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Technical Comments

Reply to Technical Comment from William H. Heiser and Jack D. Mattingly

K. L. Christensen*
KC Consulting Engineering, Rolla, Missouri 65401

THE author appreciates the interest shown in his Technical Note[1] from these two readers. They point out that the fundamental problem with a drag coefficient, defined by dividing the drag force by the dynamic pressure, is that it becomes infinitely large at static conditions because the dynamic pressure is zero. Equations with this kind of behavior can be troublesome for use in simulation computer codes, which are written to consider a complete range of flight Mach numbers, including the static condition. In any case Fig. 9.3 on p. 220 of Ref. 2 shows finite additive drag coefficient values at static conditions. This same figure also presents the equations allegedly used to generate all of the coefficient values shown in the figure. The intent of the Note was to show how these static drag coefficient values were determined because the equations provided in the figure did not appear to produce them. As was described in the Note, these values were calculated using an equation that can be derived from the two drag coefficient equations provided in the figure. This derived equation is Eq. (40) in the Note. The readers state that Eq. (40) predicts an infinitely large drag coefficient at static conditions because A_0/A_1 (A_4/A_c in the Note) is infinite at static conditions. However, Fig. 9.3 shows A_0/A_1 to be 1.0 or less. The author understands that A_0/A_1 would be zero for a nonoperating engine at static conditions. As the readers point out, for an operating engine A_0/A_1 would be infinitely large. The author recognizes this inconsistency in Fig. 9.3 of Ref. 1.

Although the author feels the purposes of the Note were met, he also recognizes the value of the suggestion made by the readers that the additive drag at static conditions be based on a dimensionless uninstalled specific thrust defined in their comments. Perhaps most importantly, their approach is consistent with an infinitely large A_0/A_1 at static conditions for operating engines. The author still prefers the use of coefficients based on freestream dynamic pressure because this seems to be the standard way of defining either drag or lift coefficients. But it is this very preference, and common usage, that produces the problem noted by the readers. The author welcomes further suggestions from these and other interested readers.

References

[1]Christensen, K. L., "Equation for Additive Drag Coefficient at Static Conditions," *Journal of Propulsion and Power*, Vol. 18, No. 1, 2002, pp. 211–213.

[2]Seddon, J., and Goldsmith, E. L., *Intake Aerodynamics*, AIAA Education Series, AIAA, New York, 1985, p. 220.

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*President.