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RESEARCH MEMORANDUM

RESULTS OF TESTS TO DETERMINE THE EFFECT OF A CONICAL WINDSHIELD

ON THE DRAG OF A BLUFF BODY AT SUPERSONIC SPEEDS

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RESULTS OF TESTS TO DETERMINE THE EFFECT OF A CONICAL WINDSHIELD

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SUMMARY

Tests have been conducted to determine the effect of a conical
windshield on the drag of a bluff body at supersonic speeds. The
following configurations were investigated: a sharp-nose fuselage
with stabilizing fins, a blunt-nose fuselage obtained by rounding
off the sharp nose to a hemispherical shape, and a blunt-nose
fuselage with a conical point, or windshield, having the same nose
angle as the original sharp nose and supported at the same position.
The results showed that at a Mach number of 1.37 the conical-wind-
shield and the sharp-nose bodies had drag coefficients 6 and 27 per-
cent lower than the blunt-nose body, respectively. Near a Mach
number of 1.0, the drag of the bodies was not appreciably affected
by the nose shapes tested.

INTRODUCTION

As part of an investigation to determine the characteristics
of free bodies at supersonic speeds, preliminary tests have been
made by the Langley Pilotless Aircraft Research Division on
Wallops Island, Va. to evaluate the effect of a conical windshield
on the drag of a bluff body. The use of a windshield of the type
tested was suggested as a possible simple means of increasing the
effective fineness ratio of a fuselage with little increase in
structural weight. It was thought that the conical point would
eliminate the intense normal shock ordinarily formed at the nose
of a blunt body and would, through the action of its wake, effec-
tively increase the fineness ratio of such a body. In addition,
if the drag of a blunt nose could be minimized in this manner, the
problem of forward vision of either seeker units or pilots in
supersonic aircraft would be simplified.

MODELS AND TESTS

The rocket-propelled test bodies were about 5 feet long and
5 inches in diameter and consisted of identical wooden afterbodies
and fins to which the various nose shapes were attached. The nose
shapes tested consisted of a sharp nose of approximately circular
arc profile, a blunt nose of hemispherical shape, and the blunt
nose with a small conical windshield having the same nose angle
and supported at the same position as the original sharp nose.
The fuselages were made hollow to accommodate the propulsion unit,
a standard 3.25-inch Mk. 7 aircraft rocket motor developing a
constant thrust of about 2200 pounds for 0.87 second at an ambient
preignition temperature of 69° F. The four stabilizing fins were
equally spaced around the rear of each fuselage and consisted
of flat surfaces with rounded leading edges swept back 45° and
trailing edges cut off perpendicular to the surface. The general
body arrangement and the nose shapes tested are shown in figure 1.
Photographs of the bodies are shown in figure 2, and a close-up
of the aluminum conical windshield and boom is shown in figure 3.
Two models of each body configuration were tested.

The experimental data were obtained by launching the body
at an angle of 75° to the horizontal and determining its velocity
along the flight path by the use of CW Doppler radar (AN/TPS-5).
Photographs of the launcher and radar are shown in figures 4(a)
and 4(b), respectively. A typical curve of velocity against
flight time obtained from a radar record is given in figure 5.
Drag data were obtained by differentiating the part of the curve
corresponding to the time the bodies were coasting (after the
propellant had been expended) and converting the values of
deceleration thus obtained into corresponding values of drag
coefficient. The tests covered an approximate range of Mach
number from 1.0 to 1.4. The corresponding Reynolds numbers,
based on the body diameter, ranged between 3 and 4 million.

RESULTS AND DISCUSSION

The test results are presented in figures 6 and 7. Figure 6
shows the variation of the deceleration of the various models with
velocity. This plot indicates the consistency of the data and the
probable error in the resultant value of drag coefficient by
comparing the data for similar configurations. A single curve was
faired through test points for each configuration. From these

faired values of deceleration, the drag coefficient and corresponding Mach number of each body configuration were calculated and plotted. This plot is presented in figure 7. The values of drag coefficient are based on the frontal area of the fuselage (0.1364 sq ft) and include the drag of the fins.

The results in figure 7 indicate that the drag coefficient of the blunt-nose and conical-windshield configurations is little affected by the nose shape at a Mach number of approximately 1.0. Although no data are available to indicate the effect of the sharp nose on the drag of the body in this range of Mach number, this effect is probably also small. At higher Mach numbers, the drag coefficient of the sharp-nose body decreased slightly to about 0.61, whereas the drag coefficient of the blunt-nose body continued to rise to a value of 0.84 at the maximum velocity obtained. At a Mach number of 1.37 the drag coefficient of the conical-wind-shield body was 94 percent of the drag coefficient of the blunt-nose body. At the same Mach number, the drag coefficient of the sharp-nose body was about 73 percent of that obtained for the blunt-nose body.

It should be realized that the results of these tests are an indication of the effectiveness of this type of device and further investigation to determine an optimum arrangement should be made.

CONCLUDING REMARKS

Tests to determine the effect of a conical windshield on the drag of a bluff body at supersonic speeds have been made. For the three nose shapes investigated (sharp-nose, blunt-nose, and conical-windshield) the results reveal that at the greatest comparable value of Mach number obtained (M = 1.37) the conical windshield and the sharp nose reduced the drag of the blunt-nose body by 6 and 27 percent, respectively. Near a Mach number of 1.0, the drag of the bodies was not appreciably affected by the nose shapes tested.

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    National Advisory Committee for Aeronautics
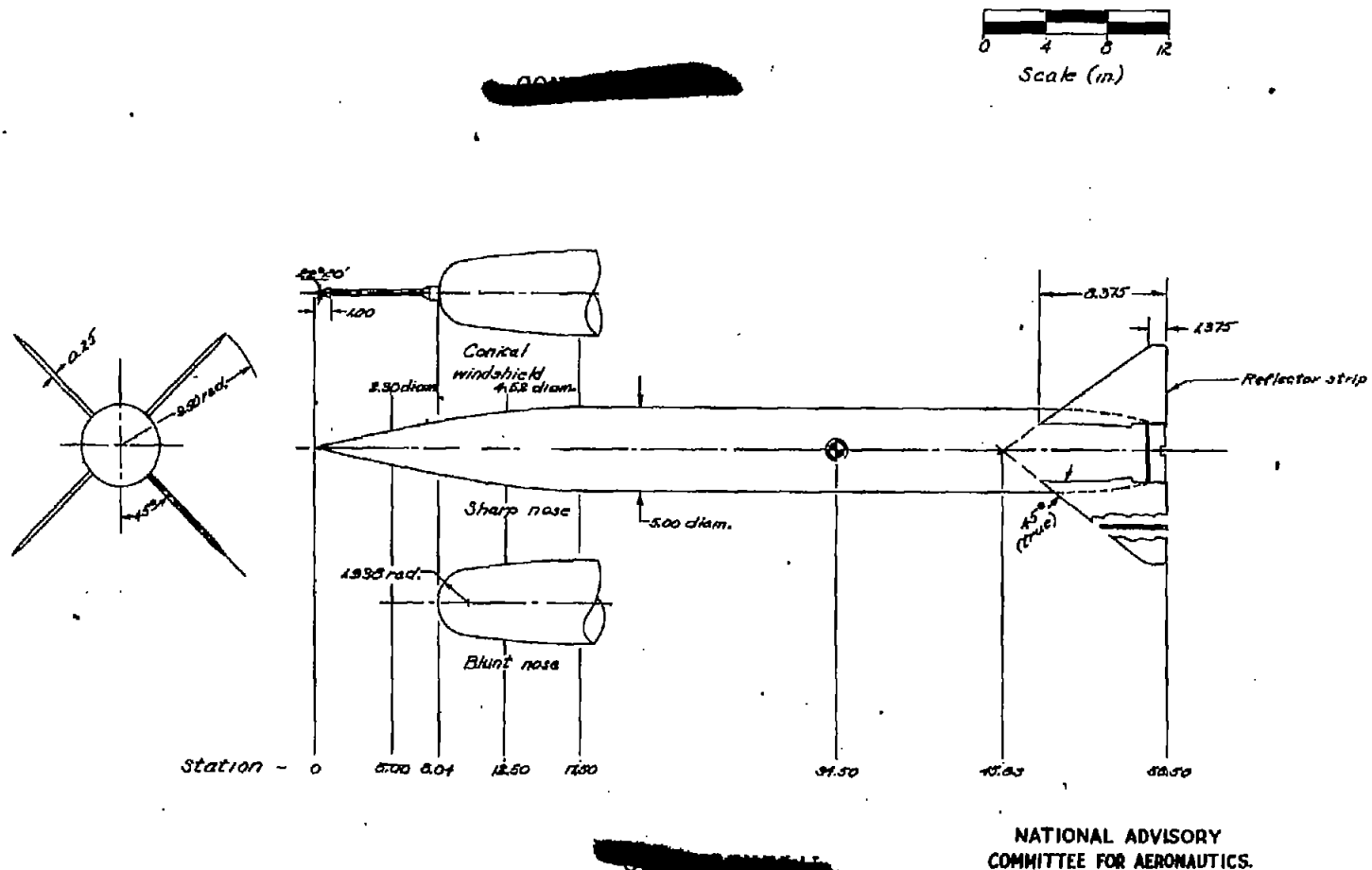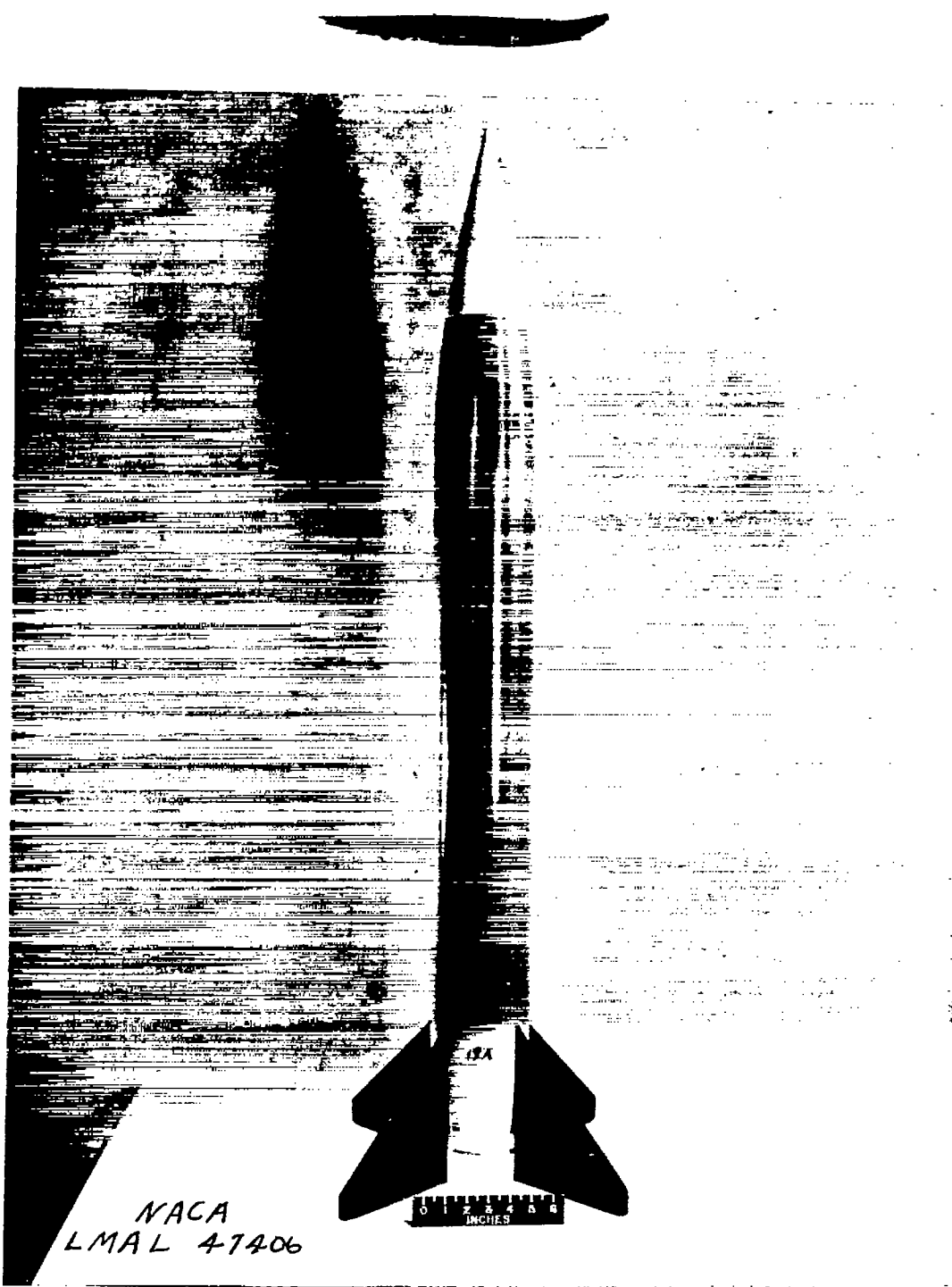   Langley Field, Va.

Figure 1.- General arrangement of test body showing nose shapes
investigated. Fin area (exposed) = 136.5 square inches; design
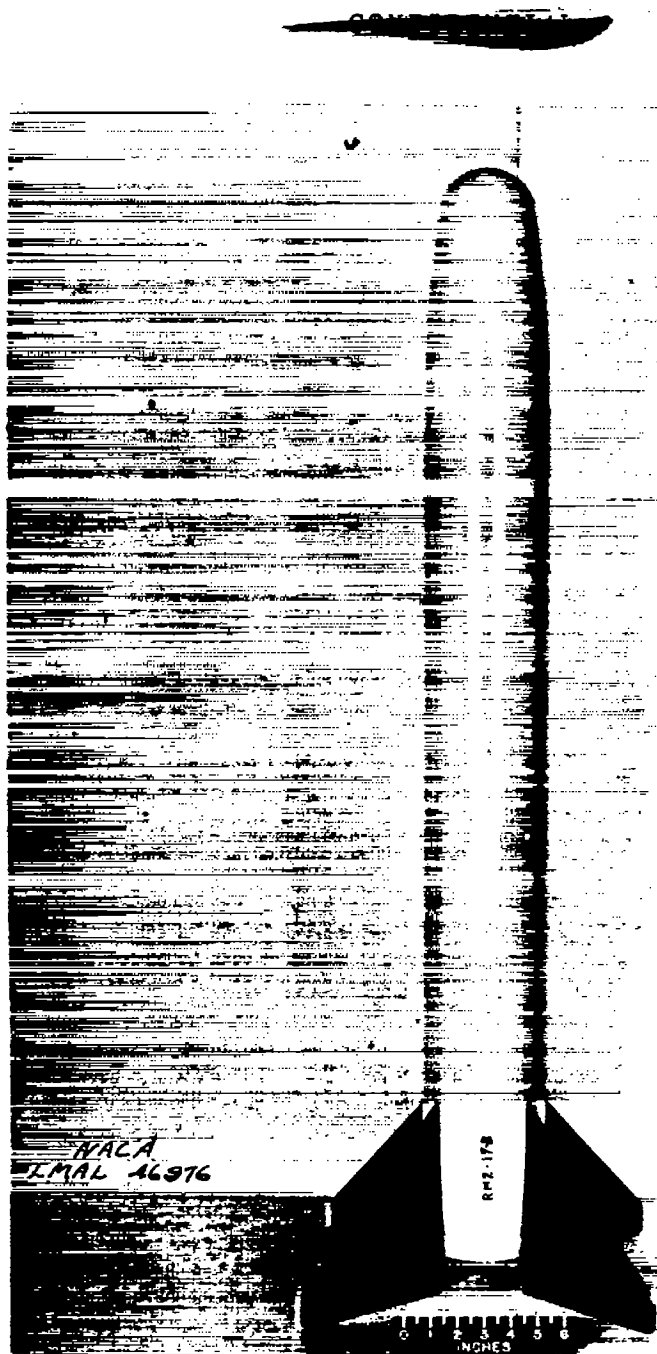weight (burnt out) = 28.8 pounds.

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Fig. 1

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(a) Sharp nose.

Figure 2.- Views of body configurations.

(b) Blunt nose.

Figure 2.- Continued.
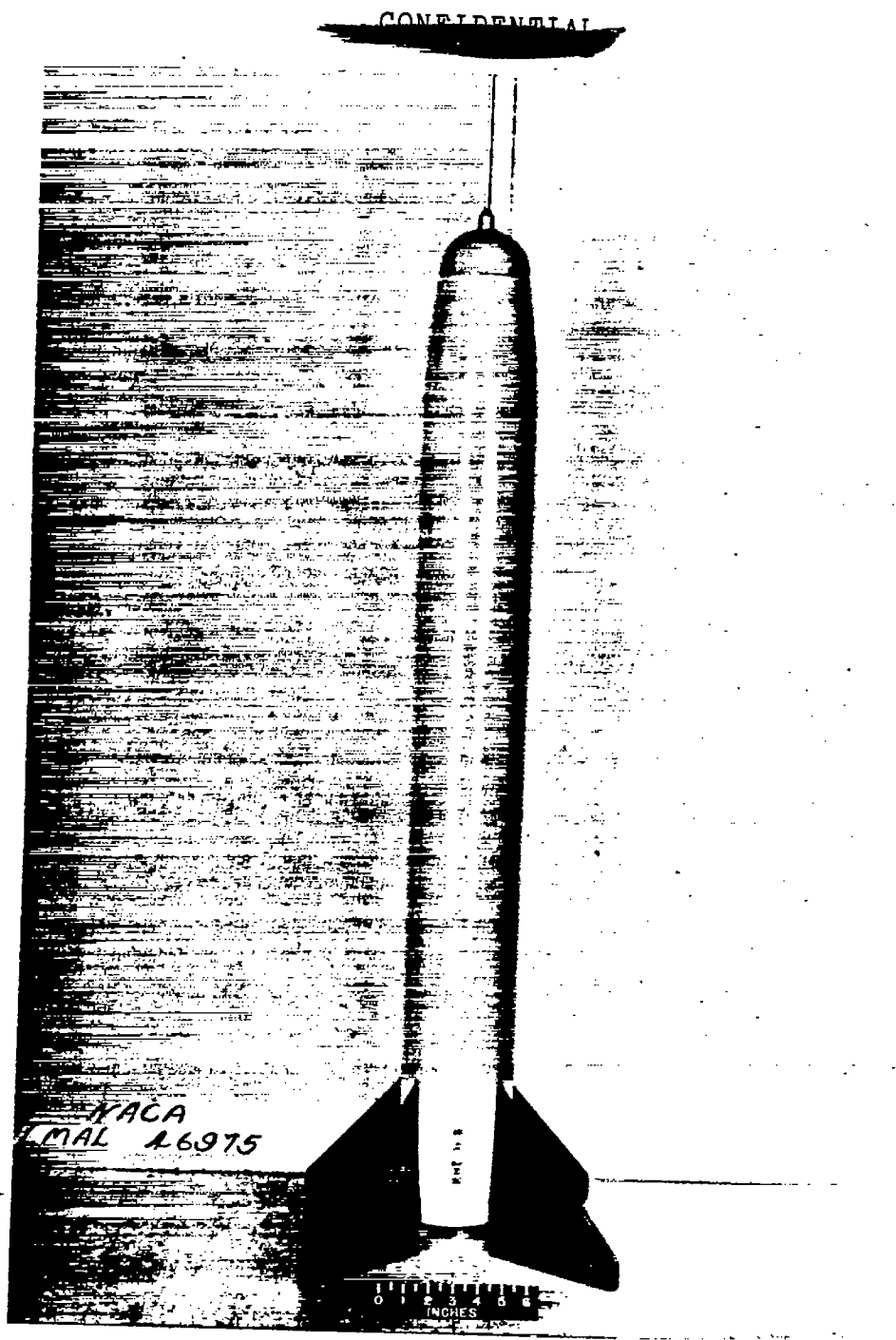
(c) Conical windshield.

Figure 2.- Concluded.
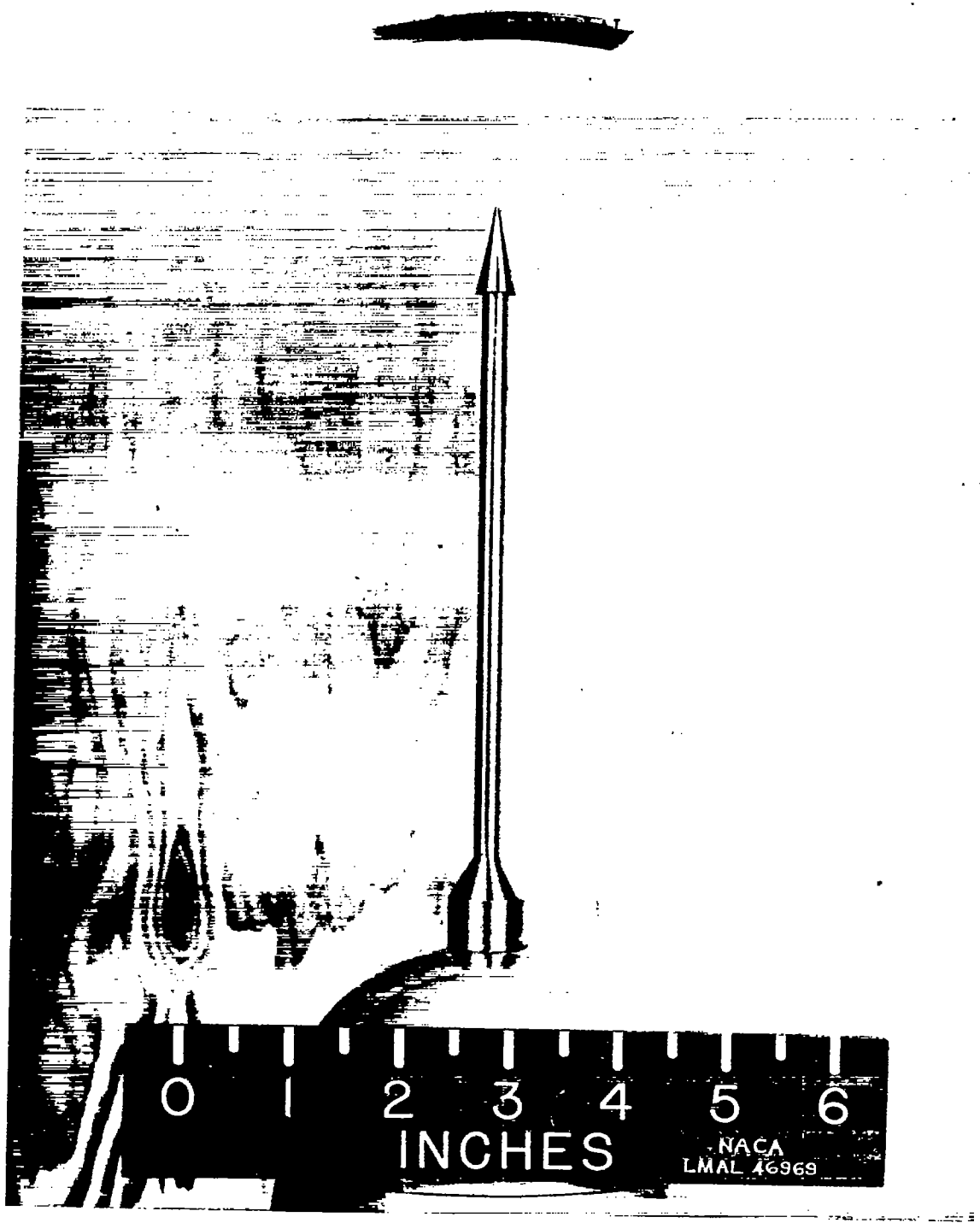
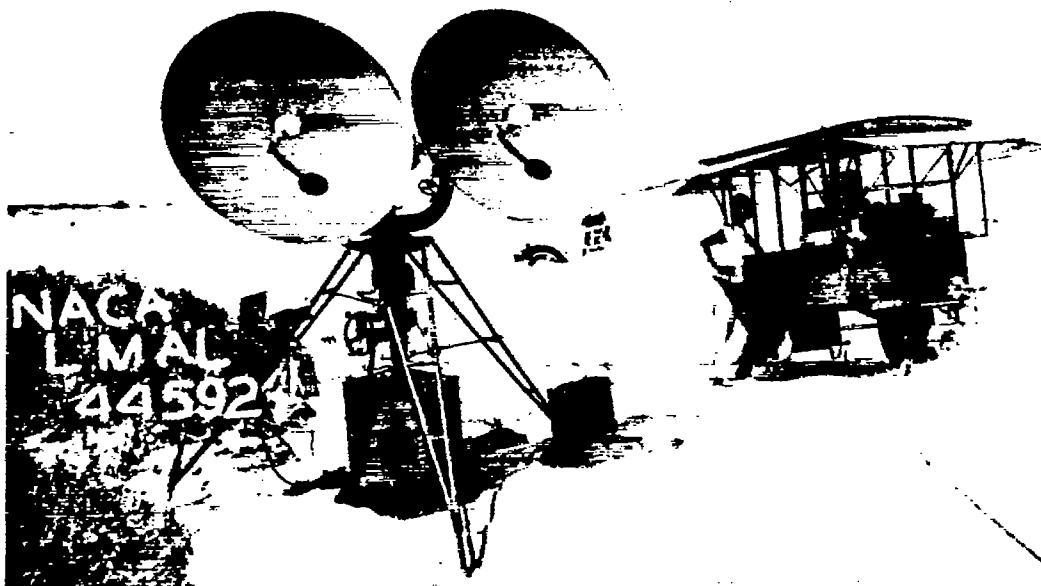Figure 3.- Close-up of conical windshield and boom.
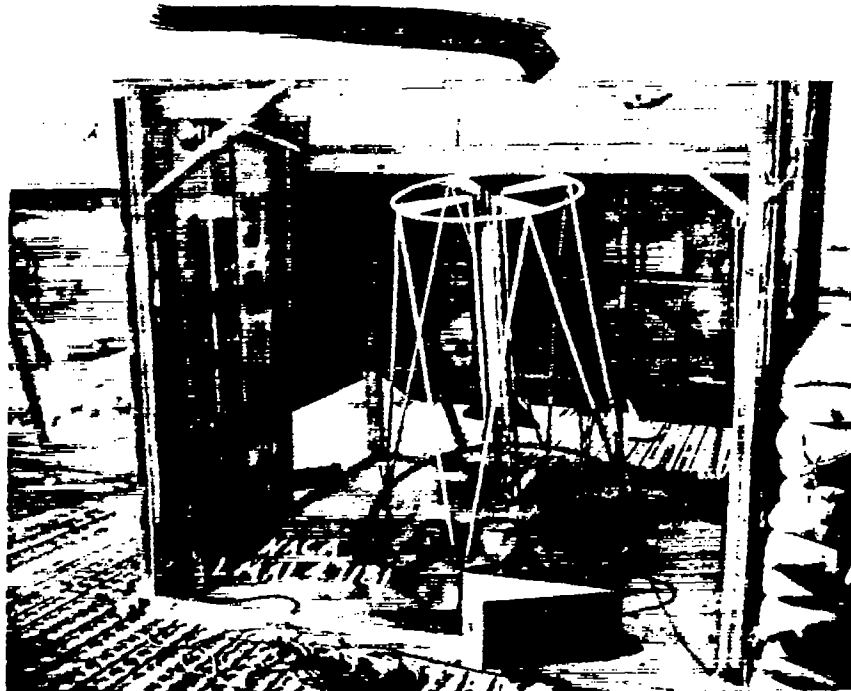
(a) Launcher with conical-windshield body
in rack.

(b) CW Doppler radar
(AN/TPS-5).

Figure 4.- Views of launcher and CW Doppler radar.

Fig. 5

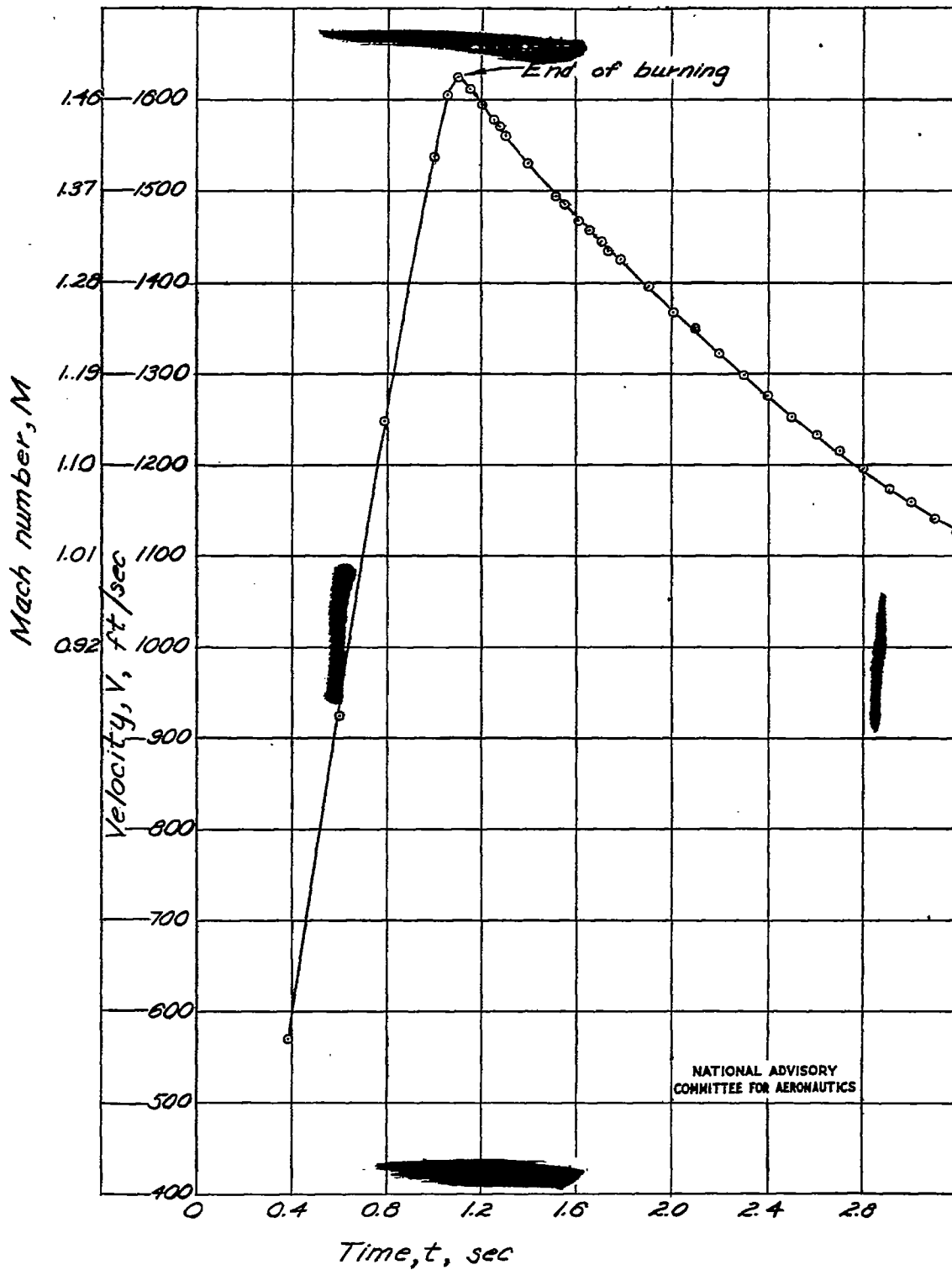

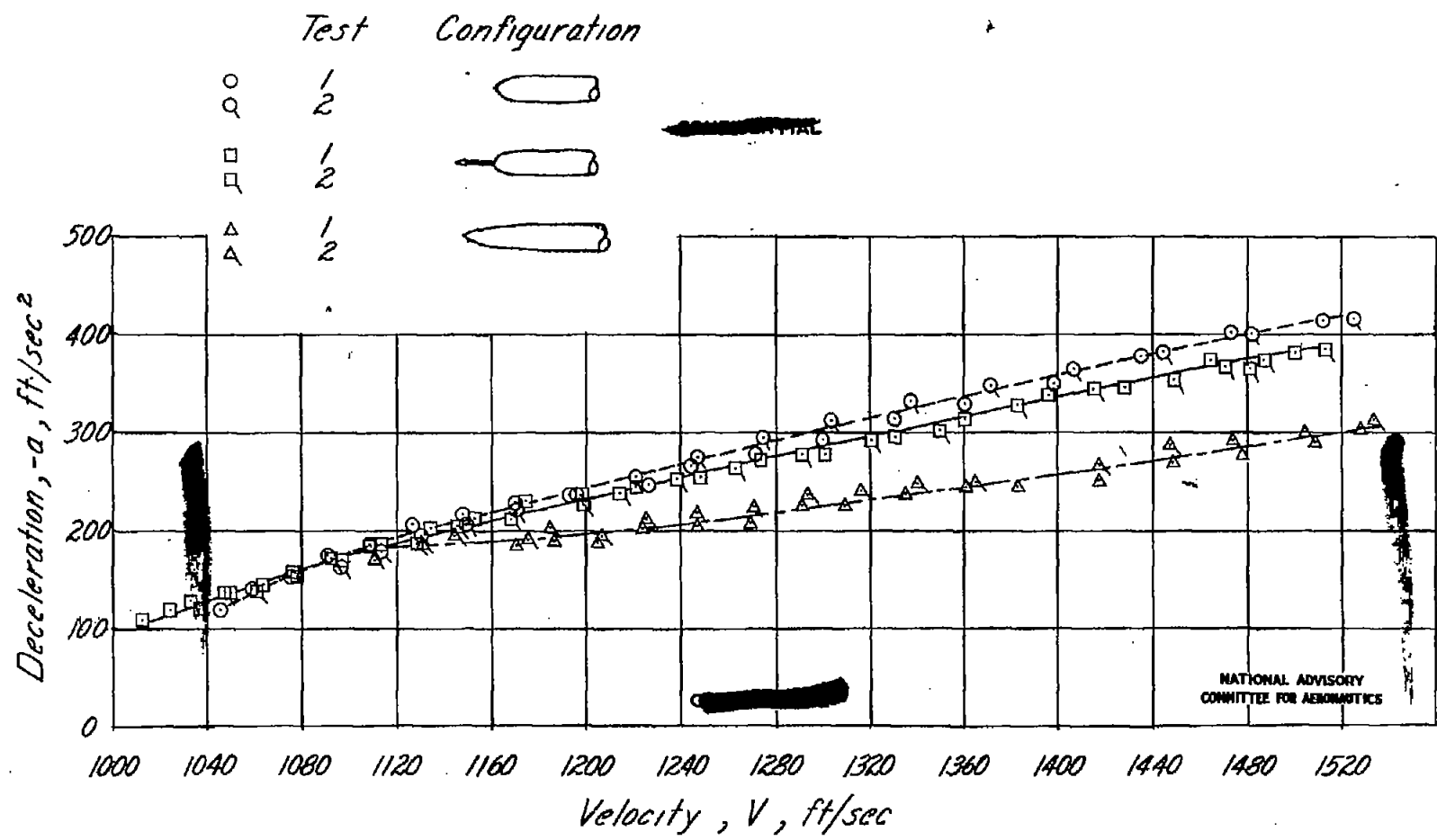Figure 5.- Typical velocity-time curve.
Sharp-nose configuration.

Fig. 6

Test   Configuration

Figure 6.- Variation of deceleration with velocity for the three body
configurations. Curves are average of similar tests.

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Nose shape
- - - - - - Blunt
———— Conical windshield
— - — Sharp

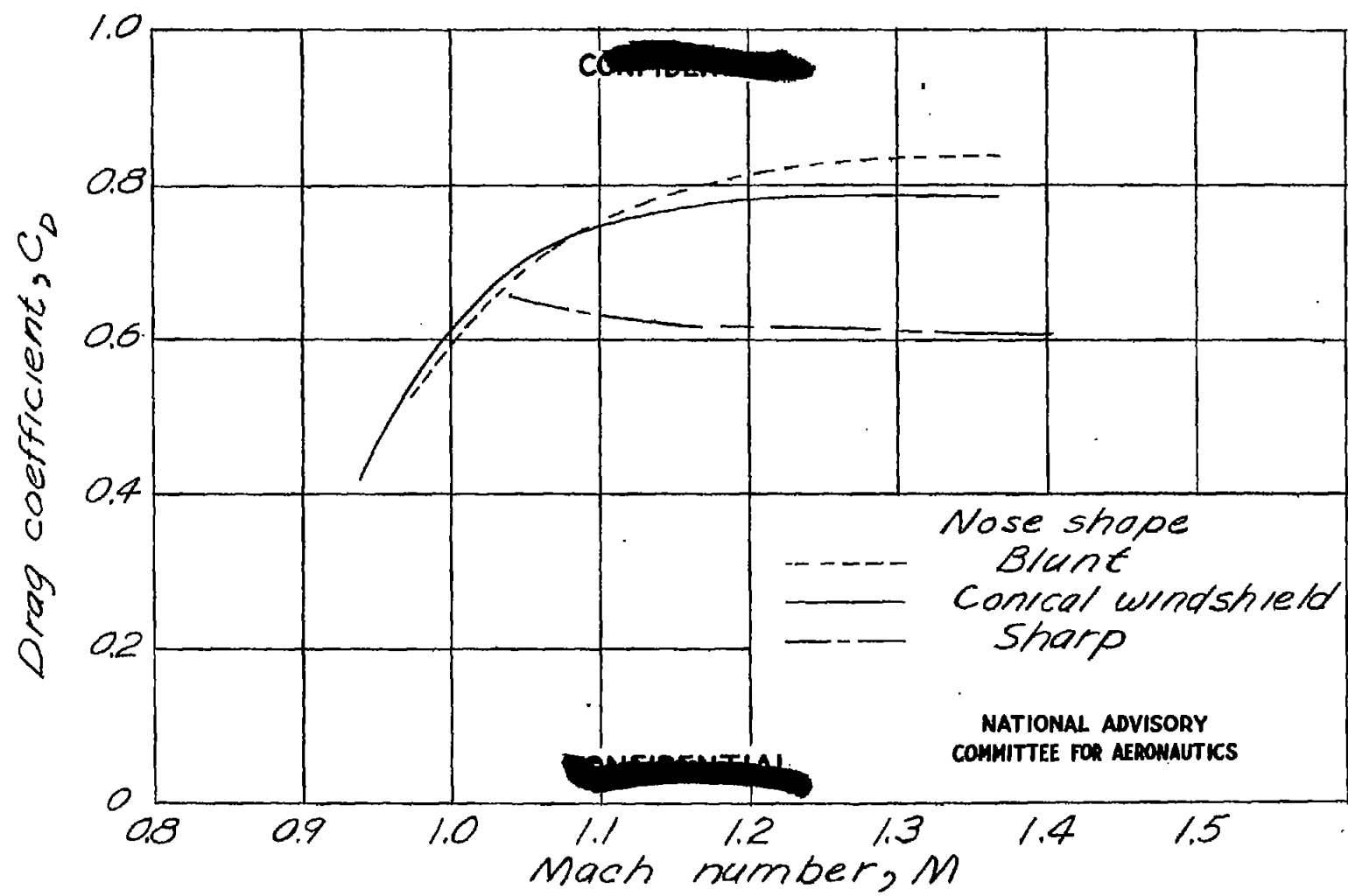**NATIONAL ADVISORY
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Figure 7.- Drag characteristics of the three body configurations tested.

Fig. 7