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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

By

Sidney R. Alexander

Langley Memorial Aeronautical Laboratory
Langley Field, Va.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

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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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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-windshield and the sharp-nose bodies had drag coefficients 6 and 27 percent 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, effectively 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-windshield 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.

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

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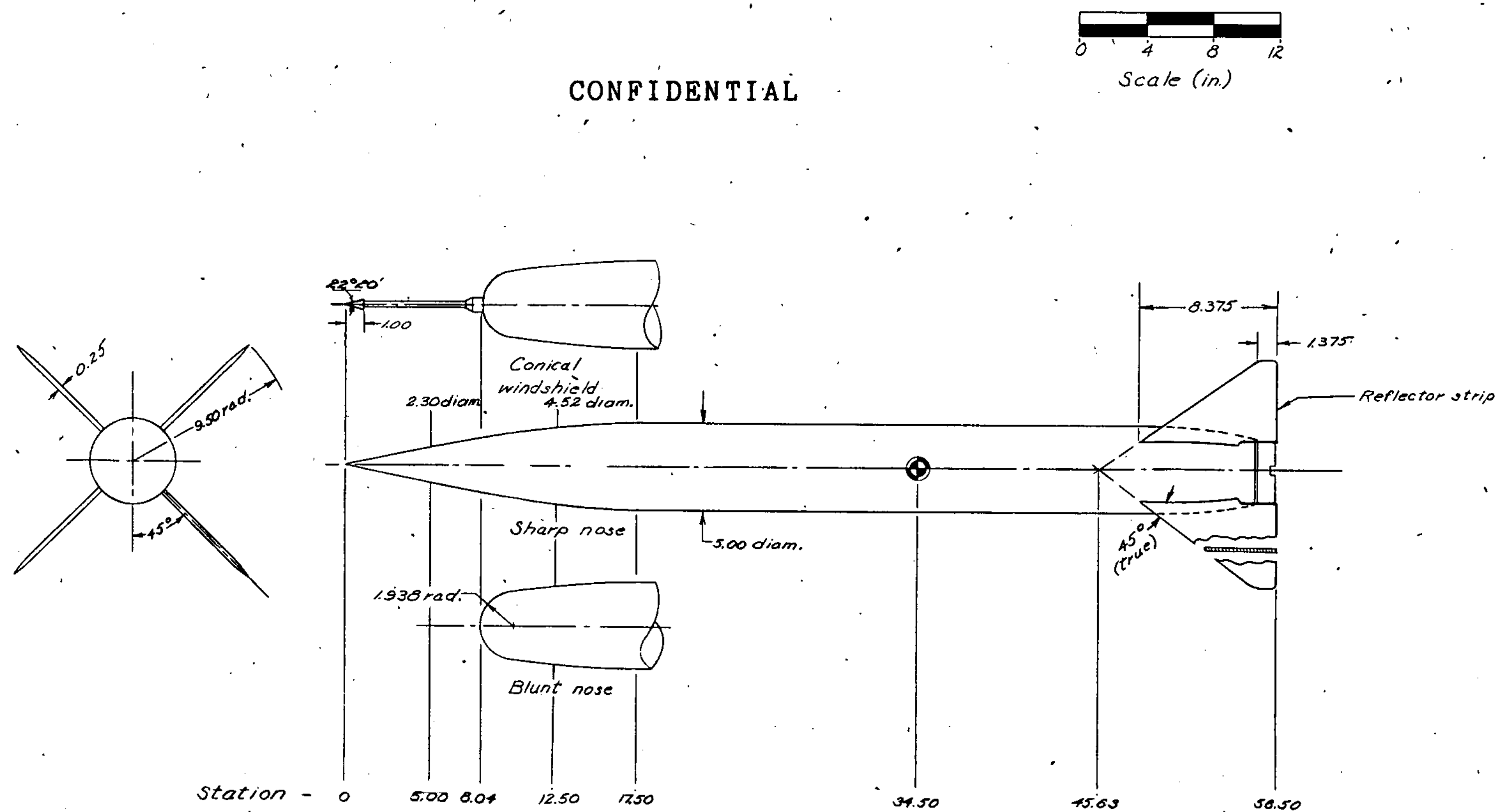

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Figure 1.- General arrangement of test body showing nose shapes investigated. Fin area (exposed) = 136.5 square inches; design weight (burnt out) = 28.8 pounds.

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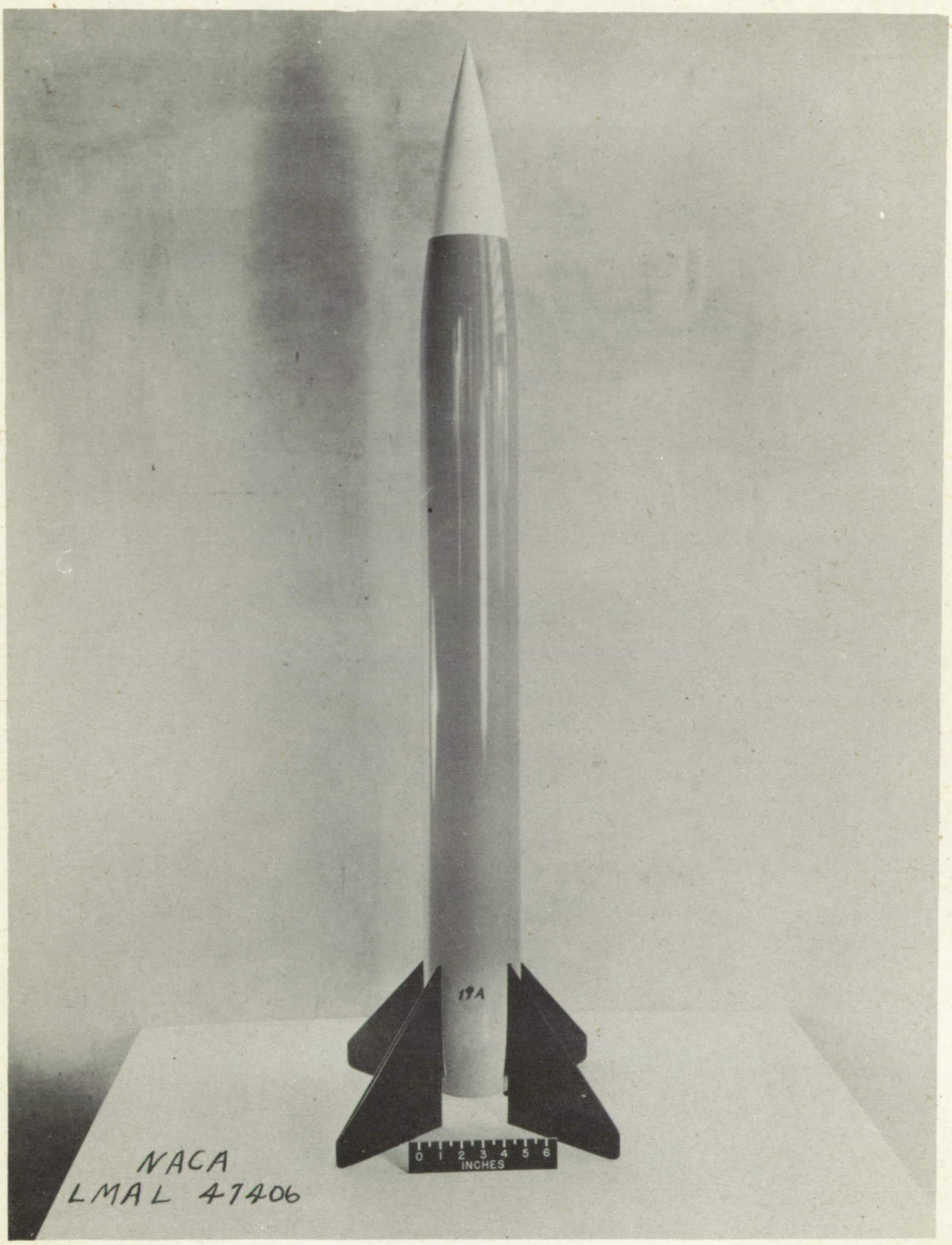

(a) Sharp nose.

Figure 2.- Views of body configurations.

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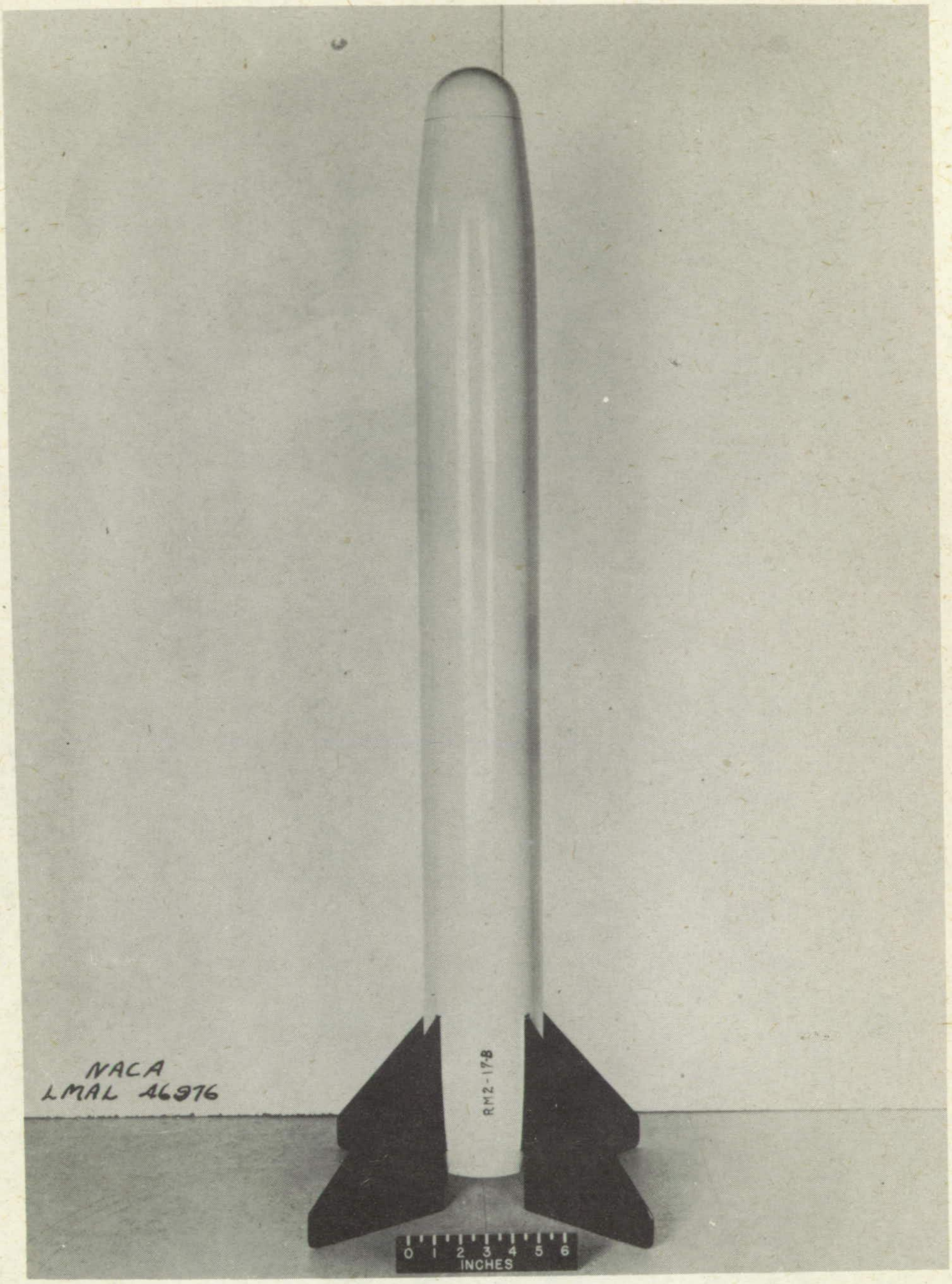

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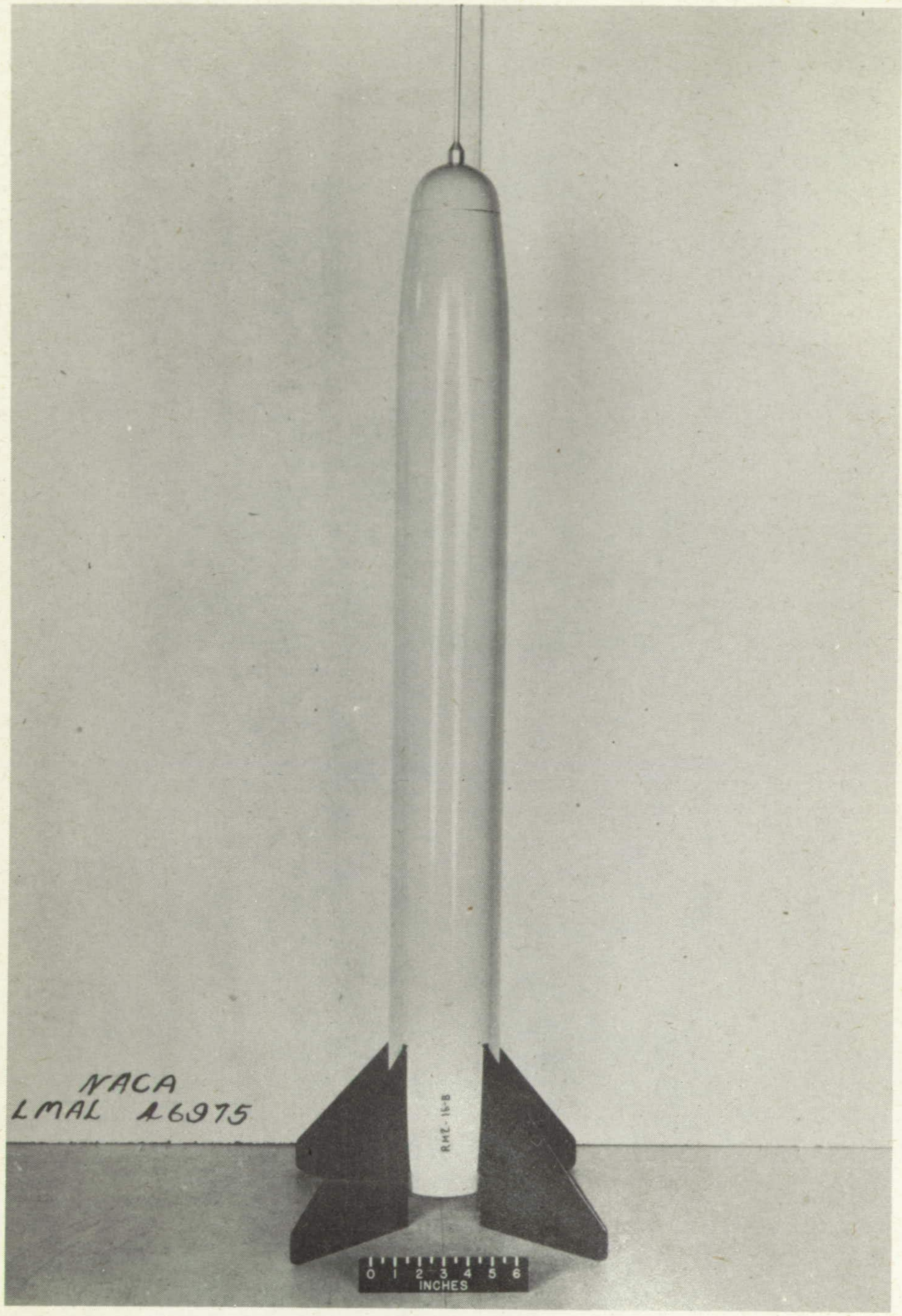
(b) Blunt nose.

Figure 2.- Continued.



(c) Conical windshield.

Figure 2.- Concluded.

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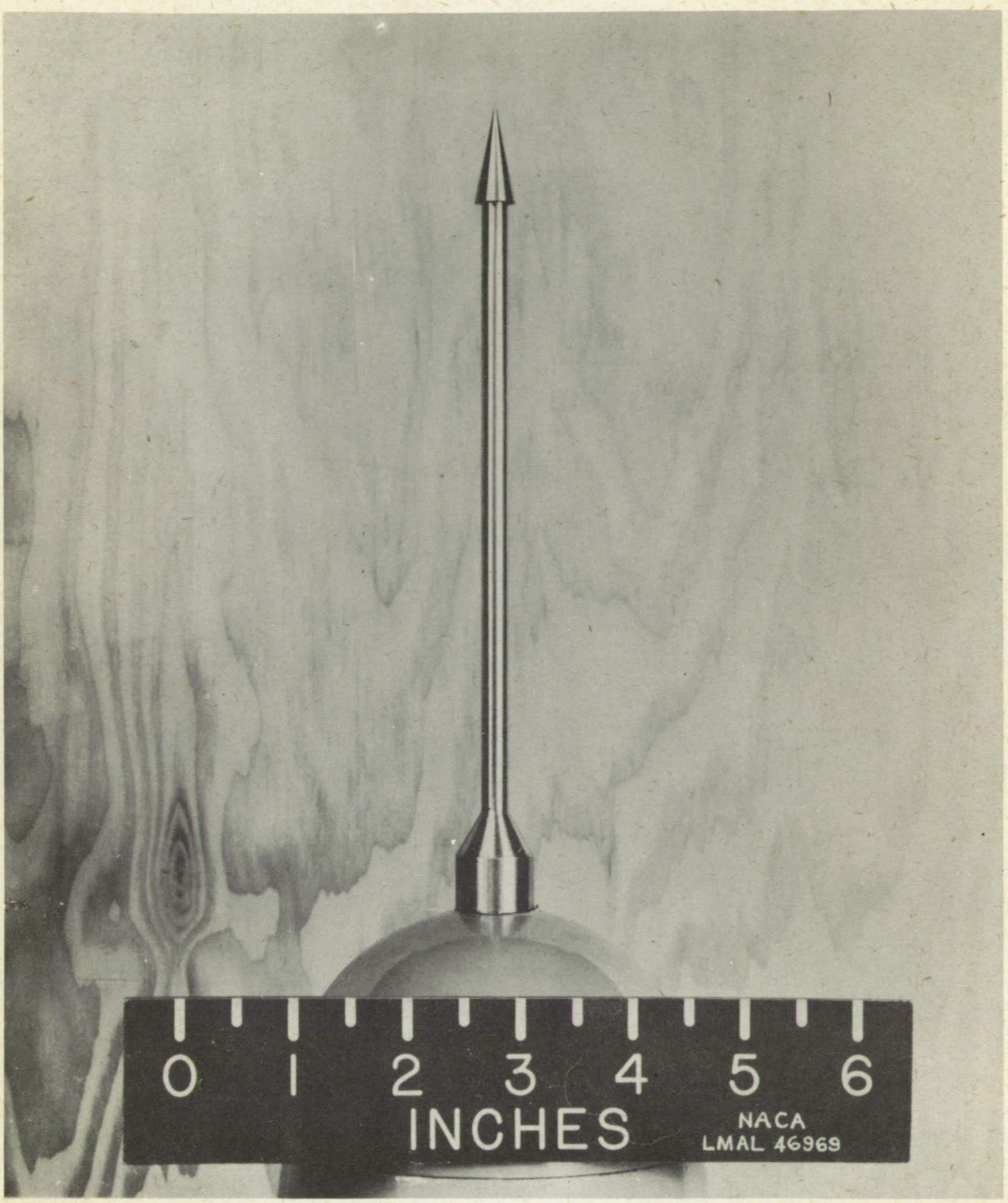

Figure 3.- Close-up of conical windshield and boom.

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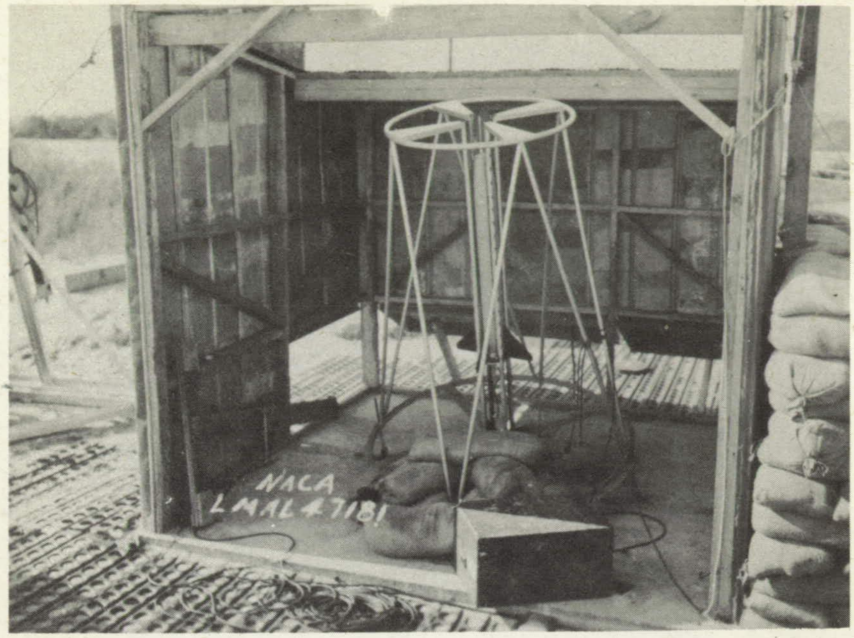

(a) Launcher with conical-windshield body in rack.

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

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

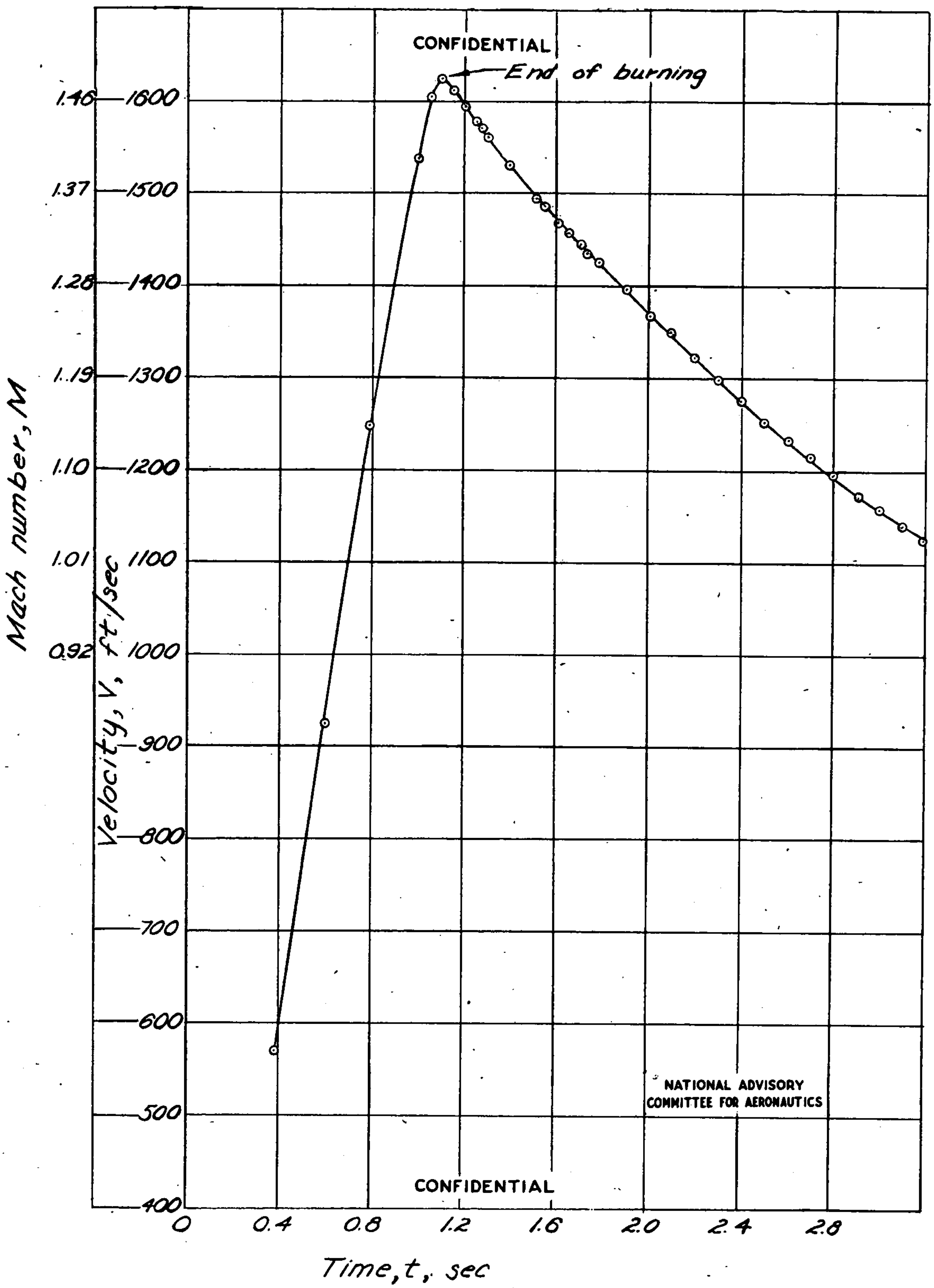

Figure 5.- Typical velocity-time curve.
Sharp-nose configuration.

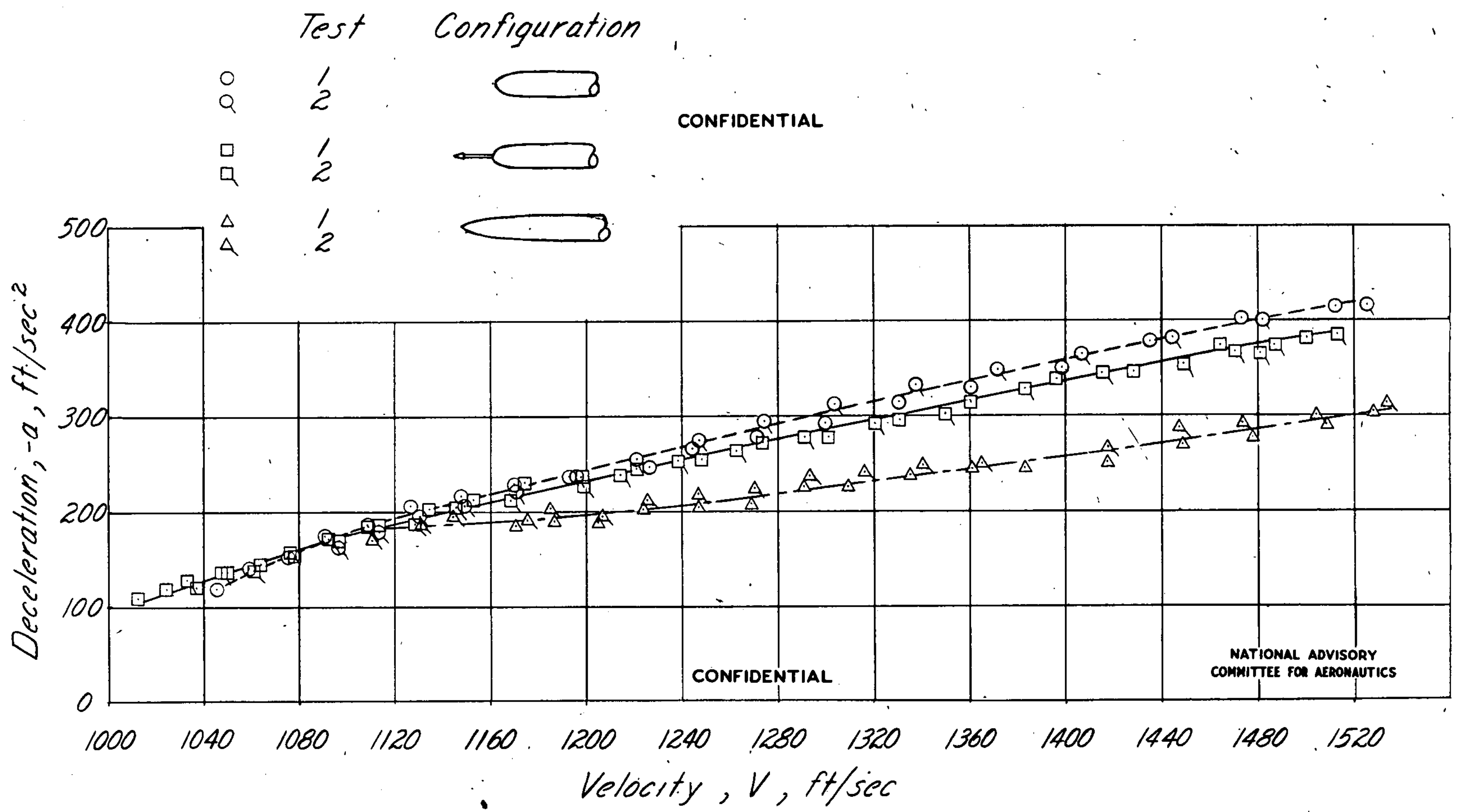

Figure 6.- Variation of deceleration with velocity for the three body configurations. Curves are average of similar tests.

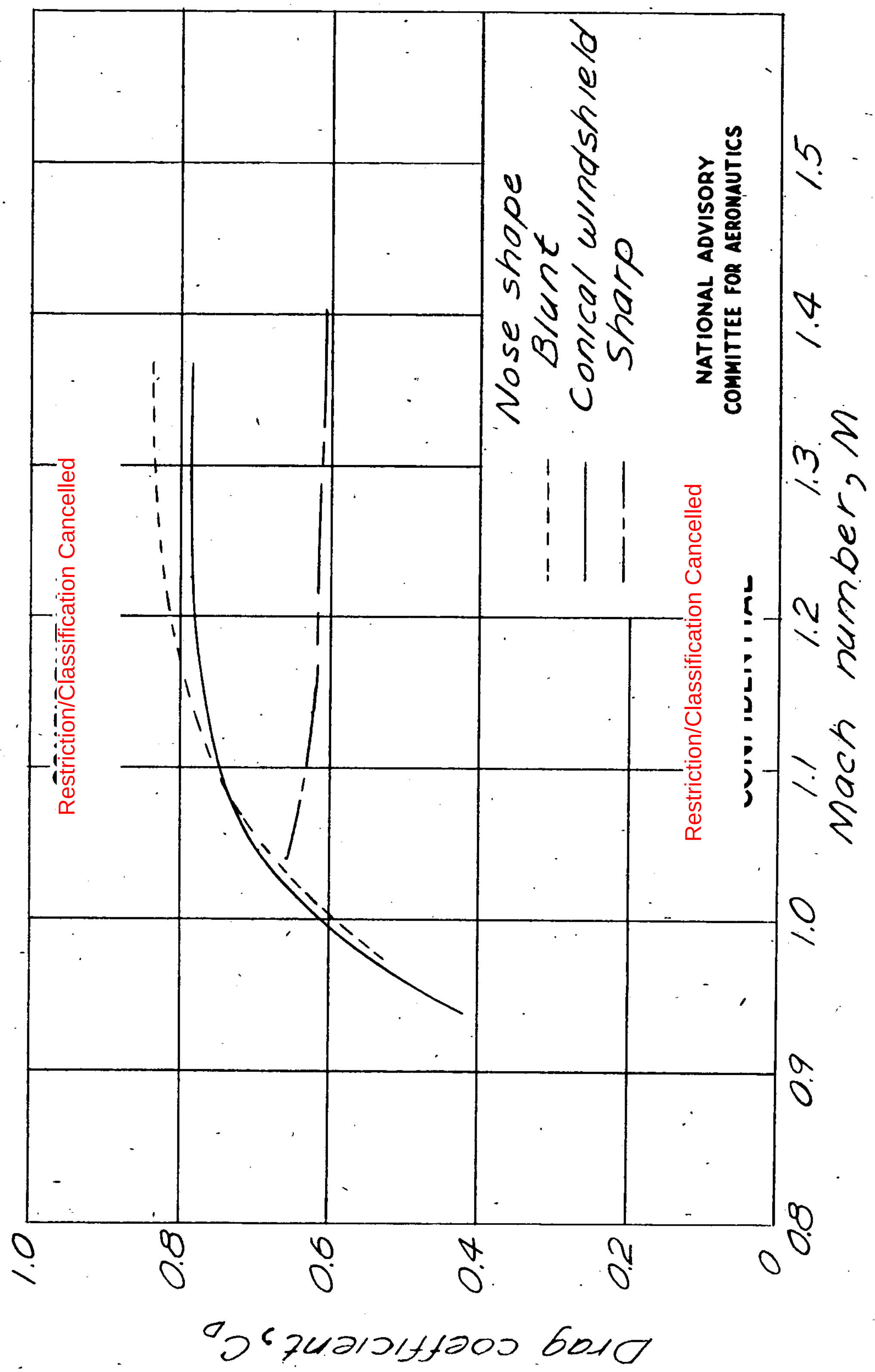

Figure 7.- Drag characteristics of the three body configurations tested.