Technical Comments

Comment on "Base Pressure Measurements on Sharp and Blunt 9° Cones at Mach Numbers from 3.50 to 9.20"

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ZARIN[1] concludes that the semiempirical estimates given by the present authors in Ref. 2 may lead to erroneous conclusions if used above Mach 4.5 and, therefore, should be avoided. Zarin is apparently confused concerning the applicable conditions for the high Mach number blunt cone estimates given in Ref. 2. Zarin's comparison of his new experimental base pressure data for a blunt 9° cone and the estimate based on Ref. 2 is shown in Fig. 1. The estimate of Ref. 2 shown here is for the essentially limiting or lower base pressure corresponding to fully turbulent boundary-layer flow (Reynolds number $\gtrsim 40 \times 10^6$). As noted in Fig. 1, Zarin's data are as much as three orders in Reynolds number below the applicable conditions. Although not discussed in Ref. 1, it should also be noted that Zarin reported in Ref. 3 that his highest Mach number (9.2) data were obtained with a laminar boundary-layer flow, and his Mach 5 and 7.5 data correspond to transitional flow. Even a successfully tripped boundary layer will not, of course, produce data directly comparable to the estimate of Ref. 2 since the relative boundary-layer thickness still would be too large.

Actually, the experimental data of Ref. 1 strongly support the analysis given in Ref. 2. The present authors predicted, at a time when systematic high Mach number base pressure data were not available, that specific, blunt vehicles would encounter a minimum and then a subsequent increase in base pressure with increasing flight Mach number. Zarin's data, although too many decades low in Reynolds number for quantitative comparison, clearly demonstrate this phenomena.

Zarin proposes in Ref. 1 a new empirical correlation of base pressure for both blunt and sharp cones. Although he points out that his data indicate more influence of bluntness than Reynolds number, he proposes a correlation based only on Reynolds number and states that its simplicity will justify its usefulness. The latter is a weak excuse for the liberties taken in order to show a set of linear curves connecting selected groups of data points representing blunt cones at the low Re_l extremes and sharp cones at the high Re_l extremes, without regard for the fact that substantial differences in local Mach numbers exist on these sharp and blunt cones. The obviously unjustified demand for a linear variation of P_b with log Re_l at constant M_∞ leads to disregard of large percentage discrepancies between the alleged correlation and Zarin's own data. Close examination of Fig. 1 in Ref. 1 will reveal that Zarin's simple correlation yields negative absolute pressures even within the Reynolds number range of his own data. Zarin presented his correlation in terms of the base pressure coefficient,

$$P_b = (p_b - p_\infty)/\tfrac{1}{2}\rho_\infty u_\infty^2$$

and apparently overlooked the fact that $P_b = -0.01688$ corresponds to zero absolute base pressure at $M_\infty = 9.2$ and $\gamma_\infty = 1.4$. Zarin's "simple correlation" is compared with the estimate of Ref. 2 in Fig. 1. This shows that the correlation has no meaning for high Mach number and high Reynolds number flows.

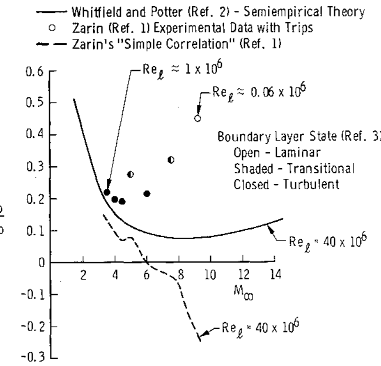

Fig. 1 Base pressure ratios for blunt 9° cone.

References

[1] Zarin, N. A., "Base pressure measurements on sharp and blunt 9° cones at Mach numbers from 3.50 to 9.20," AIAA J. 4, 743–745 (1966).

[2] Whitfield, J. D. and Potter, J. L., "On base pressures at high Reynolds numbers and hypersonic Mach numbers," Arnold Engineering Development Center, AEDC-TN-60-61 (March 1960).

[3] Zarin, N. A., "Base pressure measurements on sharp and blunt 9° cones at Mach numbers from 3.50 to 9.20," Ballistic Research Labs. Memo. Rept. 1709 (November 1965).

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Reply by Author to J. D. Whitfield and J. L. Potter

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THE author wishes to thank Messers. Whitfield and Potter for their preceding comment, parts of which are valid, and parts of which need some further clarification. Concerning the applicable conditions for the high Mach number blunt cone estimates given in Ref. 1, it was stated by Whitfield and Potter that the Reynolds number of 40×10^6 was taken as being that Reynolds number where p_b/p_1 becomes almost constant. The blunt cone data that they used in obtaining the curves in Fig. 8 of Ref. 1 were obtained at a Reynolds number of less than half that value, although their criterion of having a nearly constant value of base pressure ratio with re-

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