gradient. In these circumstances, the present authors would prefer to use the classical correction formula.[3]

References

[1]Mokry, M., "Comment on 'Tunnel-Induced Gradients and Their Effect on Drag,'" *AIAA Journal*, Vol. 36, No. 2, 1998, p. 301.

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Reply by the Author to P. R. Ashill and C. R. Taylor

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I WOULD like to thank Dr. Ashill and Mr. Taylor for their comments and their demonstration of the linkages between the result of Ref. 1, the classical result of Ref. 2, and the more recent result of Ref. 3. The early part of their comment closely parallels the analysis of Mokry,[4] and the same comments apply.[5] However, their recognition of the importance of the base pressure term in the momentum equation goes to the core of what has become a somewhat controversial issue.

The principal difficulty of the present problem is the tunnel-induced change of the shape of the displacement surface, relative to its unconstrained shape. For example, the far wake displacement (base) area in the tunnel differs from that in free air. Any attempt to force the two to be equal, as when applying the equivalence principle, distorts the relationship between model cross-sectional area and base area, with an unknown effect on drag. The choice of ϵ in Eq. (7) is also an issue. It is asserted here that, if a value of p_c is selected that is appropriate for the working section, e.g., using $\epsilon = \epsilon_w + \epsilon_s$, as in the Ashill–Taylor comment, this will result in an incorrect estimate of base drag. Rather, it is believed that a value of ϵ corresponding to the base location, i.e., $\epsilon = 2\epsilon_w$, should be used. The latter procedure is analogous to correcting the static pressure distribution along a model using a q correction that is a function of x, as described in Ref. 1.

Using $\epsilon = 2\epsilon_w$, Eq. (9) of the Ashill–Taylor comment becomes

$$\Delta D = -\rho U_1^2 Q\left[2\epsilon_w - \tfrac{1}{2}(Q/C)\right]$$

$$= -\rho U_1^2 Q \epsilon_w$$

giving

$$\Delta C_D = -C_D \epsilon_w$$

in agreement with Ref. 1.

Figure 1 extends the corrected normal flat plate drag data in Fig. 7 of Ref. 1 to include results derived using the residual drag expressions of Ashill–Taylor (and Ref. 2) and of Taylor (Ref. 3). Reference 1 uses $\Delta C_D = -C_D\epsilon_w$; Ref. 2 uses $\Delta C_D = -C_D\epsilon_s$; and Ref. 3 uses $\Delta C_D = -C_D(\epsilon_w + \epsilon_s)$. A similar comparison, using a more extensive data set, may be found in Ref. 6. The results speak for themselves.

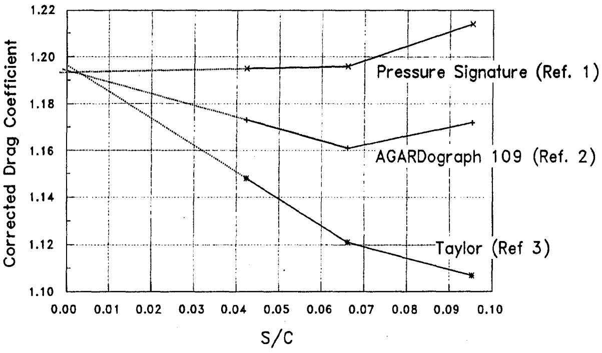

Fig. 1 Drag coefficients for square flat plates using various correction procedures.

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Received Aug. 29, 1997; accepted for publication Aug. 29, 1997.

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Comment on "Tunnel-Induced Gradients and Their Effect on Drag"

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I WOULD like to take this opportunity to point out a typographical error and a limitation in the equations for the two-step method proposed by Hackett for the blockage correction of separated flows in a closed-wall wind tunnel. At the same time, I would like to offer some experimental verification of the correct analysis that was developed by Hackett in Ref. 1.

In Ref. 1, Hackett separated Maskell's wake blockage correction into its two components—a dynamic pressure change and an incremental drag adjustment—instead of combining both correction terms into a too-large dynamic pressure correction. The benefit of the split is that drag is better corrected at large blockage and that the other forces and moments are corrected properly. The current *AIAA Journal* paper, Ref. 2, presented a version of the original analysis from Ref. 1 that was linearized to simplify its application. It was found to return a different result from that of Ref. 1. After conversations with Hackett, it appeared that part of the problem was a typographical error in the *AIAA Journal* paper that was not present

Received Aug. 14, 1997; accepted for publication Aug. 29, 1997.

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