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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

FLIGHT MEASUREMENTS OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF THE GRUMMAN F8F-1 AIRPLANE - TED NO. NACA 2379

By

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12/14/53

NACA change # 2089

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SUMMARY

This paper presents the results of flight tests to determine the longitudinal stability and control characteristics and the stalling characteristics of the Grumman F8F-1 airplane. The lateral and directional stability and control characteristics were reported in reference 1.

With the normal center-of-gravity position, approximately 26 percent mean aerodynamic chord, the airplane was unstable below the trim speed of 180 miles per hour and neutrally stable with stick free from 180 to 340 miles per hour, while with the stick fixed it was unstable below 220 miles per hour, and neutrally stable above 220 miles per hour when in the normal rated-power clean condition. The airplane was stable in the gliding condition and unstable below the trim speed in the power-approach condition, stick fixed and stick free. The instability in the rated-power and power-approach configurations was considered acceptable because of the light stick forces involved. The airplane was generally stable in the rated-power clean condition, stick fixed and stick free, in accelerated turns for the range of conditions tested. However, in the case of the aft center-of-gravity position (27.4 percent M.A.C.) and the lower speeds, the elevator control force became zero at the highest accelerations reached, a condition the pilot considered very objectionable. The elevator deflection available was always sufficient and the power of the elevator trimming tabs was adequate except that the airplane could not be trimmed below 140 miles per hour in the landing condition. The nose-up change in trim due to adding power in the landing configuration was considered large enough to be objectionable. The stalling characteristics were acceptable and recovery was normal. Changes in longitudinal trim in the form of normal acceleration and pitching induced by yawing velocities and sideslips of the airplane were deemed unsatisfactory.

INTRODUCTION

A series of flight tests have been made at the Langley Flight Research Division at the request of the Bureau of Aeronautics, Department of the Navy, to determine the flying qualities of the Grumman F8F-1 airplane. This paper presents the test results necessary to determine the longitudinal stability and control characteristics and the stalling characteristics. These tests were made between February and June of 1947. The range of Mach numbers covered in this investigation was approximately 0.10 to 0.62, and no attempt was made to investigate compressibility effects at higher Mach numbers. The lateral and directional stability and control characteristics of the subject airplane have already been reported (reference 1).

Also presented in this paper is a discussion of the normal accelerations induced by yawing velocity and sideslip which were considered objectionable by the pilot for this airplane. A discussion of the undesirable accelerations has been included with a view towards formulating some flying-qualities requirements limiting them.

DESCRIPTION OF AIRPLANE

The Grumman F8F-1, number 94873, used in this investigation was a production airplane with a modified vertical tail (configuration 3 of reference 1). A three-view drawing of the airplane is presented in figure 1. The airplane was constructed of metal except for the control surfaces, which were covered with fabric. Trimming tabs were provided on the rudder, both elevator surfaces, and the left aileron. All the control surfaces were aerodynamically balanced, the elevator having the overhanging type, the rudder a horn type, and the ailerons the Frise type balance. In addition, both ailerons had spring tabs, and a bob-weight was installed in the elevator control system which required a pull force on the control stick of approximately 5 pounds per g. Cross sections of the control surfaces are shown in figure 2. The variation of elevator position with deflection of the control stick is presented in figure 3. Elevator deflections were measured with respect to the stabilizer, the incidence of which was 0.5°, leading edge up from the fuselage reference line. The airplane was designed to incorporate a belly tank, but all the tests reported herein were made with the belly tank off. General specifications of the airplane are given in table I. A more complete description and photographs of the airplane are presented in reference 1.

INSTRUMENTATION

Standard NACA instruments were used in the F8F-1 airplane for the flying-qualities tests and the instrumentation is described in detail in reference 1. Airspeed was measured with a swiveling static head, mounted one chord length ahead of and slightly below the right wing tip, and a shielded total-head tube, also mounted ahead of the wing tip. The airspeed system was calibrated for position error by means of a trailing airspeed bomb.

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

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

where V_c is in miles per hour, q_c is the difference between total pressure and correct static pressure in inches of water, and f_o is the compressibility correction factor at sea level (reference 2).

Control-stick forces were measured by means of a strain-gage apparatus installed in a control column, replacing the service stick and having the same length, approximately 16.5 inches from the hinge line to the center of the grip. Sideslip angles were measured by a yaw vane mounted one chord length ahead of the left wing tip. The sideslip data were not corrected for any angularity in the flow existing at the yaw vane. Previous tests made with similar type airplanes showed that the correction would amount to no more than 2°.

TEST RESULTS AND DISCUSSION

The results of the tests are evaluated in terms of the specifications of reference 3.

Dynamic Longitudinal Stability

Short-period oscillations were induced in the rated-power clean condition at several speeds for each of two center-of-gravity positions at an altitude of approximately 10,000 feet. The procedure used was to trim the airplane, then abruptly pull up to approximately 2g and release the control column. Time histories of these pull-ups are presented in figure 4. Very small oscillations of the elevator occurred in some cases, particularly at low speeds, but were satisfactorily damped. The period of the elevator oscillation was short enough so that the airplane did not respond, as shown by the records of normal acceleration. No unusual rough-air effects on longitudinal stability were noted by the pilot.

Static Longitudinal Stability

The static longitudinal stability was measured at two center-of-gravity positions, approximately 26 and 22 percent M.A.C. (mean aerodynamic chord) with landing gear up. The forward shift of the center of gravity due to lowering the landing gear was approximately 0.7 percent M.A.C., whereas fuel consumption could cause forward shifts of as much as 3 percent M.A.C. The weight of the airplane at take-off was about 9500 pounds. In the presentation of the data, account has been taken of the effect of varying fuel loads on weight and center-of-gravity position.

Figures 5 to 7 contain plots of the variation of elevator angle, elevator control force, and sideslip angle in straight flight against calibrated airspeed. For this series of tests, the pilot held the airplane at essentially zero angle of bank and, therefore, laterally level flight can be assumed. Plots of the variation of the elevator angle with normal-force coefficient and the variation of elevator force divided by the impact pressure F_e/q_c with normal-force coefficient are presented in figure 8 for the three conditions tested. The stick-fixed and stick-free neutral points were determined from the slopes of these curves. 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 $\frac{dF_e/q_c}{dC_N}$ are zero. The determination of the neutral points in the rated-power clean, gliding, and power-approach conditions for several normal-force coefficients is shown in figure 9. Figure 10 shows the variation of stick-fixed and stick-free neutral points with normal-force coefficient.

It should be noted that the neutral points are accurately determined only when their locations are reasonably close to the range of center-of-gravity locations tested. When the neutral points are far removed from the normal center-of-gravity limits of the airplane, however, their exact location is of little practical significance and they serve mainly to show whether or not the airplane is stable rather than the degree of stability. The degree of stability in these cases is better indicated by the curves of elevator stick force and elevator angle against airspeed.

The requirements of reference 3 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 variation of the elevator stick force with speed shall be such that push forces are required to increase speed from trim and pull forces to decrease speed. Information received from the Grumman Aircraft Engineering Corporation indicated that the normal center-of-gravity limits were approximately 26.7 percent M.A.C. aft and 21 percent M.A.C. forward, with the landing gear retracted. For each condition tested, data were obtained for center-of-gravity positions representing approximately the fore and aft limits.

The following conclusions were reached regarding the static longitudinal stability of the F8F-1 airplane:

1. Rated-power clean condition.- The airplane was unstable up to approximately 220 miles per hour and neutrally stable from 220 to 400 miles per hour, stick fixed, and unstable up to approximately 180 miles per hour and neutrally stable from 180 to 340 miles per hour, stick free, for the aft center-of-gravity position (27.1 percent M.A.C.) when trimmed for laterally level straight flight at 180 miles per hour. For the forward center-of-gravity position (22.1 percent M.A.C.), the airplane was unstable below the trim speed and stable above, stick fixed and stick free.

2. Gliding condition.- The airplane was stable, stick fixed and stick free, for the aft center-of-gravity position (25.7 percent M.A.C.) and the forward center-of-gravity position (22.2 percent M.A.C.) when trimmed for laterally level straight flight at 140 miles per hour.

3. Power-approach condition.- The airplane was unstable below the trim speed of 110 miles per hour and stable above, stick fixed and stick free, for the aft center-of-gravity position (24.8 percent M.A.C.). For the forward center-of-gravity position (21.2 percent M.A.C.) the airplane was unstable below 100 miles per hour and stable above, stick fixed and stick free.

4. General.- The static-longitudinal-stability requirements of reference 3 were satisfied only for the airplane in the gliding condition and above the trim speed for the power-approach condition. The instability of the airplane in the rated-power and power-approach conditions was considered mild by the pilot and acceptable because of the light stick forces.

The effects of power on the stability of this airplane at low speed were rather large. These power effects were, however, less than might be expected for an airplane with an engine and propeller of such large size in relation to the rest of the airplane. The power effects were probably kept at a minimum due to the fact that the thrust axis was tilted down 3.6° from a reference line parallel to the airplane when the wing is at the angle of zero lift.

Longitudinal Control in Accelerated Flight

The longitudinal stability and control characteristics in accelerated flight were investigated in right and left turns made in the rated-power clean condition at an altitude of approximately 10,000 feet. Spot records were obtained in steady turns at 200 and 300 miles per hour at various accelerations. Figure 11 presents curves of the variation of elevator control force with normal acceleration at each speed for two center-of-gravity positions, while figure 12 shows the variation of elevator angle 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 position where values of the slope $d\delta_e/dC_N$ are zero in figure 13. The stick-fixed maneuver point was at approximately 29 percent M.A.C. at an indicated airspeed of about 350 miles per hour and a normal-force coefficient of 0.3 and moved aft with decreasing speed or increasing normal-force coefficient.

The stick-free maneuver points were also determined from figure 13 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 13. The symbol n represents normal acceleration in gravitational units. The stick-free maneuver point for a 3g turn at 350 miles per hour was at approximately 28 percent M.A.C. and moved aft as the speed and acceleration decreased.

Throughout the test range of normal-force coefficients and accelerations in right and left turns, the airplane was generally stable, stick fixed and stick free, for both forward and aft center-of-gravity positions, the stability being more positive for the forward center-of-gravity position, the higher speed, and right turns.

However, in the case of the aft center-of-gravity position (27.4 percent M.A.C.) and the lower speed, the elevator control force became zero at the highest accelerations reached (fig. 11). The pilot considered this condition very objectionable and the requirement of reference 3 which states that the elevator control-force gradient in steady turns shall never be less than 3 pounds per g was not satisfied.

Longitudinal control in landing.- The longitudinal control in landing was considered satisfactory. Figure 14 presents a time history of a typical landing from which it will be noted that with the center of gravity at approximately 24 percent M.A.C., landing gear down, about 16° up-elevator or about two-thirds of that available was used to land. Another landing record showed that, with the center of gravity at about 20 percent, approximately 21° up-elevator, or 3° less than that available, was required to land. Although in both cases it was not possible to trim the airplane below approximately 140 miles per hour, the elevator control forces were well below the maximum of 35 pounds considered satisfactory by the standards of reference 3.

Longitudinal control in take-offs.- The power of the elevator to control the longitudinal attitude of the airplane during take-offs was found to be adequate. Time histories of a few take-offs were presented in reference 1.

Longitudinal trim 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 15 for two flight conditions. It was possible to trim the elevator control forces to zero throughout the test center-of-gravity range from the highest speed reached to within a few percent of the stalling speed for all but the landing condition. The minimum trim speed for this condition was about 140 miles per hour.

Trim changes due to flaps and power.- The longitudinal trim changes due to flaps, landing gear, and power were measured with the center of gravity at approximately 26 percent M.A.C. (landing gear down) and with the elevator trimming tab set at 21.2° (full) nose-up at 140 miles per hour. The airplane was trimmed with flaps and landing gear down, engine idling, and successive changes in configuration were made as shown in the table.

Position of		Power setting	Approximate elevator control force (lb)
Flaps	Landing gear		
Down	Down	Engine idling	0
Down	Down	Normal rated (41.5 in. Hg at 2600 rpm)	24.2 push
Down	Up	Normal rated (41.5 in. Hg at 2600 rpm)	29.2 push
Up	Up	Normal rated (41.5 in. Hg at 2600 rpm)	43.0 push

The large trim change, requiring an elevator control push force of 43 pounds, in going from the landing to the normal rated-power clean condition did not satisfy the standards of reference 3 which states that it should be possible to maintain a given trim speed using any combination of engine power, flaps, or gear setting without exerting push or pull forces greater than 35 pounds. In particular, the nose-up change in trim due to adding power was considered large enough to be objectionable. Since the pilot observed that the trim change in going from the landing to the normal rated-power clean condition was by far the largest, no other configuration was tested.

Pitching moment due to sideslip.- In the course of making rudder kicks and control releases from steady sideslips, the test pilot noticed changes in longitudinal trim causing the airplane to pitch. His findings were verified from a study of the test results which showed appreciable changes in normal acceleration and pitching velocity. To ascertain the extent of these effects, a few additional tests were made and the results plotted in figures 16 to 19. Typical time histories of oscillations induced by rudder kicks are presented in figure 16, from which type of data the summary plot of figure 17 was obtained. In this figure, change in normal acceleration is plotted against change in rudder angle. It should be noted that the normal-acceleration changes which occur are dependent upon the time interval the rudder is held in the deflected position and, therefore, the values presented in figure 17 should be considered as only qualitative. The solid curves represent the first acceleration peak after the rudder is kicked. In left rudder kicks, the airplane initially pitched up but then pitched down more violently. The dashed portion of the curves represent this second peak. The pitching motion is caused by the combined effect of the gyroscopic action of the propeller and the pitching moment due to sideslip. In the case of right rudder kicks, both these effects tend to pitch the airplane down. In left rudder kicks, the airplane initially pitches up because of the gyroscopic moments, but then pitches down as the sideslip builds up. Figure 18 presents typical time histories of maneuvers in which the stick was released from steady sideslips with the rudder fixed. These results, therefore, isolate the effect of pitching moment due to sideslip. It is seen from this figure that the acceleration increased as the center of gravity was moved aft. From data of this type, the summary plot of figure 19, presenting change in normal acceleration against sideslip angle, was obtained. The large changes in normal acceleration due to release of the stick were considered unsatisfactory.

The results of these tests are to be considered as a preliminary investigation towards formulating some flying-qualities requirements limiting the amount of pitching motion of aircraft induced by yawing motion. As the results show, the elevator forces required in steady sideslips, though they do not appear excessive, may, if coupled with a low stick force per g gradient, cause high accelerations. Therefore, airplanes having low stick force per g gradients should have correspondingly small elevator stick forces due to sideslip.

Hinge moments.- The elevator hinge-moment parameters C_{h_α} and $C_{h_{\delta_e}}$ were analytically determined using the data obtained in accelerated turns. A correction to account for the moment introduced by the bobweight was applied to the data. The values of the rate of change of elevator hinge moment with angle of attack C_{h_α} and with elevator deflection $C_{h_{\delta_e}}$ were -0.0014 and -0.0068 per degree, respectively.

CONTROL FRICTION

The friction in the elevator, rudder, and aileron control systems were measured on the ground at about 60° F in terms of control forces. As shown on the following page, all three controls satisfy the requirements.

Control	Friction at neutral deflection (lb)	Maximum allowable friction at neutral deflection (lb)
Elevator	$\pm1\frac{1}{2}$	±3
Rudder	±6	±7
Aileron	$\pm1\frac{3}{4}$	±2

STALLING CHARACTERISTICS

Time histories of stall approaches and stalls in the rated-power clean, gliding, and power-approach conditions are given in figure 20. The stalling characteristics of the F8F-1 airplane for various configurations were as follows:

1. Rated-power clean (fig. 20(a)).- Stalls in this condition varied somewhat in nature and speed, probably due to differences in sideslip angle and to rate of change of angle of attack during different stalls. In a typical case, however, there was a mild roll to the left which could be easily corrected followed by an abrupt roll to the right. A very steep nose-up attitude gave some stall warning in this condition. The stalling characteristics were considered satisfactory because of the relatively small initial rolling velocity.

2. Gliding (fig. 20(b)).- The elevator control force was in the correct direction but was light. At the stall, the nose dropped abruptly with a sharp roll to the left. The stalling characteristics in this condition were acceptable.

3. Power-approach (fig. 20(c)).- Stalls in this condition were characterized by a mild roll to the left accompanied by mild buffeting. The stalling characteristics were considered acceptable because of their mildness.

4. Landing.- Rearward stick movement accompanied by a lightening of the elevator stick forces provided a good stall warning as the stall at 94 miles per hour was approached. At the stall, the nose dropped and the airplane rolled abruptly to the right about 15°. Stalling characteristics in this oondition were acceptable.

5. Wave-off.- Stall warning consisted of a fairly steep nose-up attitude and buffeting of the rudder from about 90 miles per hour to the stall at 78 miles per hour. A sudden roll to the right and a severe

nose-down pitching characterized the stall. Stall warning was considered satisfactory because of the rudder buffeting and the steep attitude. The stall was considered unsatisfactory because of the severe pitching.

The stalling characteristics were considered acceptable for all configurations, even though definite buffeting prior to the stall was not readily discernible by the pilot in most cases due to the general shaking of the airplane at the lower speeds. This shaking could not be considered a good stall warning because it covered too large a speed range, from about 115 miles per hour to the stall. Normal stall recovery procedure was used to regain control of the airplane, correcting for the roll at the same time.

A time history of a 3g wind-up turn to the stall in the rated-power clean condition is shown in figure 21. No warning preceded the stall which was characterized by an abrupt reduction in acceleration and pitching velocity but accompanied by no roll.

CONCLUSIONS

The conclusions reached regarding the longitudinal stability and control characteristics of the Grumman F8F-1 airplane (BuAer No. 94873) may be summarized as follows:

1. Small-amplitude, short-period longitudinal oscillations produced by abruptly deflecting and releasing the elevator were satisfactorily damped.

2. In the rated-power clean condition for the range of center-of-gravity positions tested (22.1 to 27.1 percent M.A.C.), the airplane was unstable, stick fixed and stick free, below the trim speed of 180 miles per hour. The airplane was stable, however, above the trim speed for the forward center-of-gravity position (22.1 percent M.A.C.), stick fixed and free.

3. Throughout the test center-of-gravity range, both stick fixed and stick free, the airplane was stable in the gliding condition and unstable below the trim speed in the power-approach condition.

4. The instability in the rated-power and power-approach configurations was considered acceptable because of the light stick forces involved.

5. The airplane was generally stable in the rated-power clean condition, stick fixed and stick free, in accelerated turns for the range of conditions tested. However, in the case of the aft center-of-gravity position (27.4 percent M.A.C.) and the lower speeds, the elevator control force became zero at the highest accelerations reached, a condition the pilot considered very objectionable.

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

7. The power of the elevator trimming tabs was adequate except that the airplane could not be trimmed below approximately 140 miles per hour in the landing configuration. The trim change in going from the landing to the normal rated-power clean condition was in excess of the standards of reference 3. In particular, the nose-up change in trim due to adding power was large enough to be considered objectionable.

8. Although no definite buffeting was present except in the wave-off condition, the stalling characteristics were considered acceptable and the recovery was normal.

9. Changes in longitudinal trim in the form of normal acceleration and pitching induced by yawing velocity and sideslip were considered objectionable and it is proposed that flying-qualities requirements should contain a provision to limit the change.

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2. Aiken, William S., Jr.: Standard Nomenclature for Airspeeds with Tables and Charts for Use in Calculation of Airspeed. NACA TN No. 1120, 1946.

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

TABLE I

GENERAL SPECIFICATIONS OF THE AIRPLANE

Make and designation	Grumman F8F-1 (BuAer No. 94873)
Engine	Pratt and Whitney R-2800-34-W Double Wasp
Power ratings	
Take-off	2100 hp at 2800 rpm at sea level
Military	1600 hp at 2800 rpm at 16,000 ft
Normal maximum (low blower)	1700 hp at 2600 rpm at 7000 ft
(high blower)	1450 hp at 2600 rpm at 18,500 ft
Propeller	Hydraulically-Controlled Four-Blade Constant-Speed - Aeroprop
Model	A 642 G-1
Blade number	65065
Basic pitch settings	Max 63.0, Min 28.5
Diameter	12'7"
Fuel capacity, gal	
Main tank	175
Droppable (belly)	100 or 150
Droppable (wings)	100
Oil capacity, gal	
One tank (in engine compartment)	17
War emergency power system fluid, gal	
One tank (in engine compartment)	16
General	
Span (wings spread), ft	35.5
Span (wings folded), ft	23.25
Length (over all), ft	27.5
Length (tail wheel on ground), ft	28.25
Length (tail wheel on ground), propeller blade vertical, ft	13.67
Weight for tests, approximate, lb	8500 to 10,000

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GENERAL SPECIFICATIONS OF THE AIRPLANE - Concluded

Wings	
Area, sq ft	244
Airfoil section	
Root	modified 23018
Tip	23009
Mean aerodynamic chord, in.	87.55
Leading-edge M.A.C. aft of leading edge of root chord, in.	8.17
Root chord, in.	115.9
Tip chord (6 in. inboard of actual tip) in.	51.5
Incidence, deg	3.0
Dihedral	5.5
Sweepback of leading edge, deg	5.1
Wing flaps	
Area, total, sq ft	18.18
Deflection, maximum down, deg	40
Ailerons	
Area, total, sq ft	15
Spring-tab area, total, sq ft	1.4
Trimming-tab area, sq ft	0.7
Trimming-tab deflection angle, deg	±5
Horizontal tail	
Span, in.	189
Total area, sq ft	52.27
Elevator area (including tabs) sq ft	18.63
Elevator trimming-tab area (total) sq ft	1.0
Elevator tab range, deg (approx.)	8 up, 20 down
Tail incidence, deg	0.5
Vertical tail (configuration 3 of reference 1)	
Total area, sq ft	20.7
Rudder area, sq ft	8.2
Rudder-tab area, sq ft	0.8
Fin offset, deg	1.5
Rudder-tab range, deg (approx.)	±17

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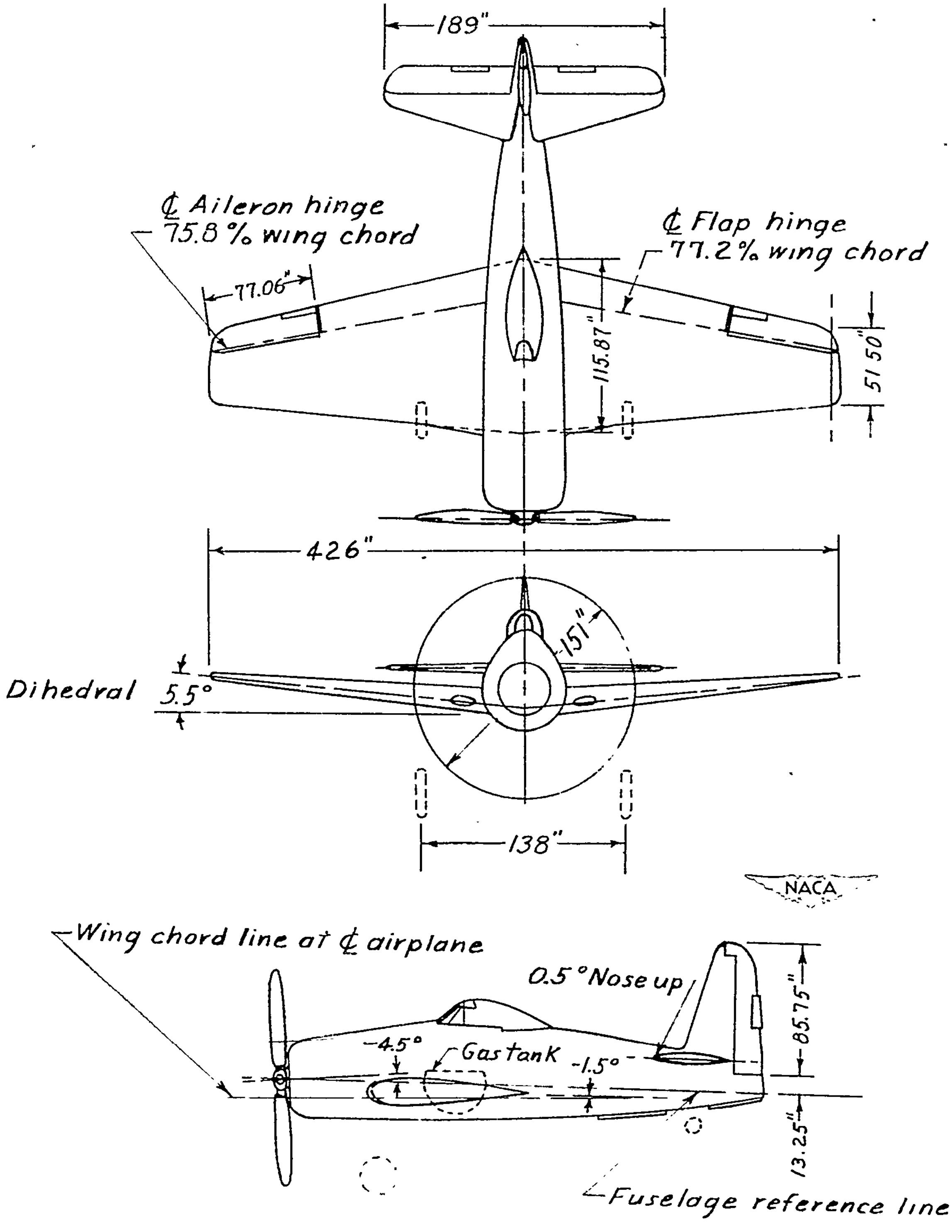
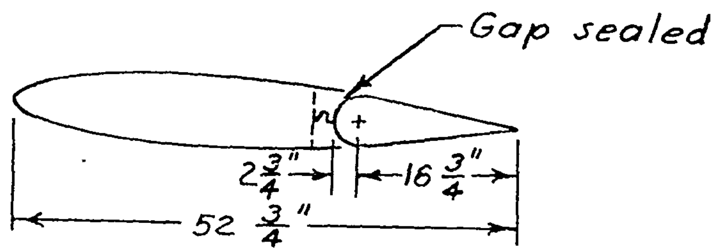
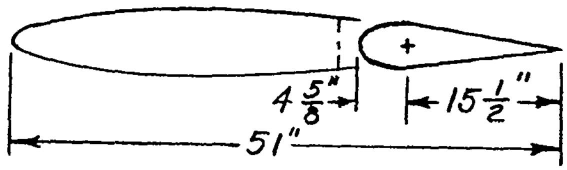


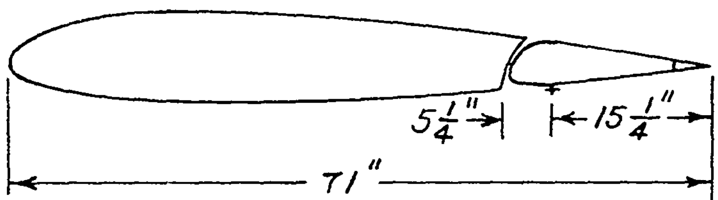
Figure 1.- Three-view drawing of the Grumman F8F-1 airplane.



Vertical tail, 21 inches above fuselage reference line



Horizontal tail, 15 inches from center line



Wing and aileron, near inboard end of aileron

Figure 2.- Section views through the aerodynamic surfaces of the Grumman F8F-1 airplane.

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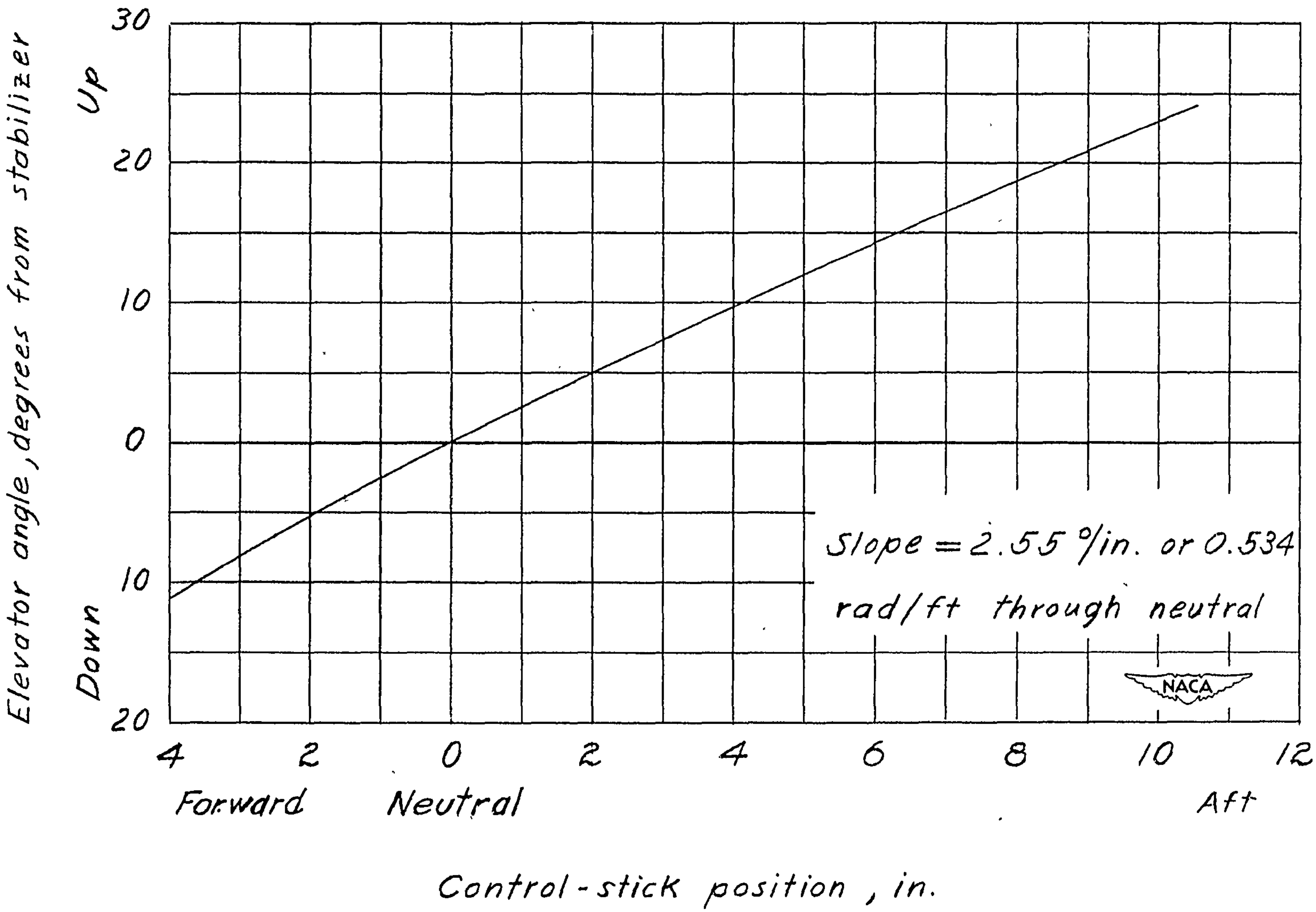
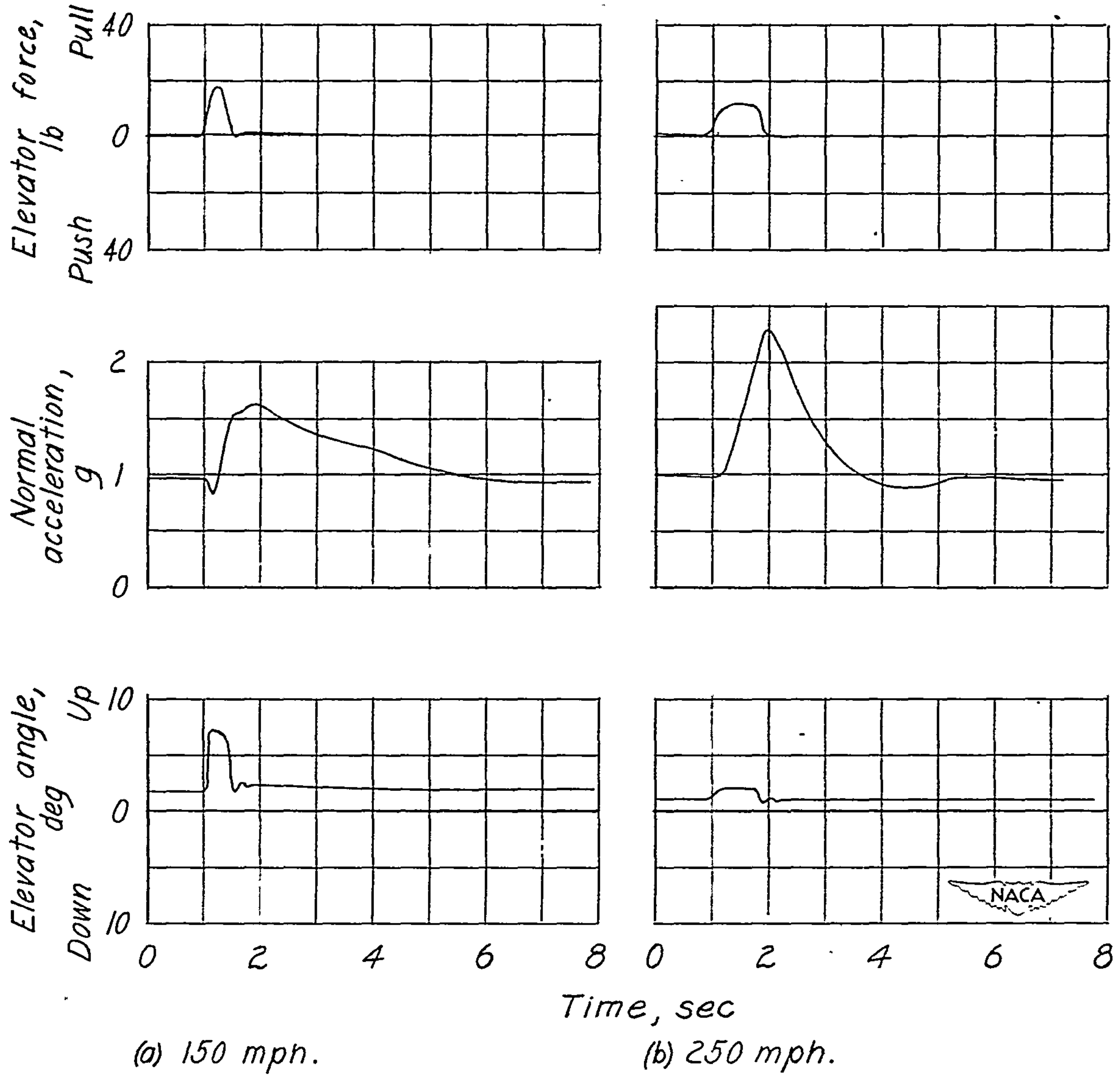
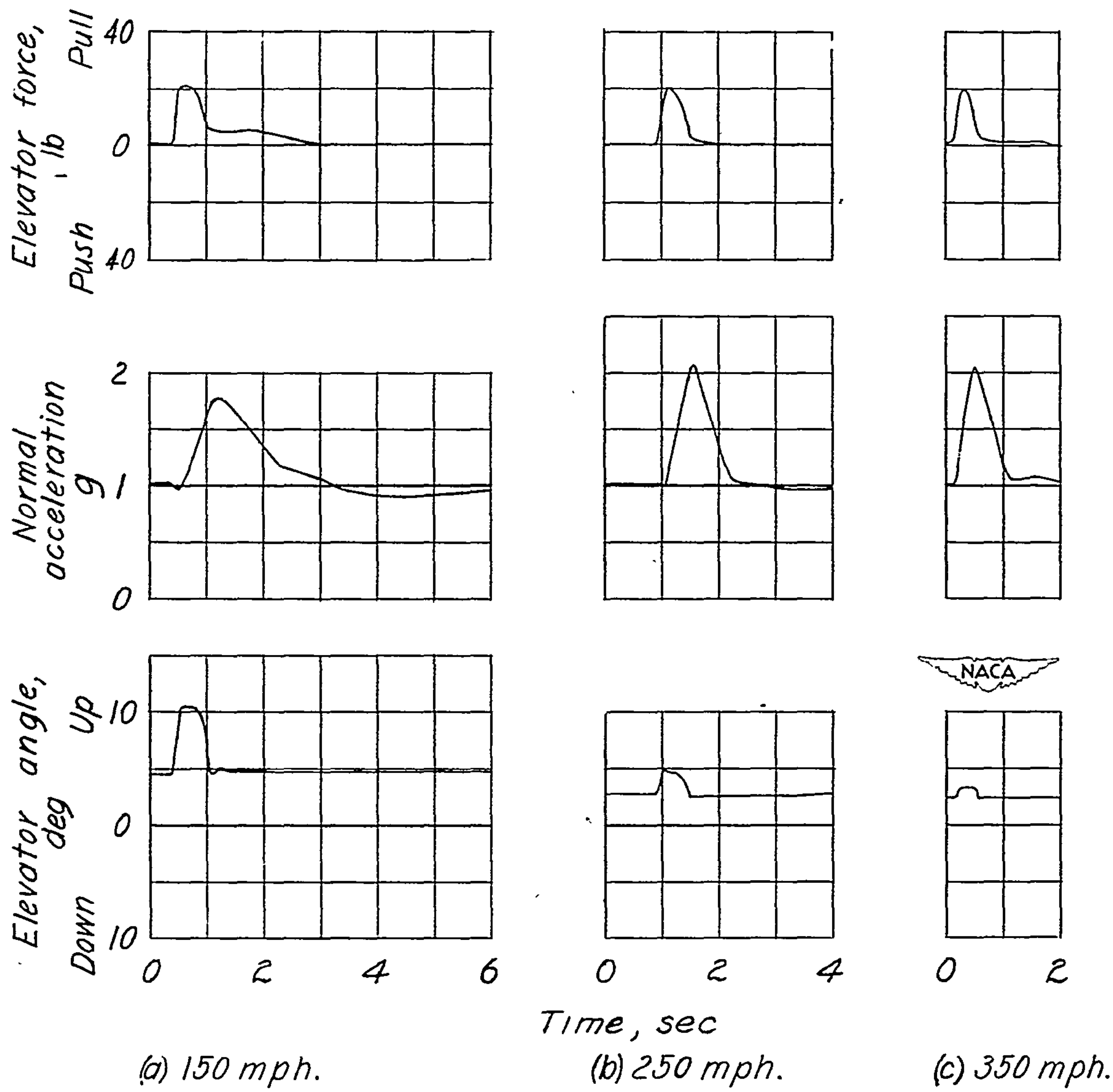


Figure 3.- Linkage between the control stick and elevator of the Grumman F8F-1 airplane.



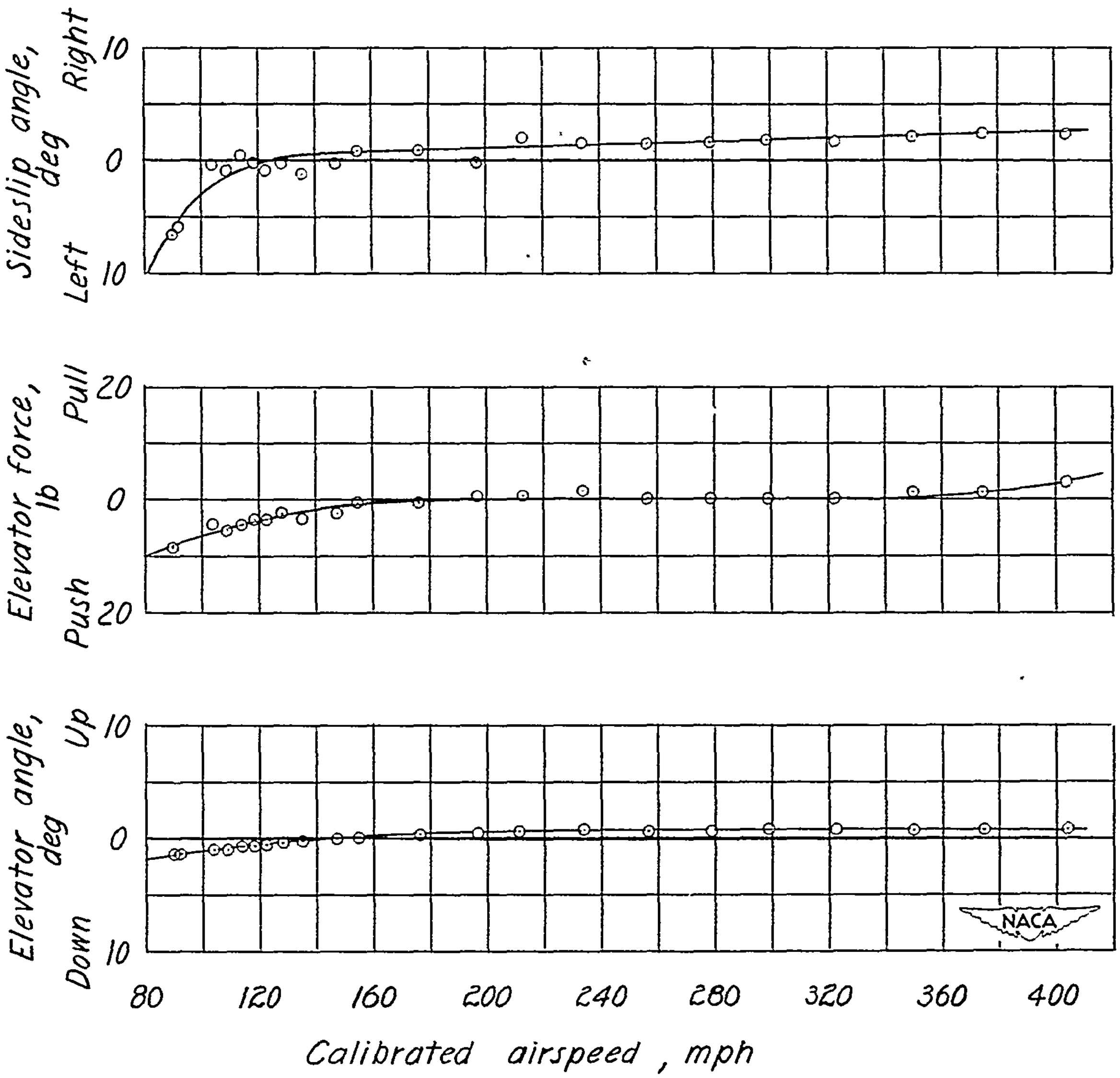
(a) Center of gravity at 25.2 percent mean aerodynamic chord.

Figure 4.- Short-period longitudinal oscillations in the rated-power clean condition, Grumman F8F-1.



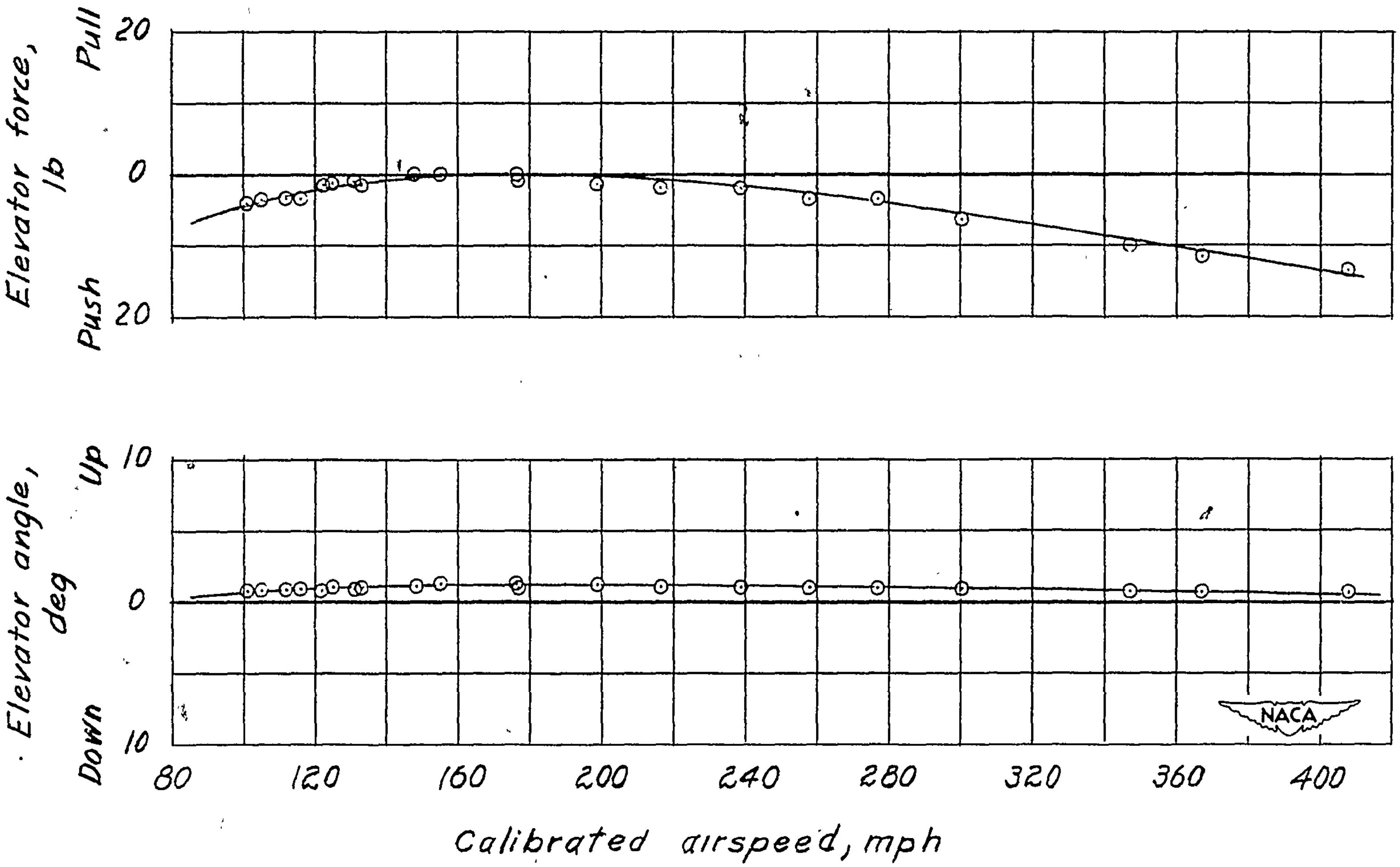
(b) Center of gravity at 20.7 percent mean aerodynamic chord.

Figure 4.- Concluded.



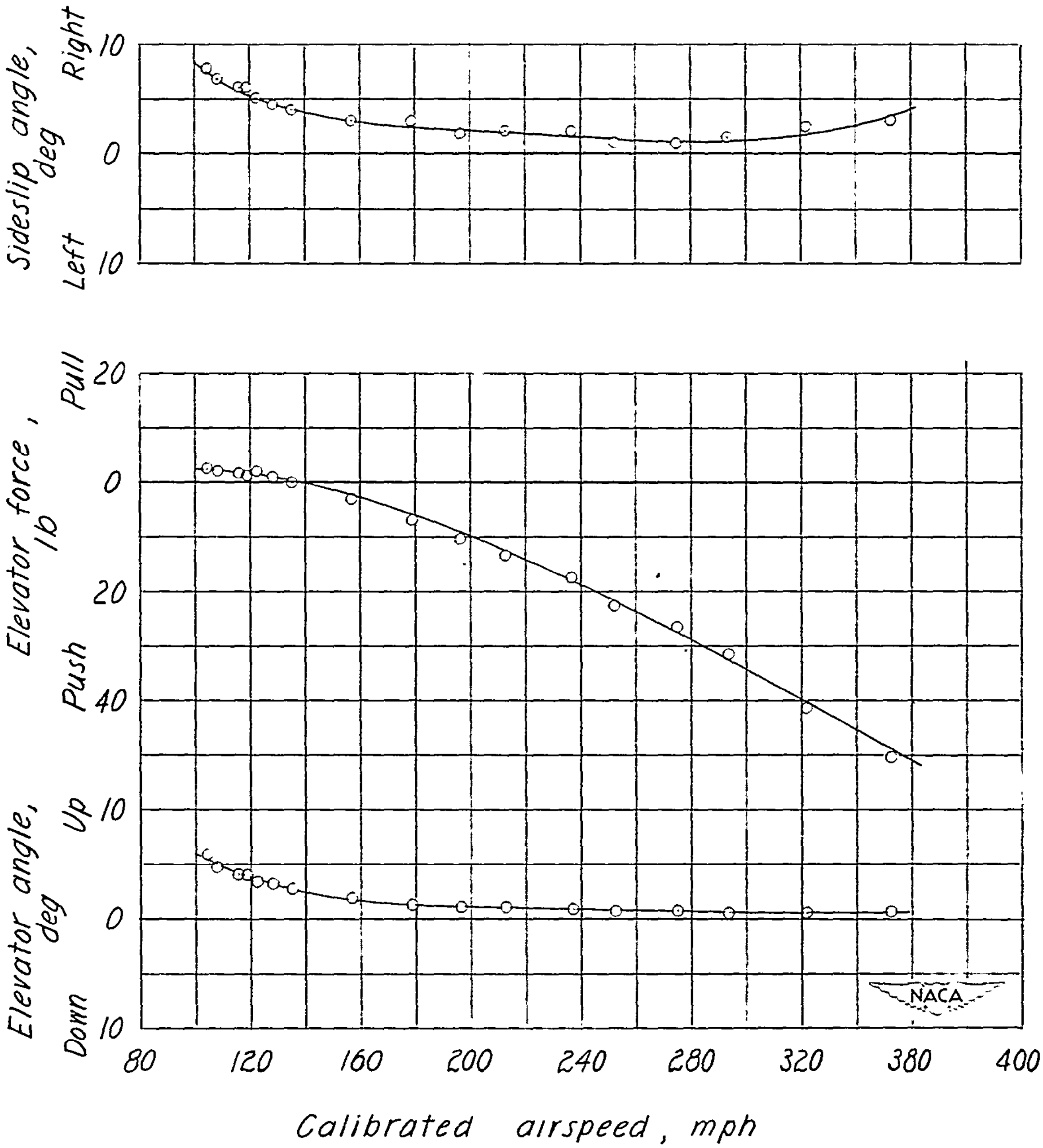
(a) Center of gravity at 27.1 percent mean aerodynamic chord and elevator trimming tabs set at neutral.

Figure 5.- Static longitudinal stability characteristics of the Grumman F8F-1 in the rated-power clean condition. Flaps up; landing gear up; 38 in. of Hg at 2600 rpm; oil cooler closed; cowl flaps, 3/4 in. open; 5000 to 12,000 feet.



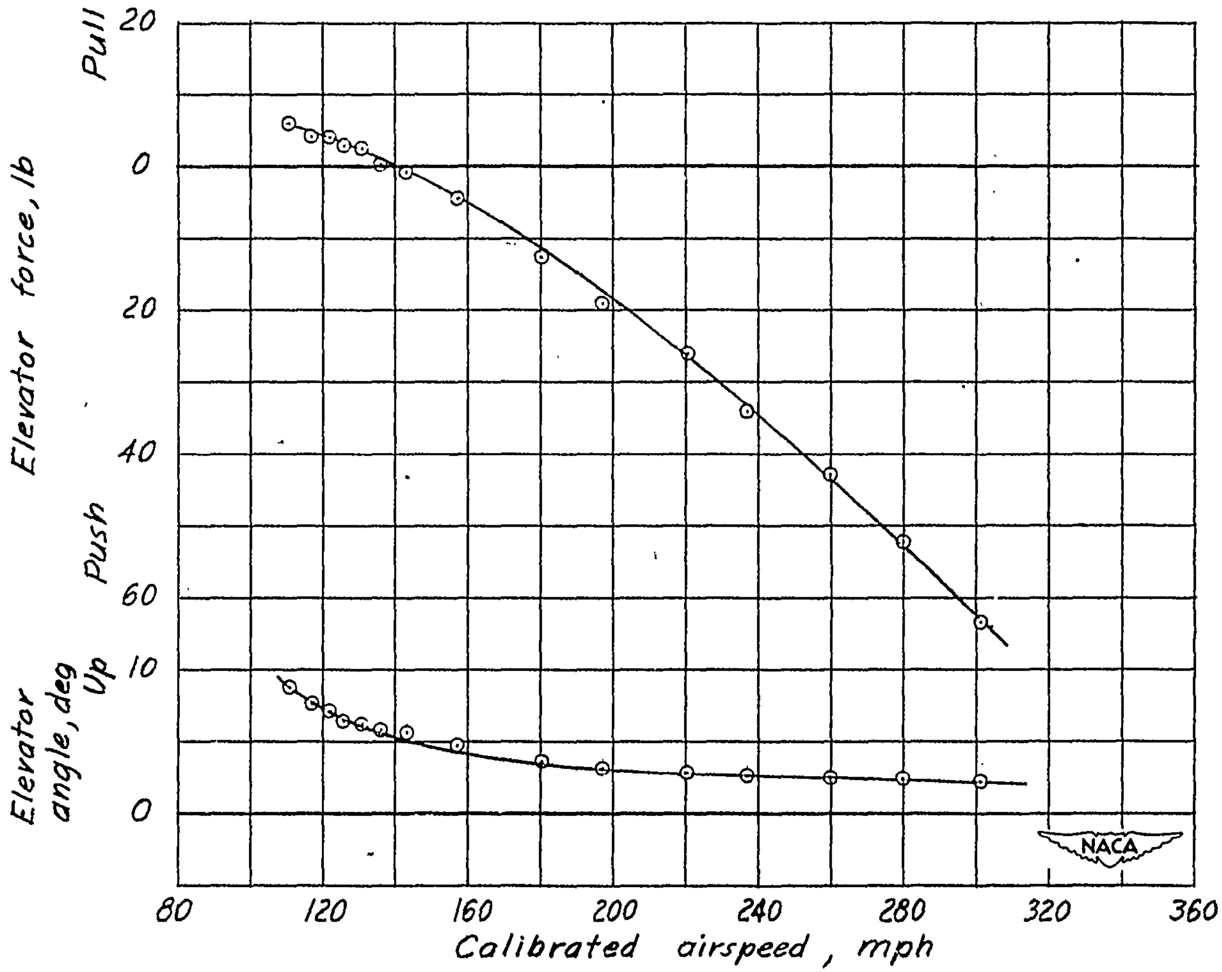
(b) Center of gravity at 22.1 percent mean aerodynamic chord and elevator trimming tabs set at 2° nose down.

Figure 5.- Concluded.



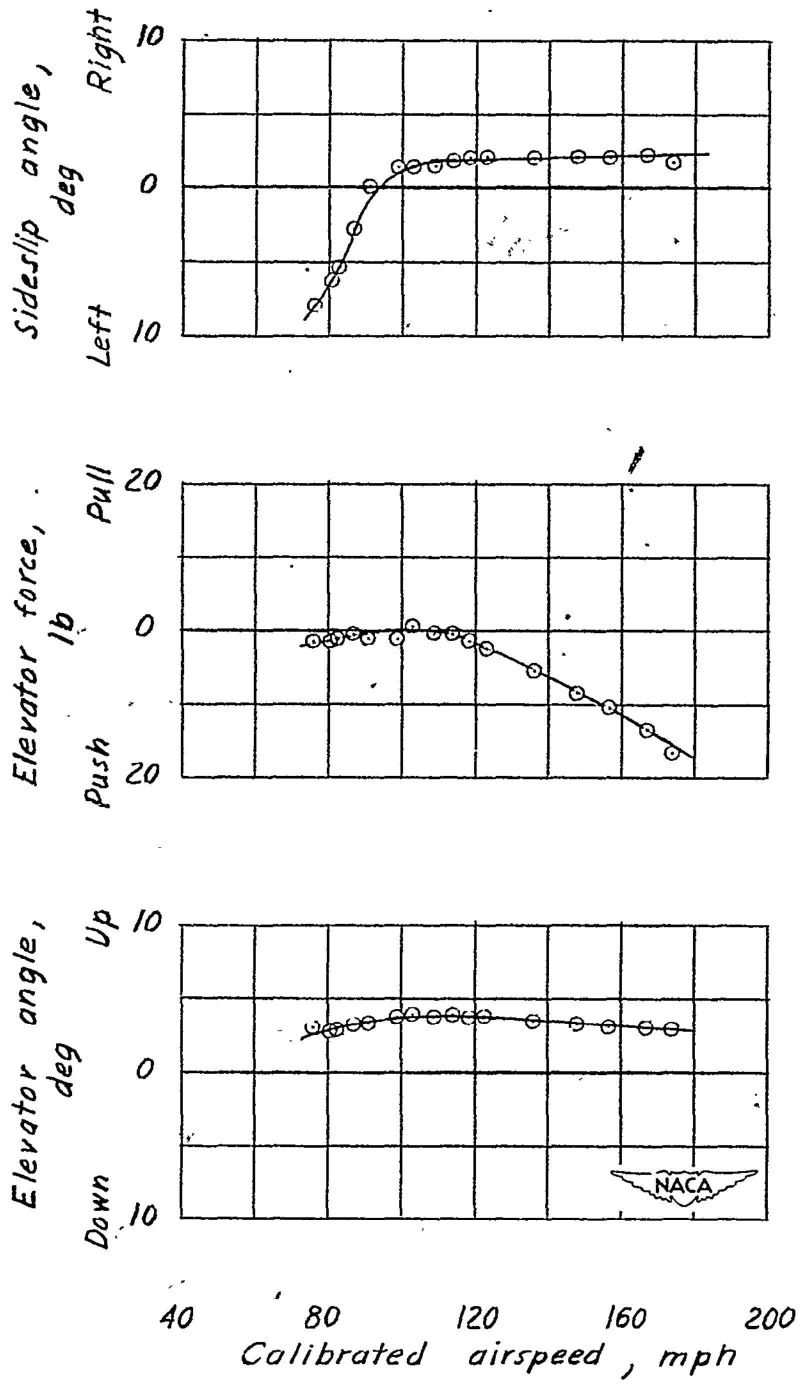
(a) Center of gravity at 25.7 percent mean aerodynamic chord and elevator trimming tabs set at 4.5° nose up.

Figure 6.- Static longitudinal stability characteristics of the Grumman F8F-1 airplane in the gliding condition. Flaps up; landing gear up; engine idling.



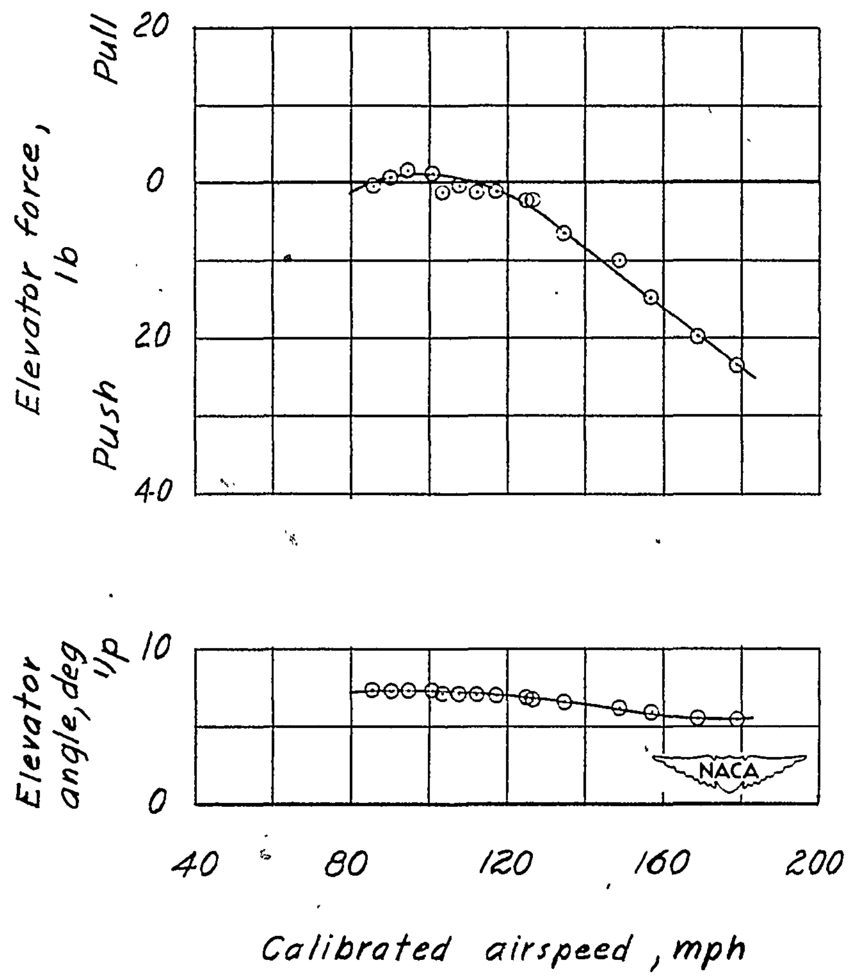
(b) Center of gravity at 22.2 percent mean aerodynamic chord and elevator trimming tabs set at 9° nose up.

Figure 6.- Concluded.



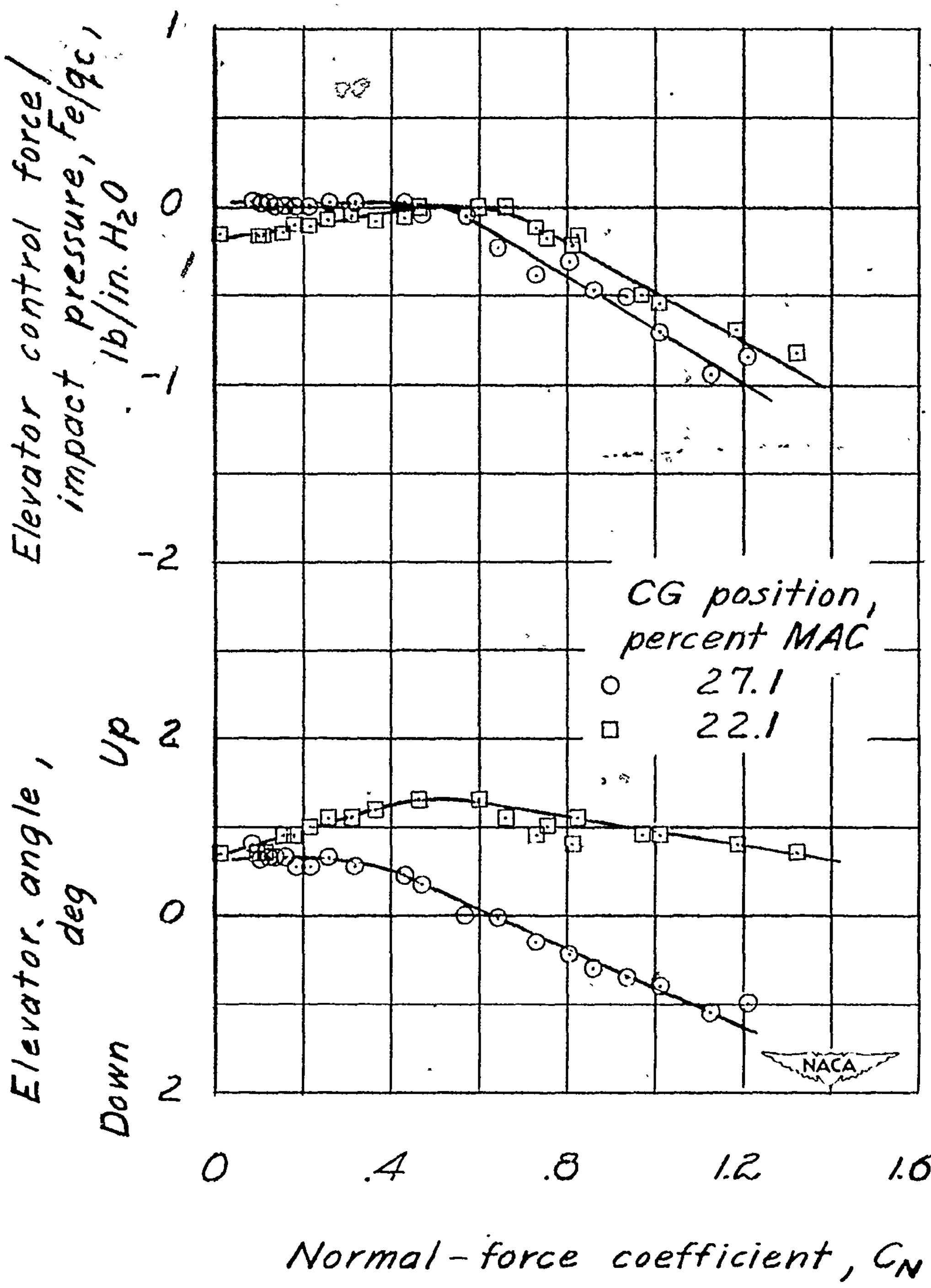
(a) Center of gravity at 24.8 percent mean aerodynamic chord and elevator trimming tabs set at 11.2° nose up.

Figure 7.- Static longitudinal stability characteristics of the Grumman F8F-1 airplane in the power-approach condition. Flaps down; landing gear down; 20 in. of Hg at 2300 rpm.



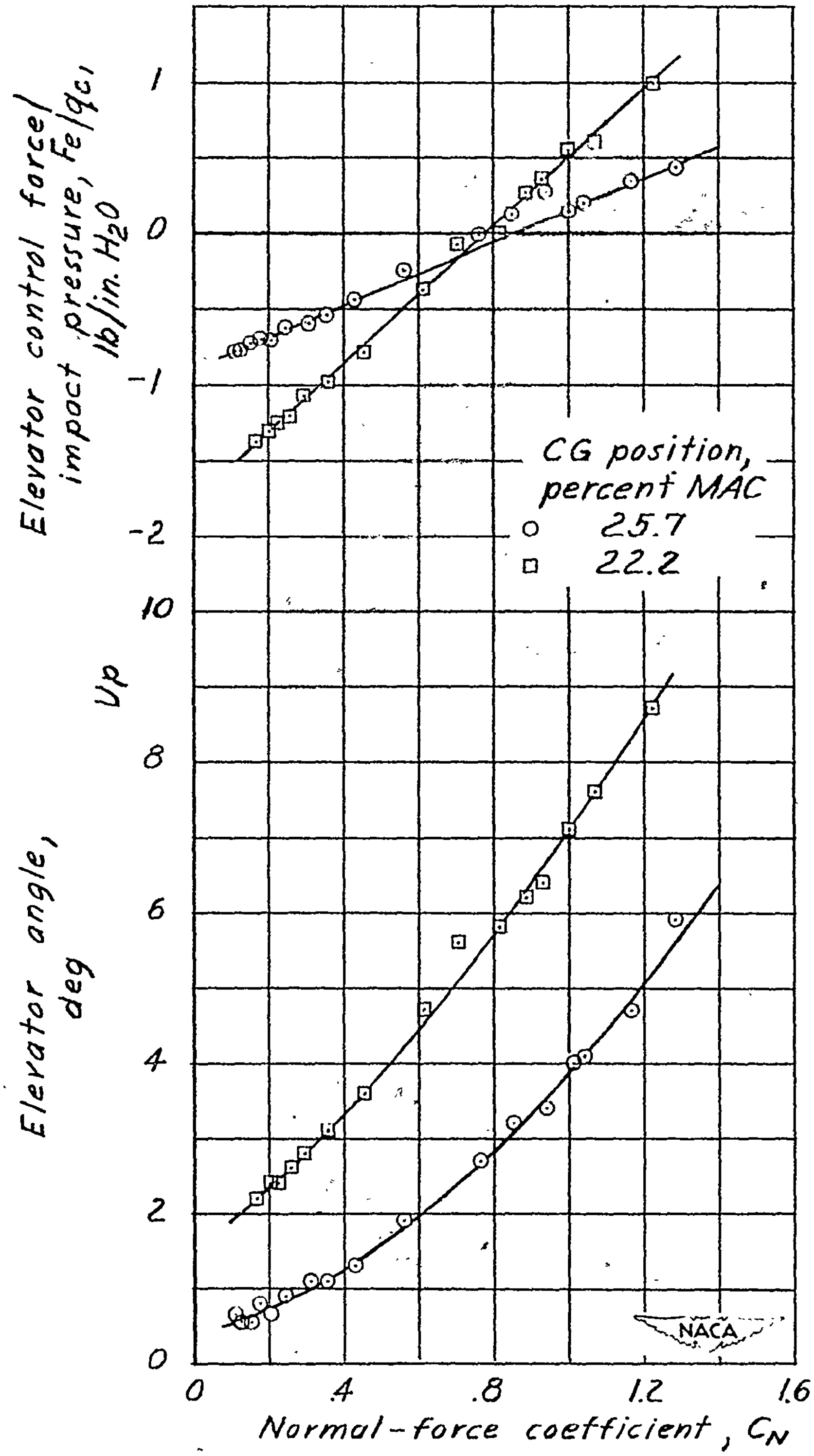
(b) Center of gravity at 21.2 mean aerodynamic chord and elevator trimming tabs set at full nose up (not trim).

Figure 7.- Concluded.



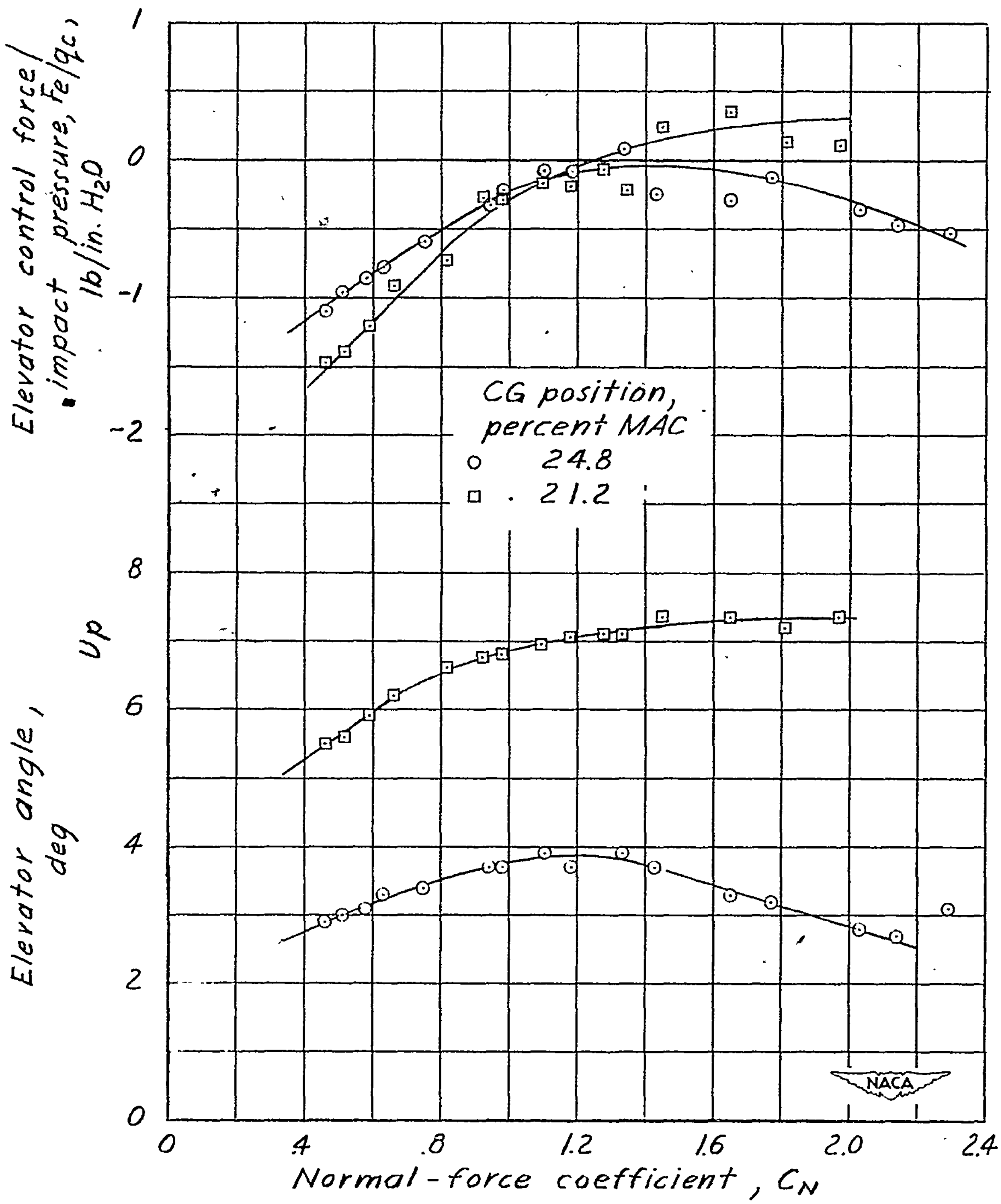
(a) Rated-power clean condition.

Figure 8.- Variation of elevator angle and elevator control force divided by impact pressure against normal-force coefficient. Grumman F8F-1 airplane.



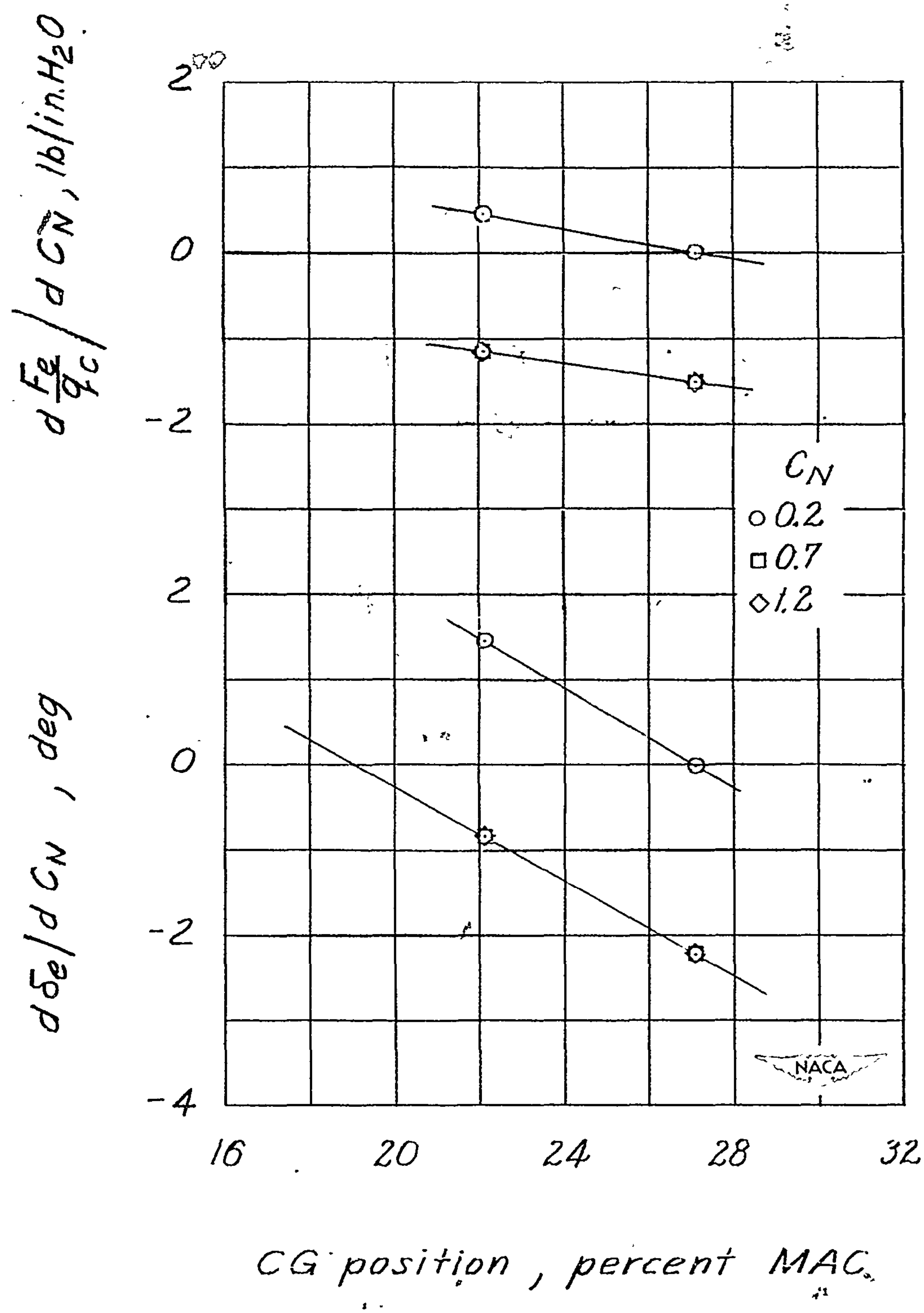
(b) Gliding condition.

Figure 8.- Continued.



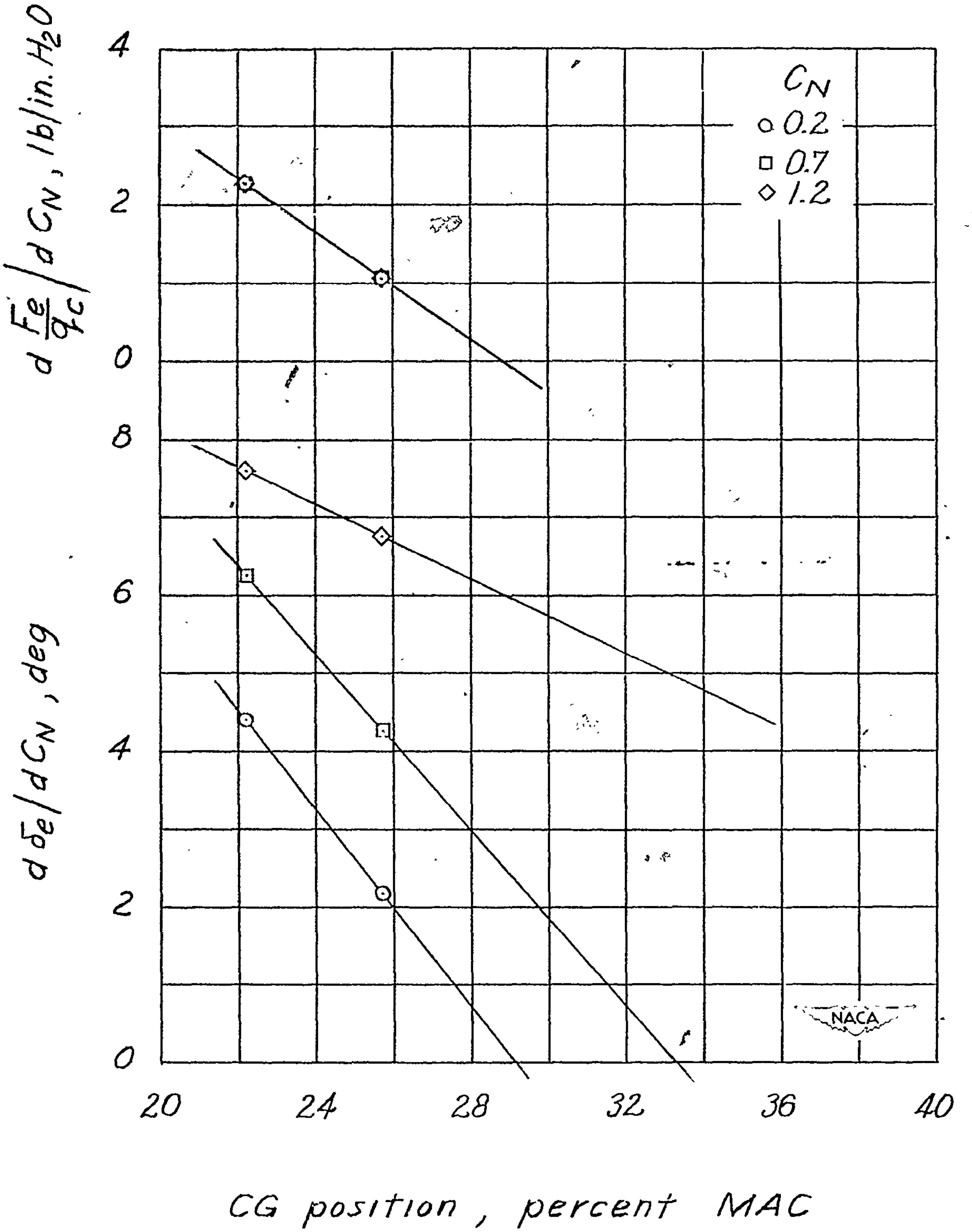
(c) Power approach condition.

Figure 8.- Concluded.



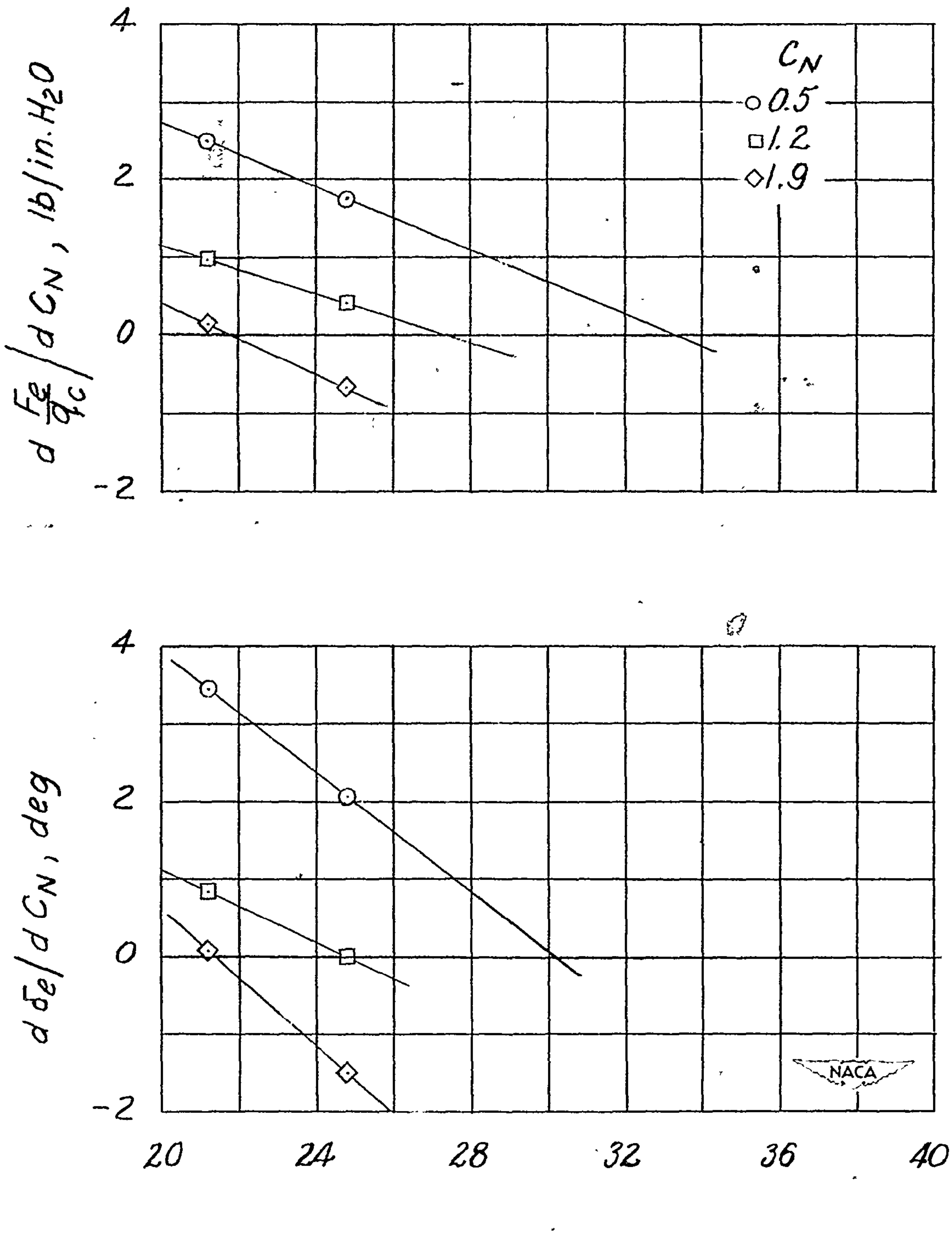
(a) Rated-power clean condition.

Figure 9.- Determination of stick-fixed and stick-free neutral points, Grumman F8F-1 airplane.



(b) Gliding condition.

Figure 9.- Continued.



(c) Power-approach condition.

Figure 9.- Concluded.

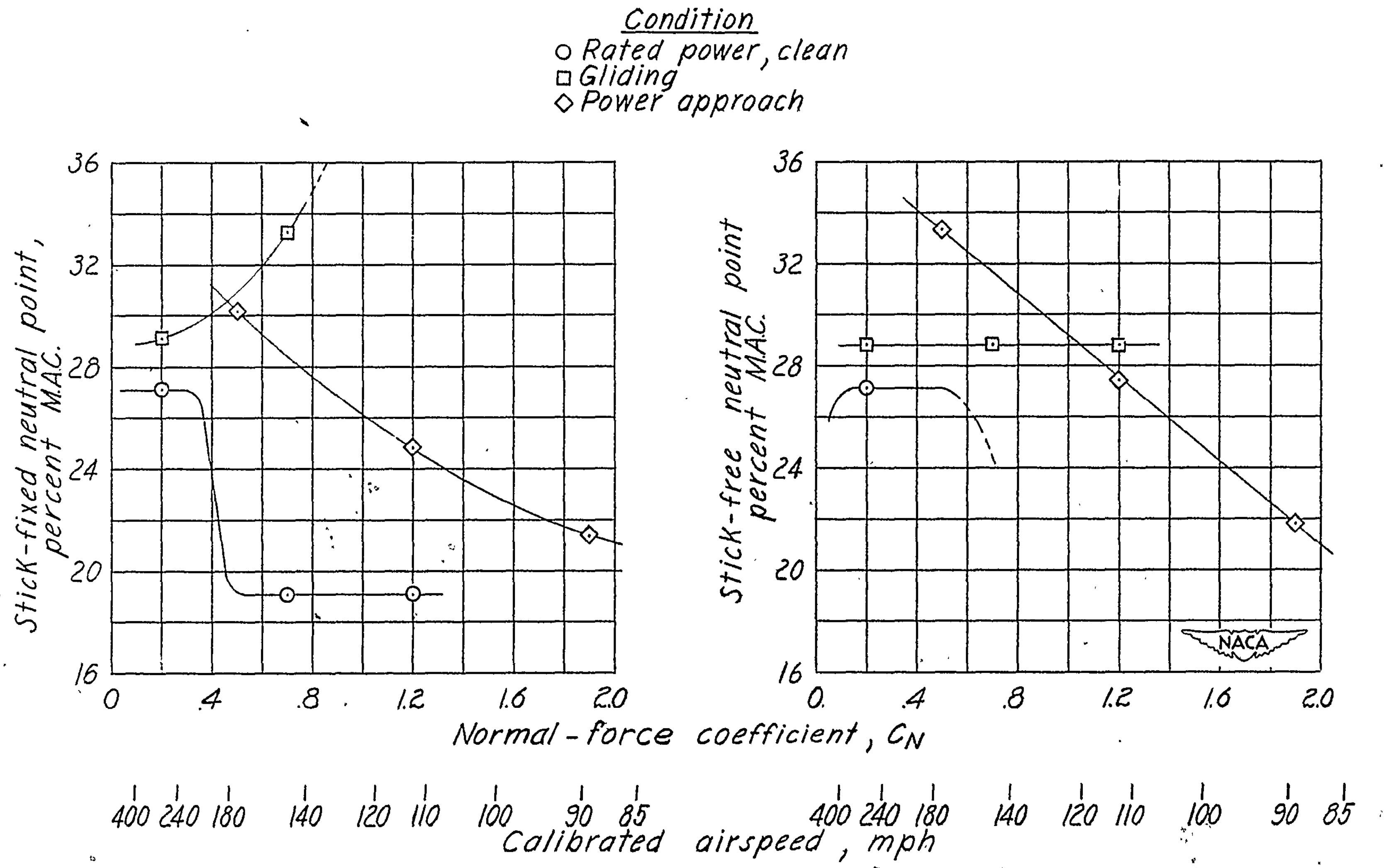
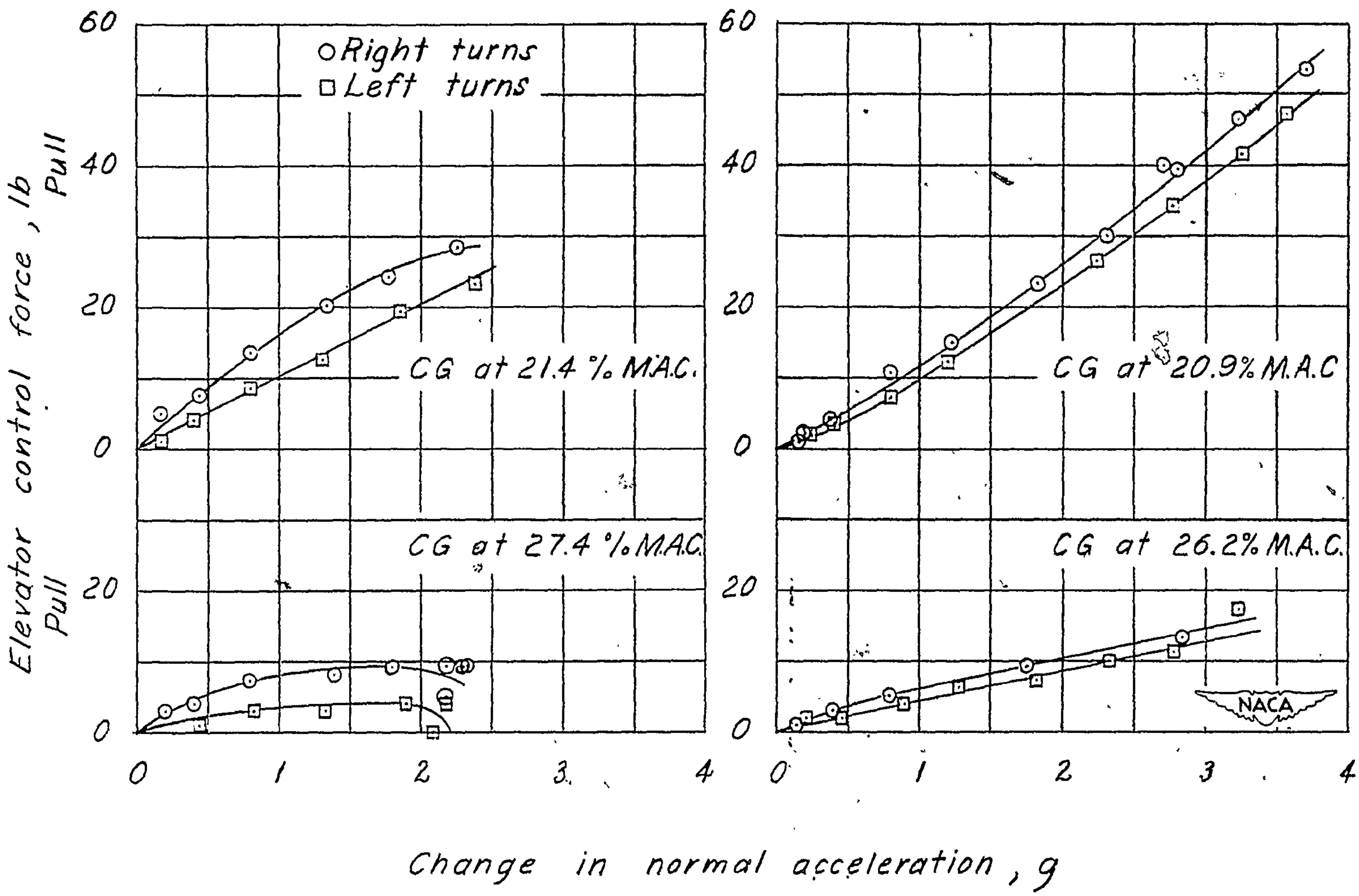


Figure 10.- Summary plots of the variation of the neutral points with normal-force coefficient, Grumman F8F-1 airplane..



(a) 200 mph. (b) 350 mph.

Figure 11.- Variation of elevator control force with change in normal acceleration for constant airspeed turns in the rated-power clean condition, Grumman F8F-1 airplane.

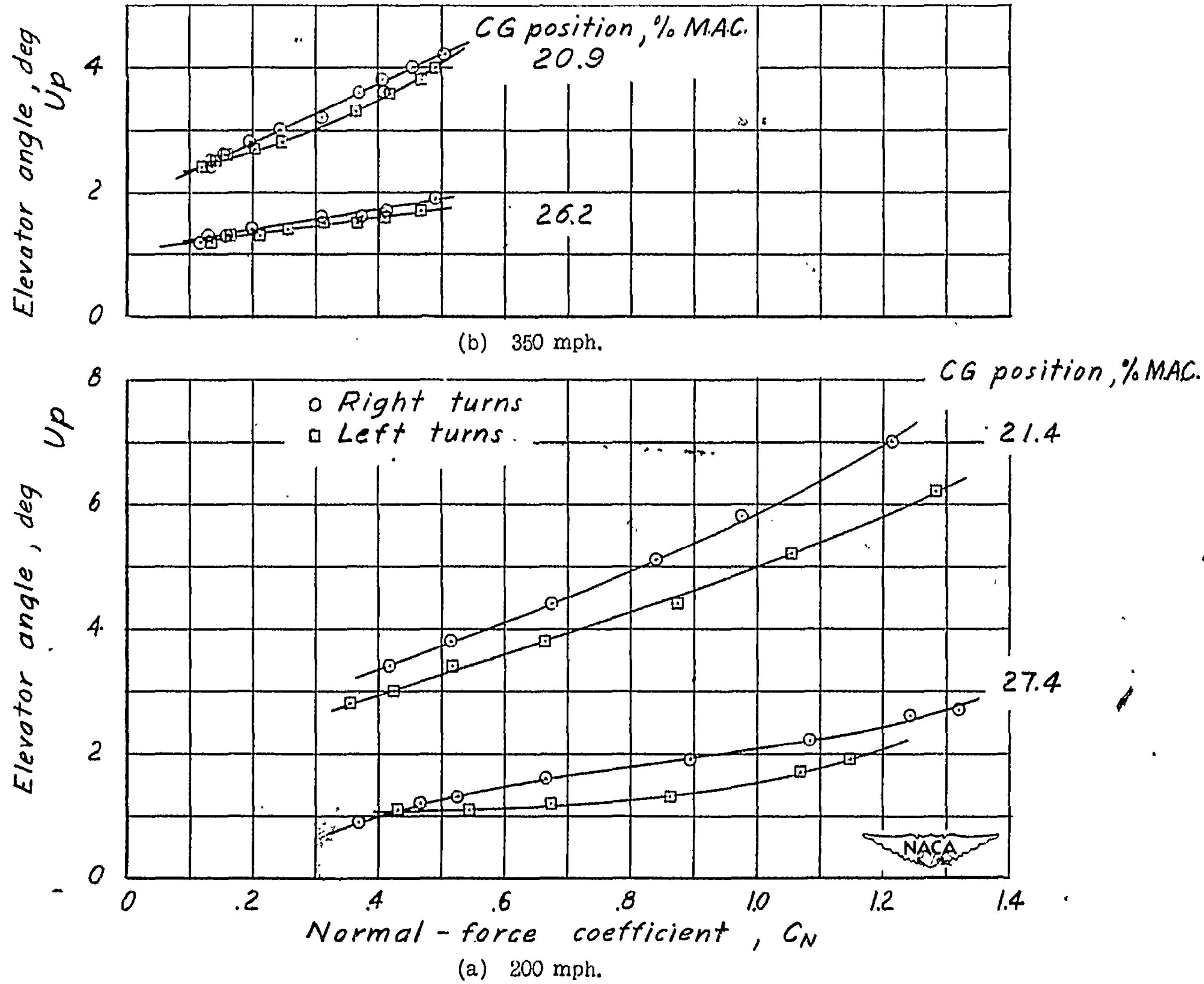


Figure 12.- Variation of elevator angle with normal-force coefficient for constant airspeed turns in the rated-power clean condition, Grumman F8F-1 airplane.

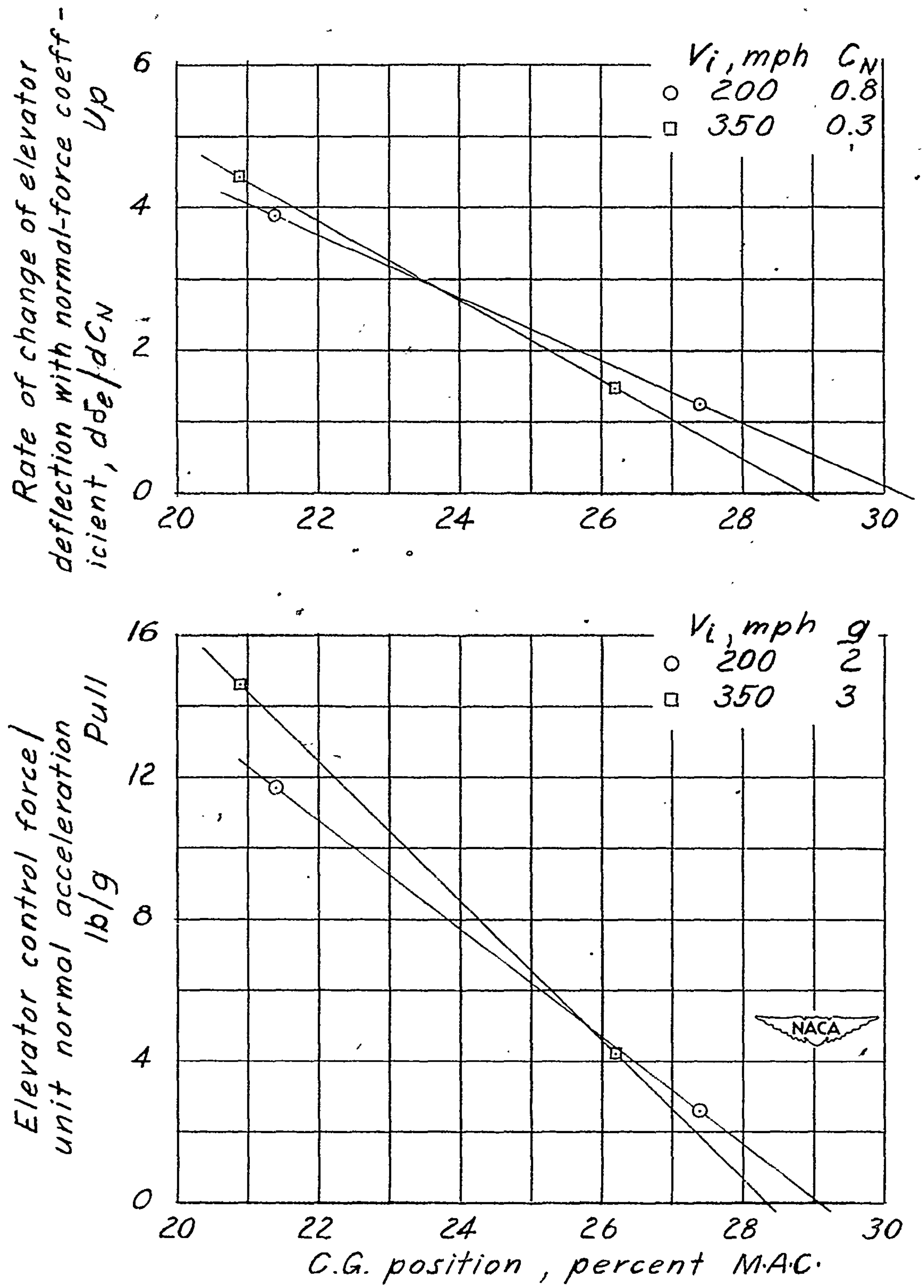


Figure 13.- Determination of maneuver points for the rated-power clean condition, Grumman F8F-1 airplane.

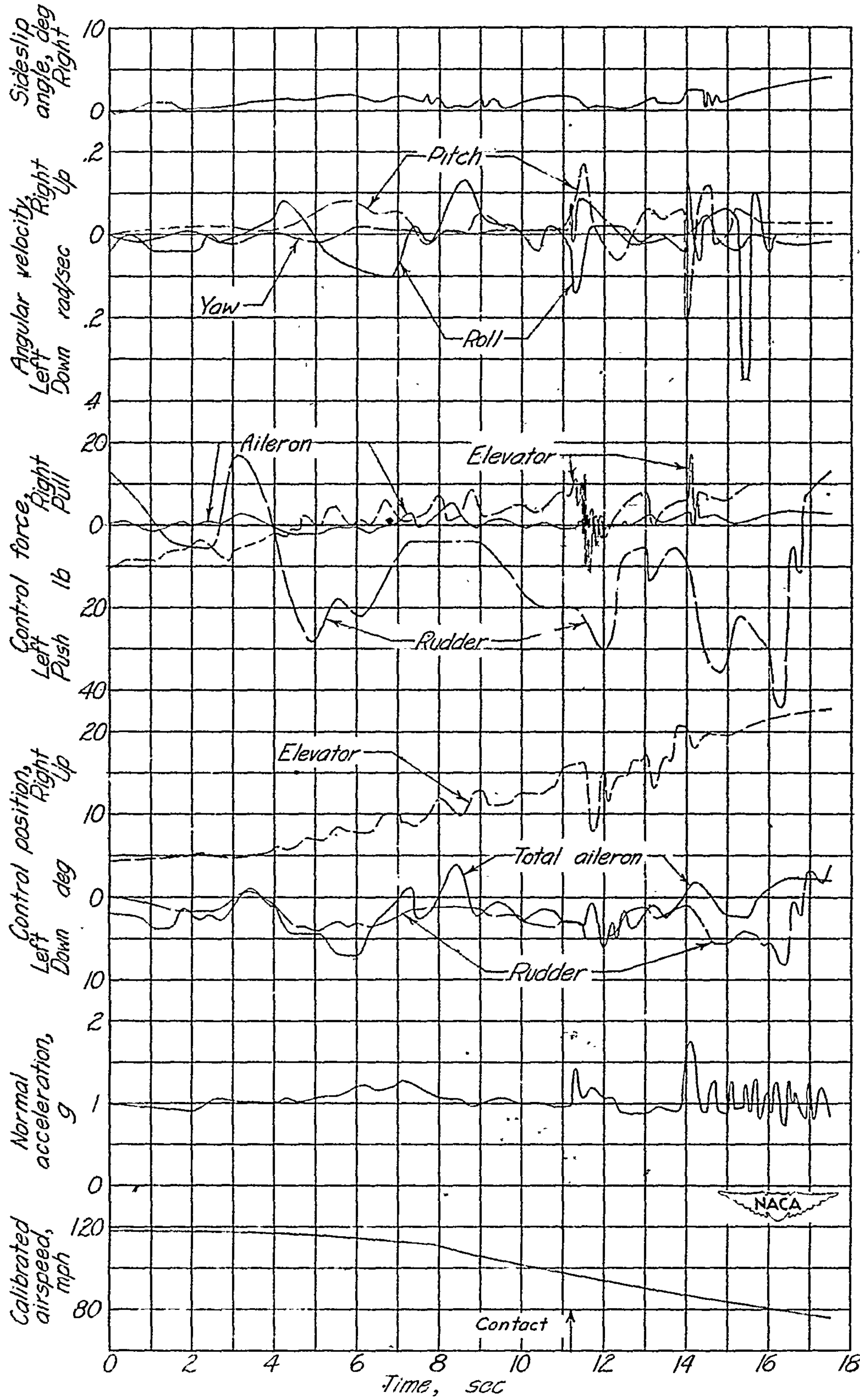


Figure 14.- Time history of a landing in the Grumman F8F-1 airplane.

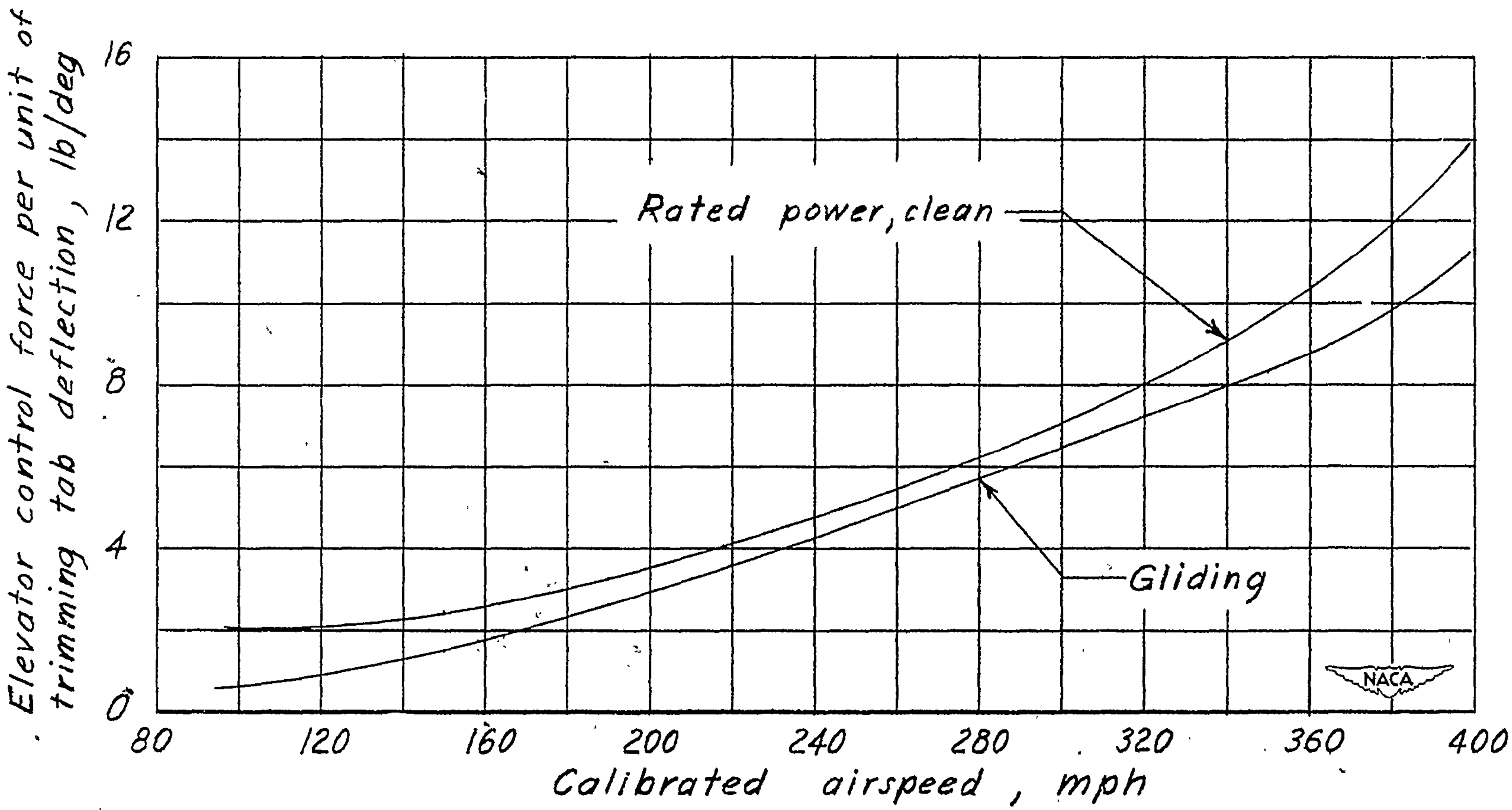
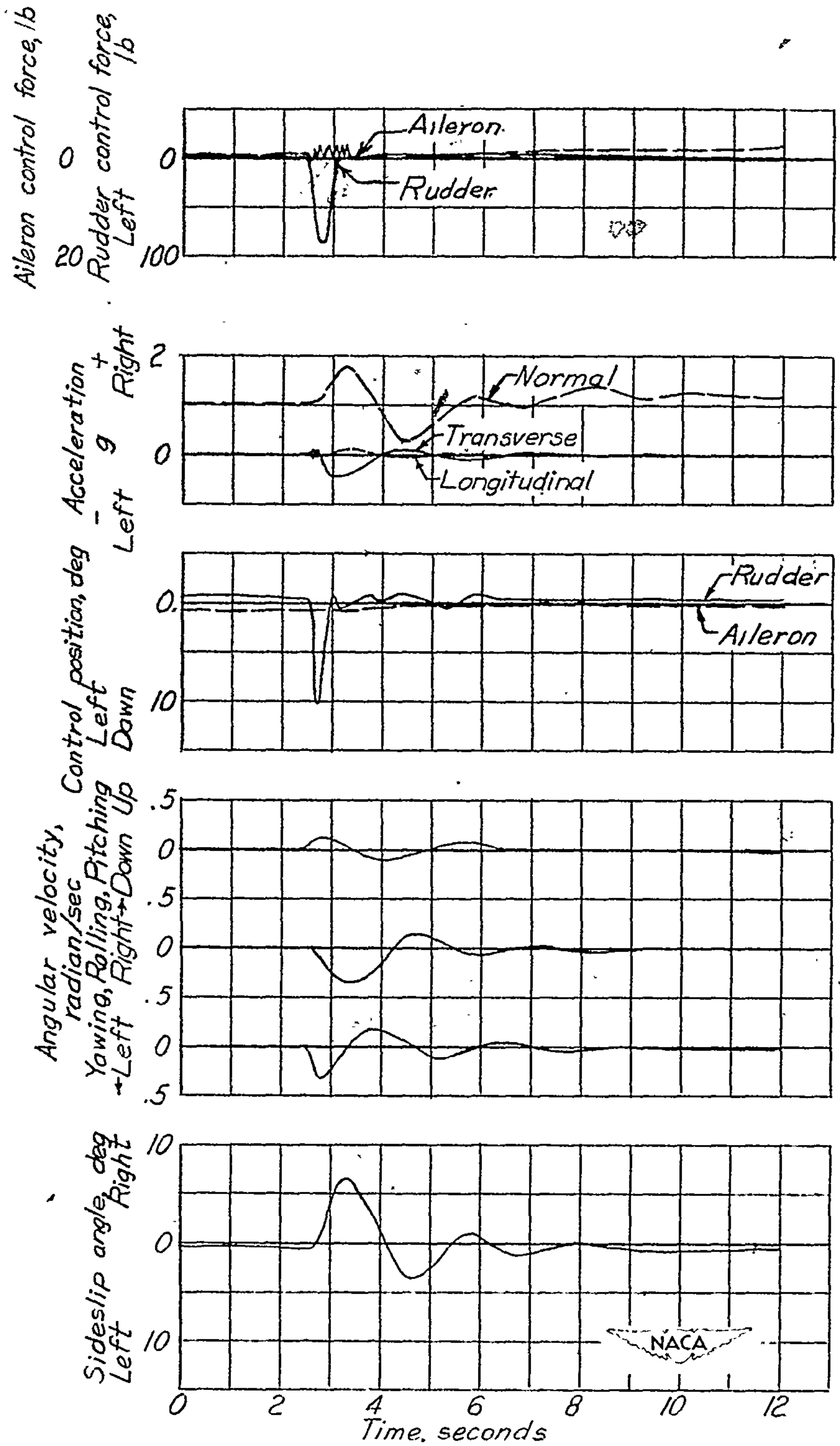


Figure 15.- Approximate power of the elevator trimming tabs, Grumman F8F-1.



(a) Left rudder kick and release.

Figure 16.- Typical time histories of oscillations of the Grumman F8F-1 airplane in the clean condition with power for level flight (28-1/2 in. of Hg at 2500 rpm) at 290 miles per hour at an altitude of 5000 feet.

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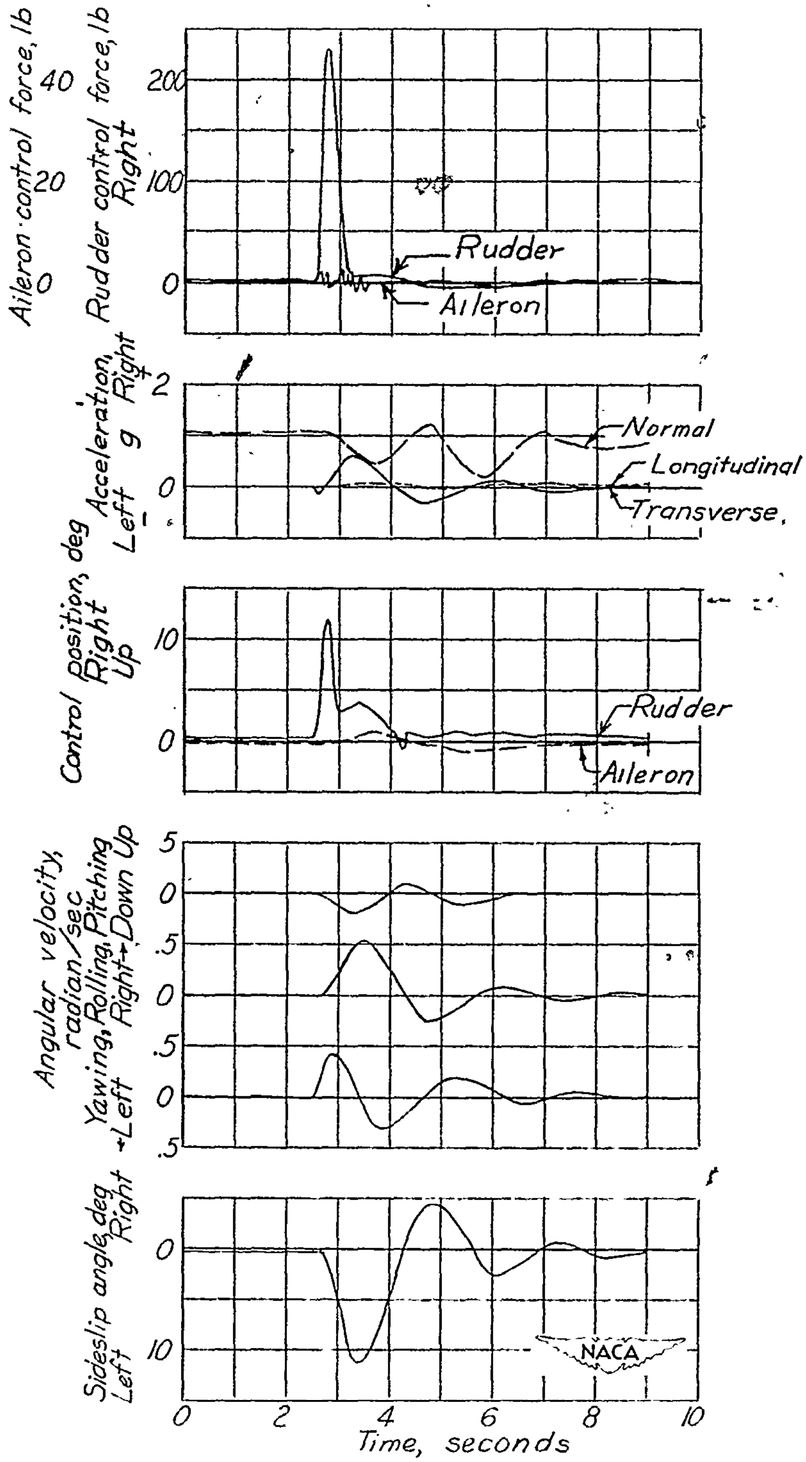


(b) Right rudder kick and release.

Figure 16.- Concluded.

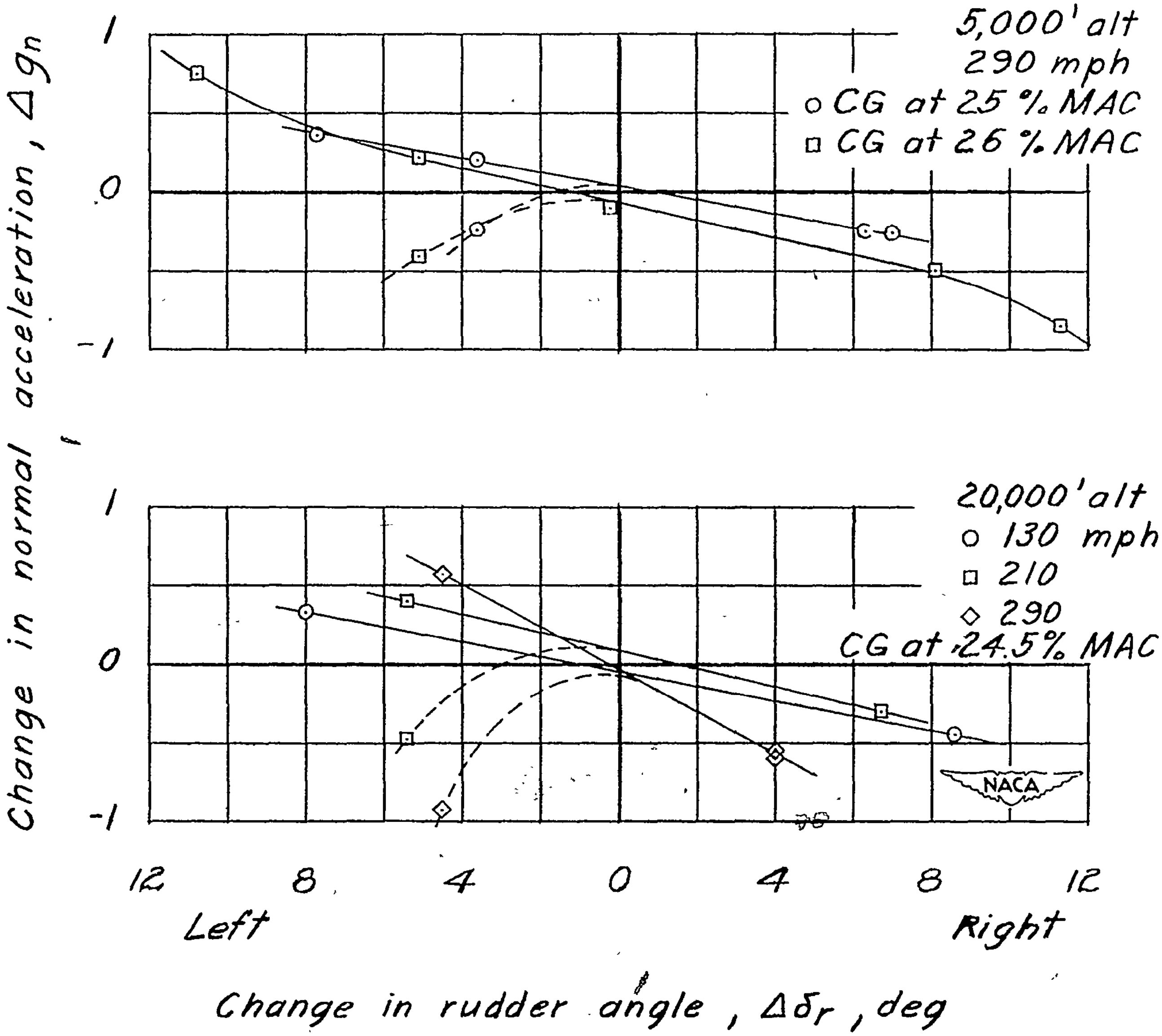
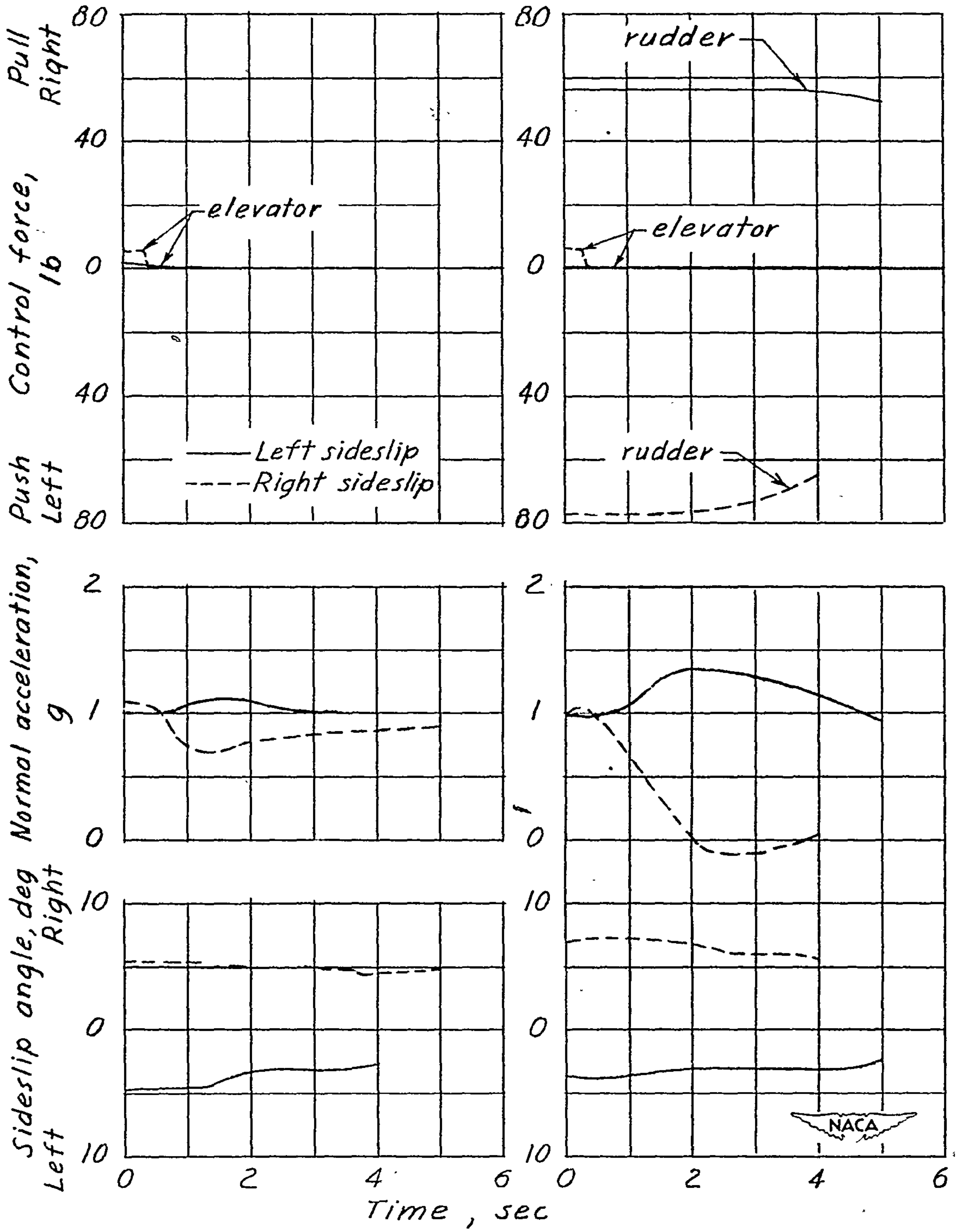


Figure 17.- Summary plot of the change in normal acceleration against change in rudder angle obtained in rudder kicks. Grumman F8F-1 airplane.



(a) CG at 19.8 percent M.A.C. (b) CG at 26.2 percent M.A.C.

Figure 18.- Typical time histories of releases from steady sideslips with the rudder fixed and the stick released. Grumman F8F-1 airplane.

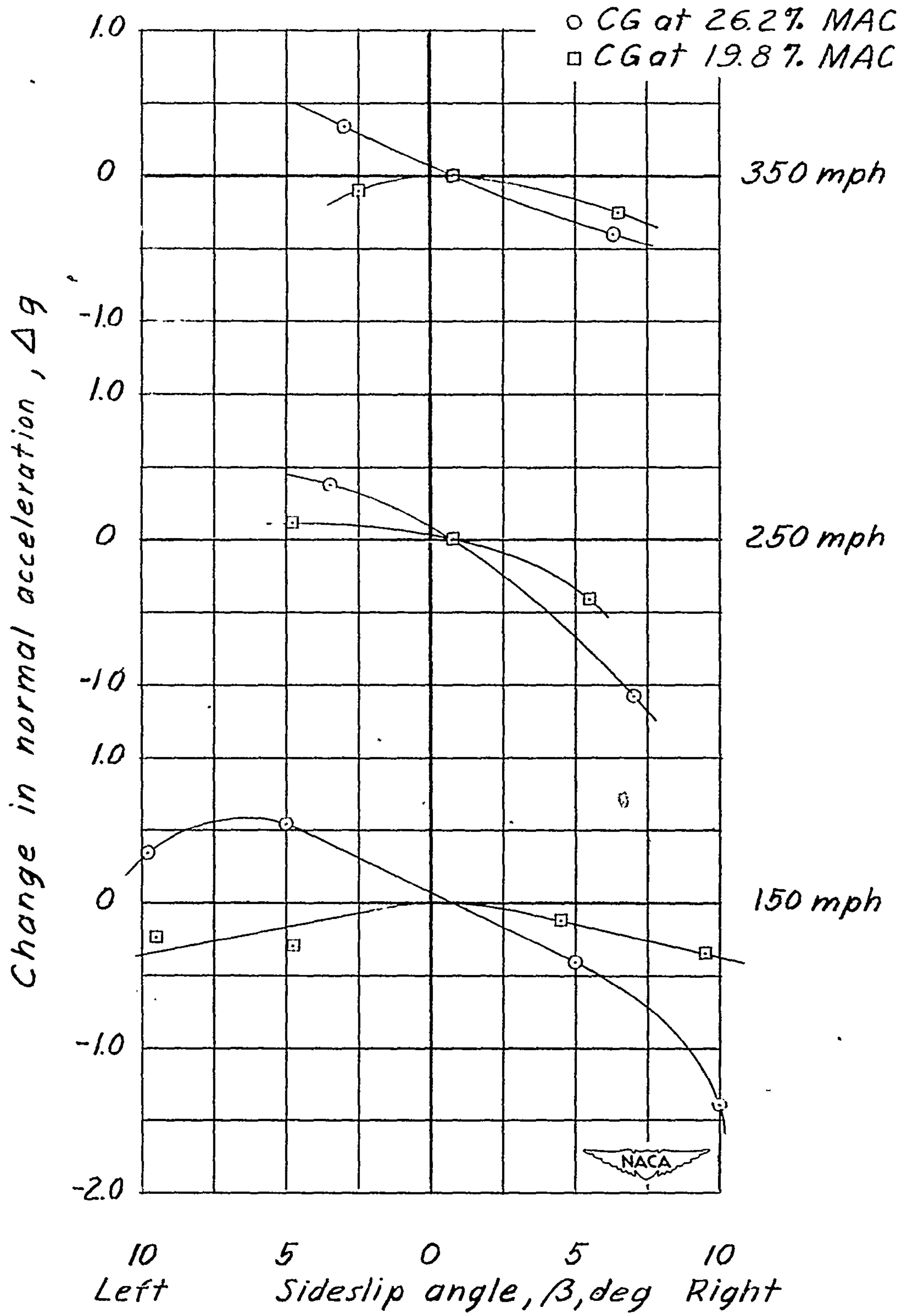
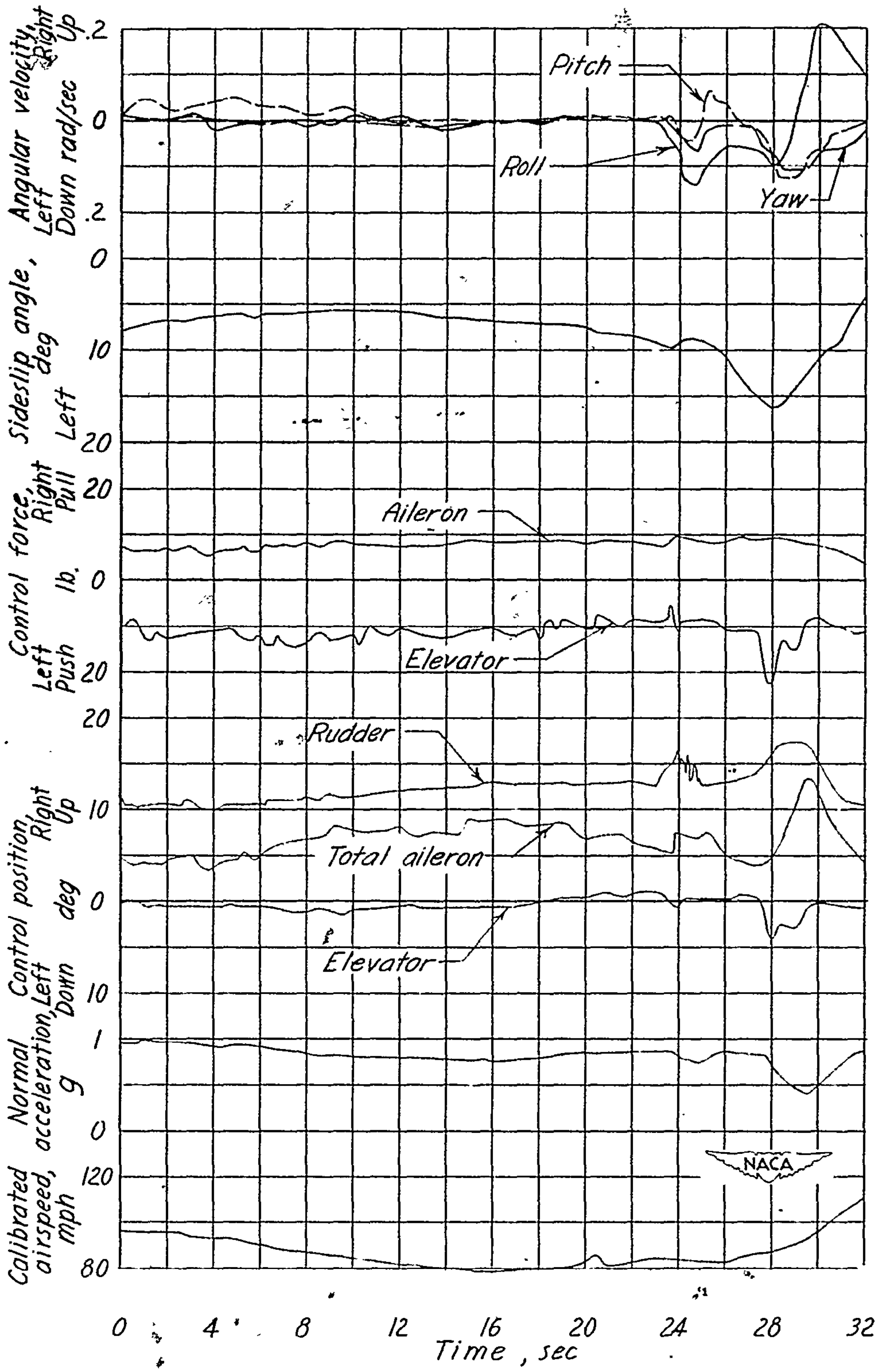
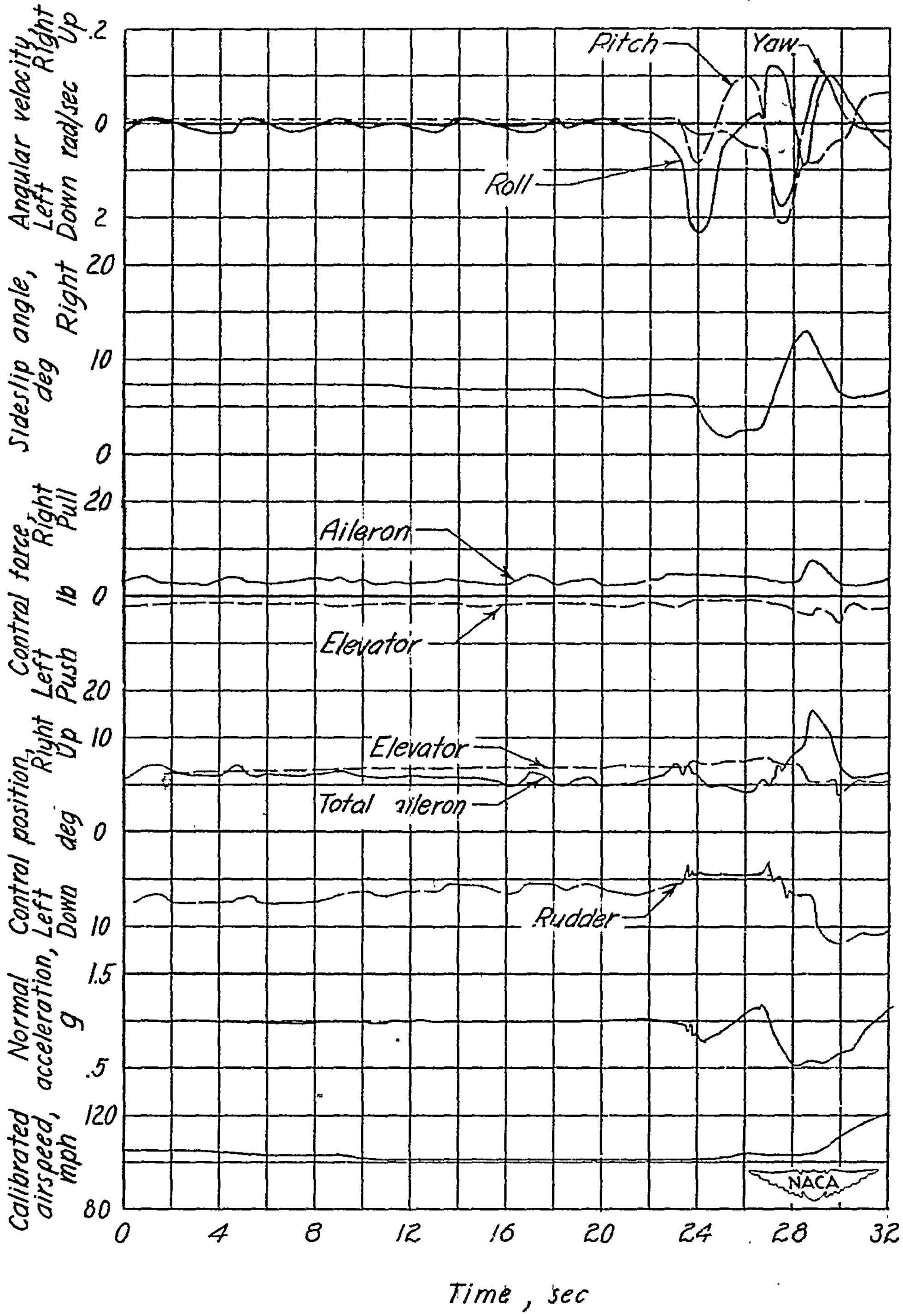


Figure 19.- Summary plot of the change in normal acceleration against sideslip angle obtained in releases from steady sideslips. Grumman F8F-1.



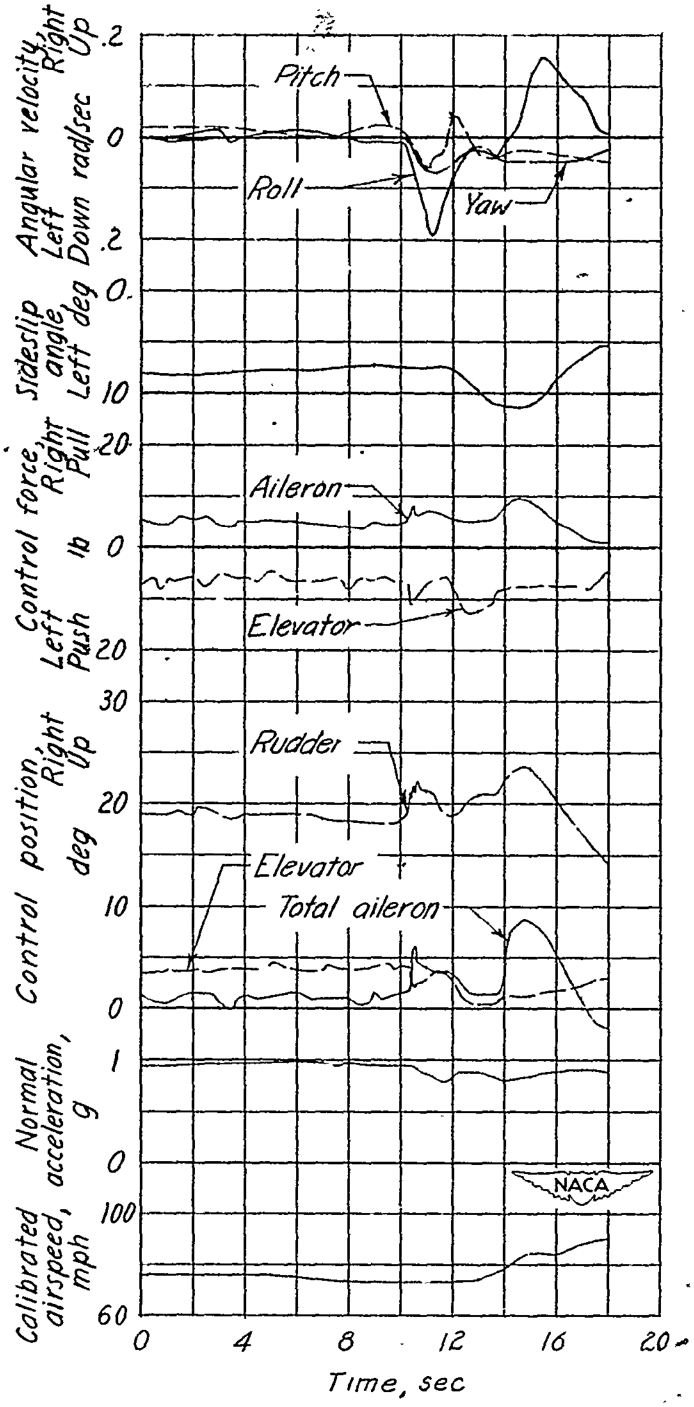
(a) Rated-power clean condition with the center of gravity at 27.1 percent mean aerodynamic chord.

Figure 20.- Time history of stalls in the Grumman F8F-1 airplane.



(b) Gliding condition with the center of gravity at 25.7 percent mean aerodynamic chord.

Figure 20. Continued.



(c) Power-approach condition with the center of gravity at 24.8 percent mean aerodynamic chord.

Figure 20.- Concluded.

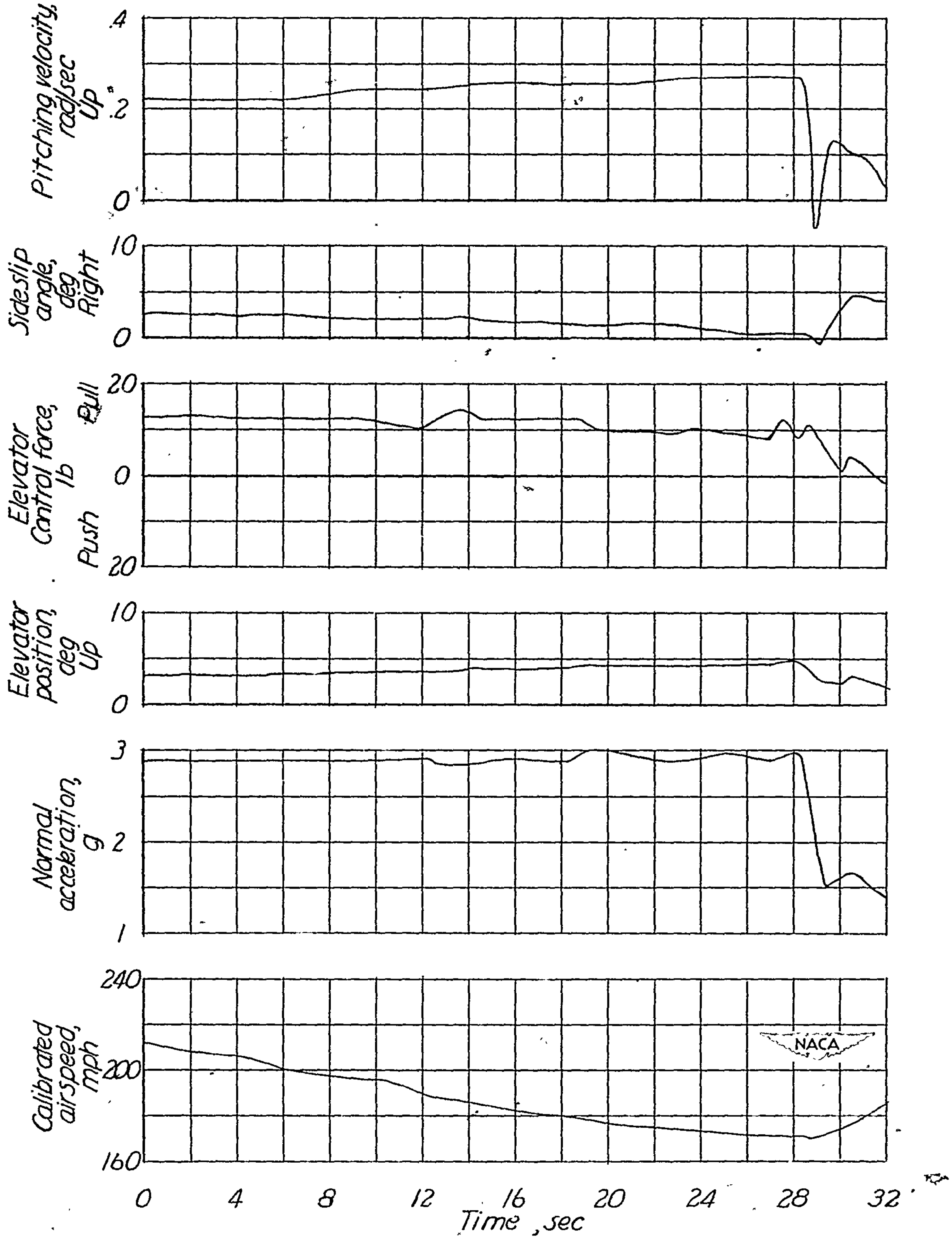


Figure 21.- Time history of a 3g windup turn from 212 miles per hour to the stall in the rated-power clean condition with the center of gravity at 25 percent mean aerodynamic chord. Grumman F8F-1 airplane.