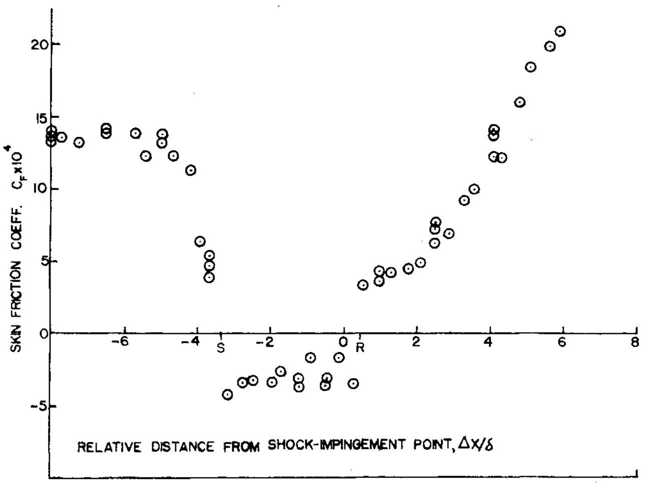

Fig. 1: Skin-friction distribution from Murthy and Rose[1] with shock generator angle = 13 deg and $M_\infty = 2.9$.

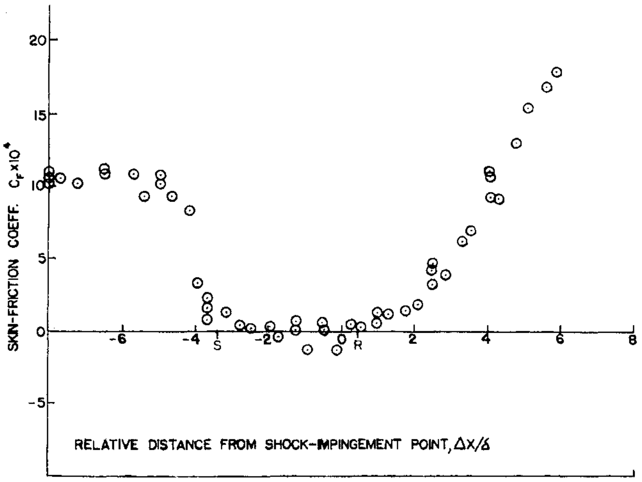

Fig. 2: Revised skin-friction distribution with shock generator angle = 13 deg and $M_\infty = 2.9$.

outputs in the separated flow regions are of the order of magnitude of the skin friction coefficients in that region. This would account for the alternating positive and negative skin friction coefficients that resulted along the separated flow region.

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Reply by Authors to R.D. Kirchner

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THE essence of Kirchner's Comment centers around the initial value of the skin friction coefficient. The original study of this flow was done by Reda and Murphy,[1] who reported a value for the coefficient of 0.0013, as determined by a Preston tube. In an independent analysis of this flow, Rubesin et al.[2] confirmed this value by a technique for examining the pitot profiles obtained in the study of Ref. 1. The use of semiempirical relationships to deduce the skin friction coefficient, as suggested by Kirchner, is questionable when applied to the flow in the NASA Ames Research Center's 8×8 in. wind tunnel, since it is a highly asymmetric, sliding-block, variable Mach number design. Any relationship between the NASA tunnel flow and that at Princeton used by Settles et al.[3] is purely coincidental. If anything is known about the skin friction in the Reda and Murphy flow, it is this upstream value. Therefore, its value must stand at 0.0013, as was used to calibrate our gages.

The negative coefficients were chosen to agree with the separation and reattachment points deduced by oil flow studies, in addition to being chosen to correspond with the numerical predictions. Kirchner's interpretation of our data would shorten the separation length to about half of that observed experimentally.

Even if one were to suppose that the upstream value of skin friction coefficient had a value of 0.0011, correct interpretation of the gage outputs would not produce Kirchner's Fig. 2 This is because the contribution to the measured data from the initial value results in a multiplying factor and not a zero shift, as assumed by Kirchner. The reason is that the measured Nusselt number in the absence of flow (i.e., skin friction = 0) must remain unaltered in any correction procedure. The calibration curve of Nusselt number vs skin friction thus rotates about its zero skin friction intercept. With this fact, the only allowable change to our data is a multiplicative one involving the ratio of assumed initial skin friction values, i.e., 0.0011/0.0013. As an example, a value of 0.0003 we reported would become 0.00025 after the correct application of a correction.

Kirchner also suggests that the alternating positive and negative skin friction coefficients in the separated flow region of his corrected data are attributable to the relatively large fluctuations in that region. As stated in our paper, the gages could not distinguish between positive and negative values; therefore, they cannot directly support any observation about the alternating nature of skin friction values. Kirchner's observation arises purely from the manner in which he has applied a correction to our data.

Unfortunately for both Kirchner and the authors, no one

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knows what these skin friction values look like in an extensively separated flow, and for anyone to presuppose their format is unwarranted. The question of positive or negative values will remain when using gages as we did, and one will have to depend on other sources of information. Confidence in our calibration procedures and data interpretation methods can be gained by examining Fig. 11 of Murthy and Rose[4] for a 10-deg shock generator angle. The separation is less extensive for this case than for the 13-deg case discussed by Kirchner. Trends of the data toward separation and away from reattachment are clearly evident and, again, are in agreement with the oil flow data.

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