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MEASUREMENT OF FLYING QUALITIES OF A DOUGLAS A-26B AIRPLANE

(AAF No. 41-39120)

II - LATERAL AND DIRECTIONAL STABILITY

AND CONTROL CHARACTERISTICS

By S. A. Sjoberg, H. L. Crane, and H. H. Hoover

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Langley Field, Va.

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MEMORANDUM REPORT

for the

Army Air Forces, Air Technical Service Command

MEASUREMENT OF FLYING QUALITIES OF A DOUGLAS A-26B AIRPLANE

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INTRODUCTION

At the request of the Army Air Forces, Air Technical Service Command, flight tests have been made to determine the flying qualities of a Douglas A-26B airplane. The results of the tests of longitudinal stability and control have been reported in Part I (reference 1). This portion of the report presents the results of the tests of lateral and directional stability and control. Part III will deal with the stalling characteristics and maximum normal-force coefficient.

DESCRIPTION

Figure 1 shows a three-view drawing of the airplane and sections of the wing and tail surfaces. A description of the airplane and several photographs of the airplane have been presented in reference 1. The control surfaces were fabric covered. The ailerons were internally sealed. Rudder and elevator were equipped with rubberized canvas seals. Both stabilizer and fin were set parallel to the thrust axis.

The linkage ratios between the ailerons and the control wheel and the rudder and rudder pedals are presented in figures 2 and 3. Figure 4 shows the variation of the aileron balance tab angle with aileron angle. The stretch of the aileron system was 1° of total aileron angle per 11 pounds of wheel force. The stretch of the rudder system between the rudder pedals and the rudder horn was approximately 1° per 60 pounds of pedal force.

INSTRUMENTATION

The instrumentation of the airplane for flying-qualities tests has been described in reference 1. Aileron angles presented in the roll data were measured at the ailerons. In all other cases the aileron angles were measured in the cockpit and were subject to error due to the stretch of the system. Rudder and elevator angles were measured at the surfaces in all cases.

To measure control forces the service wheel was replaced with one on which strain gages were mounted. Aileron control forces presented in this report are based on a wheel diameter of 14 inches to the center of the grips while the standard wheel for the A-26B is 13 inches in diameter at the center of the grips. The aileron forces for a service wheel may be obtained by multiplying the forces presented in this report by $\frac{14}{13}$.

Correct service indicated airspeed as used herein 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 by means of a trailing airspeed bomb. Total pressure was measured with a shielded total-head tube. With this system no error is introduced due to changes in angle of attack or sideslip. A sensitive airspeed indicator connected to the swiveling static head and the shielded total head was used by the pilot in making the test flights so that constant airspeeds could be maintained in yawed flight.

B. Lateral and Directional Stability and Control

1-B. Dynamic lateral and directional stability

The control-free lateral oscillation was investigated in the clean condition using power for level flight at the speed for maximum L/D, approximately 183 miles per hour. In these tests the controls were released while the airplane was in a steady sideslip. Figure 5 presents time histories of the resulting oscillations. The oscillations damped to less than one-half amplitude in one cycle. The requirements of reference 2 were therefore met. Because of the friction present in the rudder and aileron control systems the rudder and aileron did not return to their trim positions. The airplane remained in a shallow left or right turn after the oscillation had damped out. No short-period oscillation of the ailerons occurred in these maneuvers.

No tests were made with the bomb-bay doors open after the instruments had been installed because the recorders were located in the bomb bay.

2-B. Static lateral and directional stability

1. Sideslip due to aileron deflection - rudder to overcome adverse aileron yaw

The yawing moment due to aileron deflection with rudder fixed and the rudder required to overcome adverse aileron yaw were measured in rolls into turns and rolls out of turns to determine which method was the more satisfactory. Time histories of rolls out of turns are presented in figures 6 and 7, of rolls into turns in figures 8 and 9. A discussion of the two types of maneuvers follows.

Figures 6 and 7 are time histories of full deflection aileron rolls out of 30° left banked turns using various amounts of rudder deflection. These maneuvers were made with the flaps and landing gear down, engines idling at 118 miles per hour, and with the flaps and landing gear up, using power for level flight at 145 miles per hour. The maximum angle of sideslip attained in either condition with the rudder fixed is approximately 11° which is well below the allowable limit of 20° given in reference 2.

In rudder fixed, full aileron rolls made from straight flight at low speeds it was usually not possible for the pilot to continue the roll until the maximum angle of sideslip was reached because of the excessively banked attitude reached by the airplane. However, one roll at 120 miles per hour in the landing condition was continued until maximum sideslip angle, 10°, was reached.

In figures 6 and 7 where the aileron and rudder are fully deflected against the control stops, the aileron and rudder forces given include the forces being exerted against the control stop as well as the aerodynamic forces. Analysis of the data indicates that in both the landing condition at 118 miles per hour and in the clean, rated power condition at 145 miles per hour, a rudder force increment of less than 180 pounds and a rudder angle of approximately 17° will be required to overcome the yaw due to abrupt full aileron deflection.

The rudder deflection required to overcome yaw due to ailerons was also measured in rolls into left and right turns using partial aileron and enough rudder to overcome the adverse aileron yaw. Figures 8 and 9 are time histories of these maneuvers made at 115 miles per hour in the wave-off condition and at 138 miles per hour in the clean condition using power for level flight. Rolls into turns at low speed using full aileron deflection and coordinated rudder movement were not made because of the possibility of entering a snap roll. Analysis of these data indicates that approximately 19° of rudder deflection would be required to maintain zero sideslip in a full deflection aileron roll in both the wave-off condition at 115 miles per hour and in the clean, power-for-level-flight condition at 138 miles per hour. A comparison of the rudder deflections required to maintain zero sideslip after abrupt full aileron deflection as measured in rolls into turns and rolls out of turns shows good agreement; a rudder deflection of 19° was required in rolls into turns and 17° in rolls out of turns.

Of the two flight maneuvers used in measuring yaw due to ailerons and rudder required to overcome adverse aileron yaw, rolling out of a turn proved to be much more satisfactory than rolling into a turn. Rolling out of a turn using full aileron deflection simulates a flight maneuver in which the pilot is required to raise a wing after hitting a gust. This maneuver is more likely to be used than a full aileron roll into a turn at the low speeds under consideration. Rolling out of a turn also has the advantages previously mentioned of attaining maximum sideslip angle without reaching an excessively banked attitude at low speed and of minimizing the possibility of stalling in an awkward position.

2. Sideslip characteristics

The sideslip characteristics were investigated in gradually increasing sideslips made by slowly deflecting the rudder while using the ailerons and elevator to maintain straight flight. The data from these sideslips which gave measurements of the directional stability (variation of rudder angle and force with sideslip angle), dihedral effect (variation of aileron angle and force with sideslip angle), pitching moment due to sideslip (variation of elevator angle and force with sideslip angle), and the side-force characteristics (variation of angle of bank with angle of sideslip) are shown in figures 10 through 14. From the continuous records data were plotted at 2-second intervals for the rated power-clean, gliding, and landing conditions, and at 3-second intervals for the wave-off and approach conditions. The test conditions and speeds were as follows:

Condition	Power setting at 6000 to 10,000 ft	Position of: Flaps	Landing gear	Cowl flaps	Oil cooler	Speed (mph)	Figure
Clean, rated power	41.5 in. Hg 2400 rpm	Up	Up	$\frac{1}{2}$ open	$\frac{1}{2}$ open	141	10(a)
						195	(b)
						252	(c)
						320	(d)
Gliding	Engines idling	Up	Up	Closed	--do--	133	11(a)
						189	(b)
						254	(c)
Landing	Engines idling	Down	Down	Closed	--do--	112	12(a)
						150	(b)
Wave-off	41.5 in. Hg 2400 rpm	Down	Down	Open	--do--	111	13(a)
						153	(b)
Approach	30 in. Hg 2000 rpm	Down	Down	Closed	--do--	111	14

(a) Directional stability.- The control-fixed directional stability was always positive, thus satisfying the requirement of reference 2. The curves of rudder position against sideslip angle were nearly linear for all test conditions.

The rudder-free directional stability was always positive at speeds specified by reference 2. However, the pilot reported the occurrence of rudder-force reversal in a sideslip in the wave-off condition at approximately 100 miles per hour at large angles of sideslip.

(b) Dihedral effect.- The dihedral effect (variation of aileron angle and force with angle of sideslip) is shown in figures 8 through 14.

Since the sideslip data were not obtained in steady sideslips, some aileron deflection was used to produce the very gradual roll and to overcome the rolling moment due to yawing. Aileron deflections in the sideslips at 111 and 112 miles per hour were corrected for these effects. The corrections to the aileron angles were negligible in the sideslips made at higher speeds. The offset present in some of the aileron force curves near zero sideslip is believed to be due to the friction in the aileron system, approximately ±4 pounds.

The dihedral effect was positive, stick fixed and stick free, in all flaps-up conditions. At low speeds with the flaps down the stick-fixed dihedral effect was positive in all cases, but the stick-free dihedral effect became marginal at large angles of sideslip.

At approximately 250 miles per hour in both the gliding and rated power-clean conditions the effective dihedral calculated from sideslip data was approximately 6°. The geometric dihedral of the wing under no load was 4.5°. Since the nacelles are below the wing, an increase of effective dihedral due to wing-nacelle interference would be expected. Motion pictures of the outer portion of the wing taken in flight showed a large degree of wing bending which should also increase the effective dihedral. Figure 15 presents curves of the estimated variation in wing shape with acceleration which were obtained from the vertical deflection of the outboard tip of the flap and of a point on the aileron trailing edge. Because of the large degree of wing bending the value of effective dihedral calculated from flight sideslip data was surprisingly small.

(c) Pitching moment due to sideslip.- This subject was discussed under longitudinal control, reference 1. Changes in elevator force and position required to overcome the pitching moment due to sideslip were small in all conditions at all speeds. The requirements of reference 2 were easily satisfied.

(d) Side-force characteristics.- The side-force characteristics (variation of angle of bank with angle of sideslip) are shown in figures 10 through 14. The requirement that the direction of bank should always be the same as the direction of sideslip was satisfied in all flight conditions at all speeds.

3-B. Lateral and directional control

1. Rudder to overcome adverse aileron yaw

The ability of the rudder to overcome the yawing moment due to full aileron deflection with a control-force increment of less than 180 pounds has been discussed in the section on sideslip due to aileron deflection (2-B), 1.

2. Rudder control in take-off and landing

No take-offs or landings were made in a 90° crosswind. The rudder control was adequate and the rudder force was light for normal take-offs and landings.

3. Single-engine operation

(a) Rudder control with one engine inoperative and aileron control in sideslip.- The increment of rudder control force caused by failure of one engine was determined as specified in reference 2 by abruptly closing one throttle while in straight flight at 115 miles per hour with the flaps one-half down, the landing gear down, and the engines operating at full military power. These tests were made by closing the left throttle only, since loss of the left engine produces the more severe change in trim. Time histories of the maneuver are presented in figure 16. In the first case the pilot attempted to hold the wings level. In the second the airplane was banked somewhat with the idling engine high. The increment of rudder force required to maintain straight flight with less than 10° of sideslip was slightly less than 180 pounds. The increment of aileron force in these maneuvers was approximately 20 pounds.

(b) Directional trim characteristics (single-engine operation).- Figure 17 presents the directional trim characteristics for single-engine operation in the rated power-clean condition in straight flight with the wings level. It indicates that the airplane could be trimmed with the wings level at 2.5° sideslip with substantially zero rudder and aileron force at 140 miles per hour.

Figure 18 presents the rudder-free directional trim characteristics for single-engine operation in the rated power-clean condition. For straight flight at 140 miles per hour with the left propeller feathered 11° of right bank and 17° of right sideslip were required.

4. Rudder control in dives

With the rudder trim tab set for zero rudder force at the maximum level-flight speed, the rudder control force required for trim did not exceed approximately 20 pounds from a few miles per hour above the stall to the maximum permissible diving speed (425 miles per hour).

5. Power of rudder and aileron trimming tabs

The directional trim characteristics with one engine inoperative were discussed in the section on single-engine operation, (3-B) 3(b). For normal flight with both engines delivering rated power or idling it was possible to trim the rudder and aileron forces to zero in any flight condition specified in reference 2.

6. Rolling moment due to yawing

Rudder kicks were made at 140 and 200 miles per hour in the gliding condition and at 140, 200 and 320 miles per hour in the clean, rated-power condition to determine the amount of rolling due to yawing. In these maneuvers the rudder was abruptly deflected and held fixed at the deflected position as the ailerons and elevator were held fixed throughout the maneuver. Time histories of rudder kicks are shown in figure 19. The maximum sideslip angle, rolling and yawing velocity, and rudder force obtained are presented as a function of rudder deflection in figures 20 and 21. The value of $pb/2V$ which would be obtained in a rudder kick produced by a 180-pound pedal force was almost 0.04 at 140 miles per hour, and approximately 0.02 at 320 miles per hour. The pilot did not consider the rolling due to rudder kicks excessive.

7. Rudder hinge-moment coefficients

An estimate of the rudder hinge-moment coefficients was made from the rudder kick data. $\frac{dC_h}{d\delta}$ was calculated from the first part of the rudder kicks before the sideslip angle had started to change and an approximate value of $\frac{dC_h}{d\alpha}$ was calculated from the second part of the maneuvers where the rudder deflection was held constant while the sideslip developed. In the calculation of $\frac{dC_h}{d\alpha}$ it was assumed that the change of angle of attack of the vertical tail was equal to the change in sideslip angle. Correction was made for any slight change of rudder angle while the sideslip was developing. Figure 22 presents the variation of C_h with rudder deflection. Figure 23 presents the variation of C_h with change in sideslip angle. $\frac{dC_h}{d\delta}$ varied from -0.003 at 0° rudder deflection to -0.004 at 15° rudder deflection. $\frac{dC_h}{d\alpha}$ varied from -0.0005 at 0° sideslip to -0.0015 at 15° of sideslip.

8. Aileron control characteristics

The aileron control characteristics were measured in rudder-locked abrupt aileron rolls at various speeds in the following flight conditions. The figures which present the data obtained in the various conditions are also listed.

Power	Flap	Landing gear	Speed	Figure
Level flight	Down	Down	123	24
Engines idling	Down	Down	123 150	25
Level flight	Up	Up	135 167 203 254 304 351 383	26

Figure 27 gives time histories of typical aileron rolls. The aileron roll data were evaluated to determine the variation of aileron effectiveness, pb/2V, and aileron wheel force with aileron deflection. Figure 28, cross-plotted from the data of figure 26, shows the aileron deflection, aileron effectiveness, and rolling velocity at 10,000 feet altitude obtainable throughout the speed range with an 80-pound wheel force. The fabric distortion of the upper surface on the left aileron at various speeds throughout the speed range is shown in figure 29. The variation of the internal pressure in the ailerons with speed is shown in figure 30. The internal pressure in the ailerons was approximately 1 to 2 percent of the dynamic pressure below true static pressure.

The aileron control characteristics of the A-26B may be summarized as follows:

a. The maximum control force and maximum rolling velocity obtained in abrupt aileron rolls varied smoothly with aileron deflection throughout the speed range.

b. The ailerons exhibited no undesirable lag characteristics and the rolling accelerations were always in the correct directions.

c. No reversal of rolling velocity due to aileron yaw ever occurred.

d. With the flaps down, power on or off, the maximum value of pb/2V obtained in full deflection rolls was approximately 0.07 in left rolls and slightly less than 0.07 in right rolls. The requirement that pb/2V be equal to or greater than 0.07 with engines idling, flaps and landing gear down, at speeds between 1.1 and 1.5 times the stalling speed was not quite satisfied.

e. The maximum value of pb/2V obtained with full aileron deflection, flaps and landing gear up, power for level flight, was 0.063. Full aileron deflection could be obtained up to approximately 200 miles per hour with an 80-pound control force. If the aileron deflection range were increased to increase pb/2V the forces would exceed 80 pounds at 200 miles per hour. The requirement of reference 2 that $pb/2V$ be at least 0.07 up to 0.7 of the maximum level-flight speed with an 80-pound control force was not satisfied.

f. There was no tendency for the aileron forces to overbalance.

g. The variation of aileron trimming force with speed is shown to be small in figure 31.

As shown by figure 29 the trailing-edge angle of the ailerons was greatly reduced in high-speed flight due to fabric deflection. Reduction of the trailing-edge angle tends to make the value of C_{h_δ} more negative and thereby increases the control forces. It is thought that improvement in the aileron characteristics at high speed could be obtained by the use of a more rigid covering on the ailerons particularly in the vicinity of the trailing edge.

h. The average value of $\frac{dC_h}{d\delta}$ for the ailerons, including the effects of rolling, was calculated from the aileron roll data. A tendency for $\frac{dC_h}{d\delta}$ to increase slightly with speed was evident from the results of these calculations. At 165 miles per hour $\frac{dC_h}{d\delta}$ was approximately -0.0028 and at 350 miles per hour, -0.0031. Because of the differential in the aileron system, this value of $\frac{dC_h}{d\delta}$ cannot be interpreted as the value that woule be measured on an individual aileron. It provides a measure of the over-all degree of aileron balance obtained with this control system for comparison with other aileron installations.

CONCLUSIONS

The results of the tests to determine the lateral and directional stability and control characteristics of an A-26B airplane (AAF No. 41-39120) may be summarized as follows:

1. The control-free lateral and directional oscillations of the airplane were satisfactorily damped. The ailerons and elevator did not return to their trim positions because of friction in the control systems. The airplane remained in a shallow turn after the oscillations had damped out.

2. The sideslip due to full aileron deflection, rudder-fixed at 120 percent of the stalling speed in the landing and rated power-clean conditions was approximately half of the 20° limit of reference 2.

3. Control-fixed and control-free directional stability as shown by the variation of rudder position and rudder control force with sideslip angle was satisfactory at all speeds in all flight conditions.

4. The effective dihedral was positive, stick-fixed and stick-free, in all flaps-up conditions. At low speeds with flaps down at large angles of sideslip the stick-free dihedral effect became marginal but the stick-fixed dihedral was positive.

5. The side force due to sideslip was always in the correct direction.

6. The rudder control characteristics were satisfactory in all respects, for overcoming adverse aileron yaw, for maintaining straight ground paths, for maintaining straight flight paths with the wings level in all flight conditions at any speed, and for maintaining straight flight with less than 10° sideslip during single-engine operation.

7. The variation of rudder and aileron force with speed was small and the force could be easily reduced to zero at any speed by use of the trimming tabs. The trimming tabs were also sufficiently powerful to trim the airplane for level flight with 2.5° sideslip during single-engine operation in the rated power-clean condition at 120 percent of the stalling speed.

8. The response to abrupt aileron deflection was satisfactory, but the aileron effectiveness was less than that specified for an airplane of this class. The maximum value of $pb/2V$ obtained with full aileron deflection in the clean condition with power for level flight was 0.063. Full aileron deflection could be

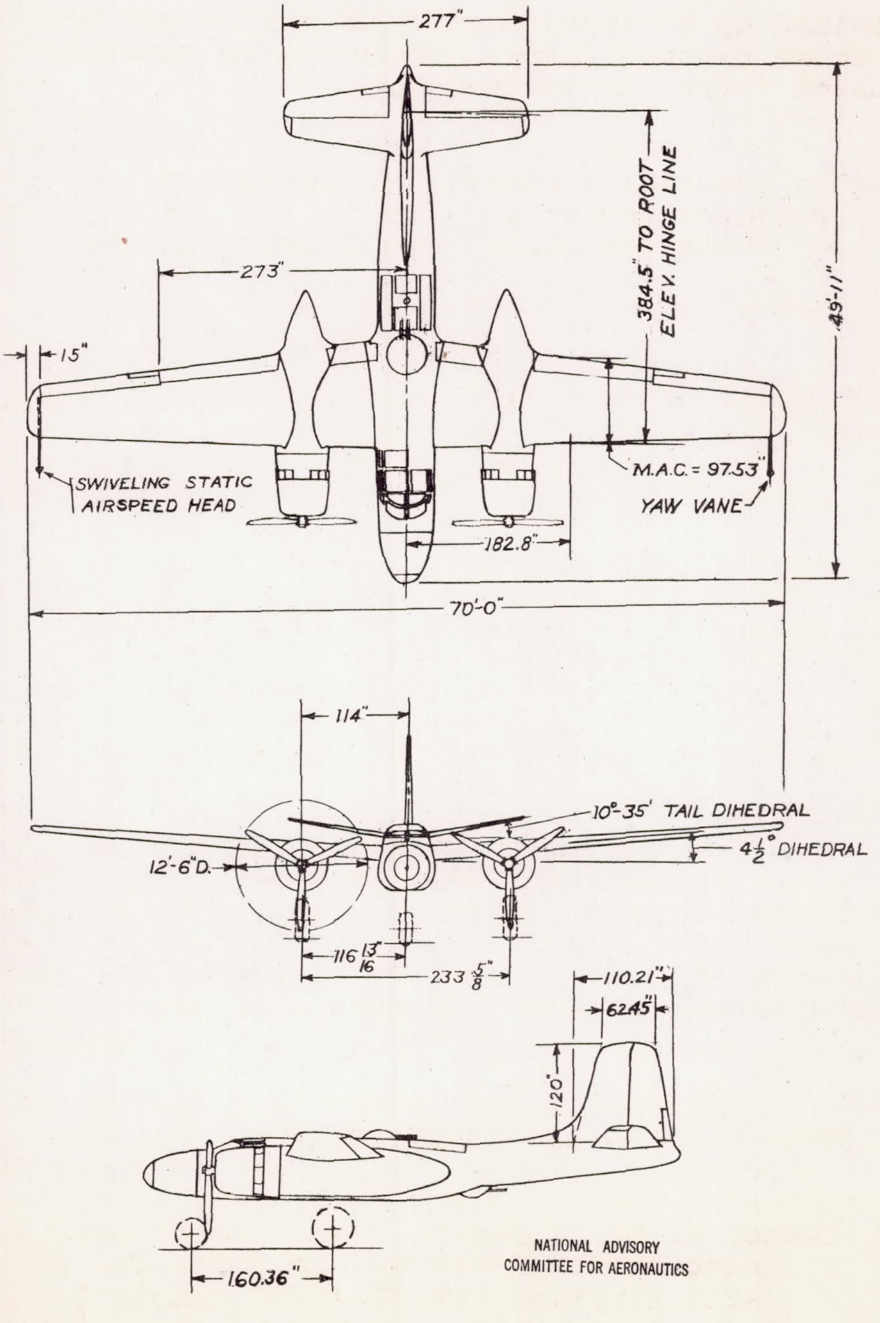
obtained up to approximately 200 miles per hour with an 80-pound control force. There was no tendency for the control forces to overbalance.

Langley Memorial Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Field, Va., January 4, 1945

REFERENCES

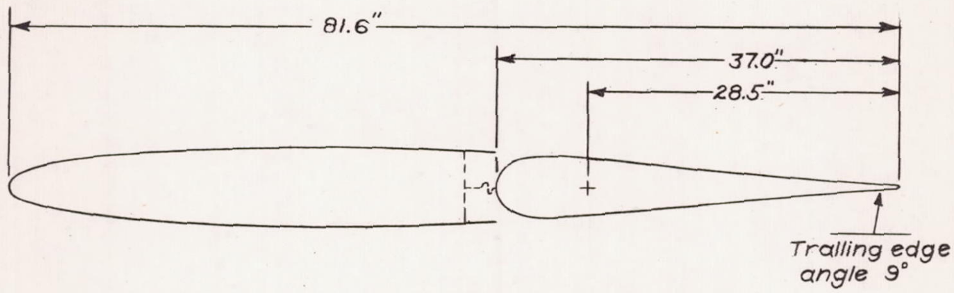
1. Crane, H. L., Sjoberg, S. A., and Hoover, H. H.: Measurement of Flying Qualities of a Douglas A-26B Airplane (AAF No. 41-39120). I - Longitudinal Stability and Control Characteristics. NACA MR No. L4L06, 1944.

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

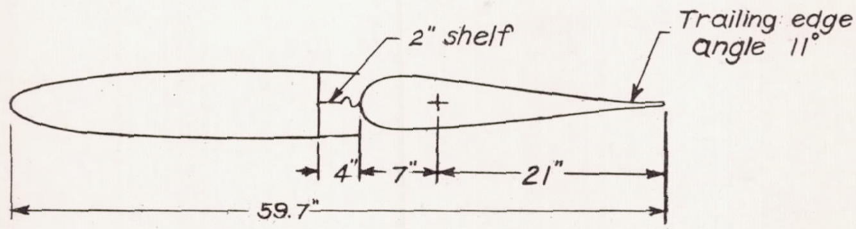


(a) Three view drawing of Douglas A-26B airplane.

Figure 1.



Section vertical tail 49 inches from tip



Section of horizontal tail 76.5 inches from airplane center line

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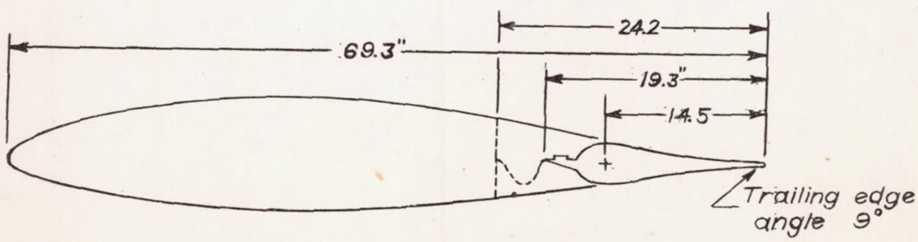
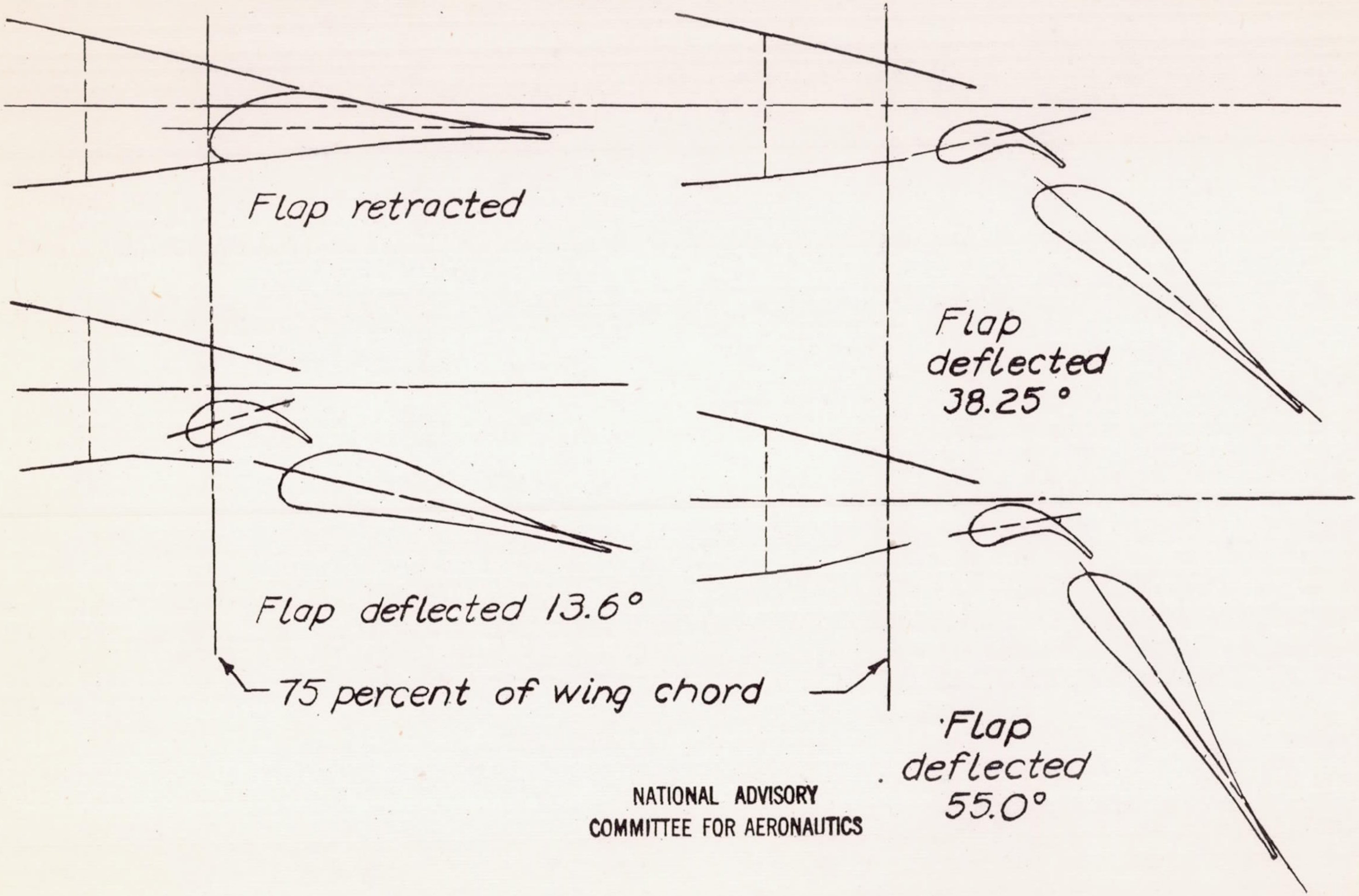


Wing section 352 inches from airplane center line

(b) Sections through vertical tail, horizontal tail, and wing at aileron. Douglas A-26B airplane.

Figure 1.



(c) Section through flap at various deflections.

Figure 1.- Concluded.

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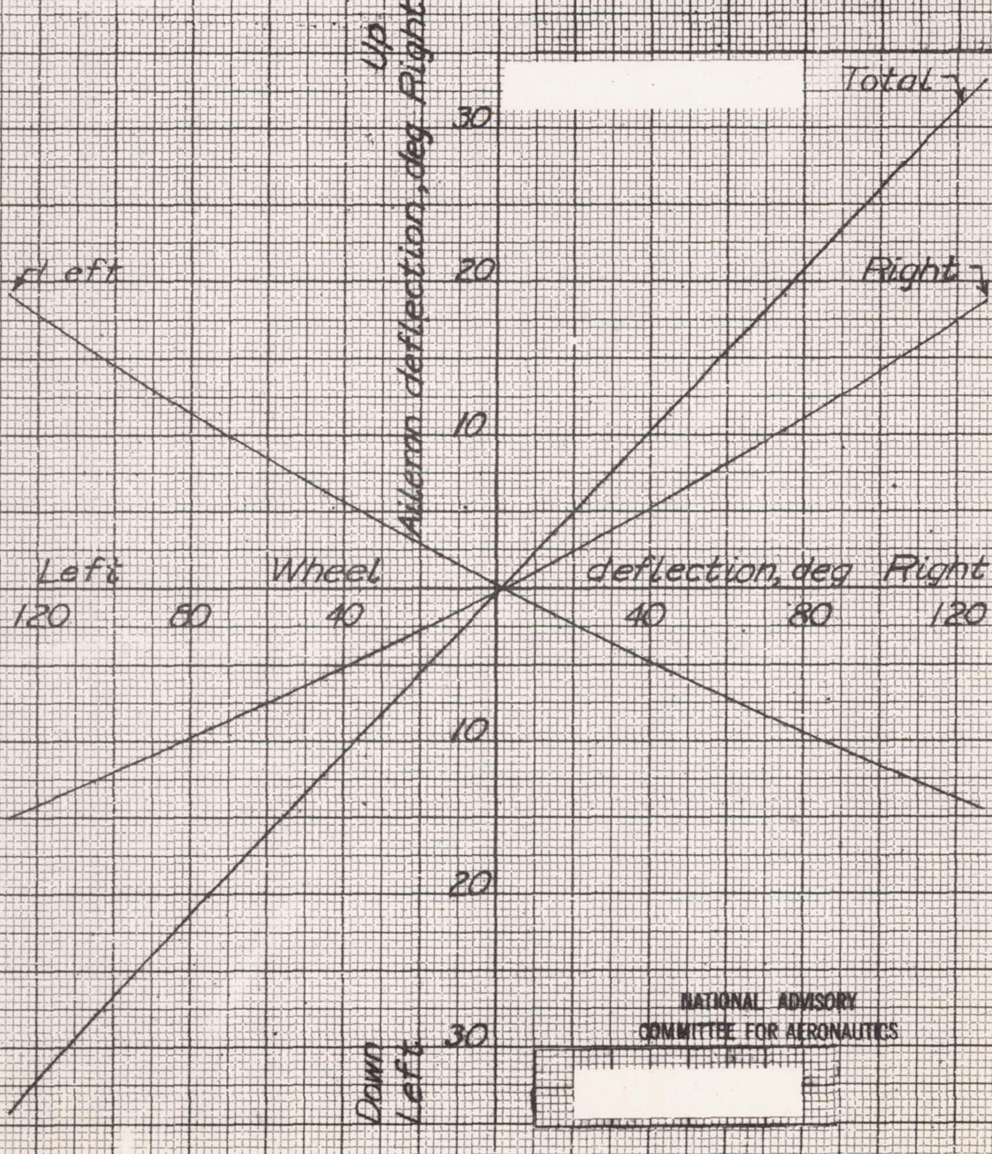

Figure 3. - Linkage between ailerons and wheel with no load on system. Douglas A-26B airplane.

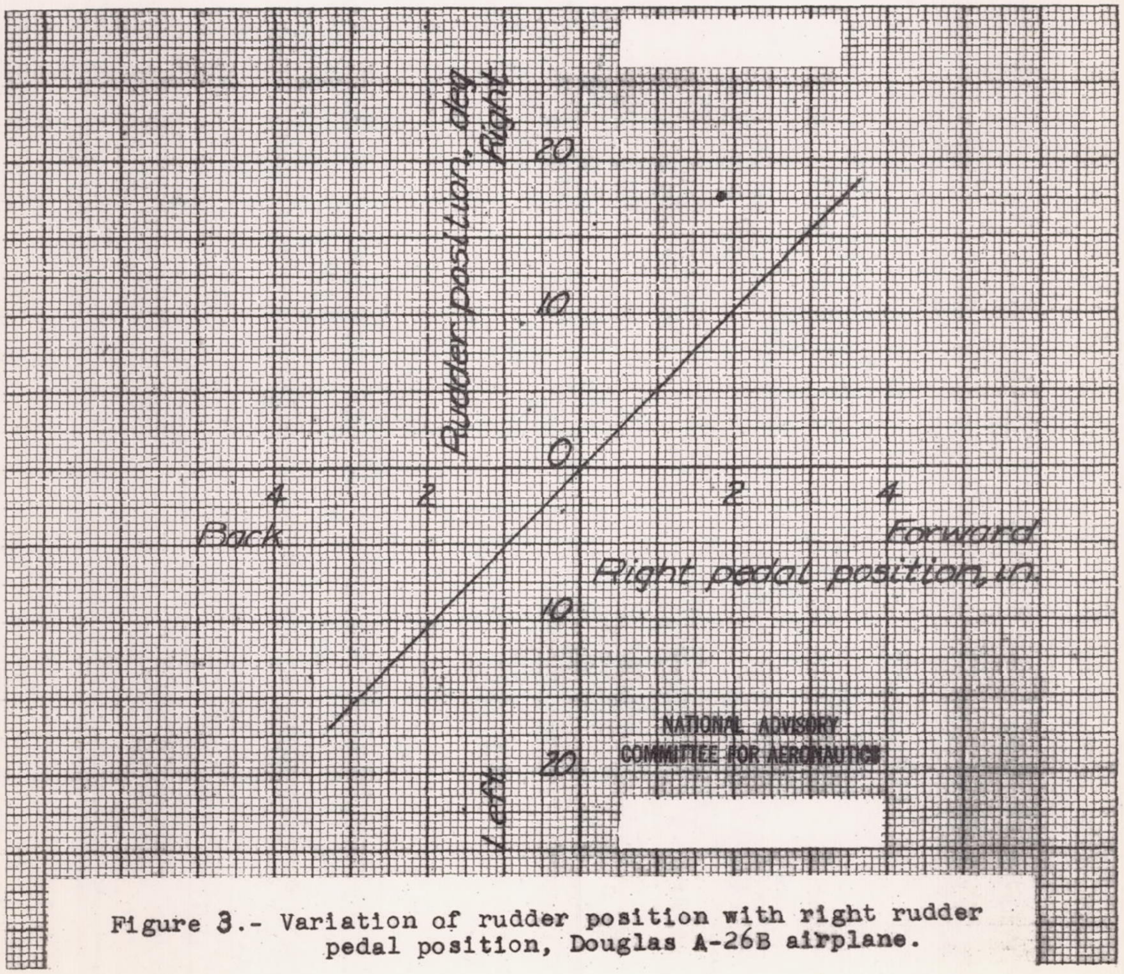

Figure 3.- Variation of rudder position with right rudder pedal position, Douglas A-26B airplane.

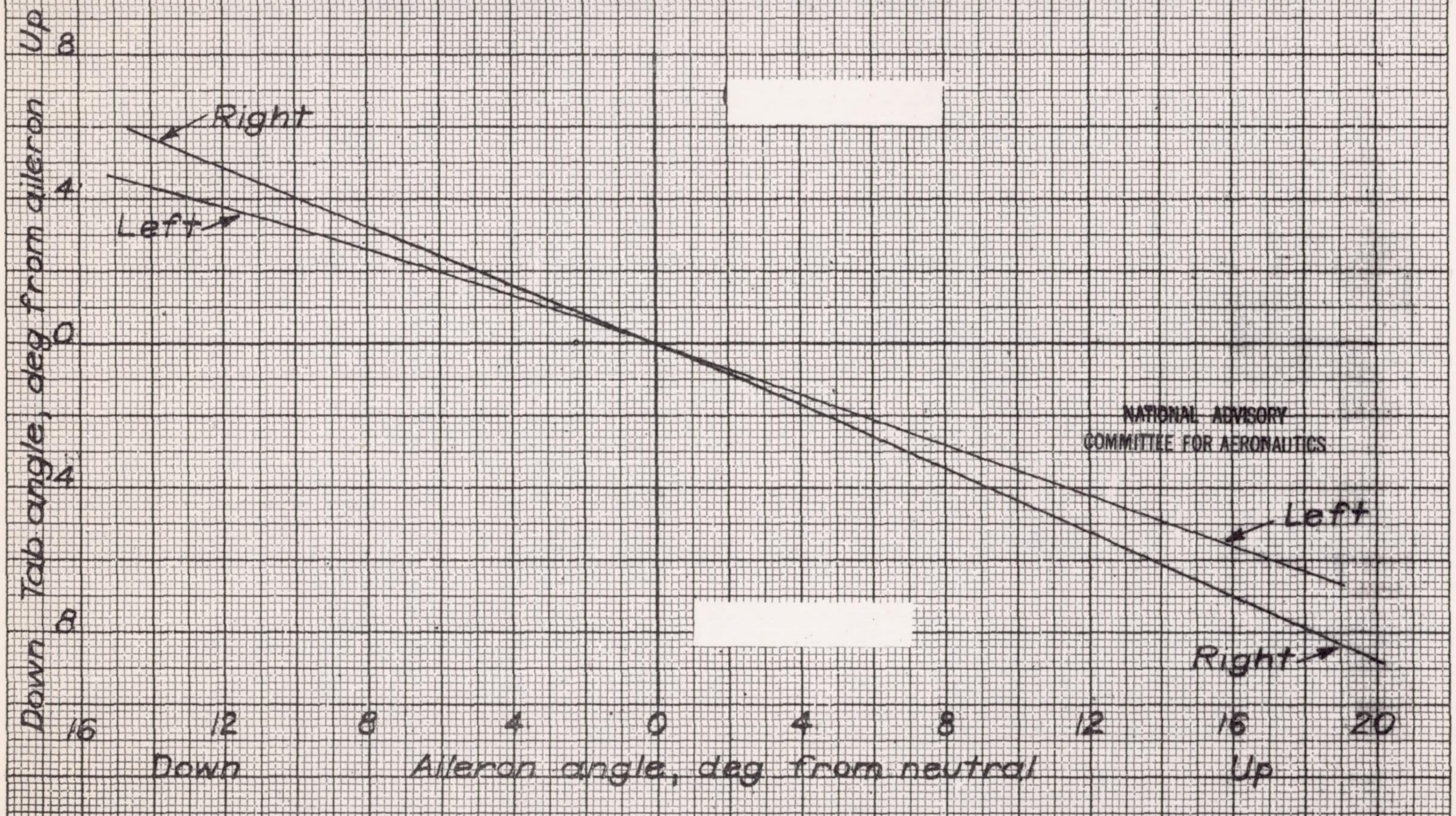

Figure 4. - Variation of aileron balance tab angle with aileron angle. Douglas A-26B airplane.

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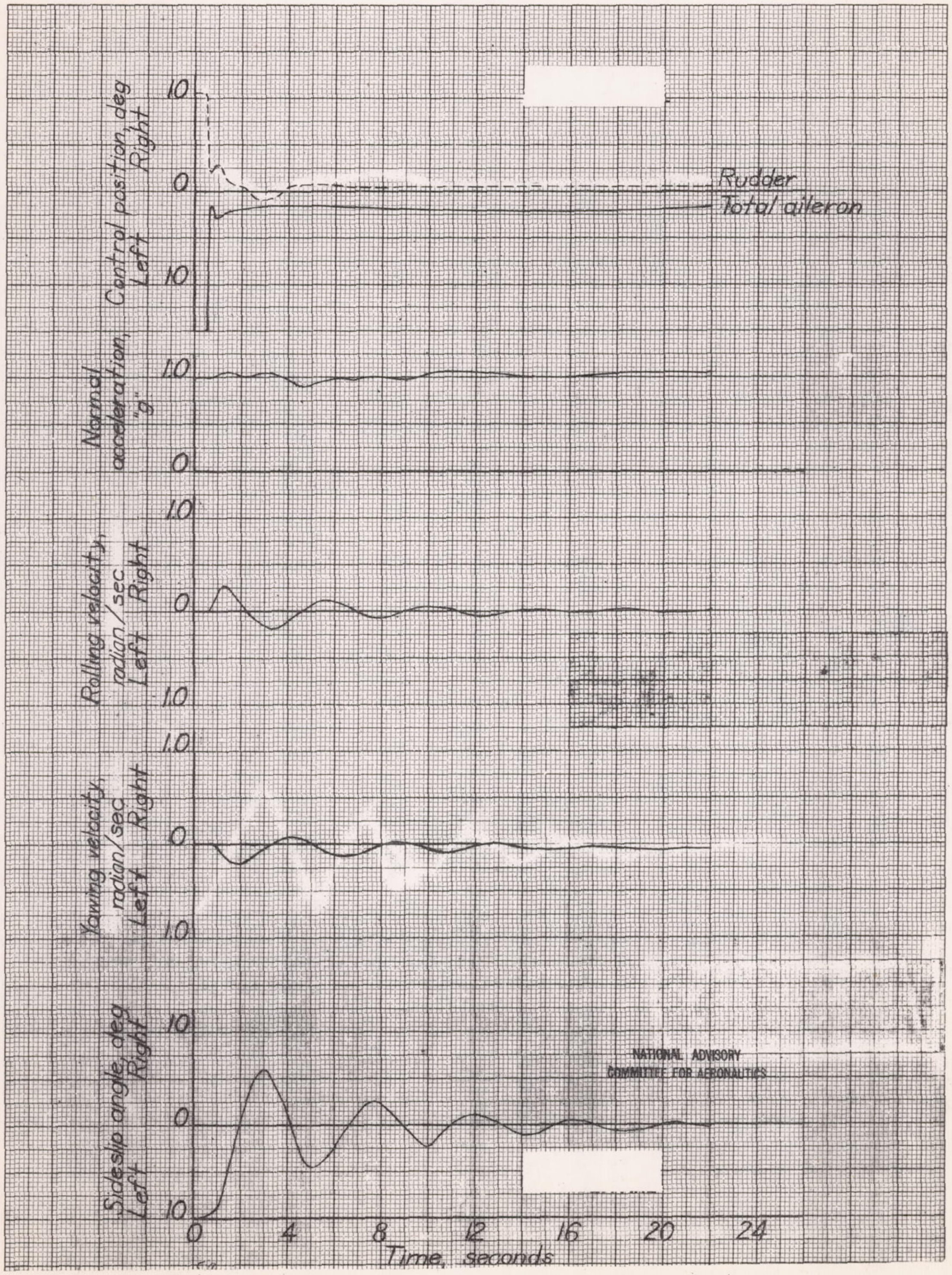

(a) From left sideslip

Figure 5 - Time history of the lateral and directional oscillation resulting from sudden release of the controls in a steady sideslip in the cruising maximum range condition (full throttle - 1450 rpm at 6000 ft, flaps up, landing gear up, cowl closed, oil cooler ½ open) V_i = 183 mph, Douglas A-26B airplane.

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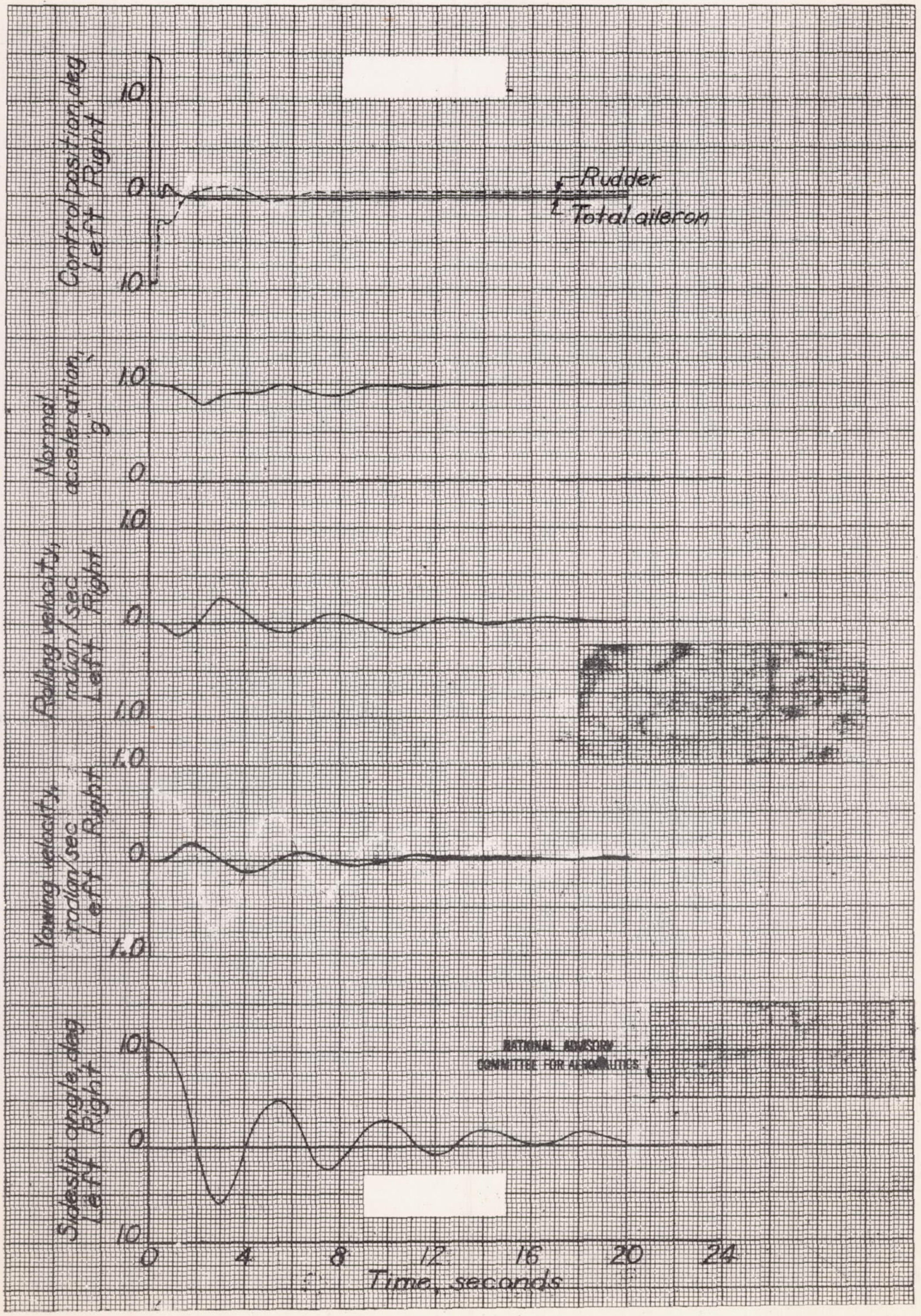


(b) From right sideslip.

Figure 5 - Concluded.

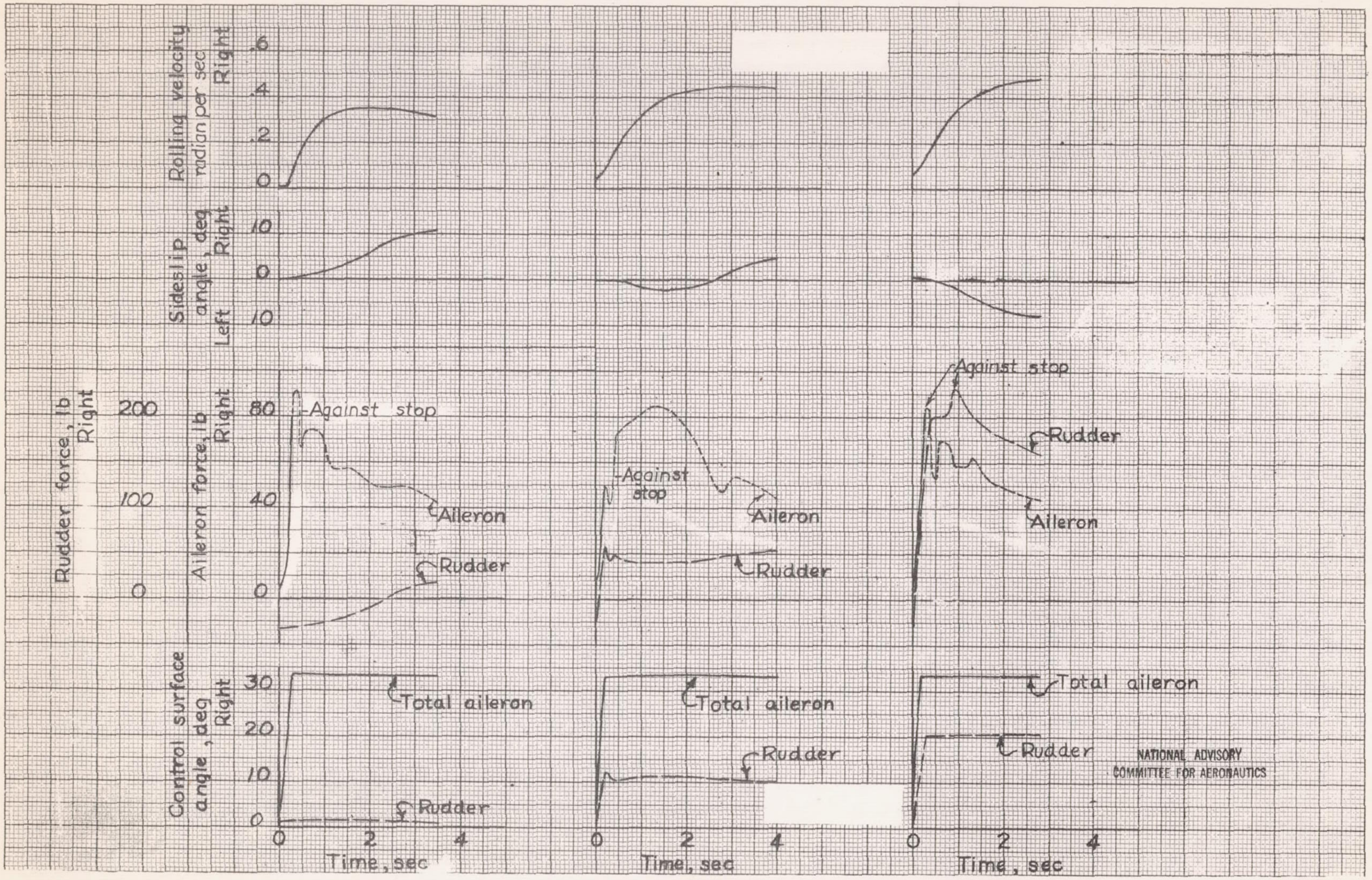


Figure 6 - Time histories of rolls out of 30° left banked turns using full aileron deflection and various amounts of rudder. Engines idling, flaps down, landing gear down, V_i = 118 mph, Douglas A-26B airplane.

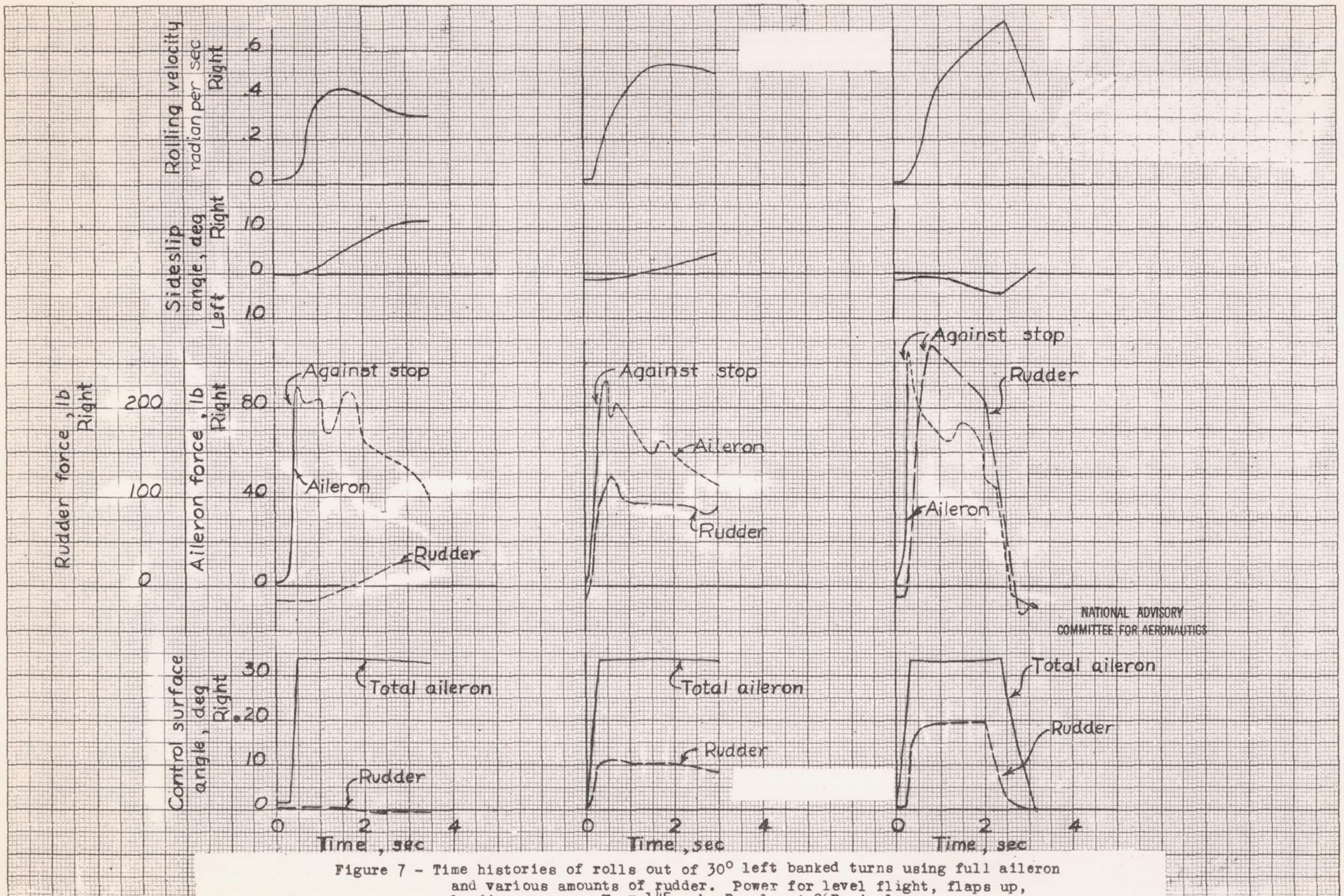
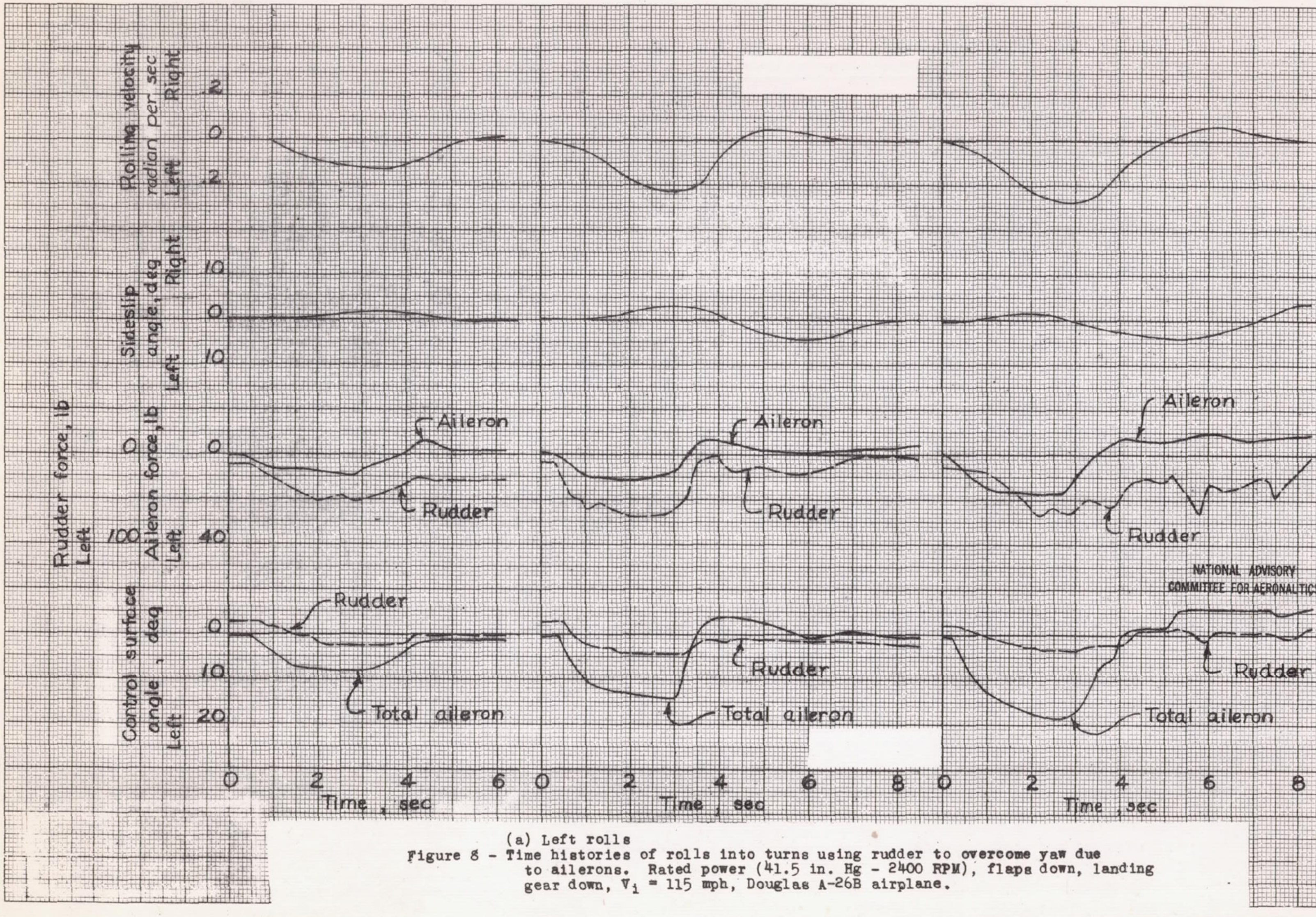


Figure 7 - Time histories of rolls out of 30° left banked turns using full aileron and various amounts of rudder. Power for level flight, flaps up, landing gear up, V_i = 145 mph, Douglas A-26B airplane.



(a) Left rolls

Figure 8 - Time histories of rolls into turns using rudder to overcome yaw due to ailerons. Rated power (41.5 in. Hg - 2400 RPM), flaps down, landing gear down, V_i = 115 mph, Douglas A-26B airplane.

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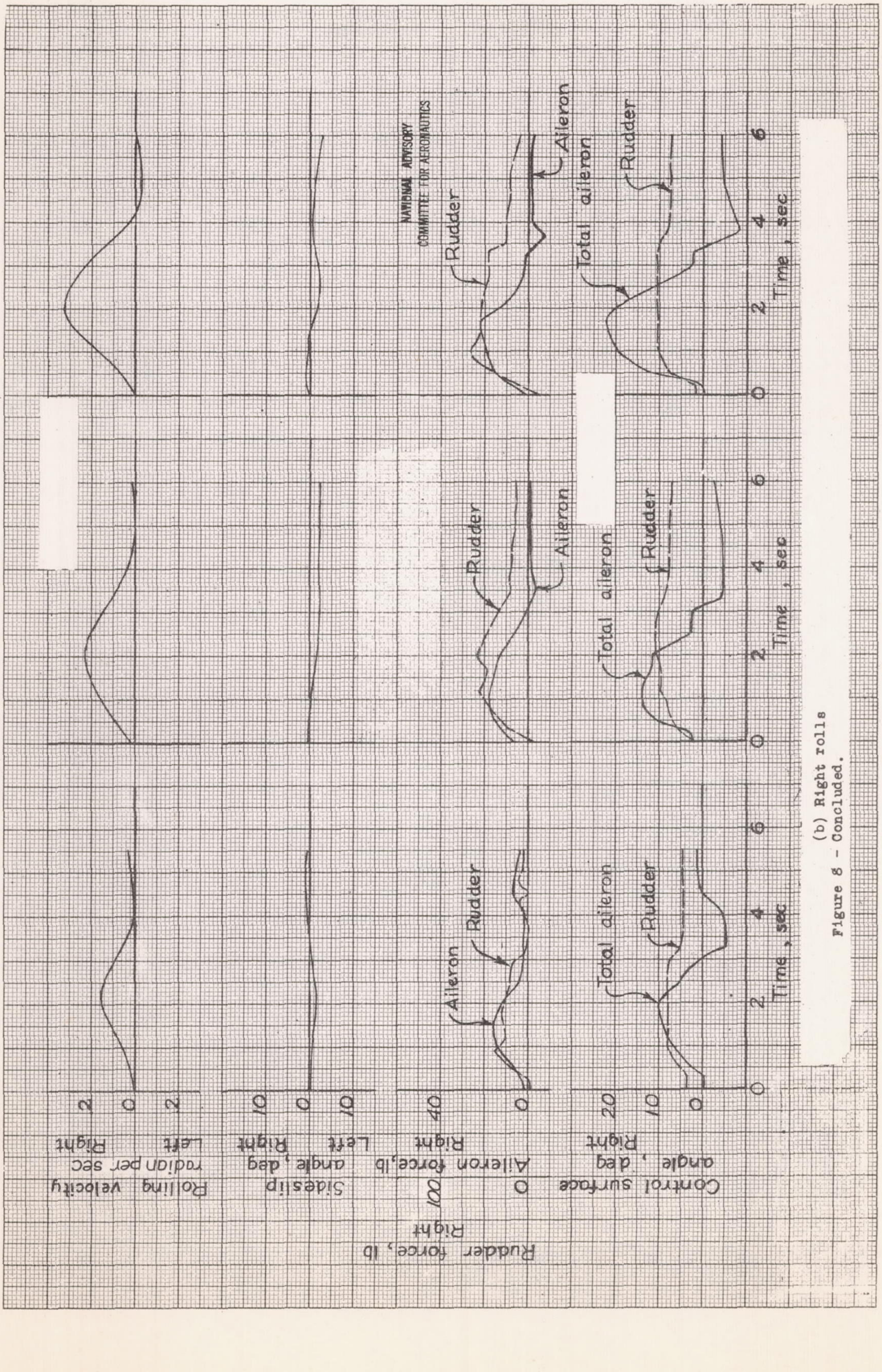
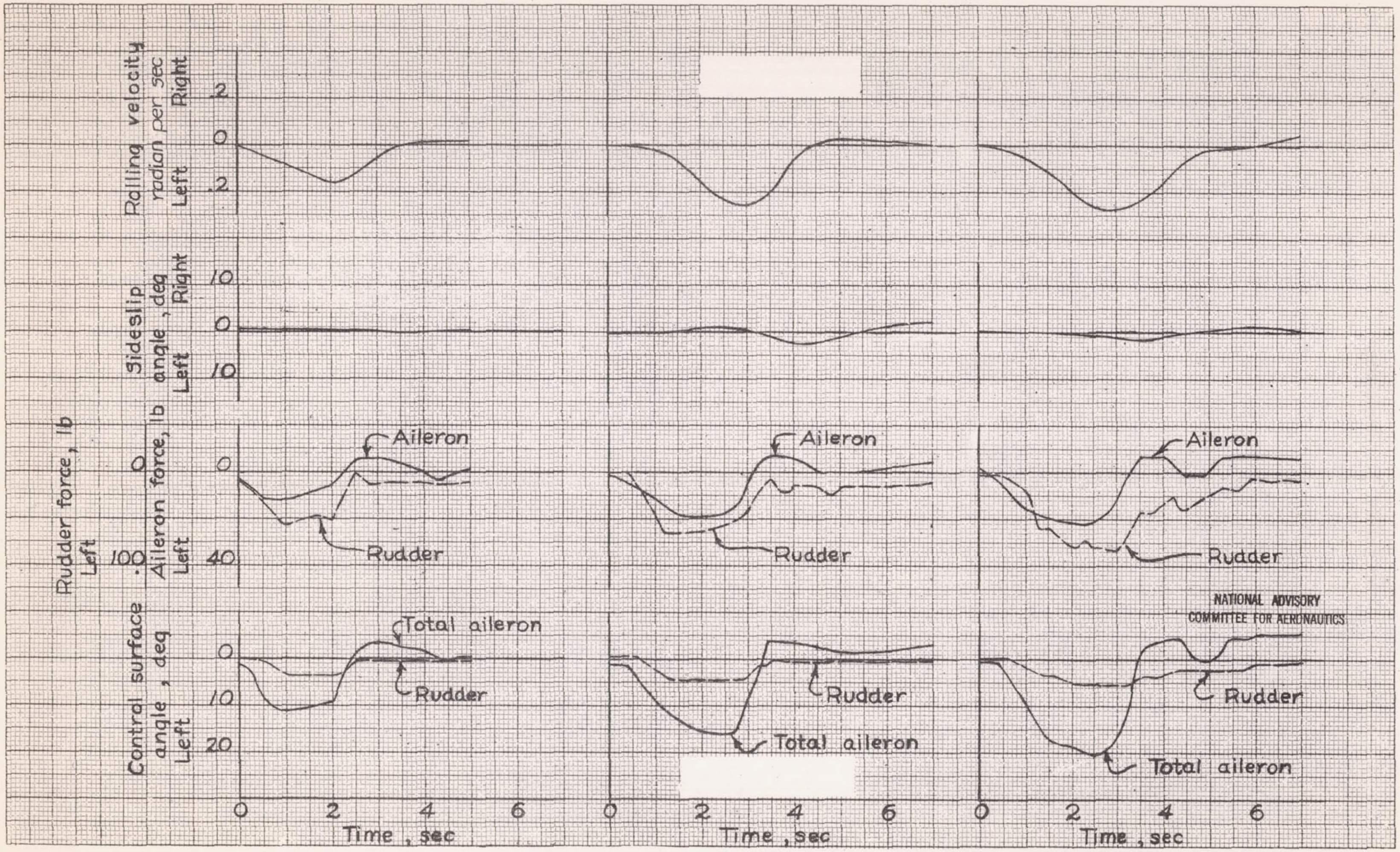


(b) Right rolls

Figure 8 - Concluded.



(a) Left rolls

Figure 9 - Time histories of rolls into turns using rudder to overcome yaw due to ailerons (20 in. Hg - 2400 RPM), flaps up, landing gear up, V_i = 138 mph, Douglas A-26B airplane.

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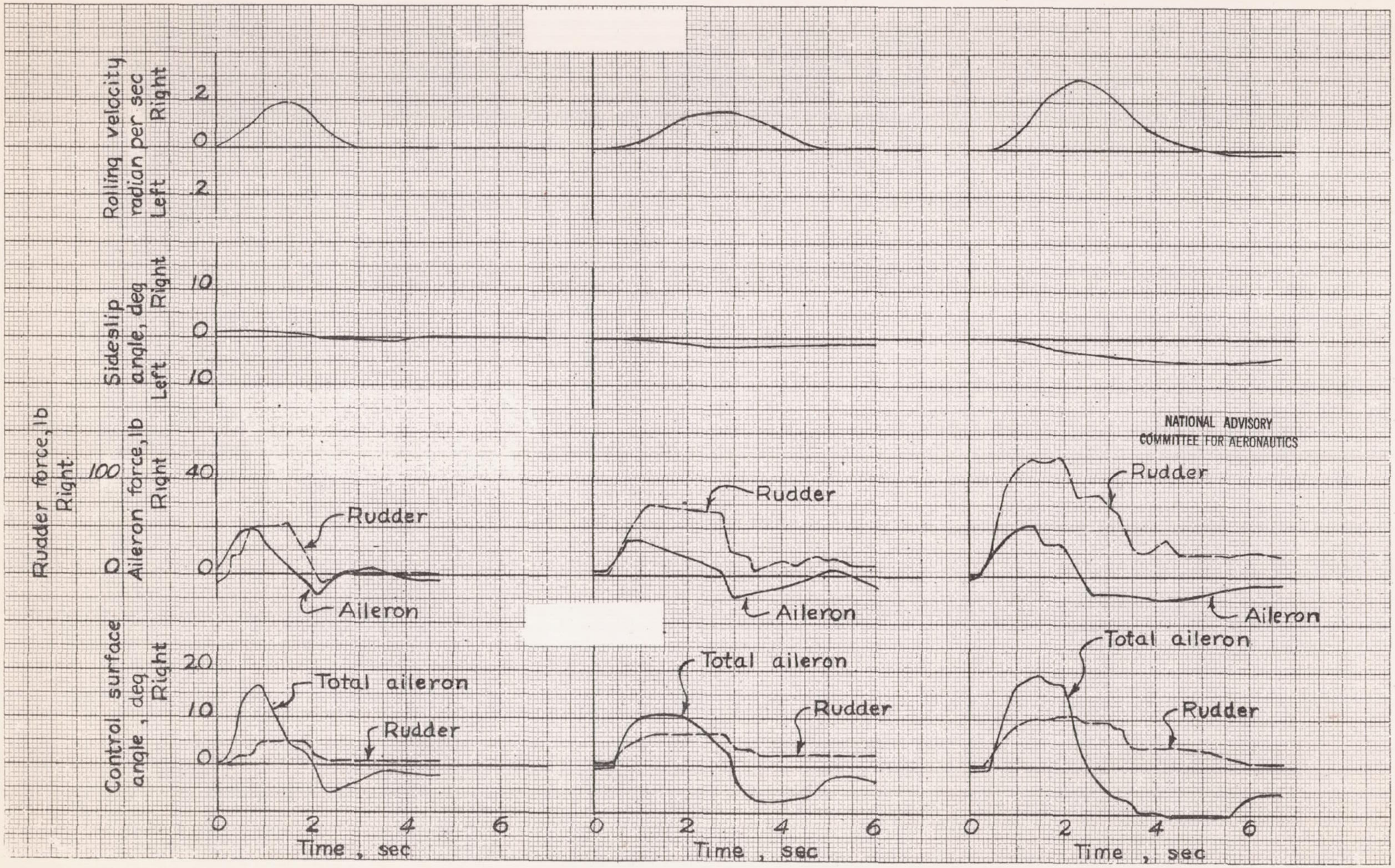

(b) Right rolls
Figure 9 - Concluded.

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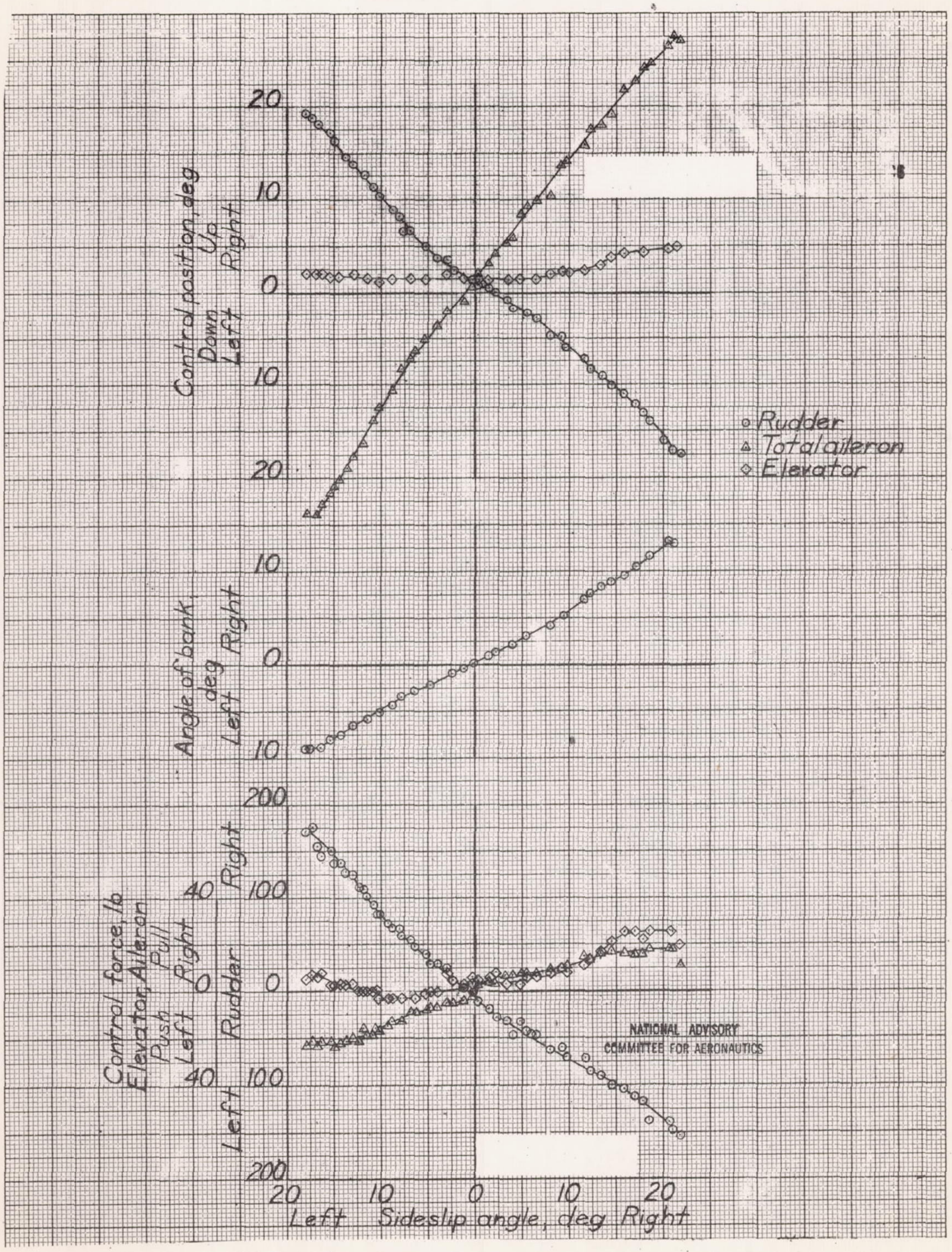

(a) Vi = 141 mph
Figure 10 - Sideslip characteristics in the rated power, clean condition, (41.5 in. Hg, 2400 RPM, flaps up, landing gear up, cowl flaps ½ open, oil cooler ½ open), Douglas A-26B airplane.

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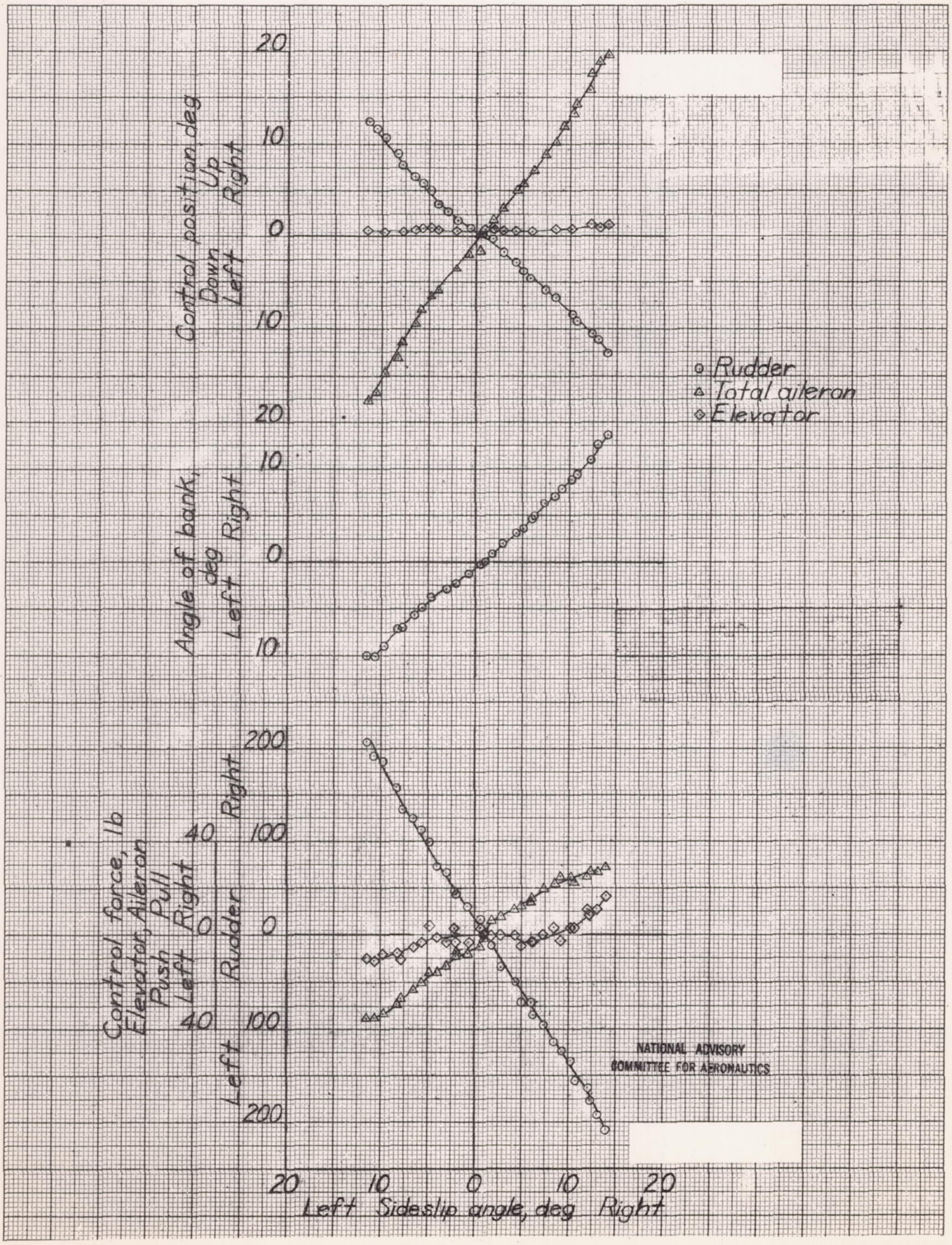
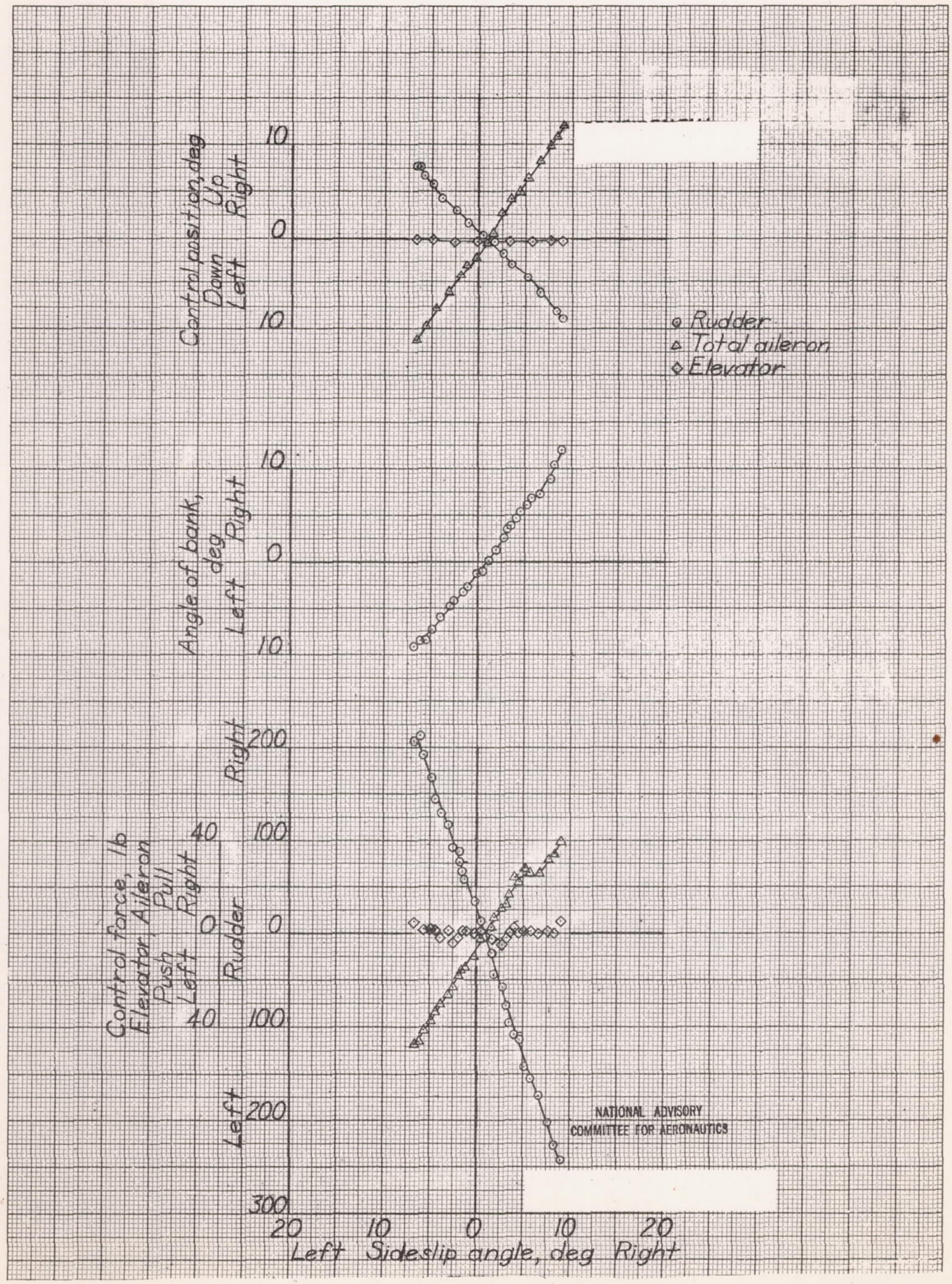


(b) V_i = 195 mph
Figure 10 - Continued.

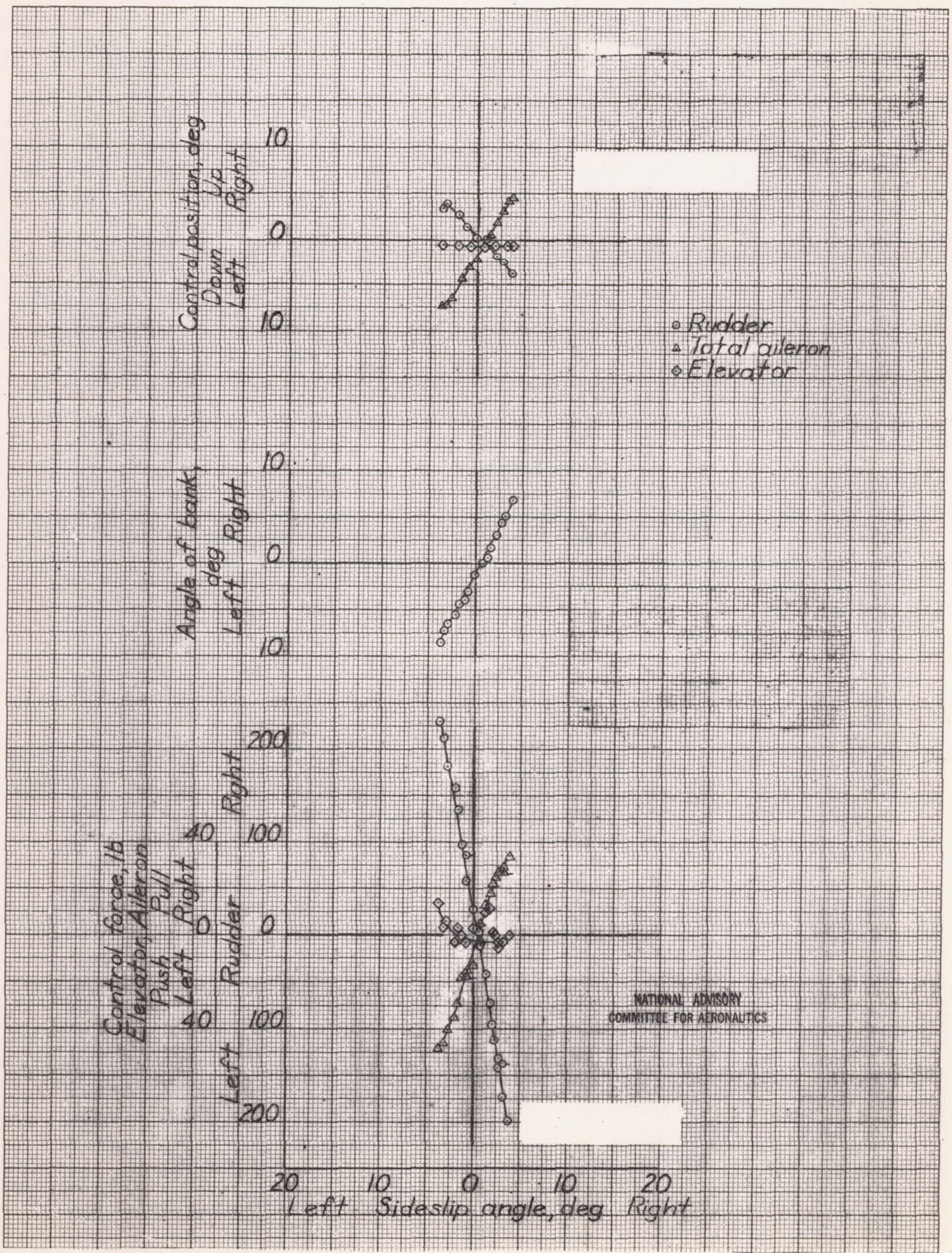
L-606



(c) V_i = 252 mph

Figure 10 - Continued.

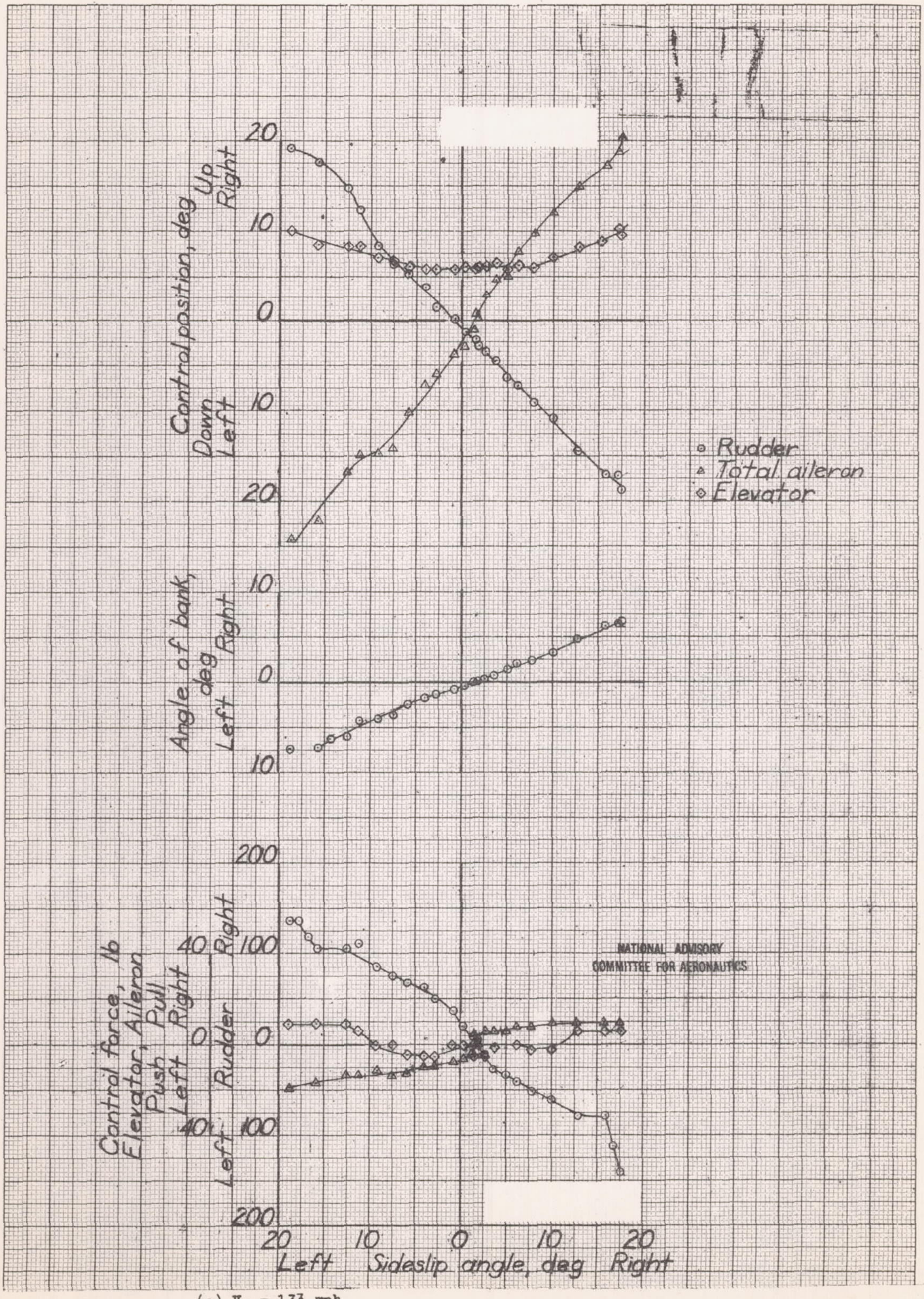
L-606



(d) V_i = 320 mph

Figure 10 - Concluded.

L-606



(a) V_i = 133 mph

Figure 11 - Sideslip characteristics in the gliding condition, (engines idling, flaps up, landing gear up, cowl flaps closed, oil cooler $\frac{1}{2}$ open), Douglas A-26B airplane.

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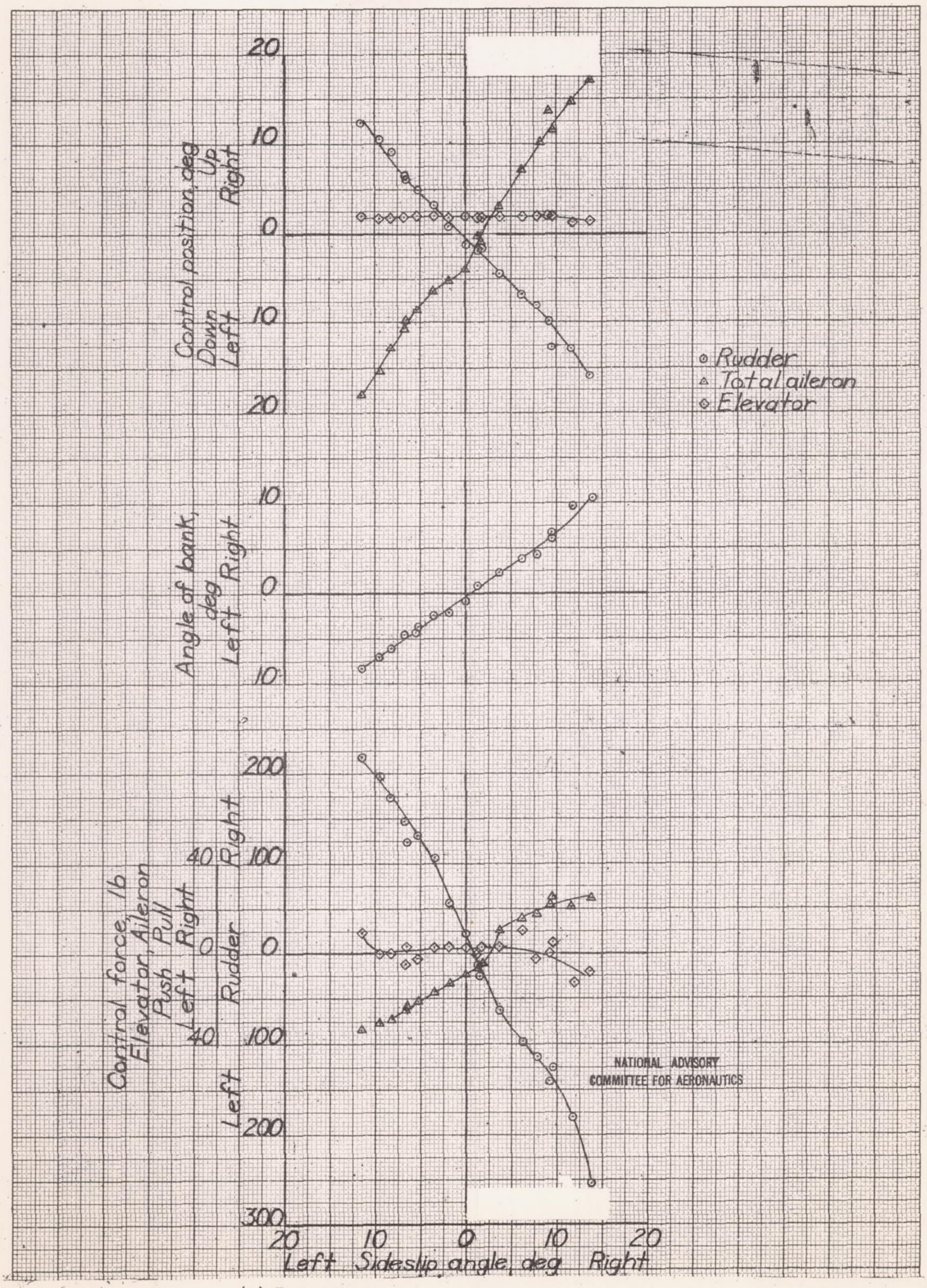
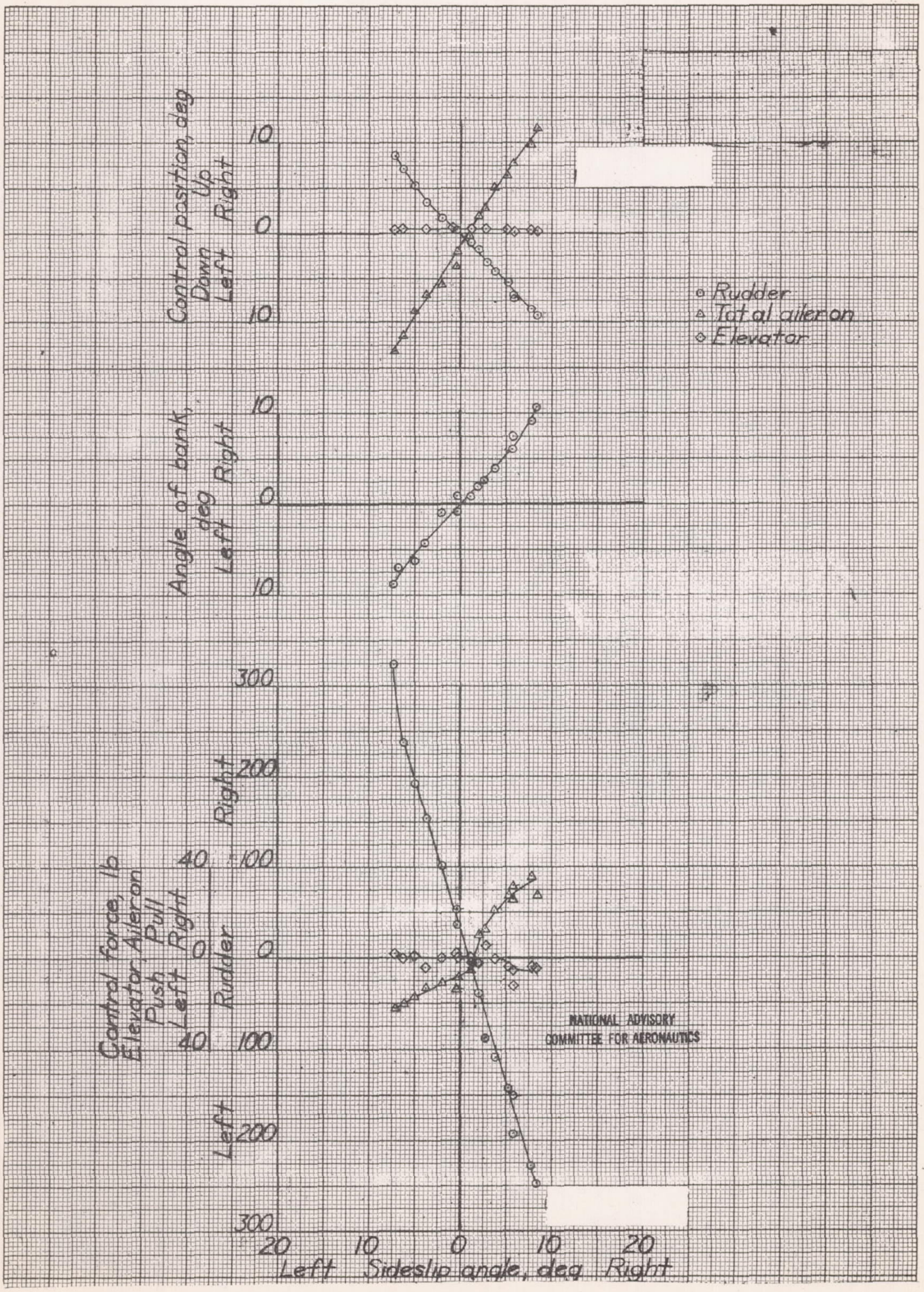


(b) V_1 = 189 mph

Figure 11 - Continued.

L-606



(c) V_i = 254 mph

Figure 11 - Concluded.

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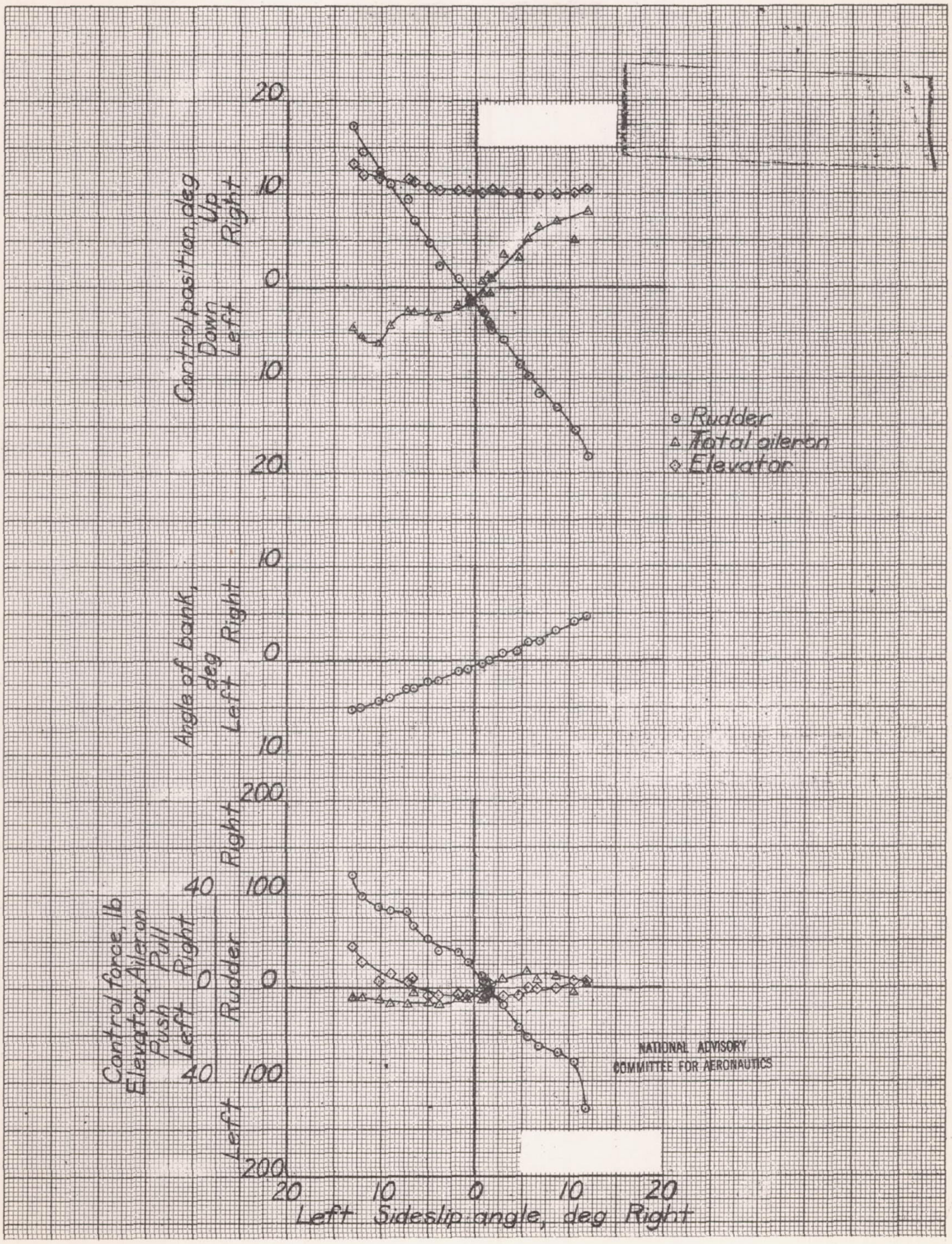

(a) V_i = 112 mph

Figure 12 - Sideslip characteristics in the landing condition (engines idling, flaps down, landing gear down, cowl flaps closed, oil cooler $\frac{1}{2}$ open), Douglas A-26B airplane.

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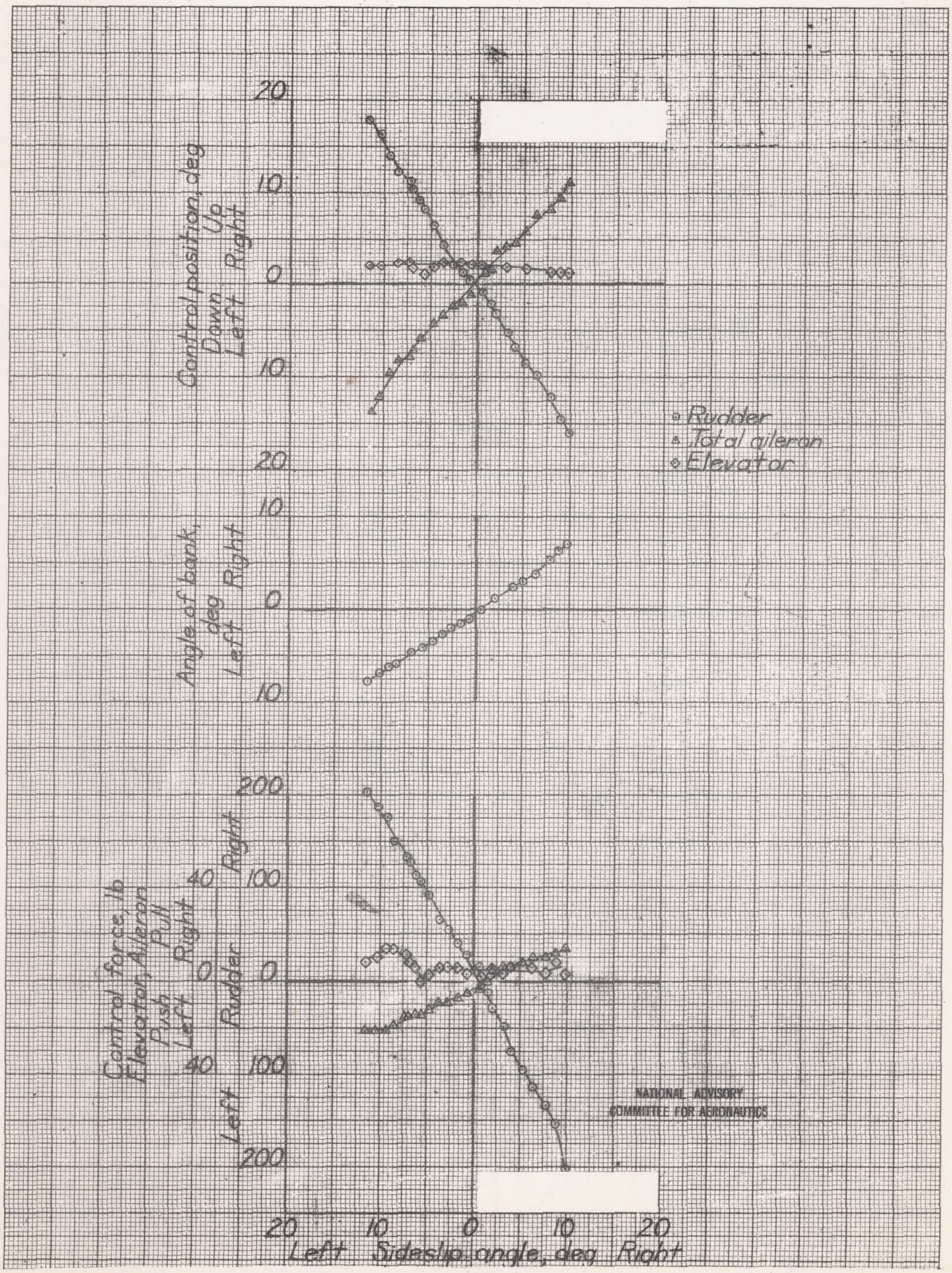
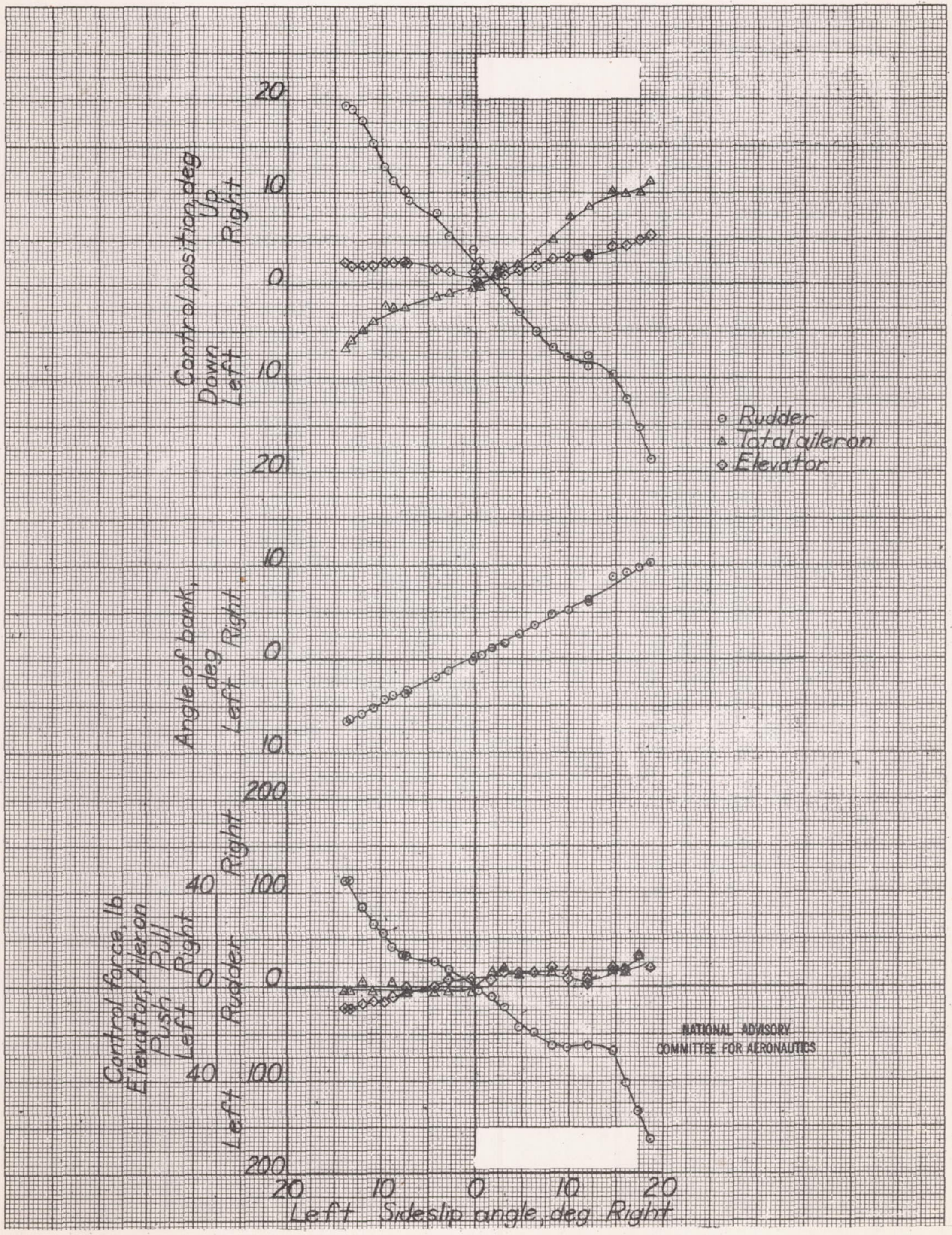


(b) V_i = 150 mph

Figure 12 - Concluded.

L-606



(a) V_i = 111 mph

Figure 13 - Sideslip characteristics in the wave-off condition (41.5 in. Hg, 2400 RPM, flaps down, landing gear down), Douglas A-26B airplane.

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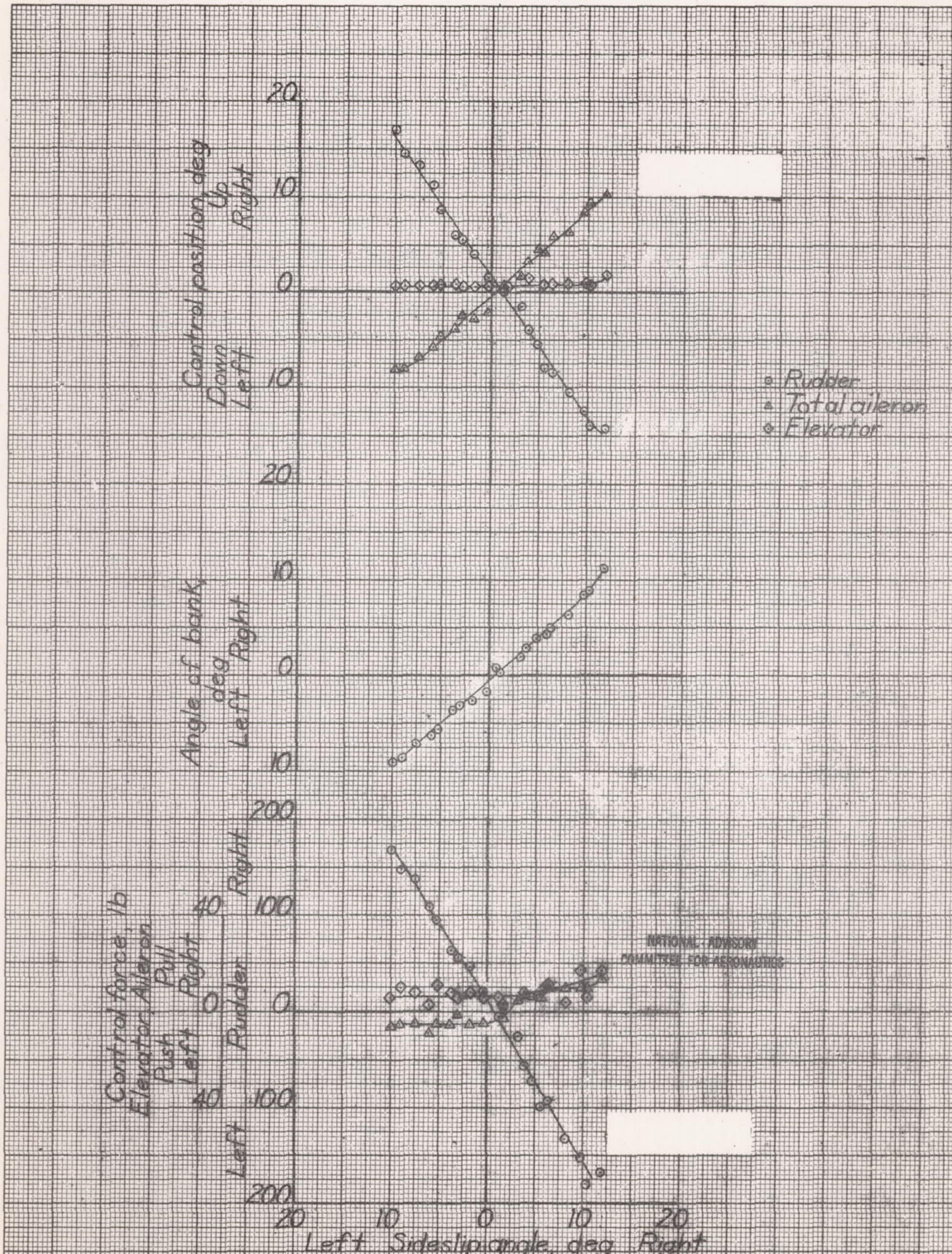

(b) V_i = 153 mph

Figure 13 - Concluded.

L-606

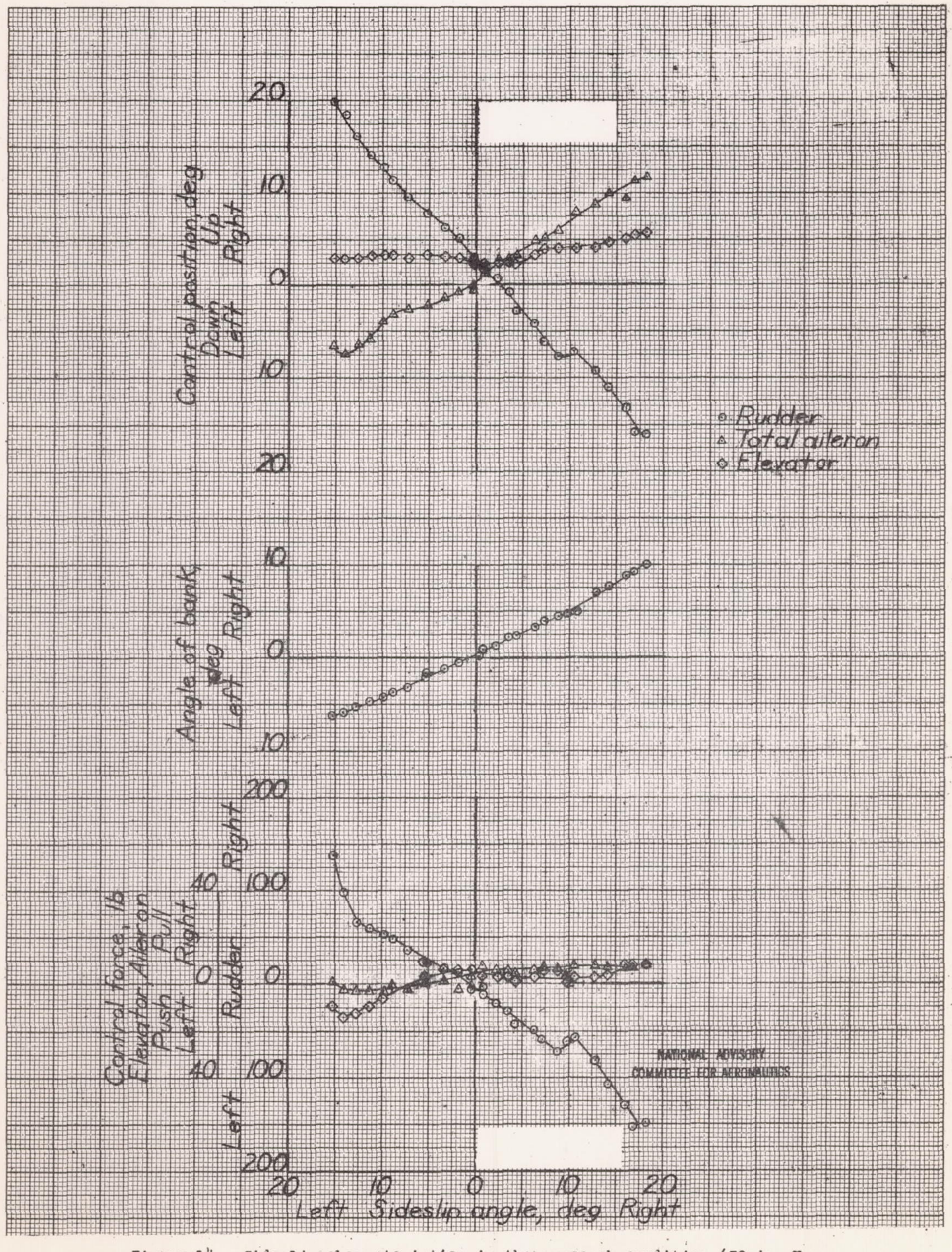

Figure 14 - Sideslip characteristics in the approach condition (30 in. Hg, 2000 RPM, flaps down, landing gear down, cowl flaps closed, oil cooler $\frac{1}{2}$ open), V_1 = 111 mph, Douglas A-26B airplane.

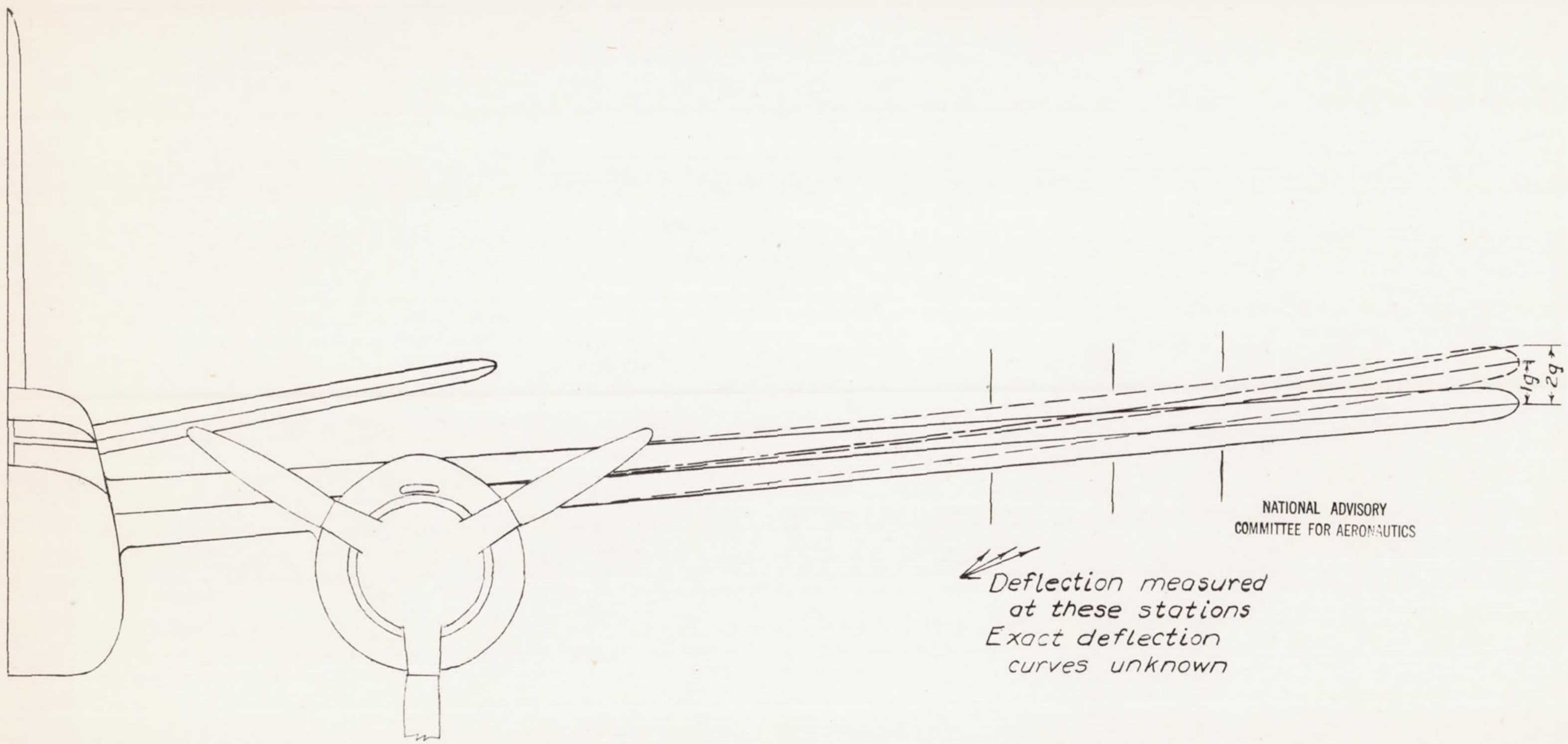

Figure 15 - Approximate wing bending in straight flight and in a 2 g pullup at 250 miles per hour, Douglas A-26B airplane.

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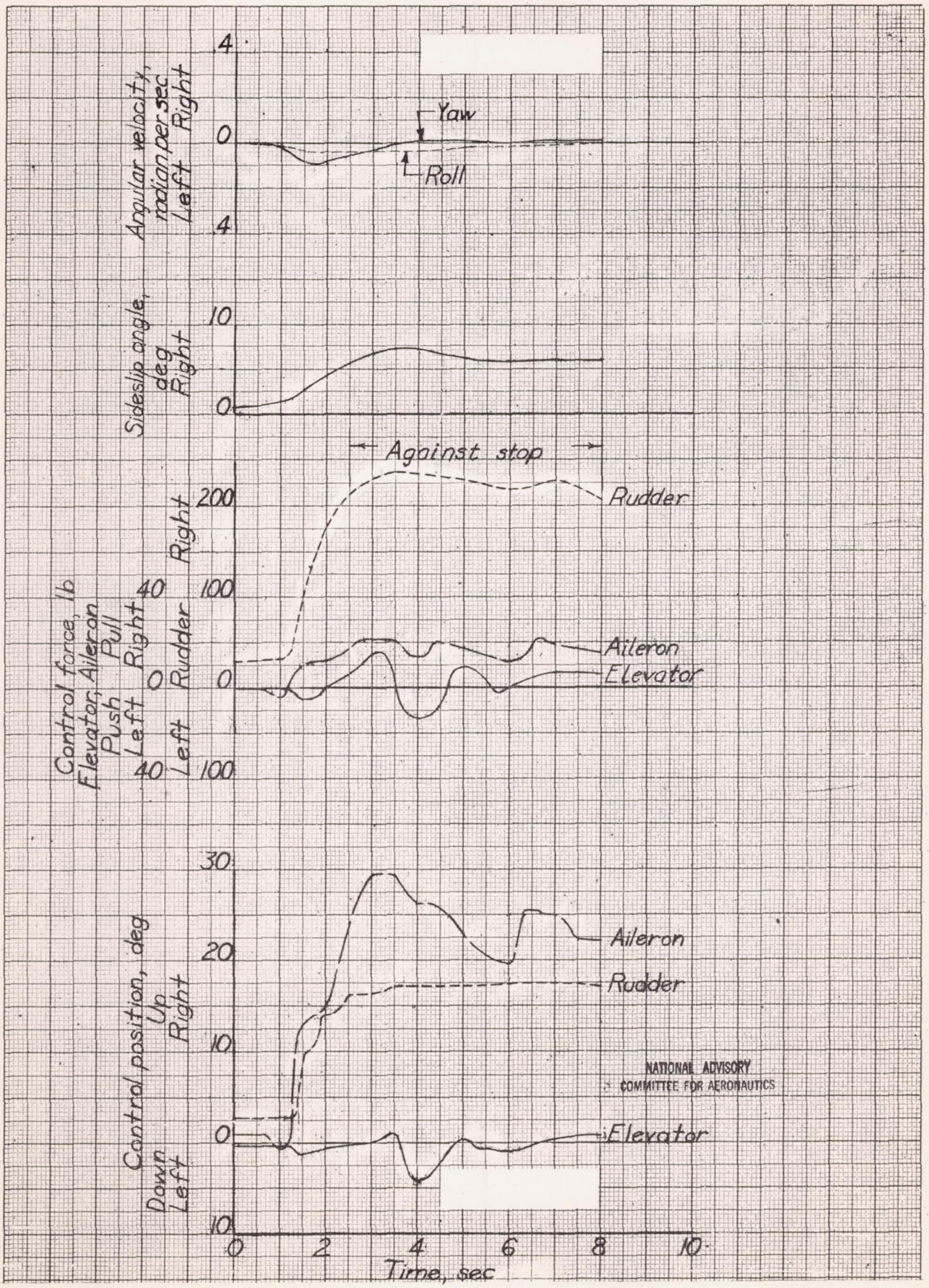

(a) Wings level.

Figure 16 - Time history of abrupt closing of left throttle while in straight flight at 115 miles per hour with landing gear down, flaps one-half down, with full military power (51.5 in. Hg at 2700 RPM high blower at 6500 ft.) cowl flaps one-half open, oil cooler flaps one-half open, Douglas A-26B airplane.

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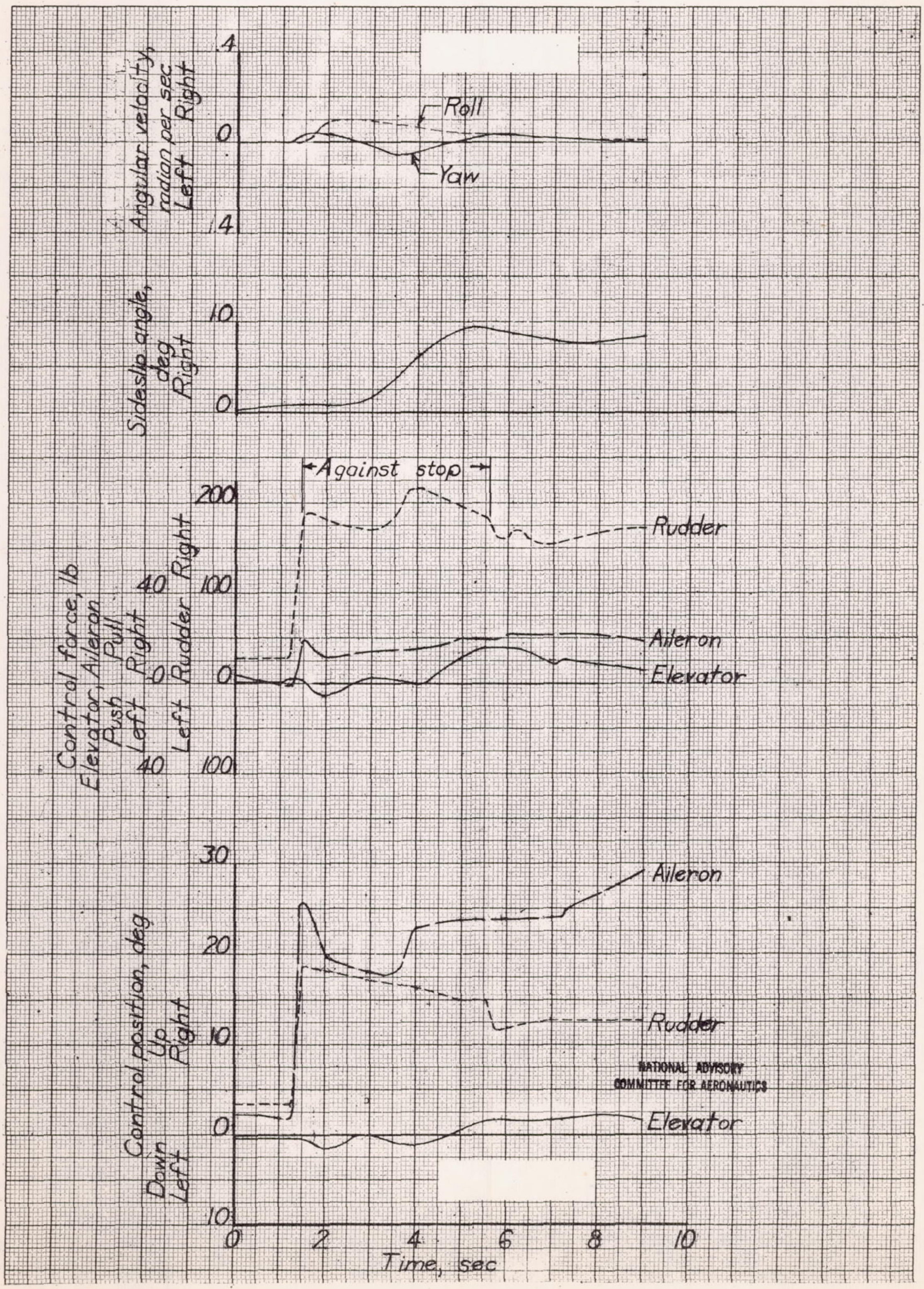

(b) Idling engine high.
Figure 16 - Concluded.

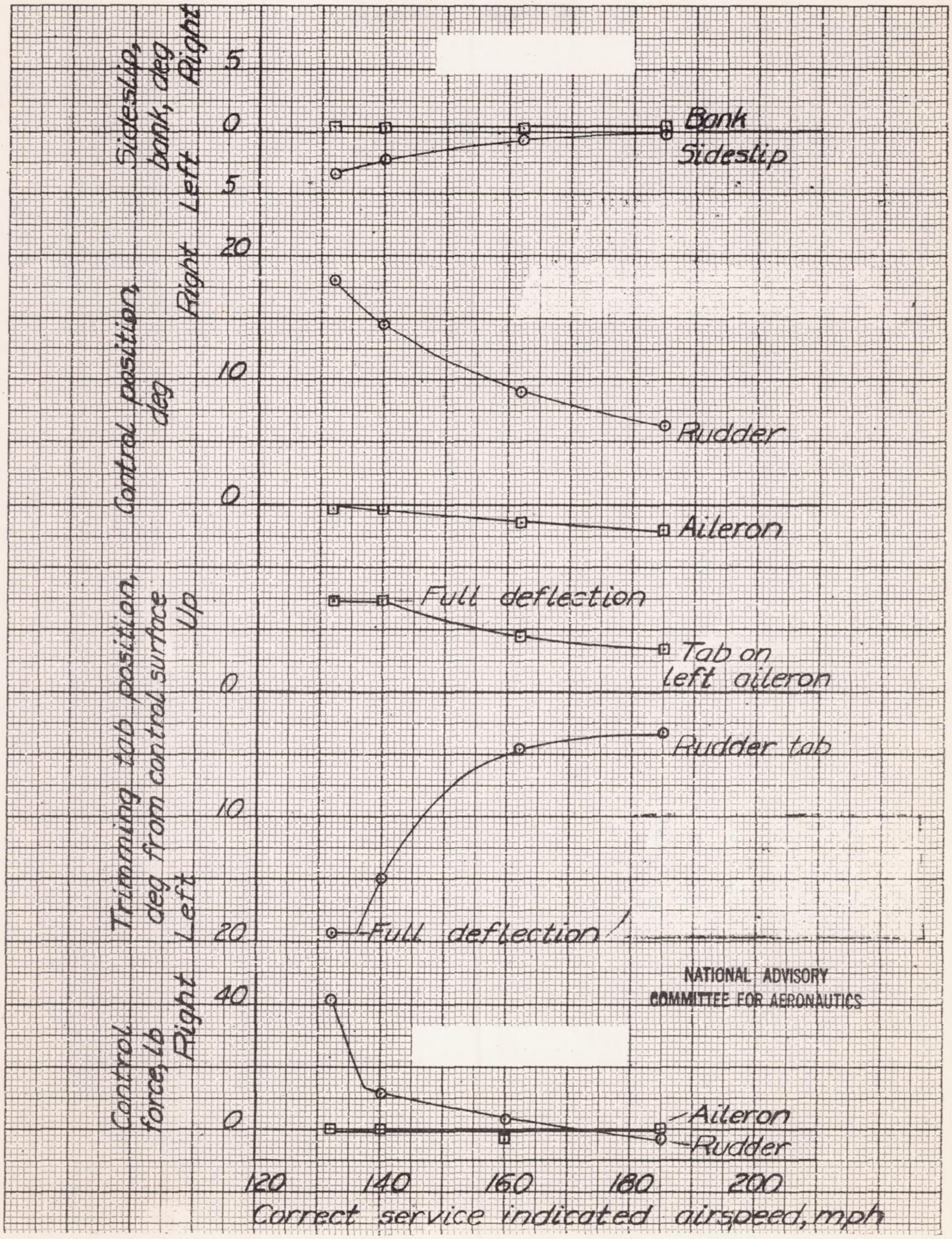

Figure 17.- Static directional trim characteristics with wings level, left propeller feathered, right engine at normal rated power (41.5 in. Hg - 2400 RPM), flaps up, landing gear up, right cowl flaps open, Douglas A-26B airplane.

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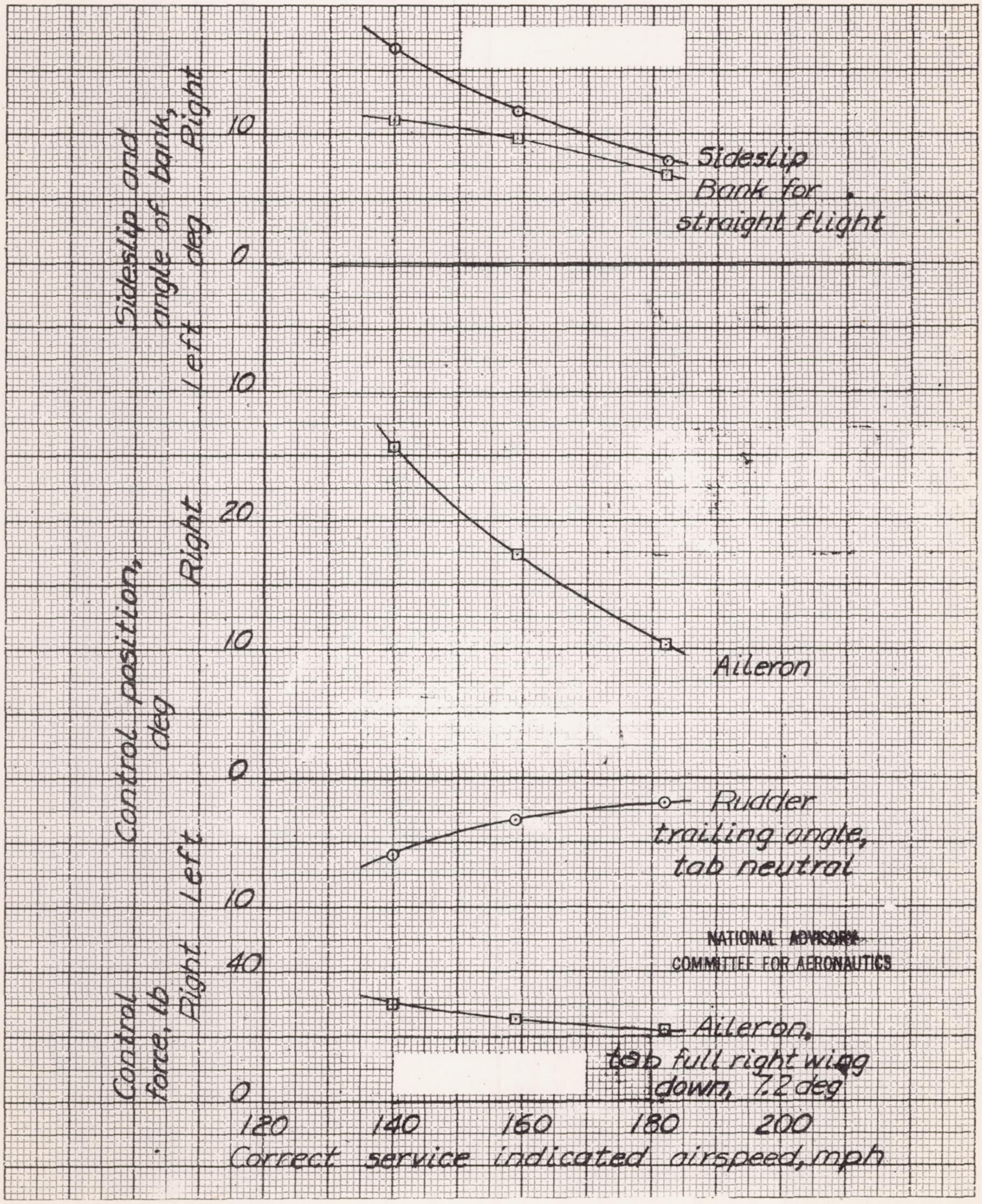

Figure 18.- Rudder-free static directional trim characteristics with left propeller feathered, right engine at normal rated power (41.5 in. Hg - 2400 RPM), flaps up, landing gear up, right cowl flaps open, Douglas A-26B airplane.

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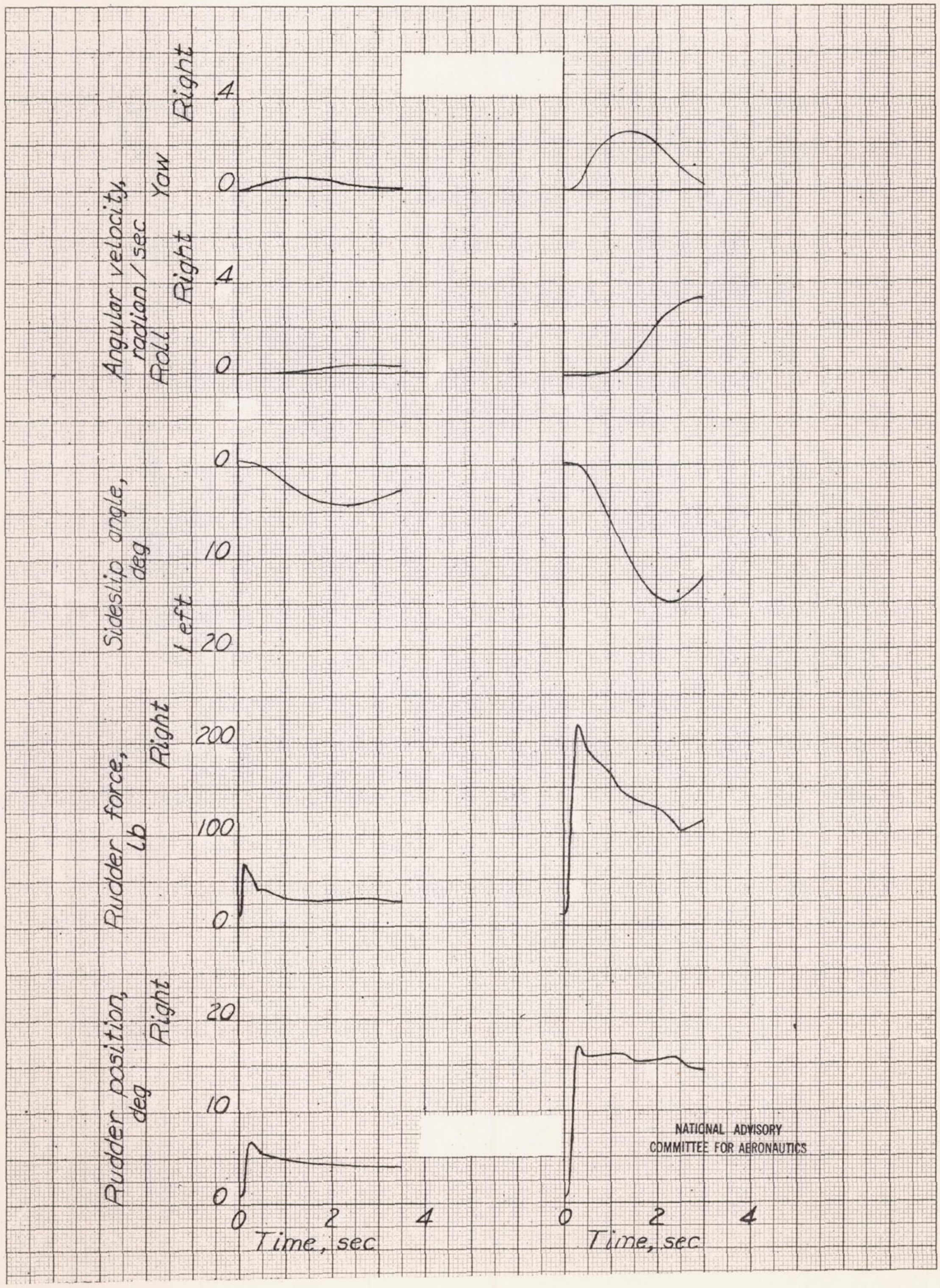

(a) V_i = 140 mph

Figure 19.- Time histories of partial and nearly full deflection right rudder kicks with ailerons and elevator fixed in the rated power clean condition (41.5 in. Hg, 2400 rpm, flaps and landing gear up), Douglas A-26B airplane.

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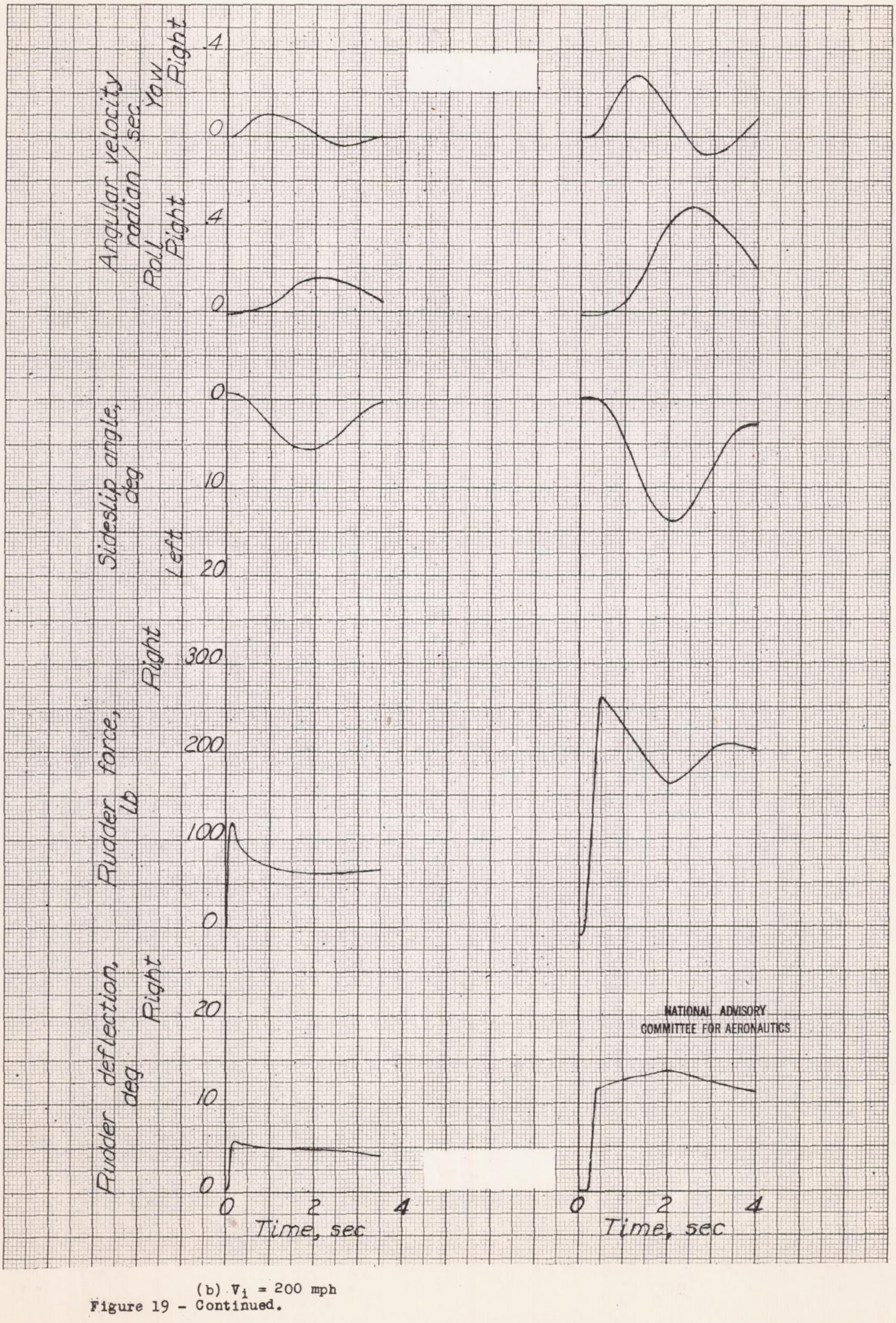
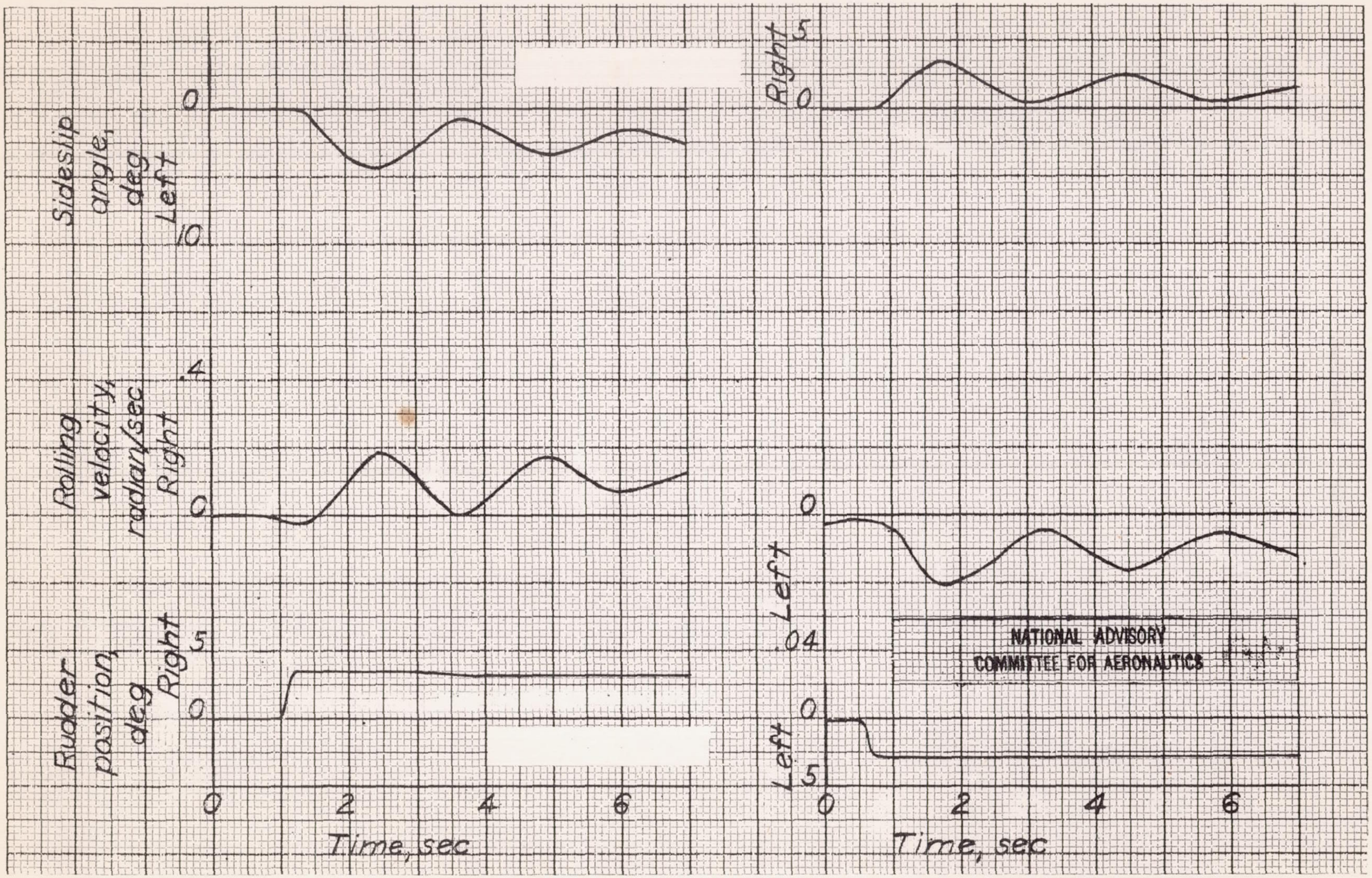


(b) V_i = 200 mph
Figure 19 - Continued.



(c) 320 miles per hour, partial deflection right and left kicks.
(Force and rolling velocity not available for same run.)

Figure 19.- Concluded.

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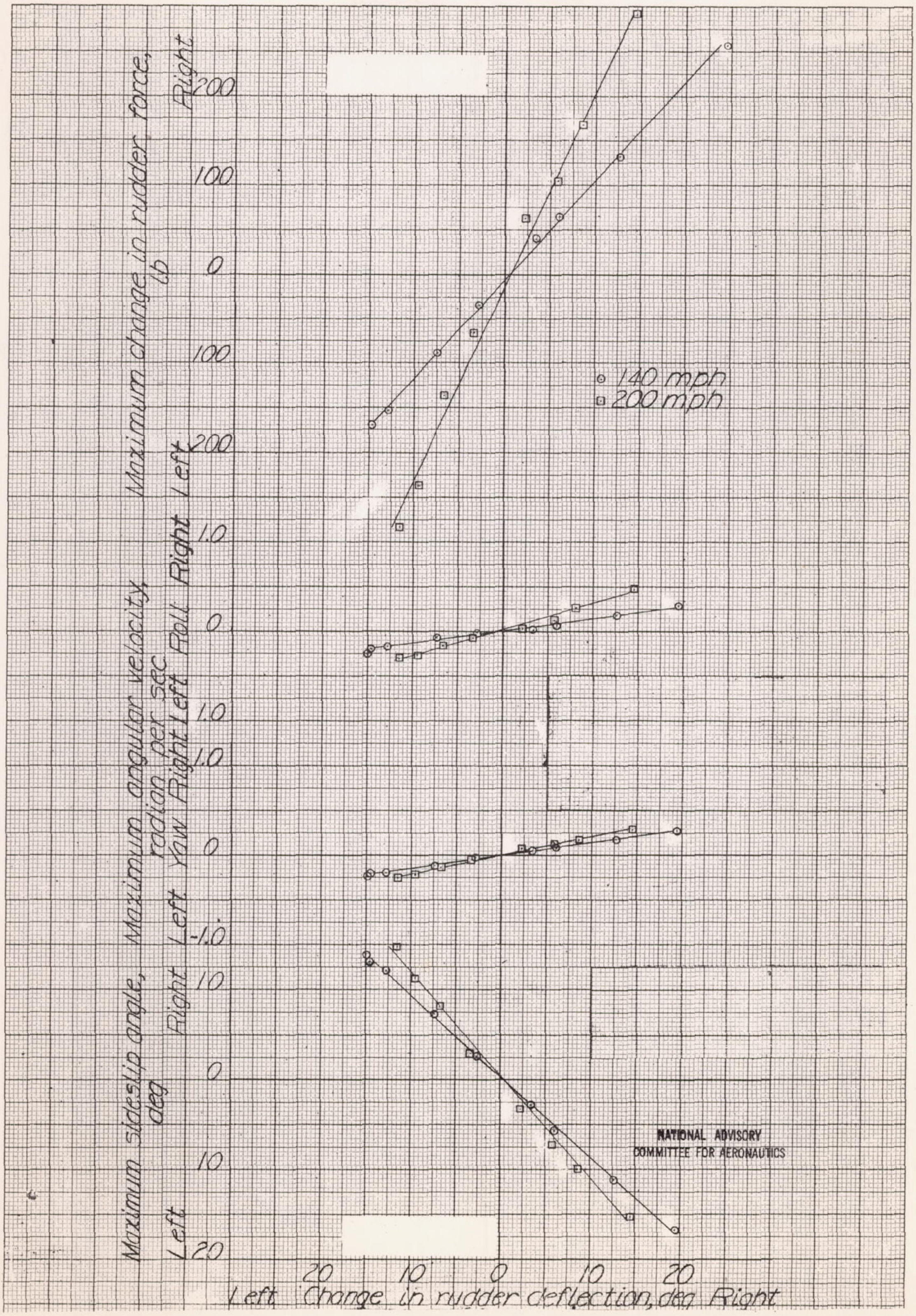

Figure 20.- Variation of maximum rudder force, rolling and yawing velocity, and sideslip angle with rudder position in rudder kicks performed in the gliding condition (engines idling, flaps up, landing gear up), Douglas A-26B airplane.

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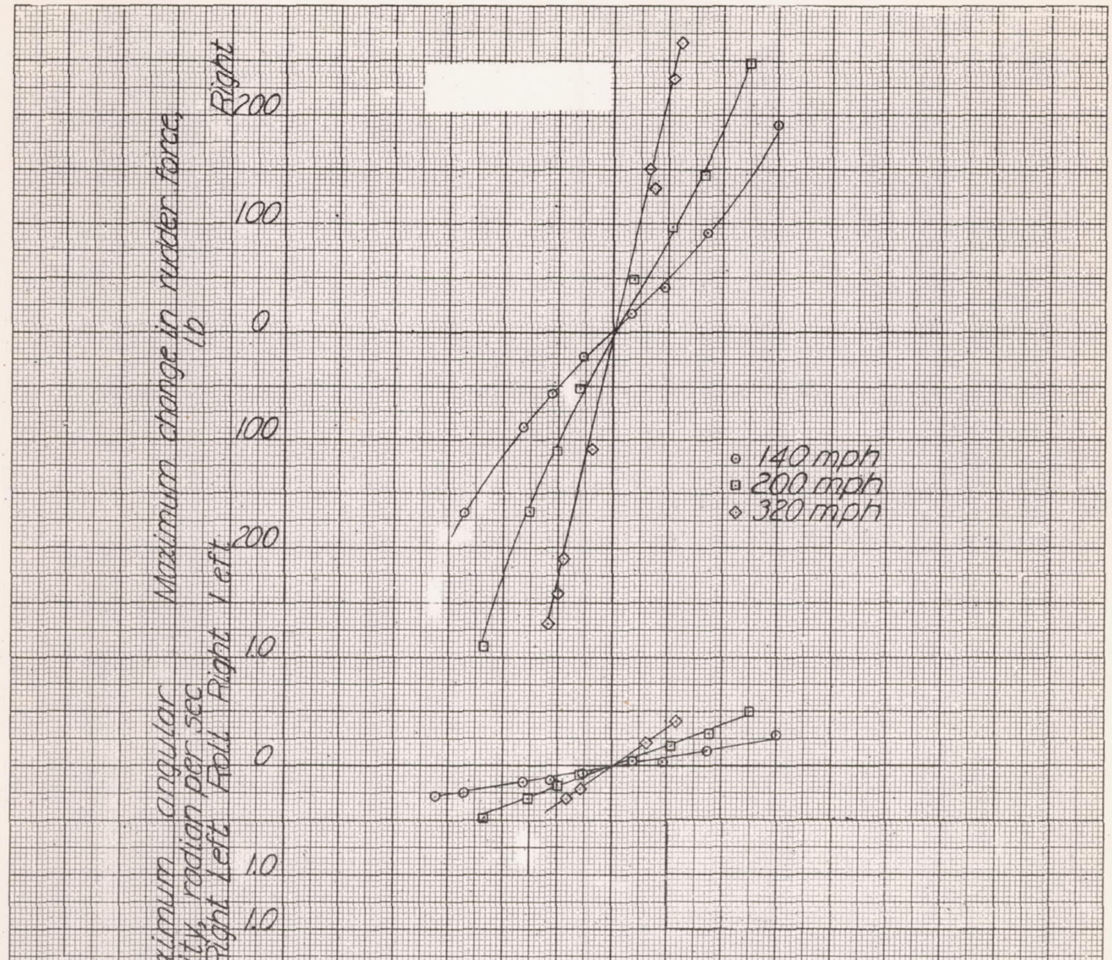

Figure 21 - Variation of maximum rudder force, rolling and yawing velocity, and sideslip angle with rudder position in rudder kicks performed in the rated power, clean condition (41.5 in. Hg, 2400 RPM, flaps up, landing gear up), Douglas A-26B airplane.

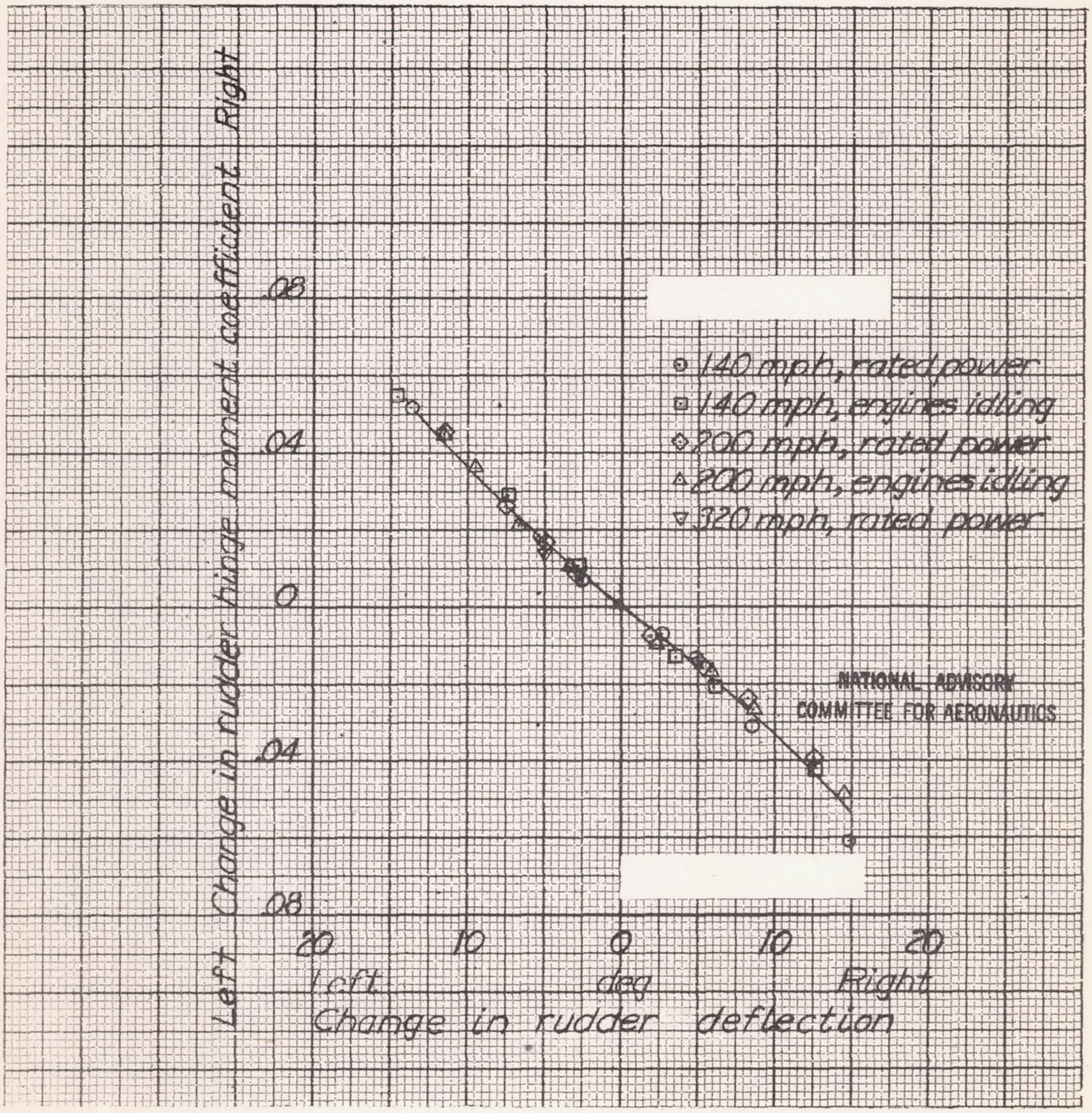

Figure 22.- Variation of rudder hinge moment coefficient with rudder deflection at various speeds with rated power and engines idling in the clean condition, Douglas A-26B airplane.

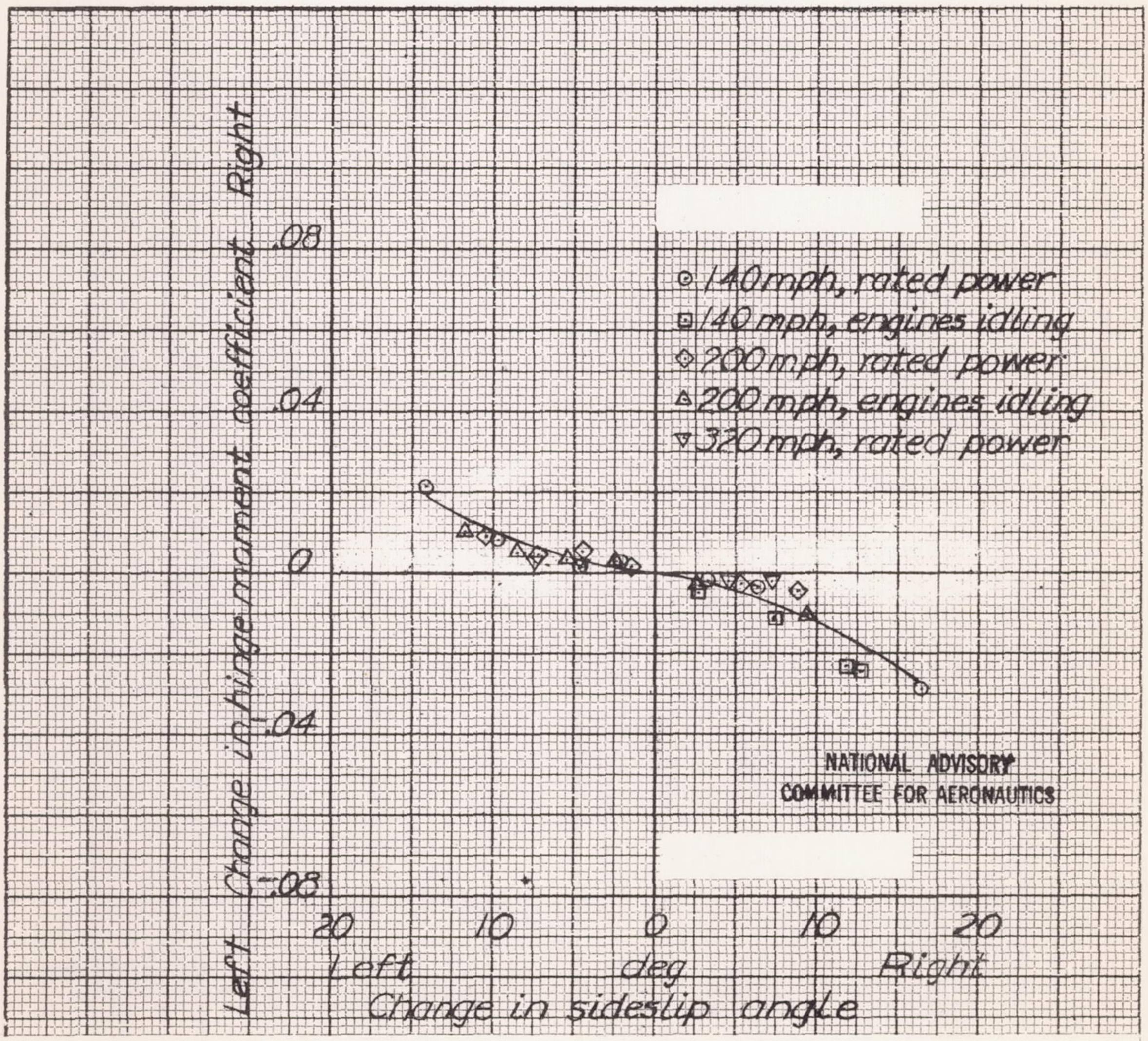

Figure 23.- Variation of rudder hinge moment coefficient with angle of sideslip at various speeds with rated power and engines idling in the clean conditions, Douglas A-26B airplane.

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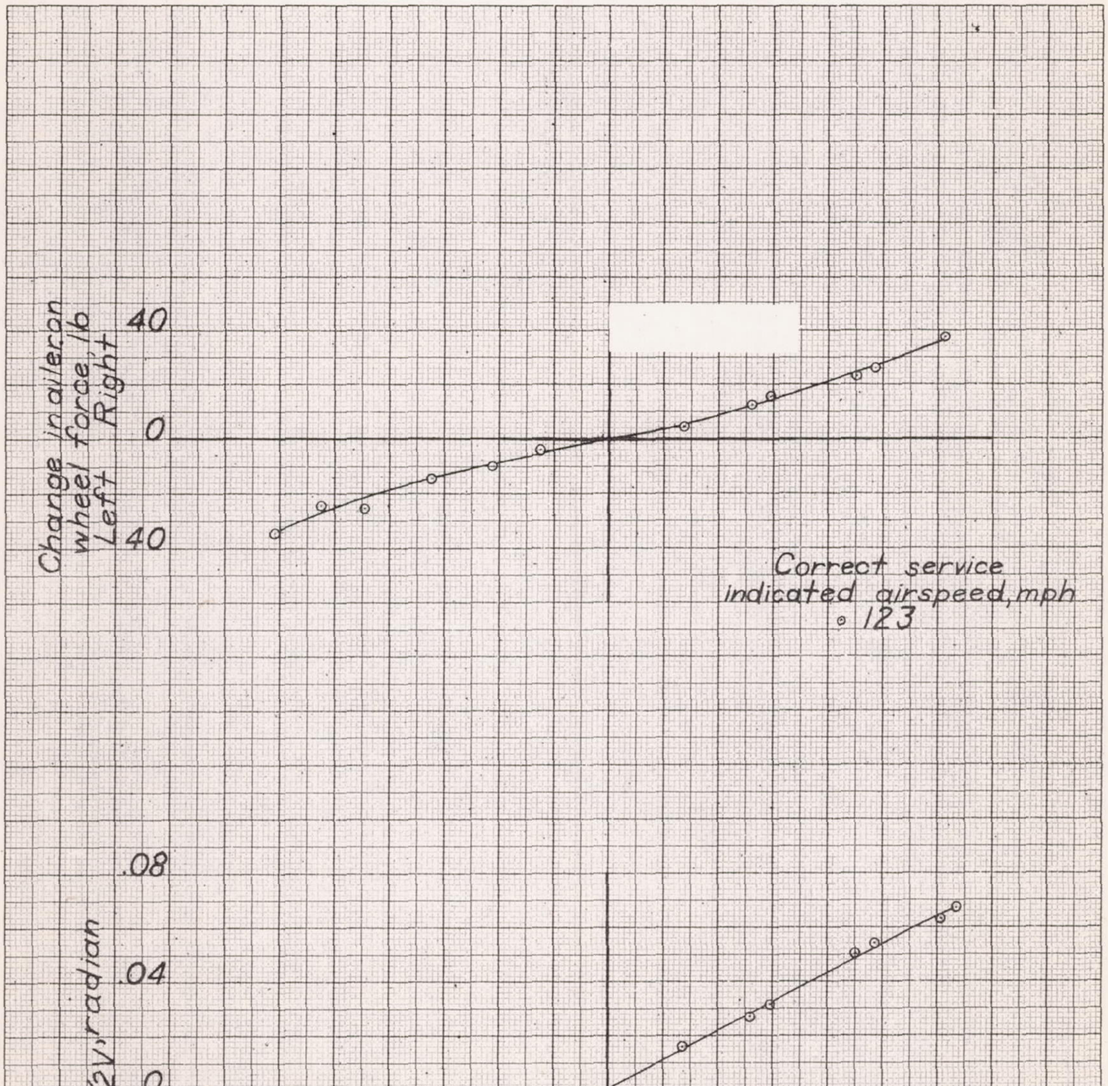

Figure 24 - Variation of aileron wheel force and helix angle pb/2V with change in total aileron angle in rolls with the rudder fixed at 123 miles per hour with flaps and landing gear down and power for level flight, Douglas A-26B airplane.

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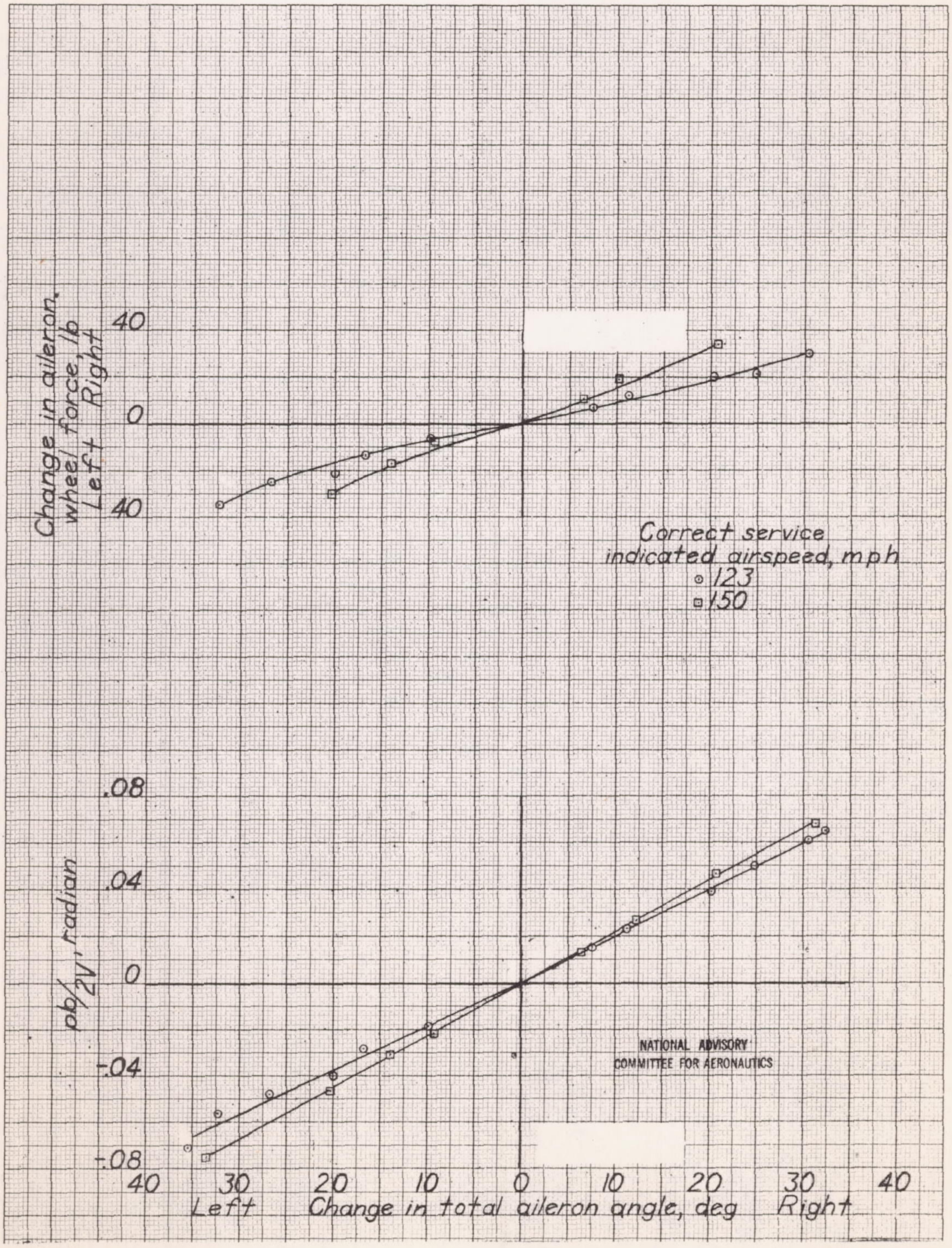

Figure 25 - Variation of aileron wheel force and helix angle pb/2V with change in total aileron angle in rolls with the rudder fixed at various speeds, flaps and landing gear down, engines idling, Douglas A-26B airplane.

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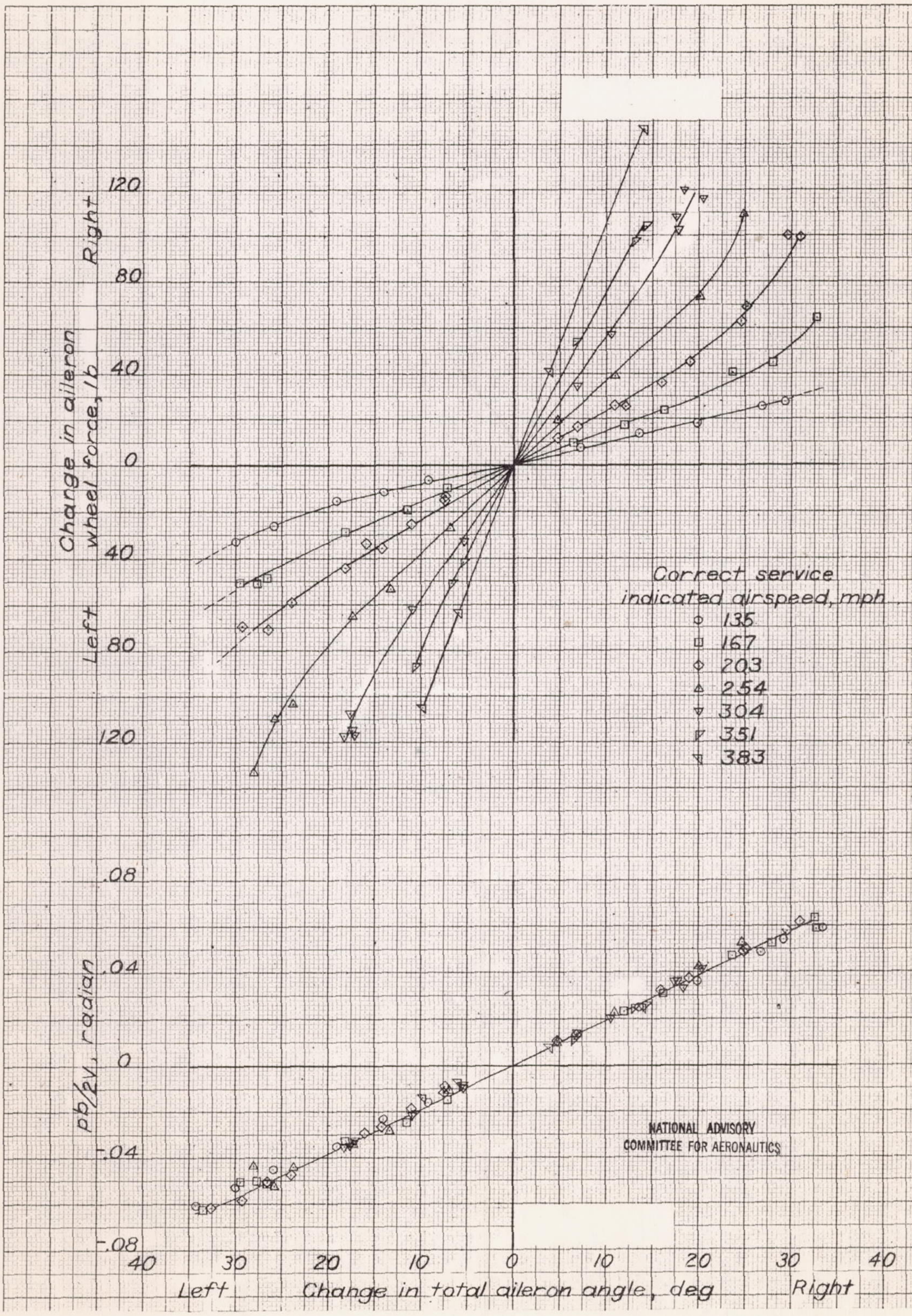

Figure 26 - Variation of aileron wheel force and helix angle pb/2V with change in total aileron angle in rolls with the rudder fixed at various speeds, flaps and gear up, power for level flight or rated power. Douglas A-26B airplane.

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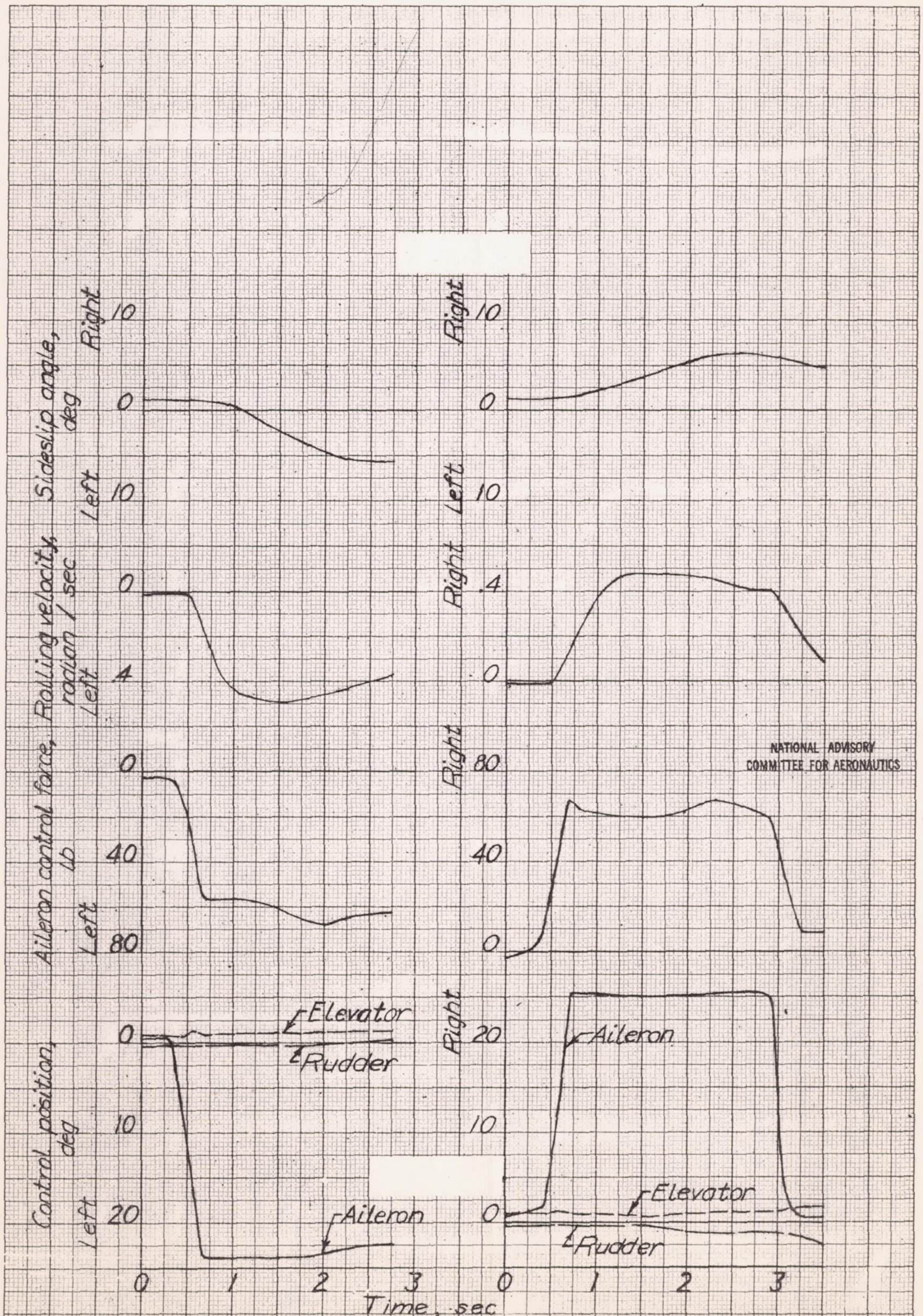

Figure 27 - Time history of aileron rolls at 205 miles per hour in the clean condition with power for level flight (26 in. Hg at 2400 rpm, flaps and landing gear up), Douglas A-26B airplane.

L-606

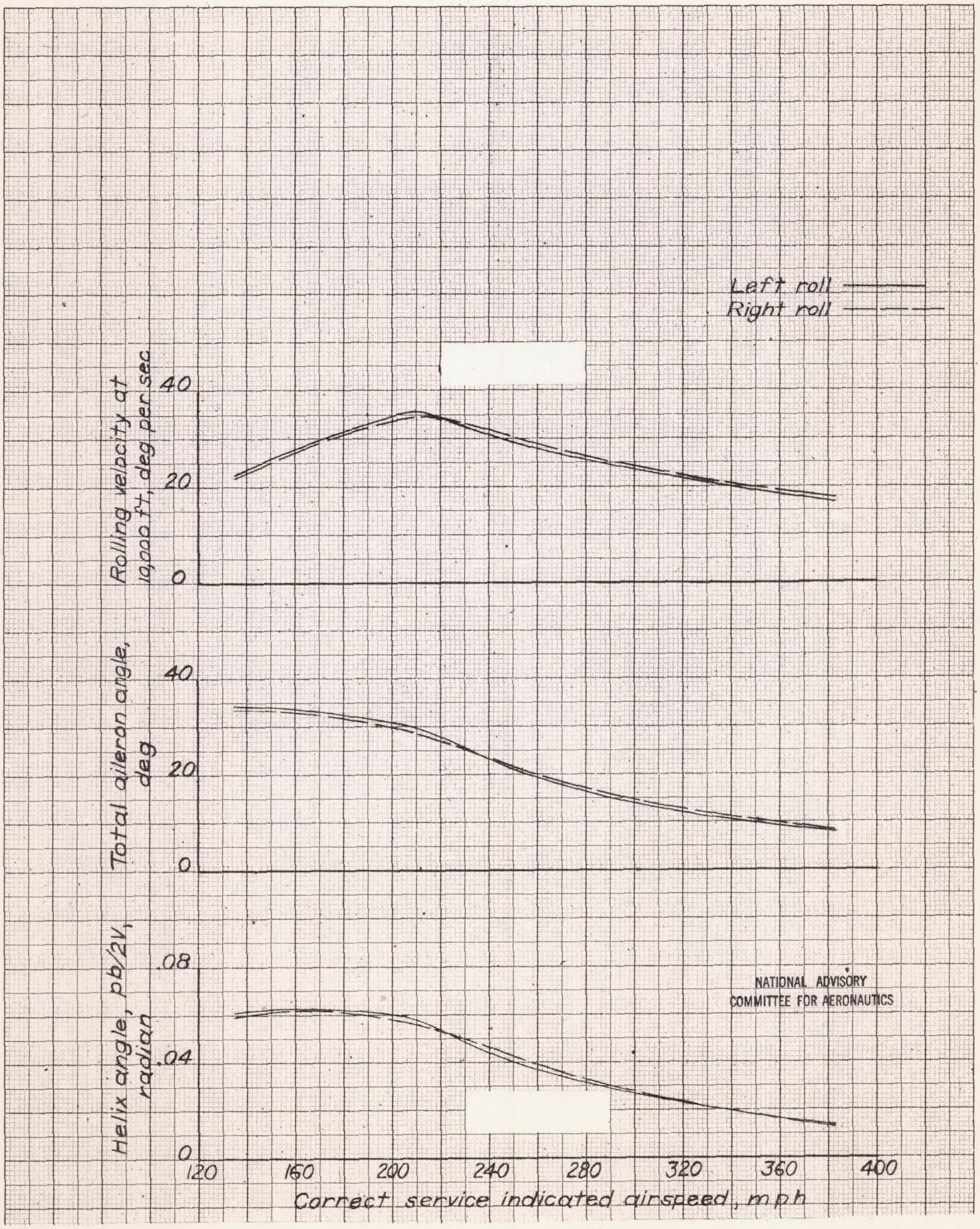

Figure 28 - Variation of helix angle pb/2V, total aileron angle, and rolling velocity at 10,000 feet altitude, with speed for an 80 pound wheel force. Flap and gear up, level flight or rated power, Douglas A-26B airplane.

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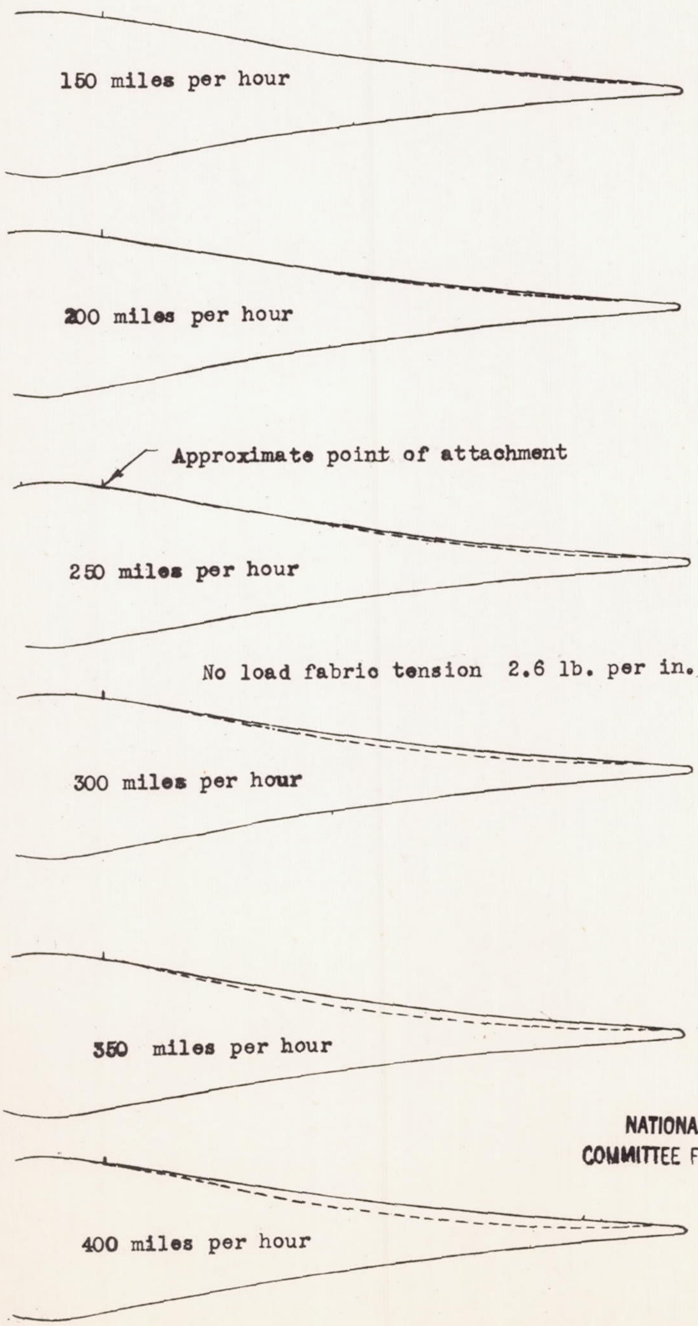

Figure 29.- Fabric distortion on the upper surface of the left aileron at various indicated airspeeds in straight flight, Douglas A-26B airplane.

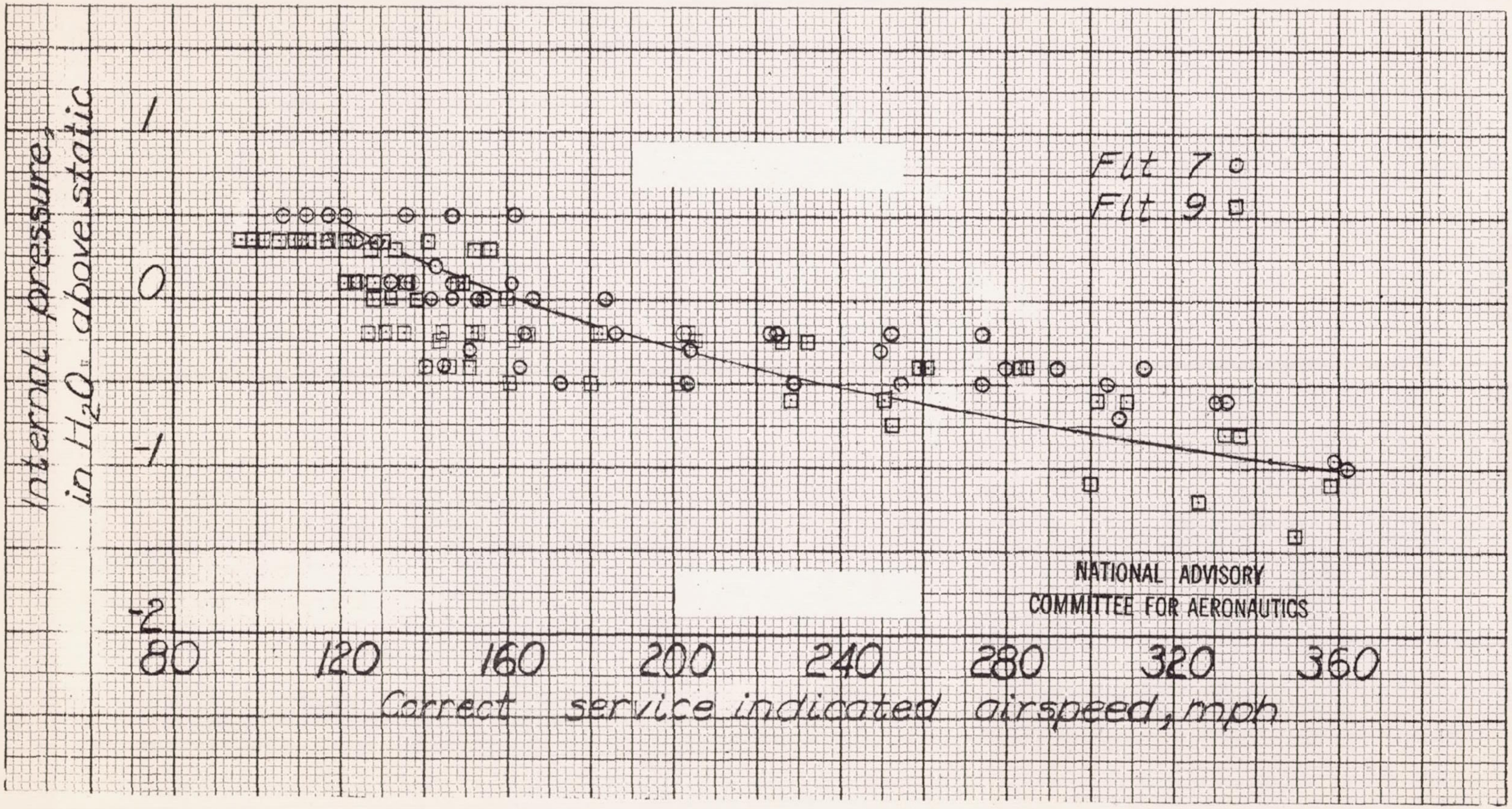

Figure 30.- Variation of internal pressure in the left aileron with speed in straight flight, Douglas A-26B airplane.

L-606

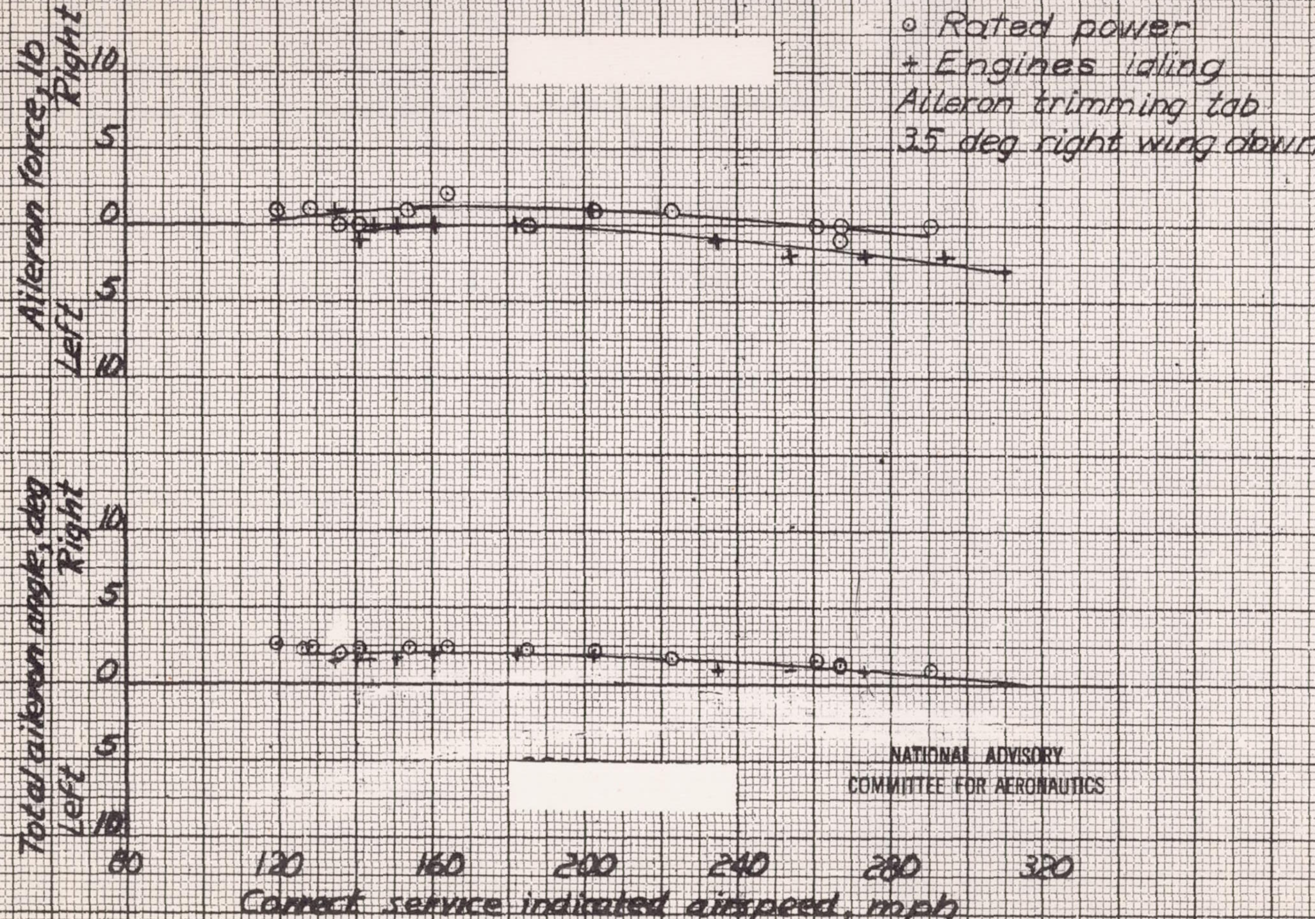

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Figure 31.- Aileron angle and aileron force required for trim throughout speed range. Flaps and gear up, Douglas A-26B airplane.

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