NACA

RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Department of the Navy

FLIGHT DETERMINATION OF MINIMUM DRAG OF 0.11-SCALE ROCKET-BOOSTED MODEL OF THE CHANCE VOUGHT XF8U-1 AIRPLANE WITH MODIFIED FUSELAGE AREA DISTRIBUTION AND FAIRED INLET AT MACH NUMBERS FROM 0.82 TO 1.68

TED NO. NACA DE 392

By Earl C. Hastings, Jr.

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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SUMMARY

A flight test has been conducted to determine the minimum drag of a 0.11-scale rocket-boosted model of the Chance Vought XF8U-1 airplane with a transonic-area-rule fuselage-cross-sectional-area development. The model (which had the underslung scoop inlet faired into a pointed nose) was tested over the Mach number range from 0.82 to 1.68.

Between Mach numbers of 0.82 and 0.92, the drag coefficient was constant at a value of 0.015. The drag rise occurred at a Mach number of 0.93, and from 1.00 to 1.68 the drag coefficient decreased slightly from a value of 0.035 to a value of approximately 0.034. The transonic trim change was small for this model with the center-of-gravity location at 6.95 percent mean aerodynamic chord.

INTRODUCTION

An investigation to determine the low-lift drag of the Chance Vought XF8U-1 airplane is being conducted by the Pilotless Aircraft Research Division at the request of the Bureau of Aeronautics, Department of the Navy.

The test reported herein is an extension of the original test program (ref. 1). The 0.11-scale model flown in this test was based on a revised version of the XF8U-1 airplane and was tested to higher Mach numbers.

[redacted]

The Chance Vought XF8U-1 is a jet-propelled swept-wing fighter airplane with an all-movable horizontal tail and a variable incidence wing. A major revision to the original designs, however, was that the fuselage cross-sectional area was changed in the region of the wing in order to provide a more efficient area distribution at transonic and low supersonic speeds. Some other changes from the previous configurations were a revised horizontal-tail plan form and an extended afterbody.

The model used in this test differed geometrically from the revised airplane only in that the underslung scoop inlet was faired into a pointed nose. The purpose of the test reported herein was to determine the minimum drag of this configuration from transonic speeds up to a Mach number near 1.7.

SYMBOLS

A	cross-sectional area, sq ft
a_l/g	longitudinal accelerometer reading
a_n/g	normal accelerometer reading
$\bar{c}$	mean aerodynamic chord, ft
C_c	chord-force coefficient, positive in rearward direction, $-\frac{a_l}{g}\frac{W}{S}\frac{1}{q}$
$C_{D_{measured}}$	measured drag coefficient, $\frac{\text{Measured drag}}{qS}$
$C_{D_{base}}$	base drag coefficient, $\frac{-\left(p_{base} - p_o\right)\text{base area}}{qS}$
C_D	drag coefficient, $\left(C_{D_{measured}} - C_{D_{base}}\right)$
C_N	normal-force coefficient, positive toward top of model from model center line, $\frac{a_n}{g}\frac{W}{S}\frac{1}{q}$
g	acceleration due to gravity, 32.2 ft/sec^2

l length, ft

M Mach number

p_{base} average base static pressure, lb/sq ft

p_o free-stream static pressure, lb/sq ft

q dynamic pressure, lb/sq ft

R Reynolds number based on mean aerodynamic chord of basic wing

r radius, ft

S model wing area (basic wing without chord extensions), sq ft

W model weight, lb

x station measured from nose, ft

MODEL AND APPARATUS

A three-view drawing of the model is shown in figure 1, and the physical characteristics presented in table I. Figure 2 shows the equivalent body of revolution and normal cross-sectional-area distribution with a breakdown of the component parts. A photograph of the model is shown in figure 3.

Construction of the model was similar to that of the earlier models of the series (ref. 1). The fuselage was made primarily of mahogany and was built around a steel thrust tube extending from the base into the fuselage. Space was provided in the fuselage for the installation of a telemeter system and a smoke tank to aid radar tracking. Access to the telemeter compartments was provided by removable fiber glass hatches.

Both the wing and tail surfaces were machined from solid aluminum alloy. The aspect-ratio-3.4 wing had a thickness ratio of 0.06 at the root and 0.05 at the tip. There was -1° of incidence between the wing mean chord line and the fuselage reference line. Dihedral angles of the wing and horizontal tail were -5° and 5.4°, respectively. There was no incidence in the horizontal tail.

The base of the model was instrumented to obtain base drag by using four static-pressure orifices located about 0.5 inch from the edge of the base. These tubes were spaced 90° apart and were manifolded together inside the model.

Prior to flight testing, a detailed investigation was conducted at the request of Chance Vought Aircraft, Inc. to determine how closely the cross-sectional-area distribution of the model duplicated that of the full-scale airplane. The results of this investigation indicated that the model area distribution was smooth and fair, and the largest disagreement between the model area profile and the full-scale airplane was less than 40 square inches full scale. The model was then considered to be geometrically satisfactory for this test since any change in the drag values due to the error in area would be within the experimental accuracy of the test. A photograph of the model-booster combination prior to launching is shown in figure 4.

APPARATUS

The model was instrumented with a telemeter system which measured the quantities necessary to determine the desired drag and longitudinal trim data and transmitted these quantities to a ground receiving station. During the flight, the longitudinal, normal and transverse accelerations, the free-stream total pressure, and the base static pressure were recorded.

Free-stream static pressure and temperature were recorded by a radiosonde released immediately after firing. The velocity of the model and its position in space were determined by a CW Doppler radar set and an NACA modified SCR 584 tracking radar.

ANALYSIS OF DATA

The coefficients presented herein are based on the total wing area, excluding the leading-edge extensions. The values of drag coefficients computed from the telemeter data are actually chord-force coefficients with no correction for normal force. Since the angle of attack at the model trim condition was small $\left(C_{n_{trim}} < -0.10\right)$, the chord-force coefficients measured can be considered numerically equal to the minimum drag coefficient.

In this test it was also possible to obtain supersonic drag data from Doppler radar data. Reference 1 discusses the method of analysis used to obtain the drag from this source.

Figure 5 presents the Reynolds number range covered by this test. These values of Reynolds number were based on the mean aerodynamic chord of the basic wing.

ACCURACY

In this flight test, Mach number values in the range from 0.95 to 1.69 were computed from both the free-stream total pressure and the velocity values obtained from the CW Doppler radar set. In this Mach number range, disagreement between the two sets of data was less than 1 percent. Although no comparison can be made below a Mach number of 0.95, other tests of this type have generally shown disagreement in Mach number in the order of 2 percent at subsonic speeds.

The accuracy of the drag values obtained in this test is indicated (by a comparison of the telemeter and Doppler data) to be in the order of 0.0015 between Mach numbers of 0.965 and 1.55. At Mach numbers between 0.82 and 0.92, a comparison of the rocket-model drag and unpublished wind-tunnel values indicates the accuracy of the drag data to be in the order of 0.0010.

RESULTS AND DISCUSSION

Trim Normal-Force Coefficient

Figure 6 presents the longitudinal trim characteristics of the configuration with no horizontal-tail deflection and a center-of-gravity location at 6.95 percent mean aerodynamic chord. The transonic trim change on the model was small, and amounted to 0.045 change in normal-force coefficient between $M = 0.94$ and $M = 0.99$.

Measured Drag

Values of the measured drag coefficient as obtained from the telemeter data and from Doppler radar set are presented in figure 7. Agreement between the two sets of data is considered good; however, the faired curve is drawn through the measured drag points determined from the telemeter values since in this test it is believed to be the more reliable of the two sets of data.

2. The transonic trim change was small for the model with the center-of-gravity location at 6.95 percent mean aerodynamic chord.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., September 15, 1955.

Earl C. Hastings, Jr.
Aeronautical Research Scientist

Approved: Joseph A. Shortal
Chief of Pilotless Aircraft Research Division

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REFERENCE

1. Blanchard, Willard S., Jr.: Minimum Drag of 0.11-Scale Rocket-Powered Models of the Chance Vought XF8U-1 Airplane, With and Without Nose Modifications, at Mach Numbers Between 0.85 and 1.30. NACA RM SL54F17, 1954.

TABLE I

PHYSICAL CHARACTERISTICS OF 0.11-SCALE MODEL

Wing:	
Total area (excluding chord extensions), sq ft	4.53
Aspect ratio	3.40
Mean aerodynamic chord (excluding chord extensions), ft	1.29
Incidence angle, deg	-1
Dihedral angle, deg	-5
Sweepback (quarter-chord line), deg	42
Airfoil section at root, parallel to free-stream direction	NACA 65A006
Airfoil section at tip, parallel to free-stream direction	NACA 65A005
Taper ratio	0.25
Span, ft	3.92
Horizontal tail:	
Total area, sq ft	1.14
Aspect ratio	3.5
Mean geometric chord, ft	0.71
Incidence angle, deg	0
Dihedral angle, deg	5.4
Sweepback (quarter-chord line), deg	45
Airfoil section at root	NACA 65A006
Airfoil section at tip	NACA 65A004
Taper ratio	0.15
Span, ft	1.99
Vertical Tail: (extended to horizontal-tail center line and not including dorsal fin)	
Area, sq ft	1.32
Aspect ratio	1.50
Mean geometric chord, ft	1.05
Sweepback (quarter-chord line), deg	45
Airfoil section at water line 3.02 inches above fuselage reference line	NACA 65A006
Airfoil section at tip	NACA 65A004
Taper ratio	0.25
Span, ft	1.41
Fuselage:	
Length, ft	6.08
Maximum cross-sectional area, sq ft	0.34
Total base area, sq ft	0.11
Weight and Balance:	
Weight, lb	174.75
Wing loading, lb/sq ft	38.6
Center-of-gravity location, percent $\bar{c}$	6.95

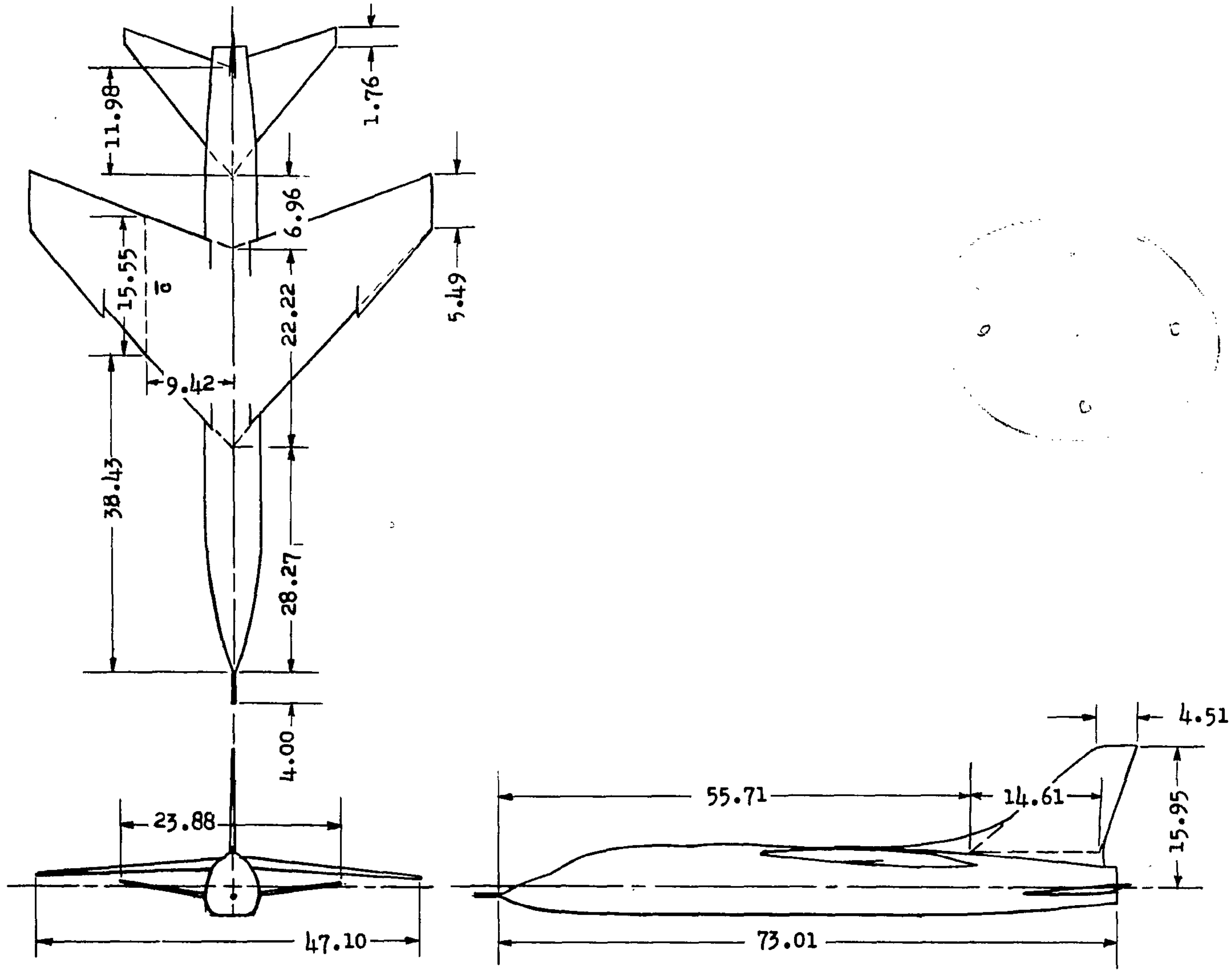
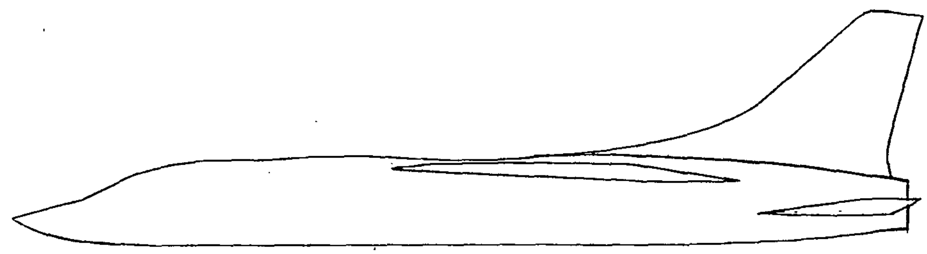
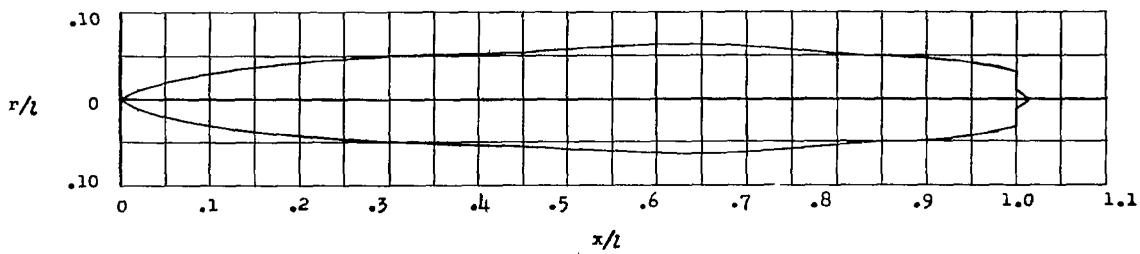


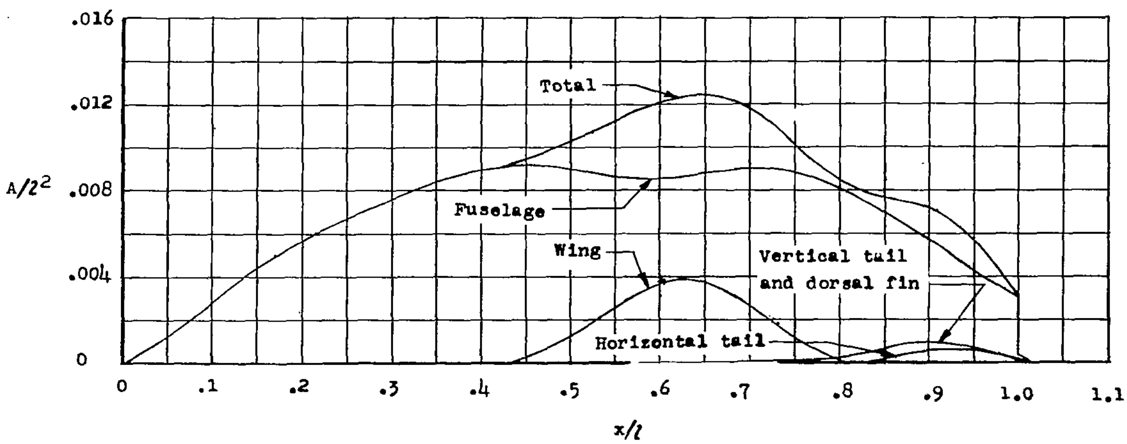
Figure 1.- Three-view drawing of model showing model design dimensions in inches.



Model

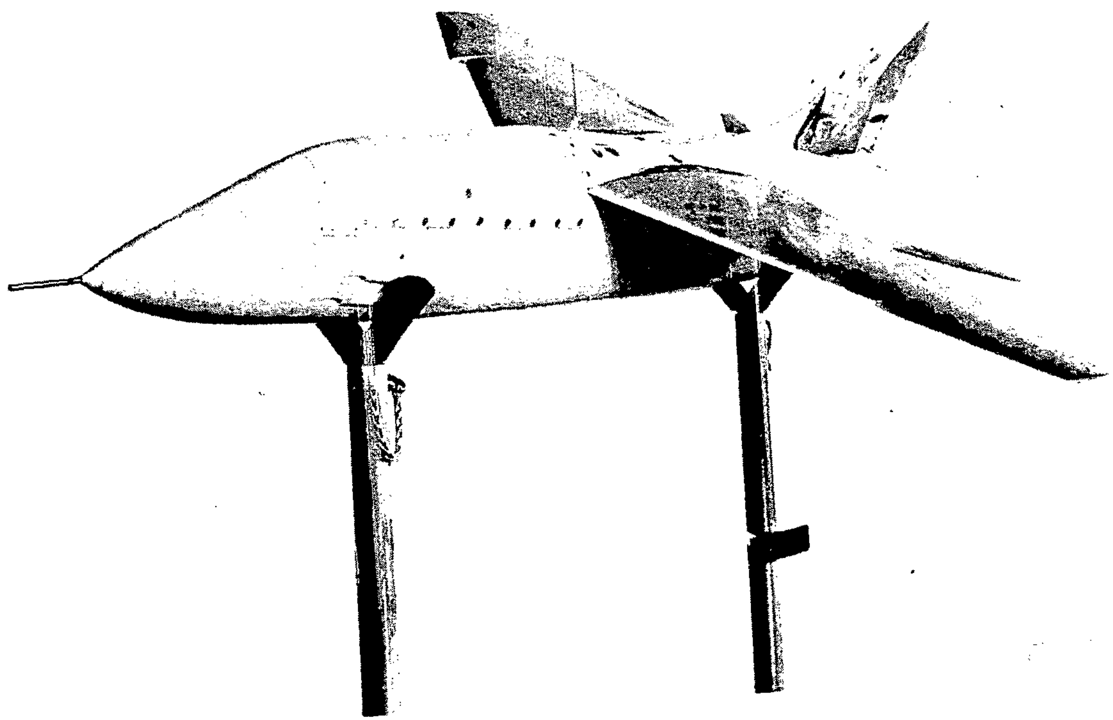


(a) Equivalent body of revolution.



(b) Normal cross-sectional area distribution.

Figure 2.- Equivalent body of revolution and cross-sectional area distribution of the model.



L-89402.1

Figure 3.- Photograph of model.

L-89540.1

Figure 4.- Photograph of model-booster combination.

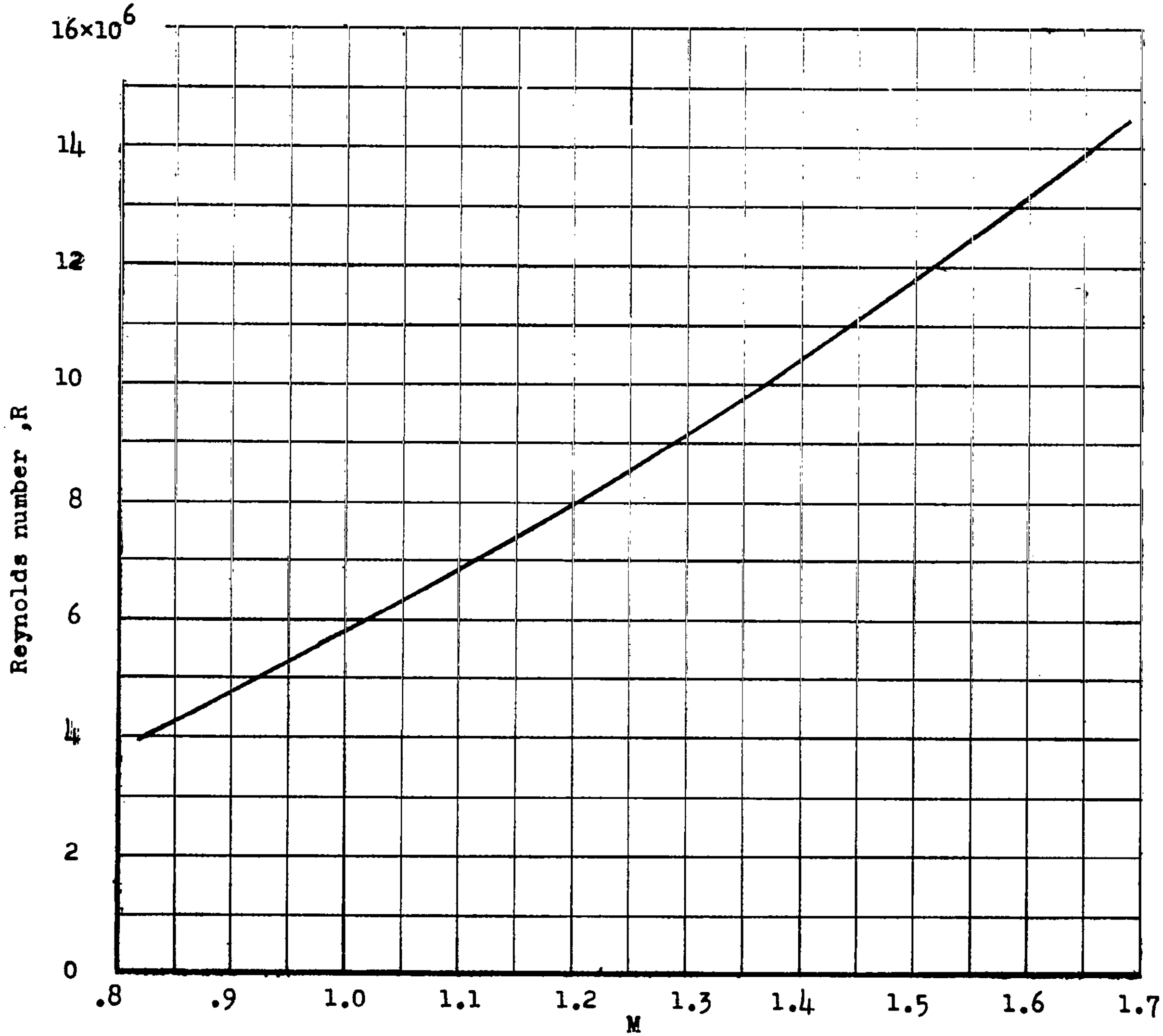


Figure 5.- Reynolds number as function of Mach number.

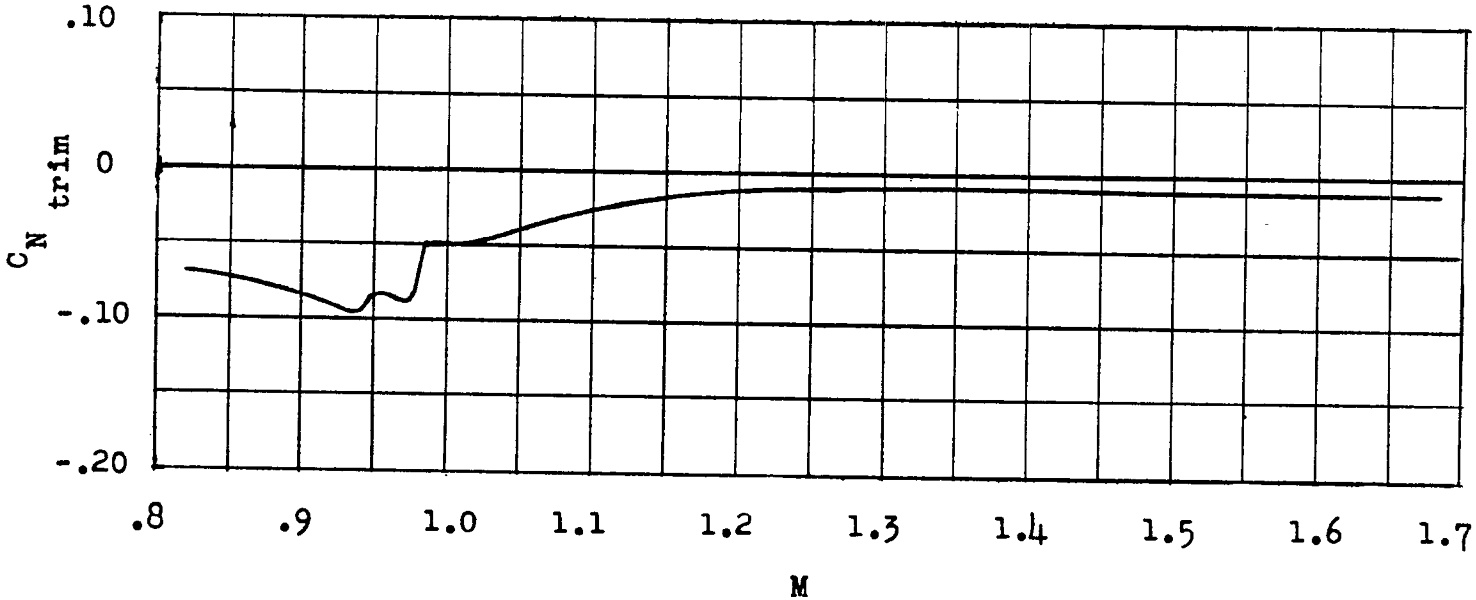


Figure 6.- Trim normal-force coefficients (center of gravity located at 6.95 percent $\bar{c}$).

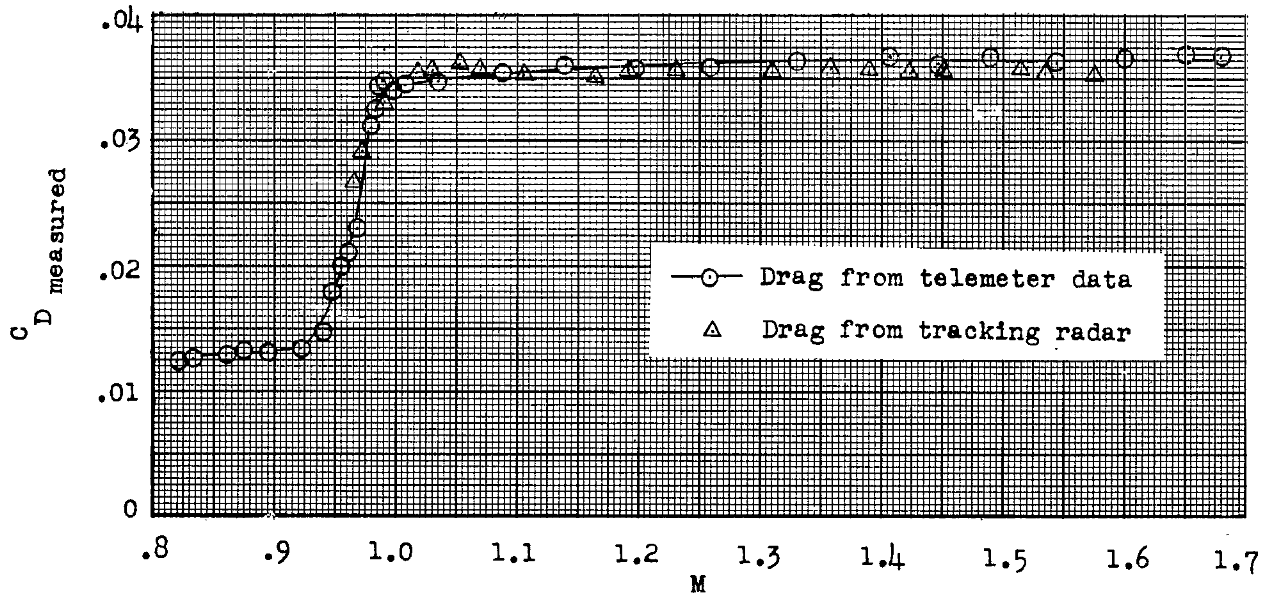


Figure 7.- Measured drag coefficients.

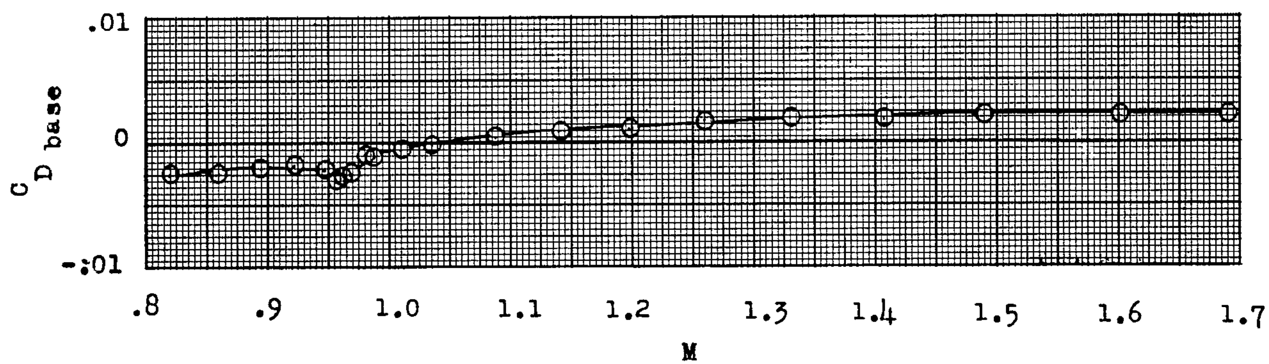


Figure 8.- Base drag coefficients.

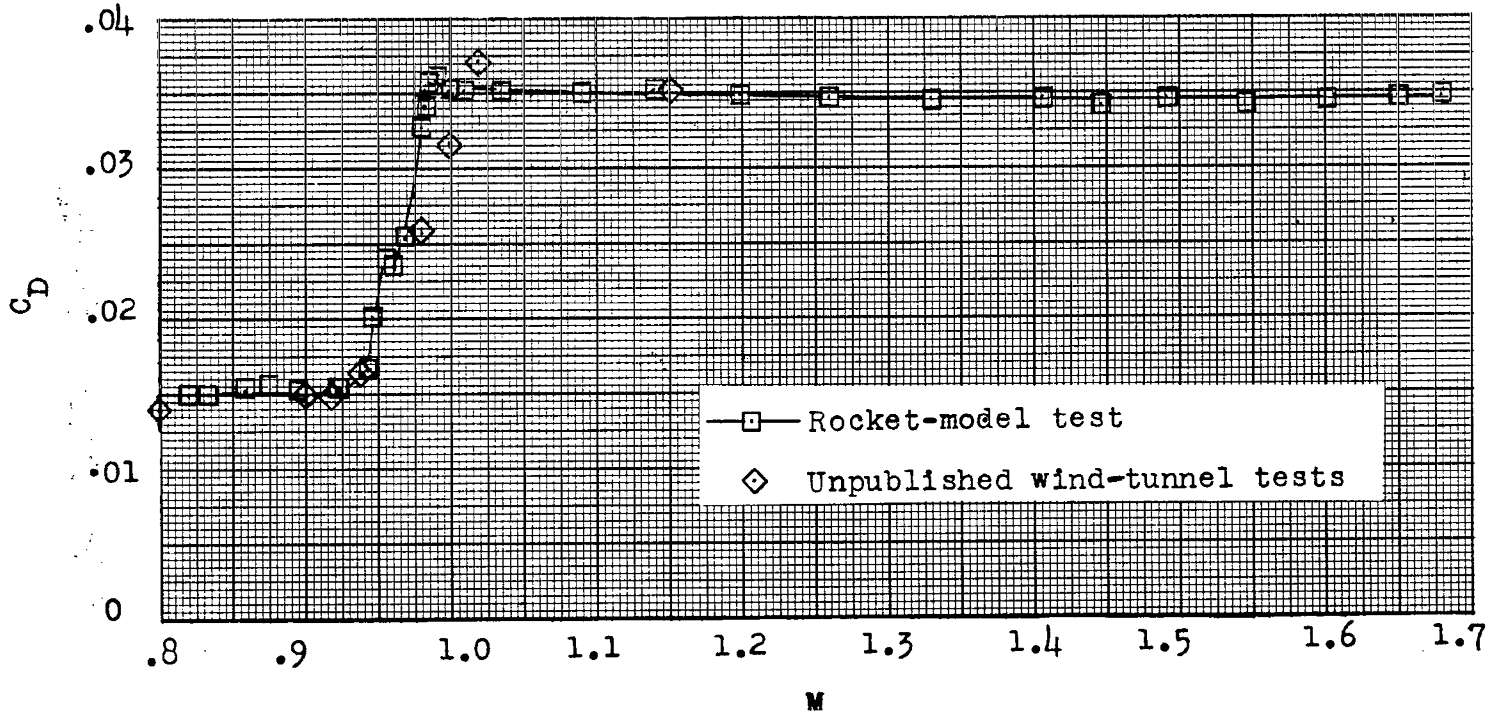


Figure 9.- Drag coefficients.

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