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RESEARCH MEMORANDUM

MEASUREMENTS OF AILERON EFFECTIVENESS OF BELL X-1 AIRPLANE UP TO A MACH NUMBER OF 0.82

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MEASUREMENTS OF AILERON EFFECTIVENESS OF BELL X-1 AIRPLANE UP TO A MACH NUMBER OF 0.82

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SUMMARY

Abrupt, rudder-fixed aileron rolls have been made with the Bell X-1 airplane having a 10-percent-thick wing in glides to a Mach number of 0.82 at about 30,000 feet pressure altitude. Aileron movements were between one-fourth and one-half of full deflection.

These aileron rolls indicate that Mach number has little effect on the aileron effectiveness up to a Mach number of 0.82.

INTRODUCTION

During the course of pilot-familiarization flights of the X-1 airplane with the 10-percent-thick wing, abrupt aileron rolls were made at Mach numbers above those that had been reported previously in reference 1. The present paper gives the results of these aileron rolls.

SYMBOLS

p	rolling angular velocity, radians per second
b	wing span, feet
V	true airspeed, feet per second
M	Mach number
q	dynamic pressure, pounds per square foot
δ_a	total aileron deflection, degrees

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AIRPLANE AND INSTRUMENTATION

The general dimensions of the Bell X-1 airplane used in the NACA transonic research program are given in figure 1. Detailed physical characteristics are tabulated in reference 1.

The ailerons of the X-1 have a span of 5.8 feet, a chord 15 percent of the wing chord, giving an area of 3.15 square feet per aileron. The root mean square chord is 0.565 feet and the deflection is $\pm 12^{\circ}$. The ailerons have no aerodynamic balance or mechanical boost.

During the aileron rolls, records were taken on standard NACA recording instruments of altitude, airspeed, rolling angular velocity, three components of acceleration, sideslip angle, control forces, and the positions of the two ailerons and the elevator and rudder. All records were synchronized by a common timer.

TEST RESULTS AND DISCUSSION

The aileron rolls were made in the gliding descent after the X-1 fuel was exhausted. Rolls were made in each direction at each Mach number by abruptly moving the ailerons to some position between one-fourth and one-half deflection and holding this position until the rolling velocity reached a constant value. The rudder was held fixed during the aileron rolls. All rolls were made between 29,000 and 33,000 feet pressure altitude.

The variation of $\frac{pb}{2V}$ with aileron deflection is presented in figure 2. Time histories of aileron rolls at $M = 0.73$ and 0.82 are presented in figure 3. Although the values of $\frac{pb}{2V}$ in figure 2 are low, the aileron control is considered by the pilots to be good because the rolling velocity is high, as shown in figure 3. The aileron forces were light in these rolls, approximately 10 pounds.

The data are presented in figure 4 as the variation of aileron effectiveness per degree deflection $\frac{pb/2V}{\delta_a}$ with Mach number and dynamic pressure. Also presented are the data from reference 1, which were obtained at lower Mach numbers and lower altitudes. These results show that there is little change in aileron effectiveness up to a Mach number of 0.82. Because of the change in altitude, the value of dynamic pressure was increased only slightly over the tests of reference 1 and the small increase had no effect on the aileron effectiveness.

CONCLUSIONS

From rudder-fixed aileron rolls made at 30,000 feet pressure altitude with the X-1 airplane, it was found that there was little apparent effect of Mach number upon the aileron effectiveness up to a Mach number of 0.82.

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REFERENCE

1. Williams, Walter C., Forsyth, Charles M., and Brown, Beverly P.: General Handling-Qualities Results Obtained during Acceptance Flight Tests of the Bell XS-1 Airplane. NACA RM No. L8A09, 1948.

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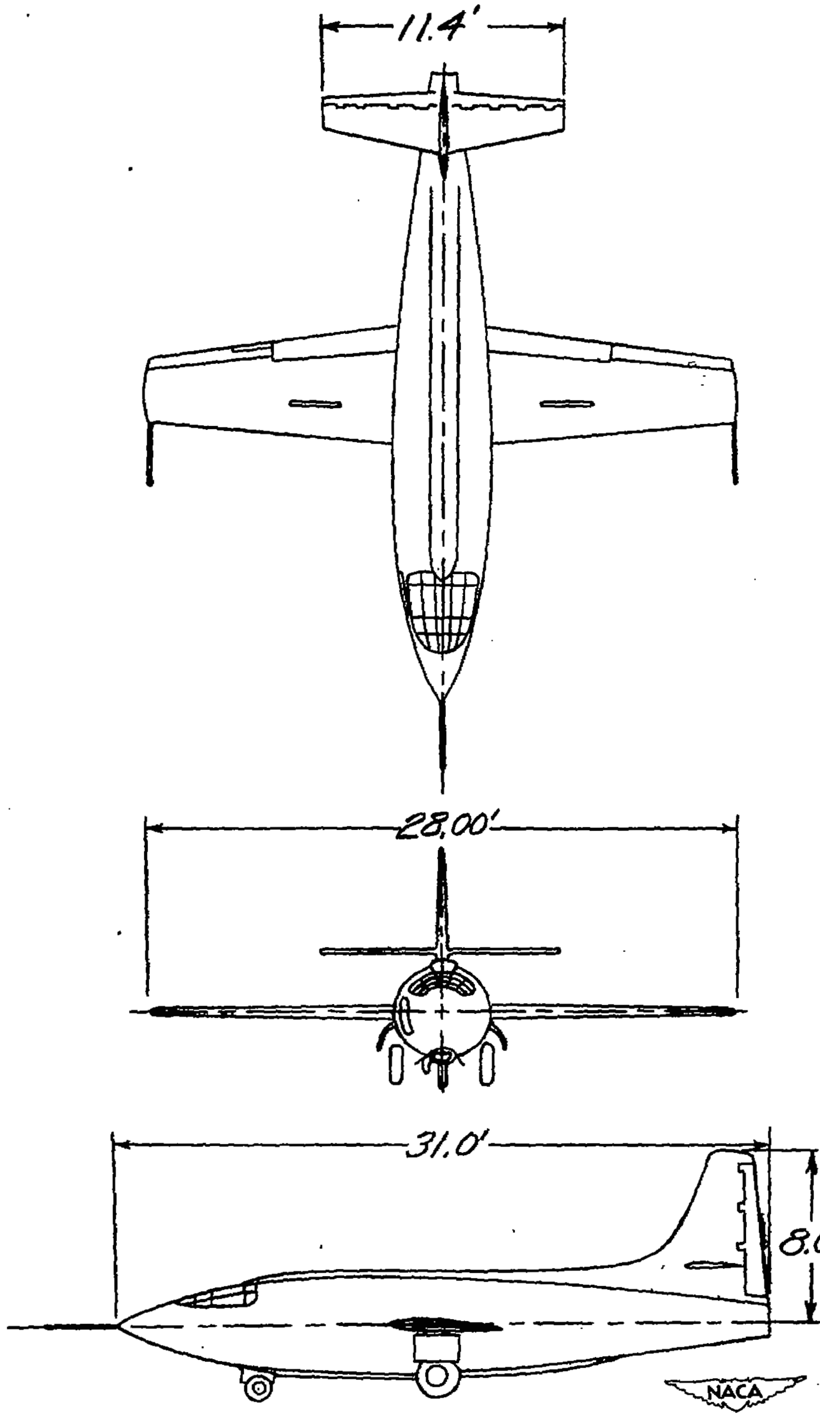

Figure 1.– Three-view sketch of X-1 airplane.

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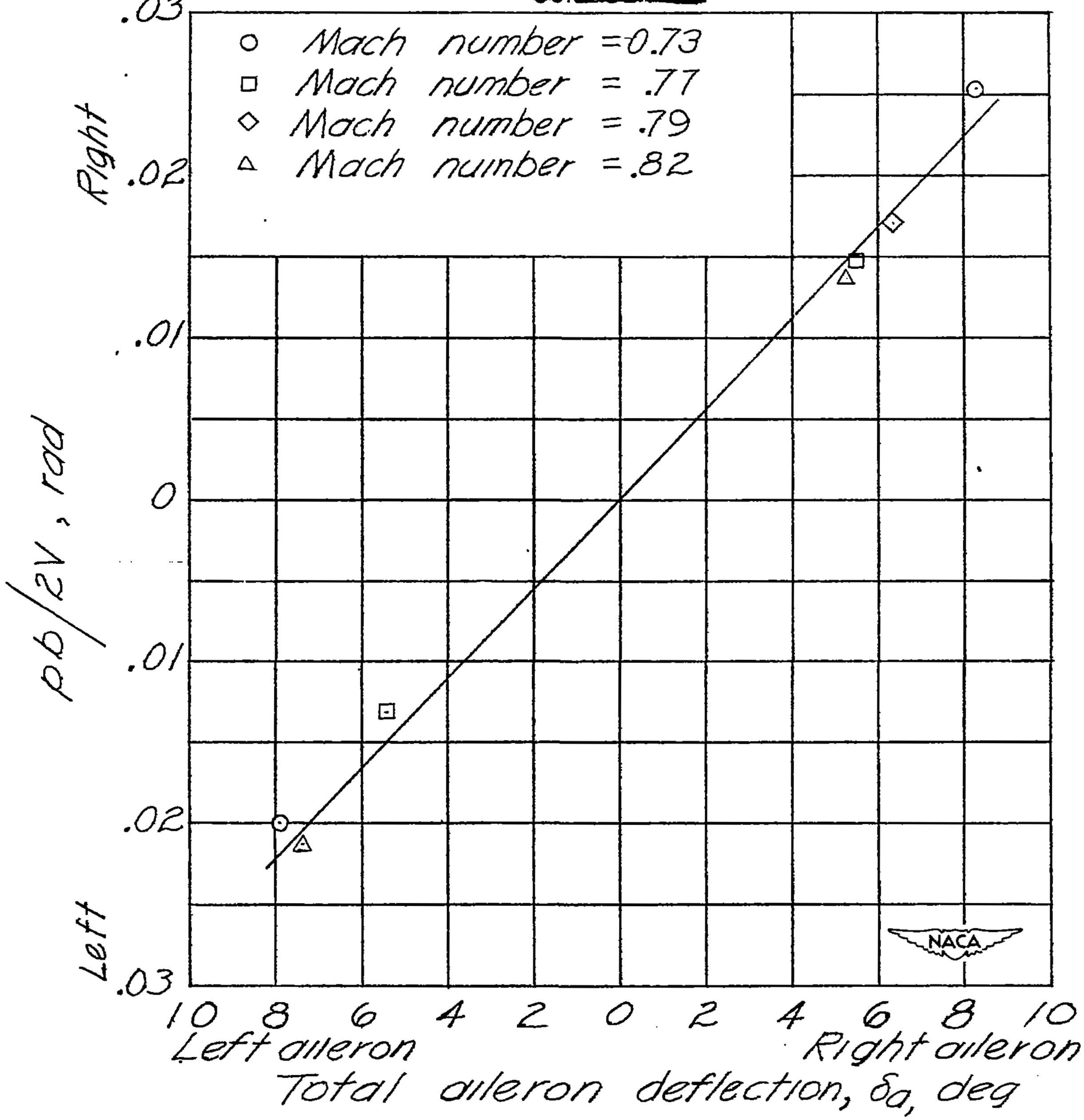

Figure 2.- Variation of $\frac{pb}{2V}$ with total aileron angle as measured in abrupt rudder-fixed aileron rolls.

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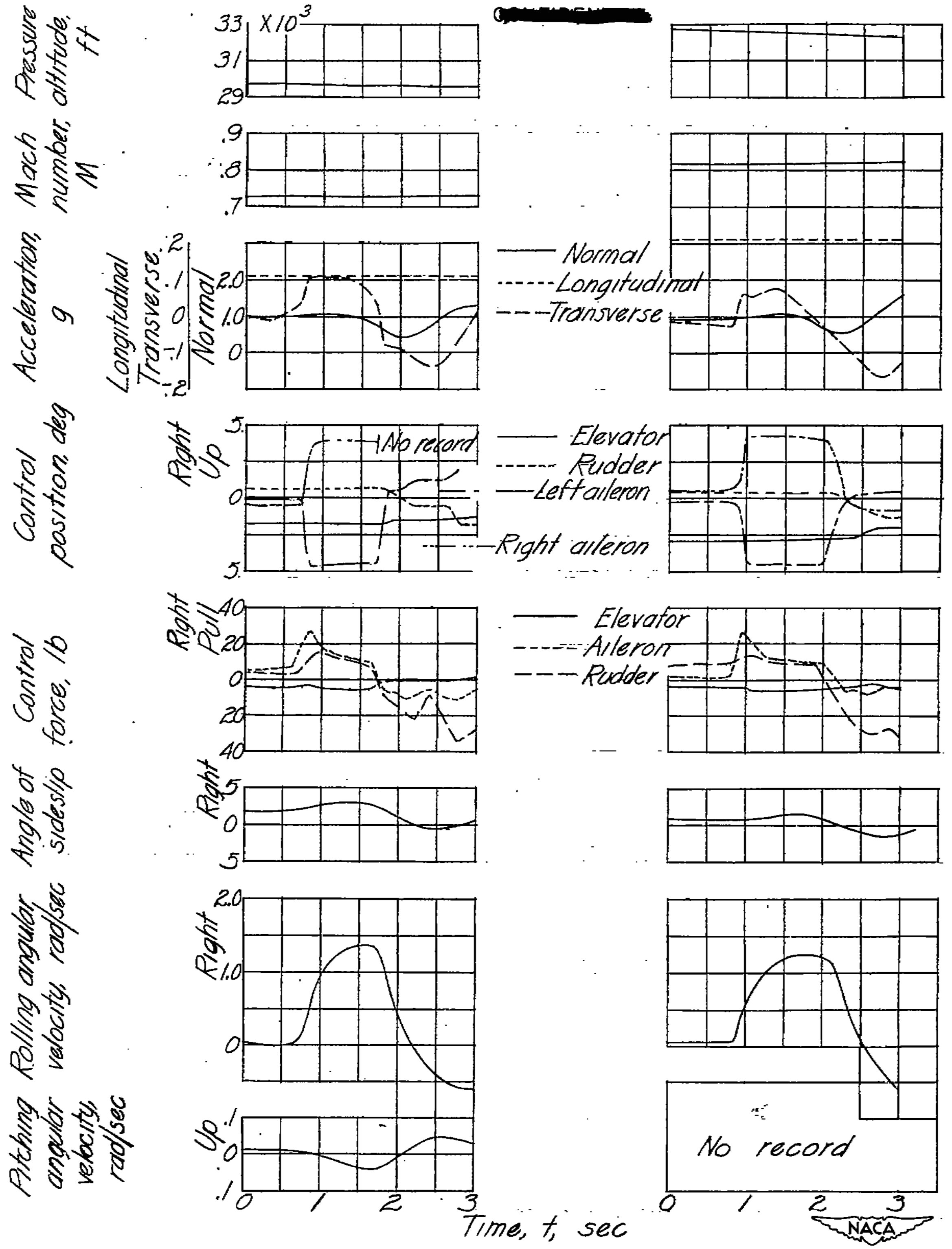

Figure 3.- Time histories of abrupt aileron rolls at Mach numbers of 0.73 and 0.82 on X-1 airplane; gross weight 7200 lb.

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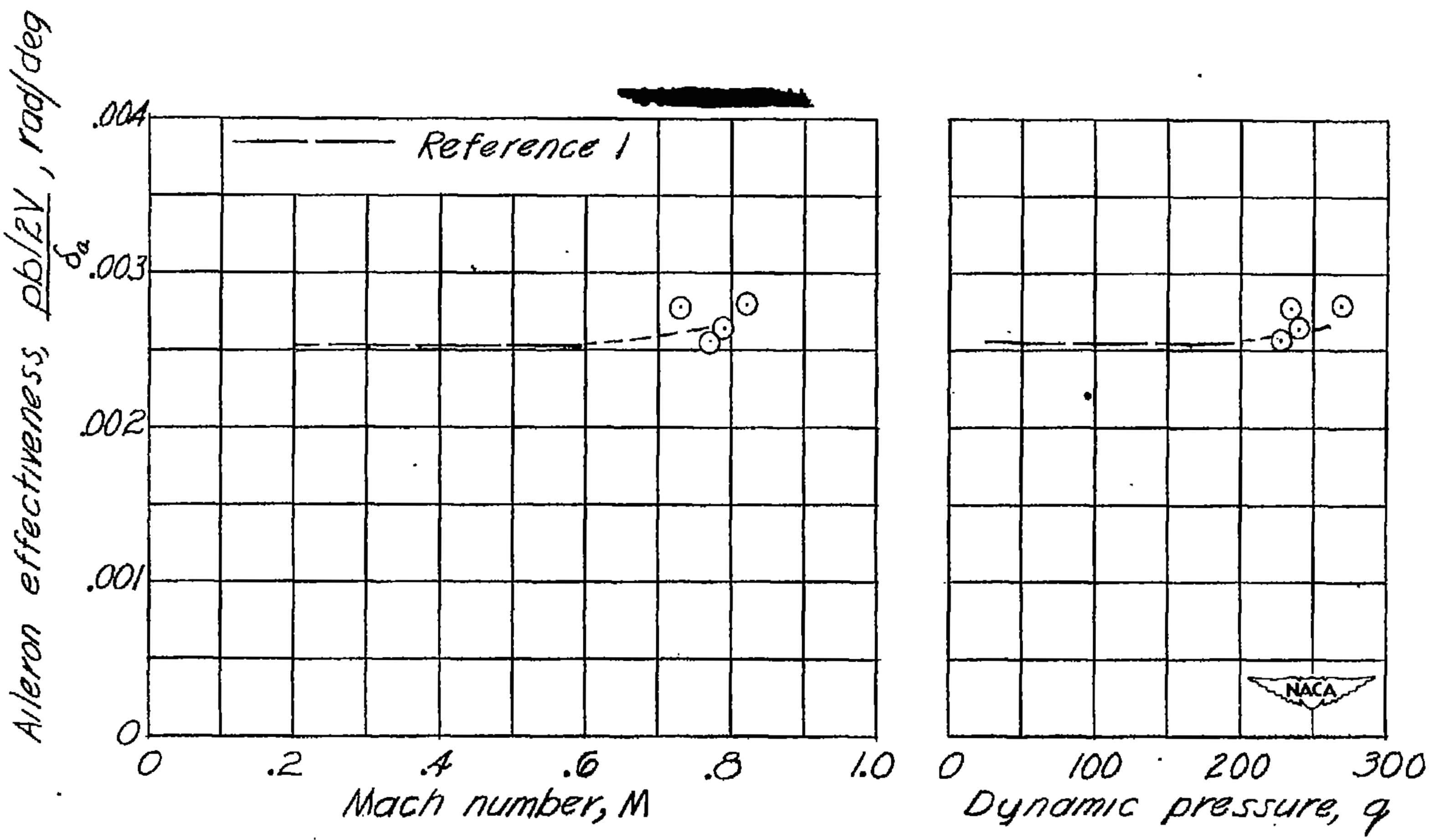

Figure 4.- Effect of Mach number and dynamic pressure on aileron effectiveness for X-1 airplane.

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