UNCLASSIFIED Copy No. 8

CONFIDENTIAL

RM No. L8B26

NACA RM No. L8B26

3 0 JUN 1948

NACA

RESEARCH MEMORANDUM

PRELIMINARY FREE-FLIGHT INVESTIGATION OF THE EFFECT OF AIRFOIL SECTION ON AILERON ROLLING EFFECTIVENESS AT TRANSONIC AND SUPERSONIC SPEEDS

By

Carl A. Sandahl

Langley Memorial Aeronautical Laboratory
Langley Field, Va.

CLASSIFIED DOCUMENT CLASSIFICATION CANCELLED

This document contains classified information affecting the National Defense of the United States within the meaning of the Espionage Act, USC 50:31 and 32. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law. Information so classified may be imparted only to persons in the military and naval services of the United States, appropriate civilian officers and employees of the Federal Government who have a legitimate interest therein, and to United States citizens of known loyalty and discretion who of necessity must be informed thereof.

Authority NACA RF 2376 Date 8/18/54

8/31/54 See

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON
June 25, 1948

CONFIDENTIAL

UNCLASSIFIED

 ~~CONFIDENTIAL~~ UNCLASSIFIED

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

PRELIMINARY FREE-FLIGHT INVESTIGATION OF THE EFFECT OF AIRFOIL SECTION ON AILERON ROLLING EFFECTIVENESS AT TRANSONIC AND SUPERSONIC SPEEDS

By Carl A. Sandahl

SUMMARY

Results have been obtained by means of a free-flight technique utilizing rocket propulsion which indicate that aileron-rolling-effectiveness characteristics are affected adversely by variations in airfoil section which produce large increases in the trailing-edge angle.

INTRODUCTION

Results have been obtained recently by means of the RM-5 free-flight technique described in references 1, 2, and 3 which indicate that, at transonic and supersonic speeds, aileron-rolling-effectiveness characteristics are adversely affected by variations in airfoil section which produce large increases in the trailing-edge angle. The rolling-effectiveness characteristics of a wing-aileron configuration consisting of a plain full-span sealed aileron and an untapered, 45° sweptback wing employing the NACA 16-009 airfoil section are presented in this report. These results are compared with the results obtained for a previously tested configuration which was identical except for the airfoil section which was the NACA 65-009 (RM-5 number 53a, reference 3). A sketch of both the aforementioned configurations is given in figure 1. The variation of Reynolds number with Mach number for the test conditions is given in figure 2.

SYMBOLS

$\frac{pb}{2V}$ wing-tip helix angle, radians

C_D drag coefficient based on total exposed wing area of 1.563 square feet

~~CONFIDENTIAL~~ UNCLASSIFIED

M Mach number

R Reynolds number based on wing chord of 7.07 inches parallel to model center line

b_1 diameter of circle swept by wing tips minus fuselage diameter

S_1 exposed area of two wing panels

A exposed aspect ratio $\left(\frac{{b_1}^2}{S_1}\right)$

c wing chord parallel to model center line

δ_a aileron deflection measured in plane perpendicular to chord plane and parallel to model center line

ϕ trailing-edge angle measured in plane perpendicular to chord plane and parallel to model center line

RESULTS AND DISCUSSION

The results of the present investigation are shown in figure 3 as curves of $\frac{pb/2V}{\delta_a}$ and drag coefficient (based on total exposed wing area of 1.563 sq ft) as a function of Mach number. Changing the airfoil section from the NACA 65-009 to the NACA 16-009 resulted in a marked reduction of aileron effectiveness in the Mach number range from 0.75 (the lower limit of the tests) to about 1.07 and a reversal of effectiveness in the Mach number range from about 1.07 to 1.45. Above Mach number 1.45 to the maximum attained (1.8) the rolling effectiveness was in the correct direction though of small magnitude. Inasmuch as the two configurations differed mainly in airfoil section aft of the 50-percent-chord point, it is reasonable to assume that this caused the marked difference in the aileron-rolling-effectiveness characteristics for the two configurations. Similar effects regarding the effect of the shape of the after portion of the airfoil section have been noted in high-speed subsonic wind-tunnel tests. For example, see reference 4. It should be noted that the aileron deflections for the two configurations differed somewhat, the deflection being 5.6° for the configuration with the NACA 65-009 airfoil section, and 3.5° for the configuration with the NACA 16-009 airfoil section. The results shown in figure 3 are, therefore, not strictly comparable; however, results shown in reference 3 indicate that the values of $\frac{pb/2V}{\delta_a}$ obtained for the configuration with the NACA 65-009 airfoil section would be substantially the same for

5.6 and 3.5 degrees aileron deflection. The necessity for further tests is indicated in order to investigate more completely the effects of the shape of the aft portion of the airfoil on control effectiveness at transonic and supersonic speeds.

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

REFERENCES

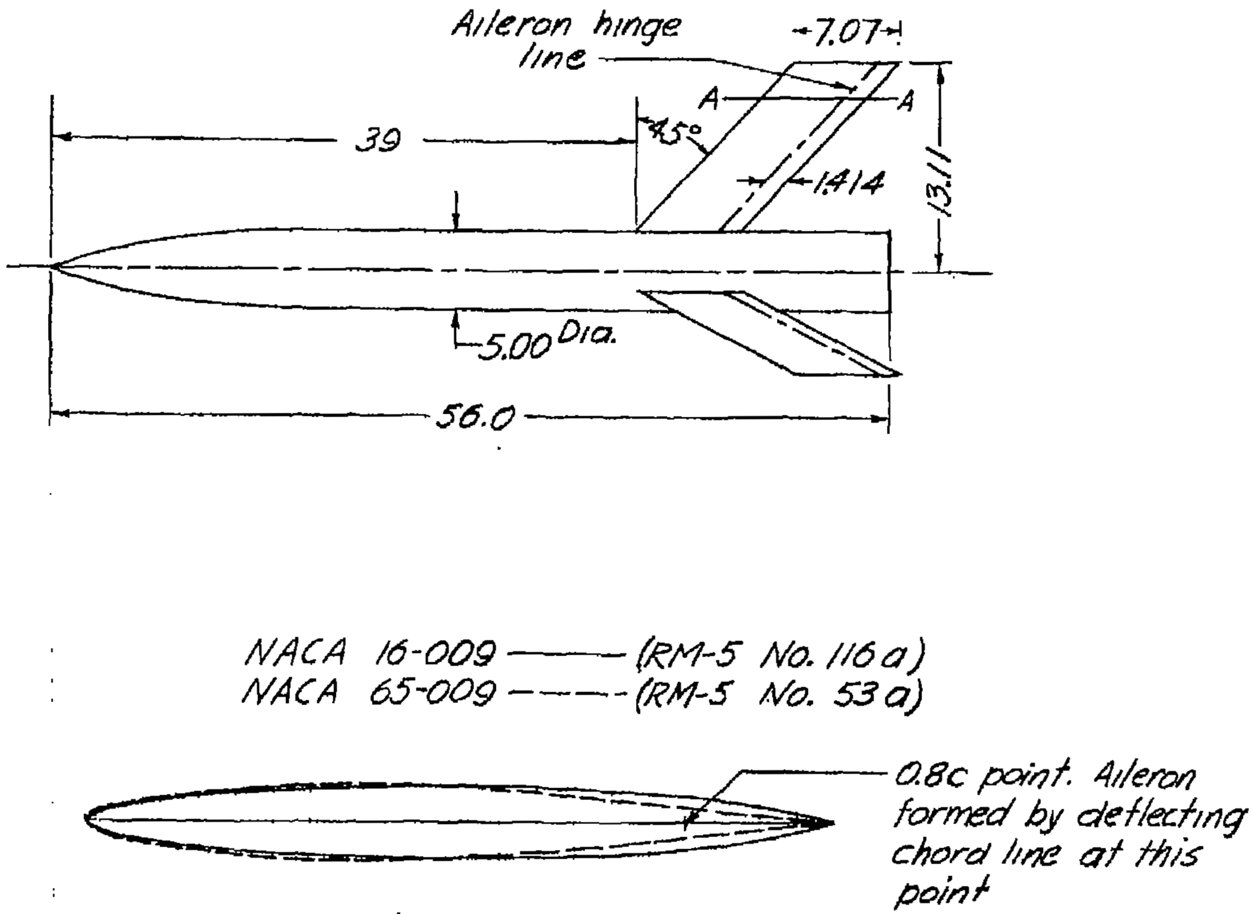
1. Sandahl, Carl A., and Marino, Alfred A.: Free-Flight Investigation of Control Effectiveness of Full-Span 0.2-Chord Plain Ailerons at High Subsonic, Transonic, and Supersonic Speeds to Determine Some Effects of Section Thickness and Wing Sweepback. NACA RM No. L7D02, 1947.

2. Sandahl, Carl A.: Free-Flight Investigation of Control Effectiveness of Full-Span, 0.2-Chord Plain Ailerons at High Subsonic, Transonic, and Supersonic Speeds to Determine Some Effects of Wing Sweepback, Taper, Aspect Ratio, and Section Thickness Ratio. NACA RM No. L7F30, 1947.

3. Sandahl, Carl A., and Strass, H. Kurt: Additional Results in a Free-Flight Investigation of Control-Effectiveness of Full-Span, 0.2-Chord Plain Ailerons at High Subsonic, Transonic, and Supersonic Speeds to Determine Some Effects of Wing Sweepback, Aspect Ratio, Taper, and Section Thickness Ratio. NACA RM No. L7L01, 1947.

4. Stevenson, David B., and Adler, Alfred A.: High-Speed Wind-Tunnel Tests of an NACA 0009-64 Airfoil Having a 33.4-Percent-Chord Flap with an Overhang 20.1 Percent of the Flap Chord. NACA TN No. 1417, 1947.

[redacted]



Section A-A
(Aileron deflection not shown)

[redacted]

Figure 1.- General arrangement of test vehicles.
(Dimensions are in inches.)

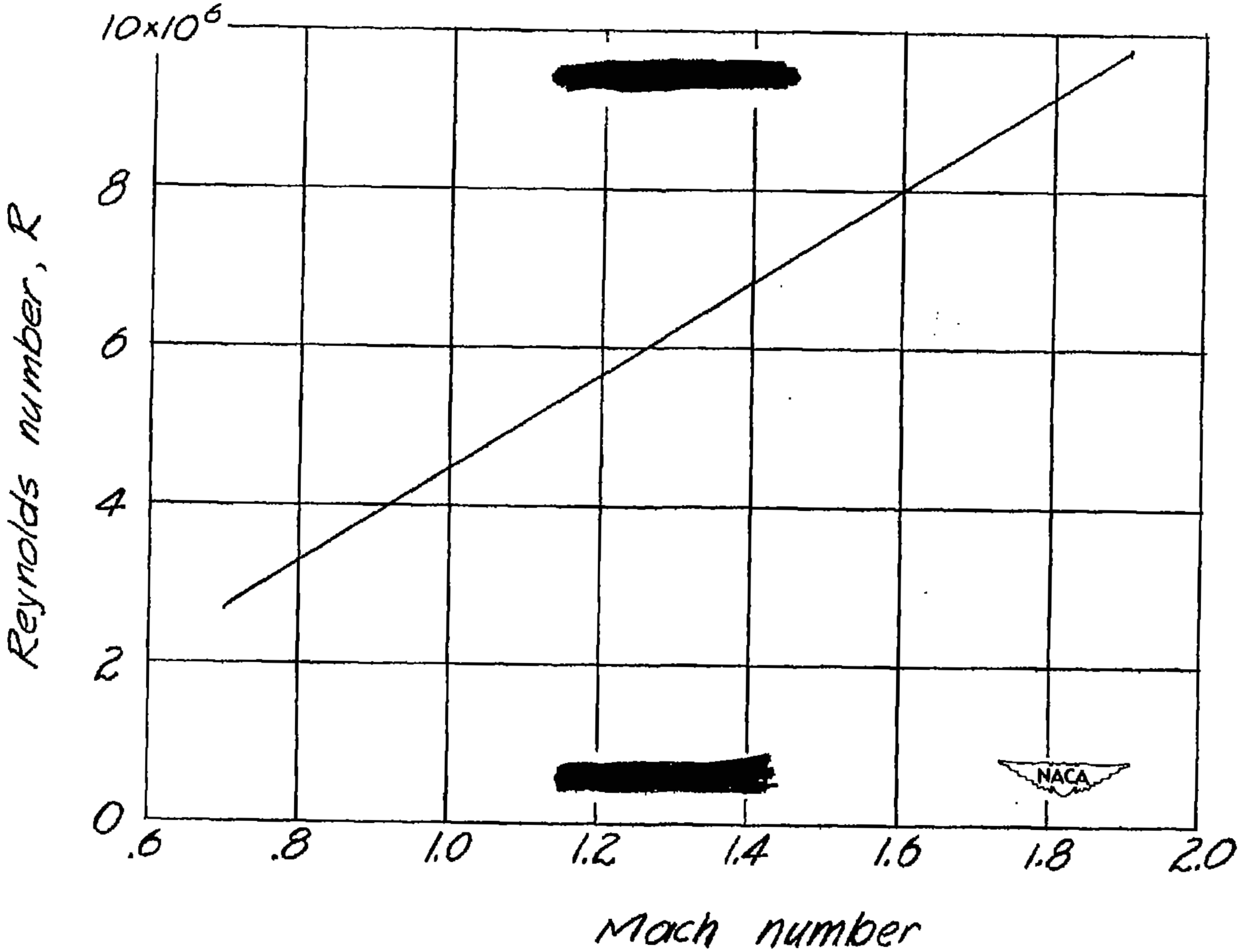


Figure 2.- Variation of Reynolds number with Mach number for test conditions.

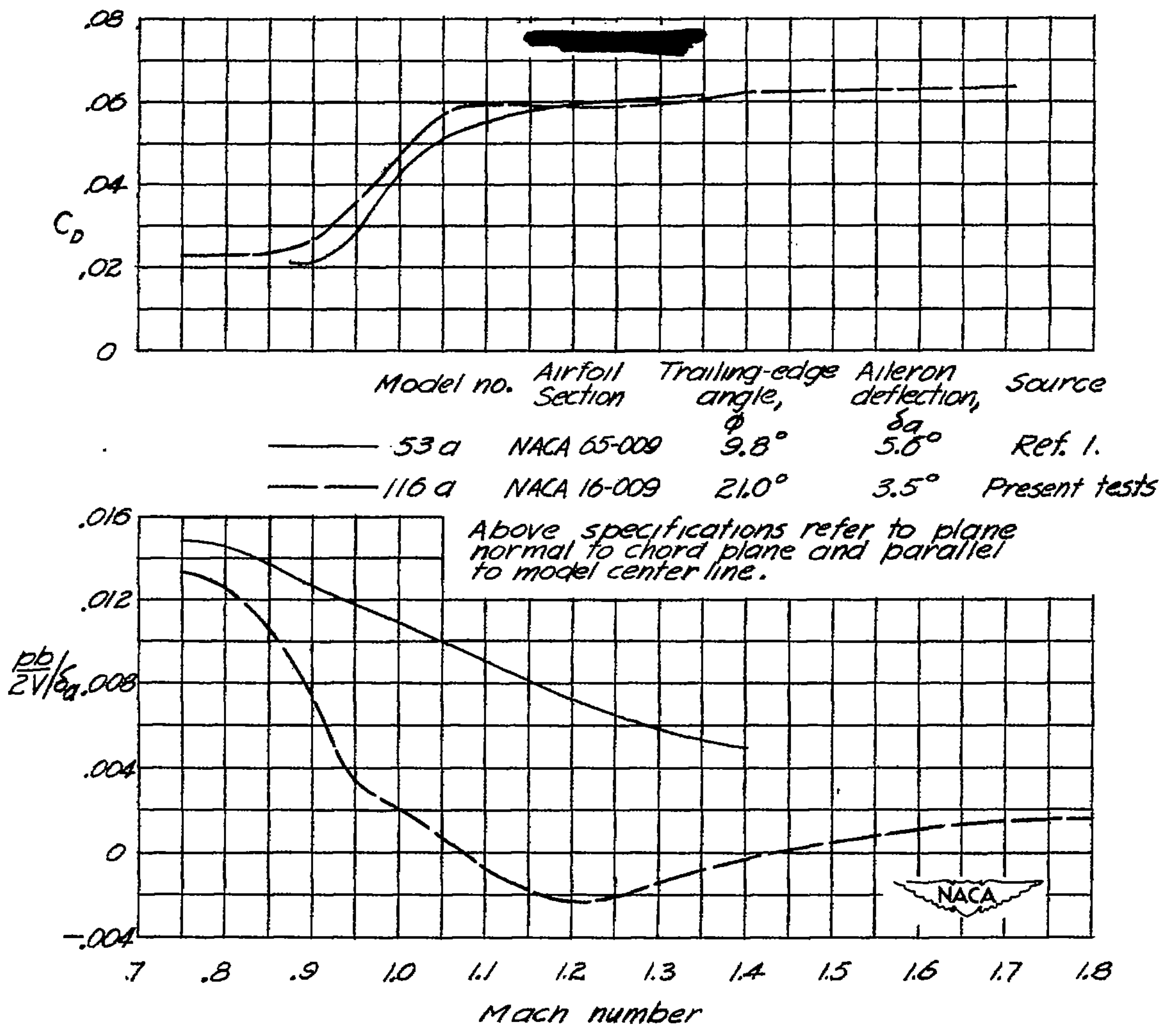


Figure 3.- Effect of airfoil section on aileron effectiveness. Aileron chord ratio, 0.2; A, 3.0; Λ, 45°.

[redacted]