Engineering Notes

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Contour Plotting for the Transonic Flight-Test Drag Polar

K. E. Ward*

Convair Division of General Dynamics, San Diego, Calif.

FOR the purpose of establishing more consistent transonic drag polars from flight-test results, a method of plotting has been developed which considers the measured values of drag to be the least accurately determined of the several parameters making up the drag polar. Mach number, pressure altitude, and weight can be established with a reasonable degree of certainty. Therefore, Mach number and lift coefficient are chosen as the independent variables, and points representing drag coefficients are plotted at the corresponding values of Mach number and lift coefficient calculated from the flight data. Contour curves are then drawn for constant values of drag coefficient which best fit the measured data. These contours are cross-plotted in order to obtain faired contour levels through the test data points. This method of plotting does not require correcting the data points to constant Mach number or constant lift coefficient as in the usual procedure.

The general shape of the drag contours is obtained directly from wind-tunnel drag polars plotted at the test Mach numbers. These contours are used to guide the fairing of the contours obtained for the airplane from the measured flight-test data points.

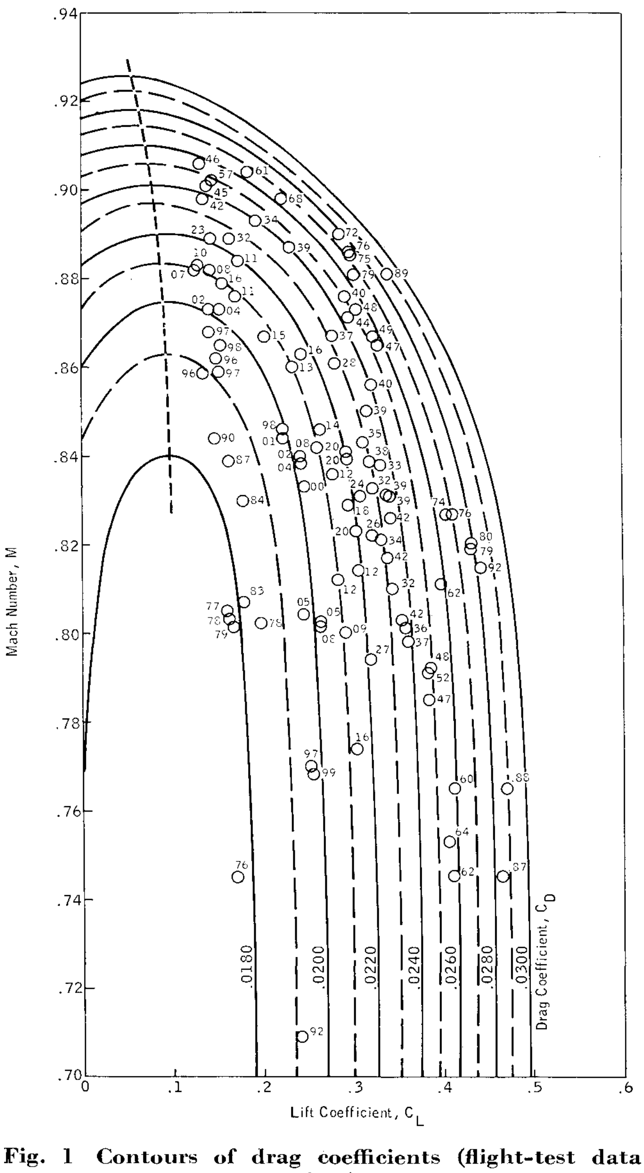

Fig. 1 Contours of drag coefficients (flight-test data points).

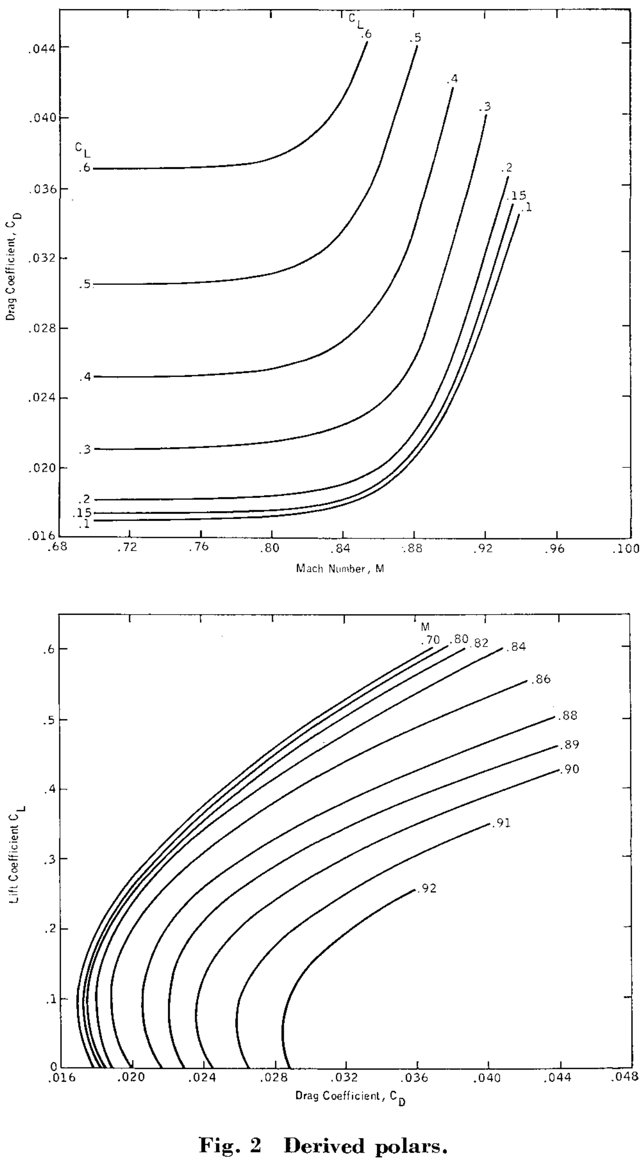

Fig. 2 Derived polars.

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* Engineering Staff Specialist. Associate Fellow AIAA

The drag data from flight test of a typical, swept wing transport are shown in Fig. 1, where the last two digits of the drag coefficient are noted at each test point. Deviations in the values of drag coefficient from a faired mean are readily apparent. However, the faired curves are believed to represent the true polars with a considerable degree of accuracy for flight data results. The faired curves of drag coefficient vs Mach number at constant lift coefficient and of drag coefficient vs lift coefficient at constant Mach numbers are shown in Fig. 2. These latter curves then become the usual working curves for use in performance calculations.

Technical Comments

Comment on "A Note on the General Instability of Eccentrically Stiffened Cylinders"

Robert M. Jones*
Aerospace Corporation, San Bernardino, Calif.

PROFESSOR Simitses[4] refers to the work of Block, Card, and Mikulas[1] in a Note that may possibly mislead the reader. Professor Simitses displays a single Donnell-Batdorf stability differential equation which is equivalent to the three stability differential equations in Ref. 1. He then states that for some special cases a closed-form solution is possible. The two special cases are, in fact, more carefully treated in the solution of Ref. 1, although not in closed form. Simitses presents these solutions with mention that they are for "simply supported [edge] boundary conditions." Unfortunately, it is not sufficient to state that simply supported edge boundary conditions are used, because that statement might apply to *any* of the following four sets of boundary conditions[2]:

$$u = v = w = \delta M_x = 0$$

$$u = \delta N_{xy} = w = \delta M_x = 0$$

$$\delta N_x = \delta N_{xy} = w = \delta M_x = 0$$

$$\delta N_x = v = w = \delta M_x = 0$$

Professor Simitses' discussion of buckling of eccentrically stiffened, circular cylindrical shells under axial compression was limited to axisymmetric buckling. As a result, he came to the conclusion that "the strongest configuration corresponds to placing the stringers on the inside," a result the reader may erroneously assume to be generally applicable. The treatment of the more general case of asymmetric buckling given in Ref. 1 makes it clear that, in most practical cases, stringers on the outside provide a more buckling-resistant configuration than do stringers on the inside. This general conclusion is reinforced and extended both theoretically and experimentally in Ref. 3.

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* Member of the Technical Staff, Technology Division.

References

[1] Block, D. L., Card, M. F., and Mikulas, M. M., Jr., "Buckling of Eccentrically Stiffened Orthotropic Cylinders," TN D-2960, Aug. 1965, NASA.

[2] Sobel, L. H., "Effects of Boundary Conditions on the Stability of Cylinders Subject to Lateral and Axial Pressures," *AIAA Journal*, Vol. 2, No. 8, Aug. 1964, pp. 1437–1440.

[3] Card, M. F. and Jones, R. M., "Experimental and Theoretical Results for Buckling of Eccentrically Stiffened Cylinders," TN D-3639, Oct. 1966, NASA.

[4] Simitses, G. J., "A Note on the Generalized Instability of Eccentrically Stiffened Cylinders," *Journal of Aircraft*, Vol. 4, No. 5, Sept.-Oct. 1967, pp. 473–475.