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PRELIMINARY DRAG TESTS IN FLIGHT OF LOW-DRAG WING ON THE CURTISS XP-60 AIRPLANE

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WASHINGTON

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

for the

Materiel Division, Army Air Corps

PRELIMINARY DRAG TESTS IN FLIGHT OF LOW-DRAG WING ON THE CURTISS XP-60 AIRPLANE

By Eastman N. Jacobs

INTRODUCTION

The following preliminary drag results obtained in flight on the low-drag wing of the Curtiss XP-60 airplane are given herewith in compliance with the request of the Army Air Corps.

TESTS

A representative section of the wing was chosen approximately 10 inches outboard of the inner end of the aileron. The section therefore included typical disturbances on the wing due to the aileron and to an ammunition door which extended over that part of the upper surface of the wing.

A rake of total head tubes on 0.3-inch centers was mounted behind the wing section as shown in figure 1. The liquid manometer and other instrument equipment mounted behind the cockpit in the fuselage are shown in figure 2.

Drag measurements were made with the original wing, in spite of the fact that some easily corrected imperfections were evident, particularly in the incomplete filling of a skin joint and rivets at the leading edge. Some filling was then applied as far back as the forward edge of the ammunition door, and the surface condition generally improved by repainting and sanding, and the drag measurements repeated.

RESULTS AND DISCUSSION

Drag coefficients were calculated from the following formula derived to accurately include compressibility effects:

$$c_d = \frac{2}{c}\int\left(\frac{H_1}{H_o}\right)^{\frac{\gamma-1}{\gamma}}\left(\frac{p_1}{p}\right)^{\frac{1}{\gamma}}\sqrt{\frac{1 - R_1}{1 - R}}\left[1 - \sqrt{\frac{1 - R_2}{1 - R}}\right]dy$$

where

$$R = \frac{1}{\left(\frac{H_o}{p}\right)^{\frac{\gamma-1}{\gamma}}}$$

$$R_1 = \frac{1}{\left(\frac{H_1}{p_1}\right)^{\frac{\gamma-1}{\gamma}}}$$

$$R_2 = \frac{1}{\left(\frac{H_1}{p}\right)^{\frac{\gamma-1}{\gamma}}}$$

and

p absolute free stream static pressure

p_1 absolute wake position static pressure

H_1 absolute wake position total pressure

H_o absolute free stream total pressure

c the airfoil chord (taken as 76.5 inches)

Taking for example the one measurement for which a photographic record of the manometer is included (fig. 3), the stream static pressure p is found from the indicated altitude, 19,000 feet, or 1013.6 pounds per square foot less 15.7, due to the error in the pilot's static tube. Thus, $p = 997.9$ pounds per square foot. The airspeed error was found by Curtiss Wright to be -5.5 percent. Thus, the static pressure as indicated by the fourth manometer tube was considered to be in error by 11 percent of its deflection from the total head level.

The stream stagnation pressure H_o is found by adding the pressure corresponding to the indicated deflection of fourth tube 142.3 + 15.7, to correct for the pilot's static tube error. Thus, H_0 = 997.9 + 142.3 + 15.7 = 1155.9 pounds per square foot. The value 142.3 is found from the measured deflection, 9.32 inches and the specific gravity of the manometer liquid, 2.94. The wake stagnation pressures H_1 indicated by the deflected tubes in the wake, and the wake static pressure indicated by the second tube may be similarly determined, except that the wake static tube was known from previous wind-tunnel tests to read too small a suction by 3.5 percent q.

The above formula then gives c_d = 0.0044. The corresponding wing lift coefficient is 0.224, the Reynolds number, 12,100,000, and the Mach number, 0.453. This drag result may be taken as representative of the wing in the final improved condition.

The Reynolds number for the section corresponds approximately to that for an assumed design condition for the airplane, 430 miles per hour at 35,000 feet. The drag coefficient value 0.0044 is somewhat less than that to be expected from previous tests in the low-turbulence tunnel of the section with aileron and ammunition door, although aerodynamically smooth sections of the same type have shown in the two-dimensional tunnel drag coefficients of approximately 0.0034. It is believed that values closely approaching this could be realized in flight by moving the ammunition door back until its front edge is near the 60-percent-chord station.

On the other hand, the drag coefficient was considerably higher for the first flight before the leading edge was improved. A record worked up for conditions otherwise most nearly comparable gave:

for

c_d = 0.0051

C_L = 0.214

R.N. = 11,130,000

M = 0.502

Thus, the wing, even with a comparatively poor surface near the leading edge, showed a drag coefficient markedly less than could have been obtained with a conventional wing section.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., December 19, 1941.

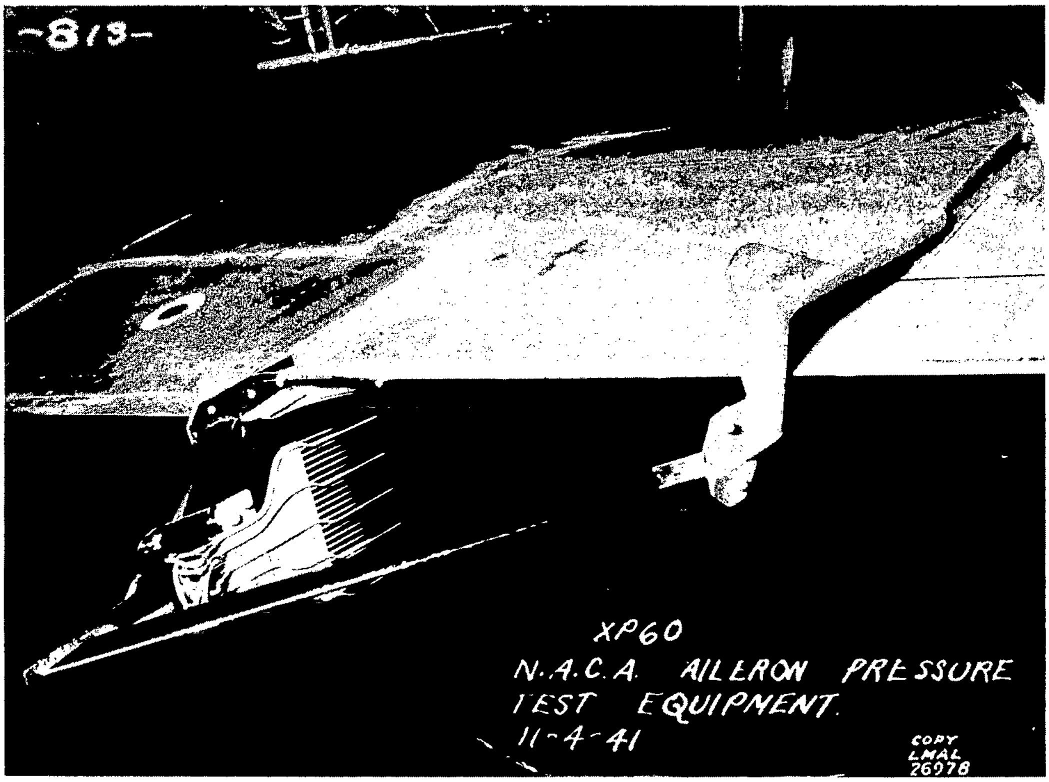

Figure 1.- Survey rake mounted behind wing.

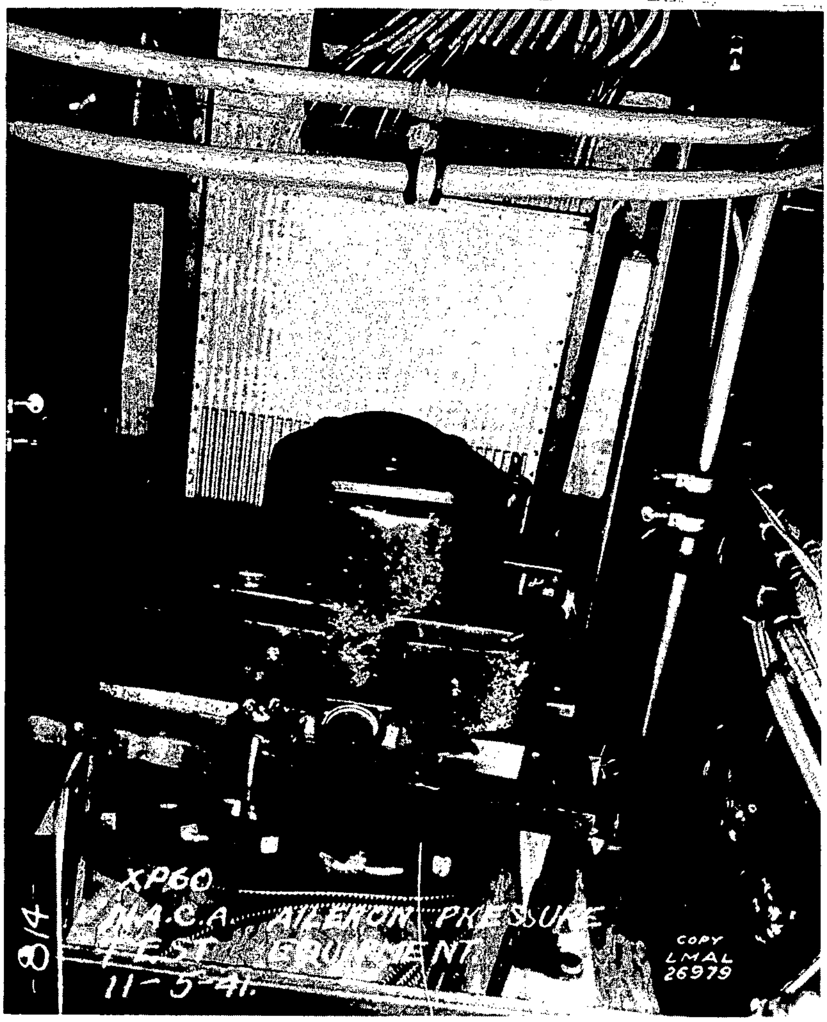

Figure 2.- Liquid manometer and recording camera mounted in fuselage.

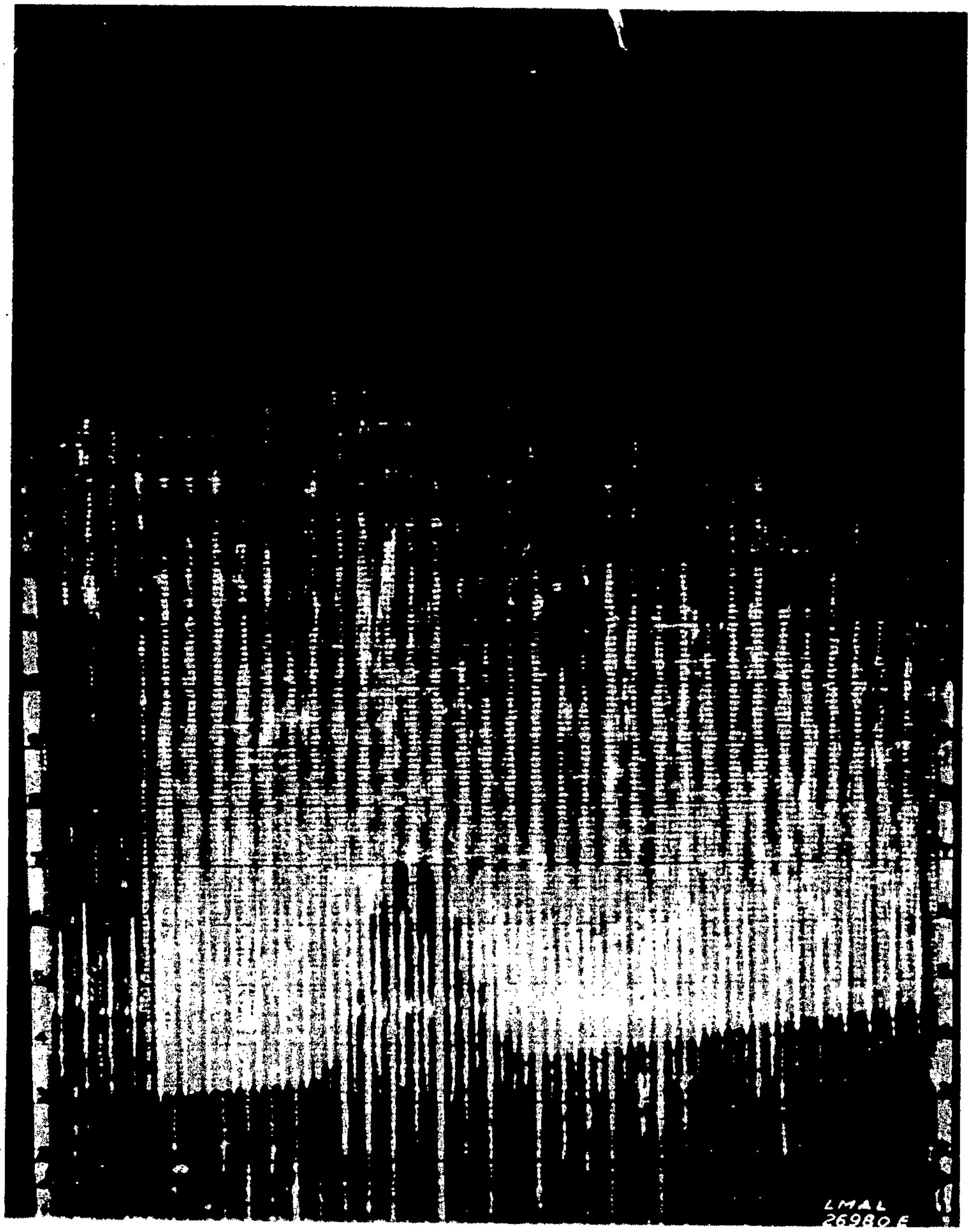

Figure 3.- Wake manometer record-smooth airfoil leading-edge condition.

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ABSTRACT: Low Drag Airfoils, a Fighter Aircraft

Drag measurements were made during flight on the low-drag wing of the Curtiss XP-60 airplane. A representative section of the wing, approximately 10 in. outboard of the inner end of the aileron, was chosen. A rake of total head tubes on 0.3 in. centers was mounted behind the wing section. A liquid manometer and other instrument equipment was mounted behind the cockpit. A formula is given, showning how to arrive at the obtained drag coefficient, which is 0.0044; the corresponding wing lift coefficient is 0.014; the Reynolds Number 12,100,000, and the Mach number 0.453.

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