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Vought XF7U-1

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RESEARCH MEMORANDUM

for the

Bureau of Aeronautics, Navy Department

AN INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF AN 0.08-SCALE
MODEL OF THE CHANCE VOUGHT XF7U-1 AIRPLANE IN THE
LANGLEY HIGH-SPEED 7- BY 10-FOOT TUNNEL
PART I -- BASIC LONGITUDINAL STABILITY CHARACTERISTICS

TED NO. NACA DE308

By

William B. Kemp, Jr., Richard E. Kuhn, and Kenneth W. Goodson

Langley Memorial Aeronautical Laboratory
Langley Field, Va.

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LANGLEY HIGH-SPEED 7- BY 10-FOOT TUNNEL
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SUMMARY

The stability and control characteristics of an 0.08-scale model of the Chance Vought XF7U-1 airplane have been investigated over a Mach number range from 0.40 to 0.91. Results of the basic longitudinal tests of the complete model with undeflected control surfaces are given in the present report with a very limited analysis of the results.

INTRODUCTION

At the request of the Bureau of Aeronautics, Navy Department, an investigation of the stability and control characteristics of an 0.08-scale model of the Chance Vought XF7U-1 airplane was conducted in the Langley high-speed 7- by 10-foot tunnel.

This report presents the results of the basic longitudinal stability tests. The results include lift, drag, and pitching-moment data for the complete model with undeflected controls over an angle-of-attack range at Mach numbers varying from 0.40 to 0.91. The inlet-velocity ratios associated with the simulated jet air-intake duct are also presented.

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The present report is published with the purpose of presenting the data available at present from high-speed tests of the 0.08-scale model of the XF7U-1 airplane. Accordingly, no detailed analysis of the data has been made.

SYMBOLS

The system of axes used for the presentation of the data, together with an indication of the sense of the positive forces and moments, is presented in figure 1. Pertinent symbols are defined as follows:

C_L	lift coefficient	$\left(\frac{\text{Lift}}{qS} \right)$
C_D	drag coefficient	$\left(\frac{\text{Drag}}{qS} \right)$
C_m	pitching-moment coefficient measured about the 17 percent M.G.C. position	$\left(\frac{\text{Pitching moment}}{qSc'} \right)$
q	dynamic pressure	$\left(\frac{1}{2} \rho V^2 \right)$
ρ	air density, slugs per cubic foot	
V	free-stream velocity, feet per second	
M	free-stream Mach number	(V/a)
a	speed of sound, feet per second	
S	wing area, square feet	(3.174 ft^2)
c'	mean geometric chord, feet	(1.046 ft)
α	angle of attack, measured from the X-axis to the fuselage center line, degrees	

APPARATUS AND METHODS

Model

The 0.08-scale steel model of the XF7U-1 airplane used in this investigation was constructed by Chance Vought Aircraft. Pertinent

dimensions of the model are presented on the three-view drawing of figure 2. The right air-intake duct contained a cluster of small, pitot pressure tubes which were used to determine the inlet-velocity ratios.

Tests and Tare Determination

In order to eliminate the serious interference introduced at high speeds by the conventional two- or three-strut model support systems, the model was supported for the present tests by a sting extending from the rear of the fuselage to a vertical strut located well behind the model in the expanding part of the tunnel. This strut was mounted on the tunnel balance system and was shielded from the air stream by a fairing. A photograph of the model supported on this system is shown in figure 3. The tare forces and moments produced by the center sting were determined by mounting the model on two wing supports which were also attached to the vertical strut and testing the model with and without the center sting. Figure 4 is a photograph of the model mounted on the wing supports with the center sting in place. Angles of attack were changed by the use of interchangeable couplings in the stings behind the model. Deflections of the support system under load were determined from static loading tests.

The variation of test Reynolds number with Mach number for average test conditions is presented in figure 5. The Reynolds number was computed using a turbulence factor of unity. The degree of turbulence of the tunnel is not known but is believed to be small because of the high contraction ratio of the tunnel. The size of the model used in the present investigation leads to an estimated choking Mach number of 0.93 based on one-dimensional-flow theory. Experience has indicated that with this value of the choking Mach number, the tunnel constriction effects should not invalidate the test results at tunnel Mach numbers below 0.90. Application of the blocking correction increases this limit to over 0.91.

Corrections

The test results have been corrected for the tare forces and moments produced by the support system and for deflections of the system under load.

The jet-boundary corrections were computed from the following equations which were determined by the method of reference 1.

$$\alpha = \alpha_M + 0.331C_{L_M}$$

$$C_D = C_{D_M} + 0.0058C_{L_M}^2$$

where the subscript M indicates measured value. The jet-boundary correction to the pitching moment was considered negligible.

The drag has been corrected for the buoyancy produced by the small longitudinal static-pressure gradient in the tunnel and all coefficients and Mach numbers were corrected for blocking by the model and its wake.

RESULTS AND DISCUSSION

The longitudinal characteristics of the complete model with neutral control surfaces are presented in figure 6. The deflection of the support system caused the angle of attack of the model to change with speed. It was necessary, therefore, to cross-plot the original test results at constant angle of attack or lift coefficient to obtain the curves shown in figure 6. Pitching-moment coefficients are presented about a center of gravity located at 17 percent of the mean geometric chord.

The pitching-moment coefficient and angle of attack are plotted against lift coefficient in figure 7 for various Mach numbers. The variation with Mach number of the slopes of these curves at low lift coefficients are presented in figures 8 and 9. The curve of $\left(\frac{\partial C_m}{\partial C_L}\right)_M$ (fig. 9) which is a measure of the static margin at a given speed, shows a marked increase in static margin at Mach numbers above 0.85. However, the negative variation of pitching-moment coefficient with Mach number which appears at high Mach numbers in the data of figure 6 may cause an unstable variation of control position with speed. The cause of this behavior at the high Mach numbers on this swept wing model is not understood but as far as the unstable variation of control position with speed is concerned the effect is similar to that which has been observed on unswept models at supercritical speeds.

The results of the duct inlet-velocity measurements are presented in figure 10 as the ratio of the duct inlet velocity to

the free-stream velocity. The measured inlet-velocity ratios are about half the magnitude of those expected in high-speed, full-power flight. At lower flight speeds, full-power operation should produce inlet-velocity ratios much higher than those measured. However, calculations have indicated that only a small pitching moment results from turning the inlet air through the angle of attack at the duct inlet.

Visual observation of tufts indicated no external flow separation from the duct inlets at any Mach number at low angles of attack. At the highest angle of attack, however, a local separation from the upper surface of the duct lip was observed at Mach numbers as low as 0.45.

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REFERENCE

1. Gillis, Clarence L., Polhamus, Edward C., and Gray, Joseph L., Jr.:
Charts for Determining Jet-Boundary Corrections for Complete
Models in 7- by 10-Foot Closed Rectangular Wind Tunnels.
NACA ARR No. L5G31, 1945.

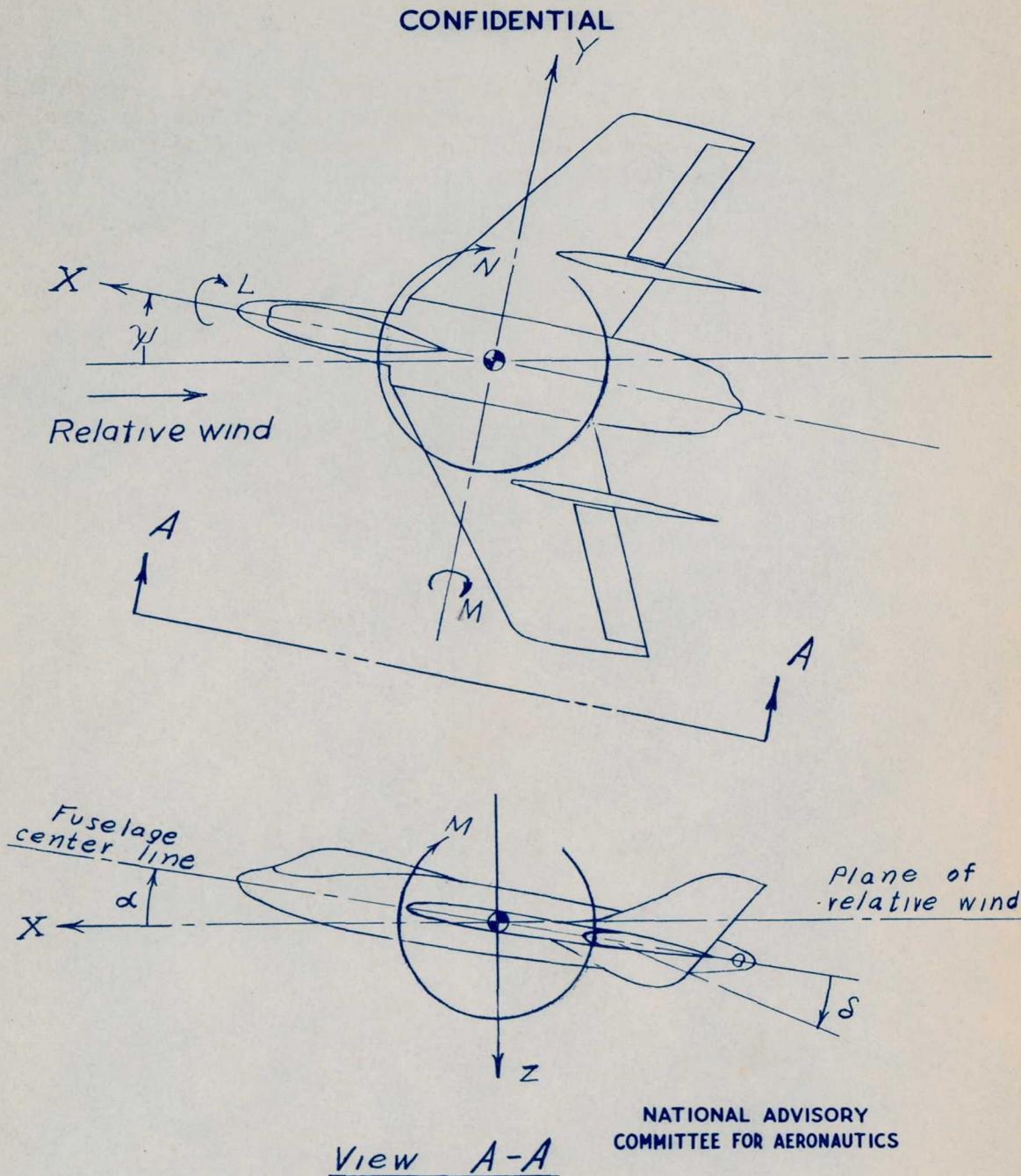
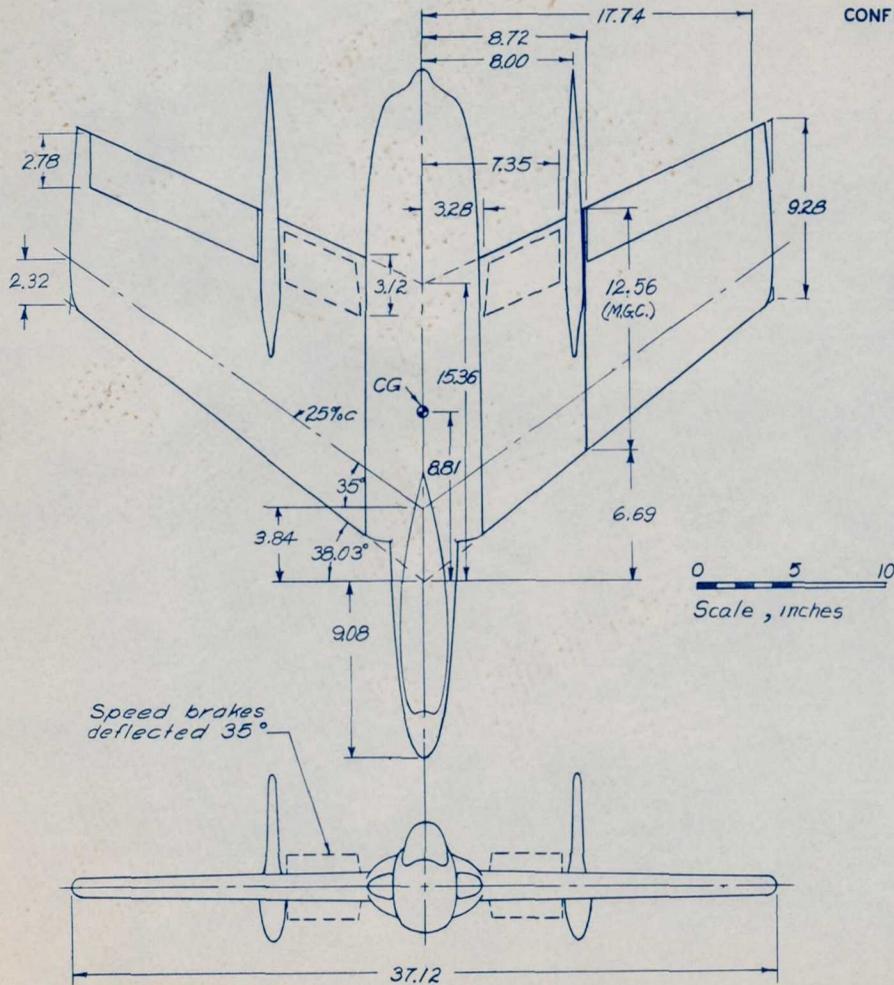


Figure 1 .- System of axes and control-surface deflections. Positive values of forces, moments, and angles are indicated by arrows.

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TABULATED DATA

Wing Area	3.174 sq. ft.
Aspect ratio	3.04
Mean geometric chord	1.046 ft.
Incidence	0°
Dihedral	0°
Airfoil (perpendicular to 0.25c)	Symmetrical
Max. thickness	0.12c
Location of max. thickness	0.40c
Vertical tail Area (two)	0.82 sq. ft.
Aspect ratio	1.75
CG location	0.17 M.G.C.

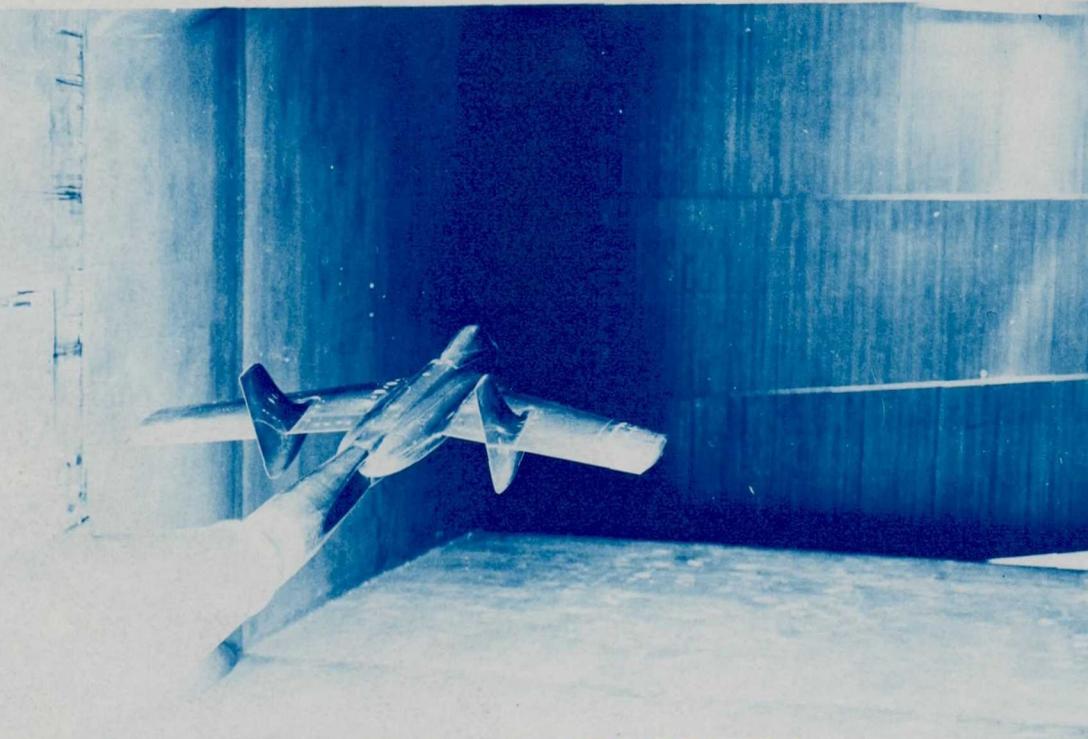
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Figure 2.- General arrangement of 0.08-scale model of Chance Vought XF7U-1 airplane.

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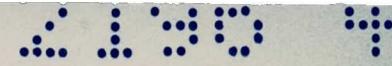
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Figure 3.- Photograph of the 0.08-scale model of the XF7U-1 airplane mounted on the center sting at a positive angle of attack.

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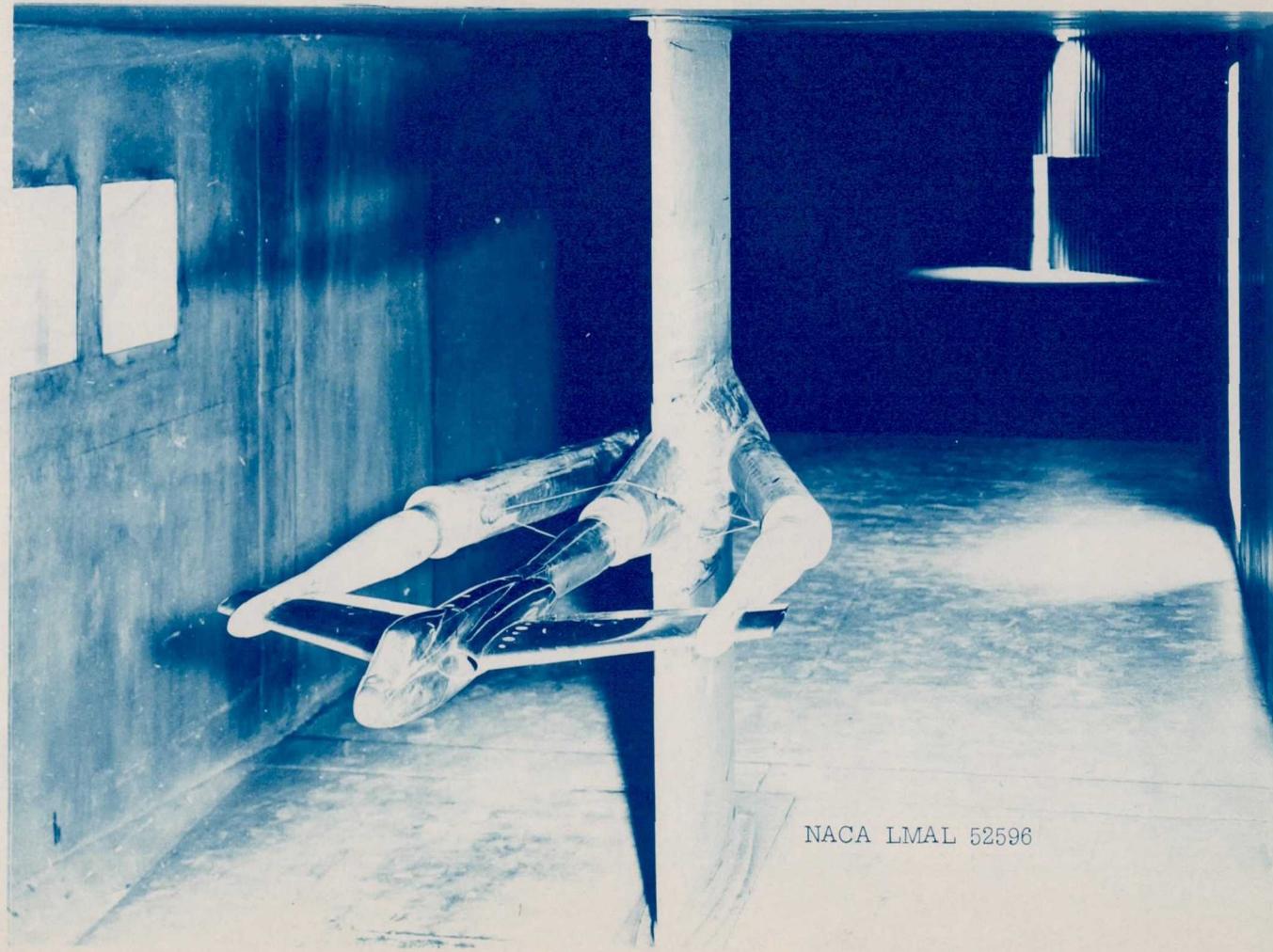
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Fig. 3



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Figure 4.- Photograph of the 0.08-scale model of the XF7U-1 airplane with vertical tails removed mounted on the wing supports with center sting in place.

Fig. 4

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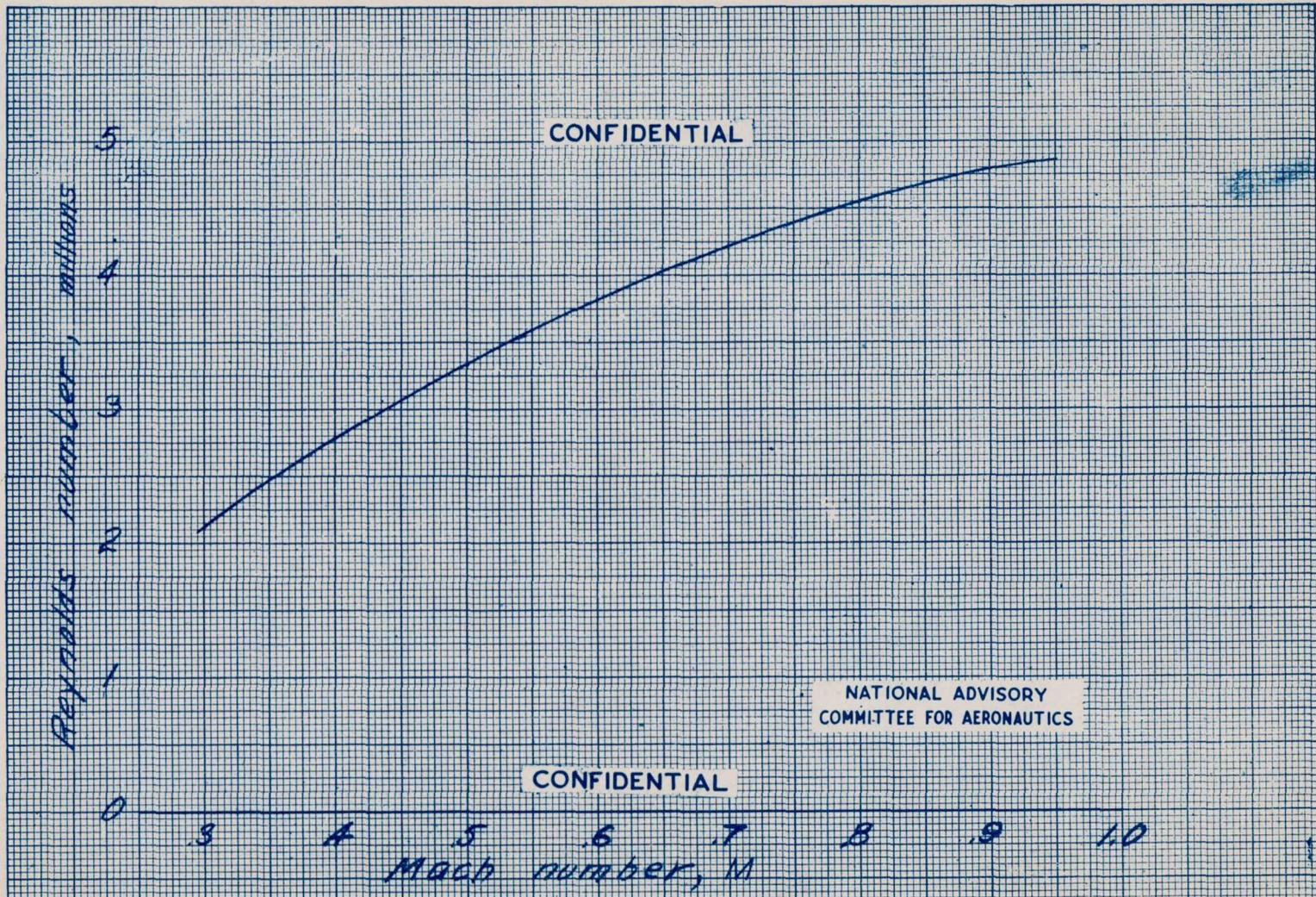


Figure 5 - Variation of test Reynolds number with Mach number for 0.08-scale XFTU-1 in the High Speed 7by10-foot tunnel

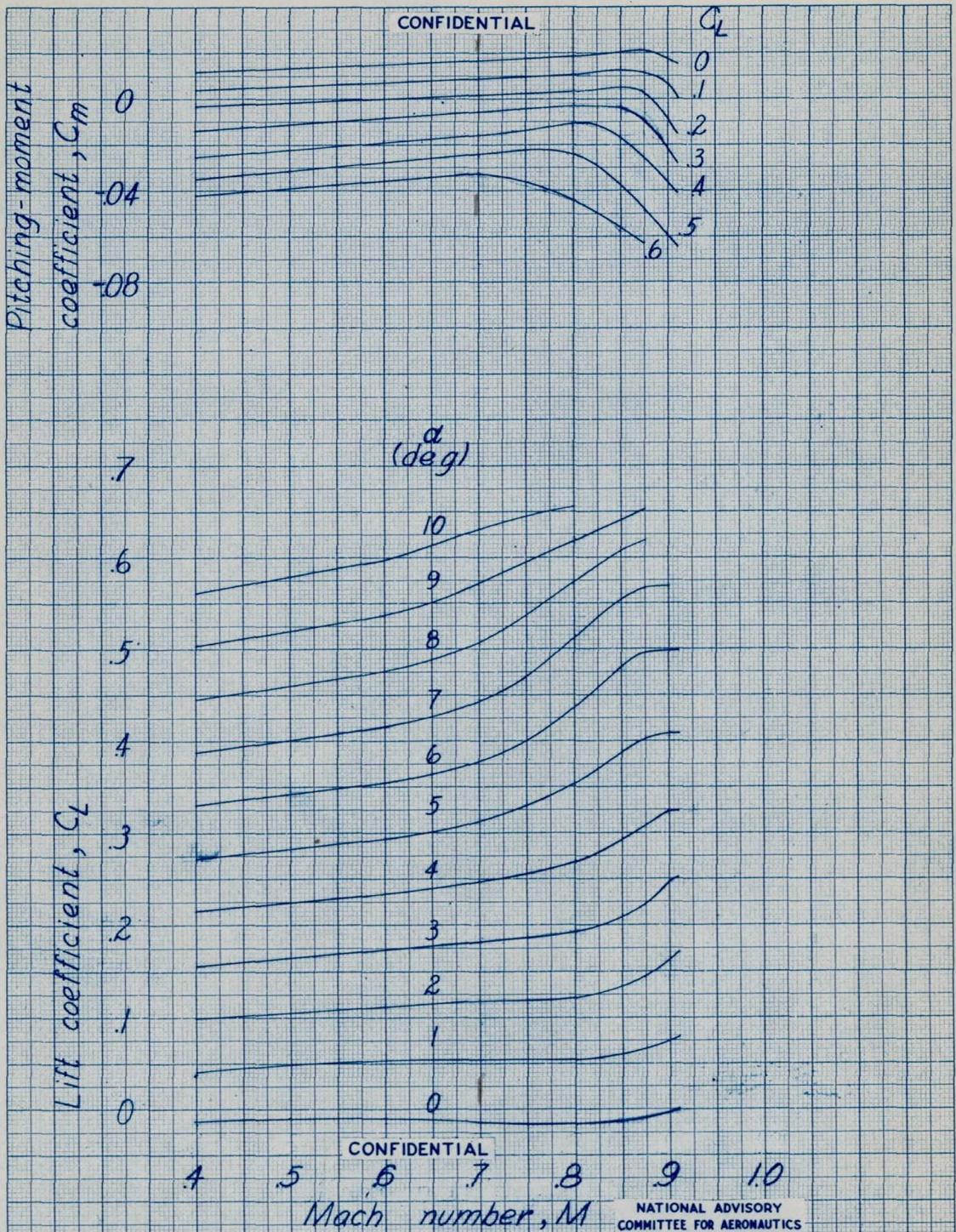


Figure 6.-Variation with Mach number of the aerodynamic characteristics in pitch of the 0.08-scale model of the XF7U-1 airplane.

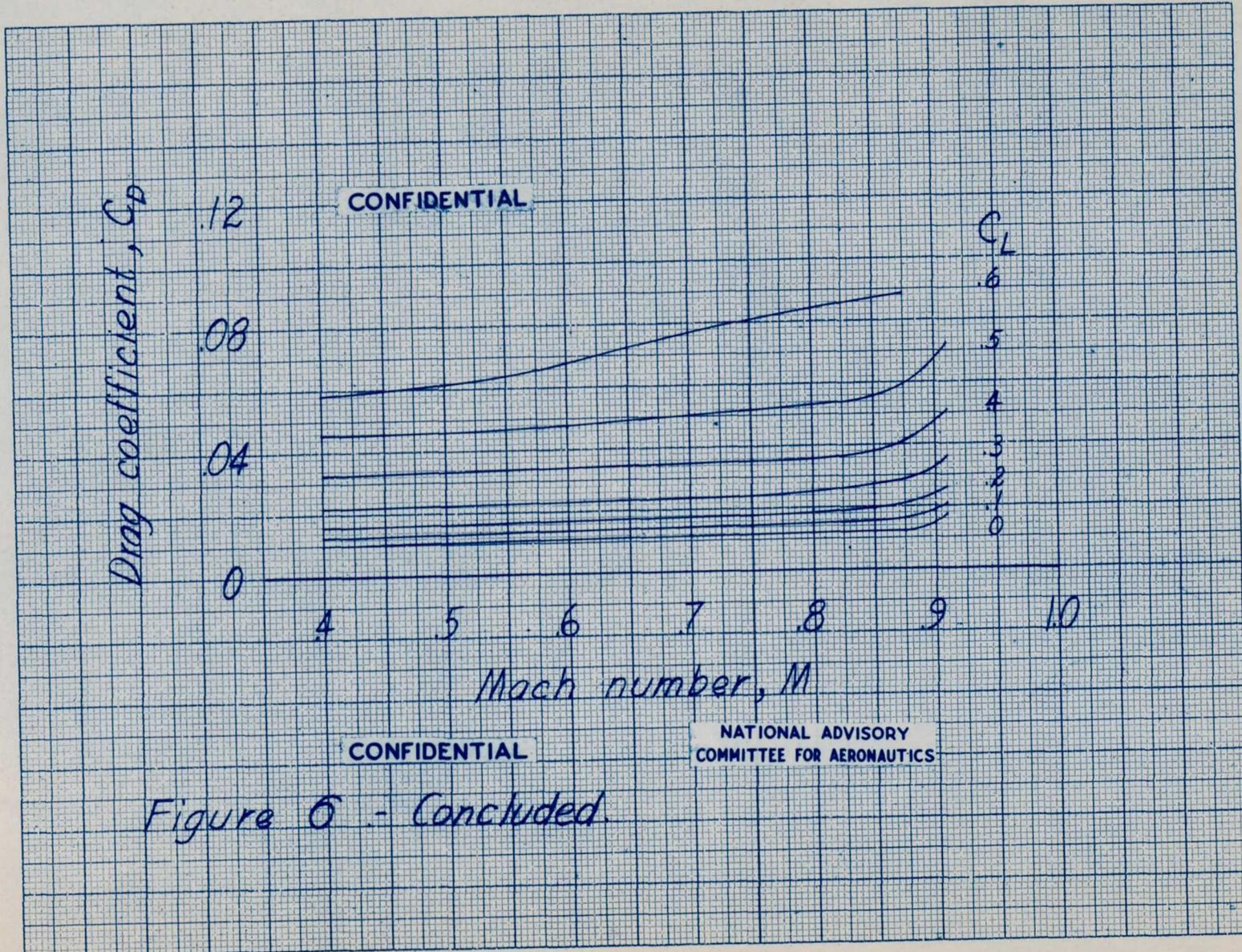
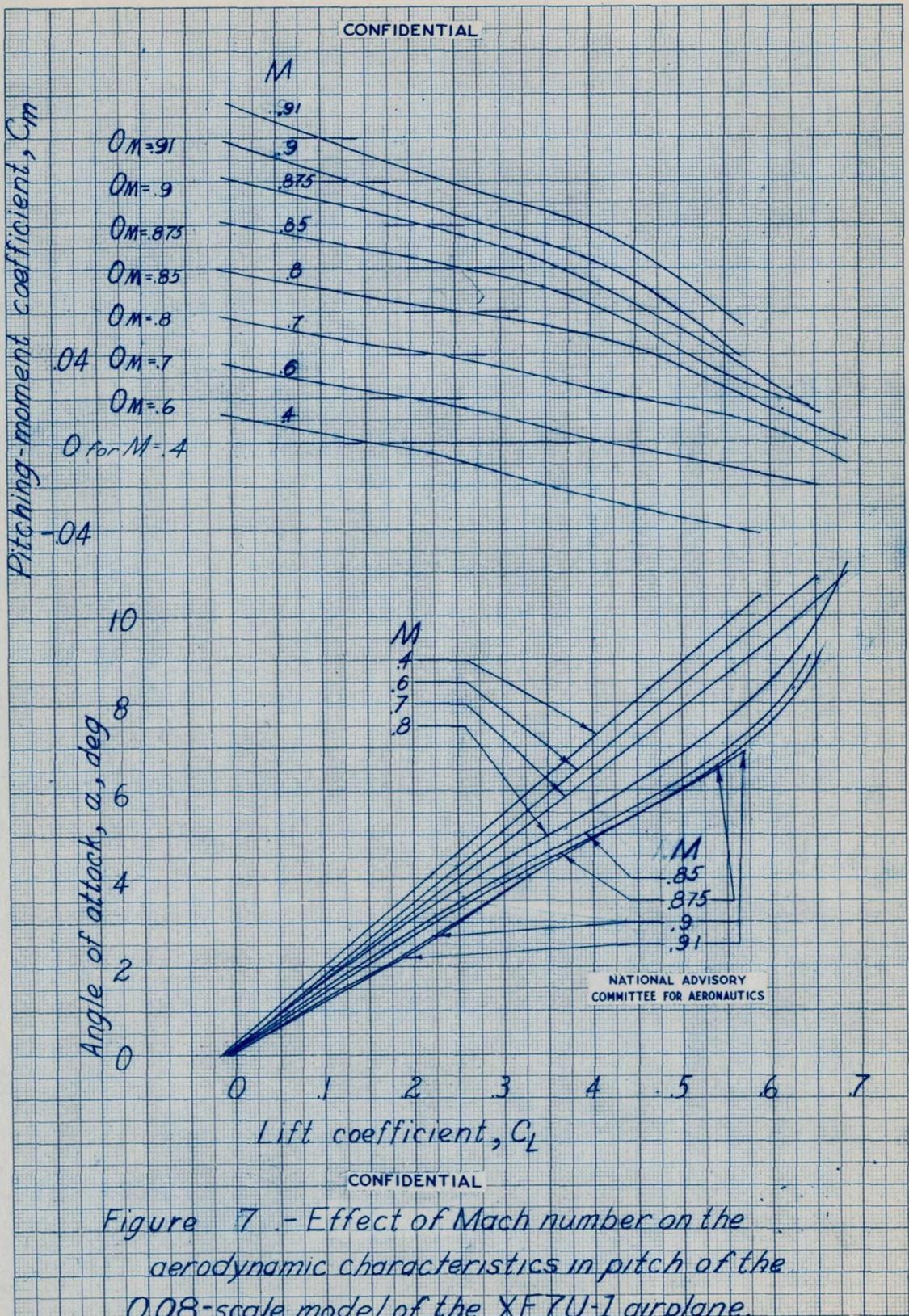
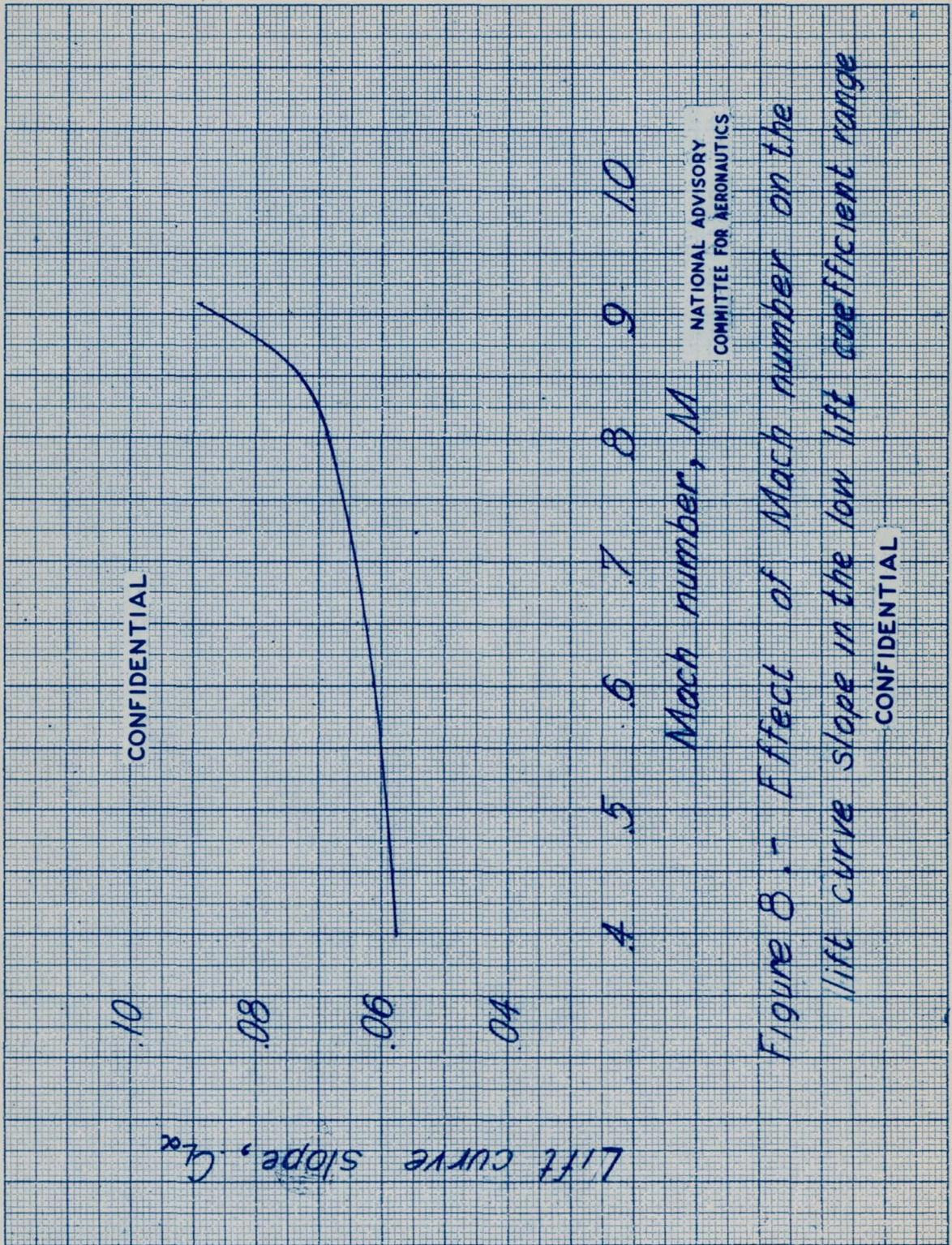


Figure 6 - Concluded.





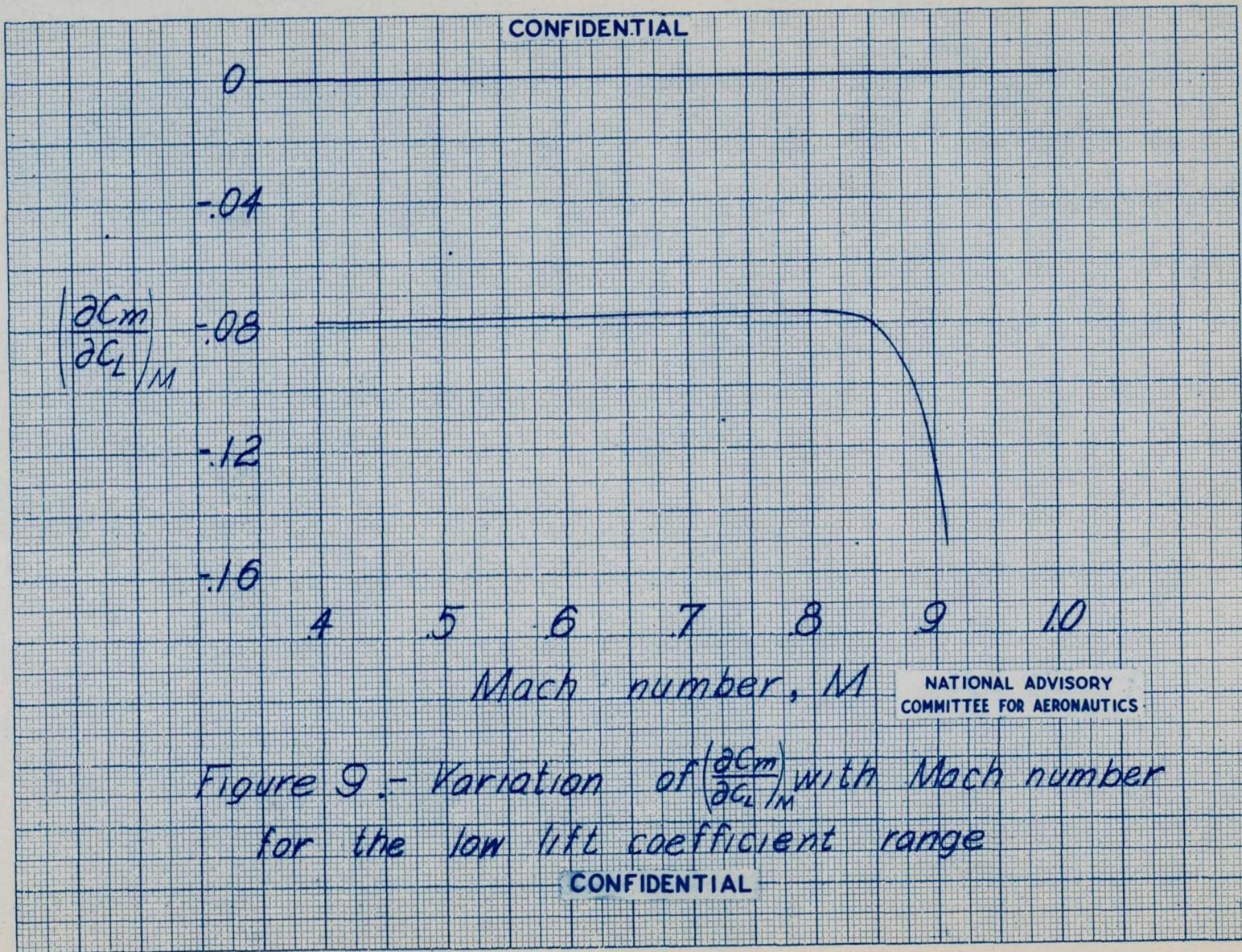
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Mach number, M

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Figure 8.- Effect of Mach number on the lift curve slope in the low lift coefficient range

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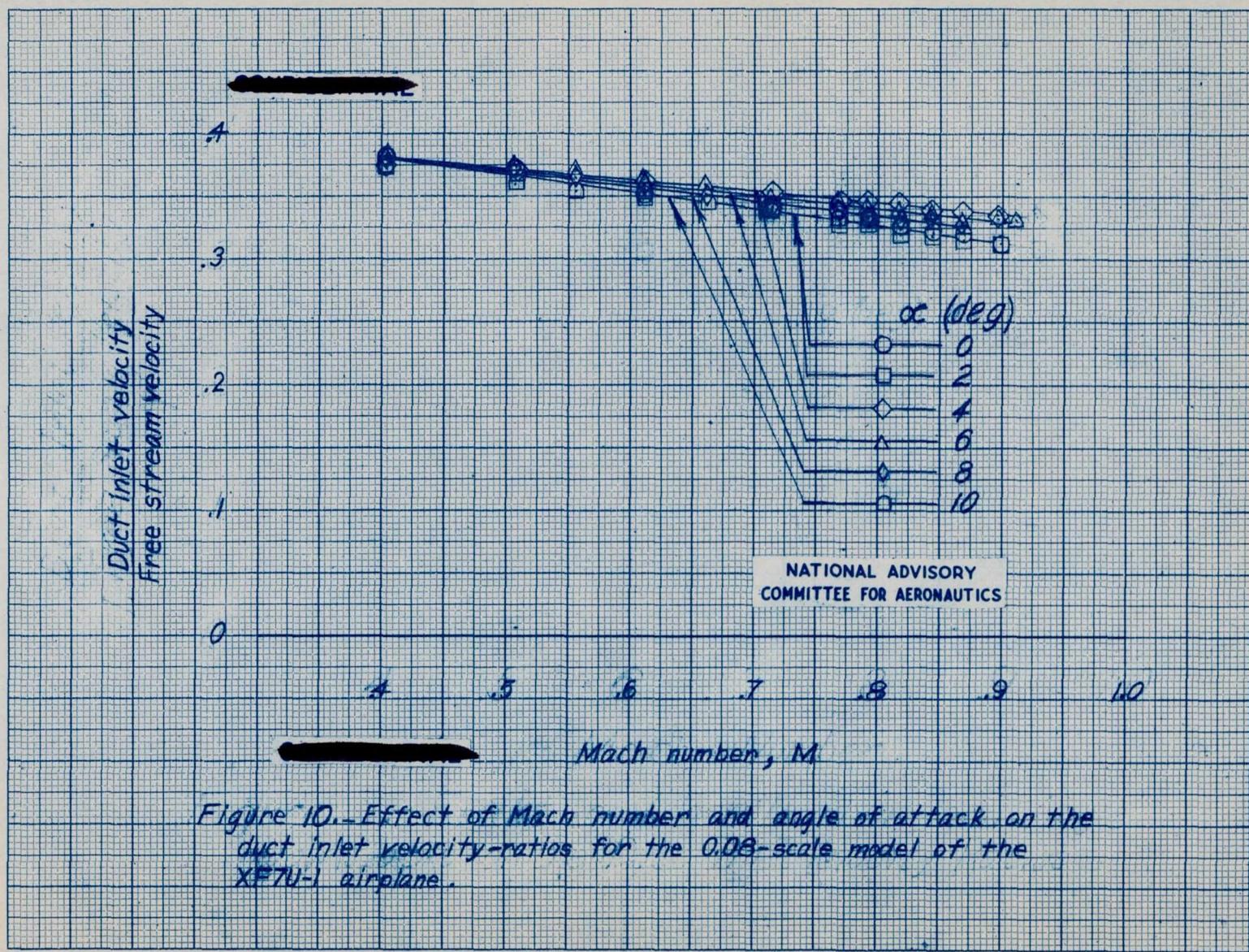


Figure 10.- Effect of Mach number and angle of attack on the duct inlet velocity-ratios for the 0.08-scale model of the XF7U-1 airplane.