[redacted]

RM SL50H18

N-481 A

Source of Acquisition
CASI Acquired

NACA

CLASSIFICATION CHANGE

To Unclassified
By authority of NASA Memo dtd 5-2-73 /s/ by H. Maines
Changed by M. Buda Date 6-6-73

RESEARCH MEMORANDUM

for the

Air Materiel Command, U. S. Air Force

LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG AT MACH NUMBERS FROM 0.90 TO 1.95 OF A $\frac{1}{14}$ -SCALE MODEL OF THE NORTHROP MX-775B PILOTLESS AIRCRAFT WITH SMALL BODY

By Warren Gillespie, Jr. and Richard G. Arbic

Langley Aeronautical Laboratory
Langley Air Force Base, Va.

Superseded by RM L50K28a

CLASSIF

Restriction/
Classification
Cancelled

This document con
affecting the Natio
States within the m
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.

NATIONAL ADVISORY COMMITTEE
FOR AERONAUTICS

WASHINGTON

AUG 17 1950

[redacted]

FILE COPY
To be returned to
the files of the National
Advisory Committee
for Aeronautics
Washington, D.C.

57 RDZ - 25846

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESEARCH MEMORANDUM

for the

Air Materiel Command, U. S. Air Force

LARGE-SCALE FLIGHT MEASUREMENTS OF ZERO-LIFT DRAG AT MACH NUMBERS FROM 0.90 TO 1.95 OF A $\frac{1}{14}$-SCALE MODEL OF THE NORTHROP MX-775B PILOTLESS AIRCRAFT WITH SMALL BODY

By Warren Gillespie, Jr. and Richard G. Arbic

SUMMARY

A flight test was made at high subsonic, transonic, and supersonic speeds and at high Reynolds numbers to determine the zero-lift drag of a $\frac{1}{14}$-scale model of the Northrop MX-775B pilotless aircraft with small body. The triangular wing of the model had $67\frac{1}{2}^{\circ}$ leading-edge sweep and 15° trailing-edge sweep. The wing airfoil sections were modified NACA 0004 sections.

The drag coefficient based on total wing area was 0.0107 at Mach number 1.60. At transonic speeds the maximum drag coefficient was 0.0125. The force-break Mach number was 0.98.

INTRODUCTION

At the request of the Air Materiel Command, U. S. Air Force, the Langley Pilotless Aircraft Research Division is investigating the aerodynamic characteristics of the Northrop MX-775B pilotless aircraft through the use of rocket-propelled scale models. Continuous data are obtained from high subsonic to supersonic speeds at high Reynolds numbers.

This paper presents zero-lift drag data for a $\frac{1}{14}$-scale model of the Northrop MX-775B pilotless aircraft with small body. The Mach number range was 0.90 to 1.95. Reynolds number, based on the wing mean aerodynamic chord of 2.31 feet, varied from 8.5×10^6 to 29.0×10^6.

SYMBOLS

C_D	drag coefficient (Drag/qS)
C_N	normal-force coefficient (Normal force/qS)
q	dynamic pressure, pounds per square foot ($\rho V^2/2$)
ρ	air density, slugs per cubic foot
V	velocity, feet per second
M	Mach number (V/c)
c	speed of sound, feet per second
R	Reynolds number ($\rho V\bar{c}/\mu$)
μ	coefficient of viscosity, slugs per foot-second
S	wing plan-form area (including area within the body), 5.61 square feet
$\bar{c}$	wing mean aerodynamic chord, 2.31 feet

MODEL AND TESTS

The model of the present test was a $\frac{1}{14}$-scale model of the Northrop MX-775B pilotless aircraft with small body. The model was designed to obtain zero-lift drag information during the coasting flight of the model.

The body and wing profile coordinates and the general arrangement of the test configuration are presented in table I and figure 1, respectively. Photographs of the model and model-booster combination are shown in figures 2 and 3. The body of the model had a fineness ratio of 15.6 with body frontal area 1.27 percent of the wing area. The triangular wing had $67\frac{1}{2}^{\circ}$ leading-edge sweep, 15° trailing-edge sweep and modified NACA 0004 airfoil sections in the streamwise direction. The wing chord plane was 1 inch below the body center line and parallel to it. The vertical tail had 0° sweep at the 50-percent-chord line, a taper ratio of 0.23, and 3-percent-thick symmetrical diamond airfoil sections which were modified by the addition of a constant thickness of 0.03 inch along the chord on each side from the chord plane. The resulting thickness ratios of the root and tip sections of the vertical tail were 0.037 and 0.060, respectively.

The model was of composite wood-metal construction and was instrumented with a two-channel telemeter and two accelerometers. The accelerometers were mounted to measure normal and longitudinal forces. There was no sustainer rocket in the model.

Figure 3 shows the model and external booster in the launching position of 76°. An ABL Deacon rocket motor was used which delivers approximately 6200 pounds thrust for 3.2 seconds.

Velocity was obtained from the Doppler radar and by integration of the data from the longitudinal accelerometer. Drag was obtained directly from the longitudinal accelerometer data and by differentiation of the Doppler determined velocity-time curve. Normal force was obtained from the normal accelerometer. Trajectory and atmospheric data were obtained from the radar tracking unit and by radiosonde observations.

The accuracy of the results is estimated to be:

Mach number . . . . ±0.010
C_D . . . . ±0.0005
C_N . . . . ±0.020

RESULTS AND DISCUSSION

Curves of drag coefficient, Reynolds number, and normal-force coefficient against Mach number are presented in figure 4 for the $\frac{1}{14}$-scale Northrop MX-775B pilotless aircraft model with small body. It is seen from the curve of normal-force coefficient against Mach number that the drag data were obtained very near to the desired zero-lift trim condition. The curve of drag coefficient against Mach number of figure 4 shows that the Northrop MX-775B small-body configuration has a remarkably low supersonic drag coefficient. The drag coefficient for the model was 0.0107 at Mach number 1.60. At transonic speeds the maximum drag coefficient was 0.0125. The drag coefficient had a gradual rise with Mach number, starting at M = 0.93 and broke sharply at M = 0.98.

The drag of the model tested is compared in figure 5 with the minimum drag of two similar wing-body combinations at high values of Reynolds number. The model of reference 1, which had a body of fineness ratio 10 and a 60° delta wing with NACA 65A003 airfoil sections, has a lower subsonic drag coefficient than the model of the present test. At supersonic Mach numbers the model of reference 1 and the MX-775B model have very nearly equal values of minimum drag coefficient. The model of reference 2, which had a body of fineness ratio 11.3 and a 63° delta wing with 5-percent-thick double-wedge airfoil sections, has a relatively high subsonic drag coefficient.

In order that a comparison could be made at the value of body-wing size of the Northrop MX-775B test model, the drag data of figure 6 were plotted against relative body-wing size. On this basis the Northrop MX-775B model has a higher minimum drag coefficient at both subsonic and supersonic Mach numbers than the model of reference 1. The test points of figure 6 at body-wing area ratio of 0.0612 are from unpublished data for a model identical to the model of reference 1, but having one-half the wing area.

CONCLUSIONS

At a Mach number of 1.60 the minimum drag coefficient was 0.0107. At transonic speeds the maximum drag coefficient was 0.0125. The force-break Mach number was 0.98.

The drag coefficient was found to be very low throughout the Mach number range of the test.

Langley Aeronautical Laboratory
National Advisory Committee for Aeronautics
Langley Air Force Base, Va.

Warren Gillespie, Jr.
Aeronautical Research Scientist

Richard G. Arbic
Richard G. Arbic
Aeronautical Engineer

Approved: Robert R. Gilruth
Robert R. Gilruth
Chief of Pilotless Aircraft Research Division

GMF

REFERENCES

1. Nelson, Robert L.: Large-Scale Flight Measurements of Zero-Lift Drag at Mach Numbers from 0.86 to 1.5 of a Wing-Body Combination Having a 60° Triangular Wing with NACA 65A003 Sections. NACA RM L50D26, 1950.

2. Edwards, George G., and Stephenson, Jack D.: Tests of a Triangular Wing of Aspect Ratio 2 in the Ames 12-Foot Pressure Wind Tunnel. I - The Effect of Reynolds Number and Mach Number on the Aerodynamic Characteristics of the Wing with Flap Undeflected. NACA RM A7K05, 1947.

TABLE I

BODY AND WING AIRFOIL-SECTION ORDINATES

Airfoil section	
Station (percent chord)	Upper and lower ordinates (percent chord)
0	0
1.25	.6325
2.50	.8660
5.00	1.1900
7.50	1.4000
10.00	1.5550
15.00	1.7780
20.00	1.9100
25.00	1.9780
30.00	2.0000
40.00	1.9310
Straight line	Straight line
75.00	1.0420
Straight line	Straight line
100.00	0
L.E.radius: 0.178	

Body ordinates	
Station (in. from nose)	Radius (in.)
0	0
1.000	.259
2.000	.491
3.000	.703
4.000	.893
7.375	1.386
10.375	1.654
13.375	1.785
15.375	1.808
18.375	1.808
20.000	1.806
23.000	1.787
26.000	1.748
29.000	1.690
32.000	1.615
35.000	1.526
38.500	1.406
42.500	1.251
46.500	1.082
49.078	.965
50.078	.909
51.078	.837
52.078	.742
53.078	.618
54.078	.457
55.078	.253
56.078	0

NACA

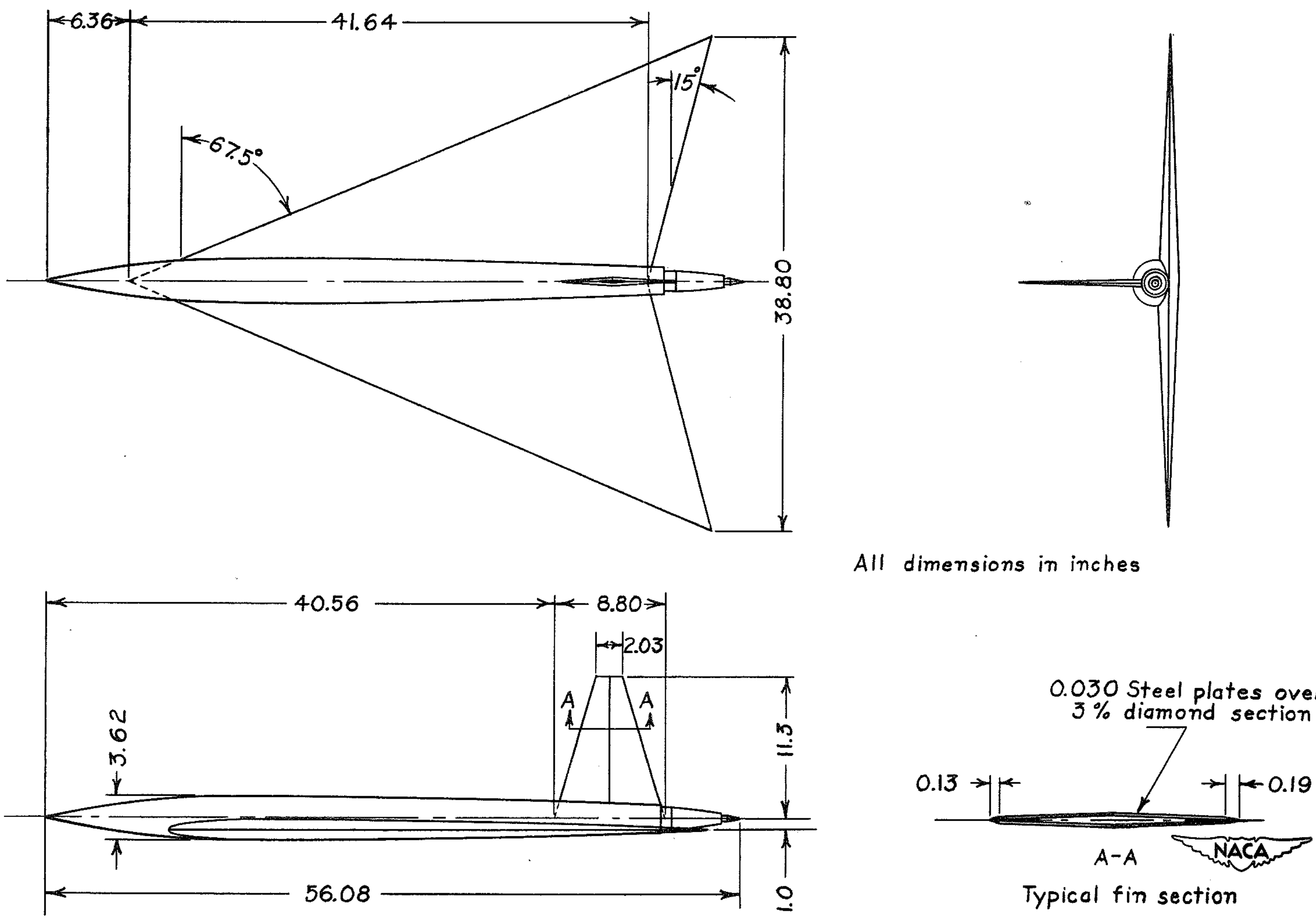
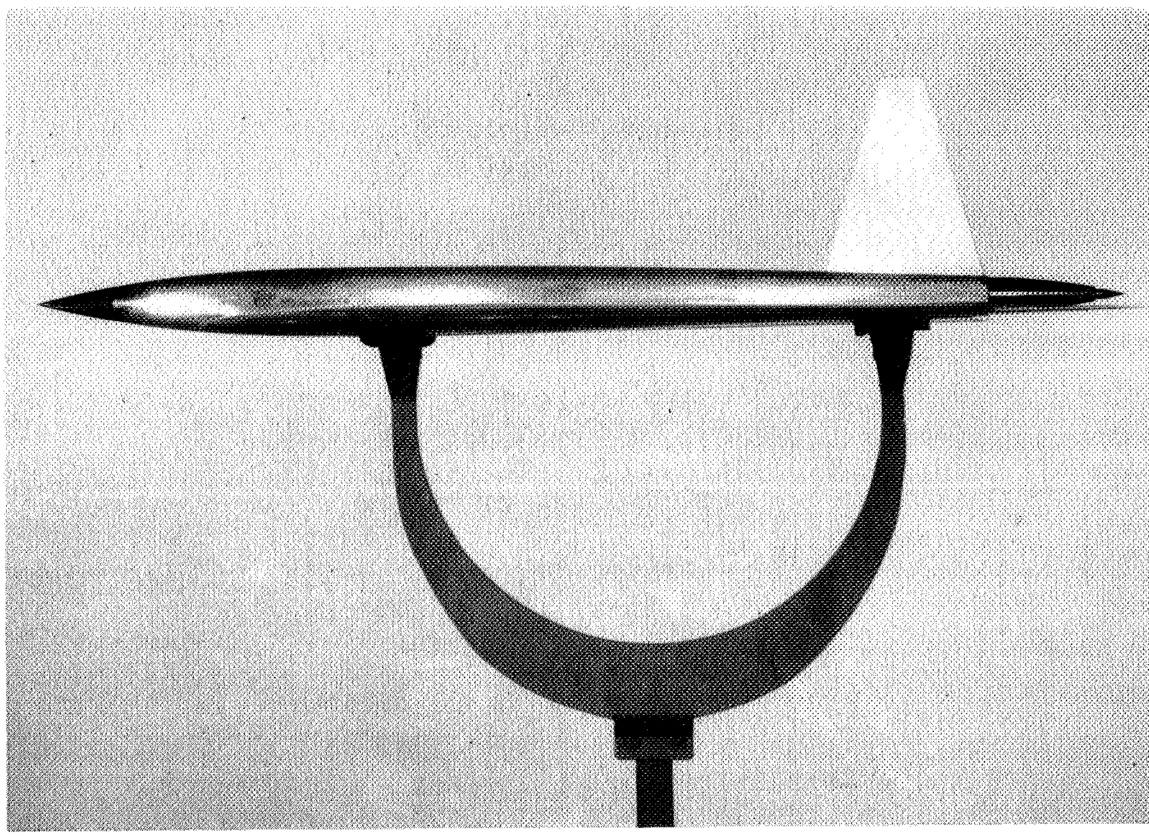


Figure 1.- General arrangement of $\frac{1}{14}$- scale model of Northrop MX-775B pilotless aircraft with small body.

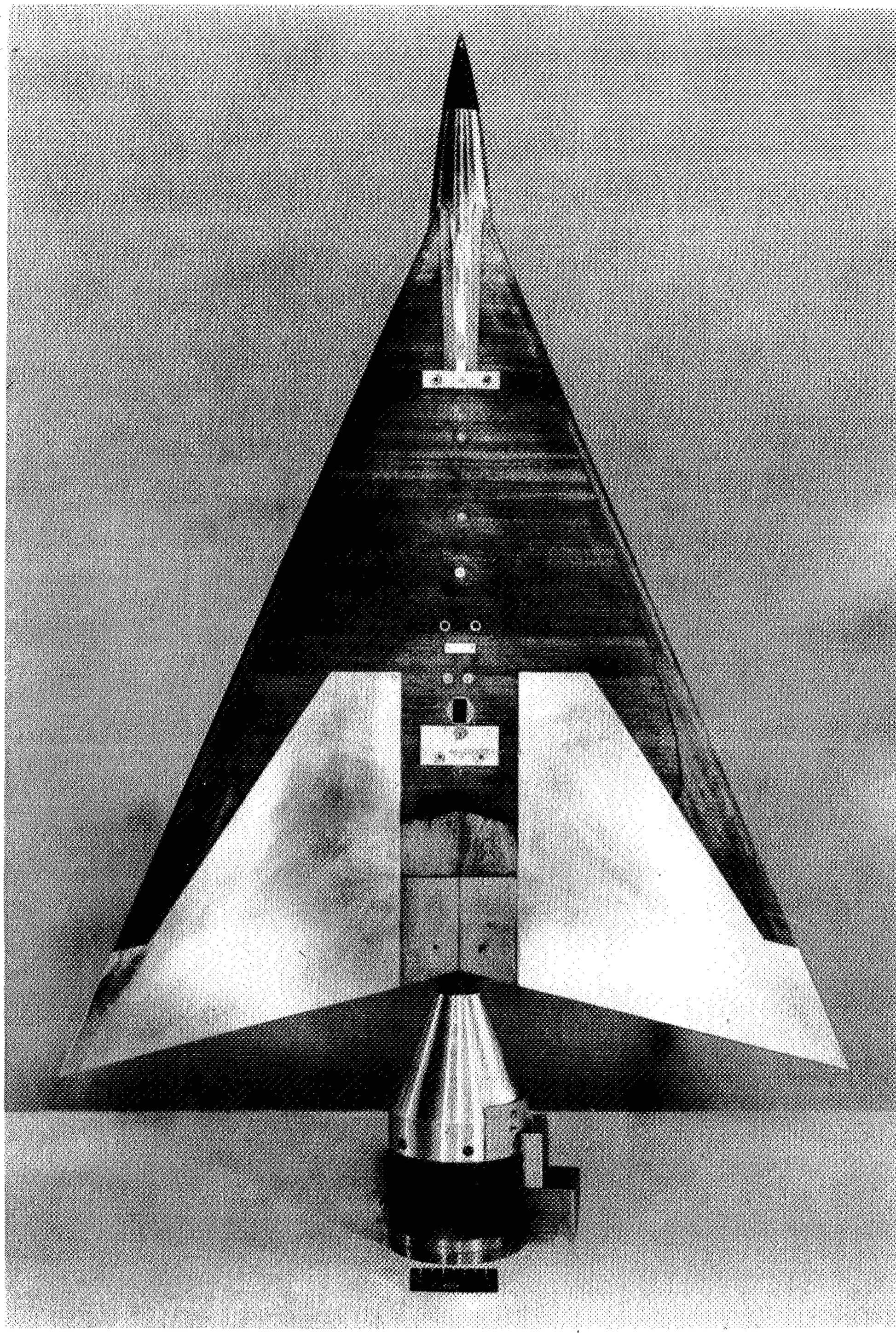
CONFIDENTIAL



(a) Side view.

L-65632

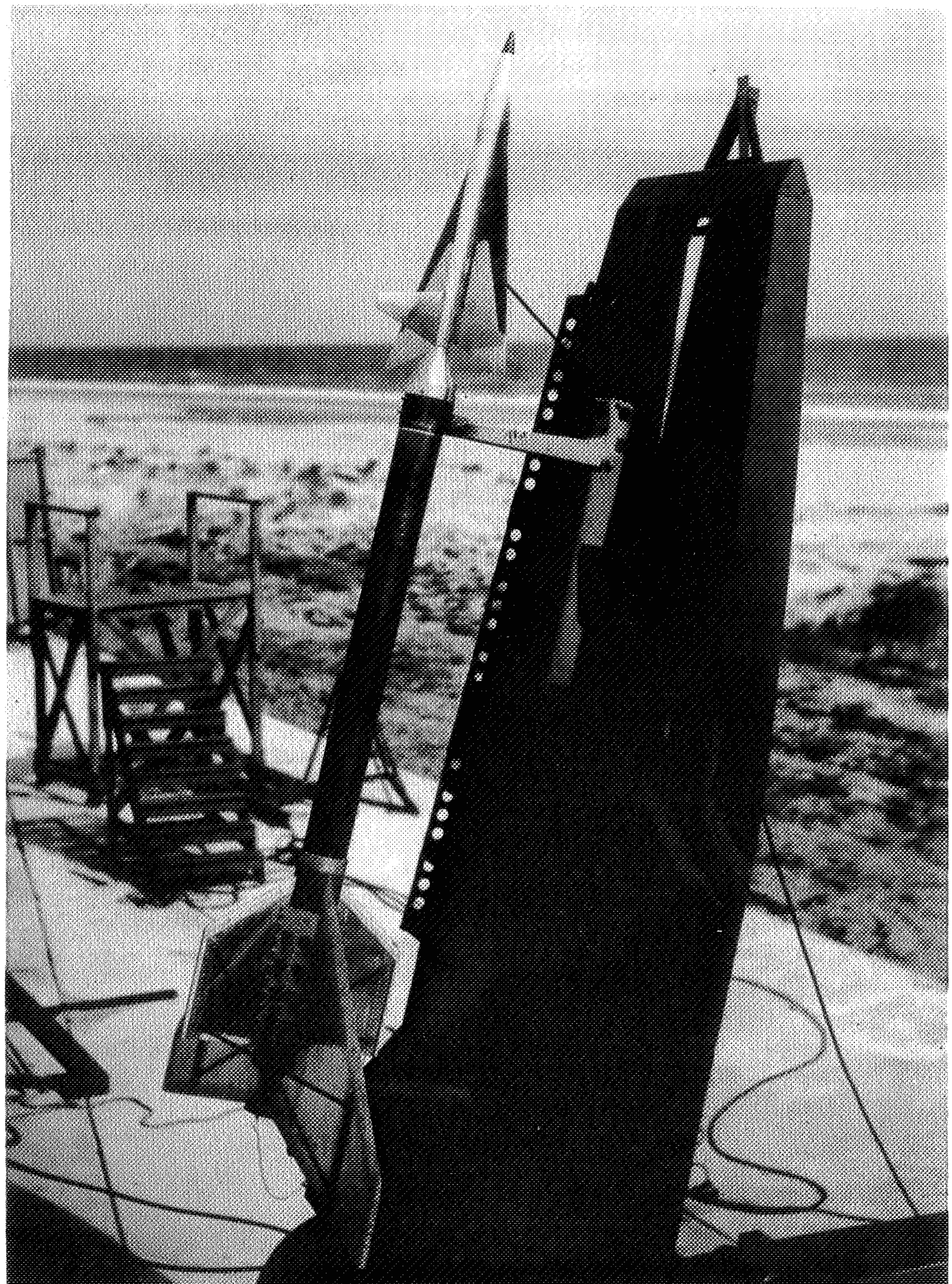
Figure 2.- Photographs of $\frac{1}{14}$-scale model of Northrop MX-775B pilotless aircraft with small body.



(b) Bottom view.

NACA
L-64658

Figure 2.- Concluded.



L-64694

Figure 3.- Model and booster combination in launching attitude.

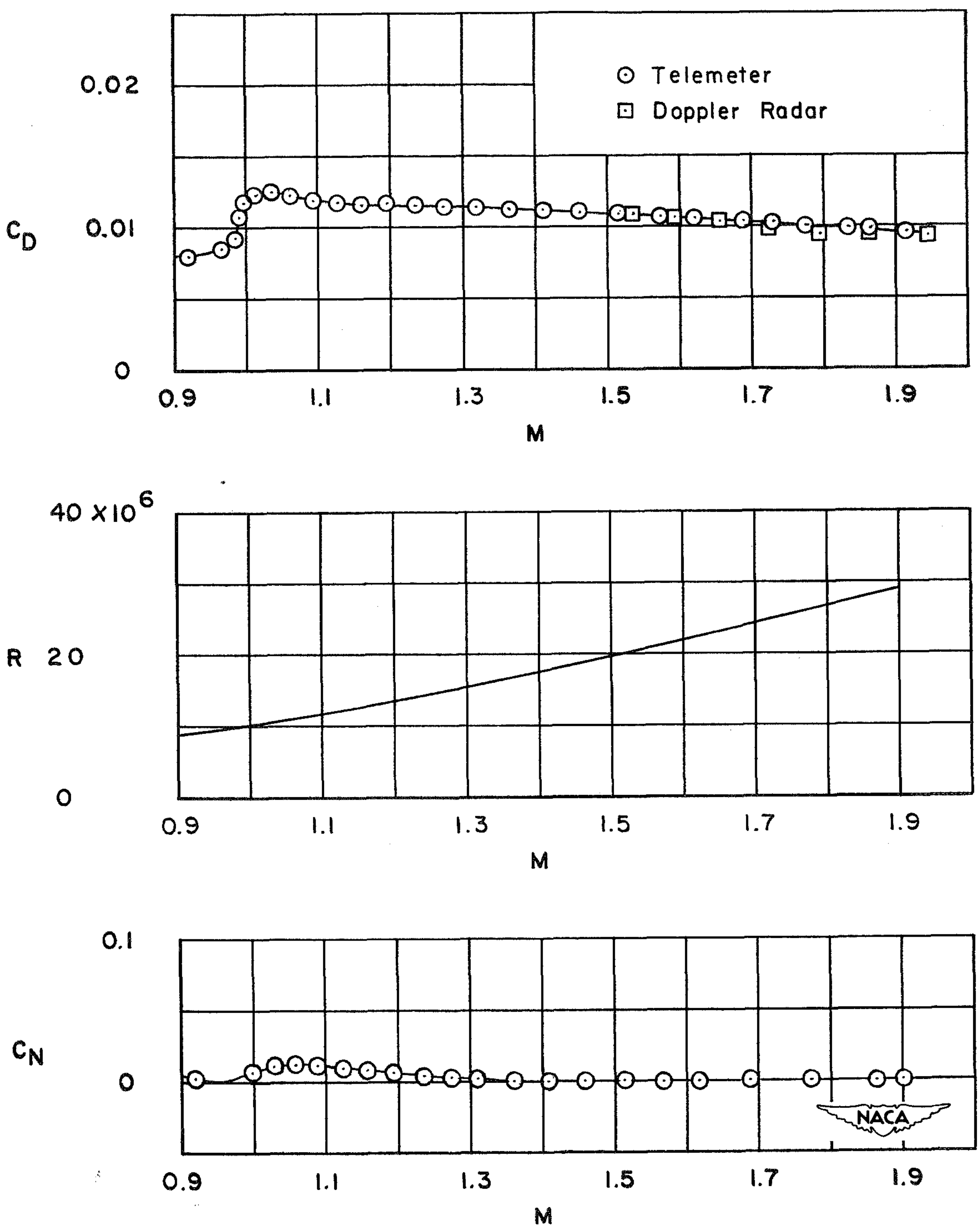


Figure 4.- Variation of drag coefficient, Reynolds number, and normal-force coefficient with Mach number for $\frac{1}{14}$ - scale Northrop MX-775B small-body model.

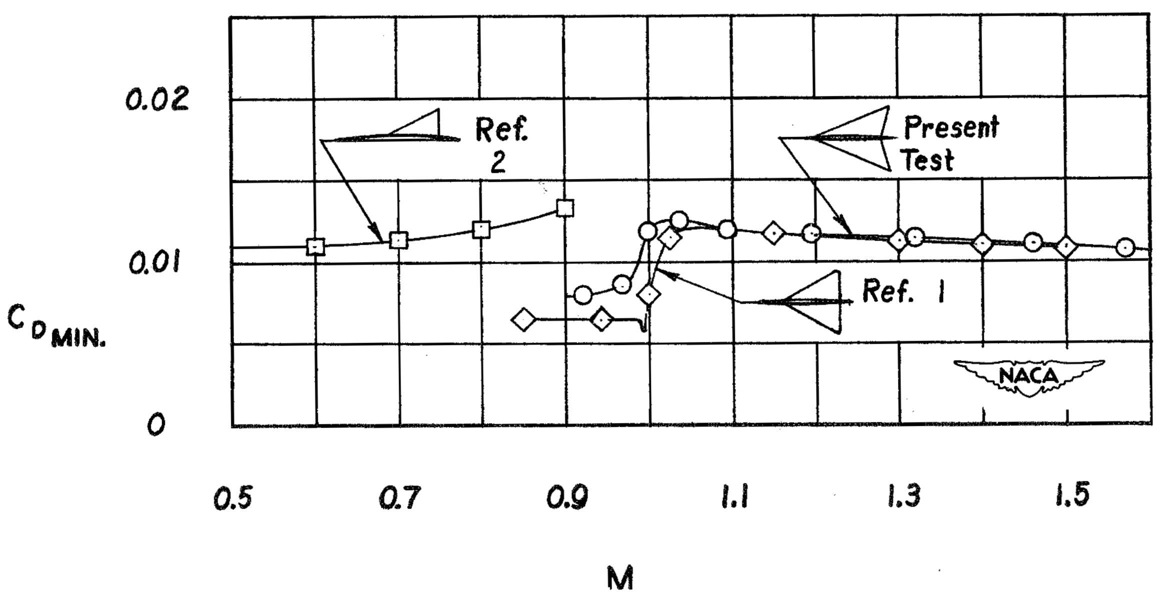


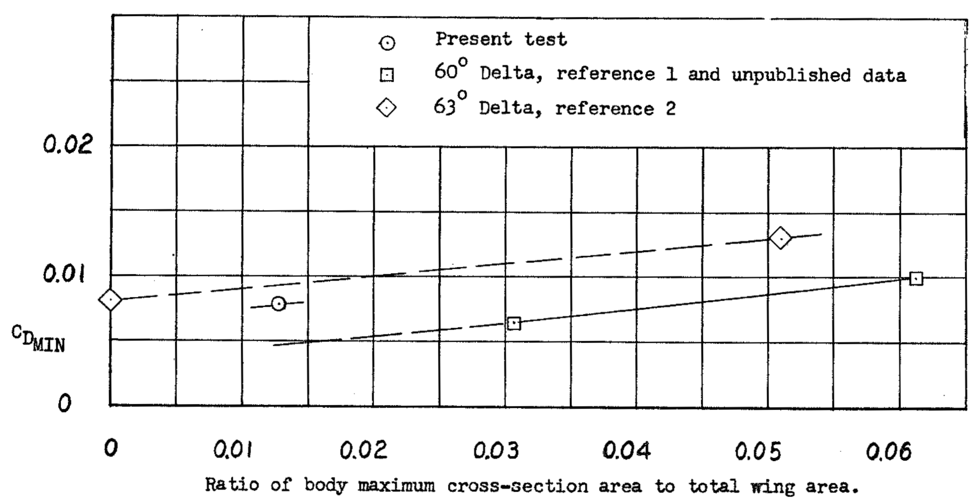
Figure 5.- Variation of minimum drag coefficients of triangular wing-body combinations at high Reynolds number with Mach number.

CONFIDENTIAL

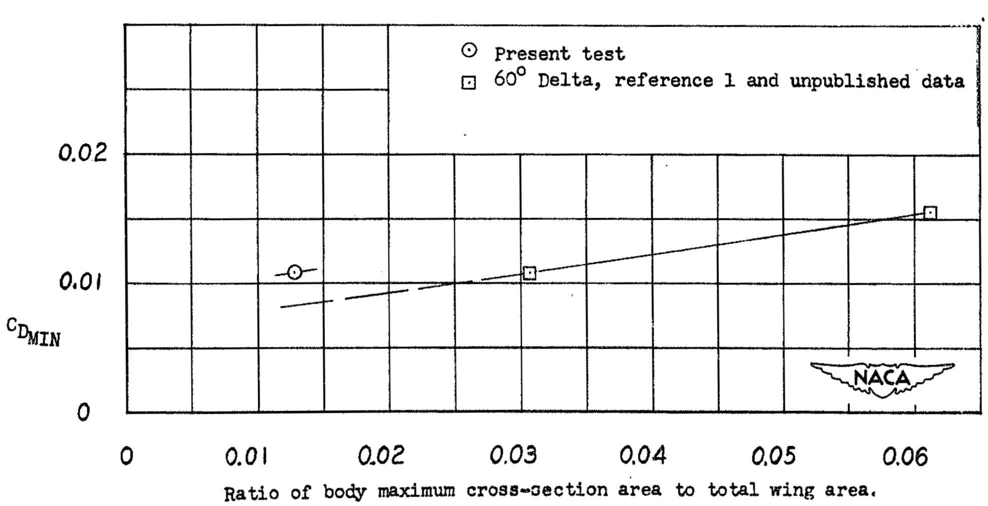
ERRATUM

NACA RM SL50H18 for Air Materiel Command, U. S. Air Force entitled "Large-Scale Flight Measurements of Zero-Lift Drag at Mach Numbers from 0.90 to 1.95 of a $\frac{1}{14}$-Scale Model of the Northrop MX-775B Pilotless Aircraft with Small Body," By Warren Gillespie, Jr. and Richard G. Arbic.

Figure 6 of this paper should be replaced by the corrected figure below.



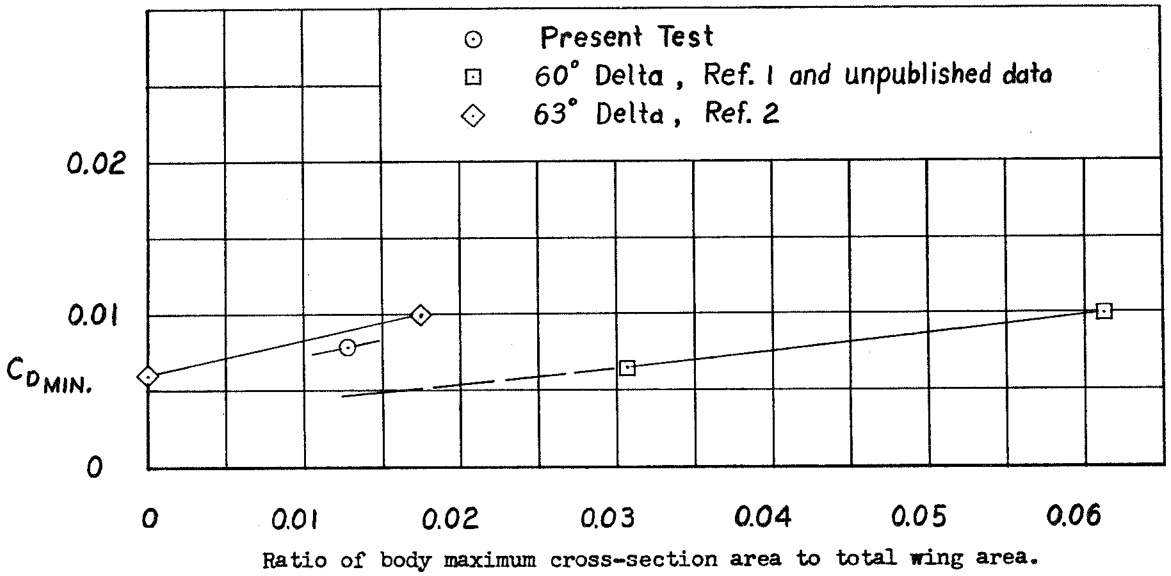
(a) Mach number 0.90.



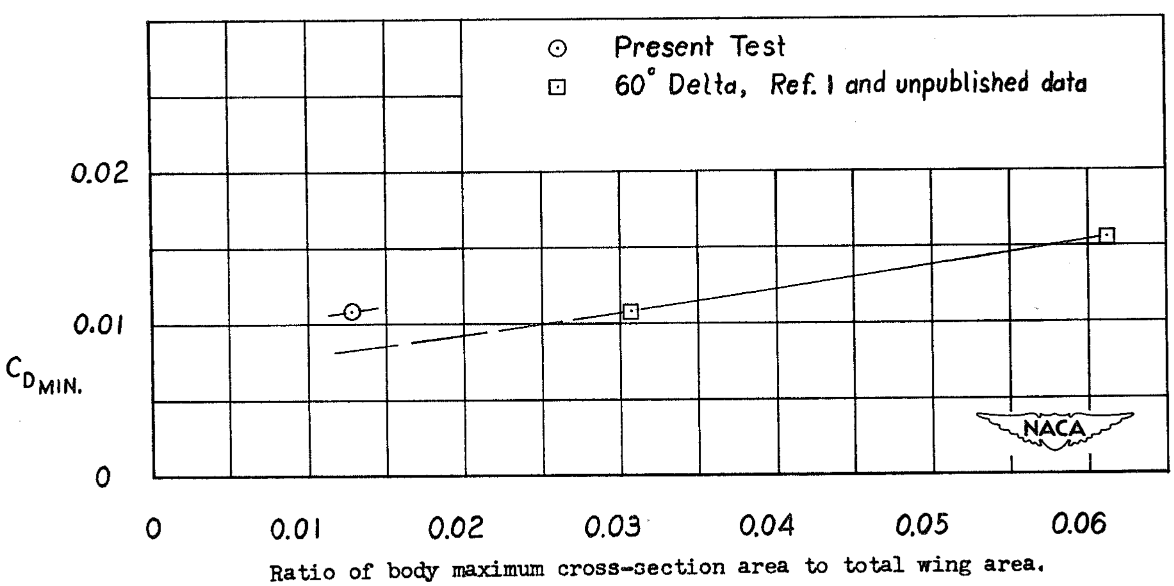
(b) Mach number 1.53.

Figure 6.- Variation of minimum drag coefficient with body-wing area ratio.

CONFIDENTIAL



(a) Subsonic Mach number.



(b) Mach number 1.53.

Figure 6.- Variation of minimum drag coefficient with body-wing-area ratio.