L.O. Copy. Mr. R.J. Templin

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SUBJECT Some Zero-Lift Characteristics of a 1/80 Scale Model of the CF-105 Aircraft at a Test Mach Number of 1.57.

PREPARED BY J. G. LaBerge

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

1.0 Introduction

At supersonic speeds the values of C_{m_o} predicted and measured by the N.A.E. were found to disagree with the values measured by the N.A.C.A. In an attempt to discover a possible explanation for this discrepancy a detailed investigation was made in the area of interest and at a Mach number of 1.57.

The effect of tunnel flow angularity was assessed by testing the model in both the inverted and upright positons while the effect of flow through the rather long and narrow intake ducts of the model was determined by testing the model with and without fairings over the intakes.

In addition the effect of duct flow on the drag was determined at zero lift.

2.0 Model Tests

Details of the model and balance are given in Ref. 1. The present series of tests consisted in measuring the lift and pitching moment through a small range of angle of attack near zero. Zero-lift drag was measured on a separate single-component balance. The various model configurations tested are listed in the table below.

Coefficients Measured

	Model Upright		Model Inverted	
	Intakes Open	Intakes Faired	Intakes Open	Intakes Faired
C_L	X	X	X	
C_m	X	X	X	
C_{D_o}			X	X

In addition, the effect of boundary layer on C_{D_o} was investigated by placing full-span sand trips, about a 1/4 inch wide, on the upper surface of the wing and a 1/4 inch or 5.5% MAC from the leading edge.

The intake fairings consisted of wooden blocks covered with plasticine which completely enclosed the ramps and extended upstream about 1-1/16 inches from the face of the intake. A photograph of the model with intake fairings in place is shown in Fig. 1.

Test Reynolds number was 1.6×10^6 based on wing mean aerodynamic chord. Measurements were made in the 30 inch tunnel.

3.0 Uncertainty in Results

C_L	± 0.0030
C_m	± 0.0020
C_D	± 0.0010
α	$\pm 0.02°$

4.0 Results

4.1 C_{m_o} Tests

Static stability plots are shown in Fig. 2 for the various model configurations tested. The C_{m_o} values obtained therefrom are plotted in Fig. 3, where they are also compared to the values given in Refs. 1, 2 and 3. It will be seen that, compared to the N.A.C.A. results, blocking the intakes produced very little change in C_{m_o}, amounting to a decrease of 0.001. On the other hand, inverting the model with intakes open increased C_{m_o} by 0.0015 to a value which was 0.0020 larger than the value given in Refs. 1 and 3. However, these are within the uncertainty limits of the pitching moment coefficient.

4.2 C_{D_o} Tests

The zero-lift drag results obtained with various model configurations and attitudes are given in Table I where they are also compared with the results of Refs. 1, 3, 4, 5 and 6. In the case of the tests reported herein no correction for internal duct flow was made due to the small scale of the model. However, the measured base pressure was corrected to free-stream static pressure. As in Ref. 1, the test model had a 30° nose.

From Table I the following evidence can be extracted:

1) The results of the present tests indicate that with natural transition a laminar boundary layer existed over a large part of the wing. Fairing the intakes produced no appreciable change in C_{D_o}. This would suggest that drag results obtained with open intakes need not be corrected for internal flow through the ducts at the test Mach number.

2) With a turbulent boundary layer over the wing, fairing the intakes reduced C_{D_o} by 0.0014. Further, inducing transition with intakes open increased C_{D_o} by 0.0036 compared to 0.0010 in Ref. 4. This implies a smaller laminar region in the N.A.C.A. tests as could be expected from the higher test Reynolds number.

3) With intakes open and induced transition the value of C_{D_o} obtained was the same as that of Ref. 4 with the 30° nose and natural transition at a Mach number of 1.41.

4) The measured drag with intakes open was within 2% of the value given in Ref. 1 and 4% lower than the value given in Ref. 6 where the model was upright.

5) Under the same flow characteristics and model configuration the half-model technique of Ref. 3 yielded a drag value within 1.7% of the value given in Ref. 5.

5.0 Conclusions

1) The effects of tunnel flow angularity and intake duct flow on C_{m_o} and C_{D_o} were small and within the experimental error.

2) Taking into account the differences in flow characteristics as well as model configurations, the actual values of C_{D_o} measured by the N.A.E. and the N.A.C.A. were in reasonable agreement.

References

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3. J. A. van der Bliek — High Speed Tunnel Tests on a 1/50 Scale Half-Model of the Avro C-105 Aircraft. N.A.E. Laboratory Memorandum AE-46f, June 1956.

4. M. L. Spearman, R. B. Robinson, C. Driver — Longitudinal and Lateral Stability, Control Characteristics, and Vertical-Tail-Load Measurements for 0.03 Scale Model of the Avro CF-105 Airplane at Mach Number 1.41. N.A.C.A. RM SL56H27.

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6. J. G. LaBerge — Minimum Drag Tests on the C-105 1/80 Scale Model. N.A.E. Laboratory Memorandum AE-46b, May 1955.

Table I Comparison of Zero-Lift Drag

Model	Intakes	Transition	NACA Ref.4 (a)	NACA Ref.5 (b)	C_{D_o} NAE Ref.1 (c)	NAE Ref.3 (d)	NAE Ref.6 (e)	NAE Present Tests
Upright	Open	Off	0.0270*	0.0240		0.0236	0.0228	
"	Faired	"	0.0269					
"	Open	On	0.0280					
Inverted	"	Off			0.0215			0.0219
"	Faired	"						0.0220
"	Open	On						0.0255
"	Faired	"						0.0241

(a) M=1.41; Re=2.7 x 10^6; 50° nose; corrected for internal drag; base pressure equal to free-stream static.

* C_{D_o}=0.0255 for 30° nose.

(b) M=1.60; Re=2.4 x 10^6; 50° nose; corrected for internal drag; base pressure equal to free-stream static.

(c) M=1.57; Re= 1.6 x 10^6; 30° nose; uncorrected for internal drag; base pressure equal to free-stream static.

(d) M=1.57; Re=2.7 x 10^6; 50°nose; corrected for internal drag; no base pressure correction required.

(e) M=1.57; Re=1.6 x 10^6; 50° nose; uncorrected for internal drag; base pressure equal to free-stream static.

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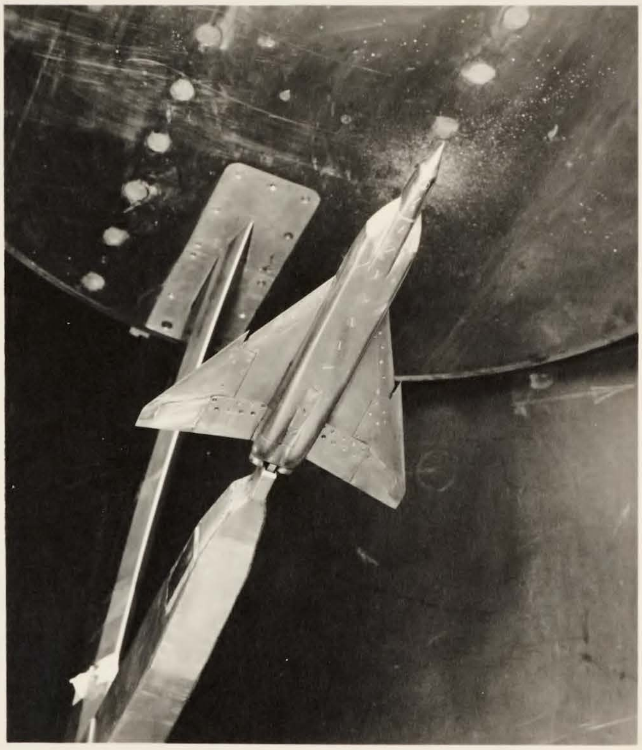

FIG. 1 TEST MODEL WITH INTAKE FAIRINGS IN PLACE