NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

ADVANCE RESTRICTED REPORT

# FLIGHT TESTS OF THE LATERAL CONTROL CHARACTERISTICS OF AN F6F-3 AIRPLANE EQUIPPED WITH SPRING-TAB AILERONS

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## SUMMARY

Flight tests were made to determine the lateral control characteristics of an F6F-3 airplane equipped with spring-tab ailerons, which were developed by the Grumman Aircraft Engineering Corp. and have been made a production installation on F6F airplanes.

The flight tests showed that the spring-tab ailerons had desirably light stick forces and no tendency to overbalance. Although the tabs were not mass-balanced, no flutter tendencies were indicated at speeds up to 400 miles per hour, and any oscillations following abrupt control deflections were heavily damped. The spring-tab ailerons gave 80 percent higher values of effectiveness with a 30-pound stick force at 400 miles per hour than the original ailerons on the F6F-3 airplane. At speeds lower than 275 miles per hour, the spring-tab ailerons were less effective than the original ailerons because of restricted aileron travel as a result of the use of large stick deflection to deflect the spring tab. Recommendations are made for modifications that would increase the aileron effectiveness at low speeds without affecting the lateral control at high speeds. The modifications consist of increasing the available aileron deflection and modifying the spring-tab arrangement. Such an arrangement might, however, be more susceptible to flutter than the production installation.

## INTRODUCTION

Flight tests were made to determine the lateral control characteristics of an F6F-3 airplane equipped with spring-tab ailerons, which were developed by the Grumman Aircraft Engineering Corp. and have been made a production

## INSTRUMENTATION

Standard NACA photographic recording instruments, synchronized by an electrical timer, were used to measure airspeed, rolling velocity, aileron stick force, and the position of the spring tab, aileron, and stick. Correct service indicated airspeed $V_{i_s}$ used herein is defined as

$$V_{i_s} = Kf_o\sqrt{q_c}$$

where

$K = 45.08$

$f_o$ compressibility correction at sea level

$q_c$ impact pressure, measured difference between static and total-head pressures corrected for position error, inches of water

## TEST RESULTS AND DISCUSSION

Tests were made to determine whether the spring-tab ailerons tended to oscillate or flutter in the speed range to 400 miles per hour. These tests consisted of maneuvers in which the pilot abruptly deflected and released the aileron control at various speeds. Typical time histories of the maneuvers are shown in figure 6, which indicates that any oscillation of the aileron or spring tab was heavily damped and disappeared completely within two cycles. The pilot reported no flutter in the speed range up to 400 miles per hour.

The lateral control characteristics were measured in abrupt aileron rolls with the rudder held fixed as described in reference 1. These rolls were made at increments of 50 miles per hour from approximately 100 to 400 miles per hour. The results are given as the variation of helix angle $pb/2V$ and change in aileron stick force at various speeds with the change in total aileron angle in figure 7 and with stick position in figure 8. No force data are shown in these figures for the spring-tab ailerons are less effective than the original ailerons at speeds lower than approximately 275 miles per hour. The loss in effectiveness of the spring-tab ailerons is caused by the limited aileron travel, which results from the use of large stick deflection to deflect the spring tab. At speeds greater than 275 miles per hour, the effect of the lighter stick forces of the spring-tab ailerons becomes predominant and, as a result, the aileron effectiveness obtained with a 30-pound stick force at 400 miles per hour is approximately 80 percent higher with the spring-tab ailerons than the aileron effectiveness obtained with the original ailerons.

The loss in effectiveness of the spring-tab ailerons can be decreased at low speeds without affecting the desirably light stick forces at high speeds if a stiffer spring is used and if, at the same time, the length of the tab actuating arm (fig. 2) is so increased that the ratio of stick force to tab deflection is kept the same as in the spring-tab aileron tested. In this suggested arrangement, the stick deflection required for full tab deflection would be decreased and this decrease would allow larger aileron deflection. Such an arrangement, however, might make the tab installation more susceptible to flutter (reference 2); that is, the tab would have a greater mechanical advantage over the control system than the spring-tab tested and, therefore, inertia effects of the tab would be more likely to cause flutter. Further increases in aileron effectiveness at the lower speeds could be accomplished by increasing the down-aileron deflection to the same value as the present up-aileron deflection. Increases in the up-aileron deflection are not recommended, however, since figure 9 indicates flow separation about the nose balance and any increase in up-aileron deflection might therefore result in aileron buffet at full deflection. Although the increase in down-aileron deflection might result in somewhat higher stick forces throughout the speed range, some reduction could be made in the spring stiffness to reduce the stick forces to the present values and, at the same time, retain increased aileron effectiveness at low speeds.

## CONCLUSIONS

Flight tests to determine the lateral control characteristics of an F6F-3 airplane equipped with spring-tab ailerons indicated the following conclusions:

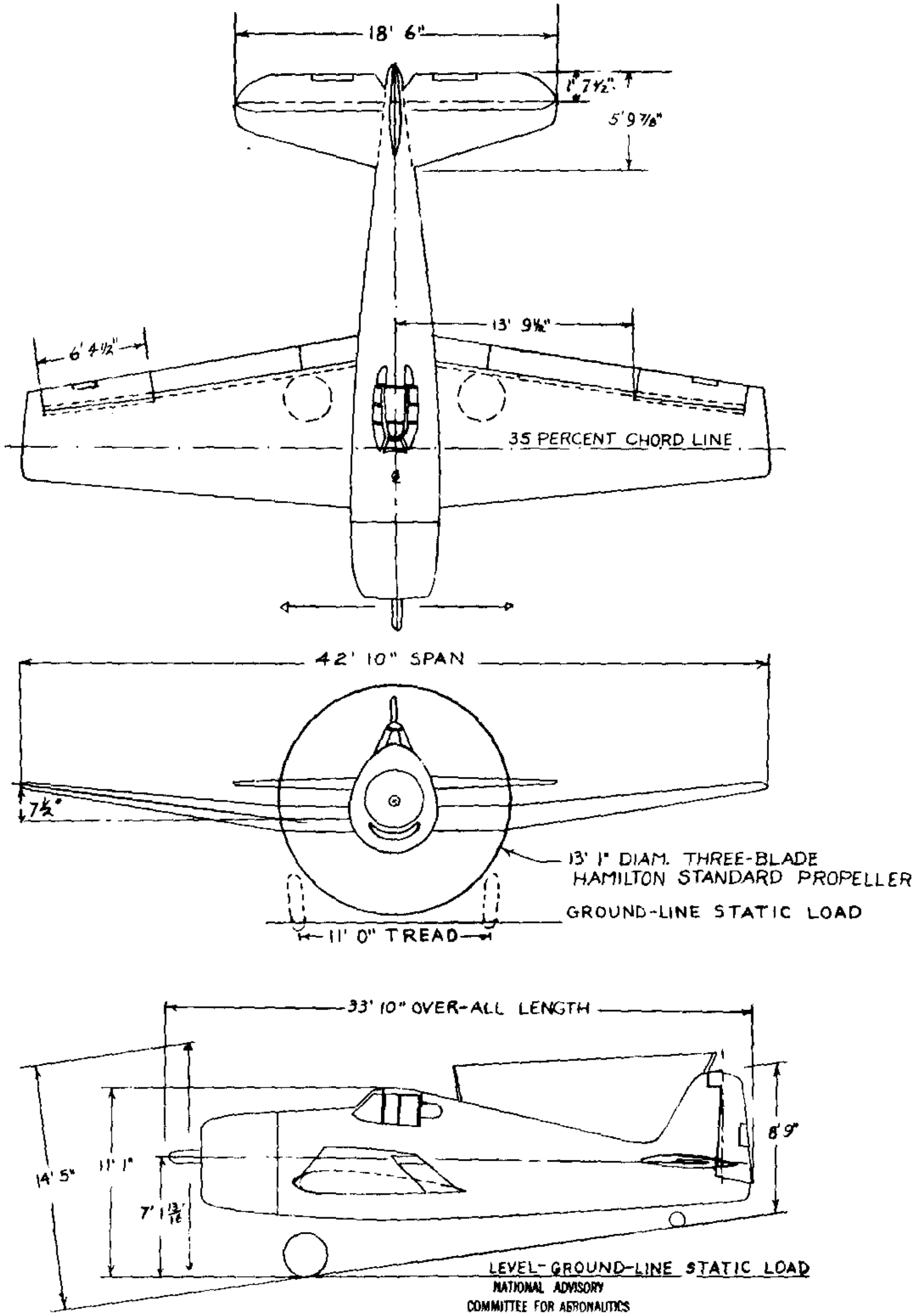


Figure 1.- Three-view drawing of F6F-3 airplane.

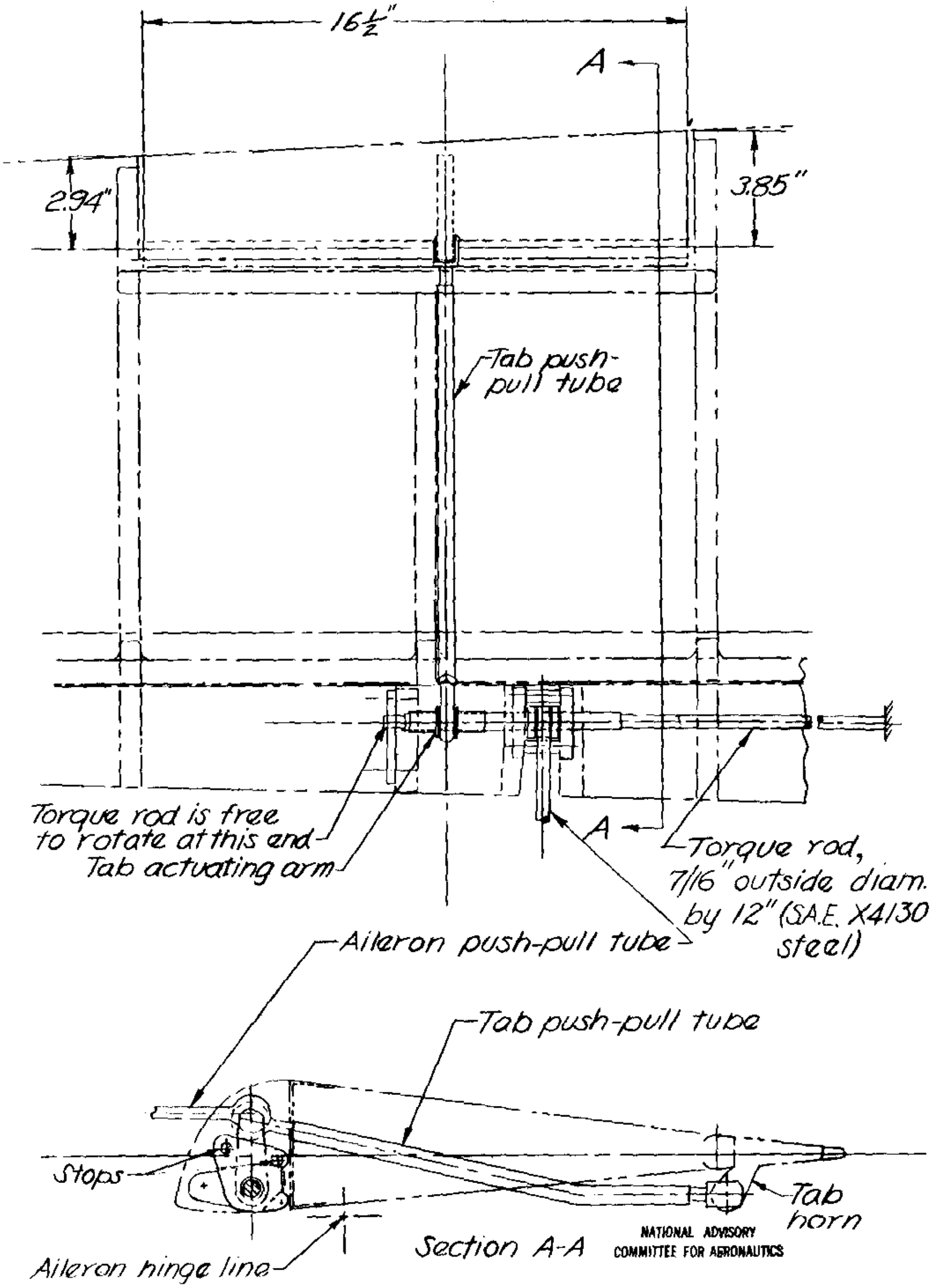


Figure 2.- Spring-tab-aileron arrangement of F6F-3 airplane. (Data furnished by Grumman Aircraft Engineering Corp.)

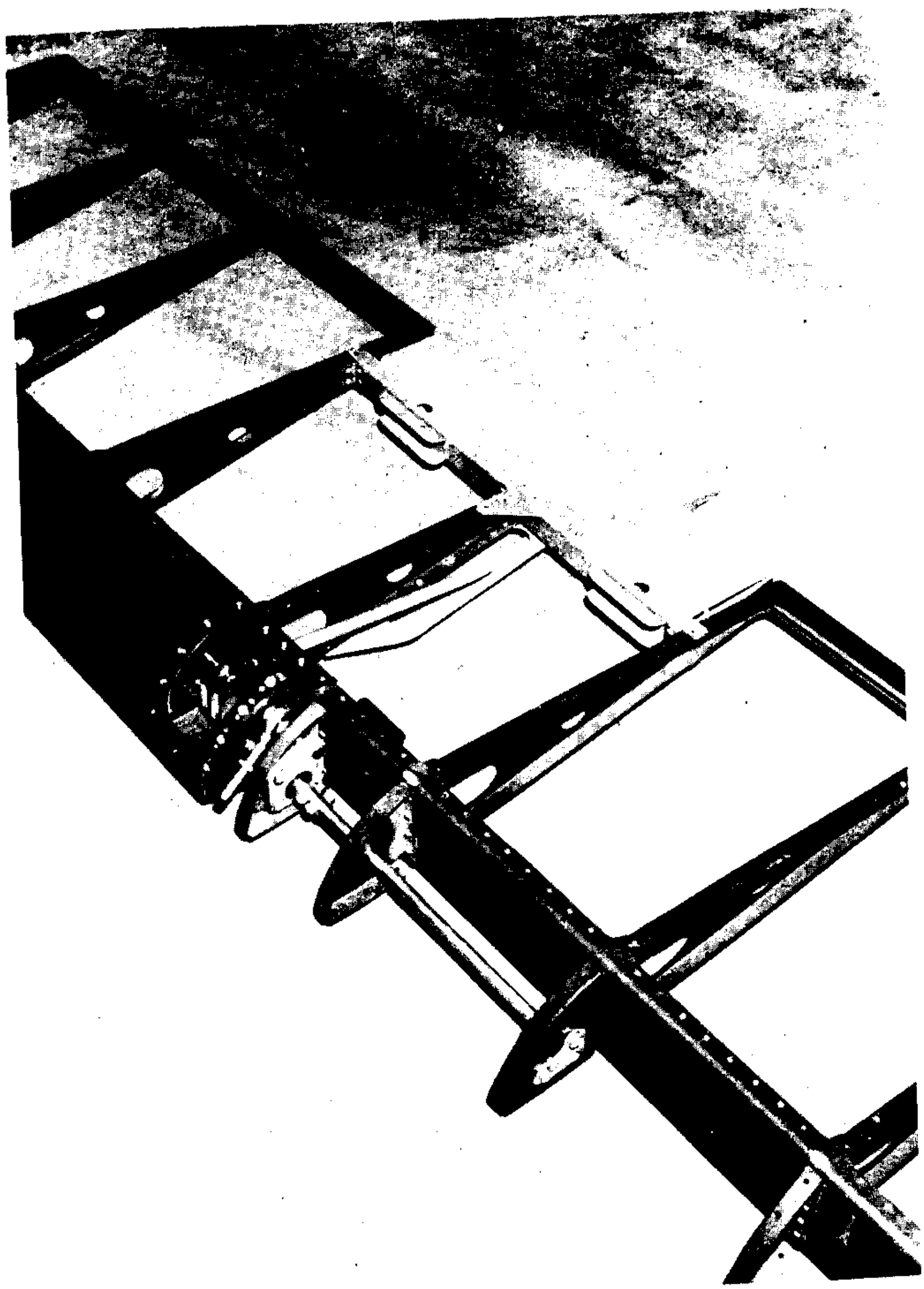

Figure 3.- Detail view of right spring-tab aileron. F6F-3 airplane.
(Photograph furnished by Grumman Aircraft Engineering Corp.)

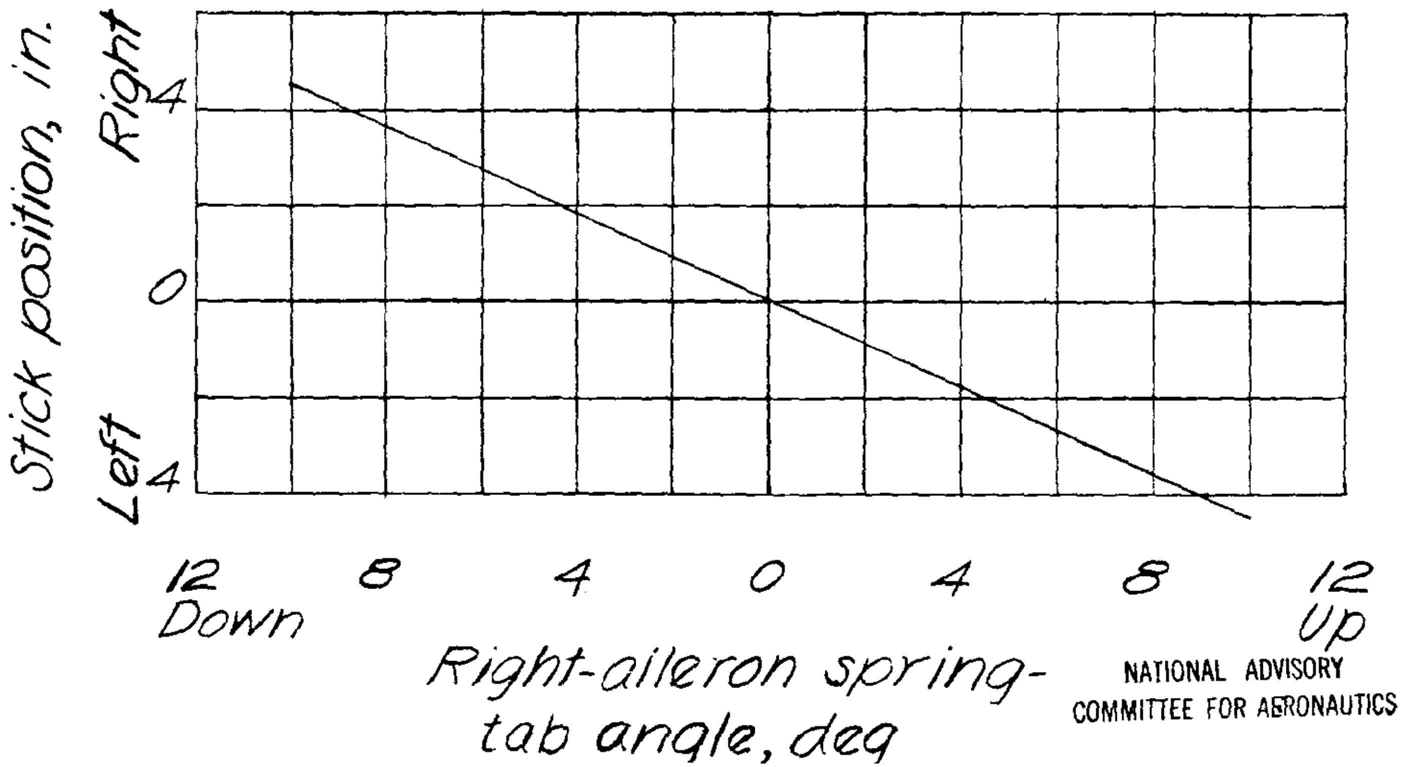


Figure 4.- Variation of stick position with right-aileron spring-tab angle. F6F-3 airplane; ailerons held neutral.

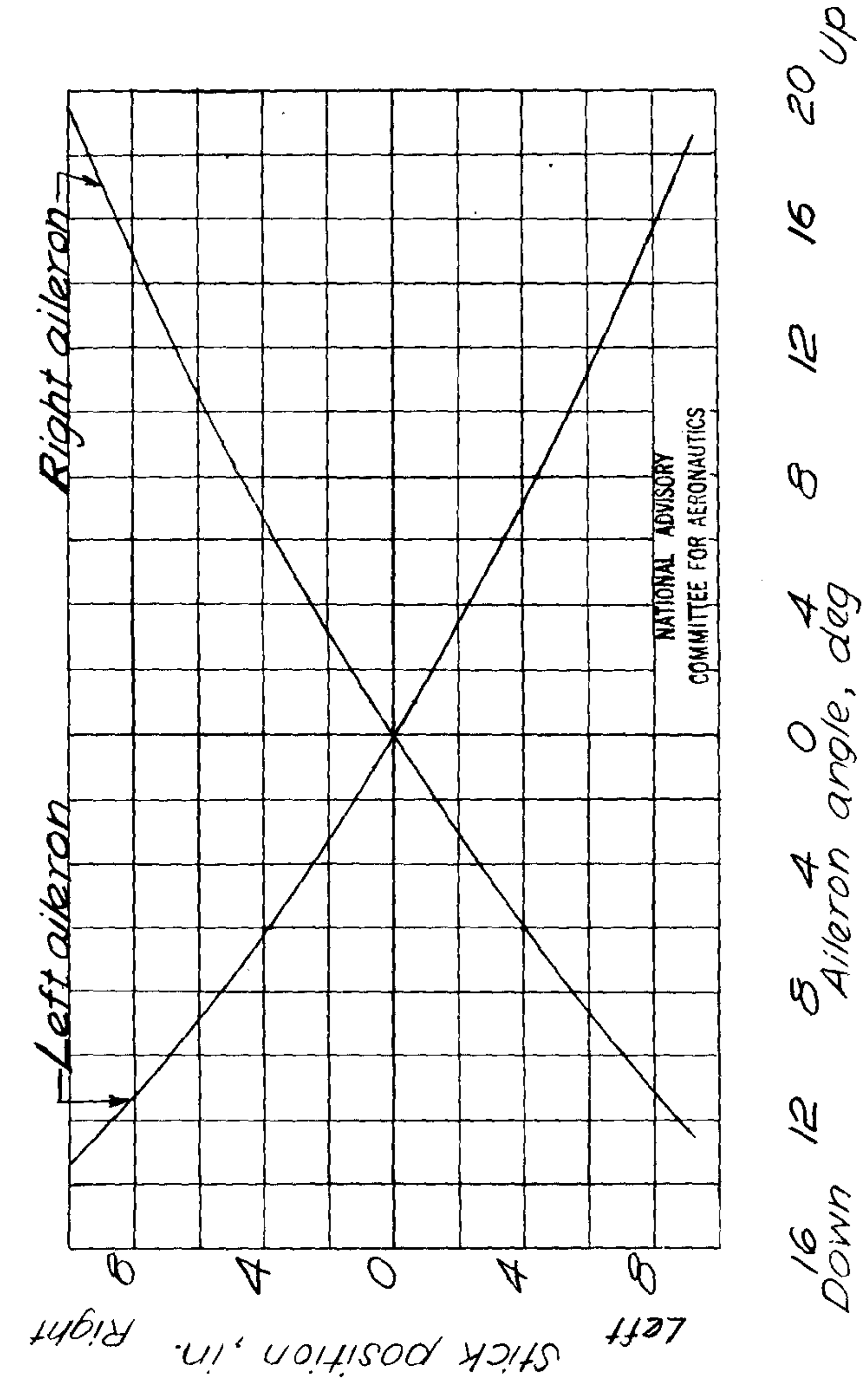


Figure 5.- Variation of stick position with left- and right-aileron angles. F6F-3 airplane with spring-tab ailerons; no load on control system.

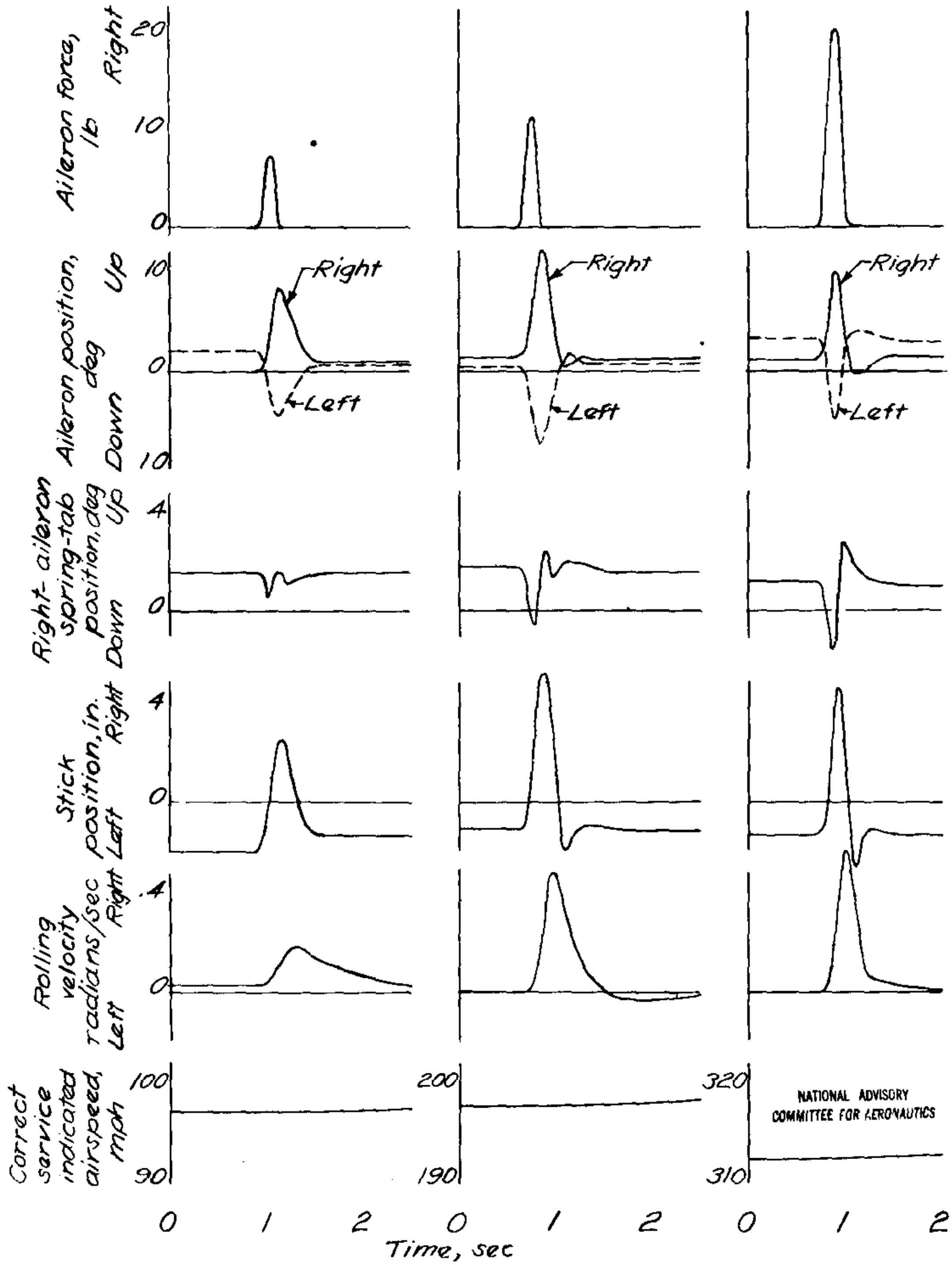


Figure 6.- Time histories of typical attempted aileron oscillations following abrupt deflection of control. F6F-3 airplane with spring-tab ailerons.

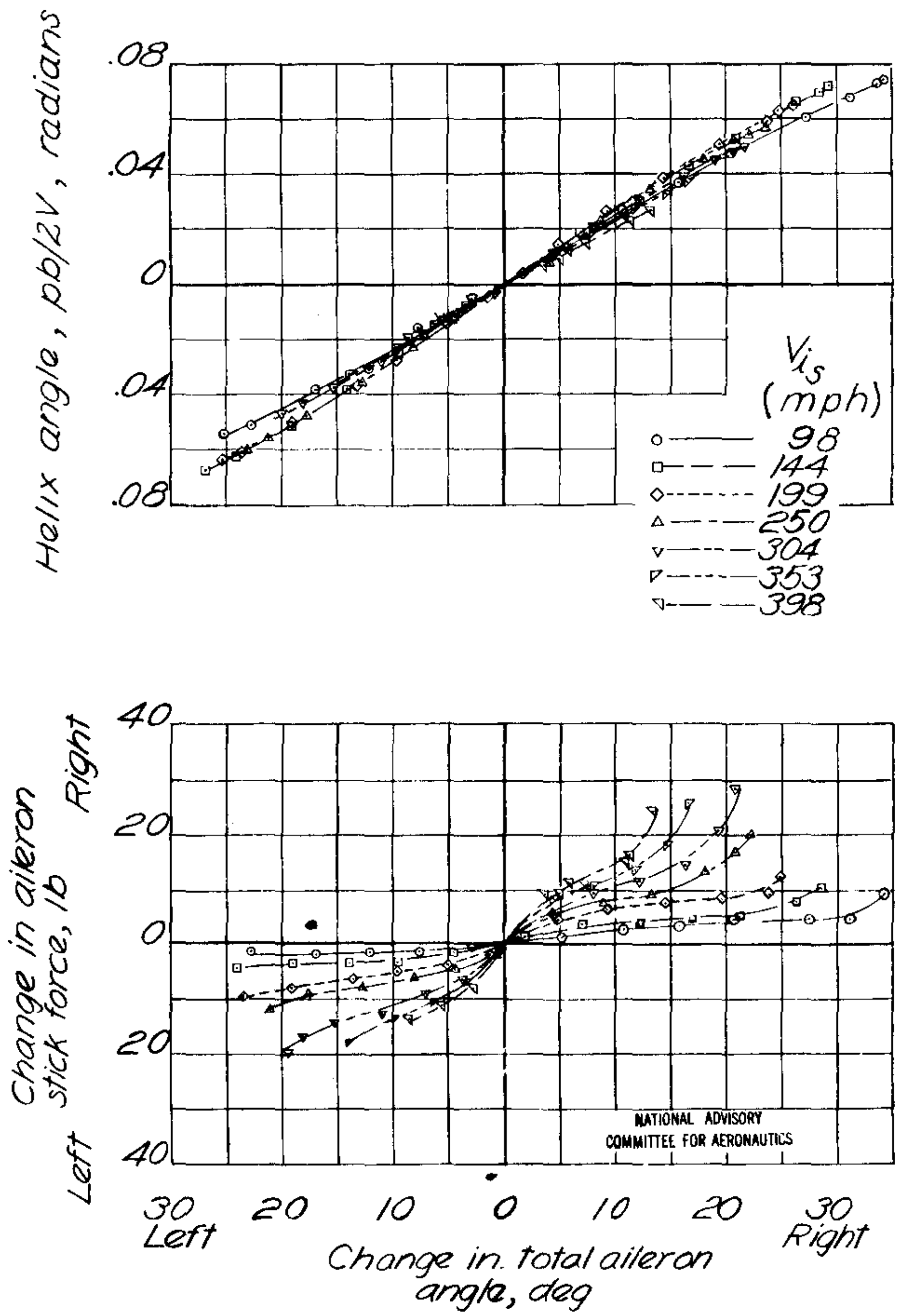


Figure 7.- Variation of pb/2V and change in aileron stick force with change in total aileron angle. F6F-3 airplane with spring-tab ailerons.

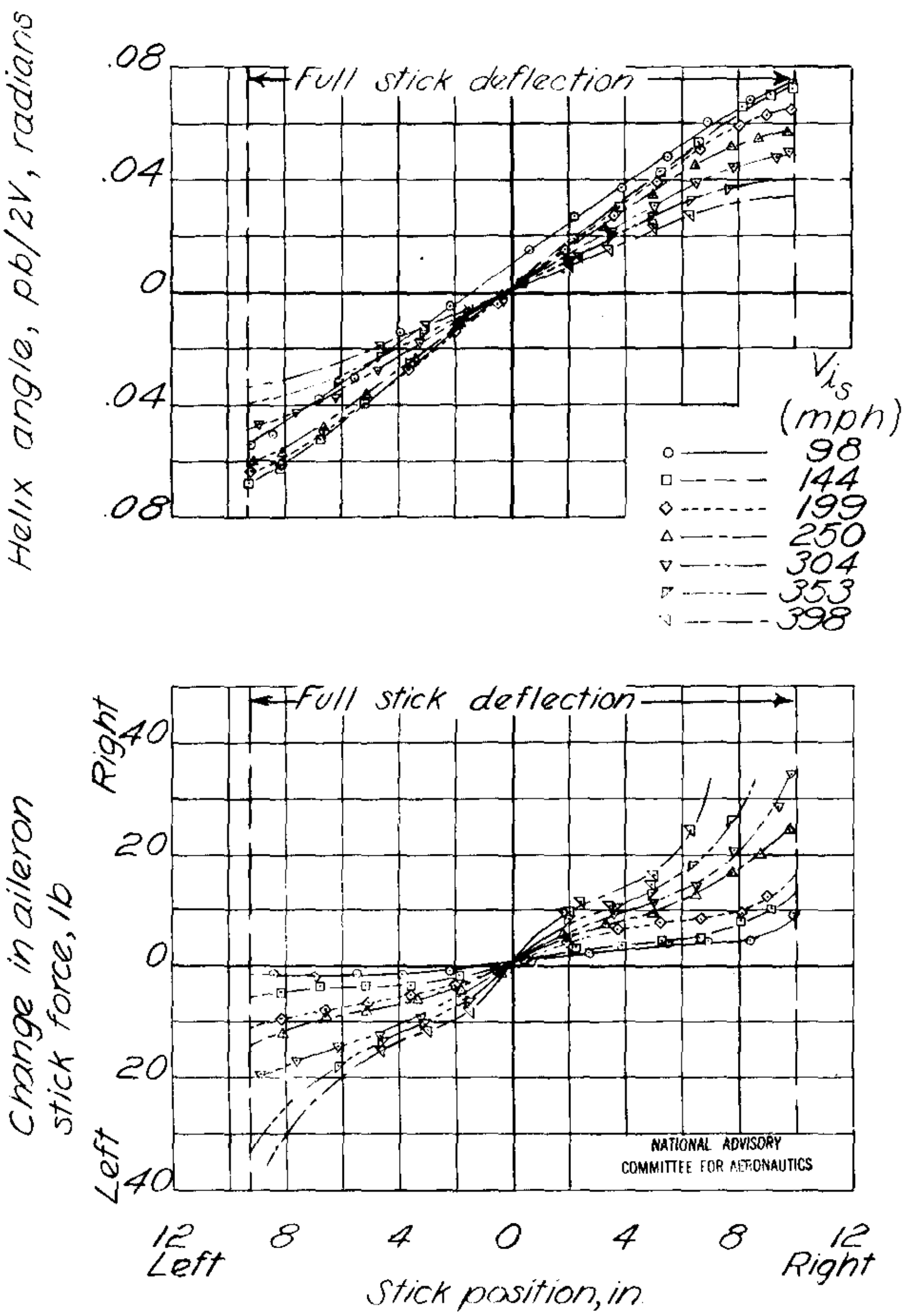


Figure 8.- Variation of pb/2V and change in aileron stick force with stick position. F6F-3 airplane with spring-tab ailerons.

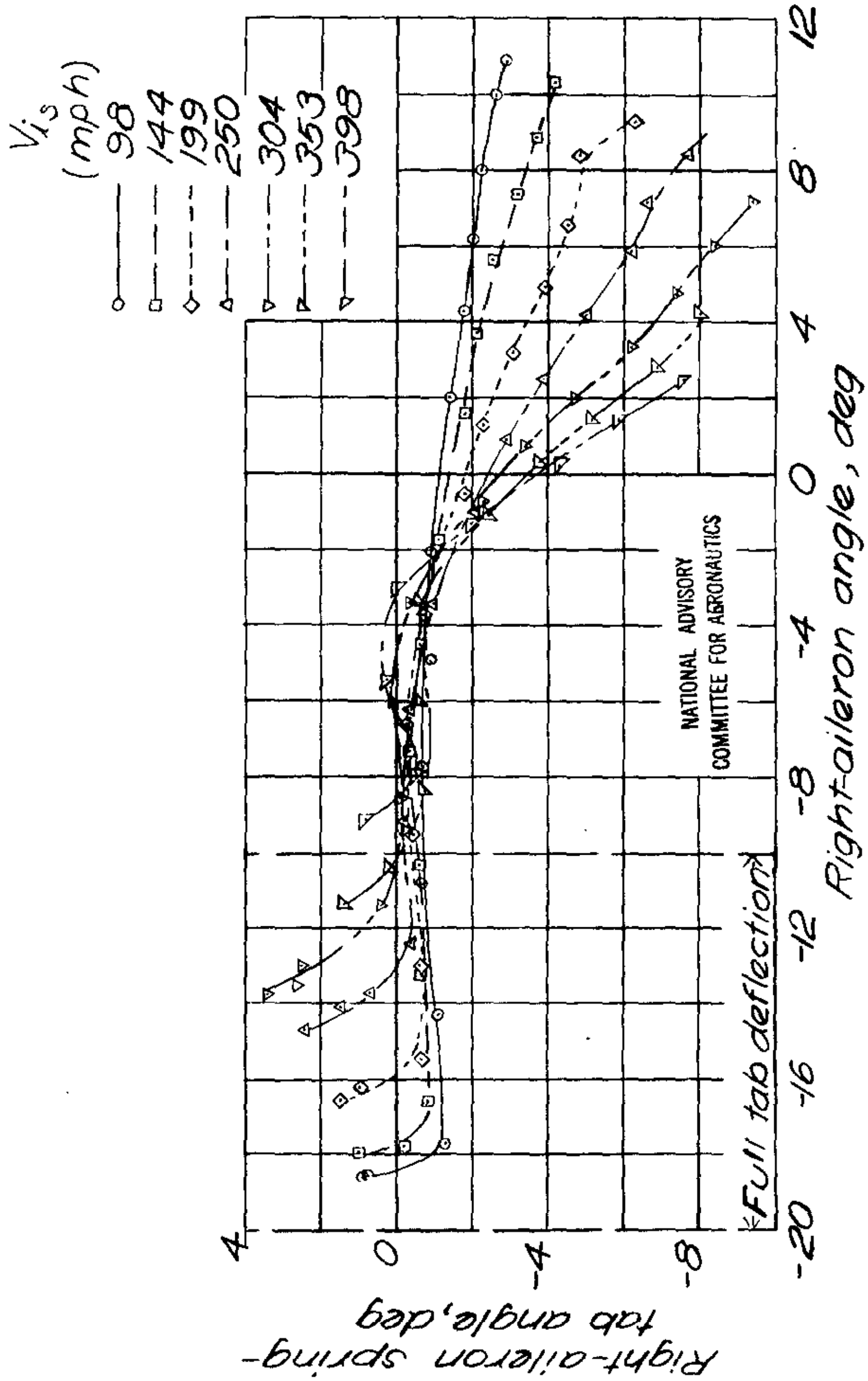


Figure 9.- Variation of right-aileron spring-tab angle with right-aileron angle in abrupt aileron rolls. F6F-3 airplane.

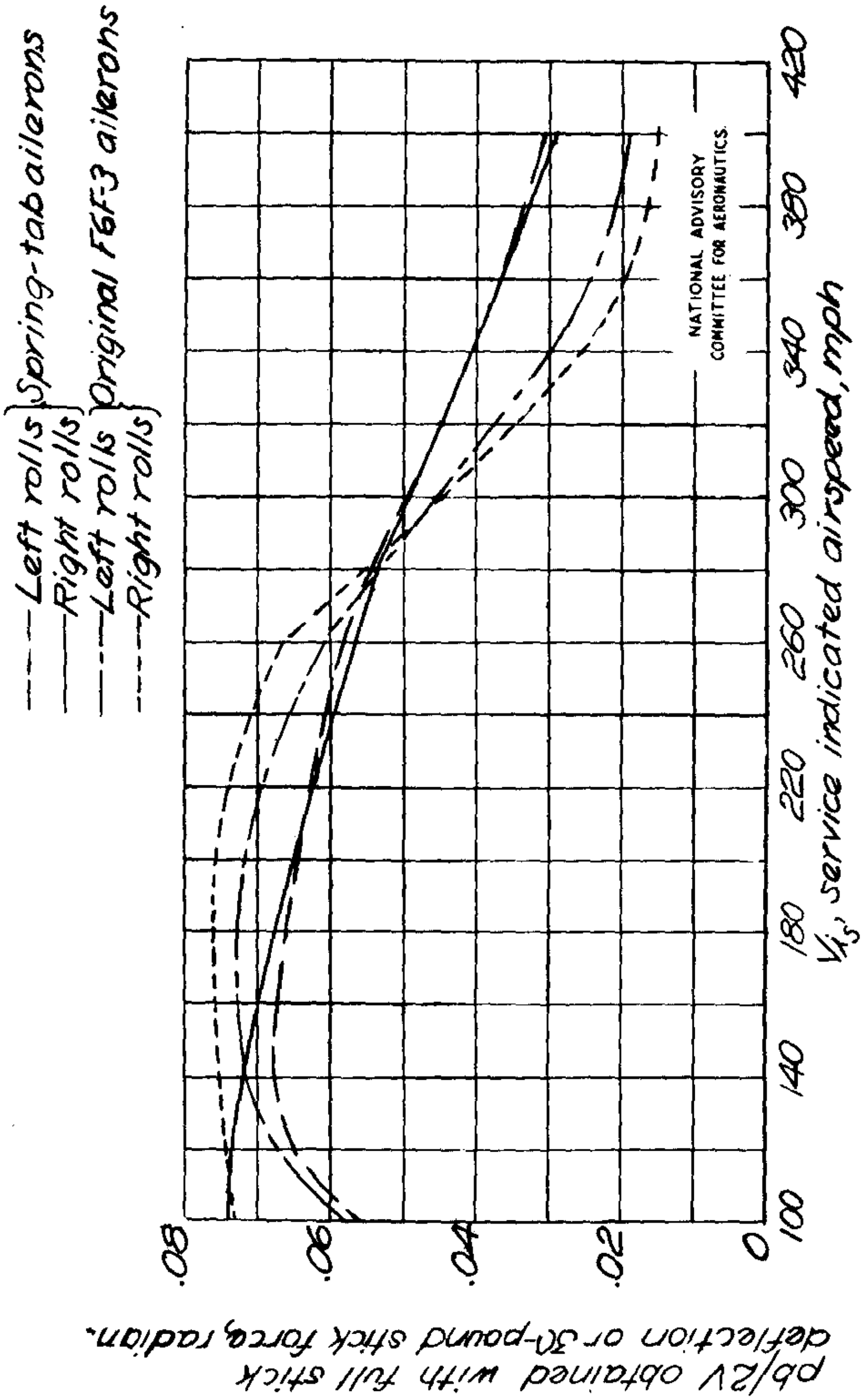


Figure 10.- Variation with correct service indicated airspeed of pb/2V obtained with full stick deflection or 30-pound stick force, whichever occurs first. F6F-3 airplane with spring-tab ailerons and with original F6F-3 ailerons.

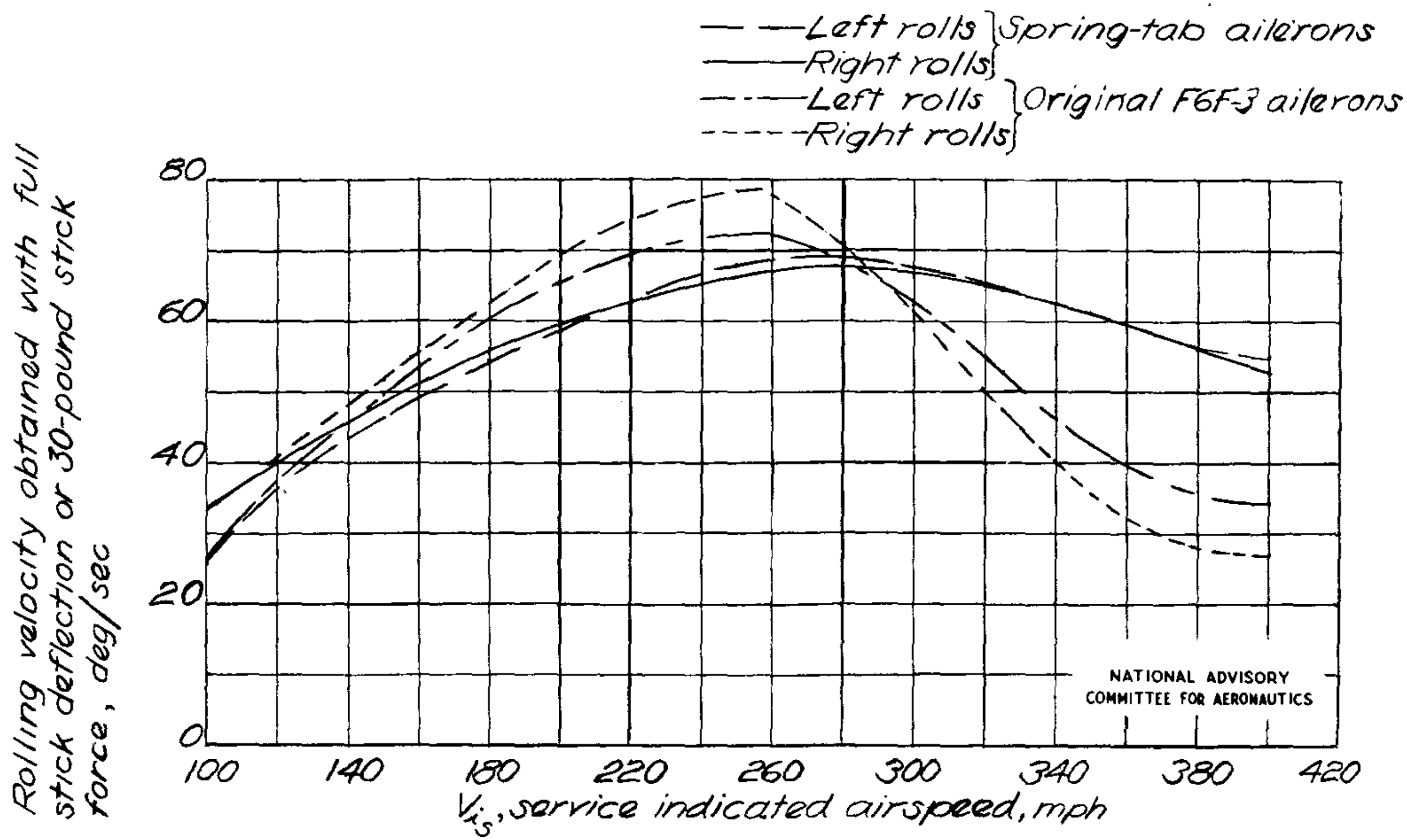


Figure 11.- Variation with correct service indicated airspeed of rolling velocity obtained at an altitude of 10,000 feet with full stick deflection or 30-pound stick force, whichever occurs first. F6F-3 airplane with spring-tab ailerons and with original F6F-3 ailerons.