NACA

RESEARCH MEMORANDUM

for the

Air Materiel Command, U. S. Air Force

GENERAL CHARACTERISTICS OF AIRSPEED SYSTEM USING FUSELAGE STATIC VENTS ON A SWEPT-WING AIRPLANE

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SUMMARY

Studies have been made by the NACA wing-flow method of the use of fuselage static orifices between the wing and tail of a swept-wing airplane for possible application to service airspeed installations. The tests were made at zero angle of attack. The results indicate that, although the maximum errors are large, these locations are usable from the consideration that the local Mach numbers at the locations studied are sensitive to variation of the true Mach number within the test Mach number range of 0.7 to 1.2. The maximum errors in Mach number in the subsonic range varied from zero for the most forward location to -0.05 for the most rearward location (indicated Mach number less than true). At Mach numbers above 1.0, the maximum errors were from 0.14 for the most forward location to 0.04 for the most rearward location.

INTRODUCTION

As part of a study of airspeed measurements at transonic speeds, the possibility of using flush orifices on the fuselage for the static pressure measurements has been considered. Fuselage orifices, when properly located, have been found satisfactory at subsonic speeds, but no information has been obtained for these installations at transonic speeds. In order to determine the general characteristics of such a system on a swept-wing airplane, measurements have been made by the NACA wing-flow method of the Mach number errors at four fuselage positions between the wing and tail of a $\frac{1}{50}$-scale half model representing the McDonnell XF-88 airplane with a modified tail. The results are reported herein.

APPARATUS AND TESTS

A sketch showing the $\frac{1}{50}$-scale half model of the McDonnell XF-88 airplane (with modified vertical tail) and the static orifices is given as figure 1. Location of the orifices at the top of the fuselage was chosen because of the low curvature of the fuselage upper meridian. The static orifices were actually installed in the end plate adjacent to the fuselage upper surface, at locations ranging from 0.28 inch to 1.78 inches behind the wing-trailing-edge intersection with the fuselage. The horizontal tail was not installed for these tests but was believed to have only small effect on the general nature of the results. The original vertical tail is shown by dashed lines on figure 1. The modified tail had been installed on the model for other tests.

The test procedure consisted in measuring the local Mach number at the orifice locations and using the flight Mach number of the test airplane as reference. Successive flights were made with and without the XF-88 model on the end plate. This use of flight Mach number as a reference is considered less accurate than the use of a reference Mach number on the test section, as was done in reference 1. This procedure, however, should be sufficient to establish the calibration to within ±0.02 in Mach number. Corrections for the effects of airplane lift coefficient on the relation of the local Mach numbers to the flight Mach number, were not considered necessary, inasmuch as the similarity of the flights resulted in substantially the same lift coefficient at a given flight Mach number. Except for the difference in reference Mach number, the instrumentation and test procedure were similar to that described in reference 1. The tests were made at approximately zero model angle of attack and covered a Mach number range from 0.7 to 1.2.

RESULTS AND DISCUSSION

The results are plotted in figure 2 as "indicated" Mach number at each of the four locations shown in figure 1 as a function of "true" Mach number. The indicated Mach number is the value obtained at the given orifice with the model on the end plate, whereas the "true" Mach number is that obtained at the same orifice at the same flight Mach number of the test airplane without the model on the end plate.

The results presented in figure 2 show that the four locations have similar calibrations, in that there are two regions of smooth variation of indicated with true Mach number separated by an abrupt rise of the indicated Mach number in the transonic range. The Mach number at the beginning of the abrupt rise was 0.98 for the most forward location and 1.05 for the most rearward location. The maximum errors in Mach number in the subsonic range varied from zero for the most forward location to -0.05 for the most rearward location (indicated Mach number less than true). Above $M = 1.0$, the maximum errors were from 0.14 for the most forward location to 0.04 for the most rearward location (indicated Mach number greater than true). Although the maximum errors are large as compared with those considered allowable for subsonic aircraft, all four locations are usable for airspeed measurement from the standpoint that the indicated Mach number is always sensitive to variations in true Mach number in the test range; that is, the slopes of the curves nowhere approach zero.

The applicability of these results to similar locations on other swept-wing aircraft will depend on the relative contributions of the fuselage, wing, and tail to the local velocities. Further studies of these effects are being undertaken.

CONCLUDING REMARKS

Studies have been made by the NACA wing-flow method of the use of fuselage static orifices between the wing and tail of the McDonnell XF-88 airplane (with modified vertical tail) for possible application to the service airspeed installation. The tests were made at zero angle of attack. The results indicated that, although the maximum errors are large, these locations are usable from the consideration that the local Mach numbers at the locations studied are sensitive to variation of the true Mach number within the test Mach number range of 0.7 to 1.2. The maximum errors in Mach number in the subsonic range varied from zero for the most forward location to -0.05 for the most rearward location (indicated Mach number less than true). Above $M = 1.0$, the maximum errors were from 0.14 for the most forward location to 0.04 for the most rearward location.

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REFERENCE

1. Danforth, Edward C. B., and Johnston, J. Ford: Error in Airspeed Measurement Due to Static-Pressure Field ahead of Sharp-Nose Bodies of Revolution at Transonic Speeds. NACA RM L9C25, 1949.

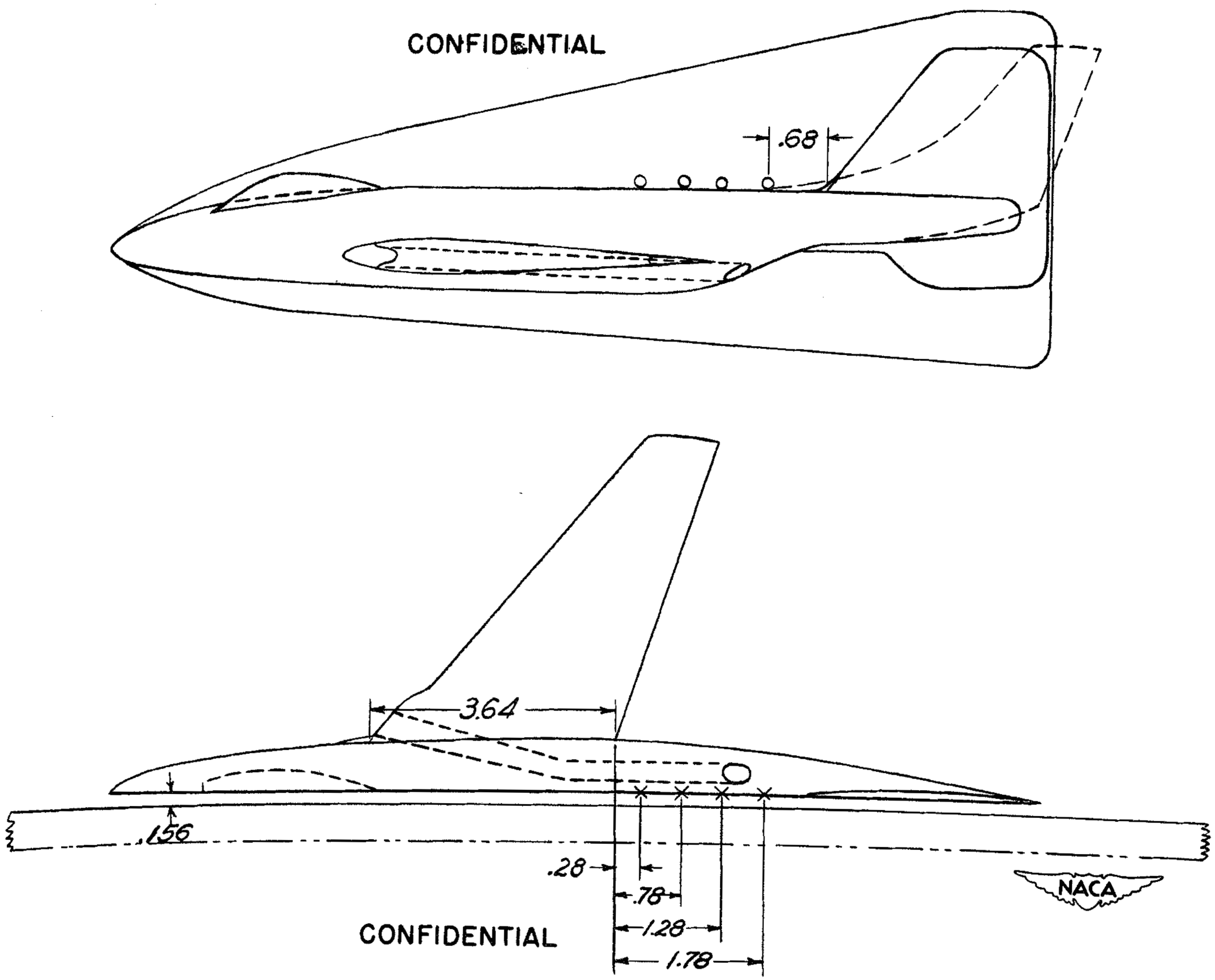

Figure 1.- The $\frac{1}{50}$-scale half model of the XF-88 airplane with modified tail showing location of static orifices at top of fuselage. All dimensions in inches.

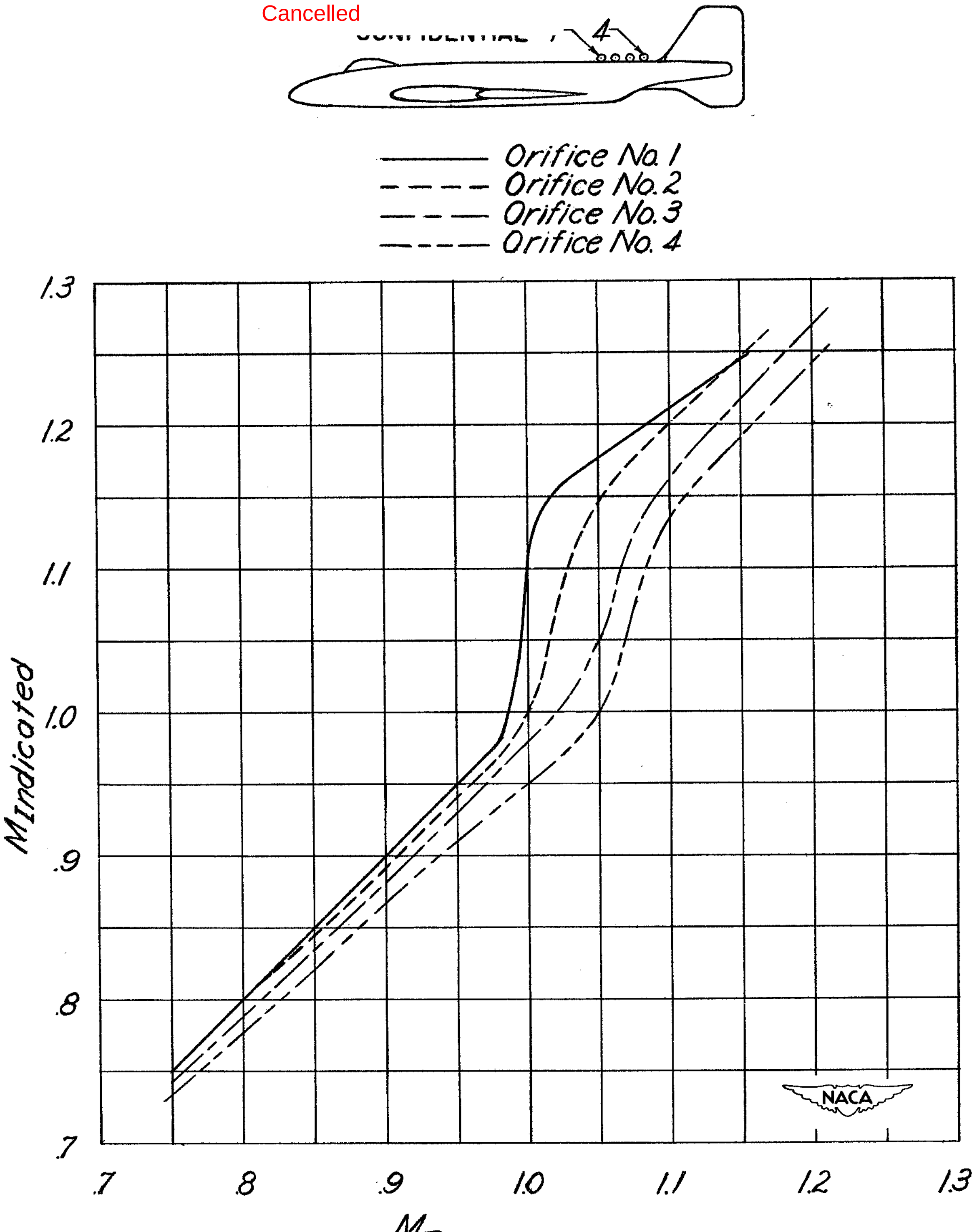

Figure 2.– Indicated Mach numbers at four locations on XF-88 model.