Table 1 Test configurations

Ref.	Figure	Aftbody	Mach number	Run
1	9	16° circular arc	0.50	14
1	10	24° elliptical	0.25	7
2	56	8° elliptical	0.50	2
2	57	16° elliptical	0.50	5
2	58	24° elliptical	0.50	8
2	59	8° circular arc	0.25	10
2	60	16° circular arc	0.25	13
2	61	24° circular arc	0.25	22
2	62	24° conical	0.70	33

Table 2 Separation pressure prediction

Run	Experimental C_F	C_{f0}	$C_{P_{min}}$ inviscid	C_{p_s}	C_P^* inviscid
14	0.0027	0.00168	−0.60	0.330	−0.06
7	0.0029	0.00168	−0.73	0.336	−0.15
2	0.0027	0.00198	−0.36	0.397	0.179
5	0.0028	0.00182	−0.54	0.364	0.020
8	0.0027	0.00153	−0.76	0.306	−0.219
10	0.0030	0.00227	−0.32	0.454	0.279
13	0.0029	0.00188	−0.54	0.376	0.04
22	0.0029	0.00170	−0.70	0.340	−0.122
33	0.0027	0.00140	−0.93	0.280	−0.389

Table 3 Separation location

Run	Oil-film separation	Pressure-slope separation	Goldschmied prediction	Figure (Ref.)
14	0.70	0.80	0.74	9(1)
7	0.47	0.82	0.70	10(1)
2	10.0″	10.0″	10.0″	56(2)
5	8.05″	8.20″	8.20″	57(2)
8	7.50″	7.55″	7.40″	58(2)
10	9.55″	9.55″	no separation	59(2)
13	7.95″	8.05″	8.00″	60(2)
22	7.30″	7.50″	7.40″	16(2)
33	6.80″	6.80″	6.95″	62(2)

The computations for Fig. 10 of Ref. 1 are as follows:

$$C_F = 0.0028 \text{ (from Table 4, p. 58, Ref. 2)} = \frac{\tau_0}{\frac{1}{2}\rho U_\infty^2}$$

$$C_{P_{min}} = -0.65 \text{ (experimental)}$$

$$C_{f0} = 0.0029/1.65 = 0.001757$$

$$C_{p_s} = 200 \times 0.001757 = 0.351$$

$$C_P^* = 1 - 0.649 \times 1.65 = -0.071$$

From the figure it is quite evident that the pressure-slope break occurs exactly at $C_P = -0.07$; thus the criterion is again verified directly by the Presz and Pitkin[1] data.

Such an excellent direct experimental verification is quite gratifying, since the criterion was derived for incompressible two-dimensional flow and the test were obtained on axisymmetric configurations at Mach numbers up to 0.50.

On the other hand, a prediction approach, as against the previous verification objective, would have to be based on the computed inviscid attached pressure distribution and on a computed skin-friction coefficient. The inviscid distribution is shown for a total of nine cases in Refs. 1 and 2; a computed skin-friction is not given, thus making it necessary to use the experimental C_F of Table 4, p. 58 (Ref. 2) (in the absence of laminar/turbulent transition data). Table 1 below lists the figure number, the aftbody type, the Mach number, and the identification run number for the nine test cases.

Table 2 presents a summary of the experimental Presz C_F, of the Goldschmied C_{f0}, of the inviscid $C_{P_{min}}$, of the computed pressure-recovery C_{p_s}, and of the inviscid C_P^* at separation.

Finally, Table 3 presents a summary of the separation locations; the oil-film separation indication is not always in agreement with the pressure-slope break.

The separation location is predicted by the intersection of the inviscid attached pressure-distribution with the line $C_P^* =$ constant as shown in Fig. 1 for the case of Run 14 (Fig. 9 of Ref. 1).

The agreement between predicted location and test data appears quite good for eight cases; for run 10, the method incorrectly predicts no separation.

References

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[4] Cebeci, T. and Smith, A.M.O., "A Finite-Difference Method for Calculating Compressible Laminar and Turbulent Boundary-Layers," *ASME Journal of Basic Engineering*, Vol. 92, Sept. 1970, pp. 523-535.

Reply by Authors to F.R. Goldschmied

Walter M. Presz Jr.
Pratt & Whitney Aircraft, East Hartford, Conn.
and
Edward T. Pitkin
University of Connecticut, Storrs, Conn.

THE boundary-layer properties measured in the referenced test program were taken at model station 6.35. This location is considerably upstream of the minimum-pressure point. Thus, Goldschmied's separation criteria was applied using a calculated skin friction coefficient at the minimum-pressure point. The measured boundary-layer values and surface static pressures were used as input for a modified Reshotko-Tucker boundary-layer analysis. This analysis was used to obtain the boundary-layer development on the afterbody and thus the skin friction coefficient at the minimum-pressure point. This calculated value can be significantly higher (i.e., $C_F = .0032$ for Fig. 9) than the C_F value used by Goldschmied, which was the measured value at station 6.35. The higher calculated C_F value can be attributed to additional energizing of the boundary layer between the measured station and the minimum-pressure point. We believe this accounts for the apparent discrepancies pointed out by Goldschmied.

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*Assistant Project Engineer, Propulsion Integration Group. Associate Member AIAA.

†Professor of Mechanical and Aerospace Engineering. Associate Fellow AIAA.