L.O. File

(Mr. R.J. Templin)

L.O. NAE-122

FILE

PREPARED BY JGL

CHECKED BY JL

NATIONAL AERONAUTICAL ESTABLISHMENT

OTTAWA, CANADA

LABORATORY MEMORANDUM

SECTION Aerodynamics

AE-46b

NO. HSAL-M-52

COPY NO. 4

DATE 31 May, 1955

SECURITY CLASSIFICATION ~~SECRET~~

SUBJECT Minimum Drag Tests on the C-105 1/80 Scale Model

PREPARED BY J. G. Laberge

ISSUED TO Mr. J. H. Parkin
Dr. D. C. MacPhail
Mr. R. J. Templin (2)
Mr. J. Lukasiewicz (2)
Author
Library

1. Introduction

Zero lift drag measurements of a 1/80 scale model of the C-105 aircraft were made in the 30-inch tunnel at subsonic and supersonic speeds. The Mach number range extended from 0.53 to 1.57 corresponding to a Reynolds number range of 1.2 to 1.7×10^6 based on wing mean aerodynamic chord, see Fig.1.

2. Wind Tunnel

Subsonic tests extending from Mach numbers 0.53 to 0.85 were performed with the slotted liner while supersonic runs were made with fixed magnesium liners giving Mach numbers of 1.35, 1.46 and 1.57. Transverse and longitudinal Mach number distributions were uniform to about 1%. Subsonic Mach numbers were determined from the static pressure measured upstream of the model at a point previously established by calibration. In addition, the static pressure at the model location was recorded in order to detect the onset of tunnel choking.

The intake air, at approximately atmospheric pressure and temperature, was dried to a specific humidity of less than 0.0005.

3. Balance and Model Mounting

The balance used was of the external sting type designed to measure axial force only. This was mounted on a sector which for the zero-lift tests performed located the model on the longitudinal axis of the tunnel. The model fuselage datum was aligned with the tunnel axis, this requiring an incidence setting of +0.28° on the sector arm.

Although the overall dimensions of the balance were such as to produce a blockage area of less than 1% of the tunnel working section area, the contribution of the sector increased the blockage to 2.7%. On this account blockage-free operation could not be expected in the range of Mach numbers between about 0.85 and 1.20, as indeed was borne out experimentally.

In view of the comparatively large model adaptor piece at the forward end of the balance the true base pressure could not be determined. The pressure existing inside the balance shield was therefore measured and used to correct drag results to free-stream base pressure.

The drag element of the balance incorporated a displacement transducer while pressures were measured with pressure transducers, all electrical outputs being fed to high-speed potentiometer recorders which provided reading accuracies of up to ±0.2%.

The drag transducer exhibited some temperature effect during a tunnel run, particularly at subsonic speeds, resulting in a temporary zero shift. However, as the effect appeared to be linear it could easily be taken into account in reading the transducer output.

4. Test Model

As the zero lift drag only was required, the model configuration used incorporated only those control surfaces and flaps having zero deflection settings. Tho following model dimensions were required:

Gross wing area, S,	27.60 in^2
Cross-sectional area of adaptor at junction with fuselage end, A_b,	0.11 in^2
Mean aerodynamic chord, $\bar{c}$,	4.53 in

The shield pressure was assumed to act over area A_b

5. Test Procedure

In the subsonic range the model was left in place and the tunnel speed changed by varying the diffuser throat area. At supersonic speeds the entire balance system, including the sector and model, was lifted out of the tunnel in order to effect nozzle changes.

Tunnel runs were of about 6 seconds duration.

6. Tunnel Corrections

With the use of a slotted liner in the subsonic regime corrections for tunnel interference were not required. In addition, at the lowest supersonic speed, namely, at M = 1.35, Mach wave interference was not present.

7. Results

Minimum drag results calculated from drag balance readings and corrected to free stream base pressure are plotted in function of Mach number in Fig.2. Excluding the transonic region where the tunnel was choked, the minimum drag has increased from $C_{D_o} = 0.008$ at M = 0.80 to $C_{D_o} = 0.024$ at M = 1.35, where C_{D_o} is based on gross wing area.

Lacking experimental measurements, no estimate of the correction to apply to C_{D_o} to account for the momentum loss of the air passing through the engine ducts was made.

An estimate of the external skin friction drag of the model was made based on a completely laminar boundary layer. In the case of the wing, for which the Reynolds number was based on the mean aerodynamic chord, C_{D_f} was found to lie between 0.0024 and 0.0020 in the Mach number range of 0.53 to 1.57. For the fuselage, the corresponding frictional drag values were 0.0014 and 0.0012 where the Reynolds number was based on the fuselage length of 10.2 in. For purposes of calculation the fuselage was simplified to a streamlined body of revolution of diameter such that the perimeter was equal to that of the actual fuselage. The contribution of the fin was neglected.

In summary the total skin friction drag coefficient was estimated at 0.0038 at $M = 0.53$ and 0.0032 at $M = 1.57$.

8. Conclusions

On the basis of the above subsonic and supersonic tests the measured C_{D_o} rise amounted to 0.016. The absolute values of C_{D_o} were estimated to include frictional drag to the extent of about 0.0035.

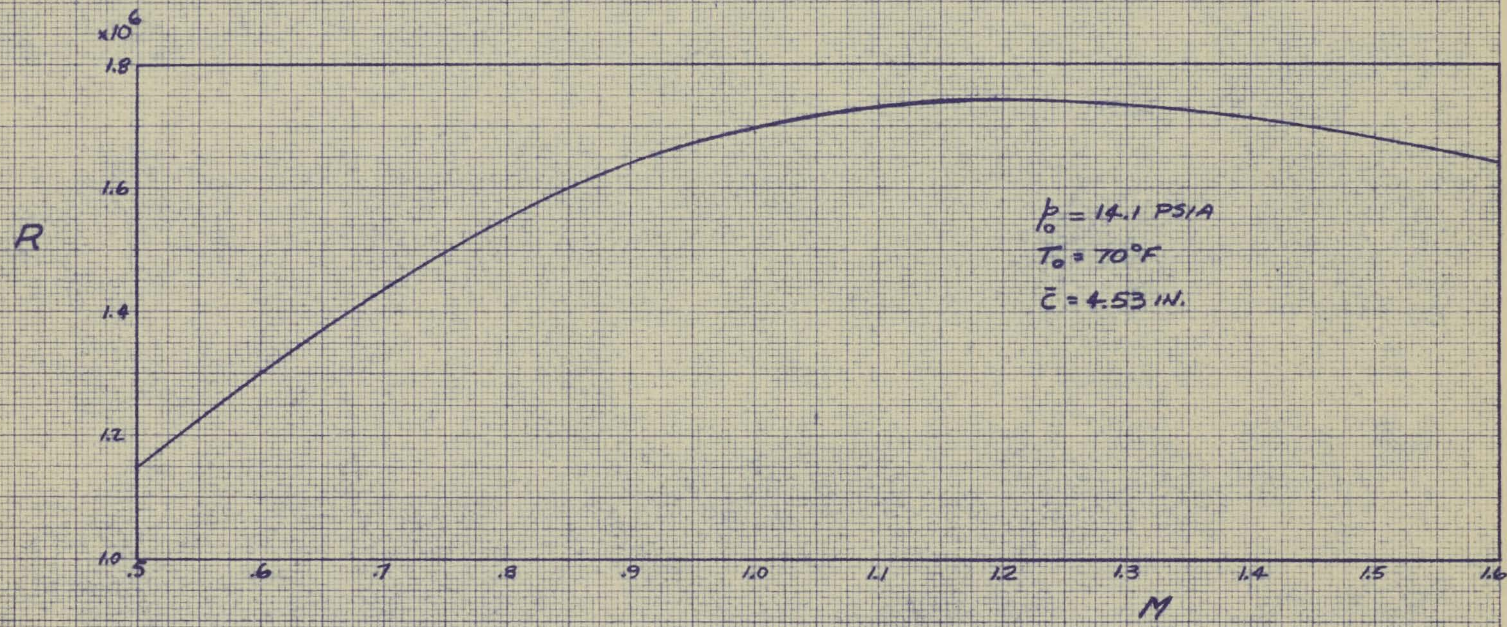

FIG. 1 REYNOLDS NUMBER VS. MACH NUMBER