UNCLASSIFIED

AD NUMBER	
ADB814151	
CLASSIFICATION CHANGES	
TO:	**unclassified**
FROM:	**confidential**
LIMITATION CHANGES	
TO: **Approved for public release; distribution is unlimited.**	
FROM: **Distribution authorized to DoD only; Administrative/Operational Use; 20 FEB 1947. Other requests shall be referred to National Aeronautics and Space Administration, Washington, DC. Pre-dates formal DoD distribution statements. Treat as DoD only.**	
AUTHORITY	
NACA research abstracts no. 70 dtd 21 Sep 1954; NASA TR Server website	

THIS PAGE IS UNCLASSIFIED

Copy No.

CONFIDENTIAL UNCLASSIFIED RM No. L6I11

FEB 25 1947

NACA

RESEARCH MEMORANDUM

DRAG MEASUREMENTS OF A 34° SWEPT-FORWARD AND SWEPT-BACK NACA 65-009 AIRFOIL OF ASPECT RATIO 2.7 AS DETERMINED BY FLIGHT TESTS AT SUPERSONIC SPEEDS

By

Sidney R. Alexander

Langley Memorial Aeronautical Laboratory
Langley Field, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WASHINGTON

February 20, 1947

CONFIDENTIAL

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

DRAG MEASUREMENTS OF A 34° SWEPT-FORWARD AND SWEPT-BACK NACA 65-009 AIRFOIL OF ASPECT RATIO 2.7 AS DETERMINED BY FLIGHT TESTS AT SUPERSONIC SPEEDS

By Sidney R. Alexander

SUMMARY

This report presents results of flight tests conducted at the NACA Pilotless Aircraft Test Station at Wallops Island, Va., to determine the zero-lift drag of an NACA 65-009 airfoil of aspect ratio 2.7 sweptforward 34°. The data were obtained by tracking rocket-propelled winged bodies moving at supersonic speeds. A comparison is made between the results of similar tests of an unswept and a 34° swept-back arrangement of a previous report, MR No. L6E17, and of this report. The test results show that for the comparable Mach number range investigated ($M = 0.9 - 1.30$) both the 34° swept-forward and swept-back airfoils produced lower values of zero-lift drag than the unswept airfoil. At Mach numbers between 1.0 and 1.3, the drag of the swept-back wing was about 50 percent and that of the swept-forward wing about 65 percent of the drag of the unswept wing.

INTRODUCTION

It is well established that the aerodynamic characteristics of wings in the proximity of sonic velocity could be considerably improved by the use of plan forms having suitable sweep angle. The effects of sweepback have been experimentally verified by various means such as the investigation of reference 1 in which the results of supersonic flight tests of swept-back airfoils have been presented. Recently, however, from practical considerations such as improved lateral stability and stalling characteristics, more than usual interest has been exhibited regarding the use of swept-forward wings for high-speed flight. To obtain information relative to the drag of swept-forward wings at supersonic speeds, tests are being conducted at the NACA Pilotless Aircraft Test Station at Wallops Island, Va., of rocket-propelled bodies carrying wings of various sweep-forward angles and aspect ratios. This report presents the results of drag tests of a 34° swept-forward NACA 65-009 airfoil of aspect ratio 2.7. This aspect ratio is based on the total wing span and area including that portion enclosed by the body. For comparison, the results of the unswept and 34° swept-back airfoils of equal aspect ratio, presented in reference 1, are included.

BODY AND TESTS

Body

A photograph of the test body equipped with the 34° swept-forward airfoil is presented in figure 1 and the general body arrangement is shown in figure 2. The airfoil was mounted on the fuselage at zero angle of attack with the midsemispan quarter-chord point at the same longitudinal station as the design center of gravity. The NACA 65-009 airfoil (chord normal to leading edge) had neither taper, twist, nor dihedral. The unswept and 34° swept-back configurations of reference 1, presented in figure 3, differed from the 34° swept-forward arrangement only in wing plan form and location. Two test bodies of each configuration were fired under similar atmospheric conditions, and the results averaged in the evaluation of the data.

All the test bodies were propelled by 3.25-inch diameter Mark 7 aircraft rocket motors enclosed within the bodies. At a preignition temperature of 69° F, the rocket motor provided about 2200 pounds of thrust for approximately 0.87 second.

Tests

The 34° swept-forward test body, as well as the bodies of reference 1, were launched at an elevation angle of 75° to the horizontal. Because of the high elevation angle and the short burning duration of the rocket motor, the trajectory of the bodies during their supersonic coasting flight, after the propellant was expended, was approximately a straight line. The flight velocity was measured during this coasting period by means of a C. W. Doppler radar set (AN/TPS-5) located at the point of launching.

RESULTS AND DISCUSSION

The variation of velocity with time for one of the 34° swept-forward models, as measured with the radar unit, is presented

[redacted]

in figure 4. The negligible amount of scatter indicates consistent data. The portion of the velocity curve during which the body was coasting (after the end of burning) was graphically differentiated to obtain the deceleration. The product of the deceleration and the known body mass was equated to the sum of the drag and the known weight of the body. The values of the drag thus obtained are presented in figure 5 as a function of the flight velocity for both models of the 34° swept-forward arrangement. A single resultant drag curve was faired through these points. Although the scatter of the velocity-time curve has been greatly magnified by its differentiation, the curve is satisfactorily determined, the average scatter of the experimental points from the faired curve being about ±3 percent.

From the drag curve of figure 5, the total drag coefficient of the body with the 34° swept-forward airfoil has been computed and is presented in figure 6(a) plotted against Mach number. The wing drag coefficient, derived by graphically taking the numerical difference between the winged body and one identical to it, but without wings, is presented in figure 6(b). For comparison, the drag-coefficient curves for the test bodies with the unswept and 34° swept-back airfoils of reference 1 are included. The values of wing drag determined by the above method include wing-fuselage interference effects. The drag coefficients were based on the constant exposed wing plan-form area of 200 square inches. Examination of the figure reveals that for the Mach number range investigated, the drag of either swept wing was less than that of the unswept wing. This effect was more pronounced for the case of the swept-back wing. The drag of the swept-back wing was about 50 percent and that of the swept-forward wing about 65 percent of the drag of the unswept wing. Aside from any differences in tip drag, part of the increase in the drag of the swept-forward wing over that of the swept-back one can be attributed to differences in flow in the wing-fuselage juncture; this flow being largely a function of the sweep angle and direction.

CONCLUDING REMARKS

The results of supersonic flight tests to determine the drag of a 34° swept-forward NACA 65-009 airfoil of aspect ratio 2.7 mounted on a rocket-propelled body have been presented herein. The drag coefficients of an unswept and a 34° swept-back airfoil of equal aspect ratio obtained in an identical fashion have also been included as a basis for comparison. Between Mach numbers of 1.0 and 1.3, the drag of the swept-back wing was about 50 percent and that of the swept-forward wing about 65 percent of the drag of the unswept wing.

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

REFERENCE

1. Alexander, Sidney R., and Katz, Ellis: Drag Characteristics of Rectangular and Swept-Back NACA 65-009 Airfoils Having Aspect Ratios of 1.5 and 2.7 as Determined by Flight Tests at Supersonic Speeds. NACA RM No. L6J16, 1946.

NACA RM No. L6I11

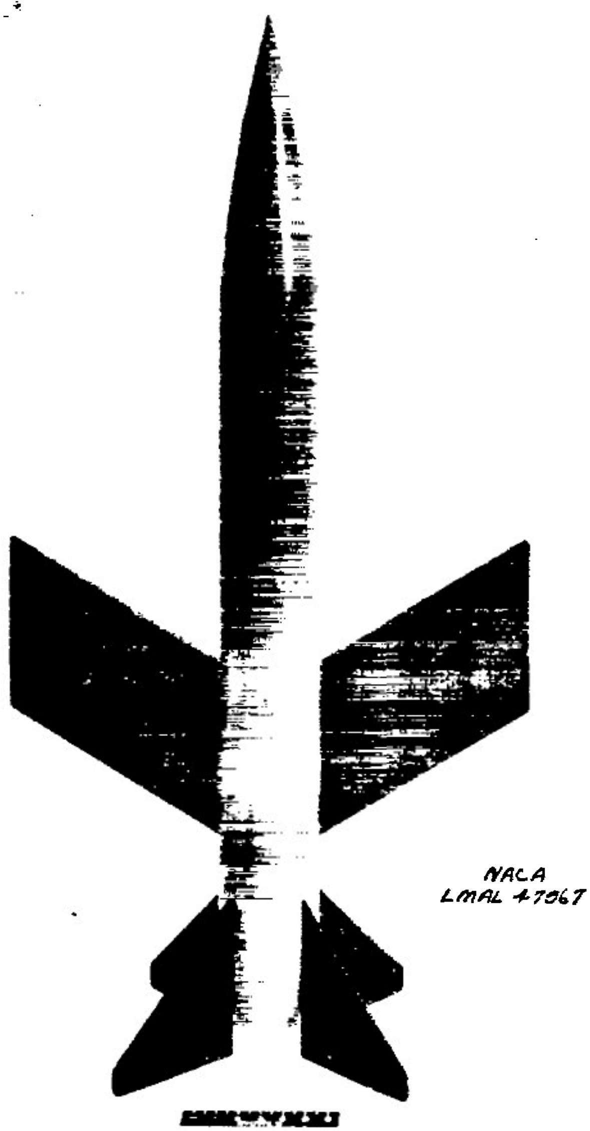


Figure 1.- The test body with 34° swept-forward wing of aspect ratio 2.7.

[redacted]

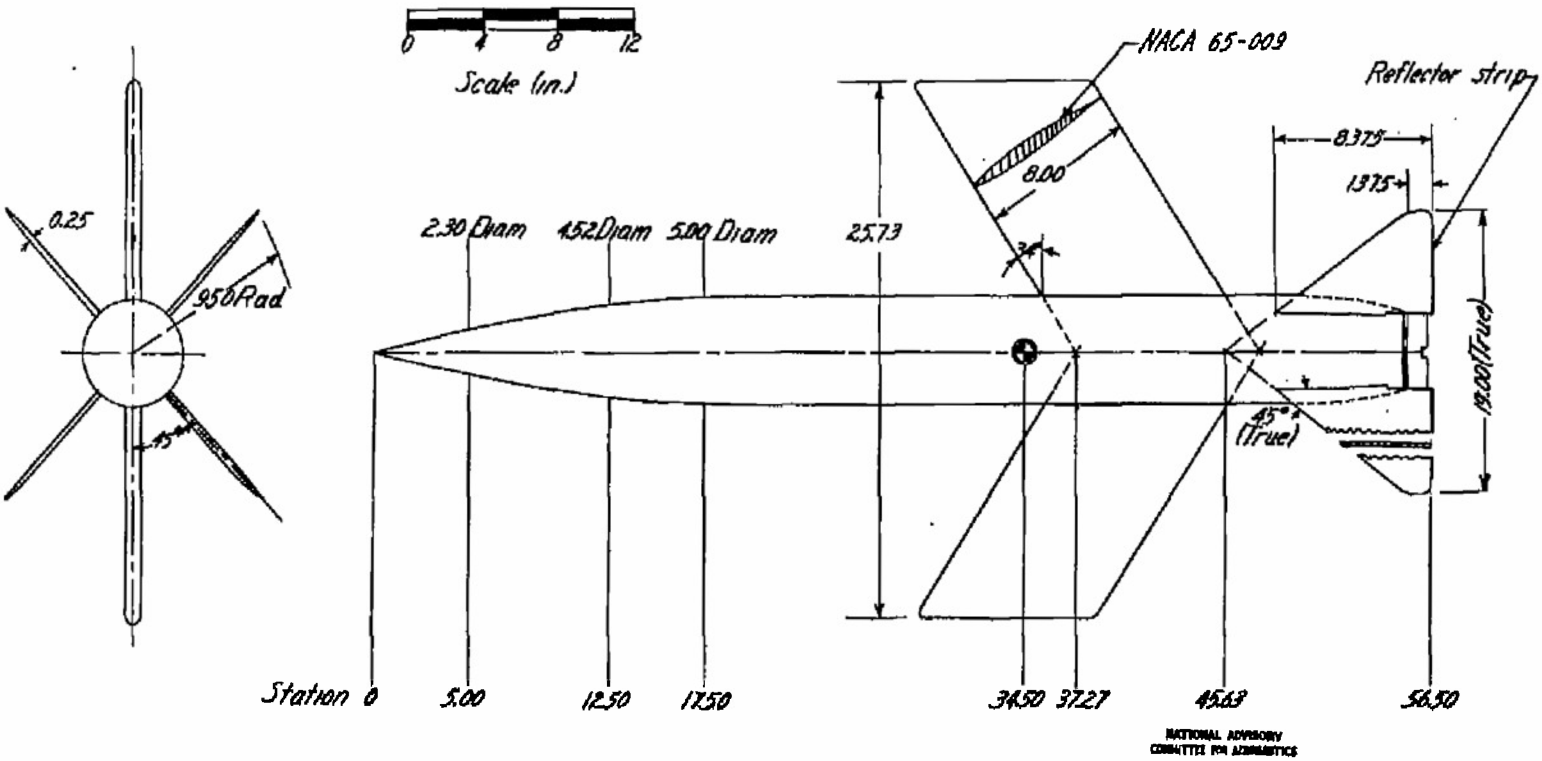


Figure 2.- General arrangement of test body. Wing area (exposed), 2.00 sq. in.; wing aspect ratio, 2.7; fin area (4 fins exposed), 136.5 sq. in.; design weight (burnt out), 31.00 lbs.

[redacted]

[redacted]

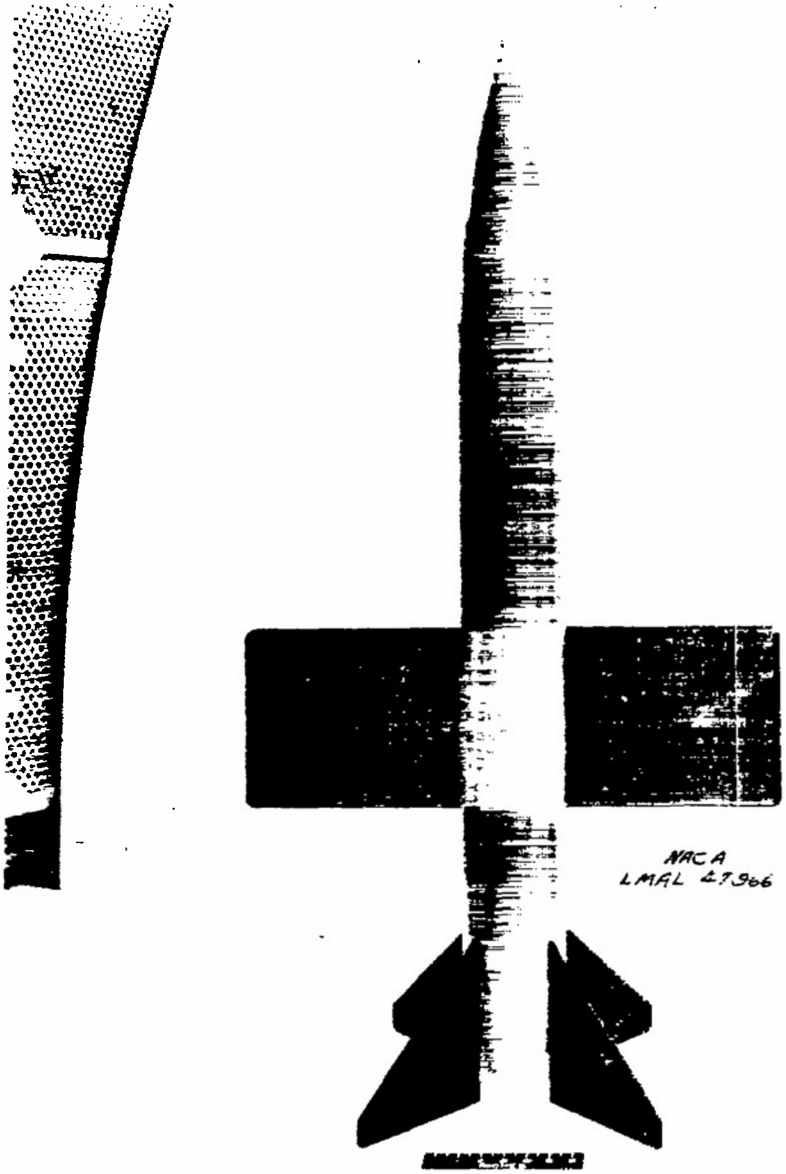


Figure 3(a).- The test body with unswept wing of aspect ratio 2.7 (reference 1).

[redacted]

[redacted]

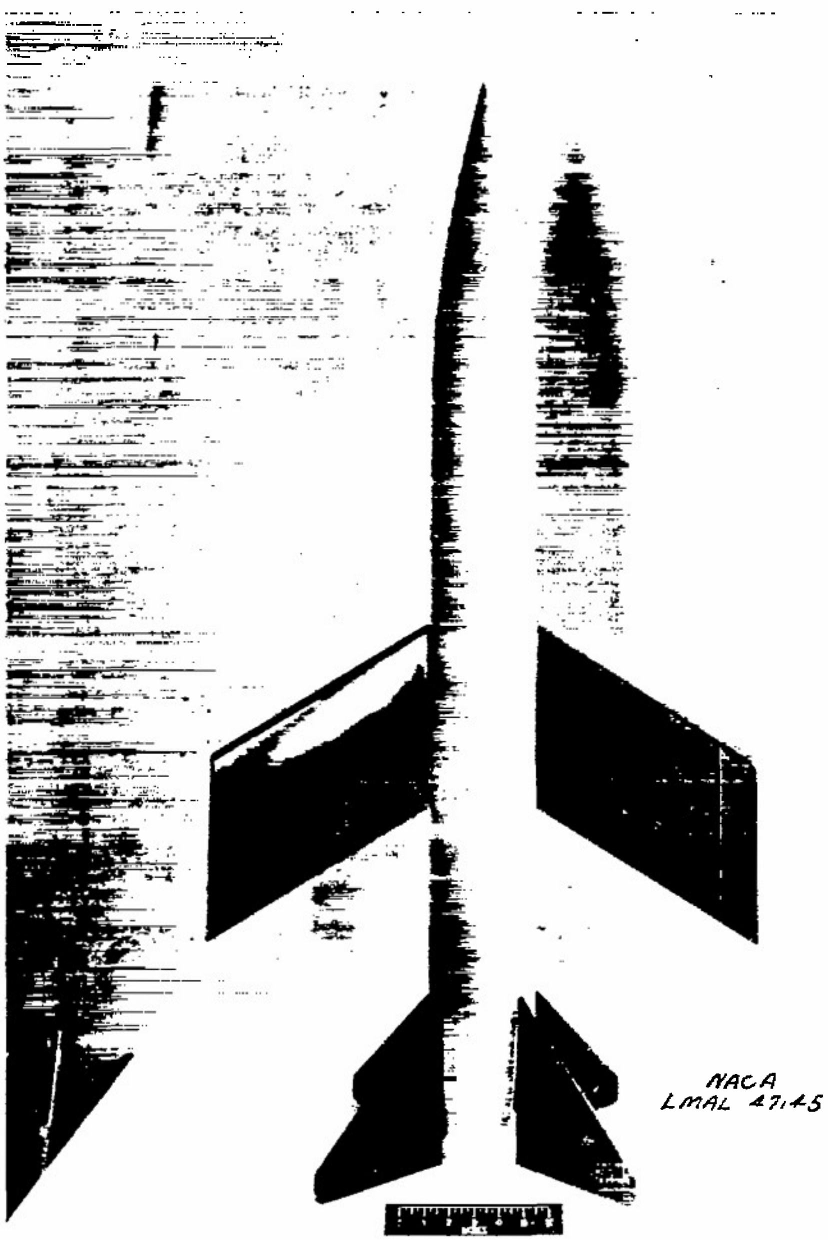


Figure 3(b).- The test body with 34° swept-back wing of aspect ratio 2.7 (reference 1).

[redacted]

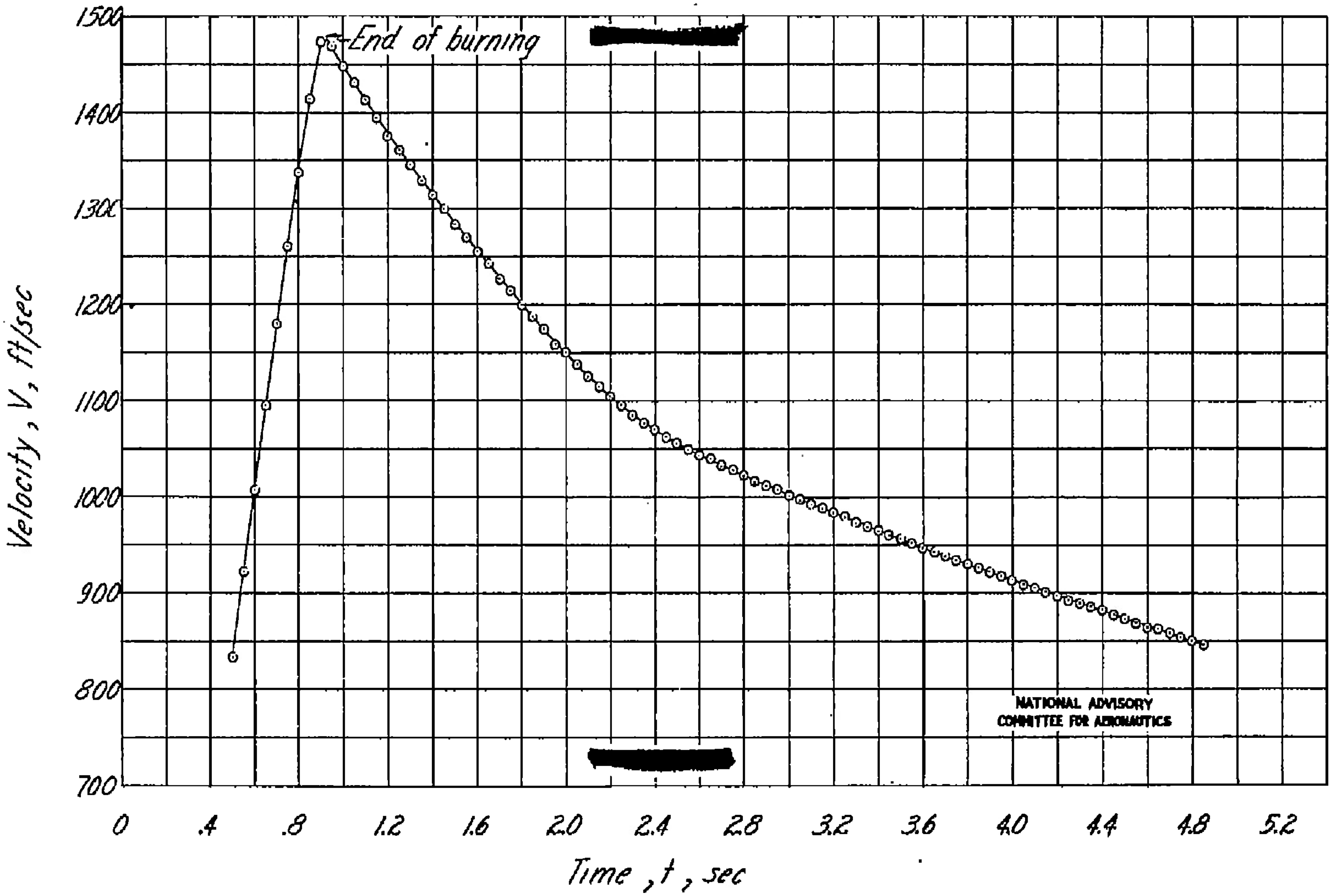


Figure 4.- Velocity-time curve. Test body with 34° sweptforward wings of aspect ratio 2.7.

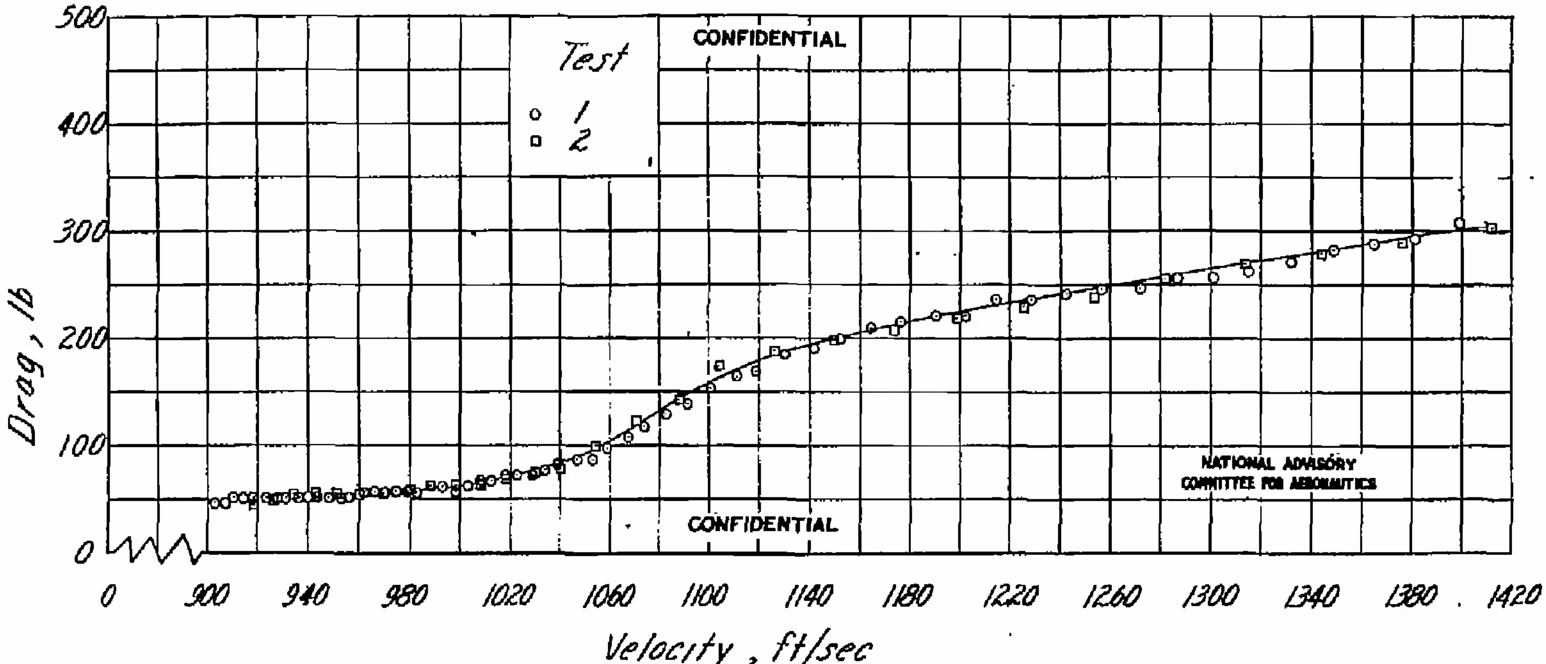
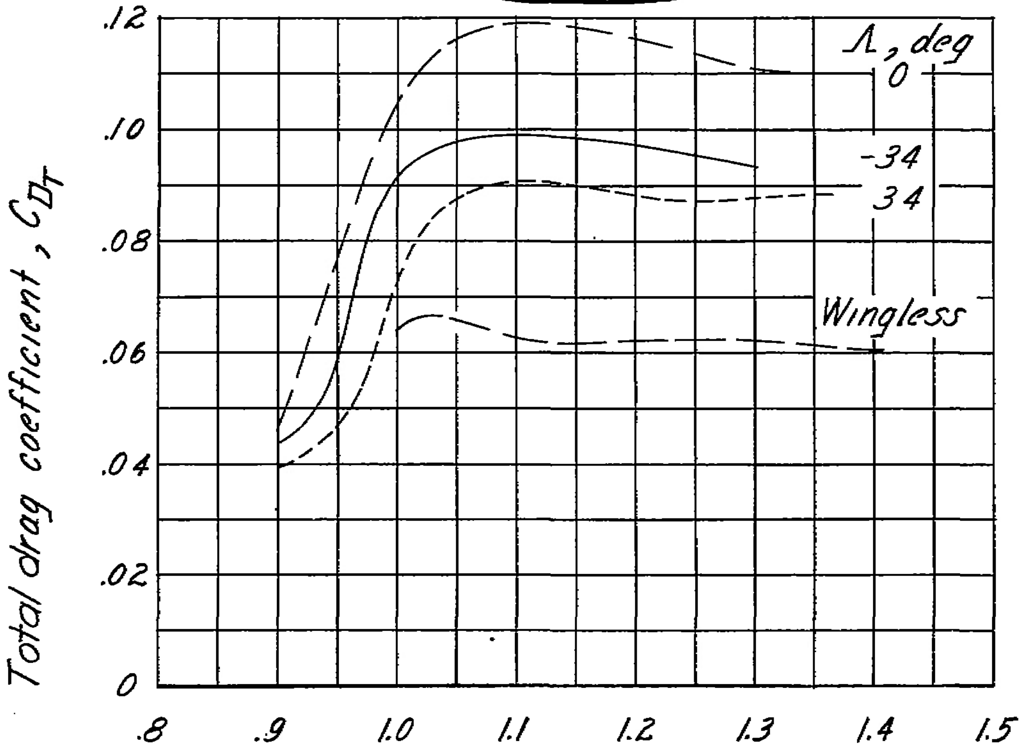
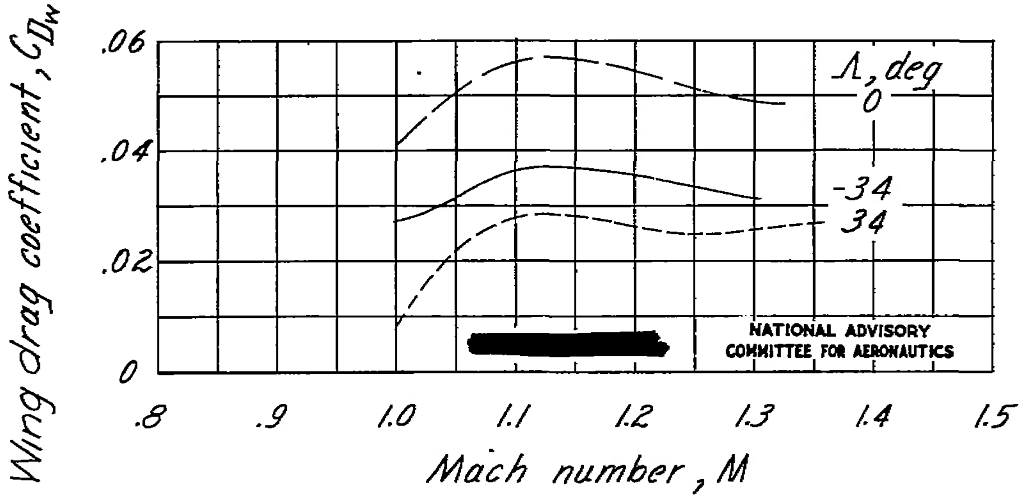


Figure 5.- Comparative drag measurements of two identical model arrangements having 34° swept-forward wings of aspect ratio 2.7

[redacted]



(a) Total drag coefficient.



(b) Wing drag coefficient.

Figure 6.- Drag coefficient curves of an NACA 65-009 airfoil of aspect ratio 2.7 mounted on a test body.

ATI- 7708

ORIG. AGENCY NUMBER: RM-L6I11

REVISION

CONFIDENTIAL

c-2-6-20

AUTHOR(S): Alexander, S. R.

DIVISION: Aerodynamics (2)

SECTION: Wings and Airfoils (6)

CROSS REFERENCES: Airfoils - Drag (08200); Airfoils, Swept-back - Drag (08280)

AMER. TITLE: Drag measurements of a 34° swept-forward and swept-back NACA 65-009 airfoil of aspect ratio 2.7 as determined by flight tests at supersonic speeds

FORG'N. TITLE:

ORIGINATING AGENCY: National Advisory Committee for Aeronautics, Washington, D. C.

TRANSLATION:

COUNTRY	LANGUAGE	FORG'N.CLASS	U. S.CLASS.	DATE	PAGES	ILLUS.	FEATURES
U.S.	Eng.		Confd'l	Feb'47	10	8	photos, graphs, drwg

ABSTRACT

The drag of a 34° swept-forward and swept-back airfoil was measured. The data was obtained by tracking rocket-propelled winged bodies moving at supersonic speeds. Comparison is made between results of similar tests of previous reports and of this report. Test results show that both the 34° swept-forward and swept-back airfoils produced lower values of zero-lift drag than the unswept airfoils. At Mach numbers 1.0-1.3, drag of swept-back wing was about 50% and that of swept-forward wing about 65% of drag of unswept wing.

NOTE: Requests for copies of this report must be addressed to: N.A.C.A., Washington, D. C.

UNCLASSIFIED per authority of NACA Research Abstracts No. 70 dated 21 September 1954. (14 Oct 54)