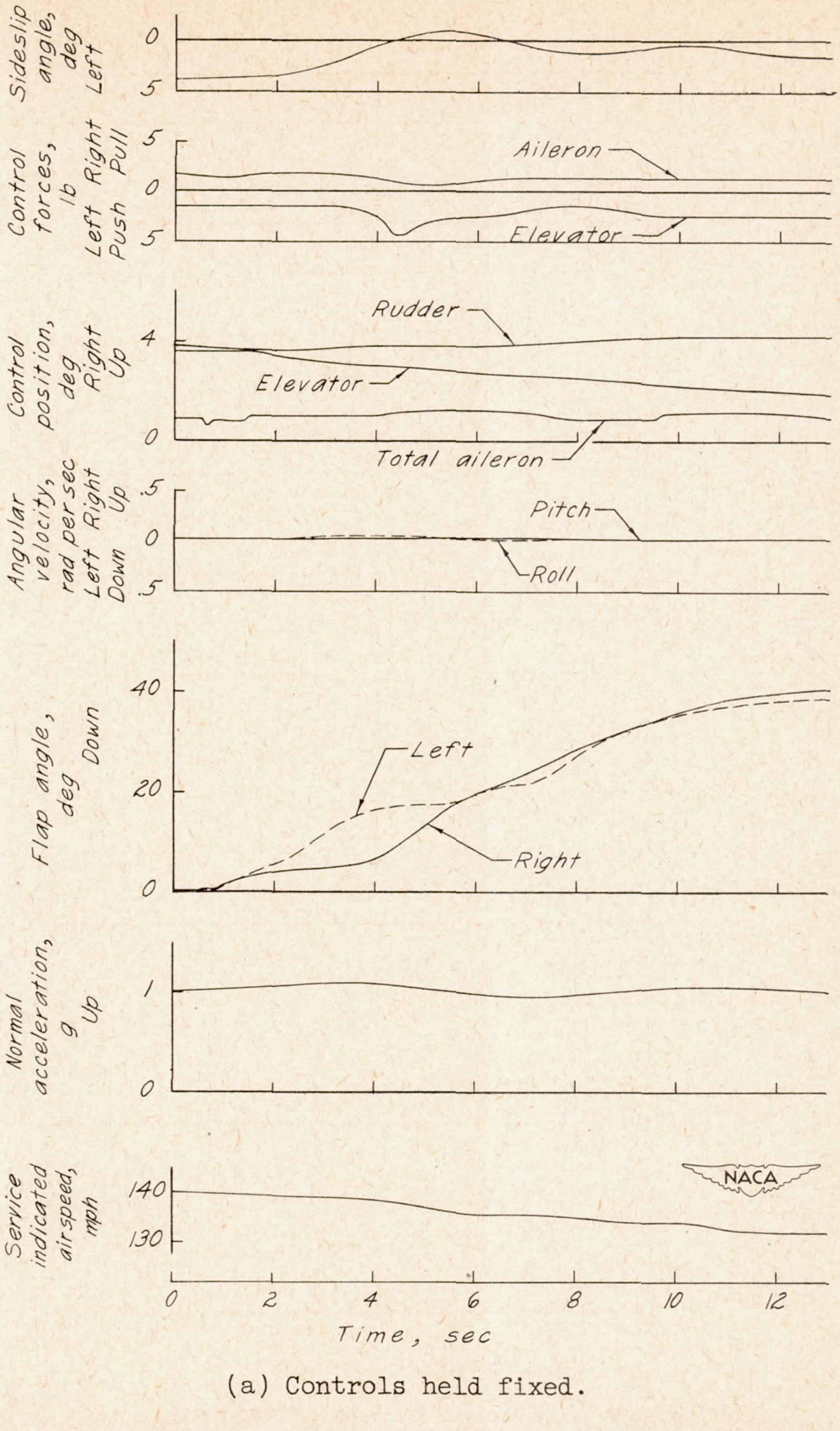
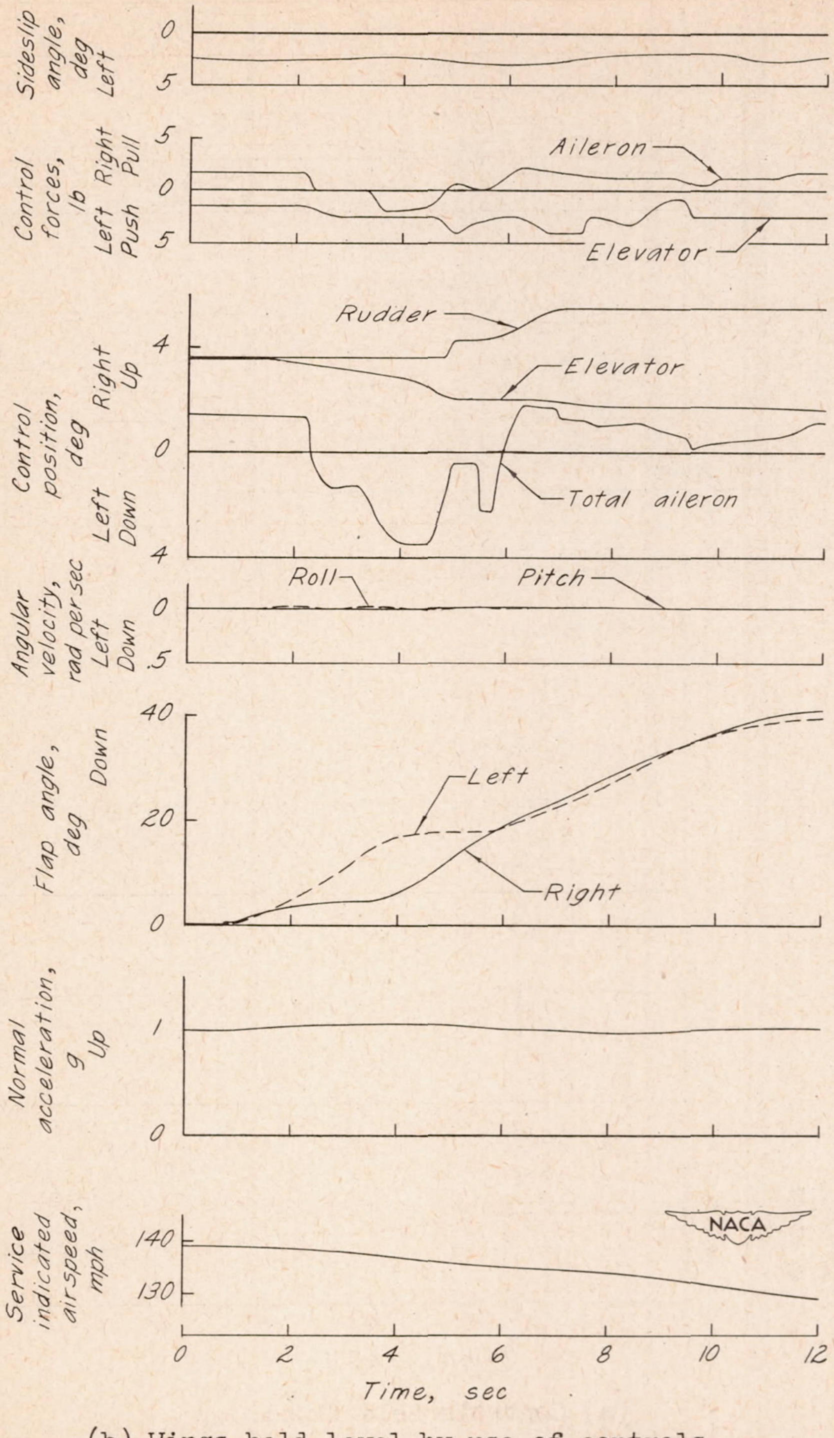



Figure 30.- Variation of elevator angle required to land with airspeed, F-47D-30 airplane.




(a) Controls held fixed.

Figure 31.- Time histories showing results of deflecting landing flaps. Center of gravity at 29.1 percent of the mean aerodynamic chord; gross weight, 13,280 pounds; altitude, 5,000 feet.




(b) Wings held level by use of controls.

Figure 31.- Concluded.

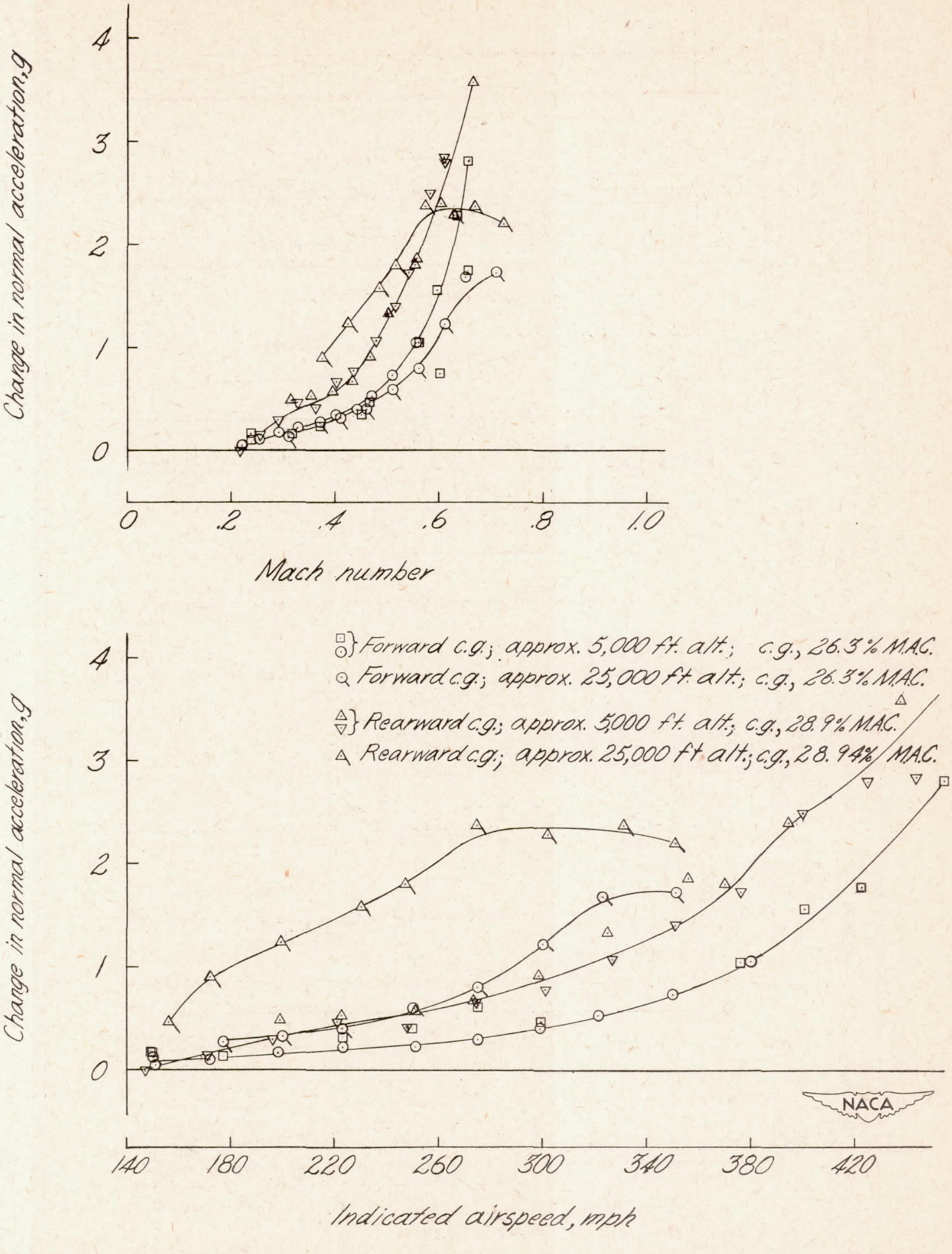
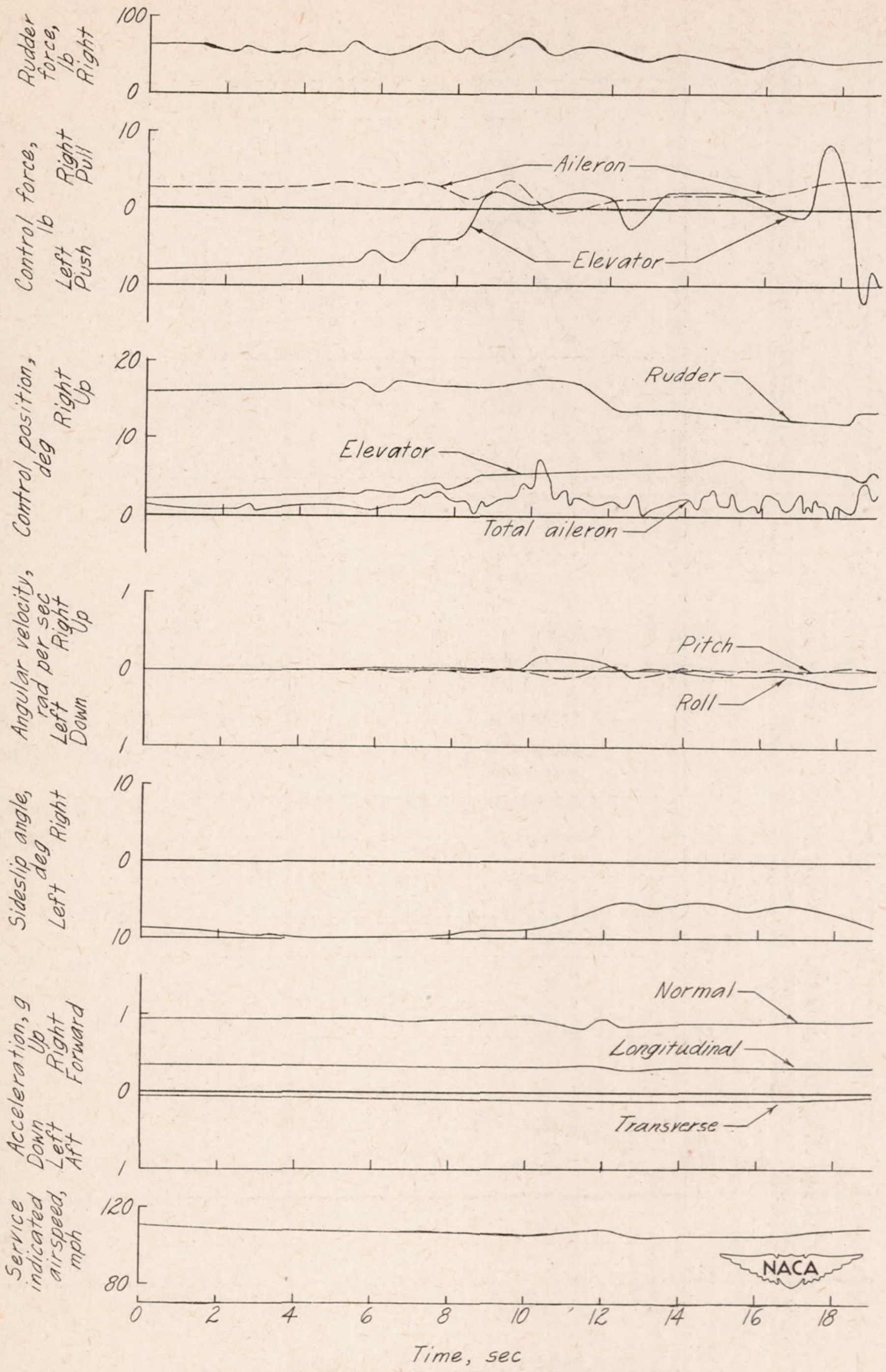
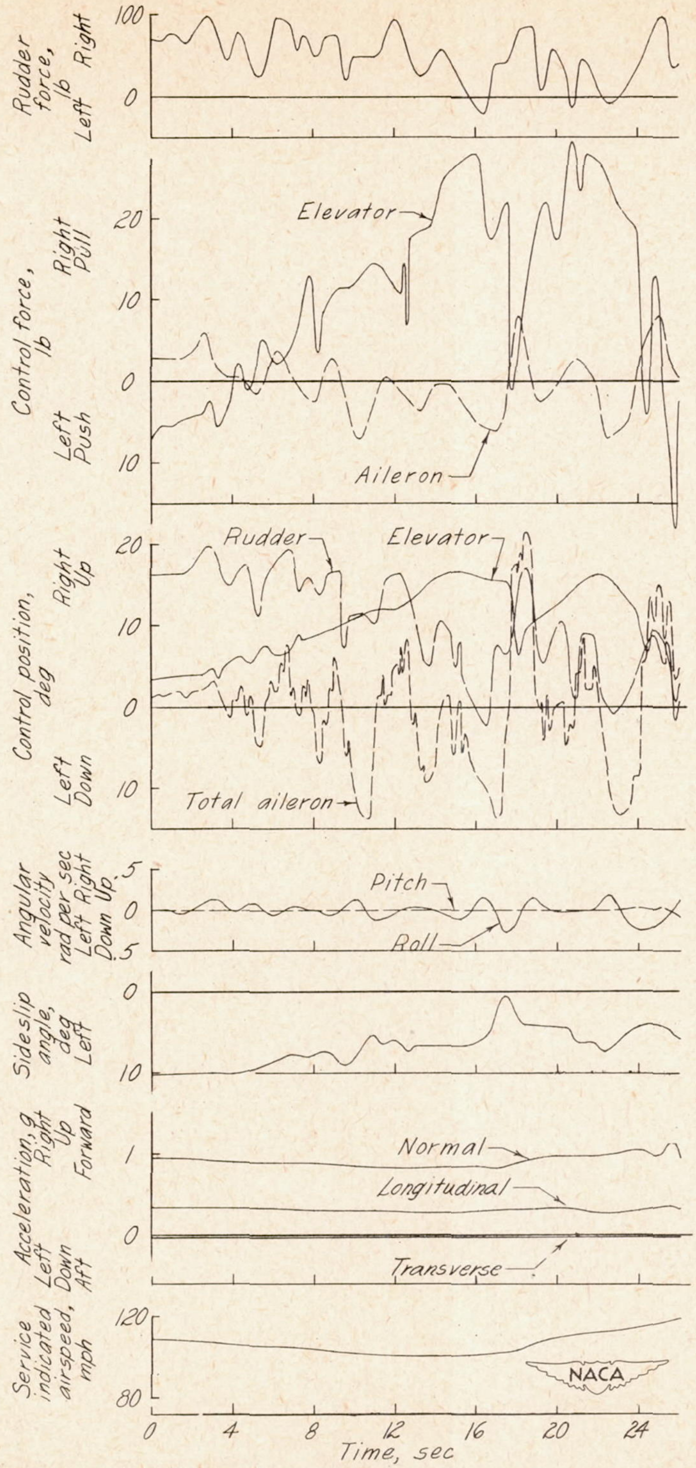



Figure 32.- Variation of the change in normal acceleration with Mach number and airspeed as the dive-recovery flaps were deflected. F-47D-30 airplane. (Two sets of points for same condition indicate data from two flights.)



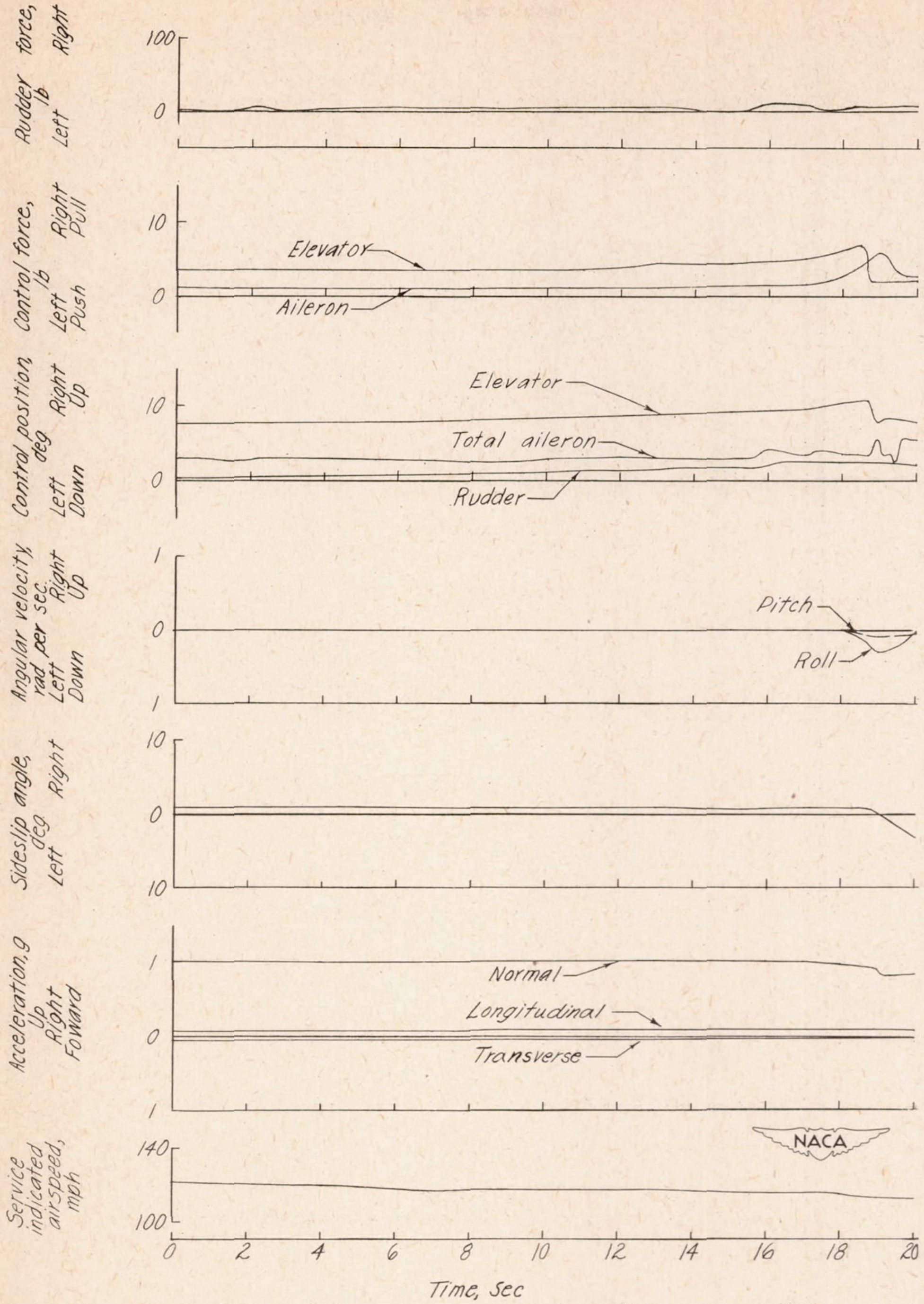

(a) Elevator alone used; pilot attempted to hold other controls fixed.

Figure 33.- Time histories of stall approaches in the power-on clean condition. Center of gravity at 26.4 percent of the mean aerodynamic chord; altitude, 5,000 feet.



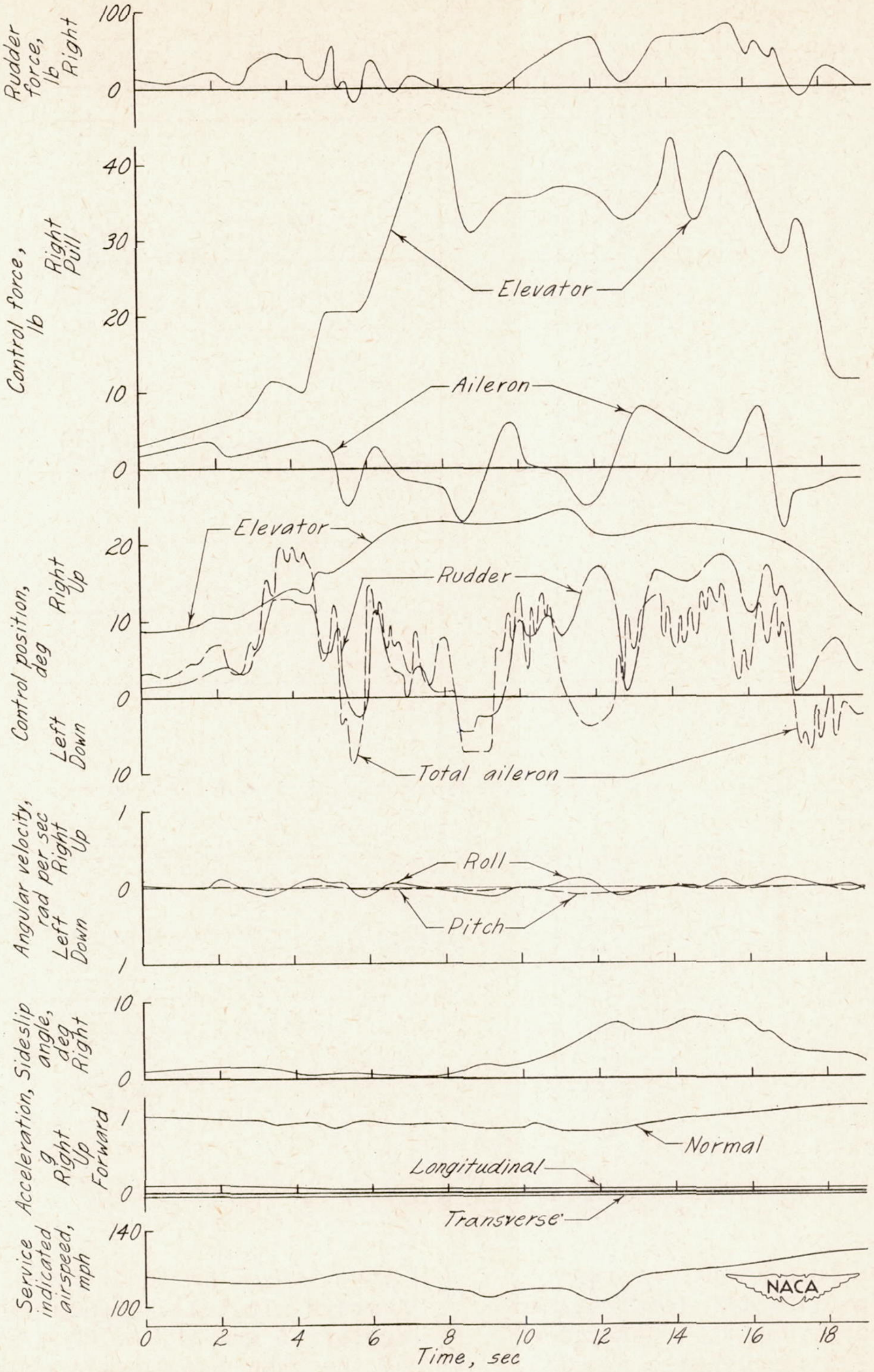

(b) All controls used to hold wings level after initial stall.

Figure 33.- Concluded.



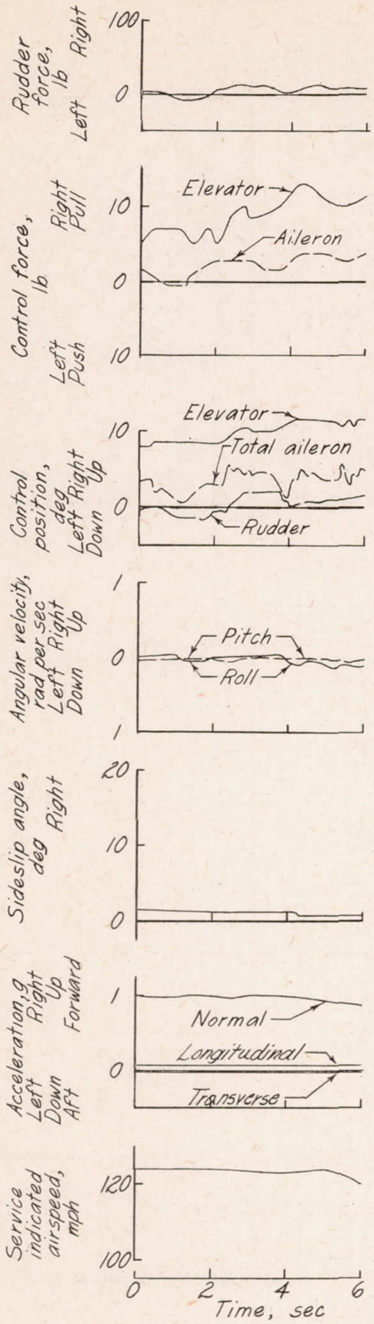

(a) Elevator alone used; pilot attempted to hold other controls fixed after initial stall.

Figure 34.- Time histories of stall approaches in the glide condition. Center of gravity at 26.3 percent of the mean aerodynamic chord; gross weight, 12,400 pounds; altitude, 5,000 feet.

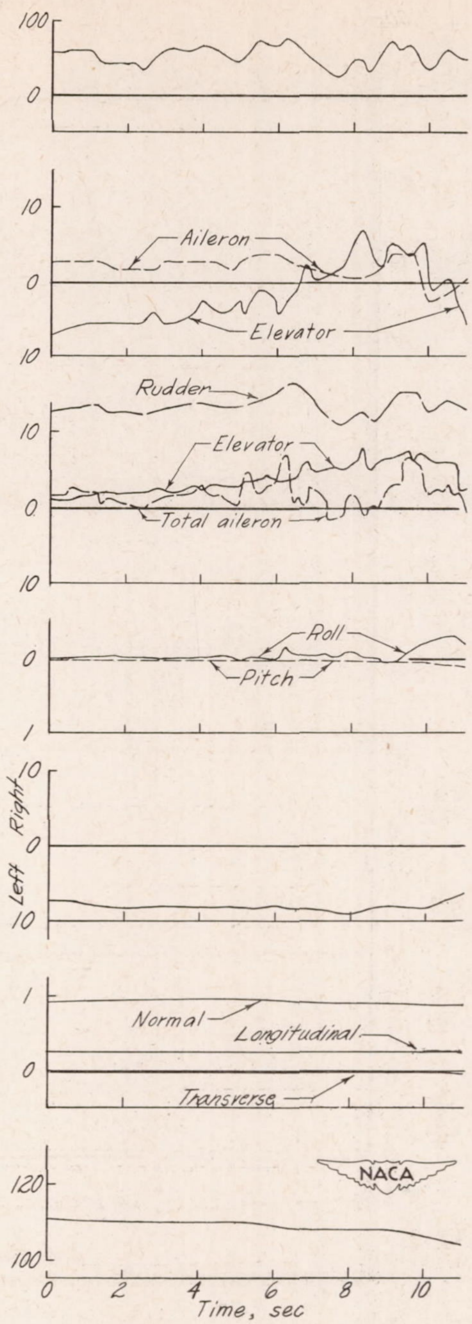



(b) All controls used to hold wings level after initial stall.

Figure 34.- Concluded.

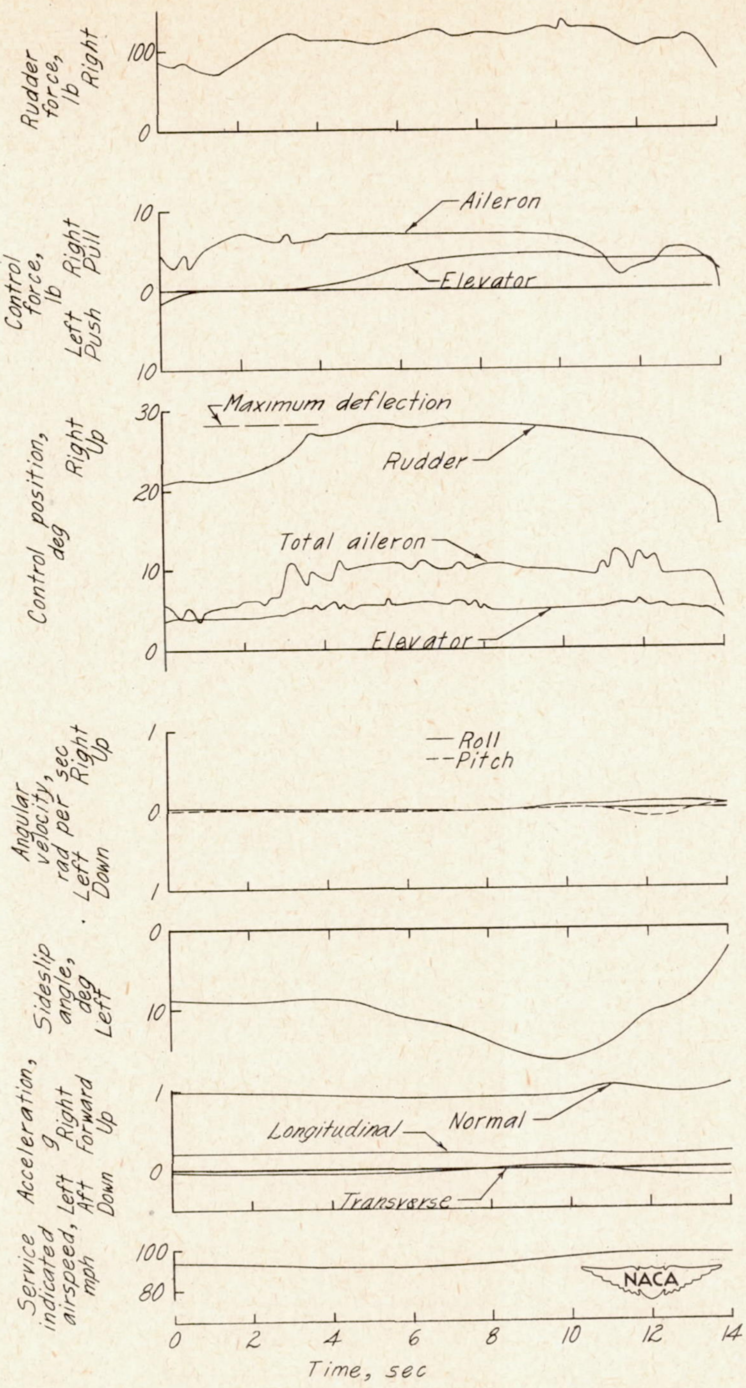



(a) Glide condition. Average altitude, 24,000 feet; center of gravity at 26.4 percent of the mean aerodynamic chord; gross weight, 12,770 pounds.



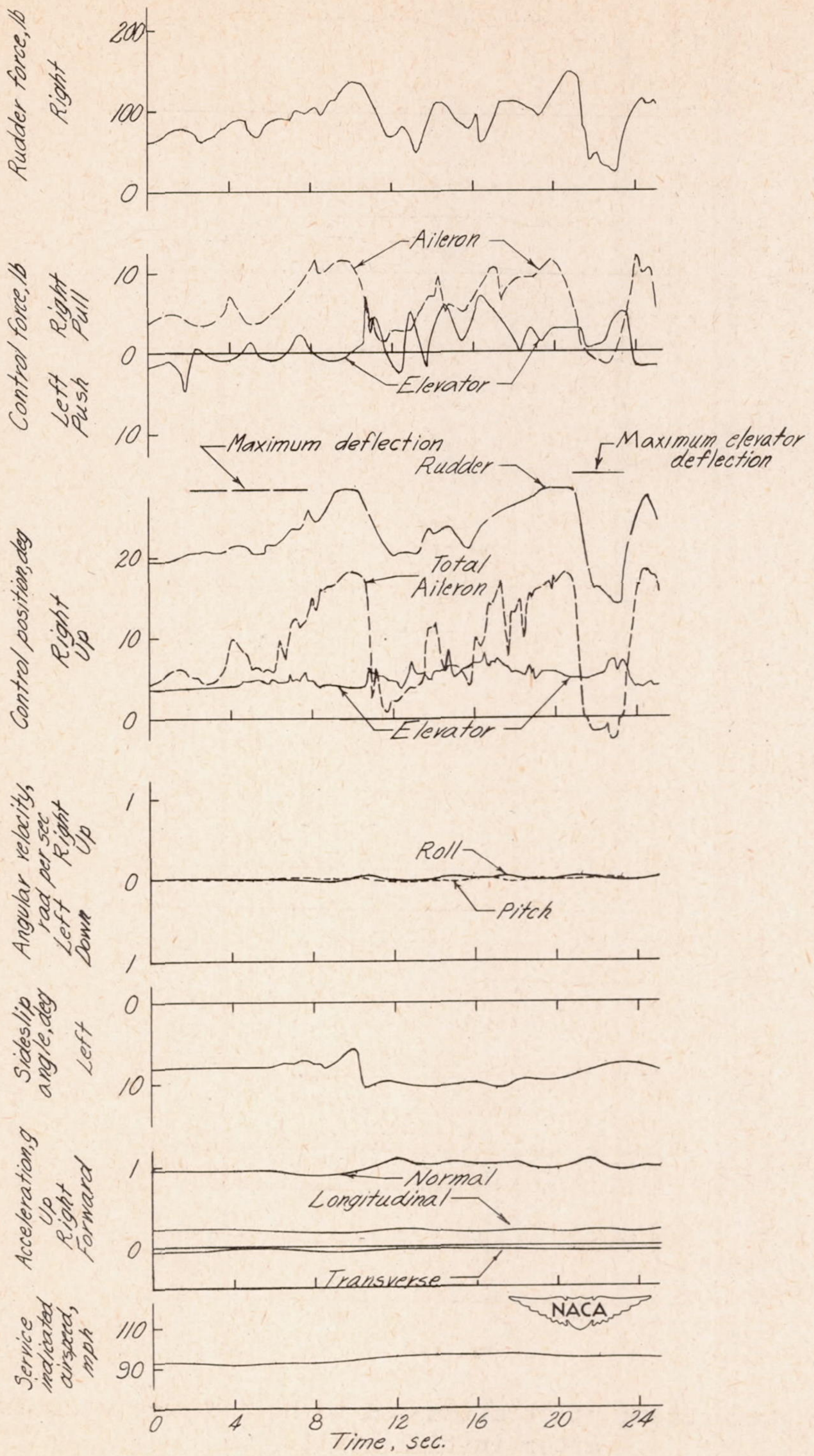

(b) Power-on clean condition. Average altitude, 26,500 feet; center of gravity at 26.4 percent of the mean aerodynamic chord; gross weight, 12,570 pounds.

Figure 35.- Time histories of stall approaches; all controls used to hold wings level after initial stall.



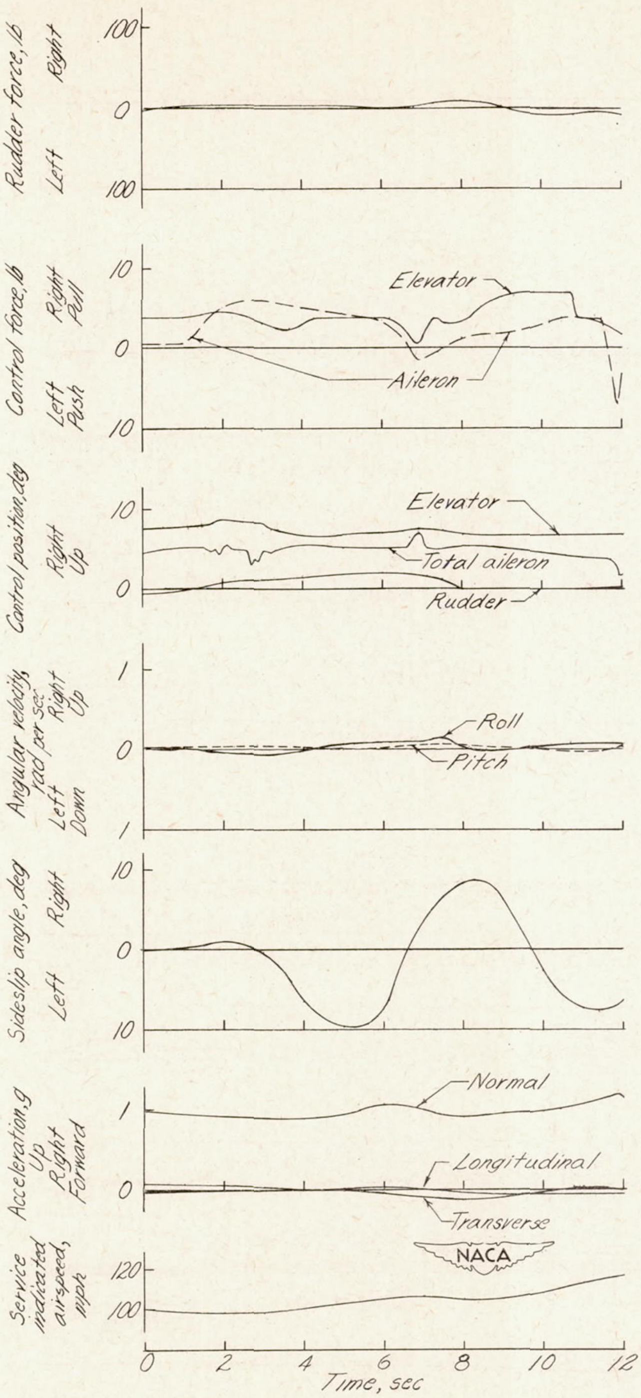

(a) Elevator alone used; pilot attempted to hold other controls fixed after initial stall.

Figure 36.- Time histories of stall approaches in the approach condition. Center of gravity at 28.9 percent of the mean aerodynamic chord; gross weight, 12,860 pounds; altitude, 5,000 feet.



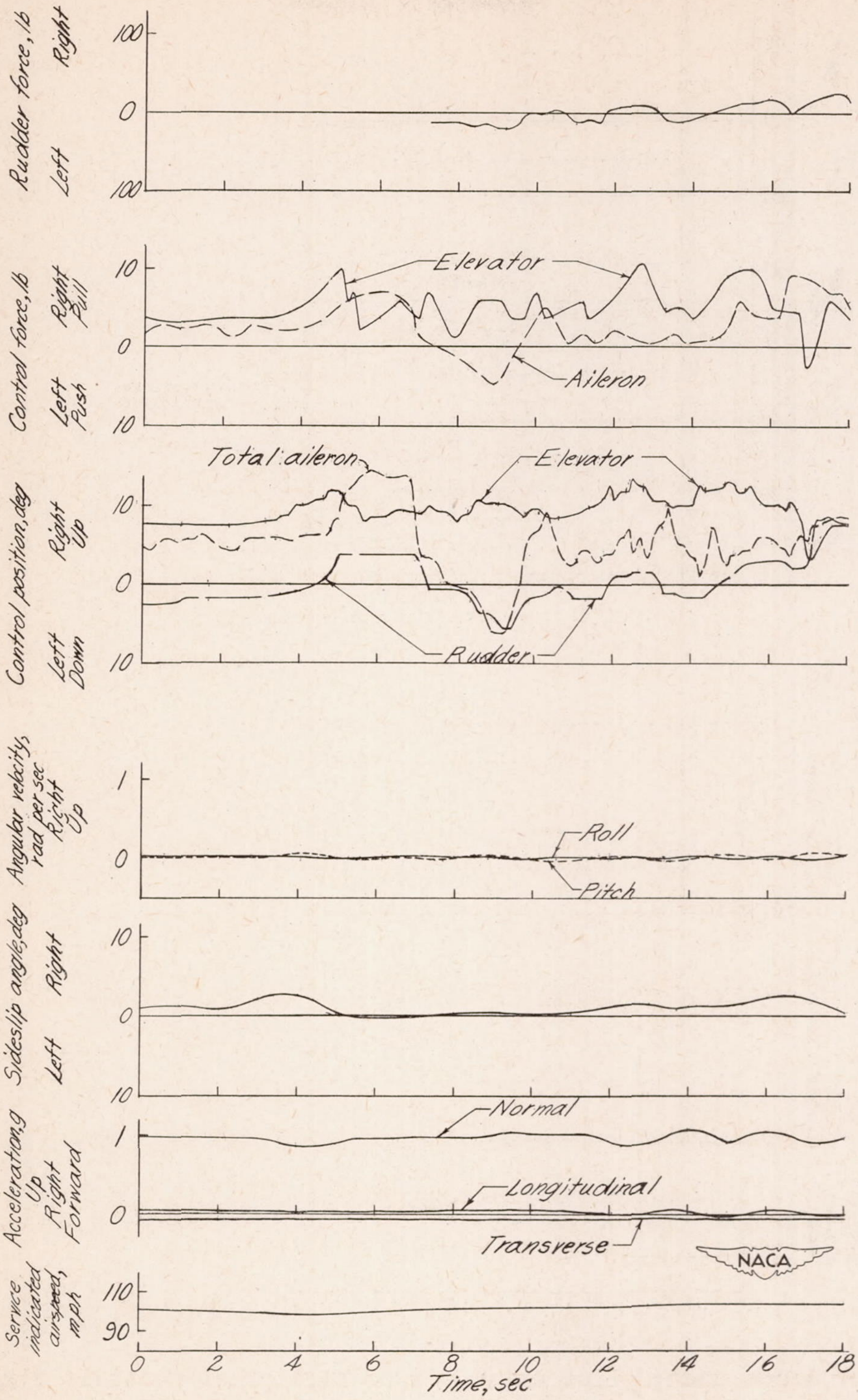

(b) All controls used to hold wings level after initial stall.

Figure 36.- Concluded.



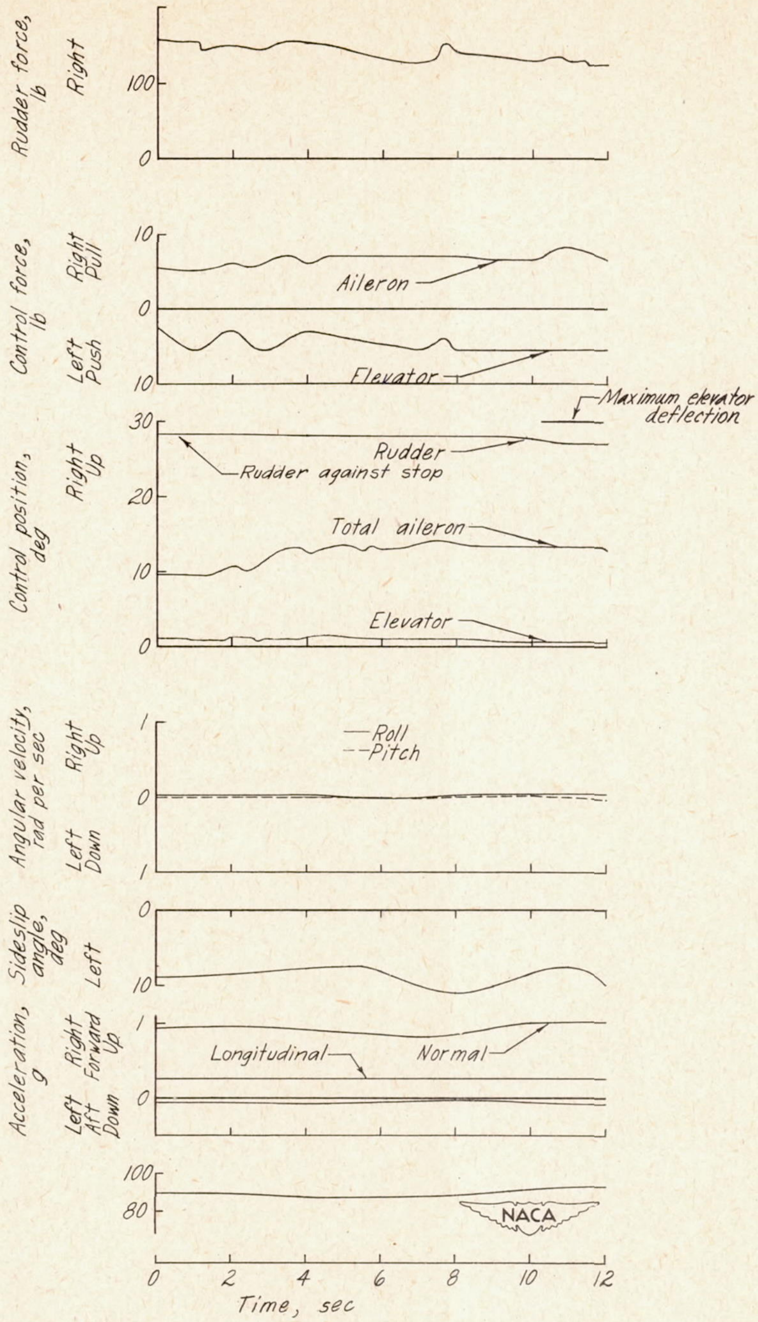

(a) Elevator alone used; pilot attempted to hold other controls fixed after initial stall.

Figure 37.- Time histories of stall approaches in the landing condition. Center of gravity at 29.0 percent of the mean aerodynamic chord; gross weight, 13,170 pounds; altitude, 5,000 feet.



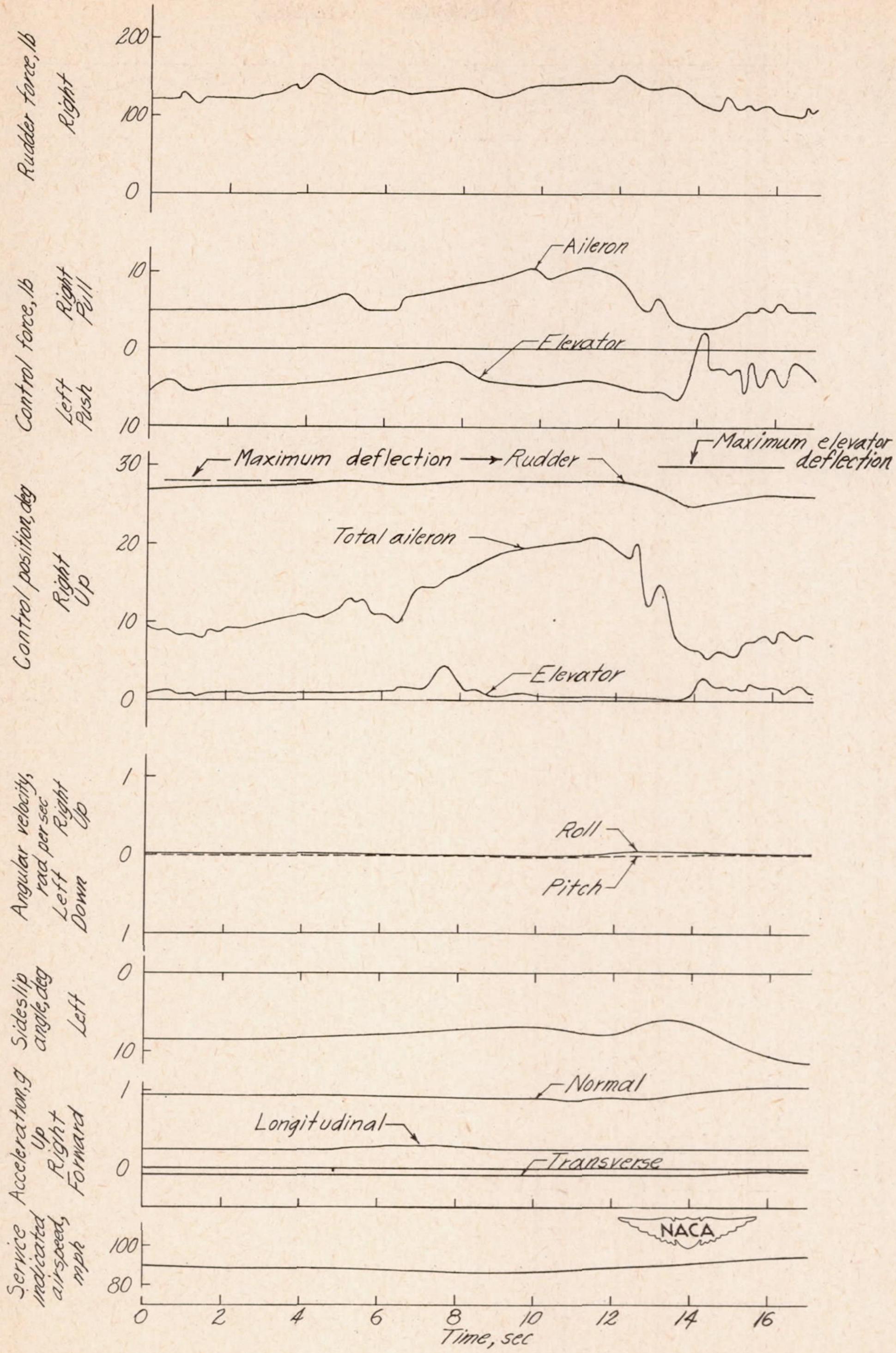

(b) All controls used to hold wings level after initial stall.

Figure 37.- Concluded.




(a) Elevator alone used; pilot attempted to hold other controls fixed after initial stall.

Figure 38.- Time histories of stall approaches in the wave-off condition. Complete stall was not reached because of insufficient rudder control. Center of gravity at 28.8 percent of the mean aerodynamic chord; gross weight, 13,210 pounds; altitude, 5,000 feet.




(b) All controls used to hold wings level after initial stall.

Figure 38.- Concluded.

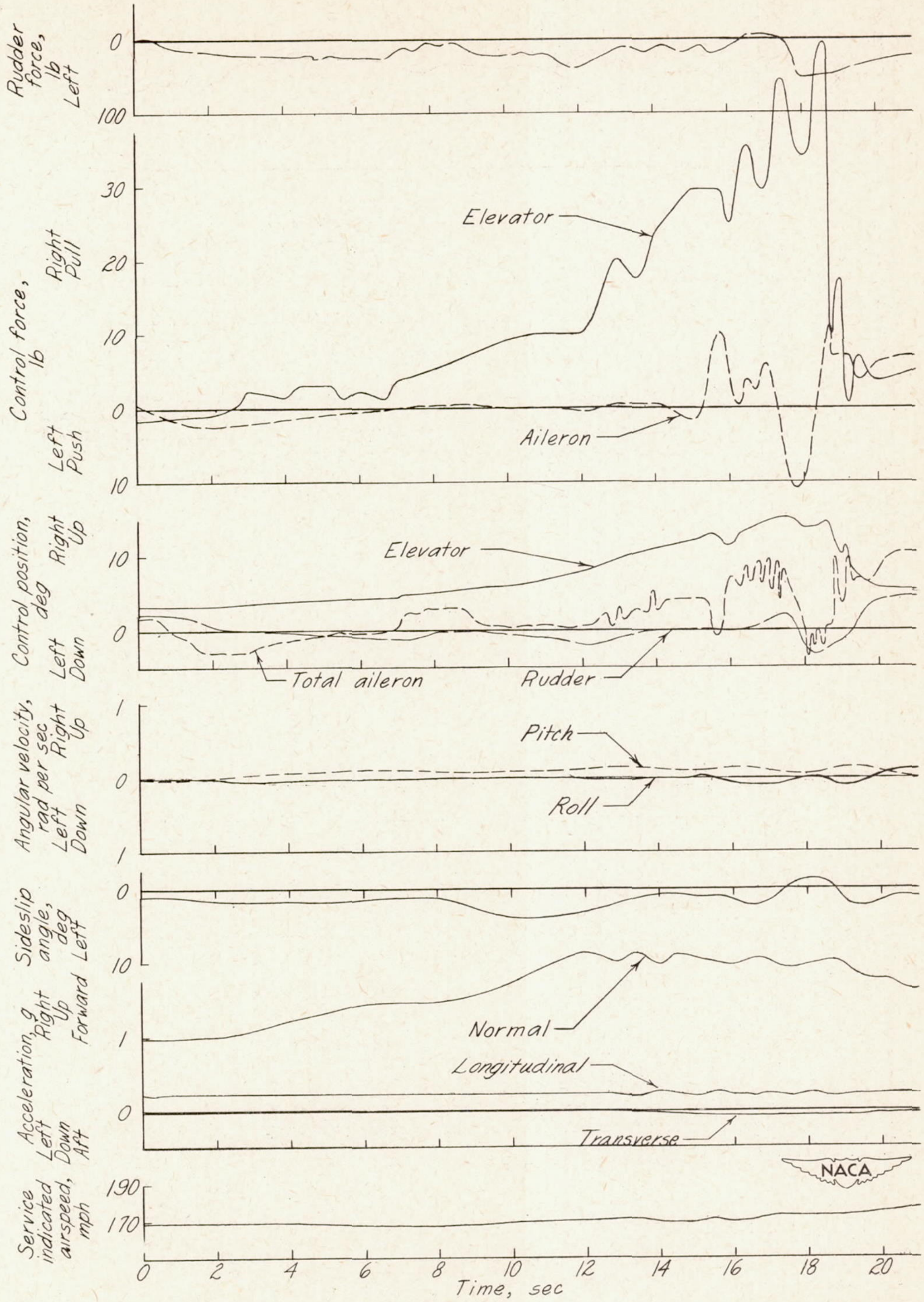



Figure 39.- Time history of a stall approach in the power-on clean condition during a low-speed left turn using elevator alone. Pilot attempted to hold other controls fixed. Center of gravity at 26.3 percent of the mean aerodynamic chord; gross weight, 12,690 pounds; altitude, 5,000 feet.

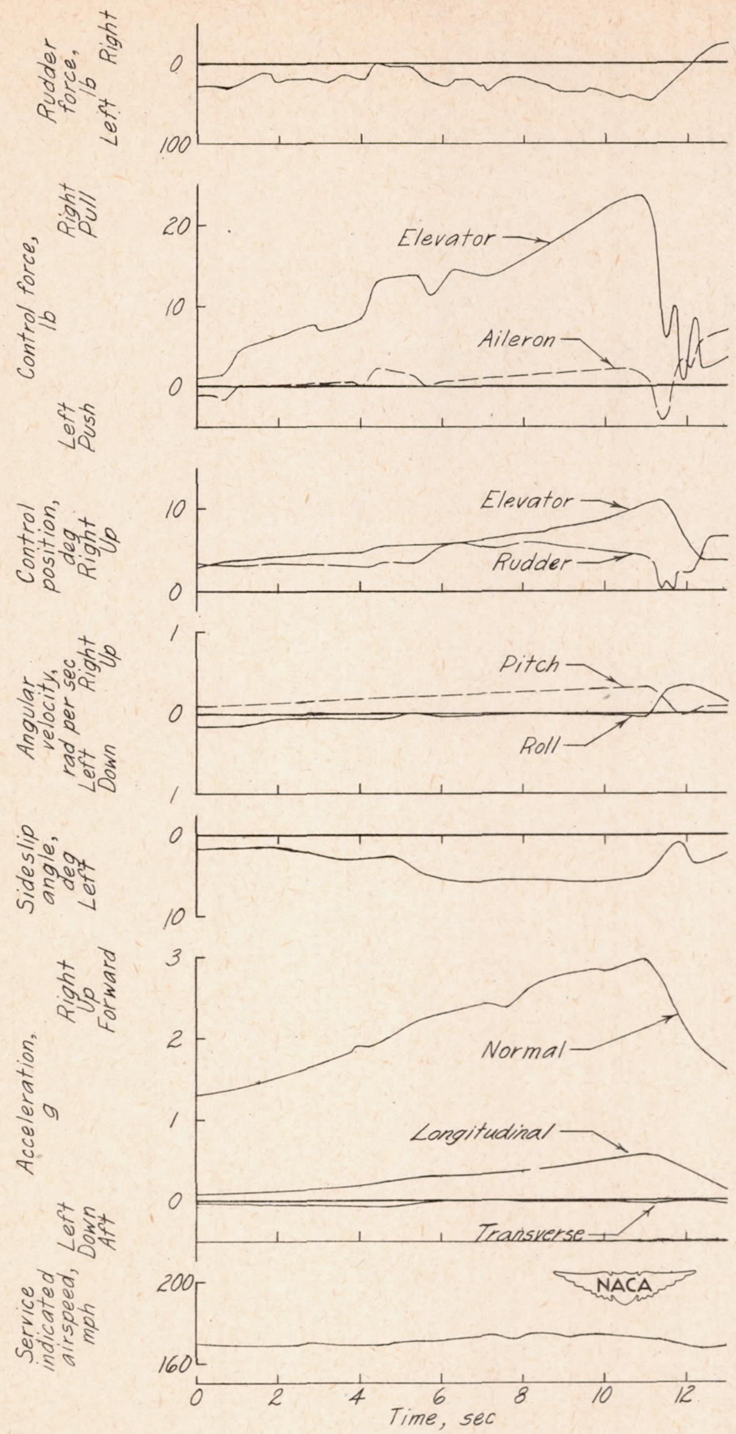



Figure 40.- Time history of a stall approach in a wind-up left turn in the landing condition using elevator alone to produce stall. Pilot attempted to hold other controls fixed. Center of gravity at 26.4 percent of the mean aerodynamic chord; gross weight, 12,680 pounds; altitude, 5,000 feet.

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