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RESEARCH MEMORANDUM

for the

Bureau of Ordnance, Department of the Navy

AN INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A $\frac{3}{4}$-SCALE MODEL OF THE EX-3 PINE-CONE-HEAD PELLET IN THE LANGLEY HIGH-SPEED 7- BY 10-FOOT WIND TUNNEL

By

George S. Campbell

Langley Aeronautical Laboratory
Langley Field, Va.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

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SUMMARY

An investigation of the EX-3 pine-cone-head pellet was made in the Langley high-speed 7- by 10-foot wind tunnel to determine the static force and moment characteristics at high Mach numbers with the reference center of gravity located at 37.5 percent of the over-all length aft of the nose. For this center-of-gravity location there were no secondary trim positions, and the center-of-pressure position was not appreciably affected by Mach number.

INTRODUCTION

At the request of the Bureau of Ordnance, Department of the Navy, tests were made in the Langley high-speed 7- by 10-foot wind tunnel to determine the static aerodynamic characteristics in yaw of the EX-3 pine-cone-head pellet at high subsonic Mach numbers. The present configuration was developed by the Bureau of Ordnance after studies of German literature on the subject and on the basis of low-speed tests conducted by the Bureau of Standards. The primary purpose of the present investigation was to determine the effects of compressibility on the static stability characteristics of this pellet at high subsonic Mach numbers.

COEFFICIENTS AND SYMBOLS

The system of axes used for the presentation of data and the direction of positive forces and moments are shown in figure 1. The symbols used in this report and their definitions are as follows:

C_X	longitudinal-force coefficient (X/qS)
C_Z	normal-force coefficient (Z/qS)
$C_{n_{cg}}$	yawing-moment coefficient about 0.375L (N_{cg}/qSL)
X	longitudinal force, twice value measured on semispan model, pounds
Z	force normal to longitudinal body axis, twice value measured on semispan model, pounds
N_{cg}	yawing moment about center of gravity, twice value measured on semispan model, inch-pounds
cg	pellet reference center-of-gravity location
D	maximum diameter of model, 3 inches
S	maximum cross-sectional area, complete model, 0.0491 square foot
L	over-all length of model, 6 inches
V	free-stream velocity, feet per second
a	free-stream velocity of sound, feet per second
M	free-stream Mach number (V/a)
ρ	free-stream density, slugs per cubic foot
q	free-stream dynamic pressure, pounds per square foot $\left(\frac{1}{2}\rho V^2\right)$
ψ	angle of yaw, degrees

APPARATUS AND METHODS

The tests were made in the Langley high-speed 7- by 10-foot wind tunnel. The semispan model tested was constructed of aluminum, the dimensions being given in figure 2. The pellet was tested as a half model using a reflection plane mounted 3 inches from the tunnel wall in order to place the model outside of the tunnel boundary layer. (See fig. 3.) Forces and moments were measured using a strain-gage balance system mounted outside the test section, the system being sealed to prevent leakage into the flow field of the model. The clearance between the yaw plane of the model and the reflection plane was about 1/32 inch.

TESTS AND CORRECTIONS

Longitudinal force, normal force, and yawing moment were obtained for a yaw range of 0° to 90° at Mach numbers of 0.50 to 0.89. Because of the very small size of the model relative to the test section, jet boundary and blockage corrections were negligible. Unpublished data obtained on semispan and complete model installations for wing–fuselage combinations have shown good agreement, and so the semispan pellet data are believed to indicate the characteristics of the complete model rather closely.

RESULTS AND DISCUSSION

The aerodynamic characteristics of the EX–3 pellet at Mach numbers from 0.50 to 0.89 are presented in figure 4. The effect of compressibility on center–of–pressure location was small. The most forward center–of–pressure location for Mach numbers from 0.50 to 0.89 occurred at a yaw angle of approximately 45°. The pellet should be statically stable throughout the yaw range for any of the Mach numbers tested when the center of gravity is forward of 0.43L. The static–restoring moment was generally greater at the higher Mach numbers.

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

George S. Campbell
George S. Campbell
Aeronautical Research Scientist

Approved: Thomas A. Harris
Thomas A. Harris
Chief of Stability Research Division

MCF

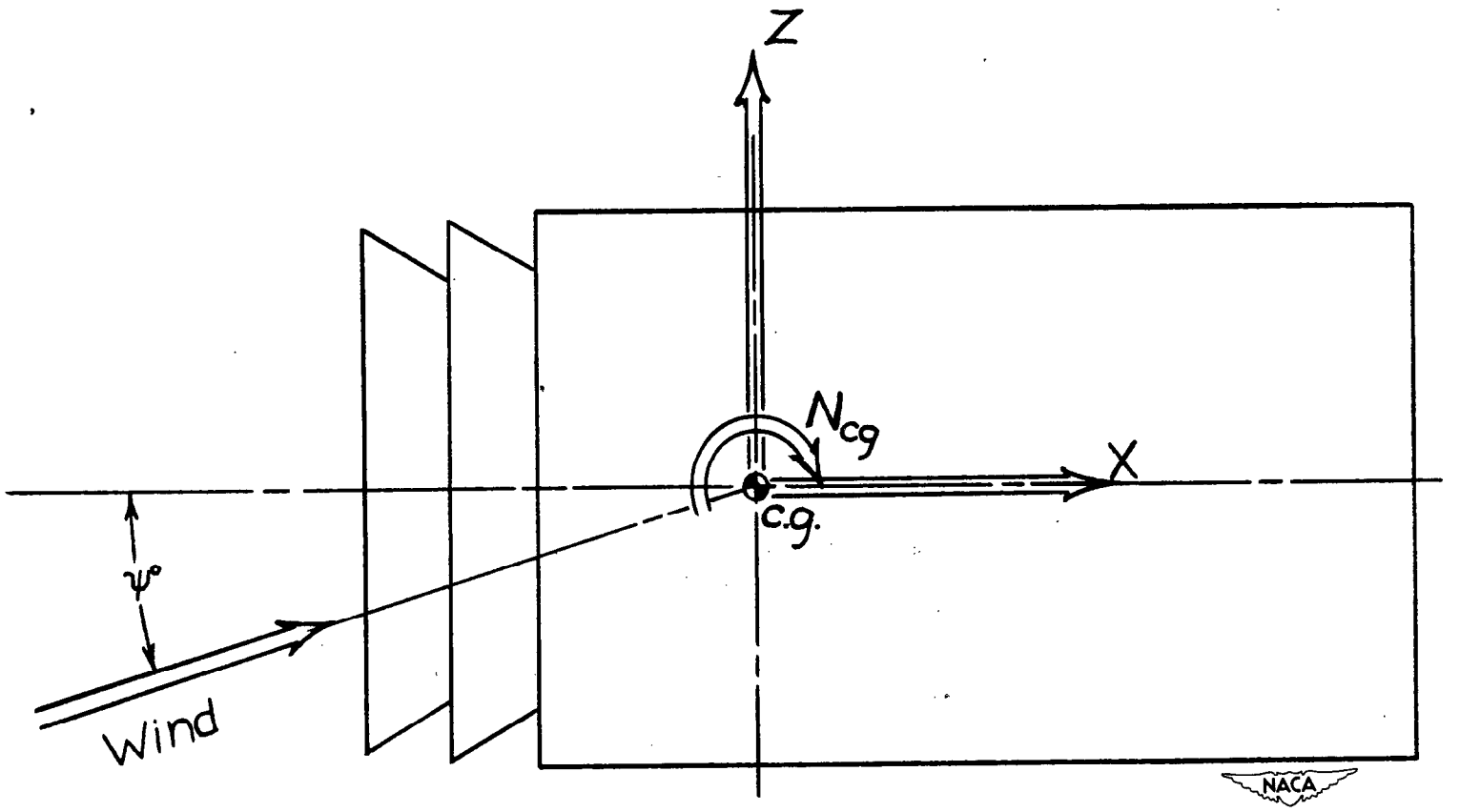

Figure 1.- System of axes with arrows indicating positive direction of forces and moments.

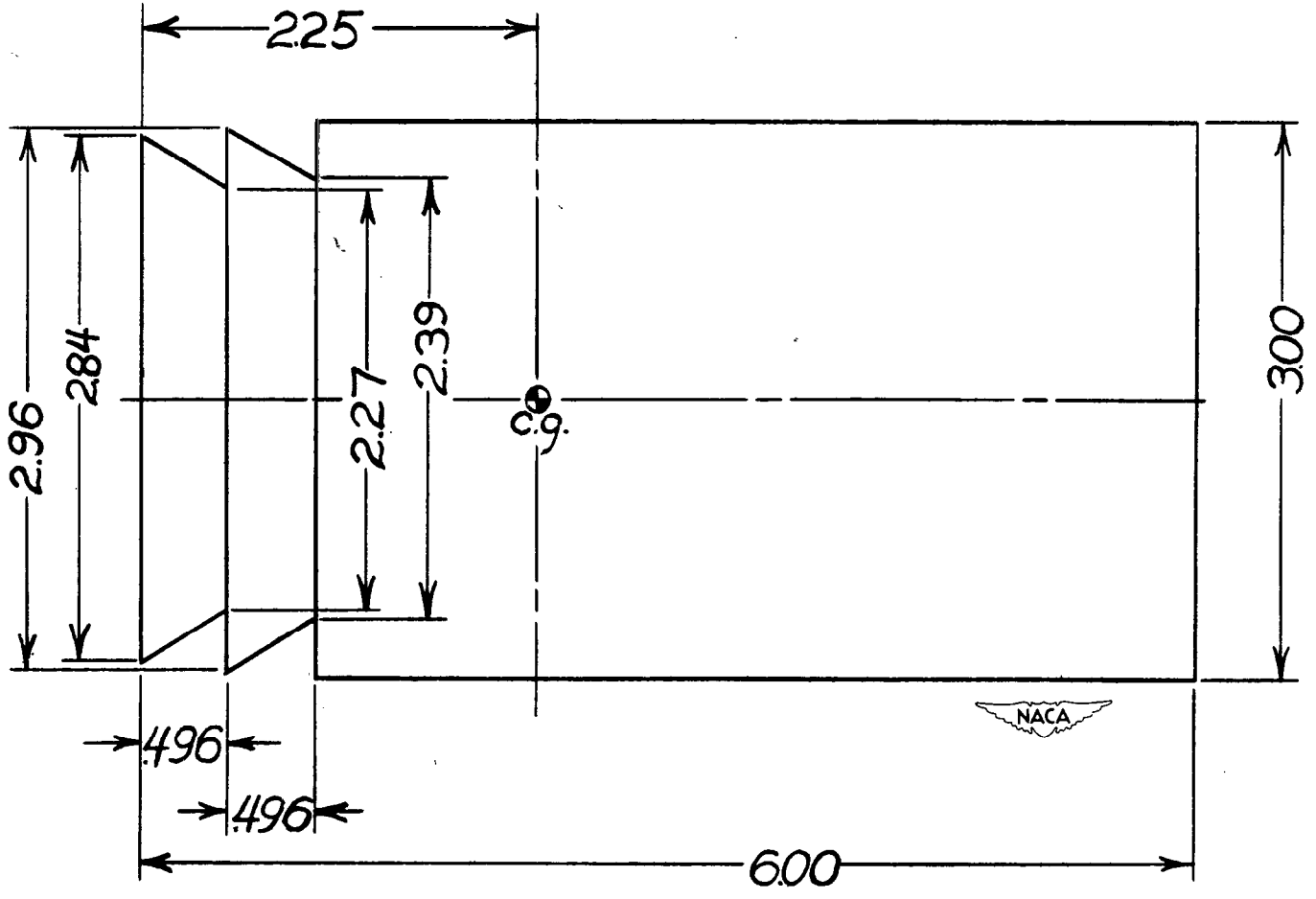

Figure 2.- Dimensions of the $\frac{3}{4}$-scale model of the Bureau of Ordnance pine-cone-head pellet EX-3 (formerly 2S) tested in the Langley high-speed 7- by 10-foot tunnel. All dimensions in inches.

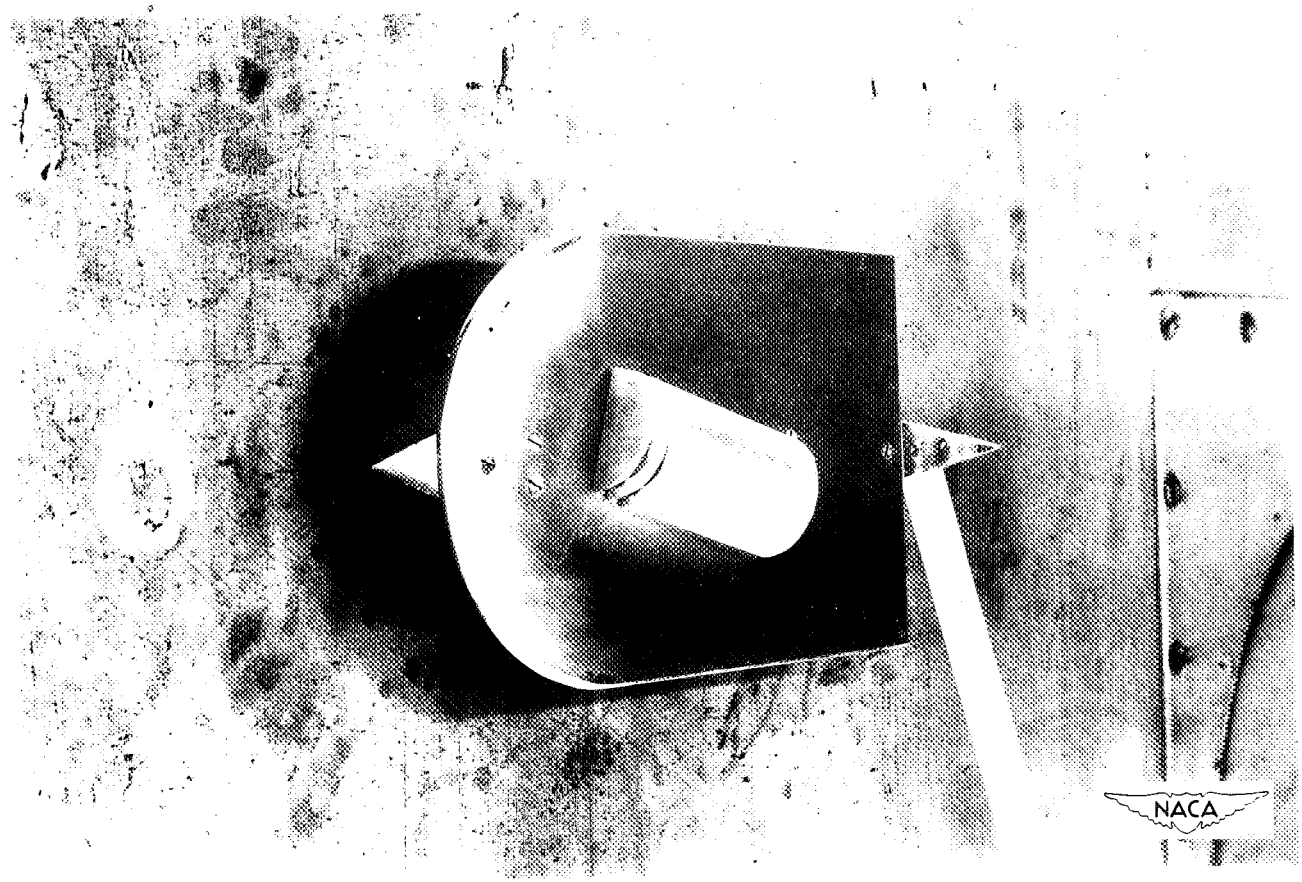

Figure 3.- Photograph of the Bureau of Ordnance pine-cone-head pellet EX-3 mounted on reflection plane of the Langley high-speed 7- by 10-foot tunnel.

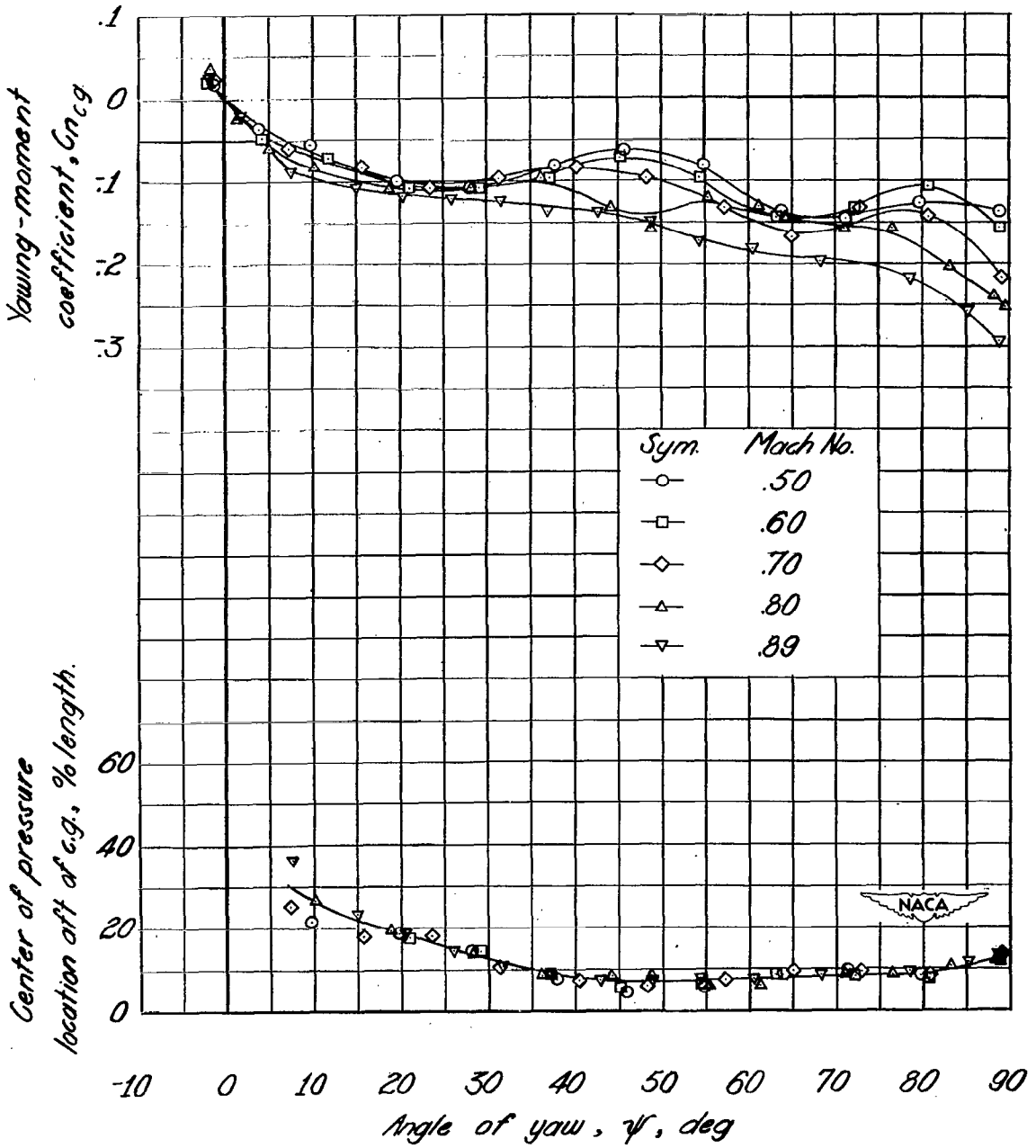

Figure 4.- Aerodynamic characteristics in yaw of the EX-3 pine-cone-head pellet at various subsonic Mach numbers.

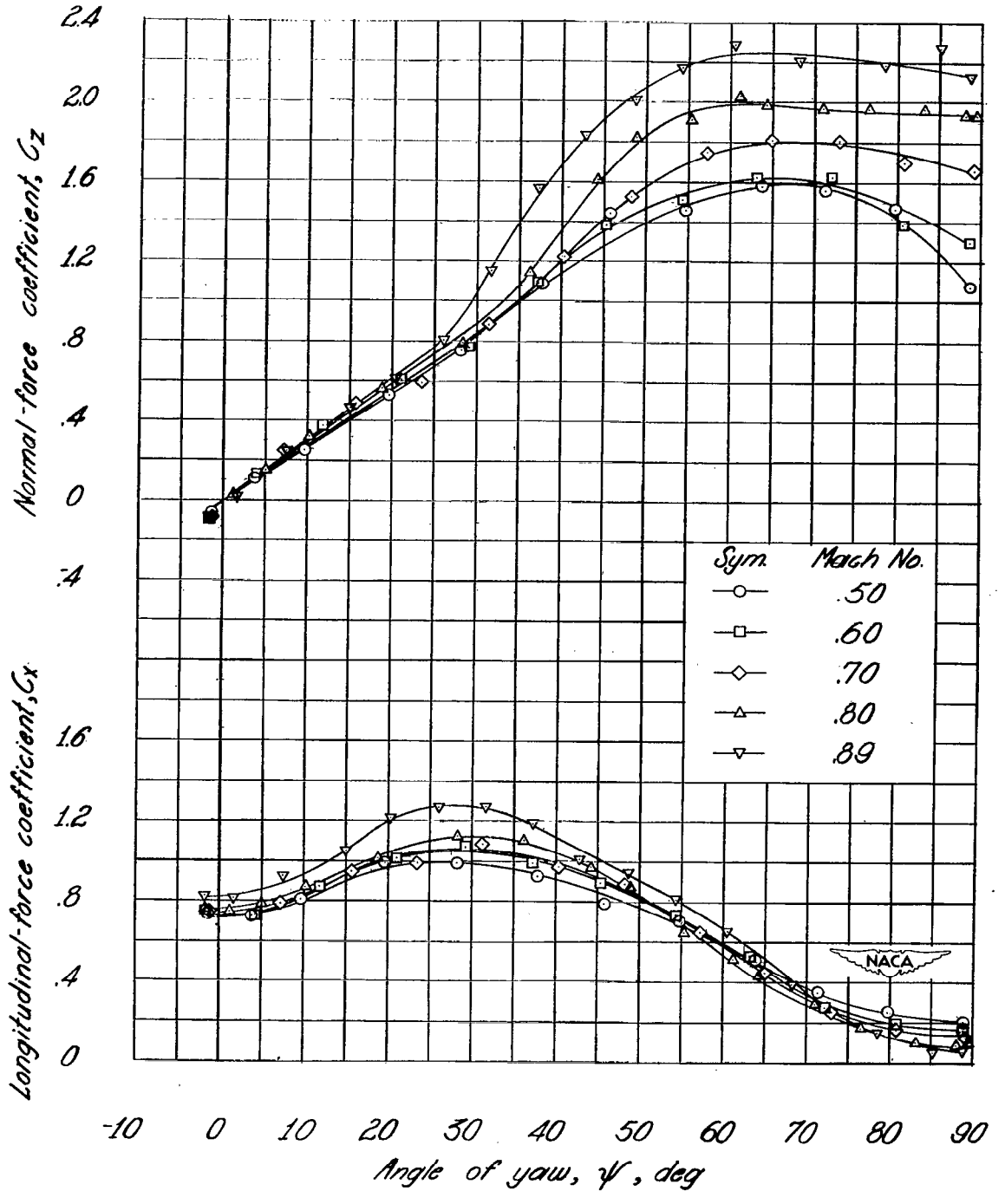

Figure 4.- Concluded.