NASA
Technical
Paper
2565
c.2
May 1986

# R4 Airfoil Data Corrected for Sidewall Boundary-Layer Effects in the Langley 0.3-Meter Transonic Cryogenic Tunnel

Renaldo V. Jenkins



NASA

# NASA Technical Paper 2565

1986

# R4 Airfoil Data Corrected for Sidewall Boundary-Layer Effects in the Langley 0.3-Meter Transonic Cryogenic Tunnel


Renaldo V. Jenkins

*Langley Research Center*
*Hampton, Virginia*



NASA
National Aeronautics and Space Administration

Scientific and Technical Information Branch

## SUMMARY

This report presents corrected aerodynamic data for the R4 airfoil at Mach numbers from 0.60 to 0.78 and angles of attack from -2.0° to 4.5°. The test Reynolds numbers were 4 million, 6 million, 10 million, 15 million, 30 million, and 40 million based on the 152.32-mm chord of the airfoil. Corrections for the effects of the sidewall boundary layer have been made. The uncorrected data were previously published in NASA Technical Memorandum 85739. Data corrected for the presence of all four walls and data corrected for the sidewalls only have approximately the same level of agreement with theoretical calculations (except that no corrected angle of attack is produced by the sidewalls-only method). The design goal of achieving a drag-divergence Mach number of 0.73 at a Reynolds number of 30 million and a normal-force coefficient of 0.65 was accomplished with the R4 airfoil.

## INTRODUCTION

As part of a cooperative airfoil research program between the U.S. National Aeronautics and Space Administration (NASA) and the Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e. V. (DFVLR), Federal Republic of Germany, the R4 airfoil, designed at DFVLR Braunschweig, was recently tested in the Langley 0.3-Meter Transonic Cryogenic Tunnel. The R4 is a 13.5-percent-thick airfoil having a normal-force coefficient of 0.65 at a Reynolds number of 30 million and a Mach number of 0.73. The airfoil was tested at Mach numbers from 0.60 to 0.78 at angles of attack from -2.0° to 4.5°. The test Reynolds numbers were 4 million, 6 million, 10 million, 15 million, 30 million, and 40 million based on the 152.32-mm chord of the airfoil. The basic data, consisting of average test conditions, surface pressure distributions, and the integrated aerodynamic coefficients, are presented in reference 1.

## SYMBOLS

$\alpha$ angle of attack, deg

$C_p$ pressure coefficient, $\dfrac{p_\ell - p_\infty}{q_\infty}$

$c$ model chord, 152.32 mm

$c_d$ section profile-drag coefficient, $\int_{\text{Wake}} c_d' \, d\left(\frac{h}{c}\right)$

$c_d'$ point drag coefficient (ref. 2)

$c_m$ section quarter-chord pitching-moment coefficient,

$$-\oint C_p\left(\frac{x}{c} - 0.25\right) d\left(\frac{x}{c}\right) + \oint C_p\left(\frac{z}{c}\right) d\left(\frac{z}{c}\right)$$

$c_n$ section normal-force coefficient, $-\oint C_p \, d\left(\frac{x}{c}\right)$

| | |
|---|---|
| $h$ | vertical height in wake profile, mm |
| $M_{dd}$ | drag-divergence Mach number (Mach number for which $dc_d/dM = 0.1$) |
| $M$ | free-stream Mach number |
| $p_{\ell}$ | local static pressure, atm (1 atm = 101.325 kPa) |
| $p_{\infty}$ | free-stream static pressure, atm |
| $q_{\infty}$ | free-stream dynamic pressure, atm |
| $R$ | Reynolds number based on chord |
| $x$ | airfoil abscissa coordinate, mm |
| $z$ | airfoil ordinate coordinate, mm |

Abbreviations:

| | |
|---|---|
| DFVLR | Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt e. V. |
| 0.3-m TCT | 0.3-Meter Transonic Cryogenic Tunnel |

Subscript:

| | |
|---|---|
| dd | at drag-divergence Mach number |

## APPARATUS AND TESTS

### Wind Tunnel

Tests of the DFVLR R4 airfoil were conducted in the 8- by 24-inch two-dimensional test section of the Langley 0.3-Meter Transonic Cryogenic Tunnel (0.3-m TCT). The 0.3-m TCT is a continuous-flow, fan-driven transonic tunnel which uses nitrogen gas as the test medium. As detailed in reference 3, the tunnel with the two-dimensional insert is capable of operating at temperatures from about 78 K to about 327 K and stagnation pressures from slightly greater than 1.0 atm to 6.0 atm. Mach number can be varied from about 0.20 to 0.90. The ability to operate at cryogenic temperatures and pressures up to 6 atm provides a high Reynolds number capability at relatively low model loading. More information on the design and operational capabilities of the 0.3-m TCT can be found in references 3 and 4. Information on the use of nitrogen as a test gas can be found in reference 5.

The two-dimensional test section contains computer-driven angle-of-attack and momentum rake systems. The angle-of-attack system is capable of varying the angle of attack over a range of about 40°. The momentum rake (see fig. 1), located 1.2c downstream of the airfoil, provides up to six total pressure measurements across the span of the model and can traverse vertically from about 100 percent of the chord above the model to about 50 percent of the chord below the model. Integration of these pressure measurements provides the profile-drag coefficient. The comparison of the spanwise pressure measurements allows the extent of the two-dimensionality of the flow to be determined.

The 0.3-m TCT operating conditions can be controlled to the following accuracies:

| | |
|---|---|
| Total temperature | ±0.10 K |
| Total pressure | ±0.007 atm |
| Free-stream Mach number | ±0.003 |

## Model

The R4 airfoil was designed at DFVLR Braunschweig, Federal Republic of Germany. This airfoil is of the supercritical type with a maximum thickness ratio of 0.135 and a blunt trailing edge with a thickness of 0.005c. The airfoil shape is given in figure 2.

The model tested has a chord of 152.32 mm (5.997 in.) and was constructed of V2A 14301 stainless steel (similar in properties to AISI type 304 stainless steel). The model was fabricated by DFVLR Göttingen, Federal Republic of Germany, in upper and lower parts, and these parts were brazed together. The surface pressure tubing was placed inside the model by trenching the joining surfaces before the two parts were brazed. The static-pressure orifices were made by drilling 0.3-mm holes normal to the model surface to meet the internal tubes. There are 31 static-pressure orifices on the model upper surface and 19 orifices on the lower surface. The fabrication procedure was the same for both the R4 airfoil and the CAST 10-2/DOA 2 airfoil reported in reference 6, which also gives additional information on the construction procedure.

Measurements by both DFVLR and NASA Langley Research Center indicated that the model as delivered to Langley had three minor defects. These defects were (1) a slight error in the shape of the leading edge, (2) a surface finish rougher than 0.5 μm ($20 \times 10^{-6}$ in.) root mean square, and (3) a coordinate tolerance greater than the desired ±0.0254 mm (±0.001 in.). The model was reworked at Langley to try to alleviate these discrepancies. This rework resulted in a model with a chord of 152.32 mm (5.997 in.) and a surface finish roughness in the range of 0.1 to 0.2 μm ($4 \times 10^{-6}$ to $8 \times 10^{-6}$ in.). The model still was not within the desired 0.0254 mm (0.001 in.) of the design values of the R4 coordinates. The upper surface, in general, was thinner than the design values. In fact, the first 2.95 percent was thinner by as much as 0.258 mm (0.0101 in.). The lower surface, on the other hand, was generally thicker than the design values with excursions as great as 0.038 mm (0.0015 in.). The total contour of the model was smooth and continuous. The design and measured coordinates of the model are given in table I, and the orifice locations are given in table II.

## Tests

The tests had a Mach number range of 0.60 to 0.78 and an angle-of-attack range of -2.0° to 4.5°. The test Reynolds numbers were 4 million, 6 million, 10 million, 15 million, 30 million, and 40 million based on the 152.32-mm (5.997-in.) model chord.

As previously mentioned, the airfoil profile-drag coefficient is determined by using the wake rake shown in figure 1. For the present tests, five of the rake pitot tubes were utilized. Pitot tube number 1 was located 12.7 mm to the right of the tunnel centerline. Pitot tube number 2 was on the tunnel centerline; number 3 was 12.7 mm to the left of the tunnel centerline; number 4 was 38.1 mm to the left of the tunnel centerline; and number 5 was 50.8 mm to the left of the tunnel centerline. The tubes had an outside diameter of 1.52 mm (0.060 in.) and an inside diameter of 1.02 mm (0.040 in.). The three static tubes of the wake rake were not used. However, static pressure was measured at nine locations on the sidewall opposite the wake rake. The nine static-pressure ports were arranged with one port midway between the tunnel floor and ceiling and four above and four below this midpoint, each spaced vertically 25.4 mm apart. Both the pitot and static-pressure measurements were made in a plane located about 183 mm (1.2c) downstream of the model trailing edge.

## UNCORRECTED AND CORRECTED DATA

### Uncorrected Data

The data for the first four columns of tables III through VIII were obtained by reading values of $c_d$, $c_m$, and $\alpha$ at constant values of normal-force coefficient and Reynolds number at the various test Mach numbers from large-scale plots of the data figures in reference 1. (The last four columns contain data that have been corrected for sidewall boundary-layer effects and are discussed separately.) Portions of these tabulated data are presented in figure 3. These uncorrected data are presented for normal-force coefficients in increments of 0.05 from 0.50 to 0.80 for each of the six test Reynolds numbers. Similarly, uncorrected pitching-moment coefficient values are plotted against Mach number in figure 4 for the same range of normal-force coefficient values.

<u>Drag divergence</u>.- The drag-divergence Mach number is defined for the present purpose as the Mach number for which $dc_d/dM = 0.1$. The drag-divergence Mach number $M_{dd}$ and drag-divergence profile-drag coefficient $c_{d,dd}$ are found from curves of the type shown in figure 3. The drag-divergence pitching-moment coefficient $c_{m,dd}$ can be obtained from curves like those of figure 4. This procedure produces the data for the first four columns of table IX.

<u>Repeatability</u>.- Experience with airfoil tests in the 0.3-m TCT has shown that if a data point is taken and then immediately retaken, the repeatability of the measured coefficients is within the following tolerances:

| | |
|---|---|
| Profile-drag coefficient ($c_d$) | $\pm 0.00004$ |
| Normal-force coefficient ($c_n$) | $\pm 0.001$ |
| Quarter-chord pitching-moment coefficient ($c_m$) | $\pm 0.0002$ |

The retaking of data on different days (weeks) in the 0.3-m TCT at a Mach number of 0.6 and a Reynolds number of 4 million gives the following extreme differences in results:

| | |
|---|---|
| Profile-drag coefficient | 0.0009 |
| Normal-force coefficient | 0.020 |
| Quarter-chord pitching-moment coefficient | 0.002 |

### Data Corrected for Wall Interference

The 0.3-m TCT is a slotted wind tunnel designed according to the classical linear wall interference precepts and empirical data of reference 7. The data from this tunnel, as with all tunnels, contain errors due to wall interference. A partial list of the possible data corrections is as follows:

1. Sidewalls only (refs. 8 and 9)

2. Top and bottom walls only (refs. 10 and 11)

3. All four walls (refs. 12 and 13)

The slotted top and bottom walls of the 0.3-m TCT are designed to have nearly zero blockage (see ref. 7), and the corrections to the Mach number and flow curvature for their effect should be minimal. The solid sidewalls, on the other hand, have boundary layers which interact with the model pressure field and must be taken into account. Experience with correcting two-dimensional data from this tunnel indicates (see ref. 14) that the data should be corrected for sidewall boundary-layer effect to get the change in Mach number and must be corrected for all four walls (see ref. 15) to get the change in both Mach number and angle of attack.

Figures 5 through 8 give a typical example of the comparisons between theoretical calculations (made with the GRUMFOIL program, ref. 16) and the data corrected by various means. In figure 5, the uncorrected data are compared with results obtained by specifying a measured Mach number of 0.748 and a normal-force coefficient of 0.5957 in the GRUMFOIL calculation. These results show a slight disparity between theory and experiment for the lower surface and a considerable difference for the upper surface, particularly at the shock location.

Using the TWINTN4 program of reference 13 with zero upstream angularity and the unified-method option produces a corrected Mach number of 0.739 and a corrected normal-force coefficient of 0.6054. Specifying these values in the GRUMFOIL program gives the results in figure 6. The agreement of the results is much improved, with nearly perfect agreement at the shock location.

Applying the TWINTN4 program with nonzero upstream angularity and the unified-method option to the measured data gives a corrected Mach number of 0.740 and a corrected normal-force coefficient of 0.6046. These values are essentially the same values as those produced by the previous correction. Thus the agreement shown in figure 7 is the same as that in figure 6.

Correcting the measured data for sidewalls only by the method of reference 9 gives a Mach number of 0.734 and normal-force coefficient of 0.6037. Specifying these values into the GRUMFOIL code gives the results in figure 8. The agreement at the shock location is not as good as the agreement of either of the two unified corrections (all four walls) in figures 6 and 7; however, at other locations the agreement is better. In fact, the entire lower surface and the upper surface immediately downstream of the suction peak are in rather good agreement.

It will be noted that the GRUMFOIL code does not compute the wave about the 26-percent chord location on the upper surface, which is evident in the experimental data for all four comparison figures. Because the GRUMFOIL program missed this wave, one would not expect it to give as good an agreement further downstream at the shock location as it does in the two unified corrections of figures 6 and 7. In any case, the overall agreement for the sidewalls-only correction (fig. 8) is no worse than the unified correction (figs. 6 and 7) for this particular airfoil. Similar results were obtained in reference 17, with and without passive removal of part of the sidewall boundary layer upstream of the airfoil test location. The sidewalls-only correction is also much easier to apply than the unified method. In view of the reasonably good agreement obtained between sidewalls-only correction data and theoretical results, it was decided that the sidewalls-only correction would be used in this report.

The data of the first three columns of tables III through VIII were corrected by the method of reference 9 (sidewalls only) to produce columns 5, 6, and 7 of these tables. Column 8 of tables III through VIII is the corrected normal-force coefficient.

It will be noted that the method of reference 9 does not produce a correction to the angle of attack. The TWINTN4 calculations, on the other hand, give a correction in terms of the absolute change in the angle of attack, and the corrected angle is directly determined by how accurately the angle is measured in the experiment.

Corrections for the drag-divergence data of the first four columns of table IX can be obtained by two paths. The first path is to use the corrected data of tables III through VIII (columns 5, 6, and 7) to plot $c_d$ and $c_m$ versus Mach number as shown in figures 3 and 4. From these plots, one proceeds as before to determine the drag-divergence values. An additional plot of the corrected normal-force coefficient versus Mach number is required to determine the corrected drag-divergence normal-force coefficients. The second path simply applies sidewalls-only corrections to the drag-divergence data in the first four columns of table IX to obtain the corrected values in the last four columns. This second path is only available with the sidewalls-only correction technique, and it is the method used in this report.

## PRESENTATION OF RESULTS

Data are presented in tables as follows:

| Table no. | Reynolds number, R, $\times 10^{-6}$ | Type of data | Page |
|---|---|---|---|
| I | | Coordinates of R4 airfoil | 11 |
| II | | Orifice locations on R4 airfoil | 13 |
| III | 4 | Cross-plotted | 14 |
| IV | 6 | Cross-plotted | 21 |
| V | 10 | Cross-plotted | 28 |
| VI | 15 | Cross-plotted | 35 |
| VII | 30 | Cross-plotted | 43 |
| VIII | 40 | Cross-plotted | 50 |
| IX | 4 to 40 | Drag-divergence | 57 |
| X | 4 to 40 | Reynolds number effects at design $c_n$ | 60 |

The remaining data are presented in figures as follows:



## RESULTS AND DISCUSSION

Table IX contains a summary of the drag-divergence conditions for the airfoil and can be used to estimate the optimal cruise parameters at any normal-force coefficient and Reynolds number in the test envelope. Table IX is used to obtain drag-divergence conditions at the airfoil design normal-force coefficient of 0.65 and a Reynolds number of 30 million. The drag-divergence Mach number of 0.742 for these conditions is 0.012 above the design Mach number of 0.73. However, if the sidewall correction is considered, the corrected Mach number is 0.727, which is essentially 0.73. Interpolating in the table to a corrected normal-force coefficient of 0.65 gives the corrected drag-divergence profile-drag coefficient as 0.00984 and the quarter-chord pitching moment as -0.1462. This procedure was repeated at each Reynolds number to develop tables, such as table X, which show the effect of Reynolds number on the drag-divergence conditions for the design normal-force coefficient of 0.65.

All data presented in figures 9 through 16 have been corrected by the method of reference 9 to account for the sidewall boundary layer. Some of the corrected profile-drag-coefficient data from tables III through VIII have been cross plotted against Reynolds number. (See fig. 9.) The profile-drag coefficient generally increases with a decrease in Reynolds number. This trend is reversed at the lower Reynolds numbers, probably as a result of the aft movement of the transition location, which produces a decrease in the profile-drag coefficient as the Reynolds number decreases. The extreme changes in profile-drag coefficient for all values of the normal-force coefficient at Mach numbers greater than or equal to 0.76, and for low Reynolds numbers with high values of the normal-force coefficient occur because these conditions are above the drag-divergence Mach number. (See table IX.) Similarly, graphs of the quarter-chord pitching-moment coefficient versus Reynolds number are presented in figure 10 for the same range of normal-force coefficient values shown in figure 9. The variation in the quarter-chord pitching moment is gradual except at low Reynolds numbers, at which dramatic changes in the transition location probably occur, and at Mach numbers above the drag-divergence Mach number.

The aerodynamic coefficients at drag divergence are plotted versus drag-divergence Mach number in figures 11, 12, and 13. The profile-drag coefficient is near its minimum for Mach numbers near the design Mach number of 0.73 (fig. 11). Figure 12 indicates that the quarter-chord pitching-moment coefficient fluctuates about the value -0.14 near the design Mach number. Figure 13 shows that the normal-force coefficient decreases very rapidly at Mach numbers slightly above 0.70.

Figures 14, 15, and 16 contain, respectively, plots of drag-divergence profile-drag coefficient, drag-divergence quarter-chord pitching-moment coefficient, and drag-divergence Mach number versus Reynolds number for various normal-force coefficients. These figures show the airfoil to have smooth drag-divergence properties for all Reynolds numbers above 15 million. The curves for normal-force coefficients of 0.609 and 0.660 (fig. 16) give the drag-divergence Mach numbers as 0.728 and 0.727, respectively, at the design Reynolds number of 30 million. Because the design normal-force coefficient of 0.65 lies between these two curves, the drag-divergence Mach number must be between 0.728 and 0.727.

## CONCLUSIONS

The aerodynamic data for the R4 airfoil have been corrected for sidewall boundary-layer effects on Mach number. The significant conclusions from this analysis are as follows:

1. Data corrected for the presence of all four walls and data corrected for sidewalls only have approximately the same level of agreement with theoretical calculations (except that no corrected angle of attack is produced by the sidewalls-only method).

2. The design goal of achieving a drag-divergence Mach number of 0.73 at a Reynolds number of 30 million and a normal-force coefficient of 0.65 was accomplished with the R4 airfoil.

NASA Langley Research Center
Hampton, VA 23665-5225
February 26, 1986

REFERENCES


1. Jenkins, Renaldo V.; Johnson, William G., Jr.; Hill, Acquilla S.; Mueller, Rudolf; and Redeker, Günter: Data From Tests of a R4 Airfoil in the Langley 0.3-Meter Transonic Cryogenic Tunnel. NASA TM-85739, 1984.

2. Baals, Donald D.; and Mourhess, Mary J.: Numerical Evaluation of the Wake-Survey Equations for Subsonic Flow Including the Effect of Energy Addition. NACA WR L-5, 1945. (Formerly NACA ARR L5H27.)

3. Ray, Edward J.; Ladson, Charles L.; Adcock, Jerry B.; Lawing, Pierce L.; and Hall, Robert M.: Review of Design and Operational Characteristics of the 0.3-Meter Transonic Cryogenic Tunnel. NASA TM-80123, 1979.

4. Kilgore, Robert A.: Design Features and Operational Characteristics of the Langley 0.3-Meter Transonic Cryogenic Tunnel. NASA TN D-8304, 1976.

5. Adcock, Jerry B.: Real-Gas Effects Associated With One-Dimensional Transonic Flow of Cryogenic Nitrogen. NASA TN D-8274, 1976.

6. Dress, David A.; Johnson, Charles B.; McGuire, Peggy D.; Stanewsky, Egon; and Ray, Edward J.: High Reynolds Number Tests of the CAST 10-2/DOA 2 Airfoil in the Langley 0.3-Meter Transonic Cryogenic Tunnel - Phase I. NASA TM-84620, 1983.

7. Barnwell, Richard W.: Design and Performance Evaluation of Slotted Walls for Two-Dimensional Wind Tunnels. NASA TM-78648, 1978.

8. Barnwell, Richard W.: Similarity Rule for Sidewall Boundary-Layer Effect in Two-Dimensional Wind Tunnels. AIAA J., vol. 18, no. 9, Sept. 1980, pp. 1149-1151.

9. Sewall, William G.: The Effects of Sidewall Boundary Layers in Two-Dimensional Subsonic and Transonic Wind Tunnels. AIAA J., vol. 20, no. 9, Sept. 1982, pp. 1253-1256.

10. Murman, E. M.: A Correction Method for Transonic Wind Tunnel Wall Interference. AIAA Paper No. 79-1533, July 1979.

11. Kemp, William B., Jr.: TWINTAN: A Program for Transonic Wall Interference Assessment in Two-Dimensional Wind Tunnels. NASA TM-81819, 1980.

12. Kemp, William B., Jr.; and Adcock, Jerry B.: Combined Four-Wall Interference Assessment in Two-Dimensional Airfoil Tests. AIAA-82-0586, Mar. 1982.

13. Kemp, William B., Jr.: TWINTN4: A Program for Transonic Four-Wall Interference Assessment in Two-Dimensional Wind Tunnels. NASA CR-3777, 1984.

14. Jenkins, Renaldo V.: Some Experience With Barnwell-Sewall Type Correction to Two-Dimensional Airfoil Data. Wind Tunnel Wall Interference Assessment/Correction - 1983, Perry A. Newman and Richard W. Barnwell, eds., NASA CP-2319, 1984, pp. 375-392.

15. Gumbert, Clyde R.; Newman, Perry A.; Kemp, William B., Jr.; and Adcock, Jerry B.: Adaptation of a Four-Wall Interference Assessment/Correction Procedure for Airfoil Tests in the 0.3-m TCT. Wind Tunnel Wall Interference Assessment/ Correction - 1983, Perry A. Newman and Richard W. Barnwell, eds., NASA CP-2319, 1984, pp. 393-411.

16. Melnik, R. E.: Turbulent Interactions on Airfoils at Transonic Speeds - Recent Developments. Computation of Viscous-Inviscid Interactions, AGARD-CP-291, Feb. 1981, pp. 10-1 - 10-34.

17. Murthy, A. V.; Johnson, C. B.; Ray, E. J.; Lawing, P. L.; and Thibodeaux, J. J.: Investigation of the Effects of Upstream Sidewall Boundary-Layer Removal on a Supercritical Airfoil. AIAA-83-0386, Jan. 1983.

TABLE I.- COORDINATES OF R4 AIRFOIL

Upper Surface

| x/c | z/c Design | z/c Actual | x/c | z/c Design | z/c Actual |
|---|---|---|---|---|---|
| .0001 | .0042 | .0043 | .3887 | .0704 | .0696 |
| .0005 | .0062 | .0063 | .3997 | .0704 | .0696 |
| .0011 | .0081 | .0079 | .4197 | .0703 | .0695 |
| .0016 | .0095 | .0093 | .4397 | .0700 | .0692 |
| .0021 | .0106 | .0103 | .4597 | .0696 | .0688 |
| .0023 | .0120 | .0104 | .4797 | .0691 | .0683 |
| .0045 | .0155 | .0140 | .4997 | .0684 | .0676 |
| .0095 | .0211 | .0197 | .5197 | .0676 | .0668 |
| .0145 | .0255 | .0240 | .5398 | .0667 | .0659 |
| .0195 | .0290 | .0276 | .5598 | .0656 | .0648 |
| .0245 | .0320 | .0305 | .5798 | .0643 | .0636 |
| .0295 | .0346 | .0332 | .5998 | .0629 | .0622 |
| .0345 | .0368 | .0355 | .6198 | .0613 | .0606 |
| .0395 | .0388 | .0376 | .6398 | .0594 | .0588 |
| .0445 | .0405 | .0393 | .6598 | .0574 | .0568 |
| .0495 | .0421 | .0409 | .6798 | .0550 | .0545 |
| .0545 | .0435 | .0423 | .6998 | .0524 | .0519 |
| .0595 | .0448 | .0436 | .7199 | .0495 | .0490 |
| .0645 | .0459 | .0449 | .7399 | .0465 | .0459 |
| .0695 | .0470 | .0460 | .7599 | .0432 | .0426 |
| .0795 | .0490 | .0480 | .7799 | .0396 | .0391 |
| .0995 | .0525 | .0515 | .7999 | .0359 | .0354 |
| .1195 | .0554 | .0545 | .8199 | .0320 | .0315 |
| .1395 | .0579 | .0570 | .8399 | .0279 | .0273 |
| .1596 | .0600 | .0592 | .8599 | .0236 | .0231 |
| .1796 | .0619 | .0611 | .8799 | .0191 | .0186 |
| .1996 | .0636 | .0628 | .8999 | .0145 | .0140 |
| .2196 | .0650 | .0643 | .9200 | .0097 | .0093 |
| .2396 | .0663 | .0655 | .9400 | .0047 | .0043 |
| .2596 | .0673 | .0666 | .9600 | -.0006 | -.0008 |
| .2796 | .0683 | .0675 | .9800 | -.0061 | -.0062 |
| .2996 | .0690 | .0683 | .9850 | -.0076 | -.0076 |
| .3196 | .0695 | .0688 | .9900 | -.0090 | -.0090 |
| .3397 | .0700 | .0692 | .9950 | -.0105 | -.0104 |
| .3597 | .0702 | .0695 | 1.0000 | -.0120 | -.0121 |
| .3797 | .0704 | .0696 | | | |

TABLE I.- Concluded

## Lower Surface

| x/c | z/c Design | z/c Actual | x/c | z/c Design | z/c Actual |
|---|---|---|---|---|---|
| .0001 | 0.0000 | .0001 | .3997 | -.0639 | -.0640 |
| .0005 | -.0018 | -.0019 | .4197 | -.0635 | -.0635 |
| .0011 | -.0033 | -.0033 | .4397 | -.0628 | -.0629 |
| .0023 | -.0058 | -.0056 | .4597 | -.0620 | -.0621 |
| .0045 | -.0086 | -.0084 | .4797 | -.0610 | -.0611 |
| .0095 | -.0128 | -.0126 | .4897 | -.0604 | -.0605 |
| .0145 | -.0158 | -.0157 | .5047 | -.0601 | -.0596 |
| .0195 | -.0185 | -.0184 | .5248 | -.0580 | -.0581 |
| .0245 | -.0208 | -.0207 | .5448 | -.0564 | -.0564 |
| .0295 | -.0227 | -.0227 | .5648 | -.0545 | -.0545 |
| .0345 | -.0245 | -.0245 | .5848 | -.0524 | -.0524 |
| .0395 | -.0262 | -.0262 | .6048 | -.0500 | -.0500 |
| .0445 | -.0277 | -.0278 | .6248 | -.0474 | -.0473 |
| .0495 | -.0292 | -.0292 | .6448 | -.0445 | -.0444 |
| .0545 | -.0305 | -.0306 | .6648 | -.0413 | -.0412 |
| .0595 | -.0318 | -.0319 | .6848 | -.0378 | -.0377 |
| .0645 | -.0330 | -.0331 | .7048 | -.0340 | -.0339 |
| .0695 | -.0695 | -.0343 | .7249 | -.0301 | -.0302 |
| .0745 | -.0353 | -.0354 | .7449 | -.0263 | -.0264 |
| .0795 | -.0363 | -.0364 | .7649 | -.0225 | -.0227 |
| .0995 | -.0402 | -.0404 | .7849 | -.0190 | -.0192 |
| .1195 | -.0437 | -.0439 | .8049 | -.0158 | -.0159 |
| .1395 | -.0468 | -.0470 | .8249 | -.0130 | -.0131 |
| .1596 | -.0497 | -.0499 | .8449 | -.0107 | -.0107 |
| .1796 | -.0523 | -.0525 | .8649 | -.0090 | -.0090 |
| .1996 | -.0547 | -.0548 | .8849 | -.0079 | -.0079 |
| .2196 | -.0568 | -.0569 | .9050 | -.0074 | -.0074 |
| .2396 | -.0587 | -.0587 | .9250 | -.0076 | -.0076 |
| .2596 | -.0603 | -.0603 | .9450 | -.0086 | -.0085 |
| .2796 | -.0616 | -.0616 | .9650 | -.0106 | -.0105 |
| .2996 | -.0626 | -.0627 | .9850 | -.0140 | -.0138 |
| .3196 | -.0634 | -.0634 | .9900 | -.0151 | -.0149 |
| .3397 | -.0639 | -.0639 | .9950 | -.0163 | -.0161 |
| .3597 | -.0641 | -.0642 | 1.0000 | -.0172 | -.0172 |
| .3797 | -.0642 | -.0642 | | | |

TABLE II.- ORIFICE LOCATIONS ON R4 AIRFOIL

| Upper Surface | | Lower Surface | |
|---|---|---|---|
| x/c | z/c | x/c | z/c |
| .0000 | .0008 | .0000 | .0008 |
| .0040 | .0141 | .0040 | -.0075 |
| .0080 | .0191 | .0080 | -.0113 |
| .0150 | .0255 | .0230 | -.0199 |
| .0250 | .0320 | .0500 | -.0292 |
| .0400 | .0388 | .1000 | -.0402 |
| .0600 | .0448 | .1500 | -.0482 |
| .0800 | .0490 | .2000 | -.0547 |
| .1000 | .0524 | .2500 | -.0595 |
| .1400 | .0579 | .3500 | -.0640 |
| .1800 | .0619 | .4500 | -.0624 |
| .2200 | .0650 | .5500 | -.0559 |
| .2600 | .0673 | .6500 | -.0436 |
| .3000 | .0690 | .7500 | -.0253 |
| .3400 | .0700 | .8000 | -.0165 |
| .3800 | .0703 | .8500 | -.0102 |
| .4200 | .0702 | .9000 | -.0074 |
| .4600 | .0696 | .9500 | -.0090 |
| .5000 | .0684 | 1.0000 | -.0120 |
| .5400 | .0667 | | |
| .5800 | .0643 | | |
| .6200 | .0613 | | |
| .6600 | .0574 | | |
| .7000 | .0524 | | |
| .7500 | .0448 | | |
| .8000 | .0359 | | |
| .8500 | .0257 | | |
| .9000 | .0145 | | |
| .9500 | .0021 | | |
| .9750 | -.0047 | | |
| 1.0000 | -.0120 | | |

TABLE III.- CROSS-PLOTTED DATA AT A REYNOLDS NUMBER OF 4.03 MILLION

(a) $c_n = 0.30$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00864 | -.1170 | -1.56 | .582 | .00882 | -.1195 | .3063 |
| .697 | .00919 | -.1280 | -1.82 | .678 | .00936 | -.1304 | .3057 |
| .716 | .00949 | -.1302 | -1.76 | .696 | .00967 | -.1327 | .3057 |
| .727 | .01057 | -.1346 | -1.86 | .709 | .01077 | -.1371 | .3056 |
| .737 | .01058 | -.1370 | -1.89 | .717 | .01077 | -.1395 | .3054 |
| .757 | .01160 | -.1410 | -1.78 | .737 | .01181 | -.1435 | .3054 |
| .776 | .01480 | -.1560 | -1.96 | .756 | .01507 | -.1588 | .3054 |

(b) $c_n = 0.35$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00869 | -.1172 | -1.12 | .582 | .00887 | -.1197 | .3574 |
| .697 | .00920 | -.1295 | -1.48 | .678 | .00937 | -.1320 | .3567 |
| .716 | .00949 | -.1321 | -1.40 | .696 | .00967 | -.1346 | .3567 |
| .727 | .01057 | -.1342 | -1.50 | .709 | .01077 | -.1367 | .3565 |
| .737 | .01064 | -.1372 | -1.56 | .717 | .01083 | -.1397 | .3563 |
| .757 | .01194 | -.1438 | -1.50 | .737 | .01215 | -.1464 | .3563 |
| .776 | .01624 | -.1565 | -1.60 | .756 | .01653 | -.1593 | .3563 |

TABLE III.- Continued

(c) $c_n = 0.40$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00878 | -.1160 | -0.66 | .582 | .00896 | -.1184 | .4084 |
| .697 | .00916 | -.1290 | -1.00 | .678 | .00933 | -.1315 | .4076 |
| .716 | .00953 | -.1300 | -1.05 | .696 | .00971 | -.1325 | .4076 |
| .727 | .01069 | -.1346 | -1.52 | .709 | .01089 | -.1371 | .4075 |
| .737 | .01069 | -.1378 | -1.28 | .717 | .01088 | -.1403 | .4072 |
| .757 | .01218 | -.1470 | -1.20 | .737 | .01240 | -.1496 | .4072 |
| .776 | .01904 | -.1600 | -1.26 | .756 | .01938 | -.1629 | .4072 |

(d) $c_n = 0.45$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00893 | -.1165 | -.21 | .582 | .00912 | -.1189 | .4595 |
| .697 | .00938 | -.1280 | -.61 | .678 | .00956 | -.1304 | .4586 |
| .716 | .00957 | -.1292 | -.69 | .696 | .00975 | -.1317 | .4586 |
| .727 | .01098 | -.1346 | -.72 | .709 | .01119 | -.1371 | .4584 |
| .737 | .01076 | -.1370 | -.90 | .717 | .01095 | -.1395 | .4581 |
| .757 | .01228 | -.1489 | -.96 | .737 | .01250 | -.1516 | .4581 |
| .776 | .02342 | -.1635 | -.92 | .756 | .02384 | -.1664 | .4581 |

TABLE III.- Continued

(e) $c_n = 0.50$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00905 | -.1180 | .26 | .582 | .00924 | -.1205 | .5105 |
| .697 | .00954 | -.1270 | -.12 | .678 | .00972 | -.1294 | .5095 |
| .716 | .00973 | -.1275 | -.29 | .696 | .00991 | -.1299 | .5095 |
| .727 | .01112 | -.1342 | -.36 | .709 | .01133 | -.1367 | .5094 |
| .737 | .01093 | -.1362 | -.51 | .717 | .01113 | -.1389 | .5090 |
| .757 | .01292 | -.1510 | -.68 | .737 | .01315 | -.1537 | .5090 |
| .776 | .02809 | -.1620 | -.48 | .756 | .02860 | -.1649 | .5090 |

(f) $c_n = 0.55$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00920 | -.1170 | .65 | .582 | .00939 | -.1195 | .5616 |
| .697 | .00978 | -.1260 | .32 | .678 | .00997 | -.1284 | .5606 |
| .716 | .00986 | -.1265 | .17 | .696 | .01005 | -.1289 | .5606 |
| .727 | .01109 | -.1289 | .09 | .709 | .01130 | -.1313 | .5603 |
| .737 | .01124 | -.1342 | -.08 | .717 | .01144 | -.1366 | .5599 |
| .757 | .01392 | -.1530 | -.31 | .737 | .01417 | -.1558 | .5599 |
| .776 | .03400 | -.1631 | 0.00 | .756 | .03461 | -.1660 | .5599 |

TABLE III.- Continued

(g) $c_n = 0.60$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00939 | -.1170 | 1.04 | .582 | .00959 | -.1195 | .6126 |
| .697 | .00989 | -.1230 | 0.68 | .678 | .01008 | -.1253 | .6114 |
| .716 | .01016 | -.1250 | 0.57 | .696 | .01035 | -.1274 | .6114 |
| .727 | .01130 | -.1280 | 0.54 | .709 | .01151 | -.1304 | .6112 |
| .737 | .01133 | -.1325 | 0.29 | .717 | .01153 | -.1349 | .6108 |
| .757 | .01514 | -.1510 | 0.09 | .737 | .01541 | -.1537 | .6108 |
| .776 | .03774 | -.1645 | 0.45 | .756 | .03842 | -.1675 | .6108 |

(h) $c_n = 0.65$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00954 | -.1170 | 1.47 | .582 | .00974 | -.1195 | .6637 |
| .697 | .01010 | -.1238 | 1.01 | .678 | .01029 | -.1262 | .6624 |
| .716 | .01048 | -.1247 | 0.97 | .696 | .01068 | -.1271 | .6624 |
| .727 | .01152 | -.1278 | 0.89 | .709 | .01174 | -.1302 | .6622 |
| .737 | .01142 | -.1330 | 0.62 | .717 | .01163 | -.1354 | .6617 |
| .757 | .01614 | -.1530 | 0.40 | .737 | .01643 | -.1558 | .6617 |
| .776 | .04200 | -.1632 | 0.94 | .756 | .04276 | -.1661 | .6617 |

TABLE III.- Continued

(i) $c_n = 0.70$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00984 | -.1167 | 1.88 | .582 | .01005 | -.1192 | .7147 |
| .697 | .01071 | -.1225 | 1.34 | .678 | .01091 | -.1248 | .7133 |
| .716 | .01113 | -.1260 | 1.24 | .696 | .01134 | -.1284 | .7133 |
| .727 | .01192 | -.1310 | 1.00 | .709 | .01214 | -.1334 | .7131 |
| .737 | .01153 | -.1342 | 0.94 | .717 | .01174 | -.1366 | .7126 |
| .757 | .01846 | -.1570 | 0.72 | .737 | .01879 | -.1598 | .7126 |
| .776 | .05460 | -.1588 | 1.58 | .756 | .05558 | -.1617 | .7126 |

(j) $c_n = 0.75$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01040 | -.1137 | 2.35 | .582 | .01062 | -.1161 | .7658 |
| .697 | .01150 | -.1227 | 1.66 | .678 | .01172 | -.1250 | .7643 |
| .716 | .01220 | -.1262 | 1.45 | .696 | .01243 | -.1286 | .7643 |
| .727 | .01250 | -.1340 | 1.36 | .709 | .01273 | -.1365 | .7640 |
| .737 | .01190 | -.1376 | 1.17 | .717 | .01213 | -.1401 | .7635 |
| .757 | .02224 | -.1580 | 1.08 | .737 | .02264 | -.1608 | .7635 |

TABLE III.- Continued

(k) $c_n = 0.80$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01129 | -.1110 | 2.87 | .582 | .01153 | -.1133 | .8168 |
| .697 | .01265 | -.1236 | 1.92 | .678 | .01289 | -.1259 | .8152 |
| .716 | .01352 | -.1275 | 1.73 | .696 | .01378 | -.1299 | .8152 |
| .727 | .01345 | -.1362 | 1.49 | .709 | .01370 | -.1387 | .8150 |
| .737 | .01310 | -.1420 | 1.47 | .717 | .01334 | -.1446 | .8144 |
| .757 | .02660 | -.1623 | 1.48 | .737 | .02708 | -.1652 | .8144 |

(l) $c_n = 0.85$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01240 | -.1082 | 3.30 | .582 | .01266 | -.1105 | .8679 |
| .697 | .01440 | -.1240 | 2.18 | .678 | .01467 | -.1264 | .8662 |
| .716 | .01544 | -.1280 | 1.92 | .696 | .01573 | -.1304 | .8662 |
| .727 | .01506 | -.1382 | 1.84 | .709 | .01534 | -.1409 | .8659 |
| .737 | .01600 | -.1460 | 1.80 | .717 | .01629 | -.1486 | .8653 |
| .757 | .03400 | -.1650 | 2.08 | .737 | .03461 | -.1680 | .8653 |

TABLE III.- Concluded

(m) $c_n = 0.90$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01408 | -.1075 | 3.70 | .582 | .01438 | -.1098 | .9189 |
| .697 | .01670 | -.1256 | 2.52 | .678 | .01702 | -.1280 | .9171 |
| .716 | .01800 | -.1300 | 2.25 | .696 | .01834 | -.1325 | .9171 |
| .727 | .01840 | -.1430 | 2.24 | .709 | .01874 | -.1457 | .9168 |
| .737 | .02090 | -.1500 | 2.18 | .717 | .02128 | -.1527 | .9162 |
| .757 | .06000 | -.1500 | ---- | .737 | .06108 | -.1527 | .9162 |

(n) $c_n = 0.95$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01618 | -.1062 | 4.20 | .582 | .01652 | -.1084 | .9700 |
| .697 | .01984 | -.1260 | 2.76 | .678 | .02022 | -.1284 | .9681 |
| .716 | .02262 | -.1342 | 2.69 | .696 | .02305 | -.1367 | .9681 |
| .727 | .02466 | -.1460 | 2.64 | .709 | .02512 | -.1487 | .9678 |
| .737 | .02800 | -.1540 | 2.68 | .717 | .02850 | -.1568 | .9671 |

(o) $c_n = 1.00$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01879 | -.1045 | 4.52 | .582 | .01910 | -.1064 | 1.0210 |
| .697 | .02400 | -.1270 | 3.08 | .678 | .02446 | -.1294 | 1.0190 |
| .716 | .02960 | -.1379 | 3.12 | .696 | .03016 | -.1405 | 1.0190 |
| .727 | .03160 | -.1480 | 3.08 | .709 | .03219 | -.1508 | 1.0187 |
| .737 | .04949 | -.1570 | 3.50 | .717 | .05038 | -.1598 | 1.0180 |

TABLE IV.- CROSS-PLOTTED DATA AT A REYNOLDS NUMBER OF 6.06 MILLION

(a) $c_n = 0.30$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00917 | -.1163 | -1.52 | .583 | .00935 | -.1186 | .3060 |
| .698 | .01002 | -.1220 | -1.53 | .680 | .01020 | -.1242 | .3054 |
| .718 | .01127 | -.1240 | -1.57 | .700 | .01147 | -.1262 | .3053 |
| .725 | .01062 | -.1278 | -1.56 | .707 | .01080 | -.1300 | .3051 |
| .738 | .01073 | -.1298 | -1.67 | .719 | .01091 | -.1320 | .3051 |
| .758 | .01150 | -.1336 | -1.72 | .739 | .01170 | -.1359 | .3051 |
| .777 | .01656 | -.1350 | -1.72 | .758 | .01684 | -.1373 | .3051 |

(b) $c_n = 0.35$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00918 | -.1172 | -1.12 | .583 | .00936 | -.1195 | .3570 |
| .698 | .01005 | -.1237 | -1.20 | .680 | .01023 | -.1259 | .3563 |
| .718 | .01196 | -.1247 | -1.25 | .700 | .01217 | -.1269 | .3562 |
| .725 | .01057 | -.1290 | -1.26 | .707 | .01075 | -.1312 | .3560 |
| .738 | .01080 | -.1300 | -1.33 | .719 | .01098 | -.1322 | .3560 |
| .758 | .01156 | -.1436 | -1.35 | .739 | .01176 | -.1460 | .3560 |
| .777 | .01736 | -.1463 | -1.39 | .758 | .01766 | -.1488 | .3560 |

TABLE IV.- Continued

(c) $c_n = 0.40$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00912 | -.1182 | -0.72 | .583 | .00930 | -.1206 | .4080 |
| .698 | .01009 | -.1246 | -0.88 | .680 | .01027 | -.1268 | .4072 |
| .718 | .01192 | -.1250 | -0.91 | .700 | .01213 | -.1272 | .4071 |
| .725 | .01054 | -.1298 | -0.93 | .707 | .01072 | -.1320 | .4068 |
| .738 | .01078 | -.1320 | -1.00 | .719 | .01096 | -.1342 | .4068 |
| .758 | .01152 | -.1360 | -1.05 | .739 | .01172 | -.1383 | .4068 |
| .777 | .01933 | -.1476 | -0.98 | .758 | .01966 | -.1501 | .4068 |

(d) $c_n = 0.45$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00927 | -.1185 | -.30 | .583 | .00946 | -.1209 | .4590 |
| .698 | .01014 | -.1250 | -.52 | .680 | .01032 | -.1273 | .4581 |
| .718 | .01053 | -.1252 | -.57 | .700 | .01072 | -.1274 | .4580 |
| .725 | .01056 | -.1300 | -.64 | .707 | .01074 | -.1322 | .4577 |
| .738 | .01079 | -.1322 | -.69 | .719 | .01097 | -.1344 | .4577 |
| .758 | .01252 | -.1393 | -.72 | .739 | .01273 | -.1417 | .4577 |
| .777 | .02269 | -.1463 | -.50 | .758 | .02308 | -.1488 | .4577 |

TABLE IV.- Continued

(e) $c_n = 0.50$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00933 | -.1189 | .14 | .583 | .00952 | -.1213 | .5100 |
| .698 | .01032 | -.1251 | -.15 | .680 | .01051 | -.1274 | .5090 |
| .718 | .01057 | -.1260 | -.19 | .700 | .01076 | -.1282 | .5089 |
| .725 | .01063 | -.1298 | -.26 | .707 | .01081 | -.1320 | .5085 |
| .738 | .01095 | -.1320 | -.36 | .719 | .01114 | -.1342 | .5085 |
| .758 | .01305 | -.1328 | -.44 | .739 | .01327 | -.1351 | .5085 |
| .777 | .02400 | -.1353 | -.15 | .758 | .02441 | -.1376 | .5085 |

(f) $c_n = 0.55$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00939 | -.1192 | .55 | .583 | .00958 | -.1216 | .5610 |
| .698 | .01050 | -.1245 | .20 | .680 | .01069 | -.1267 | .5599 |
| .718 | .01073 | -.1260 | .15 | .700 | .01092 | -.1282 | .5598 |
| .725 | .01068 | -.1293 | .08 | .707 | .01086 | -.1315 | .5594 |
| .738 | .01131 | -.1312 | 0.00 | .719 | .01150 | -.1334 | .5594 |
| .758 | .01352 | -.1430 | -.13 | .739 | .01375 | -.1454 | .5594 |
| .777 | .02933 | -.1450 | -.32 | .758 | .02983 | -.1475 | .5594 |

TABLE IV.- Continued

(g) $c_n = 0.60$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00951 | -.1198 | .94 | .583 | .00970 | -.1222 | .6120 |
| .698 | .01065 | -.1233 | .64 | .680 | .01084 | -.1255 | .6108 |
| .718 | .01079 | -.1266 | .51 | .700 | .01098 | -.1298 | .6107 |
| .725 | .01071 | -.1292 | .36 | .707 | .01089 | -.1314 | .6102 |
| .738 | .01132 | -.1308 | .29 | .719 | .01151 | -.1330 | .6102 |
| .758 | .01502 | -.1447 | .14 | .739 | .01528 | -.1472 | .6102 |
| .777 | .03128 | -.1440 | .83 | .758 | .03181 | -.1464 | .6102 |

(h) $c_n = 0.65$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00971 | -.1199 | 1.35 | .583 | .00990 | -.1223 | .6630 |
| .698 | .01093 | -.1230 | 0.95 | .680 | .01113 | -.1252 | .6617 |
| .718 | .01116 | -.1257 | 0.87 | .700 | .01136 | -.1279 | .6616 |
| .725 | .01096 | -.1289 | 0.64 | .707 | .01115 | -.1311 | .6611 |
| .738 | .01133 | -.1313 | 0.71 | .719 | .01152 | -.1335 | .6611 |
| .758 | .01657 | -.1466 | 0.51 | .739 | .01685 | -.1491 | .6611 |
| .777 | .03800 | -.1450 | 1.32 | .758 | .03865 | -.1475 | .6611 |

TABLE IV.- Continued

(i) $c_n = 0.70$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00985 | -.1199 | 1.72 | .583 | .01005 | -.1223 | .7140 |
| .698 | .01140 | -.1222 | 1.31 | .680 | .01161 | -.1244 | .7126 |
| .718 | .01166 | -.1248 | 1.16 | .700 | .01187 | -.1270 | .7125 |
| .725 | .01132 | -.1294 | 1.00 | .707 | .01151 | -.1316 | .7119 |
| .738 | .01139 | -.1328 | 0.94 | .719 | .01158 | -.1351 | .7119 |
| .758 | .01768 | -.1472 | 0.84 | .739 | .01798 | -.1497 | .7119 |

(j) $c_n = 0.75$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01017 | -.1192 | 2.14 | .583 | .01037 | -.1216 | .7650 |
| .698 | .01217 | -.1222 | 1.57 | .680 | .01239 | -.1244 | .7635 |
| .718 | .01237 | -.1261 | 1.44 | .700 | .01259 | -.1283 | .7634 |
| .725 | .01178 | -.1318 | 1.33 | .707 | .01198 | -.1340 | .7628 |
| .738 | .01214 | -.1340 | 1.28 | .719 | .01235 | -.1363 | .7628 |
| .758 | .02040 | -.1490 | 1.30 | .739 | .02075 | -.1515 | .7628 |

TABLE IV.- Continued

(k) $c_n = 0.80$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01089 | -.1189 | 2.56 | .583 | .01111 | -.1202 | .8160 |
| .698 | .01334 | -.1228 | 1.91 | .680 | .01358 | -.1250 | .8144 |
| .718 | .01365 | -.1278 | 1.72 | .700 | .01389 | -.1301 | .8142 |
| .725 | .01275 | -.1337 | 1.64 | .707 | .01297 | -.1360 | .8136 |
| .738 | .01336 | -.1373 | 1.53 | .719 | .01359 | -.1396 | .8136 |
| .758 | .03133 | -.1503 | 2.00 | .739 | .03186 | -.1529 | .8136 |

(l) $c_n = 0.85$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01169 | -.1140 | 2.98 | .583 | .01192 | -.1163 | .8670 |
| .698 | .01504 | -.1237 | 2.19 | .680 | .01531 | -.1259 | .8653 |
| .718 | .01552 | -.1301 | 2.00 | .700 | .01580 | -.1324 | .8651 |
| .725 | .01500 | -.1378 | 1.88 | .707 | .01526 | -.1401 | .8645 |
| .738 | .01822 | -.1428 | 1.92 | .719 | .01853 | -.1452 | .8645 |
| .758 | .03492 | -.1525 | 2.48 | .739 | .03551 | -.1551 | .8645 |

TABLE IV.- Concluded

(m) $c_n = 0.90$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01313 | -.1140 | 3.37 | .583 | .01339 | -.1163 | .9180 |
| .698 | .01736 | -.1247 | 2.51 | .680 | .01767 | -.1269 | .9162 |
| .718 | .01840 | -.1331 | 2.26 | .700 | .01873 | -.1355 | .9160 |
| .725 | .01880 | -.1400 | 2.21 | .707 | .01912 | -.1424 | .9153 |
| .738 | .02372 | -.1483 | 2.29 | .719 | .02412 | -.1508 | .9153 |

(n) $c_n = 0.95$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01503 | -.1128 | 1.76 | .583 | .01533 | -.1151 | .9690 |
| .698 | .02098 | -.1250 | 2.73 | .680 | .02136 | -.1273 | .9671 |
| .718 | .02346 | -.1355 | 2.62 | .700 | .02388 | -.1379 | .9669 |
| .725 | .02472 | -.1440 | 2.55 | .707 | .02514 | -.1464 | .9662 |
| .738 | .03000 | -.1500 | 2.80 | .719 | .03051 | -.1526 | .9662 |

(o) $c_n = 1.00$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01733 | -.1100 | 4.09 | .583 | .01768 | -.1122 | 1.0200 |
| .698 | .02609 | -.1262 | 3.10 | .680 | .02656 | -.1285 | 1.0180 |
| .718 | .03076 | -.1387 | 3.10 | .700 | .03131 | -.1412 | 1.0178 |
| .725 | .03600 | -.1480 | 3.12 | .707 | .03661 | -.1505 | 1.0170 |

TABLE V.- CROSS-PLOTTED DATA AT A REYNOLDS NUMBER OF 10.06 MILLION

(a) $c_n = 0.30$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00862 | −.1150 | −1.60 | .584 | .00878 | −.1171 | .3054 |
| .651 | .00876 | −.1200 | −1.57 | .634 | .00891 | −.1220 | .3051 |
| .700 | .00936 | −.1252 | −1.69 | .683 | .00952 | −.1273 | .3051 |
| .721 | .00937 | −.1278 | −1.69 | .704 | .00952 | −.1298 | .3048 |
| .732 | .00973 | −.1292 | −1.65 | .715 | .00989 | −.1313 | .3048 |
| .740 | .00971 | −.1296 | −1.60 | .723 | .00990 | −.1317 | .3048 |
| .750 | .00976 | −.1300 | −1.70 | .733 | .00992 | −.1321 | .3048 |
| .760 | .01026 | −.1339 | −1.70 | .743 | .01042 | −.1360 | .3048 |
| .769 | .01105 | −.1378 | −1.73 | .752 | .01123 | −.1400 | .3048 |
| .779 | .01315 | −.1430 | −1.69 | .762 | .01336 | −.1453 | .3048 |

(b) $c_n = 0.35$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00865 | −.1166 | −1.25 | .584 | .00881 | −.1187 | .3563 |
| .651 | .00879 | −.1210 | −1.20 | .634 | .00894 | −.1231 | .3560 |
| .700 | .00949 | −.1278 | −1.32 | .683 | .00965 | −.1300 | .3560 |
| .721 | .00944 | −.1280 | −1.32 | .704 | .00959 | −.1300 | .3556 |
| .732 | .00975 | −.1292 | −1.28 | .715 | .00991 | −.1313 | .3556 |
| .740 | .00980 | −.1300 | −1.29 | .723 | .00996 | −.1321 | .3556 |
| .750 | .00984 | −.1324 | −1.37 | .733 | .01000 | −.1345 | .3556 |
| .760 | .01046 | −.1349 | −1.39 | .743 | .01063 | −.1371 | .3556 |
| .769 | .01149 | −.1392 | −1.42 | .752 | .01167 | −.1414 | .3556 |
| .779 | .01408 | −.1462 | −1.37 | .762 | .01431 | −.1485 | .3556 |

TABLE V.- Continued

(c) $c_n = 0.40$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00869 | -.1180 | -0.84 | .584 | .00885 | -.1201 | .4072 |
| .651 | .00884 | -.1210 | -0.80 | .634 | .00899 | -.1231 | .4068 |
| .700 | .00925 | -.1268 | -0.96 | .683 | .00941 | -.1290 | .4068 |
| .721 | .00949 | -.1292 | -1.00 | .704 | .00964 | -.1313 | .4064 |
| .732 | .00976 | -.1300 | -0.92 | .715 | .00992 | -.1321 | .4064 |
| .740 | .00980 | -.1308 | -1.00 | .723 | .00996 | -.1329 | .4064 |
| .750 | .00996 | -.1332 | -1.02 | .733 | .01012 | -.1353 | .4064 |
| .760 | .01056 | -.1352 | -1.06 | .743 | .01073 | -.1374 | .4064 |
| .769 | .01216 | -.1432 | -1.09 | .752 | .01235 | -.1455 | .4064 |
| .779 | .01489 | -.1483 | -0.97 | .762 | .01513 | -.1507 | .4064 |

(d) $c_n = 0.45$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00876 | -.1183 | -.46 | .584 | .00892 | -.1204 | .4580 |
| .651 | .00889 | -.1226 | -.40 | .634 | .00904 | -.1247 | .4577 |
| .700 | .00957 | -.1276 | -.61 | .683 | .00973 | -.1298 | .4577 |
| .721 | .00959 | -.1282 | -.61 | .704 | .00974 | -.1303 | .4572 |
| .732 | .00983 | -.1300 | -.57 | .715 | .00999 | -.1321 | .4572 |
| .740 | .00980 | -.1309 | -.61 | .723 | .00996 | -.1330 | .4572 |
| .750 | .01016 | -.1340 | -.69 | .733 | .01032 | -.1361 | .4572 |
| .760 | .01097 | -.1372 | -.69 | .743 | .01115 | -.1394 | .4572 |
| .769 | .01310 | -.1460 | -.74 | .752 | .01331 | -.1483 | .4572 |
| .779 | .01796 | -.1480 | -.66 | .762 | .01825 | -.1504 | .4572 |

TABLE V.- Continued

(e) $c_n = 0.50$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00885 | -.1191 | 0.00 | .584 | .00901 | -.1212 | .5090 |
| .651 | .00897 | -.1230 | -.09 | .634 | .00912 | -.1251 | .5085 |
| .700 | .00960 | -.1280 | -.25 | .683 | .00976 | -.1302 | .5085 |
| .721 | .00973 | -.1292 | -.30 | .704 | .00989 | -.1313 | .5080 |
| .732 | .00989 | -.1300 | -.17 | .715 | .01005 | -.1321 | .5080 |
| .740 | .00984 | -.1312 | -.29 | .723 | .00984 | -.1333 | .5080 |
| .750 | .01040 | -.1342 | -.36 | .733 | .01057 | -.1363 | .5080 |
| .760 | .01151 | -.1392 | -.40 | .743 | .01169 | -.1414 | .5080 |
| .769 | .01408 | -.1480 | -.44 | .752 | .01431 | -.1504 | .5080 |
| .779 | .02176 | -.1478 | -.22 | .762 | .02211 | -.1502 | .5080 |

(f) $c_n = 0.55$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00896 | -.1196 | .48 | .584 | .00912 | -.1218 | .5599 |
| .651 | .00910 | -.1238 | .38 | .634 | .00925 | -.1259 | .5594 |
| .700 | .00960 | -.1276 | .14 | .683 | .00976 | -.1298 | .5594 |
| .721 | .00989 | -.1300 | .05 | .704 | .01005 | -.1321 | .5588 |
| .732 | .01003 | -.1315 | .15 | .715 | .01019 | -.1336 | .5588 |
| .740 | .01005 | -.1324 | 0.00 | .723 | .01021 | -.1345 | .5588 |
| .750 | .01084 | -.1364 | -.07 | .733 | .01101 | -.1386 | .5588 |
| .760 | .01216 | -.1420 | -.13 | .743 | .01235 | -.1443 | .5588 |
| .769 | .01520 | -.1480 | -.10 | .752 | .01544 | -.1504 | .5588 |
| .779 | .02516 | -.1478 | -.16 | .762 | .02556 | -.01502 | .5588 |

TABLE V.- Continued

(g) $c_n = 0.60$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00911 | -.1200 | .89 | .584 | .00927 | -.1222 | .6108 |
| .651 | .00925 | -.1235 | .76 | .634 | .00941 | -.1256 | .6102 |
| .700 | .00969 | -.1261 | .49 | .683 | .00985 | -.1282 | .6102 |
| .721 | .01010 | -.1296 | .37 | .704 | .01026 | -.1317 | .6096 |
| .732 | .01050 | -.1320 | .50 | .715 | .01067 | -.1341 | .6096 |
| .740 | .01022 | -.1310 | .32 | .723 | .01038 | -.1331 | .6096 |
| .750 | .01103 | -.1355 | .25 | .733 | .01121 | -.1377 | .6096 |
| .760 | .01310 | -.1448 | .25 | .743 | .01331 | -.1471 | .6096 |
| .769 | .01787 | -.1482 | .20 | .752 | .01816 | -.1506 | .6096 |
| .779 | .02680 | -.1482 | .64 | .762 | .02723 | -.1506 | .6096 |

(h) $c_n = 0.65$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00920 | -.1190 | 0.88 | .584 | .00937 | -.1211 | .6617 |
| .651 | .00946 | -.1230 | 1.16 | .634 | .00962 | -.1251 | .6611 |
| .700 | .00992 | -.1270 | .84 | .683 | .01009 | -.1292 | .6611 |
| .721 | .01045 | -.1290 | .69 | .704 | .01062 | -.1311 | .6604 |
| .732 | .01068 | -.1300 | .76 | .715 | .01085 | -.1321 | .6604 |
| .740 | .01038 | -.1300 | .61 | .723 | .01055 | -.1321 | .6604 |
| .750 | .01139 | -.1348 | .58 | .733 | .01157 | -.1370 | .6604 |
| .760 | .01480 | -.1460 | .51 | .743 | .01504 | -.1483 | .6604 |
| .769 | .02013 | -.1478 | -.60 | .752 | .02045 | -.1502 | .6604 |

TABLE V.- Continued

(i) $c_n = 0.70$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00941 | -.1180 | 1.71 | .584 | .00958 | -.1201 | .7126 |
| .651 | .00990 | -.1220 | 1.56 | .634 | .01007 | -.1241 | .7119 |
| .700 | .01036 | -.1260 | 1.17 | .683 | .01054 | -.1281 | .7119 |
| .721 | .01098 | -.1282 | 1.06 | .704 | .01116 | -.1303 | .7112 |
| .732 | .01102 | -.1292 | 1.03 | .715 | .01120 | -.1313 | .7112 |
| .740 | .01061 | -.1310 | 0.94 | .723 | .01078 | -.1331 | .7112 |
| .750 | .01189 | -.1342 | 0.89 | .733 | .01208 | -.1363 | .7112 |
| .760 | .01620 | -.1456 | 0.96 | .743 | .01646 | -.1479 | .7112 |
| .769 | .02276 | -.1476 | 1.08 | .752 | .02312 | -.1500 | .7112 |

(j) $c_n = 0.75$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00974 | -.1176 | 2.12 | .584 | .00992 | -.1197 | .7635 |
| .651 | .01058 | -.1210 | 1.92 | .634 | .01076 | -.1231 | .7628 |
| .700 | .01109 | -.1245 | 1.51 | .683 | .01128 | -.1266 | .7628 |
| .721 | .01180 | -.1281 | 1.34 | .704 | .01199 | -.1301 | .7620 |
| .732 | .01121 | -.1296 | 1.37 | .715 | .01139 | -.1317 | .7620 |
| .740 | .01129 | -.1340 | 1.28 | .723 | .01147 | -.1361 | .7620 |
| .750 | .01280 | -.1372 | 1.20 | .733 | .01300 | -.1394 | .7620 |
| .760 | .01865 | -.1451 | 1.36 | .743 | .01895 | -.1474 | .7620 |
| .769 | .02874 | -.1485 | 1.69 | .752 | .02920 | -.1509 | .7620 |

TABLE V.- Continued

(k) $c_n = 0.80$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01019 | -.1190 | 2.53 | .584 | .01037 | -.1211 | .8144 |
| .651 | .01158 | -.1180 | 2.30 | .634 | .01178 | -.1200 | .8136 |
| .700 | .01250 | -.1248 | 1.84 | .683 | .01271 | -.1269 | .8136 |
| .721 | .01302 | -.1280 | 1.60 | .704 | .01323 | -.1300 | .8128 |
| .732 | .01161 | -.1310 | 1.68 | .715 | .01180 | -.1331 | .8128 |
| .740 | .01275 | -.1370 | 1.58 | .723 | .01295 | -.1392 | .8128 |
| .750 | .01492 | -.1432 | 1.60 | .733 | .01516 | -.1455 | .8128 |
| .760 | .02156 | -.1500 | 1.72 | .743 | .02190 | -.1524 | .8128 |

(l) $c_n = 0.85$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01120 | -.1150 | 2.96 | .584 | .01140 | -.1171 | .8653 |
| .651 | .01296 | -.1168 | 2.69 | .634 | .01318 | -.1188 | .8645 |
| .700 | .01440 | -.1240 | 2.12 | .683 | .01464 | -.1261 | .8645 |
| .721 | .01492 | -.1286 | 1.84 | .704 | .01516 | -.1307 | .8636 |
| .732 | .01292 | -.1336 | 1.92 | .715 | .01313 | -.1357 | .8636 |
| .740 | .01568 | -.1420 | 1.92 | .723 | .01593 | -.1443 | .8636 |
| .750 | .02007 | -.1458 | 2.00 | .733 | .02039 | -.1481 | .8636 |

TABLE V.- Concluded

(m) $c_n = 0.90$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01270 | -.1136 | 3.34 | .584 | .01293 | -.1156 | .9162 |
| .651 | .01455 | -.1152 | 2.99 | .634 | .01480 | -.1172 | .9153 |
| .700 | .01680 | -.1240 | 2.36 | .683 | .01709 | -.1261 | .9153 |
| .721 | .01760 | -.1332 | 2.22 | .704 | .01788 | -.1353 | .9144 |
| .732 | .01770 | -.1376 | 2.25 | .715 | .01798 | -.1398 | .9144 |
| .740 | .02086 | -.1442 | 2.32 | .723 | .02119 | -.1465 | .9144 |
| .750 | .03200 | -.1470 | 2.64 | .733 | .03251 | -.1494 | .9144 |

(n) $c_n = 0.95$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01461 | -.1100 | 3.72 | .584 | .01487 | -.1120 | .9671 |
| .651 | .01672 | -.1130 | 3.44 | .634 | .01700 | -.1149 | .9662 |
| .700 | .02025 | -.1240 | 2.72 | .683 | .02059 | -.1261 | .9662 |
| .721 | .02240 | -.1350 | 2.64 | .704 | .02276 | -.1372 | .9652 |
| .732 | .02500 | -.1430 | 2.68 | .715 | .02540 | -.1453 | .9652 |
| .740 | .03210 | -.1440 | 2.97 | .723 | .03261 | -.1463 | .9652 |

(o) $c_n = 1.00$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01694 | -.1090 | 4.12 | .584 | .01724 | -.1110 | 1.018 |
| .651 | .01949 | -.1126 | 3.72 | .634 | .01982 | -.1145 | 1.017 |
| .700 | .02458 | -.1238 | 3.12 | .683 | .02500 | -.1259 | 1.017 |
| .721 | .03080 | -.1360 | 3.17 | .704 | .03129 | -.1382 | 1.016 |

TABLE VI.- CROSS-PLOTTED DATA AT A REYNOLDS NUMBER OF 15.01 MILLION

(a) $c_n = 0.30$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00821 | -.1176 | -1.57 | .585 | .00835 | -.1196 | .3051 |
| .650 | .00838 | -.1240 | -1.68 | .634 | .00851 | -.1260 | .3048 |
| .700 | .00899 | -.1296 | -1.69 | .684 | .00899 | -.1317 | .3048 |
| .720 | .00902 | -.1318 | -1.74 | .704 | .00916 | -.1338 | .3045 |
| .728 | .00956 | -.1328 | -1.74 | .712 | .00970 | -.1348 | .3045 |
| .739 | .00953 | -.1342 | -1.78 | .723 | .00967 | -.1362 | .3045 |
| .749 | .00973 | -.1367 | -1.78 | .733 | .00988 | -.1388 | .3045 |
| .758 | .00985 | -.1368 | -1.69 | .742 | .01000 | -.1389 | .3045 |
| .768 | .01069 | -.1389 | -1.72 | .752 | .01085 | -.1410 | .3045 |
| .778 | .01224 | -.1447 | -1.72 | .762 | .01242 | -.1469 | .3045 |

(b) $c_n = 0.35$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00826 | -.1183 | -1.14 | .585 | .00840 | -.1203 | .3560 |
| .650 | .00845 | -.1248 | -1.27 | .634 | .00856 | -.1268 | .3556 |
| .700 | .00902 | -.1297 | -1.36 | .684 | .00916 | -.1318 | .3556 |
| .720 | .00906 | -.1326 | -1.39 | .704 | .00920 | -.1346 | .3533 |
| .728 | .01009 | -.1339 | -1.41 | .712 | .01024 | -.1359 | .3533 |
| .739 | .00968 | -.1341 | -1.46 | .723 | .00983 | -.1361 | .3533 |
| .749 | .00985 | -.1375 | -1.45 | .733 | .01000 | -.1396 | .3533 |
| .758 | .00995 | -.1378 | -1.41 | .742 | .01010 | -.1399 | .3533 |
| .768 | .01107 | -.1420 | -1.02 | .752 | .01124 | -.1441 | .3533 |
| .778 | .01288 | -.1476 | -1.36 | .762 | .01307 | -.1498 | .3533 |

TABLE VI.- Continued

(c) $c_n = 0.40$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00832 | -.1198 | -0.73 | .585 | .00846 | -.1218 | .4068 |
| .650 | .00852 | -.1250 | -0.87 | .634 | .00866 | -.1270 | .4064 |
| .700 | .00905 | -.1300 | -1.01 | .684 | .00915 | -.1321 | .4064 |
| .720 | .00916 | -.1330 | -1.02 | .704 | .00930 | -.1350 | .4060 |
| .728 | .01027 | -.1340 | -1.10 | .712 | .01042 | -.1360 | .4060 |
| .739 | .00976 | -.1349 | -1.16 | .723 | .00991 | -.1369 | .4060 |
| .749 | .01000 | -.1389 | -1.11 | .733 | .01015 | -.1410 | .4060 |
| .758 | .01021 | -.1390 | -1.11 | .742 | .01036 | -.1411 | .4060 |
| .768 | .01193 | -.1443 | -1.10 | .752 | .01211 | -.1465 | .4060 |
| .778 | .01464 | -.1492 | -1.04 | .762 | .01486 | -.1514 | .4060 |

(d) $c_n = 0.45$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00840 | -.1210 | -.32 | .585 | .00854 | -.1231 | .4577 |
| .650 | .00856 | -.1250 | -.50 | .634 | .00870 | -.1270 | .4572 |
| .700 | .00916 | -.1300 | -.65 | .684 | .00931 | -.1321 | .4572 |
| .720 | .00929 | -.1334 | -.68 | .704 | .00943 | -.1354 | .4568 |
| .728 | .01017 | -.1348 | -.78 | .712 | .01032 | -.1368 | .4568 |
| .739 | .00993 | -.1350 | -.84 | .723 | .01008 | -.1370 | .4568 |
| .749 | .01020 | -.1400 | -.80 | .733 | .01035 | -.1421 | .4568 |
| .758 | .01057 | -.1411 | -.79 | .742 | .01073 | -.1432 | .4568 |
| .768 | .01236 | -.1460 | -.80 | .752 | .01255 | -.1480 | .4568 |
| .778 | .01640 | -.1512 | -.72 | .762 | .01665 | -.1535 | .4568 |

TABLE VI.- Continued

(e) $c_n = 0.50$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00846 | -.1211 | .05 | .585 | .00860 | -.1232 | .5085 |
| .650 | .00859 | -.1250 | -.14 | .634 | .00873 | -.1270 | .5080 |
| .700 | .00928 | -.1312 | -.28 | .684 | .00943 | -.1333 | .5080 |
| .720 | .00941 | -.1340 | -.32 | .704 | .00955 | -.1360 | .5075 |
| .728 | .00970 | -.1353 | -.47 | .712 | .00985 | -.1375 | .5075 |
| .739 | .01012 | -.1362 | -.52 | .723 | .01027 | -.1382 | .5075 |
| .749 | .01046 | -.1418 | -.49 | .733 | .01062 | -.1439 | .5075 |
| .758 | .01104 | -.1430 | -.49 | .742 | .01121 | -.1451 | .5075 |
| .768 | .01374 | -.1478 | -.49 | .752 | .01395 | -.1500 | .5075 |
| .778 | .01796 | -.1529 | -.30 | .762 | .01823 | -.1552 | .5075 |

(f) $c_n = 0.55$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00857 | -.1212 | .47 | .585 | .00872 | -.1233 | .5594 |
| .650 | .00870 | -.1253 | .24 | .634 | .00884 | -.1273 | .5588 |
| .700 | .00941 | -.1324 | .04 | .684 | .00941 | -.1345 | .5588 |
| .720 | .00956 | -.1340 | -.01 | .704 | .00970 | -.1360 | .5583 |
| .728 | .00985 | -.1356 | -.12 | .712 | .01000 | -.1376 | .5583 |
| .739 | .01039 | -.1360 | -.14 | .723 | .01055 | -.1380 | .5583 |
| .749 | .01095 | -.1428 | -.18 | .733 | .01111 | -.1449 | .5583 |
| .758 | .01157 | -.1448 | -.16 | .742 | .01174 | -.1470 | .5583 |
| .768 | .01595 | -.1500 | -.15 | .752 | .01619 | -.1523 | .5583 |
| .778 | .01636 | -.1530 | -.12 | .762 | .01661 | -.1553 | .5583 |

TABLE VI.- Continued

(g) $c_n = 0.60$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00865 | -.1218 | .84 | .585 | .00880 | -.1239 | .6102 |
| .650 | .00891 | -.1252 | .64 | .634 | .00905 | -.1272 | .6096 |
| .700 | .00953 | -.1331 | .40 | .684 | .00968 | -.1352 | .6096 |
| .720 | .00978 | -.1342 | .32 | .704 | .00993 | -.1362 | .6090 |
| .728 | .01008 | -.1350 | .18 | .712 | .01023 | -.1370 | .6090 |
| .739 | .01066 | -.1368 | .19 | .723 | .01082 | -.1389 | .6090 |
| .749 | .01166 | -.1449 | .15 | .733 | .01183 | -.1471 | .6090 |
| .758 | .01280 | -.1465 | .13 | .742 | .01299 | -.1487 | .6090 |
| .768 | .01834 | -.1521 | .16 | .752 | .01862 | -.1544 | .6090 |
| .778 | .02626 | -.1498 | .53 | .762 | .02665 | -.1520 | .6090 |

(h) $c_n = 0.65$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00876 | -.1220 | 1.20 | .585 | .00891 | -.1241 | .6611 |
| .650 | .00914 | -.1245 | 1.04 | .634 | .00929 | -.1265 | .6604 |
| .700 | .00986 | -.1320 | 0.74 | .684 | .01002 | -.1341 | .6604 |
| .720 | .01014 | -.1330 | 0.65 | .704 | .01029 | -.1350 | .6598 |
| .728 | .01032 | -.1350 | 0.52 | .712 | .01047 | -.1370 | .6598 |
| .739 | .01090 | -.1362 | 0.54 | .723 | .01106 | -.1382 | .6598 |
| .749 | .01266 | -.1460 | 0.44 | .733 | .01285 | -.1482 | .6598 |
| .758 | .01422 | -.1468 | 0.50 | .742 | .01443 | -.1490 | .6598 |
| .768 | .02049 | -.1519 | 0.58 | .752 | .02080 | -.1542 | .6598 |
| .778 | .02747 | -.1479 | 1.00 | .762 | .02788 | -.1501 | .6598 |

TABLE VI.- Continued

(i) $c_n = 0.70$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00895 | -.1210 | 1.64 | .585 | .00910 | -.1231 | .7119 |
| .650 | .00946 | -.1238 | 1.40 | .634 | .00961 | -.1258 | .7112 |
| .700 | .01040 | -.1308 | 1.08 | .684 | .01057 | -.1329 | .7112 |
| .720 | .01059 | -.1307 | 1.01 | .704 | .01075 | -.1327 | .7105 |
| .728 | .01059 | -.1350 | 0.84 | .712 | .01075 | -.1370 | .7105 |
| .739 | .01133 | -.1386 | 0.77 | .723 | .01150 | -.1407 | .7105 |
| .749 | .01450 | -.1488 | 0.74 | .733 | .01472 | -.1510 | .7105 |
| .758 | .01529 | -.1498 | 0.89 | .742 | .01552 | -.1520 | .7105 |
| .768 | .02219 | -.1511 | 0.99 | .752 | .02252 | -.1534 | .7105 |
| .778 | .03668 | -.1470 | 1.52 | .762 | .03723 | -.1492 | .7195 |

(j) $c_n = 0.75$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00926 | -.1210 | 2.05 | .585 | .00942 | -.1231 | .7628 |
| .650 | .01005 | -.1225 | 1.80 | .634 | .01021 | -.1245 | .7620 |
| .700 | .01106 | -.1305 | 1.46 | .684 | .01124 | -.1326 | .7620 |
| .720 | .01114 | -.1301 | 1.34 | .704 | .01131 | -.1331 | .7613 |
| .728 | .01104 | -.1362 | 1.12 | .712 | .01121 | -.1382 | .7613 |
| .739 | .01191 | -.1420 | 1.04 | .723 | .01209 | -.1441 | .7613 |
| .749 | .01646 | -.1518 | 1.09 | .733 | .01671 | -.1541 | .7613 |
| .758 | .01650 | -.1520 | 1.27 | .742 | .01675 | -.1543 | .7613 |
| .768 | .02900 | -.1473 | 1.72 | .752 | .02944 | -.1495 | .7613 |

TABLE VI.- Continued

(k) $c_n = 0.80$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .00974 | -.1200 | 2.48 | .585 | .00991 | -.1220 | .8136 |
| .650 | .01089 | -.1210 | 2.16 | .634 | .01106 | -.1229 | .8128 |
| .700 | .01229 | -.1296 | 1.73 | .684 | .01249 | -.1317 | .8128 |
| .720 | .01184 | -.1338 | 1.60 | .704 | .01202 | -.1358 | .8120 |
| .728 | .01200 | -.1398 | 1.44 | .712 | .01218 | -.1419 | .8120 |
| .739 | .01336 | -.1436 | 1.40 | .723 | .01356 | -.1458 | .8120 |
| .749 | .01843 | -.1532 | 1.51 | .733 | .01871 | -.1555 | .8120 |
| .758 | .02059 | -.1533 | 1.69 | .742 | .02090 | -.1556 | .8120 |

(l) $c_n = 0.85$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01049 | -.1176 | 2.88 | .585 | .01067 | -.1196 | .8645 |
| .650 | .01208 | -.1185 | 2.57 | .634 | .01227 | -.1204 | .8636 |
| .700 | .01404 | -.1265 | 2.02 | .684 | .01426 | -.1285 | .8636 |
| .720 | .01320 | -.1350 | 1.84 | .704 | .01340 | -.1350 | .8628 |
| .728 | .01370 | -.1420 | 1.72 | .712 | .01399 | -.1441 | .8628 |
| .739 | .01798 | -.1460 | 1.77 | .723 | .01825 | -.1482 | .8628 |
| .749 | .03100 | -.1500 | 2.44 | .733 | .03147 | -.1523 | .8628 |

TABLE VI.- Continued

(m) $c_n = 0.90$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01173 | -.1160 | 3.32 | .585 | .01193 | -.1180 | .9153 |
| .650 | .01373 | -.1163 | 2.94 | .634 | .01395 | -.1182 | .9144 |
| .700 | .01656 | -.1263 | 2.28 | .684 | .01682 | -.1283 | .9144 |
| .720 | .01585 | -.1380 | 2.09 | .704 | .01609 | -.1401 | .9135 |
| .728 | .01649 | -.1432 | 2.01 | .712 | .01674 | -.1453 | .9135 |
| .739 | .02400 | -.1496 | 2.27 | .723 | .02436 | -.1518 | .9135 |
| .749 | .04060 | -.1460 | 3.01 | .733 | .04121 | -.1482 | .9135 |

(n) $c_n = 0.95$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01360 | -.1135 | 3.72 | .585 | .01383 | -.1154 | .9662 |
| .650 | .01611 | -.1150 | 3.33 | .634 | .01637 | -.1168 | .9652 |
| .700 | .01991 | -.1292 | 2.57 | .684 | .02023 | -.1312 | .9652 |
| .720 | .02100 | -.1401 | 2.52 | .704 | .02132 | -.1422 | .9643 |
| .728 | .02296 | -.1480 | 2.51 | .712 | .02330 | -.1502 | .9643 |
| .739 | .05008 | -.1412 | 3.52 | .723 | .05083 | -.1433 | .9643 |

TABLE VI.- Concluded

(o) $c_n = 1.00$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01609 | -.1110 | 4.16 | .585 | .01636 | -.1129 | 1.017 |
| .650 | .01900 | -.1139 | 3.69 | .634 | .01930 | -.1157 | 1.016 |
| .700 | .02456 | -.1336 | 2.93 | .684 | .02495 | -.1357 | 1.016 |
| .720 | .03009 | -.1430 | 2.59 | .704 | .03054 | -.1451 | 1.015 |
| .728 | .03400 | -.1455 | 3.24 | .712 | .03451 | -.1477 | 1.015 |

(p) $c_n = 1.05$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .600 | .01937 | -.1082 | 4.47 | .585 | .01970 | -.1100 | 1.0679 |
| .650 | .02200 | -.1040 | 4.05 | .634 | .02235 | -.1057 | 1.0668 |
| .700 | .03336 | -.1320 | 3.49 | .684 | .03389 | -.1341 | 1.0668 |
| .720 | .04624 | -.1392 | 4.00 | .704 | .04693 | -.1413 | 1.0658 |

TABLE VII.- CROSS-PLOTTED DATA AT A REYNOLDS NUMBER OF 30.11 MILLION

(a) $c_n = 0.30$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00746 | -.1222 | -1.77 | .587 | .00758 | -.1242 | .3048 |
| .651 | .00760 | -.1250 | -1.82 | .637 | .00771 | -.1269 | .3045 |
| .701 | .00789 | -.1330 | -1.86 | .686 | .00800 | -.1349 | .3042 |
| .719 | .00796 | -.1339 | -1.85 | .704 | .00807 | -.1358 | .3042 |
| .729 | .00814 | -.1360 | -1.78 | .714 | .00825 | -.1379 | .3042 |
| .739 | .00823 | -.1370 | -1.84 | .724 | .00835 | -.1389 | .3042 |
| .749 | .00844 | -.1389 | -1.84 | .734 | .00856 | -.1408 | .3042 |
| .760 | .00895 | -.1400 | -1.86 | .745 | .00908 | -.1420 | .3042 |
| .767 | .01019 | -.1482 | -1.89 | .752 | .01033 | -.1503 | .3042 |
| .779 | .01259 | -.1528 | -1.85 | .764 | .01277 | -.1549 | .3042 |

(b) $c_n = 0.35$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00750 | -.1232 | -1.39 | .587 | .00762 | -.1252 | .3556 |
| .651 | .00773 | -.1260 | -1.48 | .637 | .00785 | -.1279 | .3553 |
| .701 | .00784 | -.1340 | -1.49 | .686 | .00795 | -.1359 | .3549 |
| .719 | .00808 | -.1345 | -1.49 | .704 | .00819 | -.1364 | .3549 |
| .729 | .00818 | -.1368 | -1.47 | .714 | .00829 | -.1387 | .3549 |
| .739 | .00834 | -.1380 | -1.52 | .724 | .00846 | -.1399 | .3549 |
| .749 | .00858 | -.1420 | -1.46 | .734 | .00870 | -.1440 | .3549 |
| .760 | .00910 | -.1436 | -1.54 | .745 | .00923 | -.1456 | .3549 |
| .767 | .01072 | -.1489 | -1.54 | .752 | .01087 | -.1510 | .3549 |
| .779 | .01372 | -.1553 | -1.47 | .764 | .01391 | -.1575 | .3549 |

TABLE VII.- Continued

(c) $c_n = 0.40$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00760 | -.1240 | -0.96 | .587 | .00772 | -.1260 | .4064 |
| .651 | .00777 | -.1266 | -1.08 | .637 | .00789 | -.1285 | .4060 |
| .701 | .00789 | -.1345 | -1.14 | .686 | .00800 | -.1364 | .4056 |
| .719 | .00812 | -.1354 | -1.13 | .704 | .00823 | -.1373 | .4056 |
| .729 | .00827 | -.1376 | -1.08 | .714 | .00839 | -.1395 | .4056 |
| .739 | .00849 | -.1389 | -1.28 | .724 | .00861 | -.1408 | .4056 |
| .749 | .00873 | -.1435 | -1.20 | .734 | .00885 | -.1455 | .4056 |
| .760 | .00934 | -.1450 | -1.69 | .745 | .00947 | -.1470 | .4056 |
| .767 | .01146 | -.1523 | -1.32 | .752 | .01162 | -.1544 | .4056 |
| .779 | .01494 | -.1576 | -1.11 | .764 | .01515 | -.1576 | .4056 |

(d) $c_n = 0.45$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00762 | -.1241 | -.57 | .587 | .00774 | -.1261 | .4572 |
| .651 | .00786 | -.1266 | -.70 | .637 | .00798 | -.1285 | .4568 |
| .701 | .00800 | -.1348 | -.80 | .686 | .00811 | -.1367 | .4563 |
| .719 | .00817 | -.1360 | -.75 | .704 | .00828 | -.1379 | .4563 |
| .729 | .00834 | -.1378 | -.72 | .714 | .00846 | -.1397 | .4563 |
| .739 | .00857 | -.1400 | -.93 | .724 | .00869 | -.1420 | .4563 |
| .749 | .00904 | -.1442 | -.87 | .734 | .00917 | -.1462 | .4563 |
| .760 | .00981 | -.1470 | -.97 | .745 | .00995 | -.1491 | .4563 |
| .767 | .01259 | -.1565 | -.97 | .752 | .01277 | -.1587 | .4563 |
| .779 | .01631 | -.1589 | -.80 | .764 | .01654 | -.1611 | .4563 |

TABLE VII.- Continued

(e) $c_n = 0.50$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00770 | -.1246 | -.14 | .587 | .00782 | -.1266 | .5080 |
| .651 | .00790 | -.1272 | -.32 | .637 | .00802 | -.1291 | .5075 |
| .701 | .00810 | -.1350 | -.49 | .686 | .00821 | -.1369 | .5070 |
| .719 | .00820 | -.1360 | -.44 | .704 | .00831 | -.1379 | .5070 |
| .729 | .00840 | -.1389 | -.41 | .714 | .00852 | -.1408 | .5070 |
| .739 | .00872 | -.1400 | -.60 | .724 | .00884 | -.1420 | .5070 |
| .749 | .00945 | -.1460 | -.50 | .734 | .00958 | -.1480 | .5070 |
| .760 | .01094 | -.1500 | -.60 | .745 | .01109 | -.1521 | .5070 |
| .767 | .01449 | -.1580 | -.66 | .752 | .01469 | -.1602 | .5070 |
| .779 | .01773 | -.1600 | -.44 | .764 | .01798 | -.1622 | .5070 |

(f) $c_n = 0.55$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00778 | -.1249 | .25 | .587 | .00790 | -.1269 | .5588 |
| .651 | .00800 | -.1290 | .13 | .637 | .00812 | -.1309 | .5583 |
| .701 | .00817 | -.1350 | 0.00 | .686 | .00828 | -.1369 | .5577 |
| .719 | .00836 | -.1367 | -.13 | .704 | .00848 | -.1386 | .5577 |
| .729 | .00855 | -.1396 | -.12 | .714 | .00867 | -.1416 | .5577 |
| .739 | .00896 | -.1420 | -.24 | .724 | .00909 | -.1440 | .5577 |
| .749 | .00983 | -.1466 | -.24 | .734 | .00997 | -.1487 | .5577 |
| .760 | .01197 | -.1538 | -.26 | .745 | .01214 | -.1560 | .5577 |
| .767 | .01584 | -.1600 | -.29 | .752 | .01606 | -.1622 | .5577 |
| .779 | .02358 | -.1610 | -.02 | .764 | .02391 | -.1633 | .5577 |

TABLE VII.- Continued

(g) $c_n = 0.60$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00789 | -.1250 | .70 | .587 | .00802 | -.1270 | .6096 |
| .651 | .00813 | -.1290 | .53 | .637 | .00825 | -.1309 | .6090 |
| .701 | .00834 | -.1350 | .36 | .686 | .00846 | -.1369 | .6084 |
| .719 | .00859 | -.1362 | .23 | .704 | .00871 | -.1381 | .6084 |
| .729 | .00870 | -.1393 | .18 | .714 | .00882 | -.1413 | .6084 |
| .739 | .00920 | -.1430 | .14 | .724 | .00933 | -.1450 | .6084 |
| .749 | .01023 | -.1469 | .01 | .734 | .01037 | -.1490 | .6084 |
| .760 | .01289 | -.1545 | .02 | .745 | .01307 | -.1567 | .6084 |
| .767 | .01769 | -.1620 | .01 | .752 | .01794 | -.1643 | .6084 |
| .779 | .02542 | -.1563 | .44 | .764 | .02578 | -.1585 | .6084 |

(h) $c_n = 0.65$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00808 | -.1255 | 1.20 | .587 | .00821 | -.1275 | .6604 |
| .651 | .00825 | -.1288 | 0.93 | .637 | .00837 | -.1307 | .6598 |
| .701 | .00865 | -.1347 | 0.66 | .686 | .00877 | -.1366 | .6591 |
| .719 | .00898 | -.1368 | 0.58 | .704 | .00911 | -.1387 | .6591 |
| .729 | .00913 | -.1376 | 0.55 | .714 | .00926 | -.1395 | .6591 |
| .739 | .00954 | -.1432 | 0.53 | .724 | .00967 | -.1452 | .6591 |
| .749 | .01098 | -.1480 | 0.32 | .734 | .01113 | -.1501 | .6591 |
| .760 | .01409 | -.1560 | 0.29 | .745 | .01429 | -.1582 | .6591 |
| .767 | .02046 | -.1603 | 0.52 | .752 | .02075 | -.1625 | .6591 |
| .779 | .03029 | -.1550 | 0.98 | .764 | .03071 | -.1572 | .6591 |

TABLE VII.- Continued

(i) $c_n = 0.70$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00814 | -.1260 | 1.59 | .587 | .00827 | -.1280 | .7112 |
| .651 | .00854 | -.1273 | 1.33 | .637 | .00867 | -.1292 | .7105 |
| .701 | .00902 | -.1340 | 1.02 | .686 | .00915 | -.1359 | .7098 |
| .719 | .00932 | -.1368 | 0.92 | .704 | .00945 | -.1387 | .7098 |
| .729 | .00969 | -.1370 | 0.77 | .714 | .00983 | -.1389 | .7098 |
| .739 | .00985 | -.1420 | 0.72 | .724 | .00999 | -.1440 | .7098 |
| .749 | .01193 | -.1520 | 0.66 | .734 | .01210 | -.1541 | .7098 |
| .760 | .01553 | -.1566 | 0.66 | .745 | .01575 | -.1588 | .7098 |
| .767 | .02400 | -.1570 | 1.00 | .752 | .02434 | -.1592 | .7098 |

(j) $c_n = 0.75$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00835 | -.1258 | 1.93 | .587 | .00848 | -.1278 | .7620 |
| .651 | .00897 | -.1260 | 1.72 | .637 | .00910 | -.1279 | .7613 |
| .701 | .00944 | -.1330 | 1.36 | .686 | .00957 | -.1349 | .7605 |
| .719 | .00968 | -.1360 | 1.20 | .704 | .00982 | -.1379 | .7605 |
| .729 | .01017 | -.1362 | 1.08 | .714 | .01031 | -.1381 | .7605 |
| .739 | .01014 | -.1440 | 1.00 | .724 | .01028 | -.1460 | .7605 |
| .749 | .01288 | -.1526 | 0.99 | .734 | .01306 | -.1547 | .7605 |
| .760 | .01864 | -.1580 | 1.10 | .745 | .01890 | -.1602 | .7605 |
| .767 | ------ | -.1560 | 1.50 | .752 | ------ | -.1582 | .7605 |

TABLE VII.- Continued

(k) $c_n = 0.80$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00893 | -.1248 | 2.32 | .587 | .00907 | -.1268 | .8128 |
| .651 | .00989 | -.1253 | 2.08 | .637 | .01004 | -.1272 | .8120 |
| .701 | .01044 | -.1289 | 1.70 | .686 | .01059 | -.1307 | .8112 |
| .719 | .00993 | -.1345 | 1.48 | .704 | .01007 | -.1364 | .8112 |
| .729 | .01064 | -.1368 | 1.42 | .714 | .01079 | -.1387 | .8112 |
| .739 | .01134 | -.1465 | 1.32 | .724 | .01150 | -.1486 | .8112 |
| .749 | .01400 | -.1550 | 1.35 | .734 | .01420 | -.1572 | .8112 |
| .760 | .02536 | -.1576 | 1.69 | .745 | .02572 | -.1598 | .8112 |

(l) $c_n = 0.85$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .00928 | -.1222 | 2.77 | .587 | .00943 | -.1242 | .8636 |
| .651 | .01112 | -.1238 | 2.40 | .637 | .01129 | -.1257 | .8628 |
| .701 | .01253 | -.1275 | 1.92 | .686 | .01271 | -.1293 | .8619 |
| .719 | .01145 | -.1360 | 1.82 | .704 | .01161 | -.1379 | .8619 |
| .729 | .01213 | -.1398 | 1.74 | .714 | .01230 | -.1418 | .8619 |
| .739 | .01434 | -.1500 | 1.70 | .724 | .01454 | -.1521 | .8619 |
| .749 | .01859 | -.1560 | 1.75 | .734 | .01885 | -.1582 | .8619 |
| .760 | ------ | -.1570 | 2.34 | .745 | ------ | -.1592 | .8619 |

TABLE VII.- Concluded

(m) $c_n = 0.90$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .01058 | -.1180 | 3.20 | .587 | .01075 | -.1199 | .9144 |
| .651 | .01268 | -.1220 | 2.72 | .637 | .01287 | -.1238 | .9135 |
| .701 | .01508 | -.1270 | 2.24 | .686 | .01529 | -.1288 | .9126 |
| .719 | .01436 | -.1360 | 2.12 | .704 | .01456 | -.1379 | .9126 |
| .729 | .01552 | -.1446 | 2.10 | .714 | .01574 | -.1466 | .9126 |
| .739 | .01912 | -.1535 | 2.12 | .724 | .01939 | -.1557 | .9126 |
| .749 | .02800 | -.1570 | 2.28 | .734 | .02839 | -.1592 | .9126 |

(n) $c_n = 0.95$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .01236 | -.1166 | 3.60 | .587 | .01256 | -.1185 | .9652 |
| .651 | .01440 | -.1185 | 3.08 | .637 | .01462 | -.1203 | .9643 |
| .701 | .01812 | -.1289 | 2.57 | .686 | .01837 | -.1307 | .9633 |
| .719 | .01878 | -.1386 | 2.51 | .704 | .01904 | -.1405 | .9633 |
| .729 | .01898 | -.1458 | 2.40 | .714 | .01925 | -.1478 | .9633 |
| .739 | .02506 | -.1560 | 2.59 | .724 | .02541 | -.1582 | .9633 |

(o) $c_n = 1.00$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .601 | .01474 | -.1148 | 4.00 | .587 | .01498 | -.1166 | 1.016 |
| .651 | .01720 | -.1165 | 3.42 | .637 | .01746 | -.1182 | 1.015 |
| .701 | .02160 | -.1296 | 2.96 | .686 | .02190 | -.1314 | 1.014 |
| .719 | .02466 | -.1388 | 2.92 | .704 | .02501 | -.1509 | 1.014 |
| .729 | .02794 | -.1488 | 3.01 | .714 | .02833 | -.1509 | 1.014 |
| .739 | ------ | -.1530 | 3.50 | .724 | ------ | -.1551 | 1.014 |

TABLE VIII.- CROSS-PLOTTED DATA AT A REYNOLDS NUMBER OF 40.03 MILLION

(a) $c_n = 0.30$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00772 | −.1345 | −1.86 | .688 | .00783 | −.1364 | .3042 |
| .720 | .00804 | −.1352 | −1.86 | .706 | .00814 | −.1370 | .3039 |
| .730 | .00853 | −.1346 | −1.86 | .716 | .00864 | −.1363 | .3039 |
| .742 | .00816 | −.1412 | −1.92 | .728 | .00827 | −.1430 | .3039 |
| .762 | .00942 | −.1489 | −1.93 | .748 | .00954 | −.1508 | .3039 |
| .781 | .01374 | −.1580 | −1.91 | .767 | .01392 | −.1601 | .3039 |

(b) $c_n = 0.35$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00777 | −.1346 | −1.48 | .688 | .00788 | −.1365 | .3549 |
| .720 | .00802 | −.1360 | −1.51 | .706 | .00812 | −.1378 | .3546 |
| .730 | .00857 | −.1358 | −1.46 | .716 | .00868 | −.1376 | .3546 |
| .742 | .00822 | −.1418 | −1.56 | .728 | .00833 | −.1436 | .3546 |
| .762 | .00972 | −.1520 | −1.67 | .748 | .00985 | −.1540 | .3546 |
| .781 | .01432 | −.1600 | −1.53 | .767 | .01451 | −.1621 | .3546 |

TABLE VIII.- Continued

(c) $c_n = 0.40$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00786 | -.1348 | -1.09 | .688 | .00797 | -.1367 | .4056 |
| .720 | .00803 | -.1370 | -1.13 | .706 | .00813 | -.1388 | .4052 |
| .730 | .00859 | -.1372 | -1.16 | .716 | .00870 | -.1390 | .4052 |
| .742 | .00836 | -.1425 | -1.29 | .728 | .00847 | -.1444 | .4052 |
| .762 | .01017 | -.1526 | -1.34 | .748 | .01030 | -.1546 | .4052 |
| .781 | .01592 | -.1612 | -1.20 | .767 | .01613 | -.1633 | .4052 |

(d) $c_n = 0.45$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00800 | -.1350 | -0.72 | .688 | .00811 | -.1369 | .4593 |
| .720 | .00806 | -.1375 | -0.77 | .706 | .00816 | -.1393 | .4559 |
| .730 | .00867 | -.1378 | -0.88 | .716 | .00878 | -.1396 | .4559 |
| .742 | .00952 | -.1436 | -0.96 | .728 | .00964 | -.1456 | .4559 |
| .762 | .01098 | -.1546 | -1.04 | .748 | .01112 | -.1566 | .4559 |
| .781 | .01880 | -.1628 | -0.84 | .767 | .01904 | -.1649 | .4559 |

TABLE VIII.- Continued

(e) $c_n = 0.50$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00814 | -.1355 | -.38 | .688 | .00825 | -.1374 | .5070 |
| .720 | .00807 | -.1382 | -.45 | .706 | .00817 | -.1400 | .5065 |
| .730 | .00887 | -.1387 | -.53 | .716 | .00899 | -.1405 | .5065 |
| .742 | .00862 | -.1440 | -.66 | .728 | .00899 | -.1459 | .5065 |
| .762 | .01168 | -.1548 | -.70 | .748 | .01183 | -.1568 | .5065 |
| .781 | .02280 | -.1528 | -.49 | .767 | .02310 | -.1548 | .5065 |

(f) $c_n = 0.55$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00825 | -.1364 | -.05 | .688 | .00837 | -.1383 | .5577 |
| .720 | .00827 | -.1377 | -.12 | .706 | .00838 | -.1395 | .5572 |
| .730 | .00902 | -.1393 | -.16 | .716 | .00914 | -.1411 | .5572 |
| .742 | .00889 | -.1450 | -.24 | .728 | .00901 | -.1469 | .5572 |
| .762 | .01340 | -.1580 | -.33 | .748 | .01357 | -.1601 | .5572 |
| .781 | .02600 | -.1618 | 0.00 | .767 | .02634 | -.1639 | .5572 |

TABLE VIII.- Continued

(g) $c_n = 0.60$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00842 | -.1370 | .33 | .688 | .00854 | -.1389 | .6084 |
| .720 | .00835 | -.1378 | .17 | .706 | .00846 | -.1396 | .6078 |
| .730 | .00928 | -.1400 | .16 | .716 | .00940 | -.1418 | .6078 |
| .742 | .00934 | -.1465 | 0.00 | .728 | .00946 | -.1484 | .6078 |
| .762 | .01539 | -.1600 | -.01 | .748 | .01559 | -.1621 | .6078 |
| .781 | .02748 | -.1589 | -.48 | .767 | .02784 | -.1610 | .6078 |

(h) $c_n = 0.65$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00857 | -.1363 | 0.65 | .688 | .00869 | -.1382 | .6591 |
| .720 | .00853 | -.1372 | 0.56 | .706 | .00864 | -.1390 | .6585 |
| .730 | .00946 | -.1418 | 0.53 | .716 | .00958 | -.1436 | .6585 |
| .742 | .00976 | -.1468 | 0.00 | .728 | .00989 | -.1489 | .6585 |
| .762 | .01706 | -.1630 | 0.32 | .748 | .01728 | -.1651 | .6585 |
| .781 | .03380 | -.1550 | 1.16 | .767 | .03424 | -.1570 | .6585 |

TABLE VIII.- Continued

(i) $c_n = 0.70$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00889 | -.1360 | 1.05 | .688 | .00901 | -.1379 | .7098 |
| .720 | .00899 | -.1358 | 0.90 | .706 | .00911 | -.1376 | .7091 |
| .730 | .00973 | -.1385 | 0.76 | .716 | .00986 | -.1403 | .7091 |
| .742 | .01012 | -.1450 | 0.64 | .728 | .01025 | -.1469 | .7091 |
| .762 | .01977 | -.1635 | 0.64 | .748 | .02003 | -.1656 | .7091 |

(j) $c_n = 0.75$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .00953 | -.1354 | 1.38 | .688 | .00966 | -.1374 | .7605 |
| .720 | .00967 | -.1345 | 1.17 | .706 | .00980 | -.1362 | .7598 |
| .730 | .01000 | -.1383 | 1.06 | .716 | .01013 | -.1401 | .7598 |
| .742 | .01039 | -.1460 | 0.97 | .728 | .01053 | -.1479 | .7598 |
| .762 | .02289 | -.1642 | 0.68 | .748 | .02319 | -.1663 | .7598 |

TABLE VIII.- Continued

(k) $c_n = 0.80$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .01092 | -.1323 | 1.68 | .688 | .01107 | -.1342 | .8112 |
| .720 | .01053 | -.1320 | 1.52 | .706 | .01067 | -.1337 | .8104 |
| .730 | .01096 | -.1400 | 1.34 | .716 | .01110 | -.1418 | .8104 |
| .742 | .01168 | -.1488 | 1.32 | .728 | .01183 | -.1507 | .8104 |
| .762 | .02585 | -.1648 | 1.51 | .748 | .02619 | -.1669 | .8104 |

(l) $c_n = 0.85$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | $\alpha$, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .01270 | -.1300 | 1.93 | .688 | .01288 | -.1318 | .8619 |
| .720 | .01200 | -.1355 | 1.79 | .706 | .01216 | -.1373 | .8611 |
| .730 | .01331 | -.1444 | 1.68 | .716 | .01348 | -.1463 | .8611 |
| .742 | .01508 | -.1550 | 1.68 | .728 | .01528 | -.1570 | .8611 |
| .762 | .02885 | -.1623 | 2.02 | .748 | .02923 | -.1644 | .8611 |

TABLE VIII.- Concluded

(m) $c_n = 0.90$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .01480 | -.1332 | 2.14 | .688 | .01501 | -.1351 | .9126 |
| .720 | .01408 | -.1385 | 2.05 | .706 | .01426 | -.1403 | .9117 |
| .730 | .01773 | -.1480 | 2.11 | .716 | .01796 | -.1499 | .9117 |
| .742 | .02076 | -.1450 | 2.04 | .728 | .02103 | -.1469 | .9117 |

(n) $c_n = 0.95$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .01776 | -.1360 | 2.46 | .688 | .01801 | -.1379 | .9633 |
| .720 | .01820 | -.1440 | 2.48 | .706 | .01844 | -.1459 | .9624 |
| .730 | .02360 | -.1450 | 2.68 | .716 | .02391 | -.1469 | .9624 |
| .742 | .02712 | -.1600 | ---- | .728 | .02747 | -.1621 | .9624 |

(o) $c_n = 1.00$

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| M | $c_d$ | $c_m$ | α, deg | M | $c_d$ | $c_m$ | $c_n$ |
| .702 | .02180 | -.1380 | 2.68 | .688 | .02211 | -.1399 | 1.014 |
| .720 | .02760 | -.1472 | 3.09 | .706 | .02796 | -.1491 | 1.013 |
| .730 | ------ | -.1450 | 3.37 | .716 | ------ | -.1469 | 1.013 |

TABLE IX.- CONDITIONS AT DRAG DIVERGENCE

(a) R = 4.03 million

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ | $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ |
| .30 | .01160 | .757 | -.1410 | 0.305 | .01181 | .737 | -.1435 |
| .35 | .01194 | .757 | -.1438 | 0.356 | .01215 | .737 | -.1464 |
| .40 | .01168 | .753 | -.1452 | 0.407 | .01189 | .733 | -.1478 |
| .45 | .01155 | .752 | -.1452 | 0.458 | .01176 | .732 | -.1478 |
| .50 | .01174 | .749 | -.1460 | 0.509 | .01195 | .729 | -.1486 |
| .55 | .01182 | .745 | -.1408 | 0.560 | .01203 | .725 | -.1433 |
| .60 | .01133 | .737 | -.1325 | 0.611 | .01153 | .717 | -.1349 |
| .65 | .01142 | .737 | -.1330 | 0.662 | .01163 | .717 | -.1354 |
| .70 | .01153 | .737 | -.1342 | 0.713 | .01174 | .717 | -.1366 |
| .75 | .01192 | .737 | -.1376 | 0.764 | .01213 | .717 | -.1401 |
| .80 | .01310 | .737 | -.1420 | 0.814 | .01334 | .717 | -.1446 |
| .85 | .01545 | .733 | -.1427 | 0.865 | .01573 | .713 | -.1453 |
| .90 | .01840 | .727 | -.1430 | 0.916 | .01873 | .707 | -.1456 |
| .95 | .02055 | .705 | -.1288 | 0.968 | .02094 | .686 | -.1312 |
| 1.00 | .02294 | .688 | -.1355 | 1.019 | .02338 | .669 | -.1381 |

(b) R = 6.06 million

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ | $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ |
| .30 | .01150 | .758 | -.1336 | .305 | .01170 | .739 | -.1359 |
| .35 | .01156 | .758 | -.1346 | .356 | .01176 | .739 | -.1369 |
| .40 | .01152 | .758 | -.1360 | .407 | .01172 | .739 | -.1383 |
| .45 | .01155 | .751 | -.1372 | .458 | .01175 | .732 | -.1395 |
| .50 | .01160 | .748 | -.1330 | .509 | .01180 | .729 | -.1353 |
| .55 | .01173 | .748 | -.1380 | .559 | .01193 | .729 | -.1403 |
| .60 | .01132 | .738 | -.1308 | .610 | .01151 | .719 | -.1330 |
| .65 | .01133 | .738 | -.1313 | .661 | .01152 | .719 | -.1335 |
| .70 | .01139 | .738 | -.1328 | .712 | .01158 | .719 | -.1351 |
| .75 | .01214 | .738 | -.1340 | .763 | .01235 | .719 | -.1363 |
| .80 | .01336 | .738 | -.1373 | .814 | .01359 | .719 | -.1396 |
| .85 | .01500 | .725 | -.1378 | .864 | .01526 | .707 | -.1401 |
| .90 | .01880 | .725 | -.1400 | .915 | .01912 | .707 | -.1424 |
| .95 | .02098 | .698 | -.1250 | .967 | .02136 | .680 | -.1273 |
| 1.00 | .02275 | .669 | -.1196 | 1.018 | .02316 | .651 | -.1218 |

TABLE IX.- Continued

(c) R = 10.06 million

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ | $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ |
| .30 | .01065 | .766 | -.1361 | .305 | .01081 | .749 | -.1383 |
| .35 | .01100 | .766 | -.1380 | .356 | .01118 | .749 | -.1402 |
| .40 | .01056 | .760 | -.1352 | .406 | .01073 | .743 | -.1374 |
| .45 | .01060 | .756 | -.1360 | .457 | .01077 | .739 | -.1382 |
| .50 | .01040 | .750 | -.1342 | .508 | .01057 | .739 | -.1363 |
| .55 | .01084 | .750 | -.1362 | .559 | .01101 | .733 | -.1384 |
| .60 | .01103 | .750 | -.1355 | .610 | .01121 | .733 | -.1377 |
| .65 | .01038 | .740 | -.1300 | .660 | .01055 | .723 | -.1321 |
| .70 | .01061 | .740 | -.1292 | .711 | .01078 | .723 | -.1313 |
| .75 | .01129 | .740 | -.1296 | .762 | .01147 | .723 | -.1317 |
| .80 | .01161 | .732 | -.1310 | .813 | .01180 | .715 | -.1331 |
| .85 | .01292 | .732 | -.1336 | .864 | .01313 | .715 | -.1357 |
| .90 | .01770 | .732 | -.1376 | .914 | .01798 | .715 | -.1398 |
| .95 | .02240 | .700 | -.1430 | .966 | .02278 | .683 | -.1454 |
| 1.00 | .02168 | .676 | -.1174 | 1.017 | .02205 | .659 | -.1194 |

(d) R = 15.01 million

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ | $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ |
| .30 | .01069 | .768 | -.1389 | .304 | .01084 | .752 | -.1409 |
| .35 | .01043 | .762 | -.1400 | .355 | .01058 | .746 | -.1421 |
| .40 | .01021 | .758 | -.1390 | .406 | .01036 | .742 | -.1411 |
| .45 | .01057 | .758 | -.1411 | .457 | .01073 | .742 | -.1432 |
| .50 | .01104 | .758 | -.1430 | .508 | .01121 | .742 | -.1451 |
| .55 | .01157 | .758 | -.1448 | .558 | .01174 | .742 | -.1470 |
| .60 | .01166 | .749 | -.1449 | .609 | .01183 | .733 | -.1471 |
| .65 | .01090 | .739 | -.1362 | .660 | .01106 | .723 | -.1382 |
| .70 | .01104 | .737 | -.1382 | .711 | .01121 | .721 | -.1403 |
| .75 | .01126 | .735 | -.1400 | .761 | .01143 | .719 | -.1421 |
| .80 | .01246 | .733 | -.1413 | .812 | .01265 | .717 | -.1434 |
| .85 | .01354 | .727 | -.1409 | .863 | .01374 | .711 | -.1430 |
| .90 | .01600 | .725 | -.1418 | .914 | .01624 | .709 | -.1439 |
| .95 | .02058 | .715 | -.1377 | .964 | .02089 | .696 | -.1398 |
| 1.00 | .02100 | .671 | -.1198 | 1.016 | .02134 | .655 | -.1217 |
| 1.05 | .02200 | .650 | -.1040 | 1.067 | .02235 | .634 | -.1057 |

TABLE IX.- Concluded

(e) R = 30.11 million

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ | $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ |
| .30 | .00895 | .760 | -.1400 | .304 | .00927 | .745 | -.1418 |
| .35 | .00910 | .760 | -.1436 | .355 | .00922 | .745 | -.1455 |
| .40 | .00934 | .760 | -.1450 | .405 | .00956 | .745 | -.1469 |
| .45 | .00981 | .760 | -.1470 | .456 | .00994 | .745 | -.1489 |
| .50 | .00945 | .749 | -.1460 | .507 | .00957 | .734 | -.1479 |
| .55 | .00943 | .745 | -.1460 | .557 | .00956 | .730 | -.1480 |
| .60 | .00955 | .743 | -.1452 | .608 | .00968 | .728 | -.1472 |
| .65 | .00974 | .742 | -.1440 | .659 | .00988 | .727 | -.1460 |
| .70 | .00985 | .739 | -.1420 | .710 | .00999 | .724 | -.1440 |
| .75 | .01014 | .739 | -.1440 | .761 | .01028 | .724 | -.1460 |
| .80 | .01134 | .739 | -.1465 | .811 | .01150 | .724 | -.1486 |
| .85 | .01213 | .729 | -.1398 | .862 | .01230 | .714 | -.1418 |
| .90 | .01552 | .729 | -.1446 | .913 | .01574 | .714 | -.1466 |
| .95 | .01898 | .729 | -.1458 | .963 | .01925 | .714 | -.1478 |
| 1.00 | .01990 | .685 | -.1234 | 1.014 | .02018 | .670 | -.1251 |

(f) R = 40.03 million

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ | $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ |
| .30 | .00942 | .762 | -.1489 | .304 | .00954 | .748 | -.1508 |
| .35 | .00972 | .762 | -.1520 | .355 | .00985 | .748 | -.1540 |
| .40 | .01017 | .762 | -.1526 | .405 | .01030 | .748 | -.1546 |
| .45 | .01098 | .762 | -.1542 | .456 | .01112 | .748 | -.1562 |
| .50 | .00918 | .748 | -.1490 | .507 | .00930 | .734 | -.1509 |
| .55 | .00989 | .742 | -.1450 | .557 | .00901 | .728 | -.1469 |
| .60 | .00934 | .742 | -.1465 | .608 | .00946 | .728 | -.1484 |
| .65 | .00976 | .742 | -.1468 | .658 | .00989 | .728 | -.1487 |
| .70 | .01012 | .742 | -.1450 | .709 | .01025 | .728 | -.1469 |
| .75 | .01039 | .742 | -.1460 | .760 | .01053 | .728 | -.1479 |
| .80 | .01168 | .742 | -.1488 | .810 | .01183 | .728 | -.1507 |
| .85 | .01200 | .720 | -.1355 | .861 | .01216 | .706 | -.1373 |
| .90 | .01409 | .720 | -.1383 | .912 | .01427 | .706 | -.1401 |
| .95 | .01820 | .720 | -.1440 | .962 | .01844 | .706 | -.1459 |

TABLE X.- EFFECTS OF REYNOLDS NUMBER ON DRAG-DIVERGENCE CONDITIONS AT THE DESIGN NORMAL-FORCE COEFFICIENT

[$c_n$ = 0.65]

| Uncorrected data | | | | Data corrected by method of reference 9 | | | |
|---|---|---|---|---|---|---|---|
| $R \times 10^{-6}$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ | $c_n$ | $c_{d,dd}$ | $M_{dd}$ | $c_{m,dd}$ |
| 4.03 | .01142 | .737 | -.1330 | 0.662 | .01163 | .717 | -.1354 |
| 6.06 | .01133 | .738 | -.1313 | 0.661 | .01152 | .719 | -.1335 |
| 10.06 | .01038 | .740 | -.1300 | 0.660 | .01055 | .723 | -.1321 |
| 15.01 | .01090 | .739 | -.1362 | 0.660 | .01106 | .723 | -.1382 |
| 30.11 | .00974 | .742 | -.1440 | 0.659 | .00988 | .727 | -.1460 |
| 40.03 | .00976 | .742 | -.1468 | 0.658 | .00989 | .728 | -.1487 |

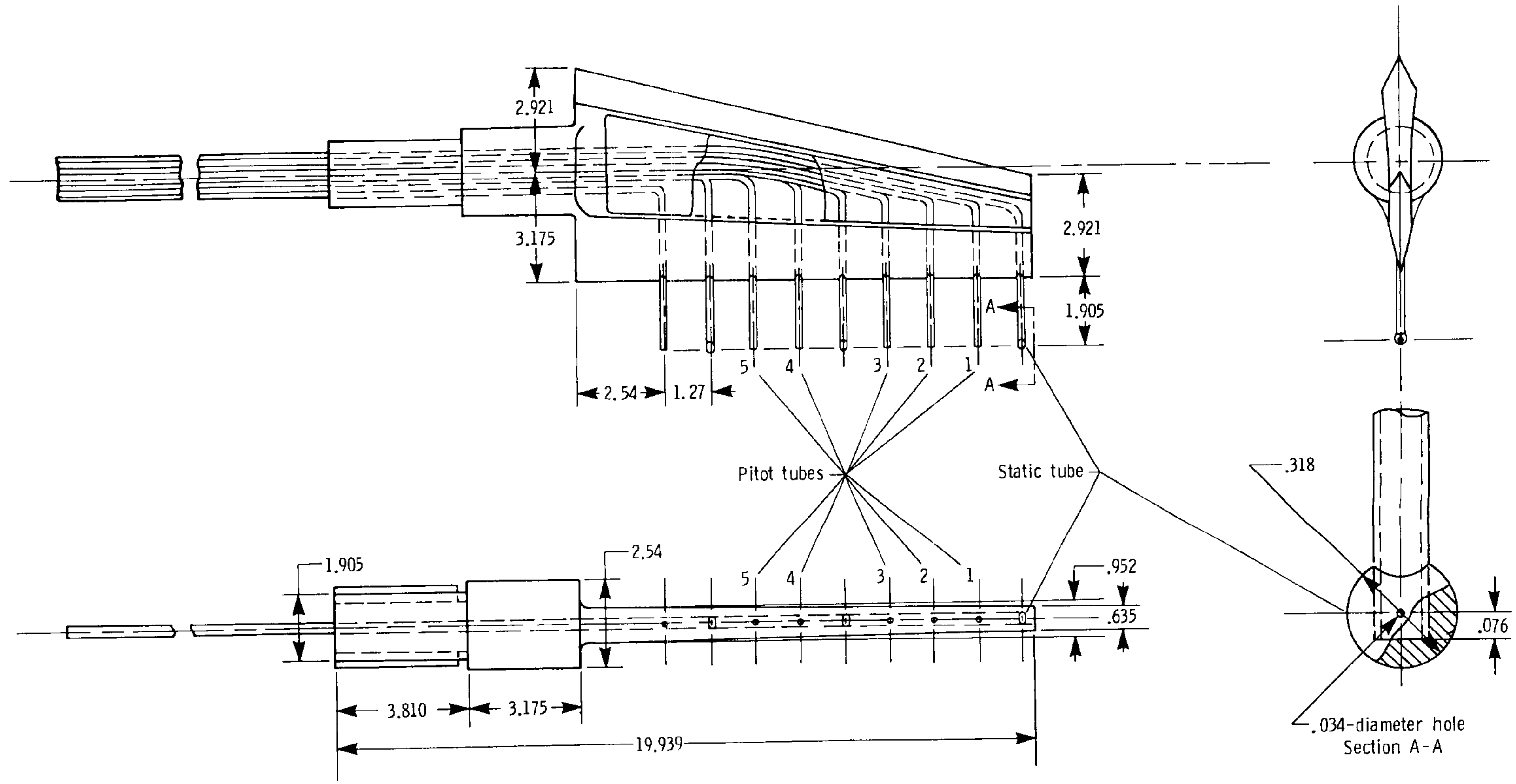



Figure 1.- Details of wake survey probe. All dimensions in centimeters.

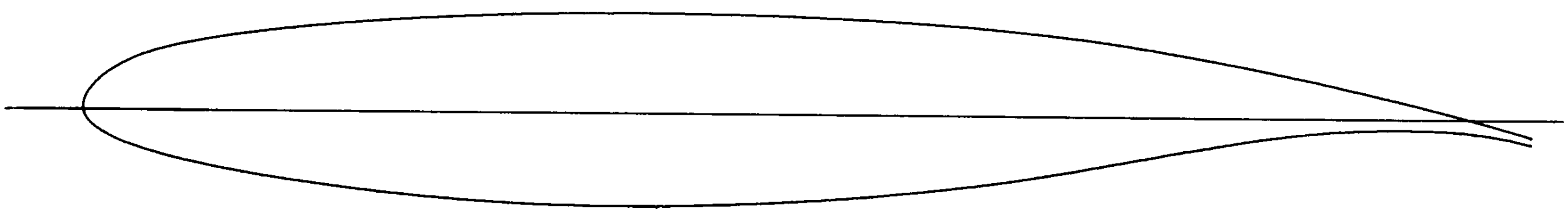
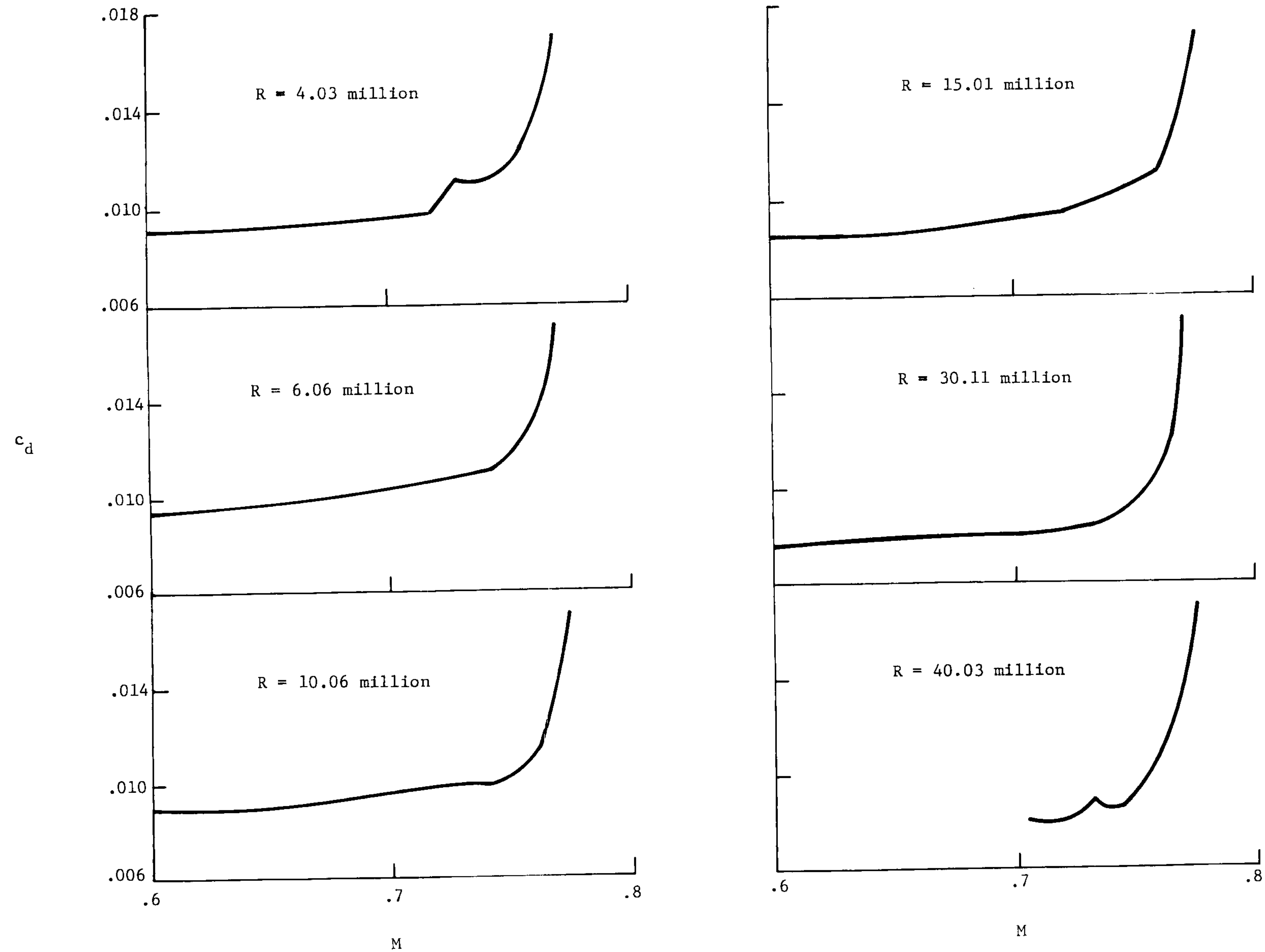
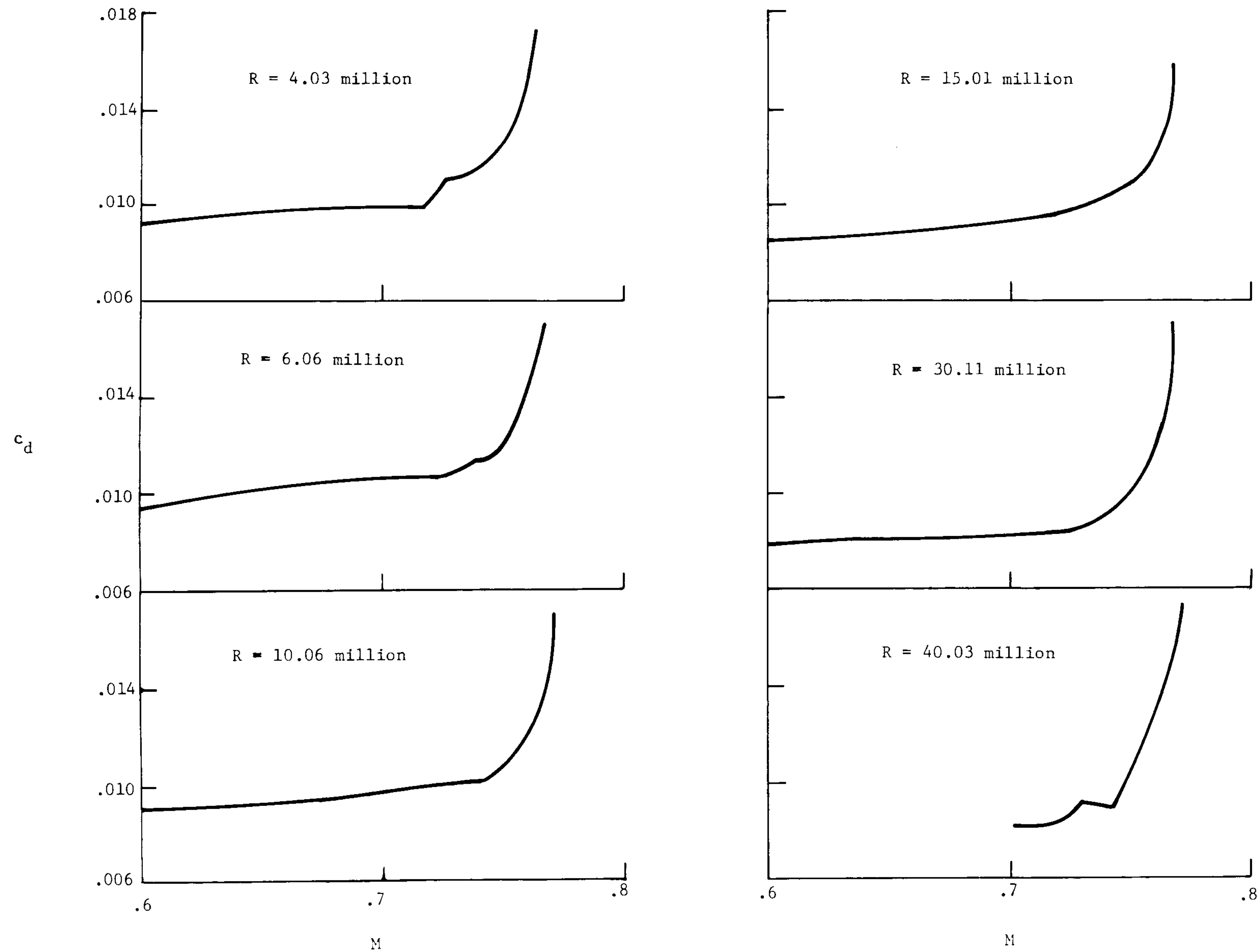


Figure 2.- R4 airfoil shape.



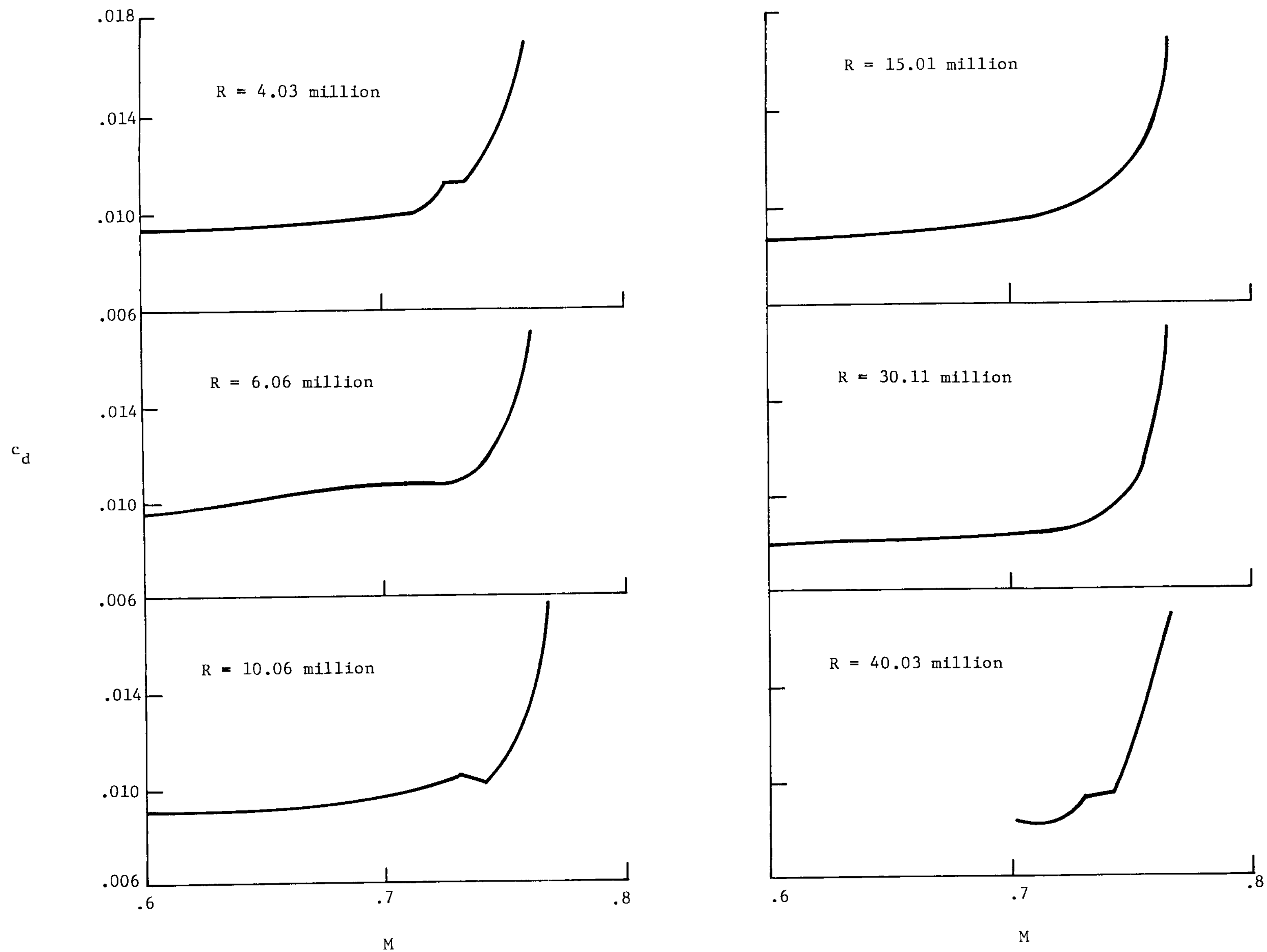

(a) $c_n = 0.50$.

Figure 3.- Cross plots of profile-drag coefficient versus Mach number at various normal-force coefficients. Uncorrected data.



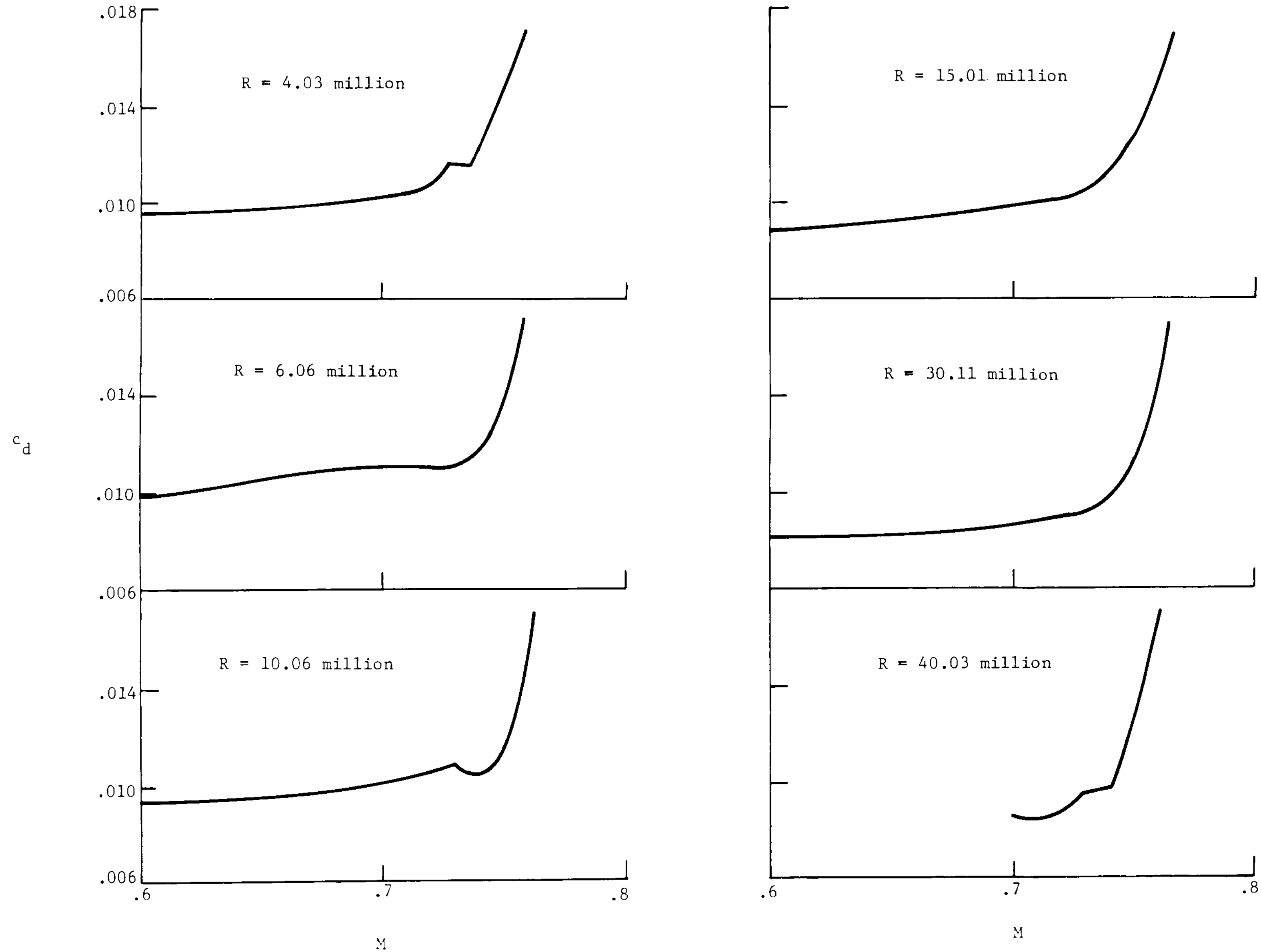

(b) $c_n = 0.55$.

Figure 3.- Continued.



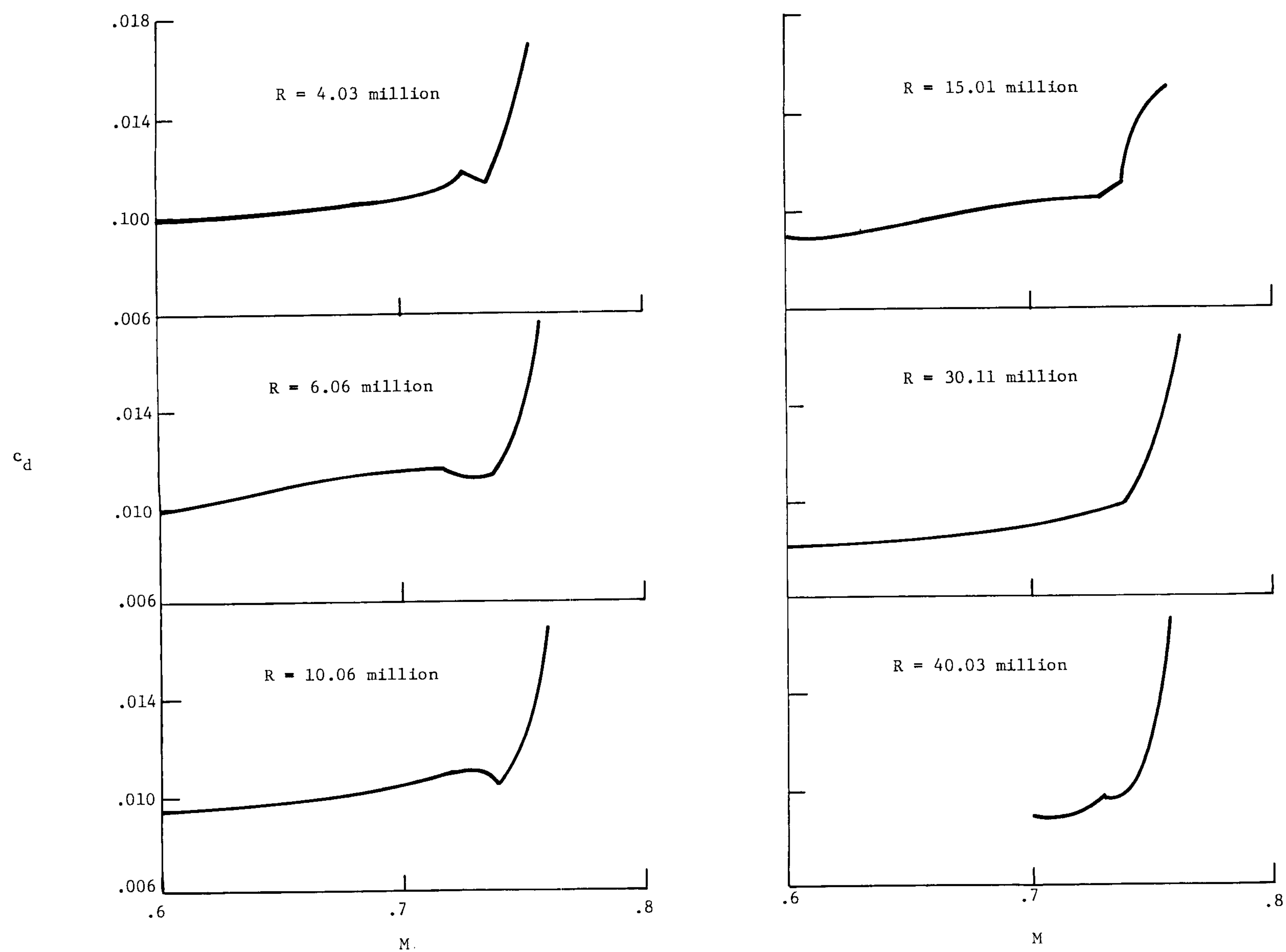

(c) $c_n = 0.60.$

Figure 3.- Continued.



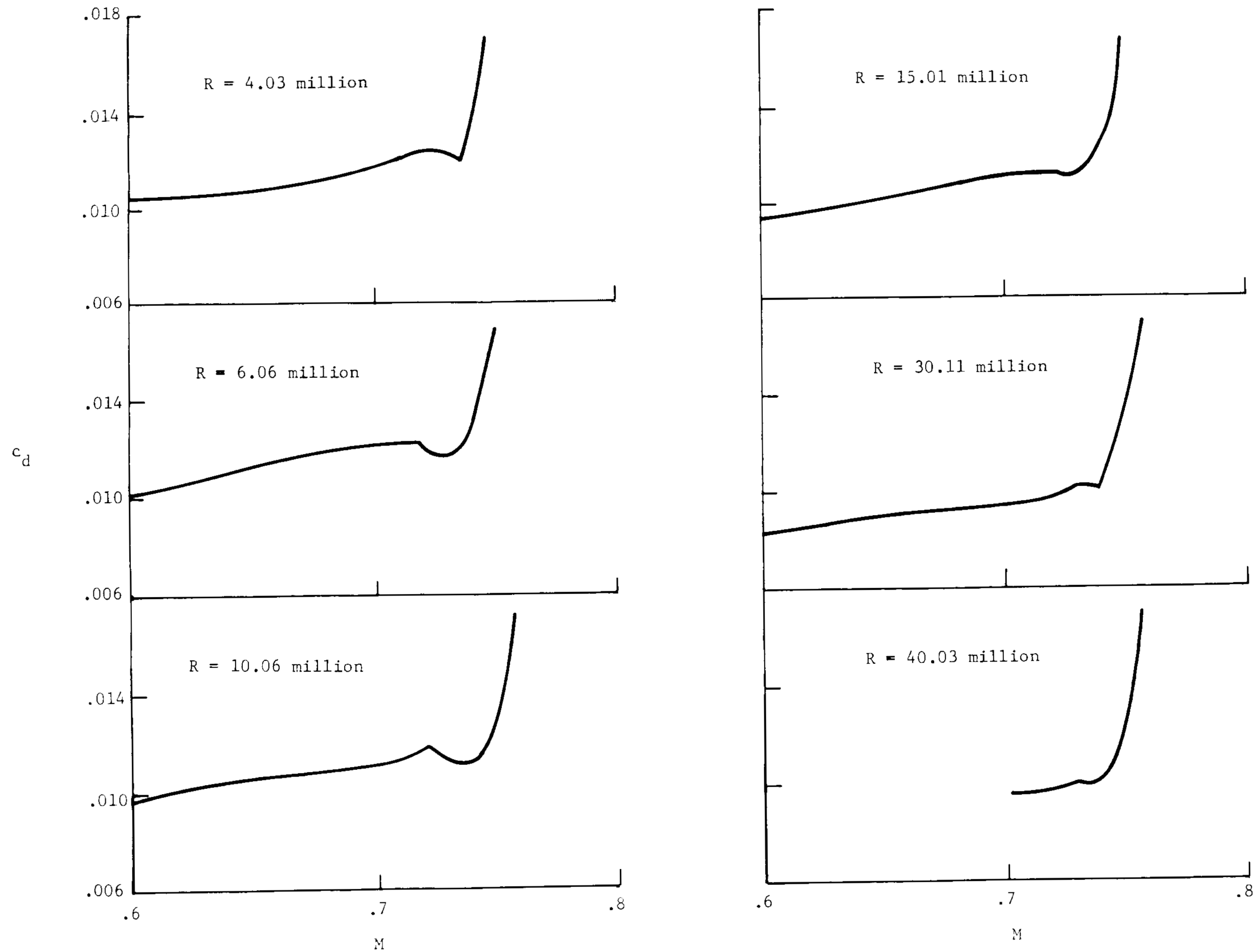

(d) $c_n = 0.65$.

Figure 3.- Continued.



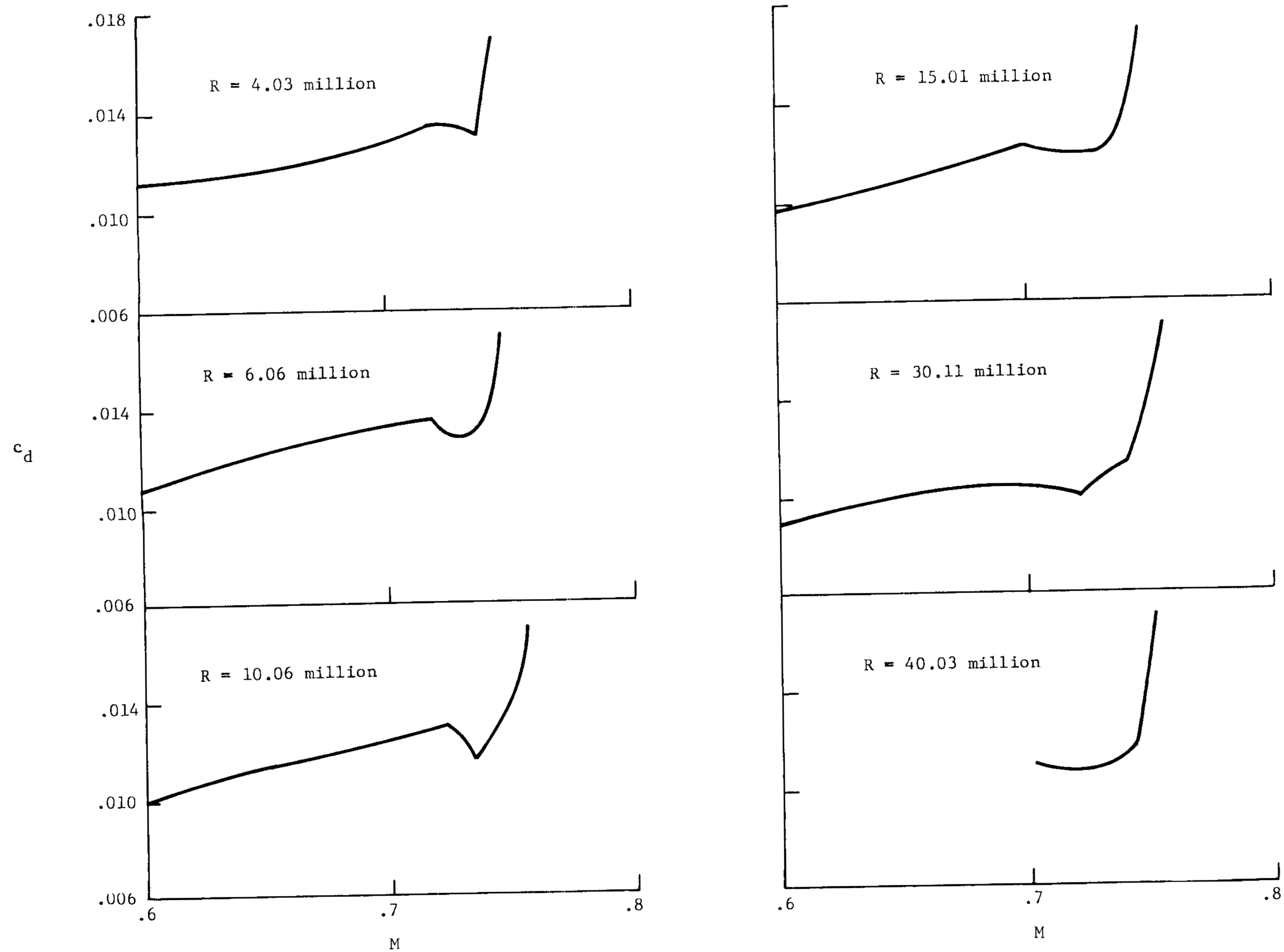

(e) $c_n = 0.70$.

Figure 3.- Continued.



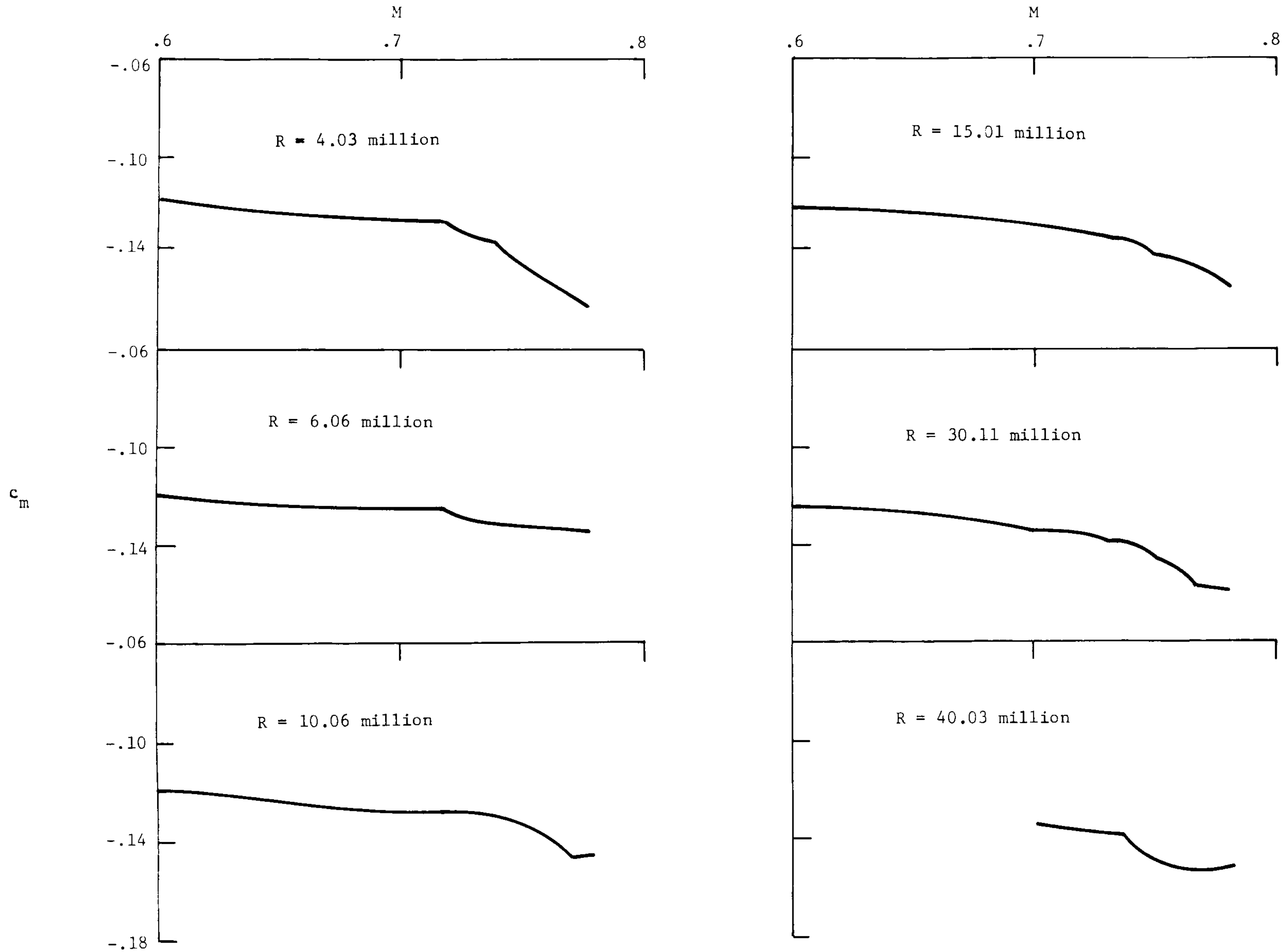

(f) $c_n = 0.75$.

Figure 3.- Continued.



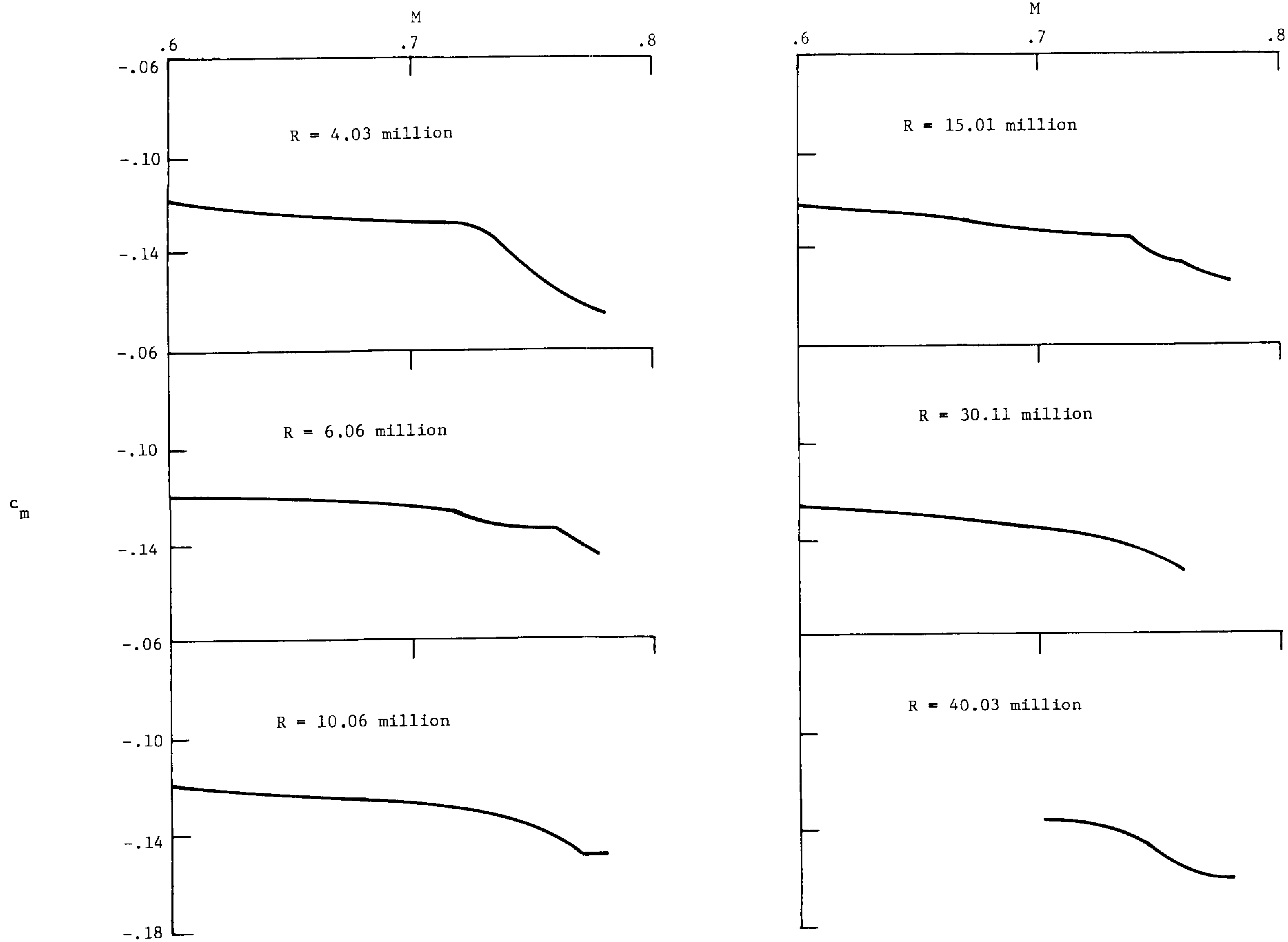

(g) $c_n = 0.80$.

Figure 3.- Concluded.



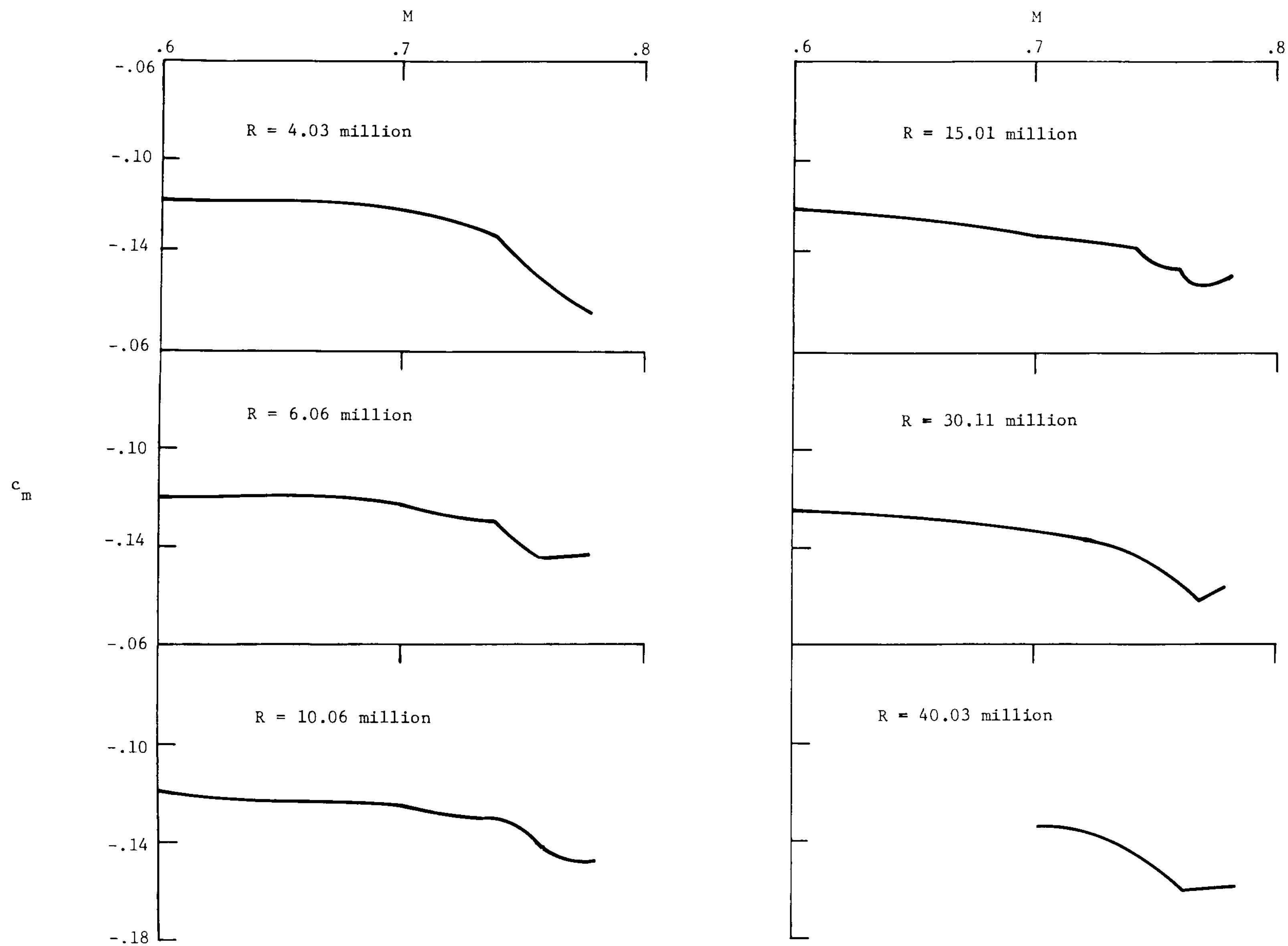

(a) $c_n = 0.50$.

Figure 4.- Cross plots of quarter-chord pitching-moment coefficient versus Mach number at various normal-force coefficients. Uncorrected data.



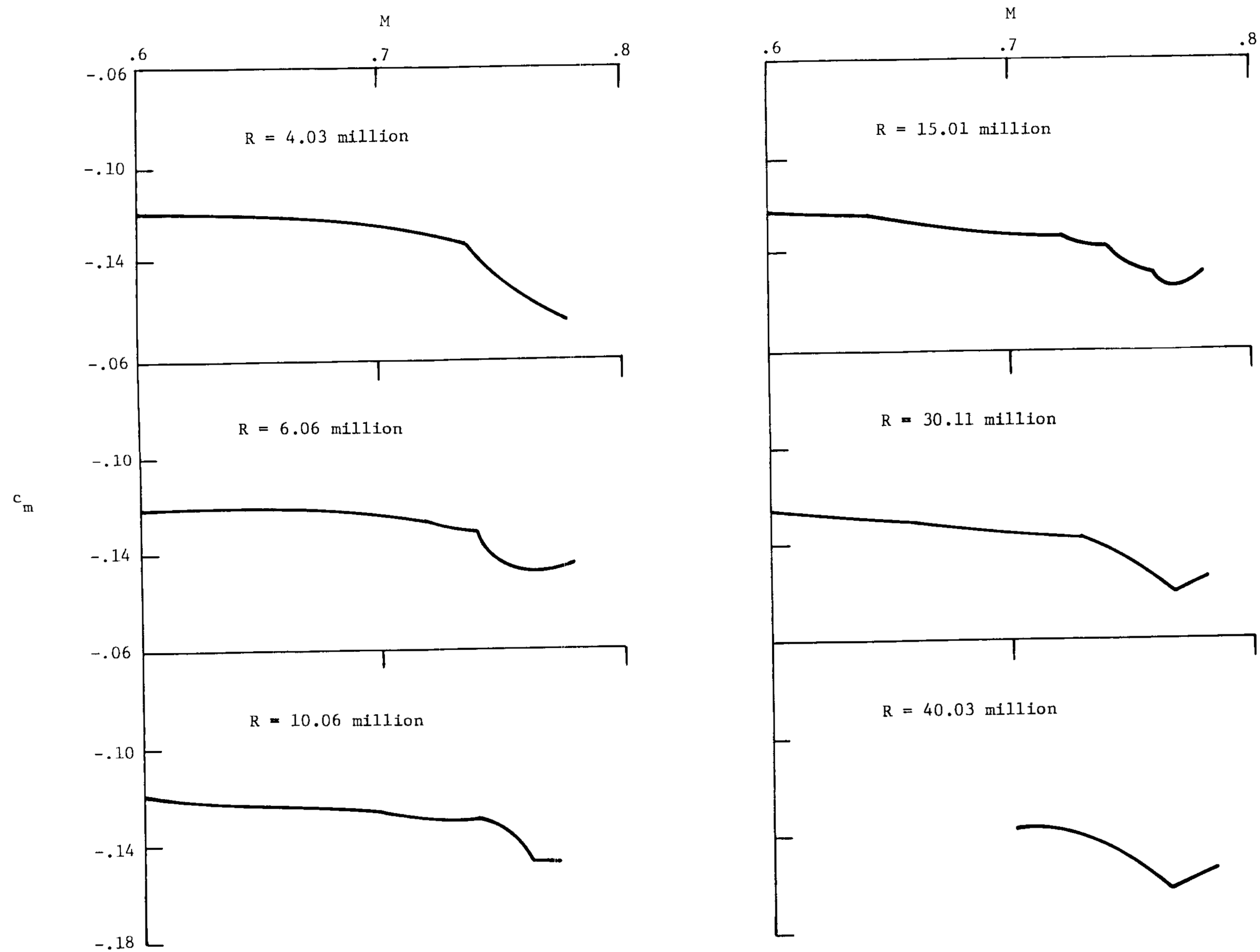

(b) $c_n = 0.55$.

Figure 4.- Continued.



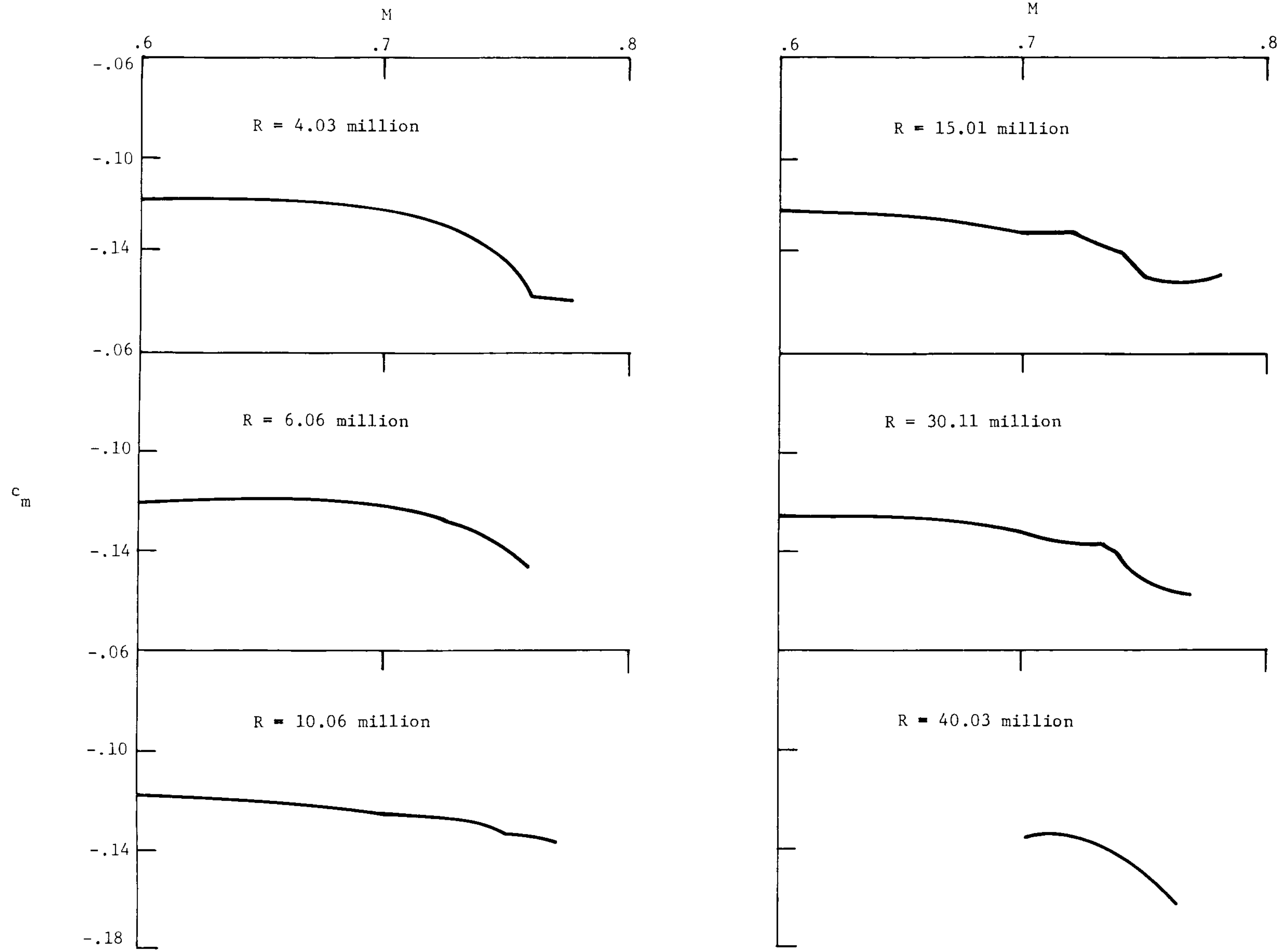

(c) $c_n = 0.60$.

Figure 4.- Continued.



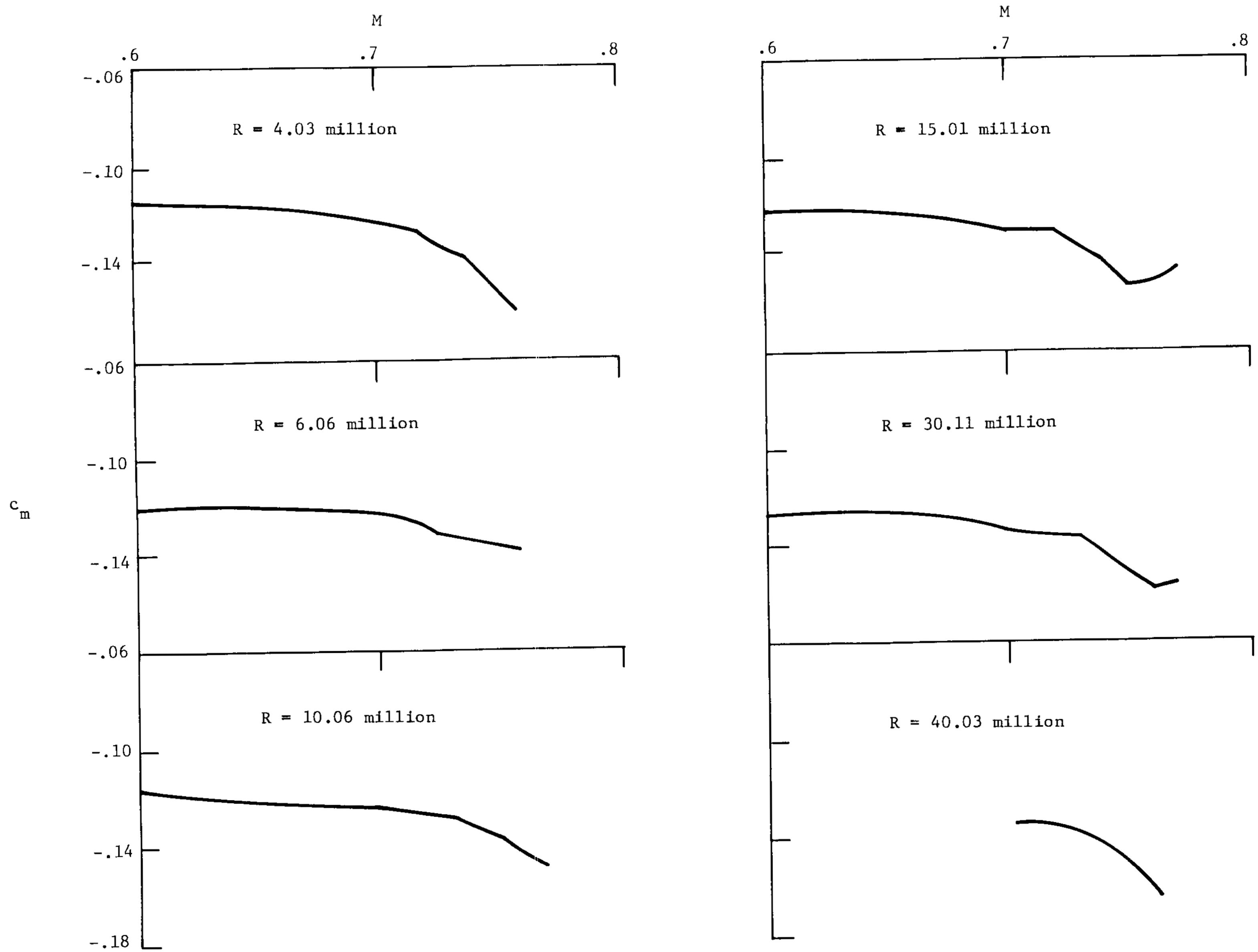

(d) $c_n = 0.65$.

Figure 4.- Continued.



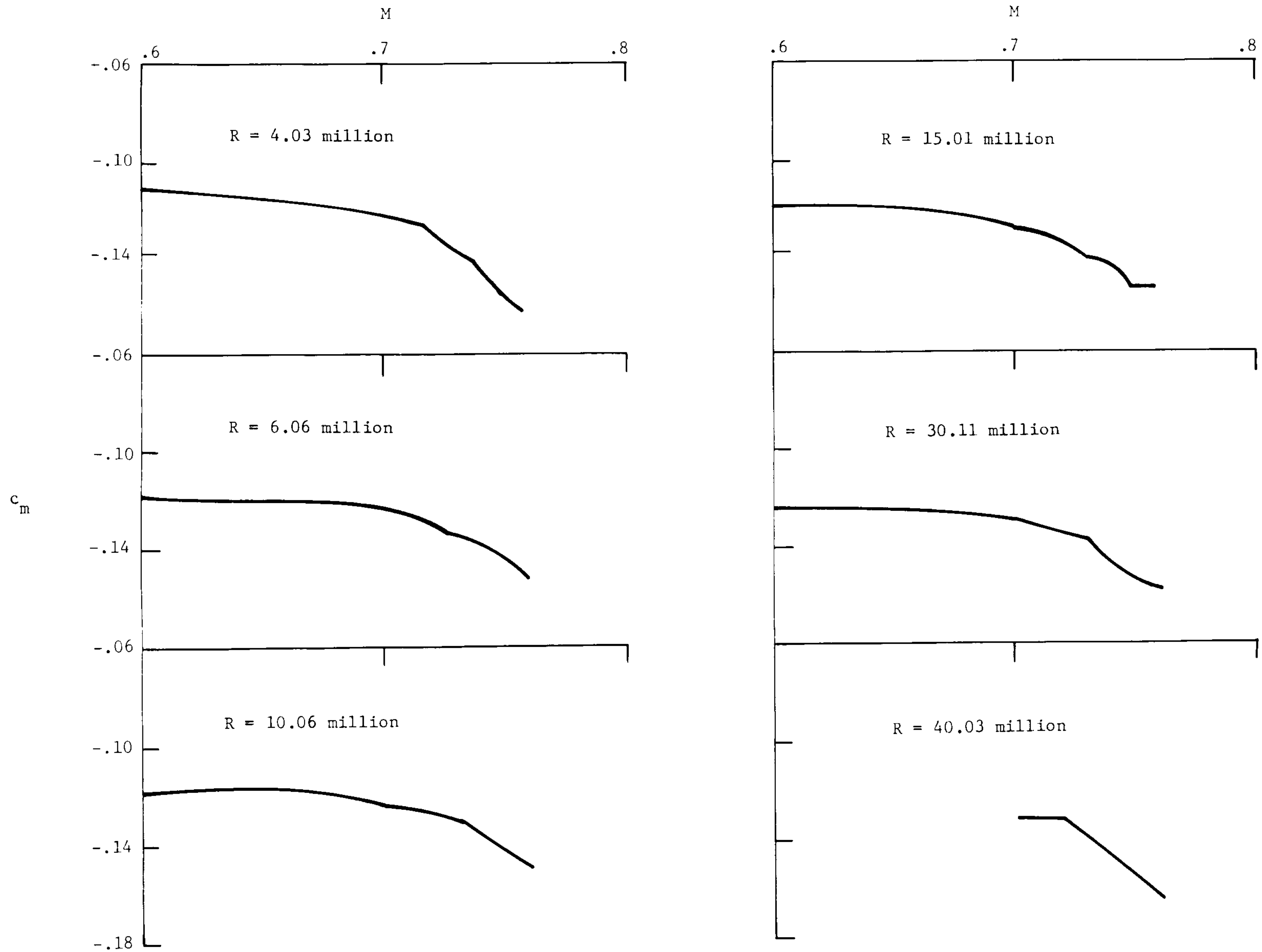

(e) $c_n = 0.70$.

Figure 4.- Continued.




(f) $c_n = 0.75$.

Figure 4.- Continued.




(g) $c_n = 0.80$.

Figure 4.- Concluded.

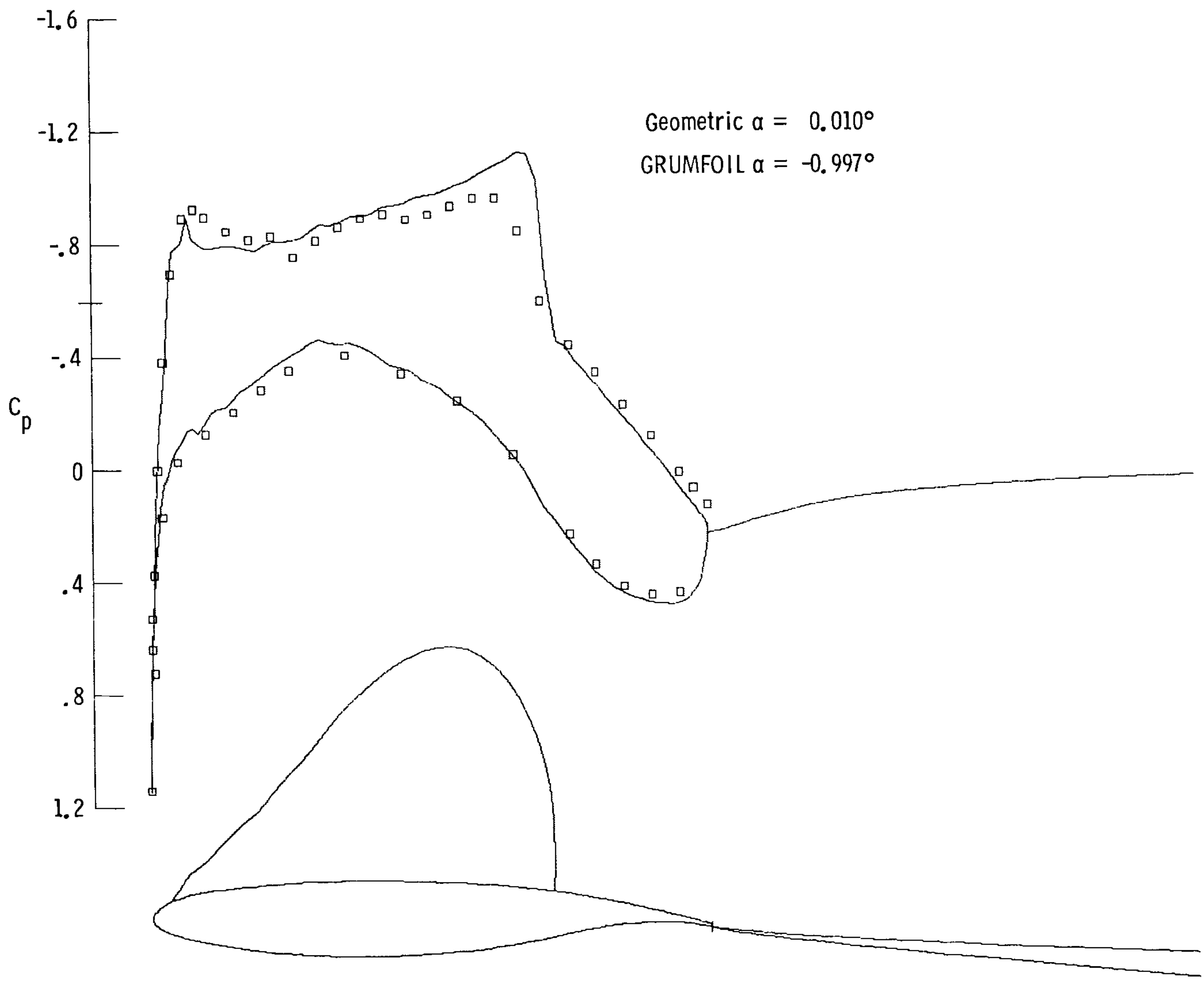



Figure 5.- Uncorrected data compared with theoretical results.
$M = 0.748$; $c_n = 0.5957$; $R = 30$ million.

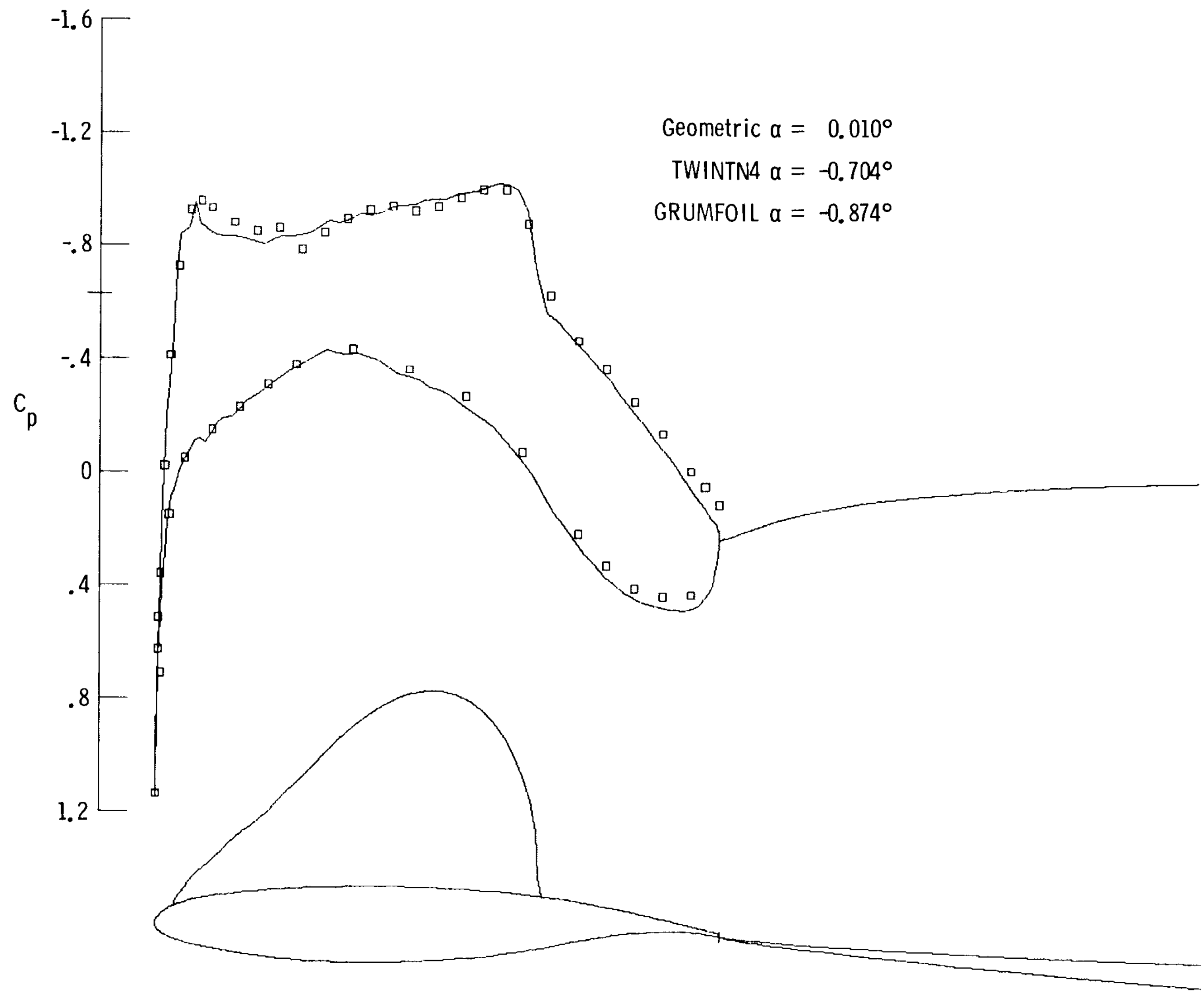



Figure 6.- Data corrected for all four walls and zero upstream angularity compared with theoretical results. M = 0.739; $c_n$ = 0.6054; R = 30 million.

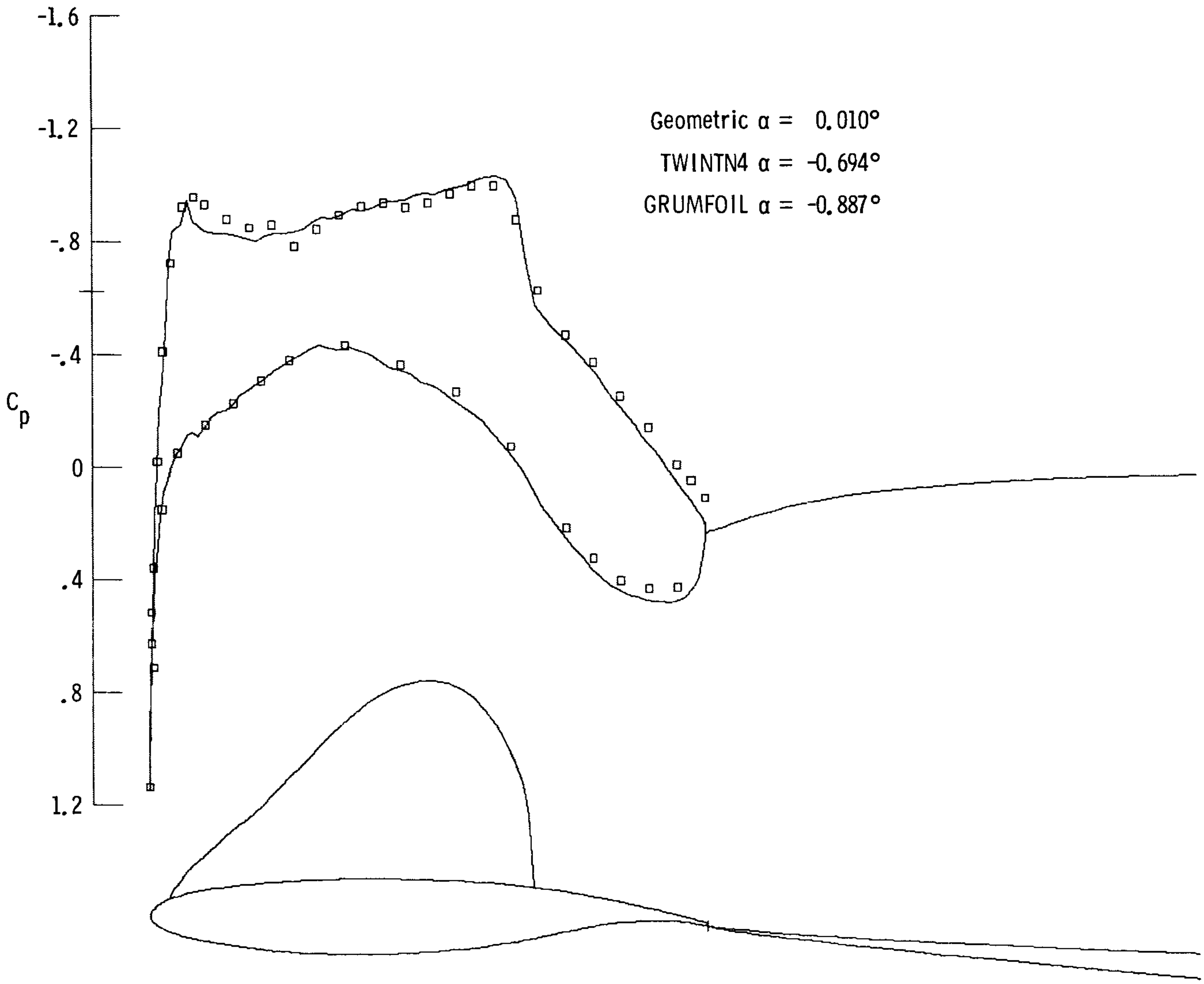



Figure 7.- Data corrected for all four walls with nonzero upstream angularity compared with theoretical results. M = 0.740; $c_n$ = 0.6046; R = 30 million.

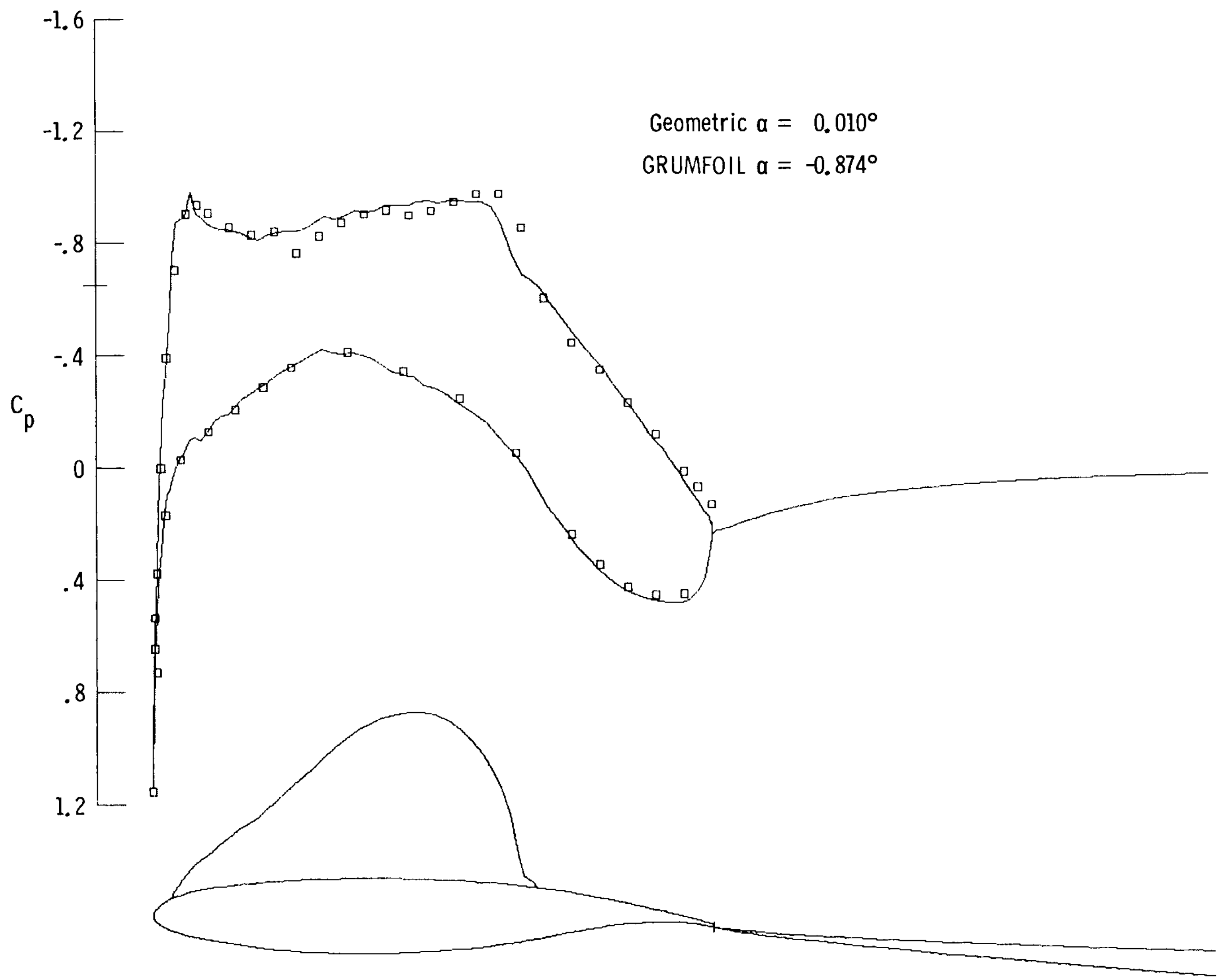
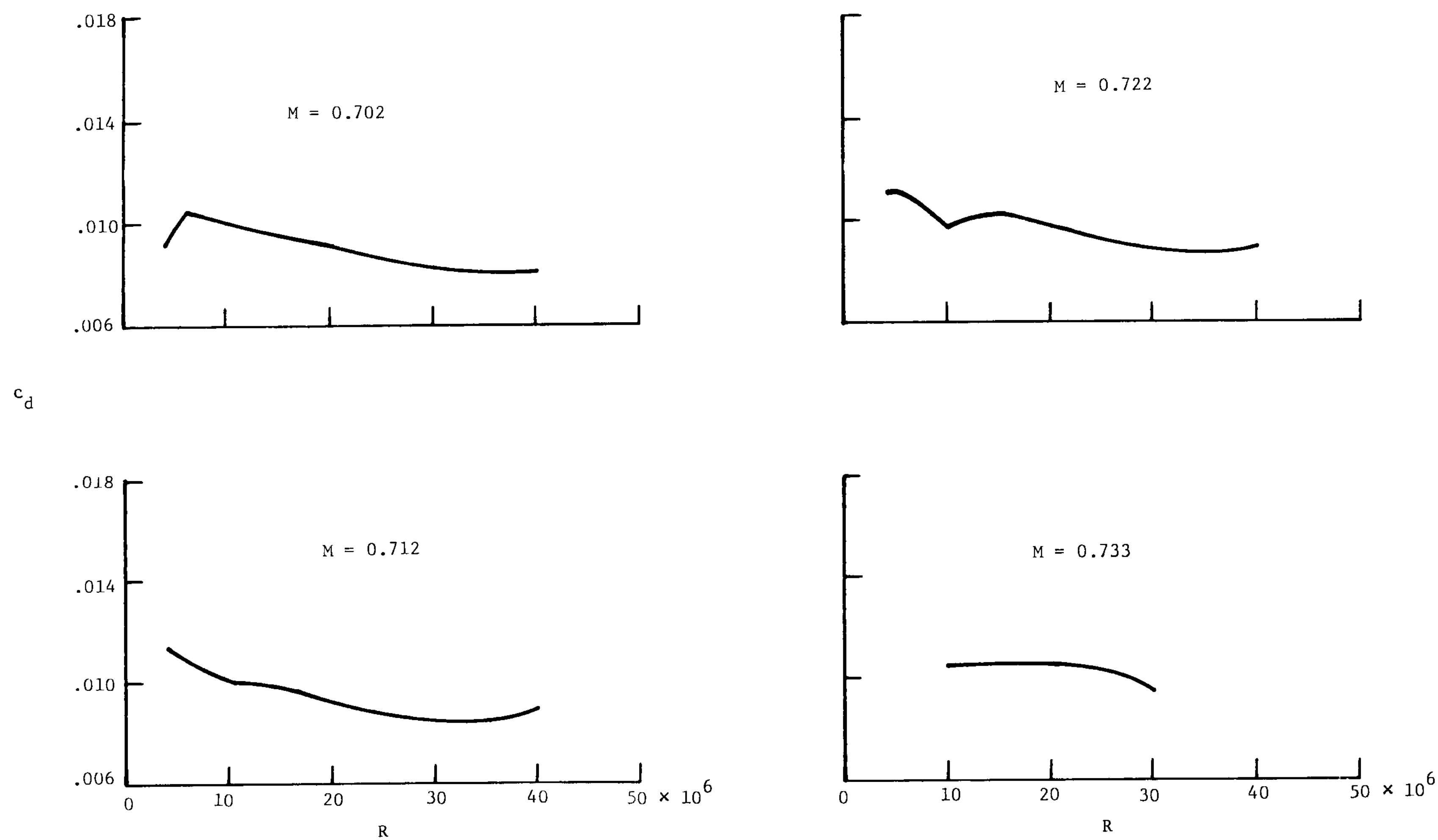
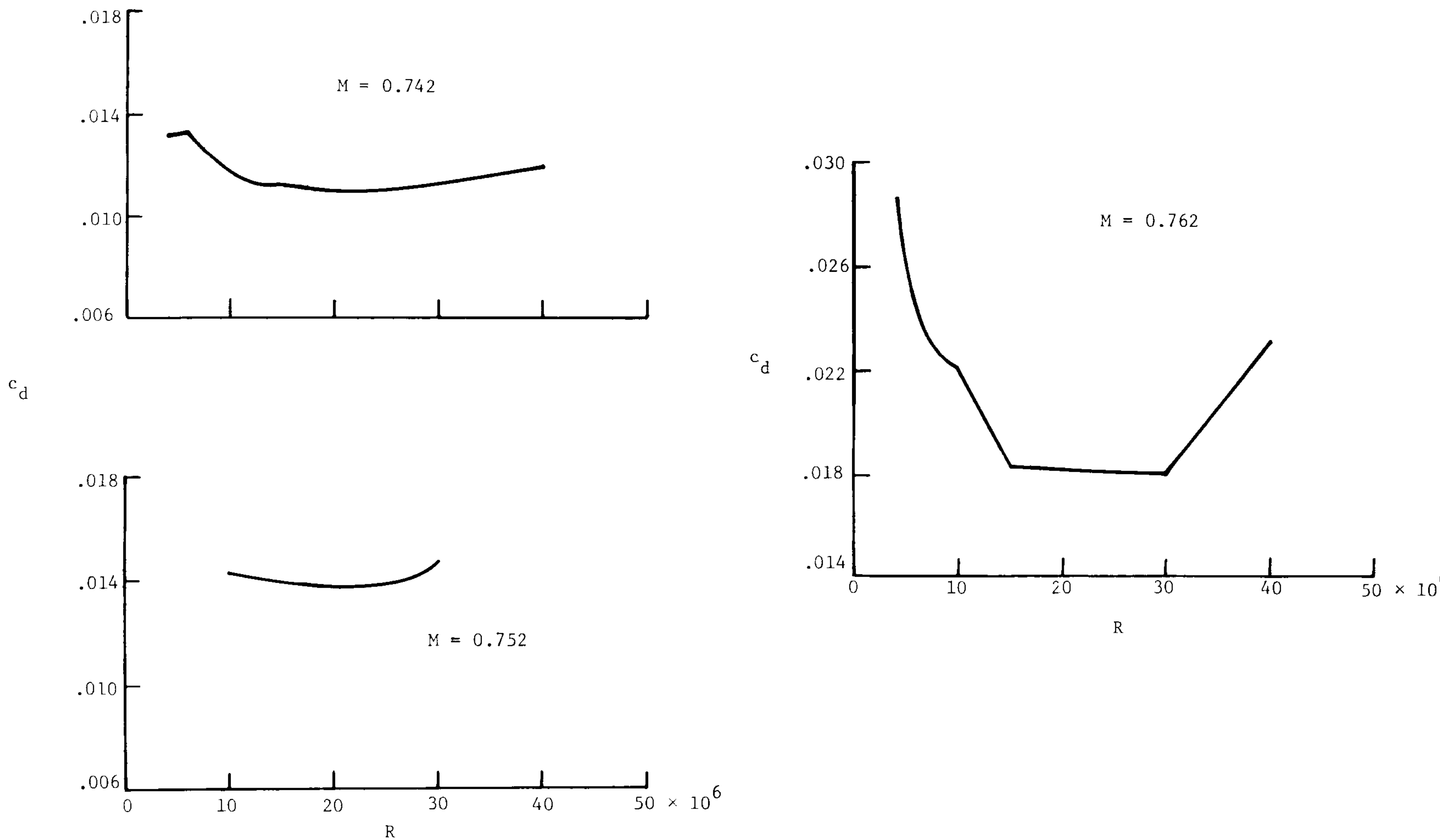



Figure 8.- Data corrected for sidewalls only compared with theoretical results. M = 0.734; $c_n$ = 0.6037; R = 30 million.



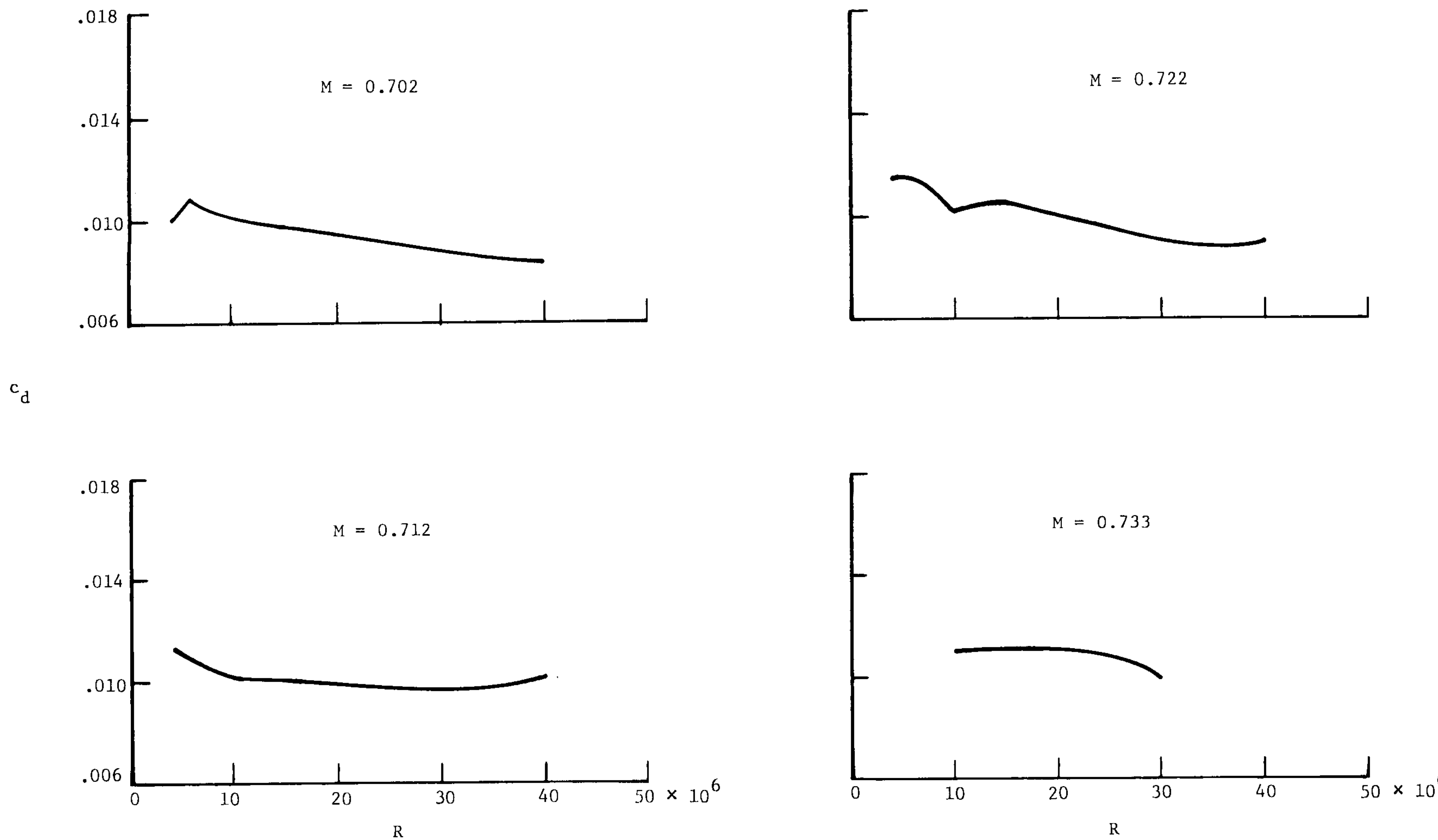

(a) $c_n = 0.508$.

Figure 9.- Profile-drag coefficient versus Reynolds number at various normal-force coefficients. Data corrected by method of reference 9.



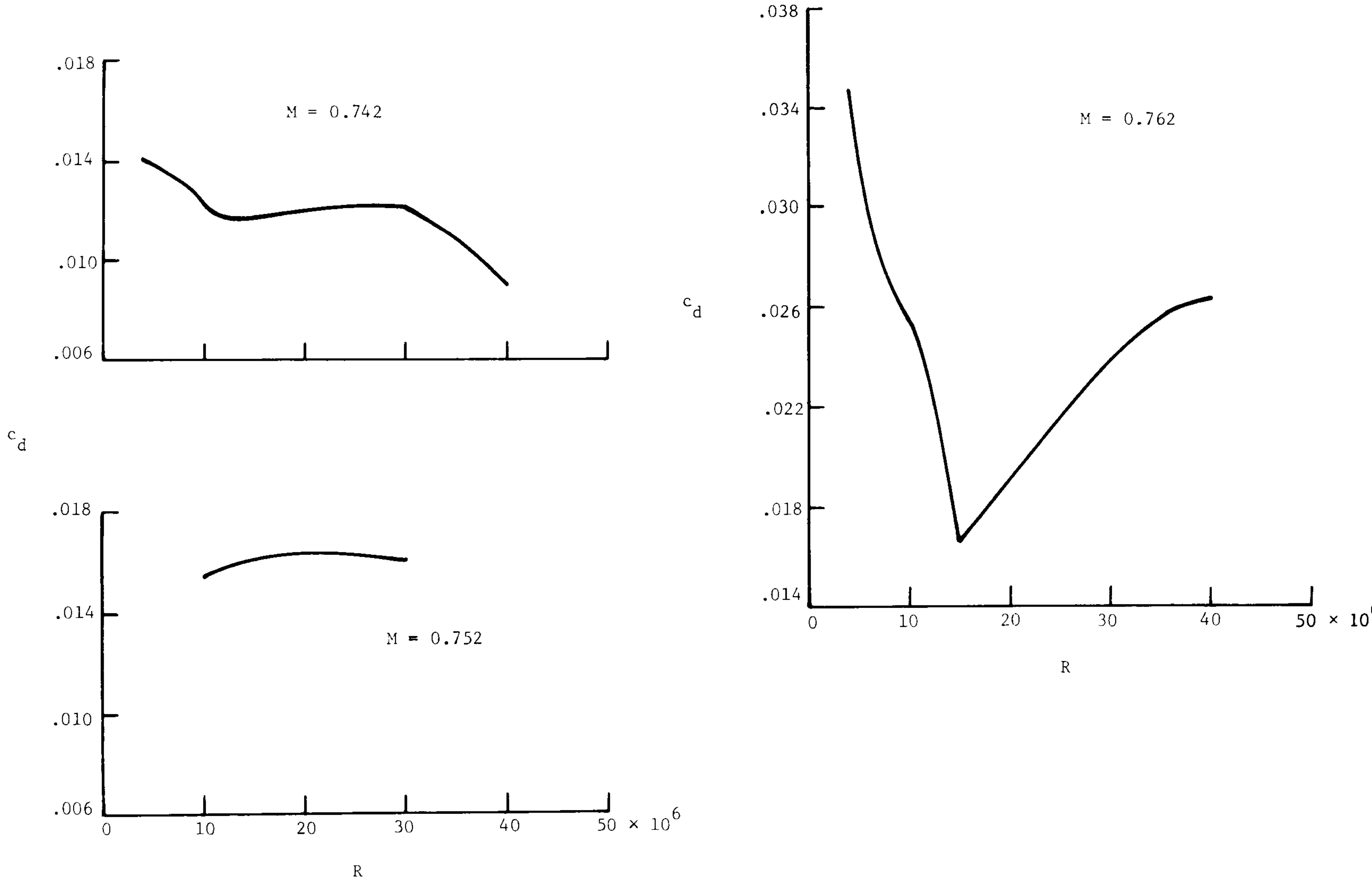

(a) Concluded.

Figure 9.- Continued.



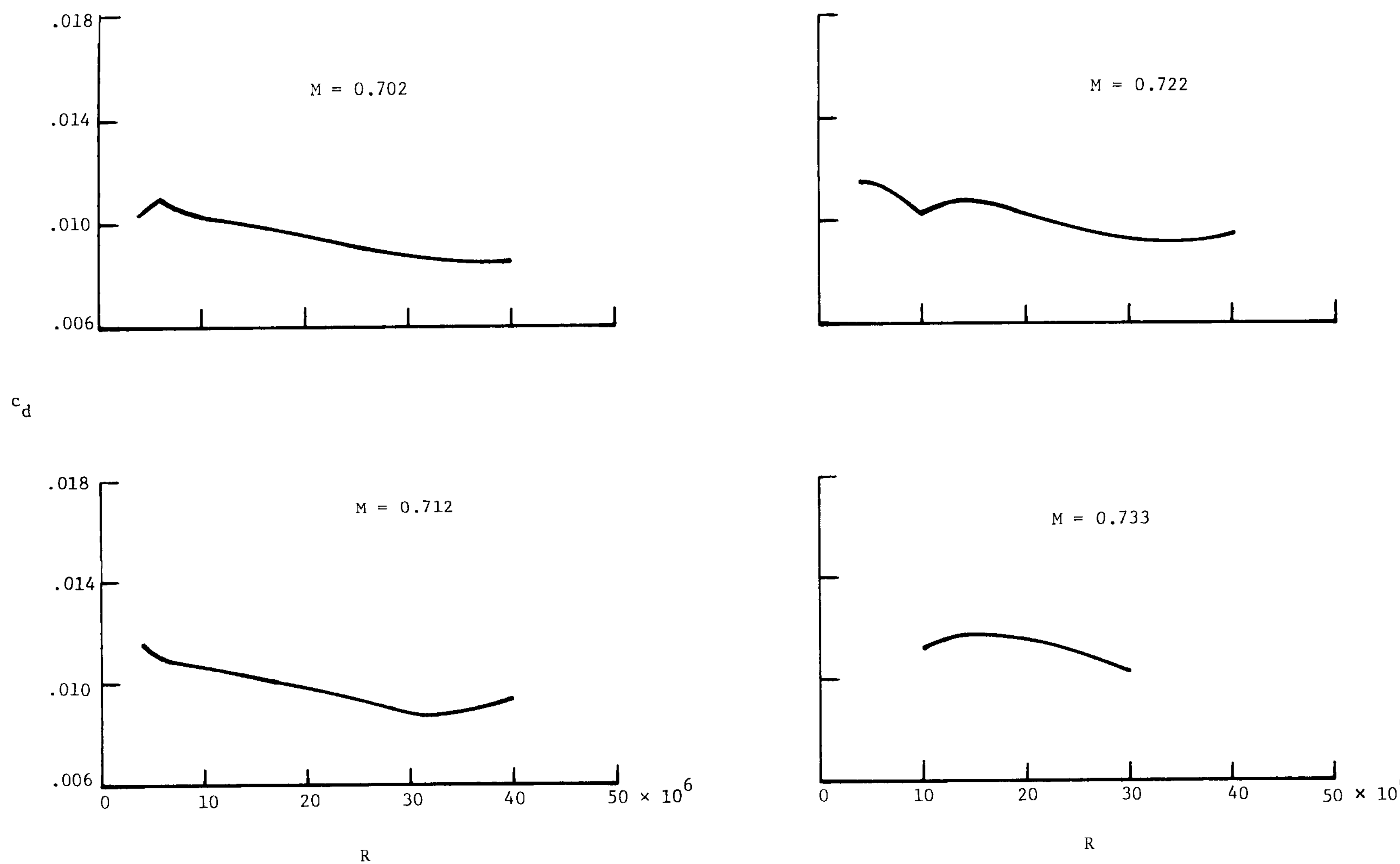

(b) $c_n$ = 0.559.

Figure 9.- Continued.



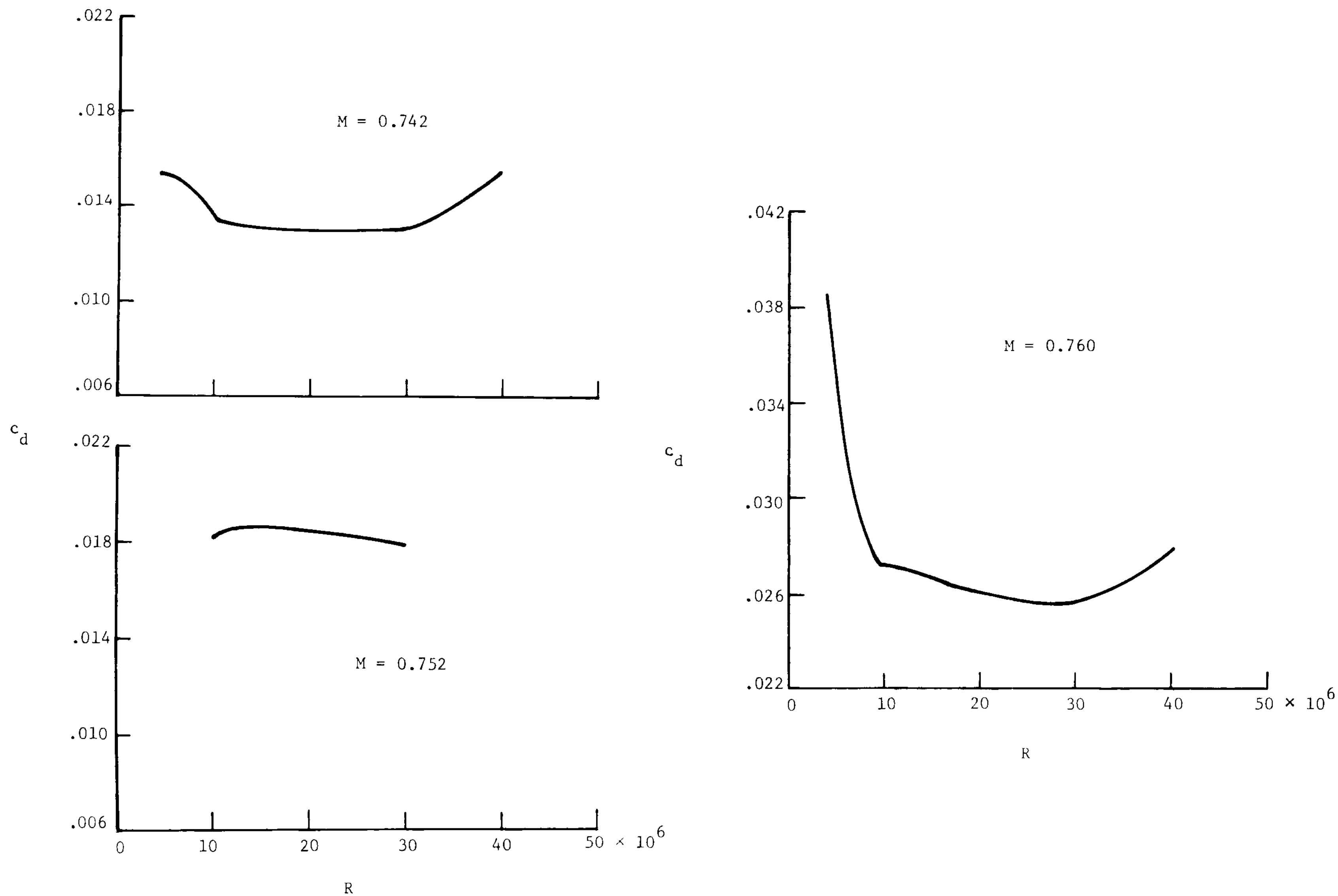

(b) Concluded.

Figure 9.- Continued.



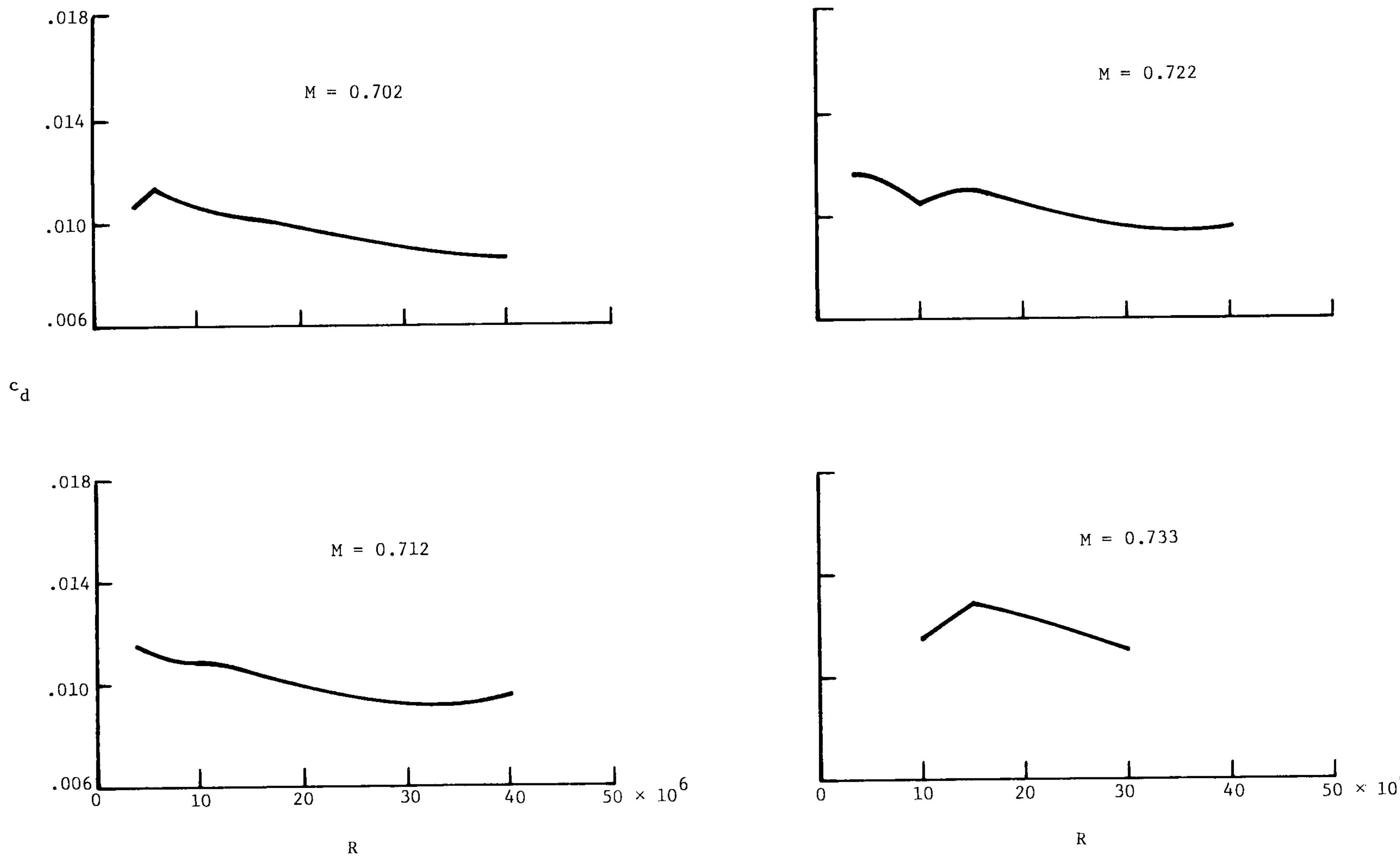

(c) $c_n = 0.609$.

Figure 9.- Continued.



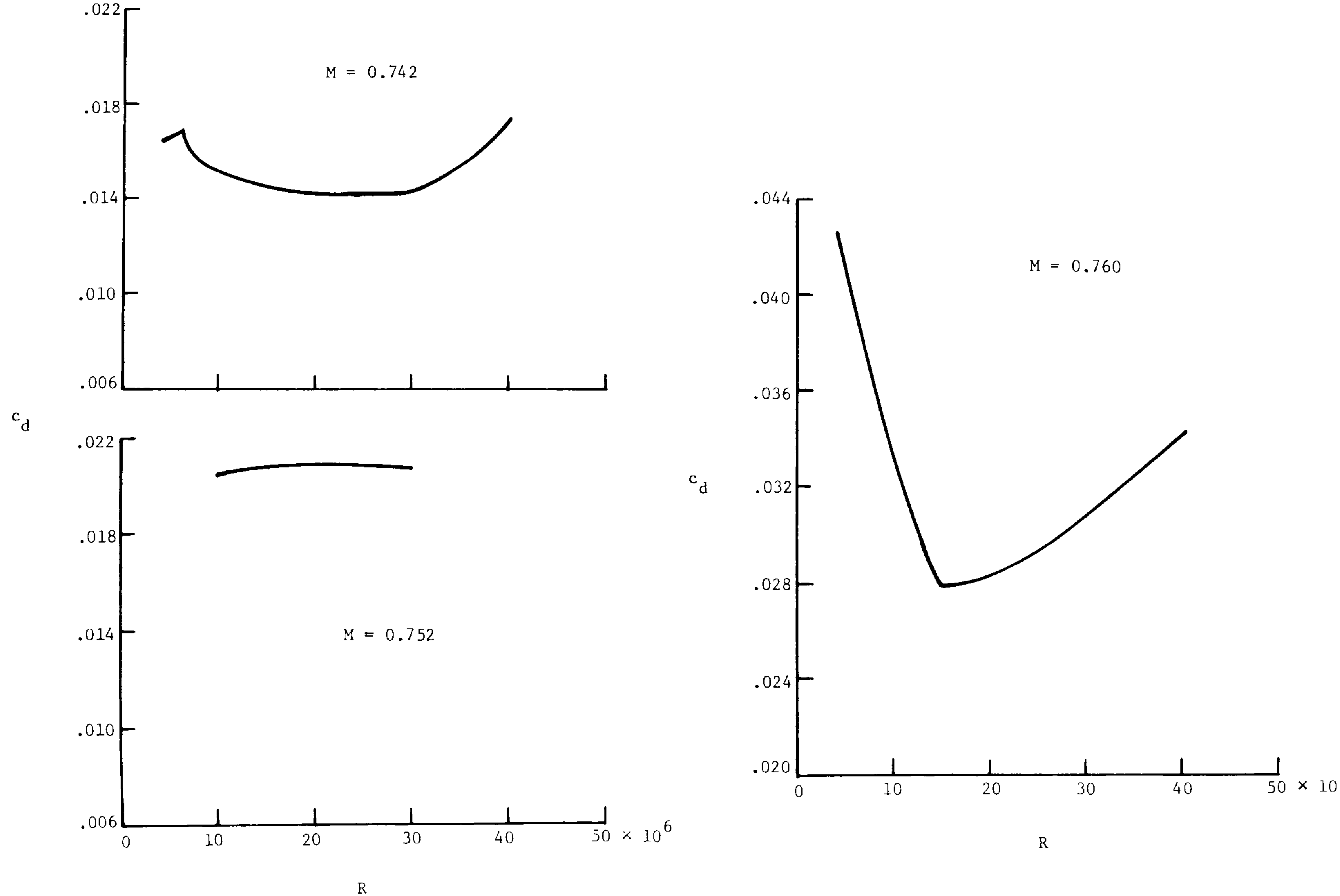

(c) Concluded.

Figure 9.- Continued.



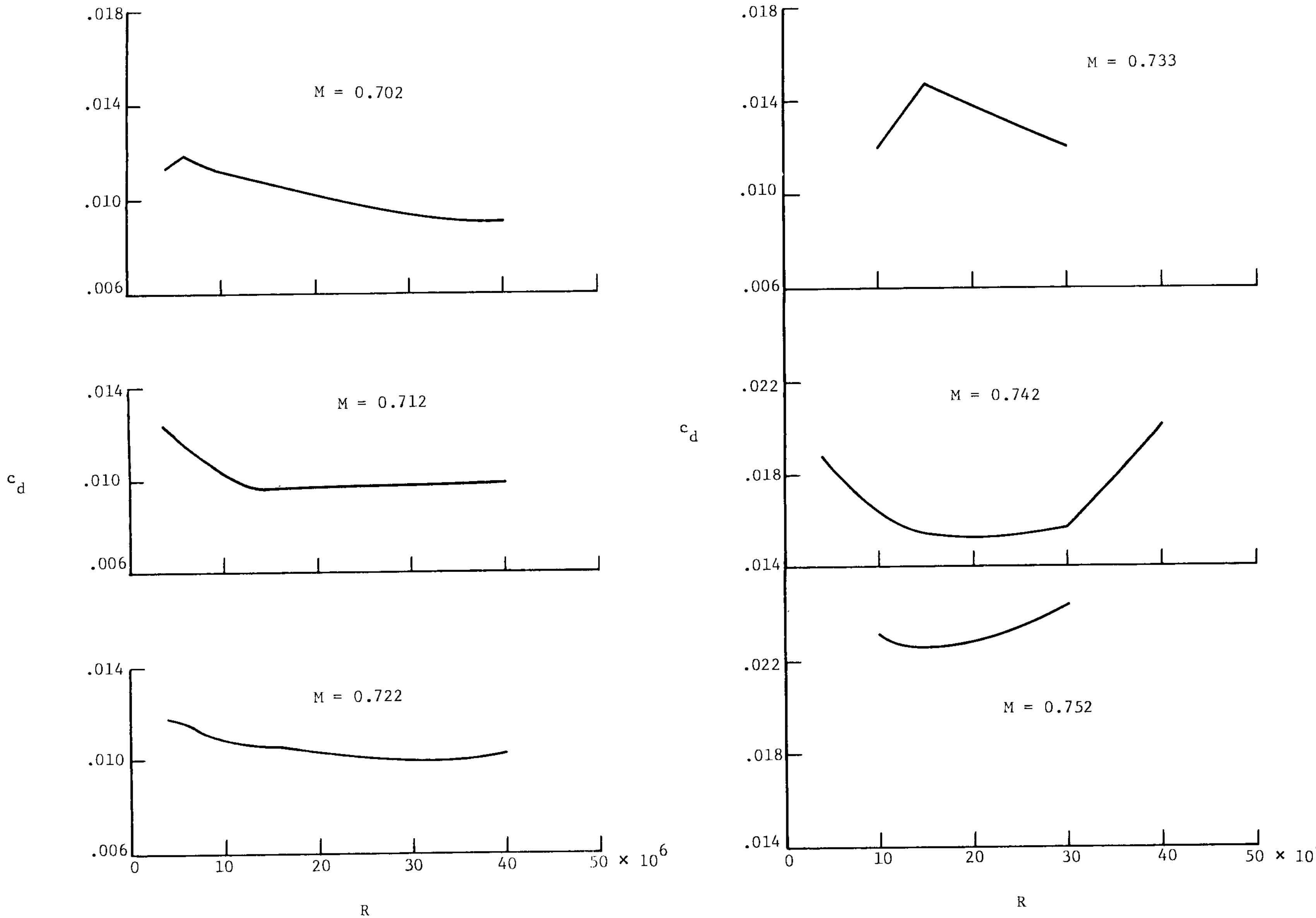

(d) $c_n = 0.660$.

Figure 9.- Continued.



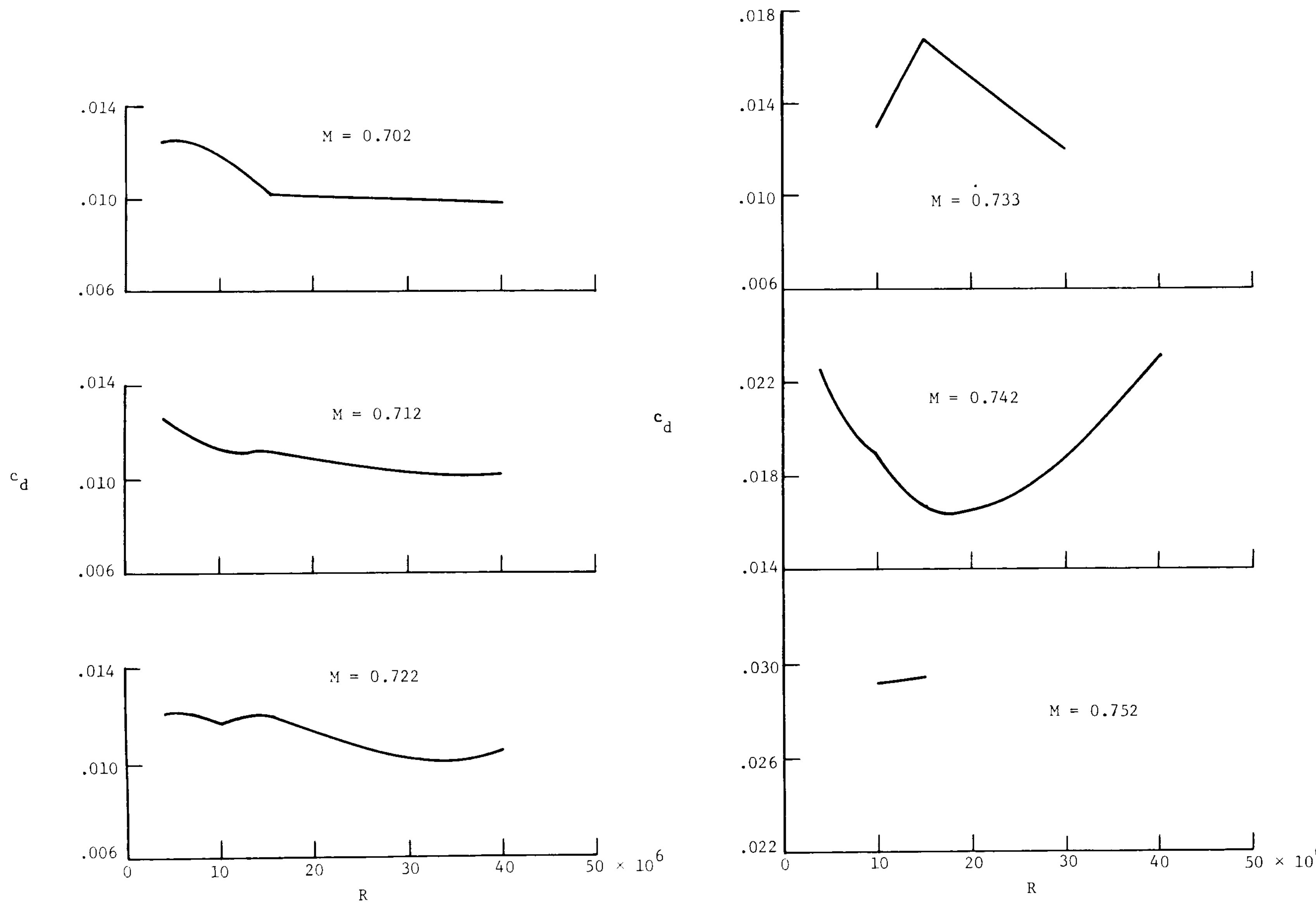

(d) Concluded.

Figure 9.- Continued.



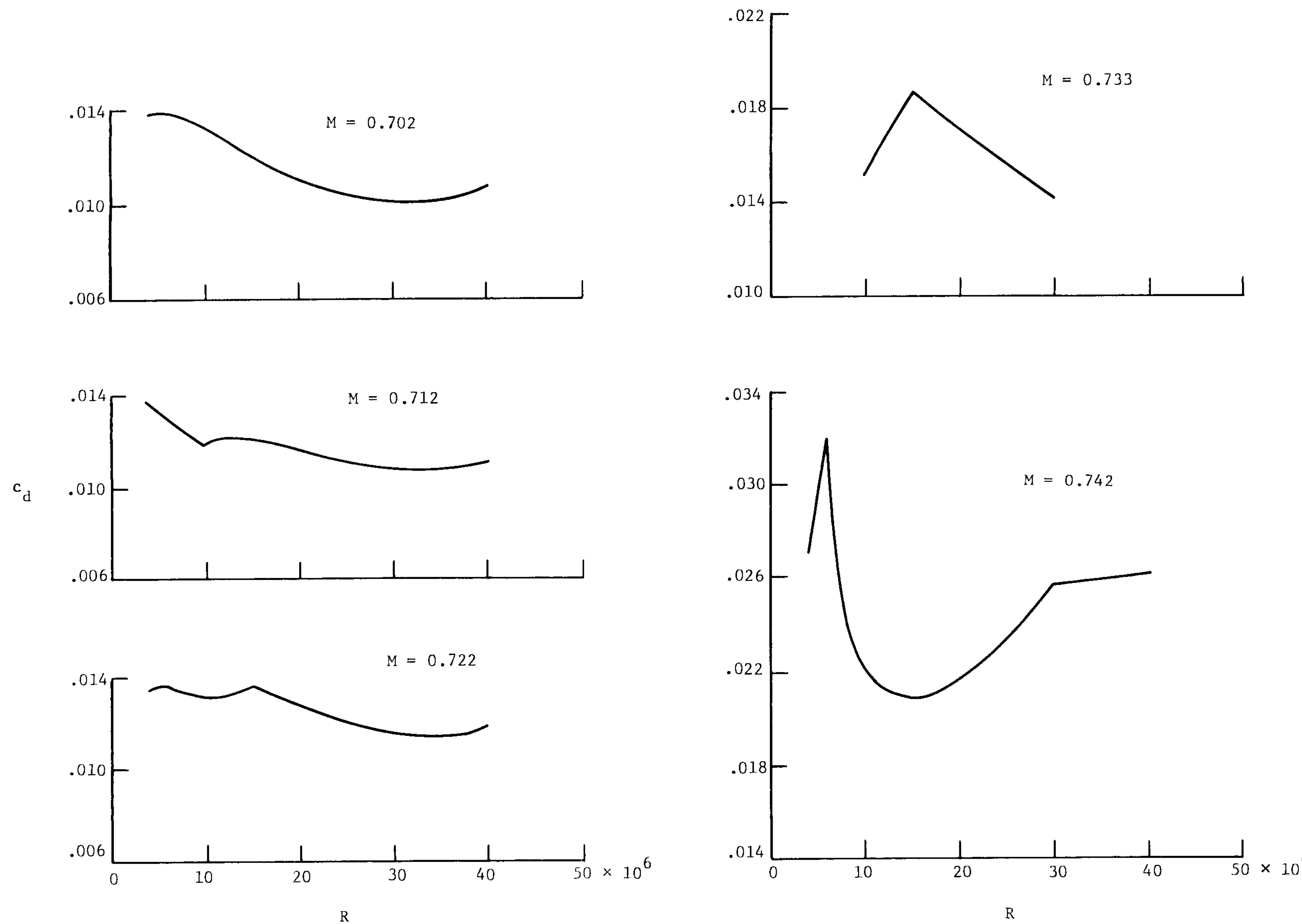

(e) $c_n = 0.711$.

Figure 9.- Continued.



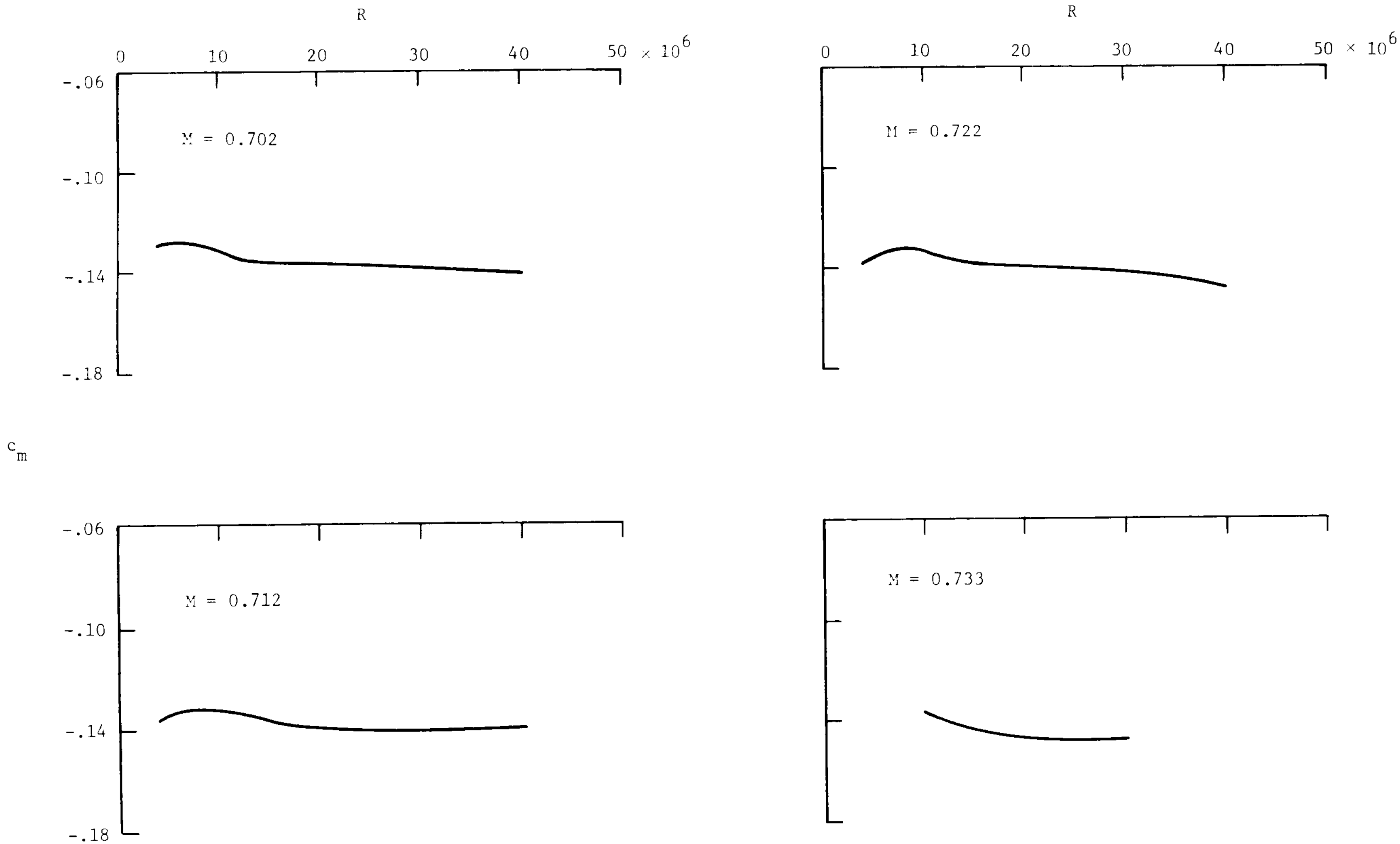

(f) $c_n = 0.762$.

Figure 9.- Continued.



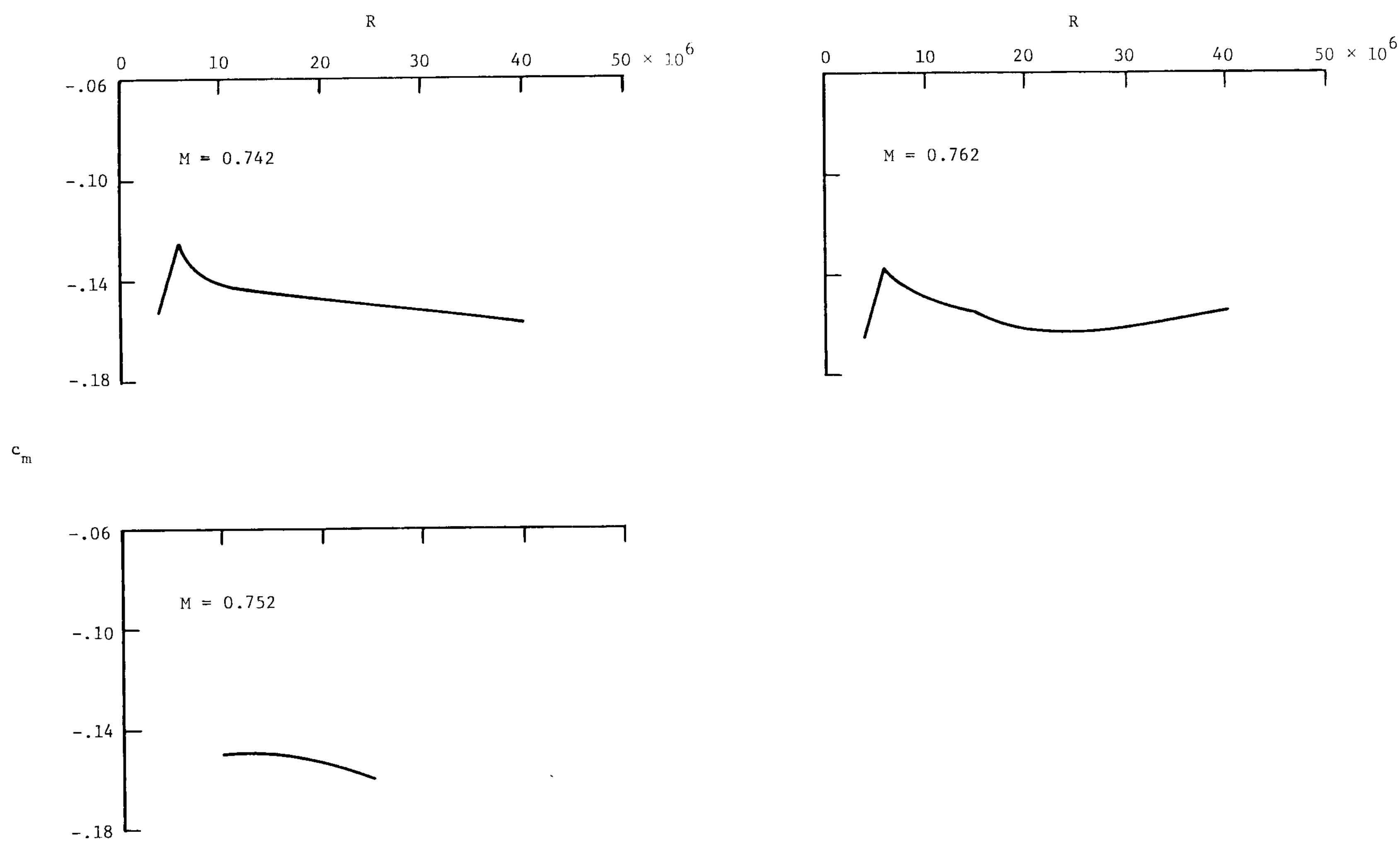

(g) $c_n = 0.813$.

Figure 9.- Concluded.



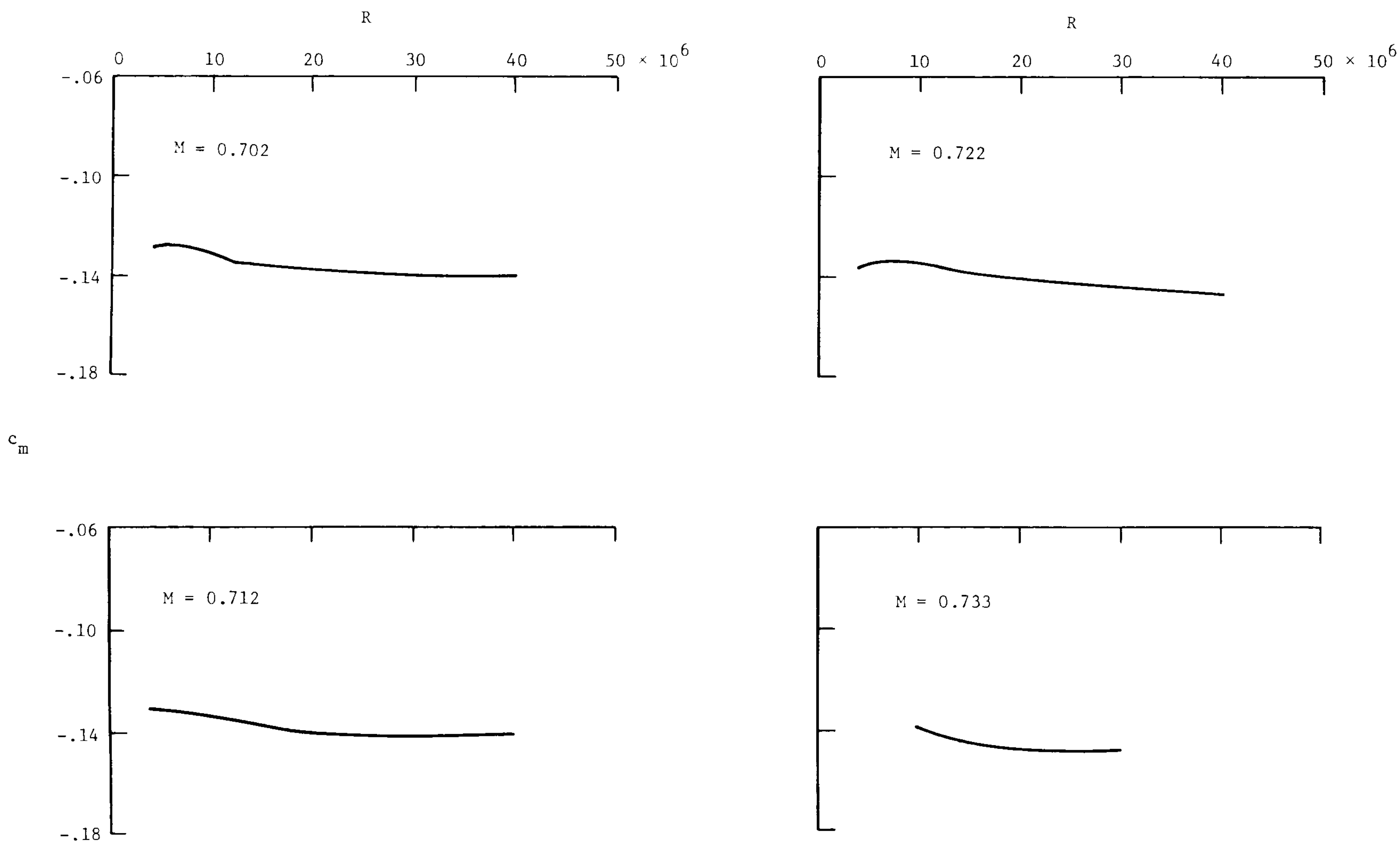

(a) $c_n = 0.508$.

Figure 10.- Quarter-chord pitching-moment coefficient versus Reynolds number for various normal-force coefficients. Data corrected by method of reference 9.



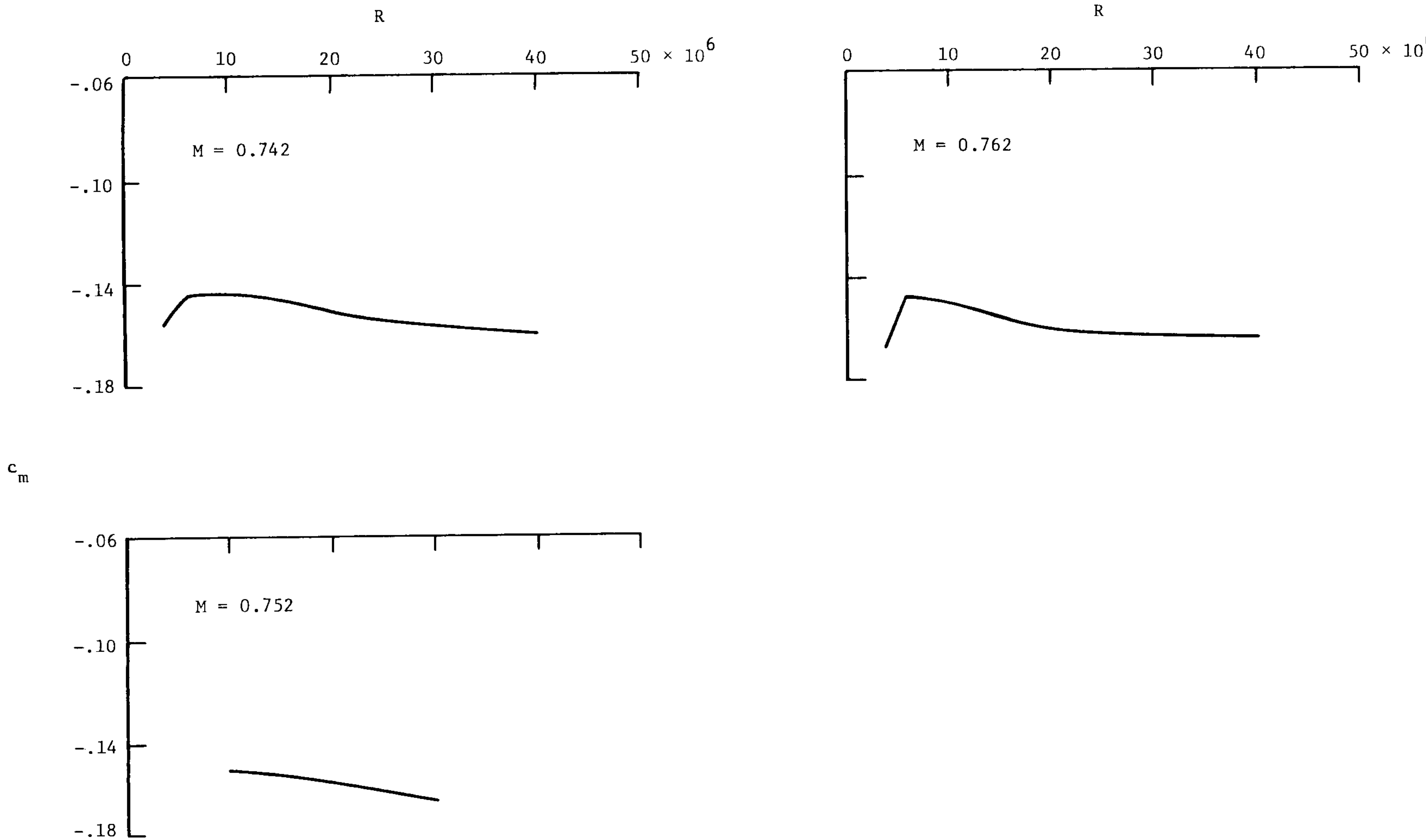

(a) Concluded.

Figure 10.- Continued.



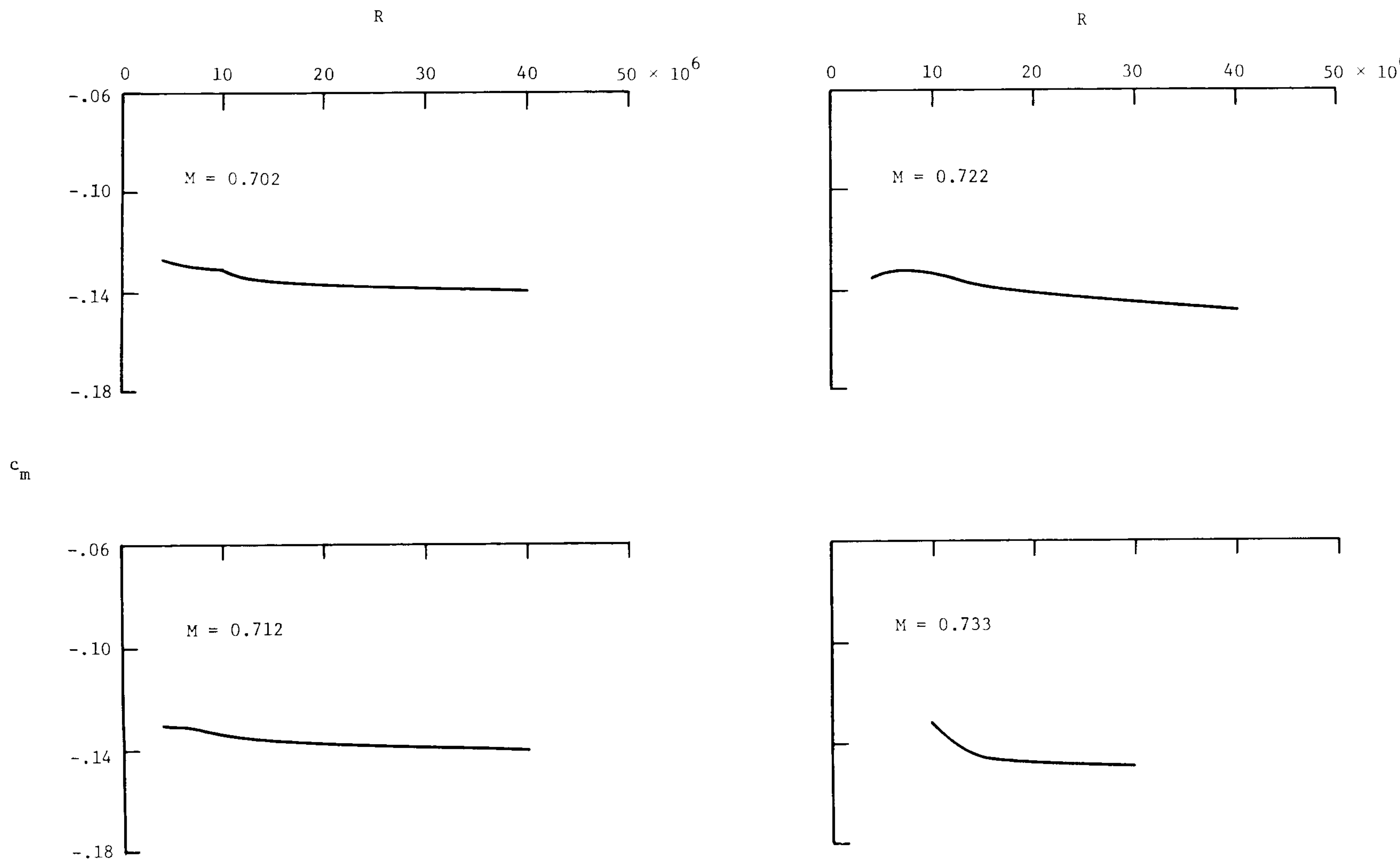

(b) $c_n = 0.559$.

Figure 10.- Continued.



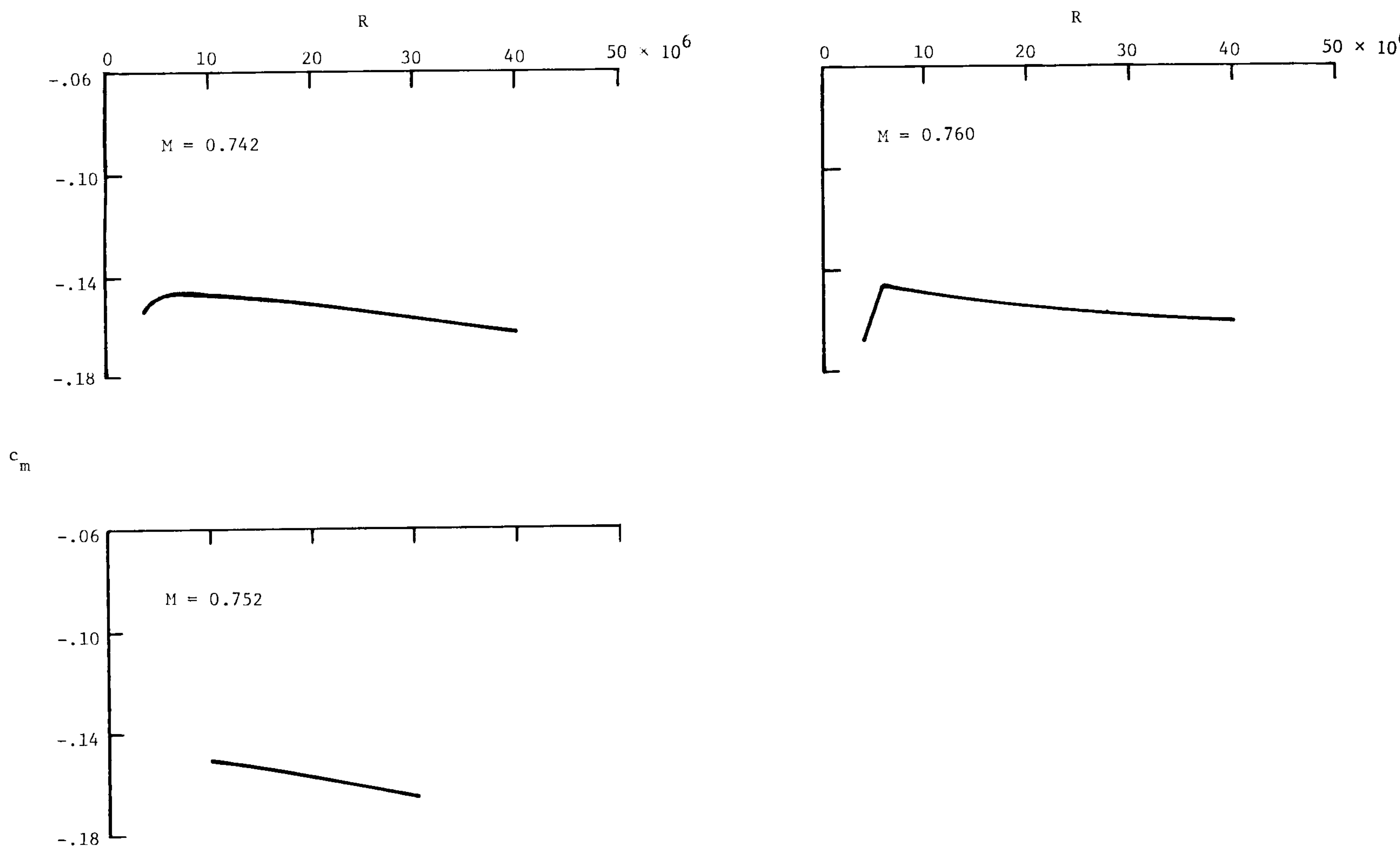

(b) Concluded.

Figure 10.- Continued.



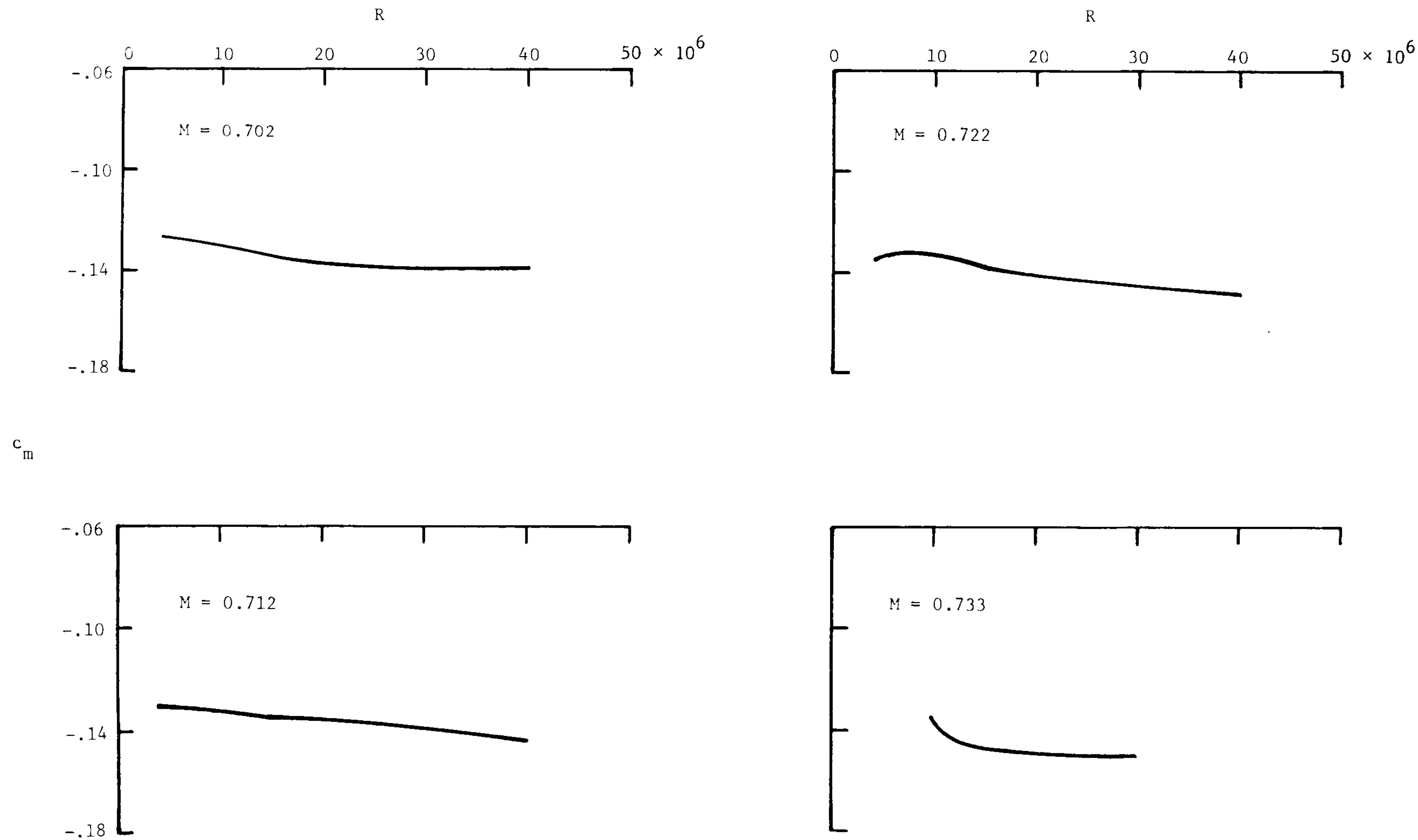

(c) $c_n = 0.609$.

Figure 10.- Continued.



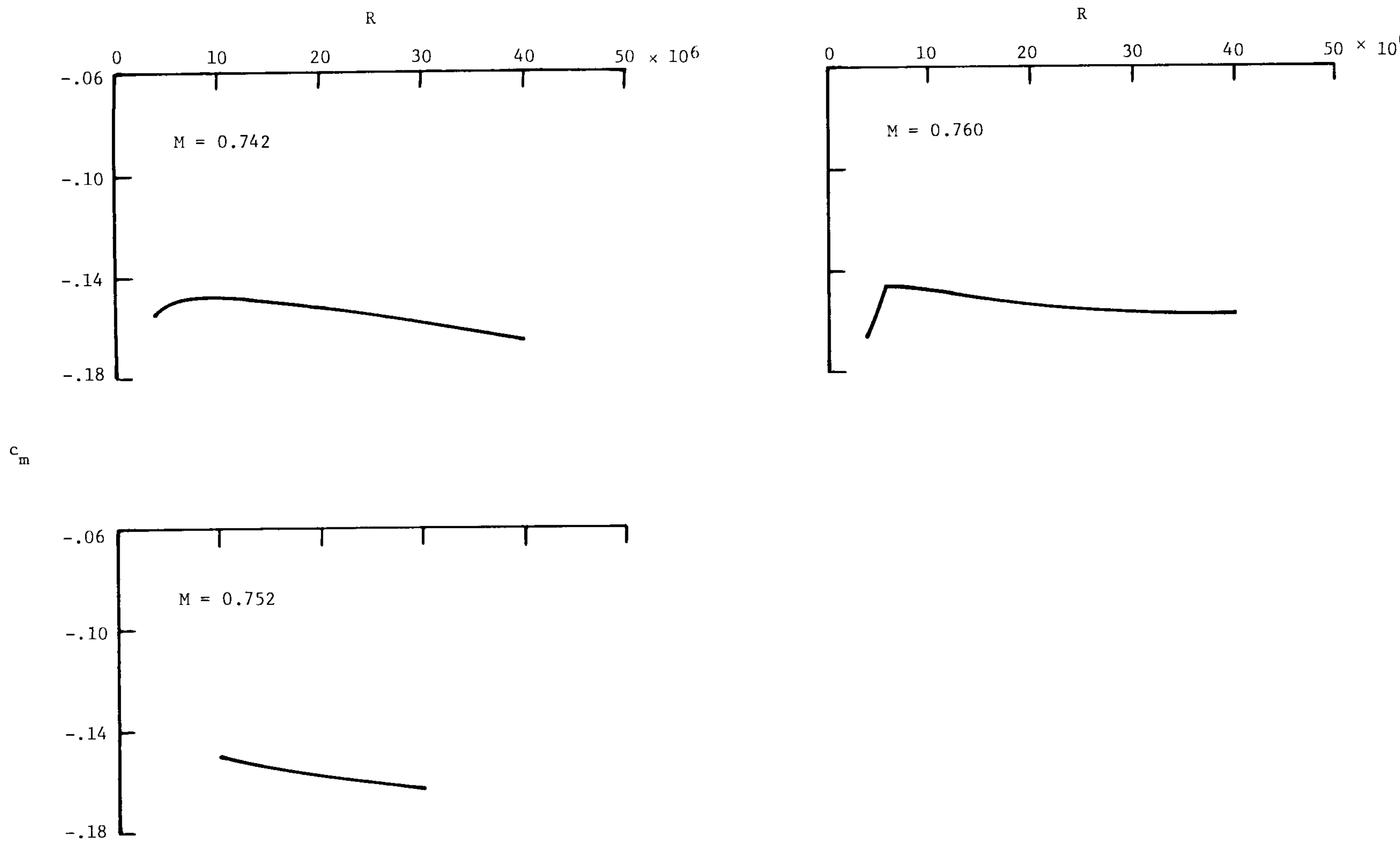

(c) Concluded.

Figure 10.- Continued.



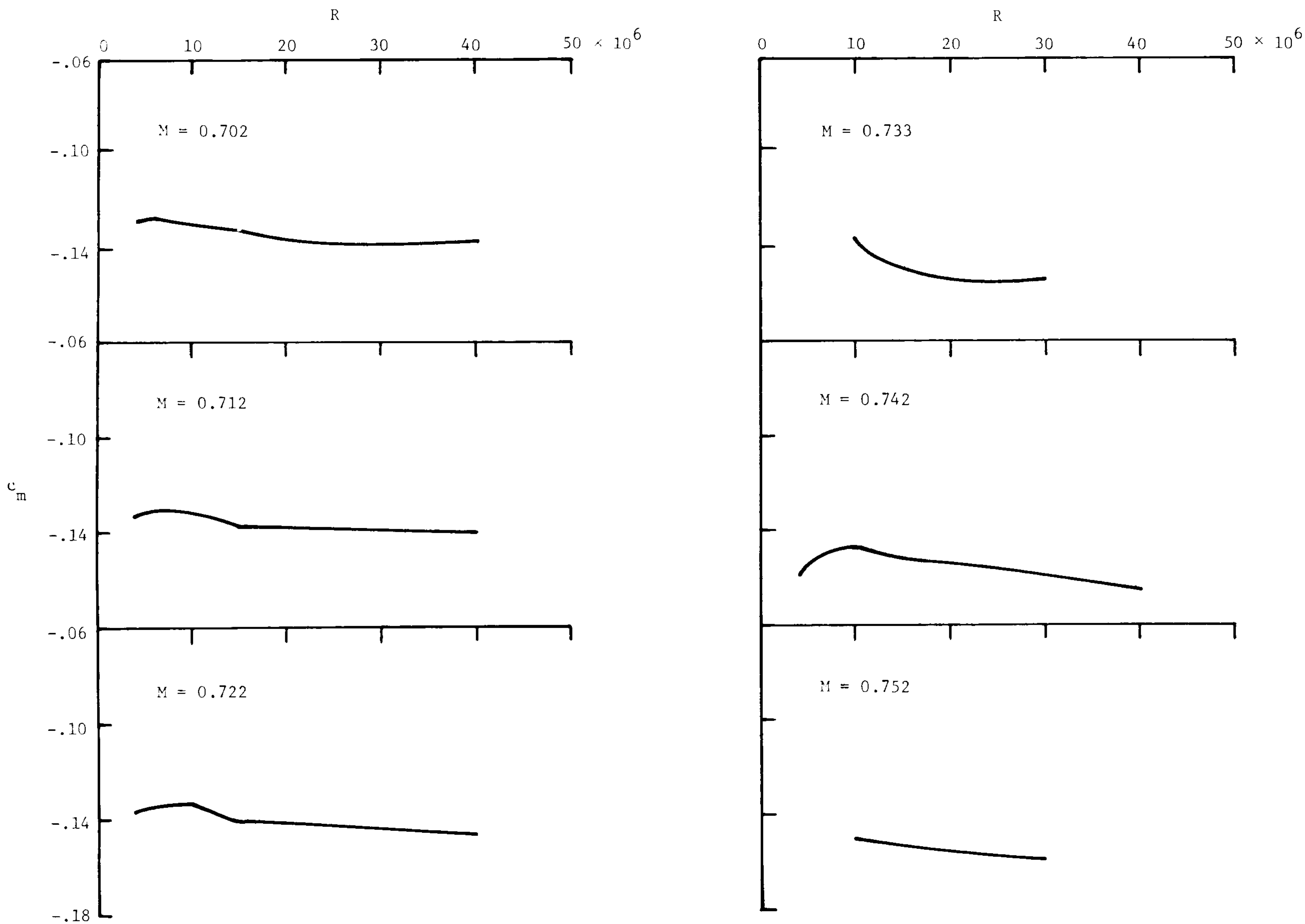

(d) $c_n = 0.660$.

Figure 10.- Continued.



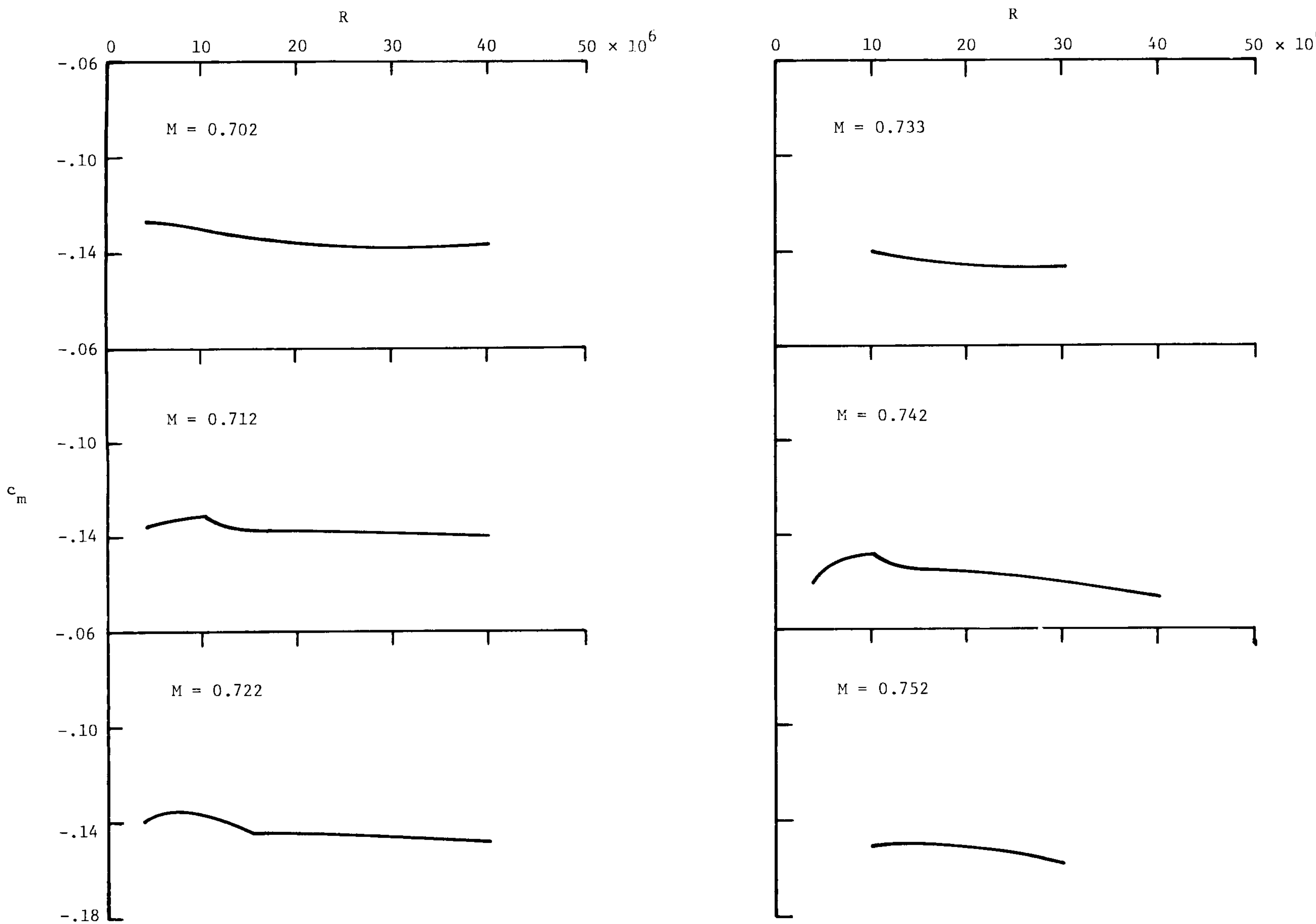

(d) Concluded.

Figure 10.- Continued.



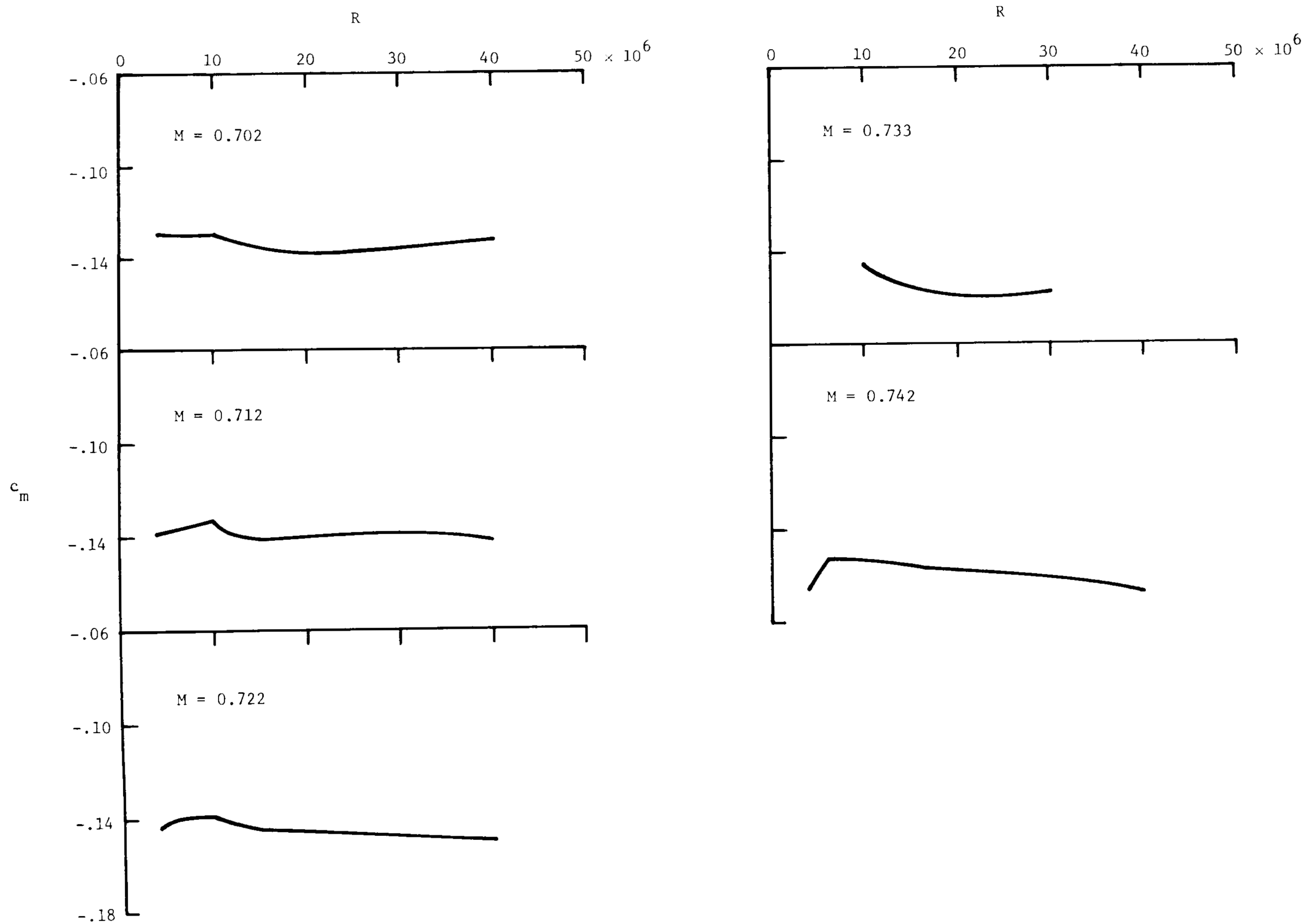

(e) $c_n = 0.711$.

Figure 10.- Continued.




(f) $c_n = 0.762$.

Figure 10.- Continued.




(g) $c_n = 0.813$.

Figure 10.- Concluded.

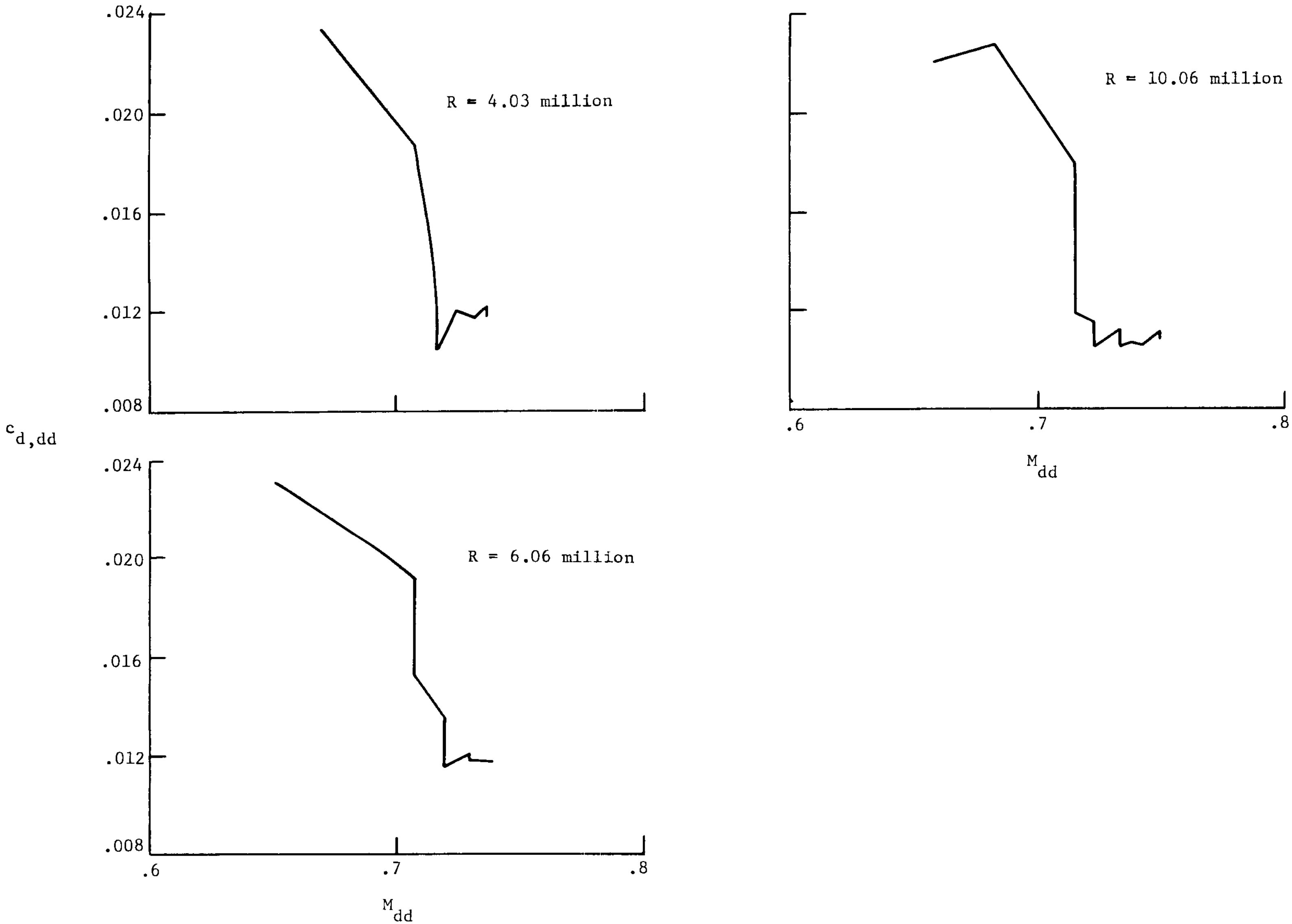



Figure 11.- Drag-divergence profile-drag coefficient versus drag-divergence Mach number for six test Reynolds numbers. All data corrected for sidewalls (ref. 9).

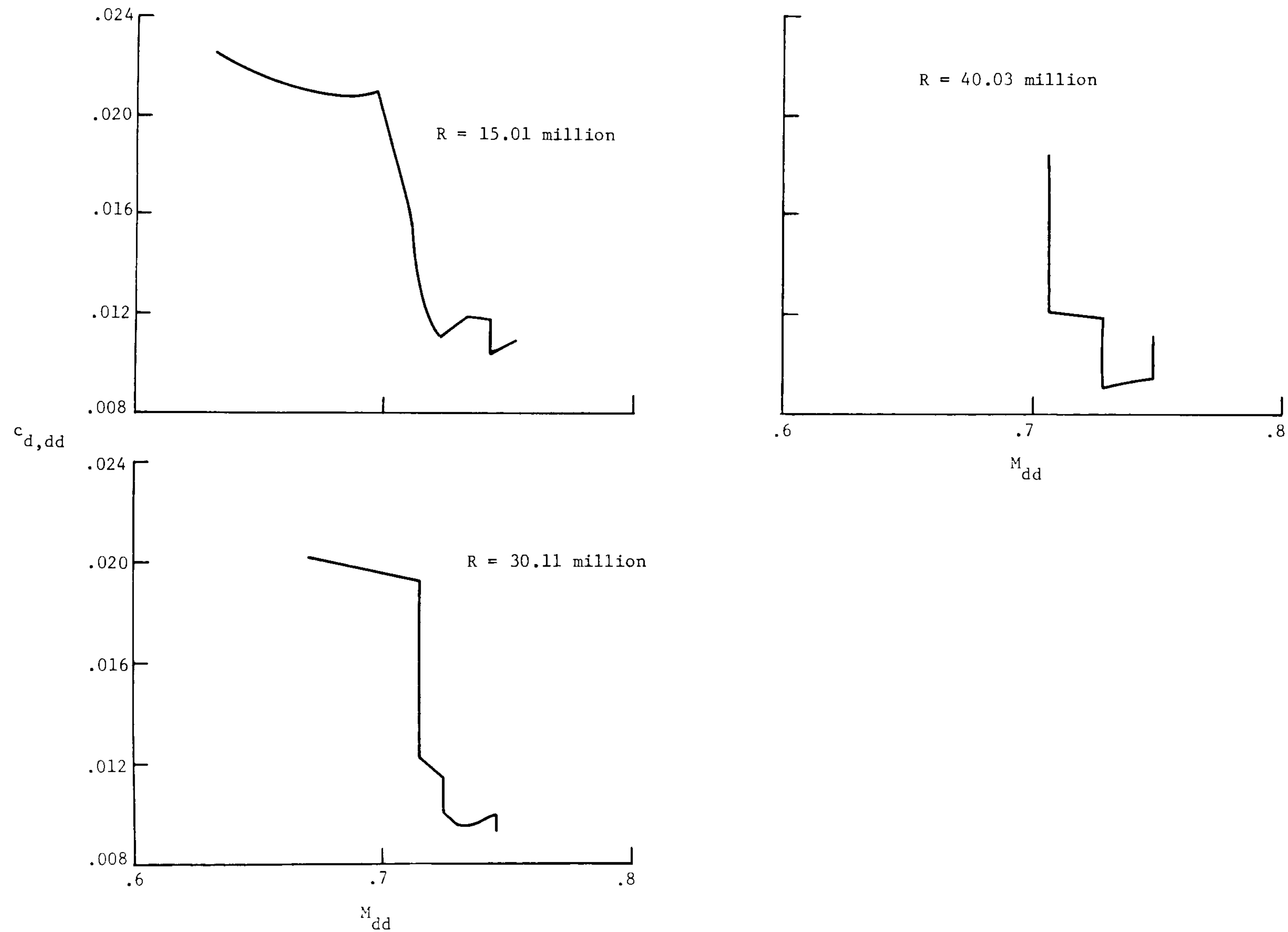



Figure 11.- Concluded.

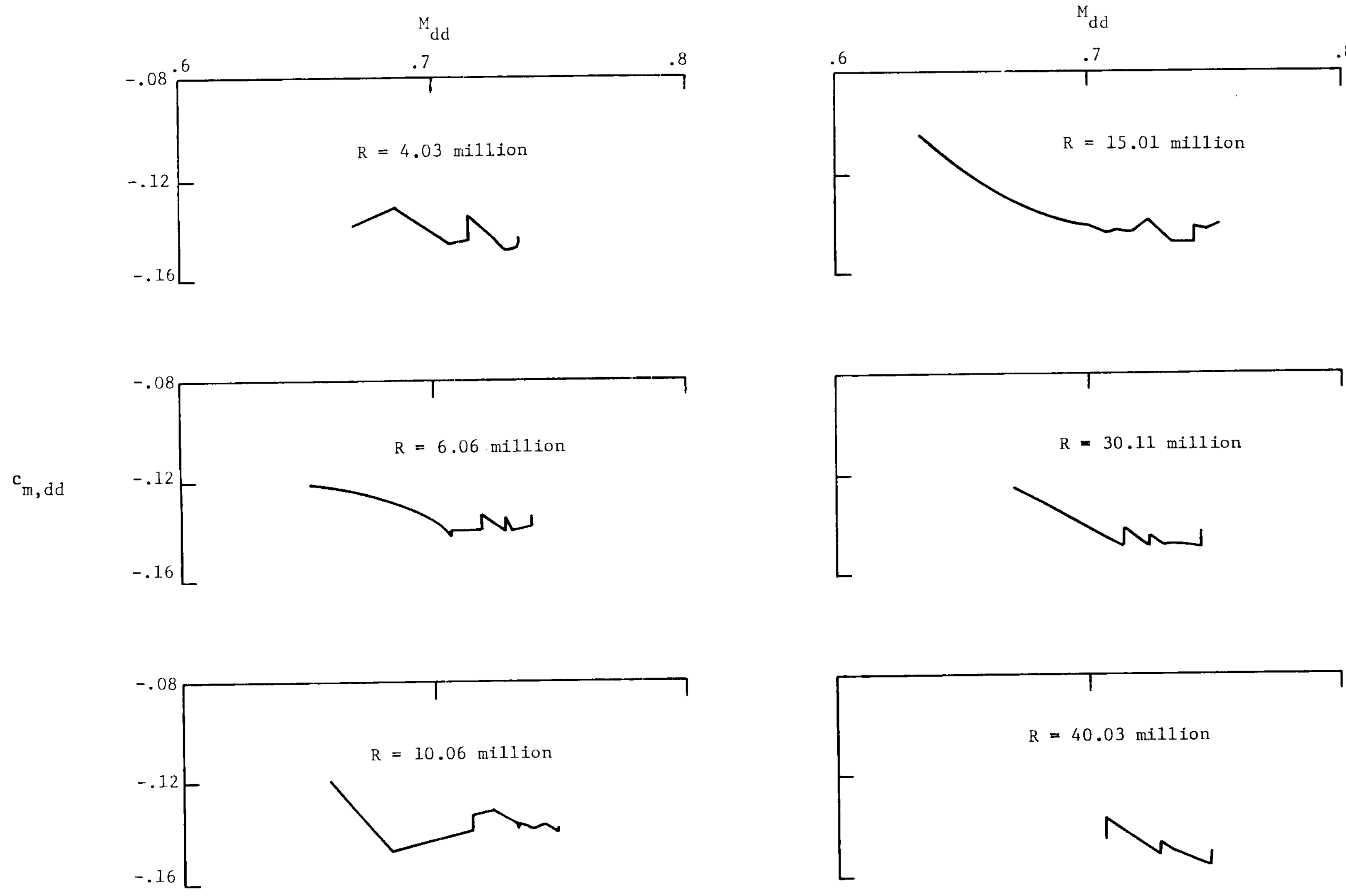



Figure 12.- Drag-divergence quarter-chord pitching-moment coefficient versus drag-divergence Mach number for six test Reynolds numbers. All data corrected for sidewalls (ref. 9).

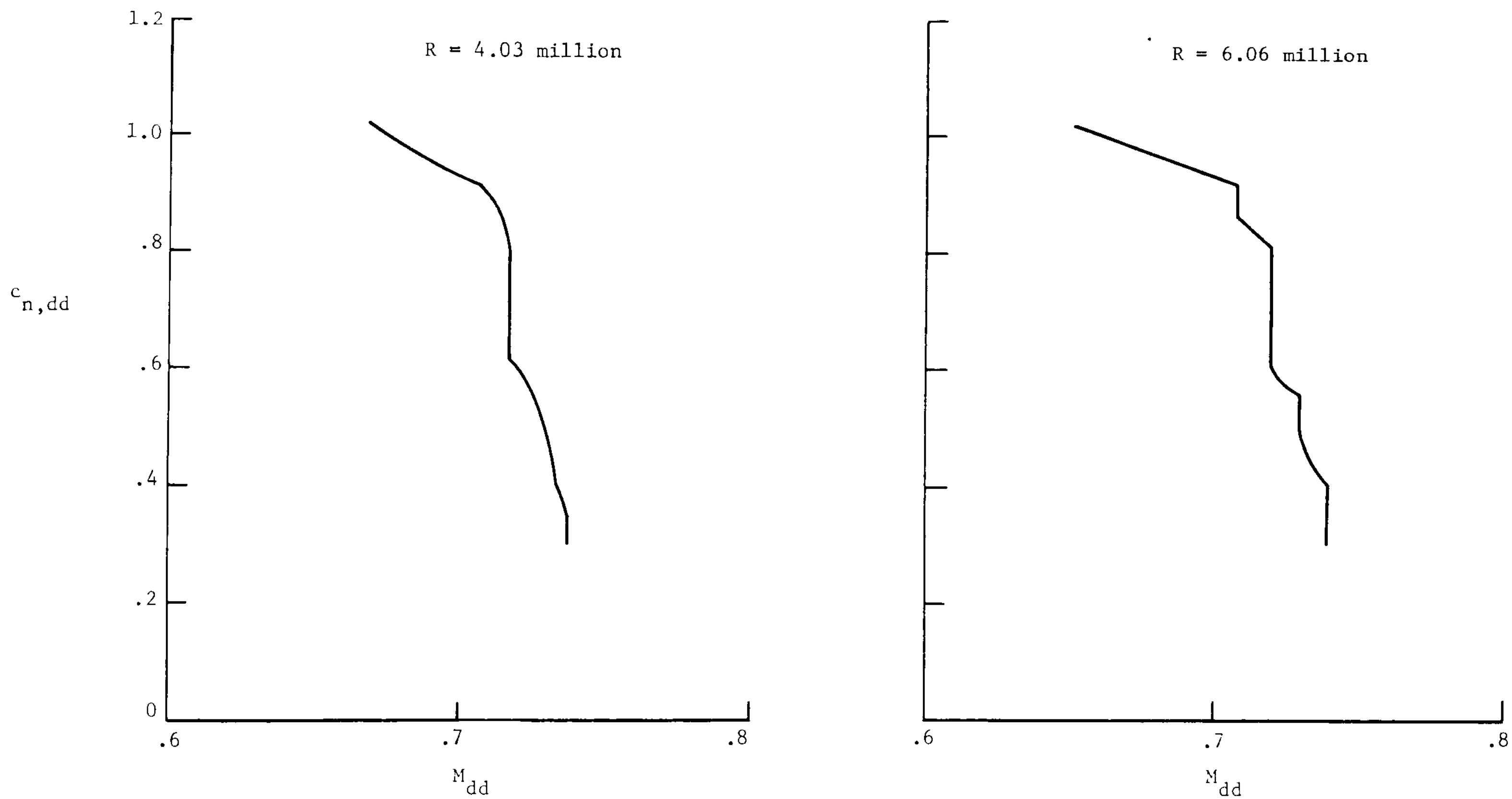



Figure 13.- Drag-divergence normal-force coefficient versus drag-divergence Mach number for six test Reynolds numbers. All data corrected for sidewalls (ref. 9).

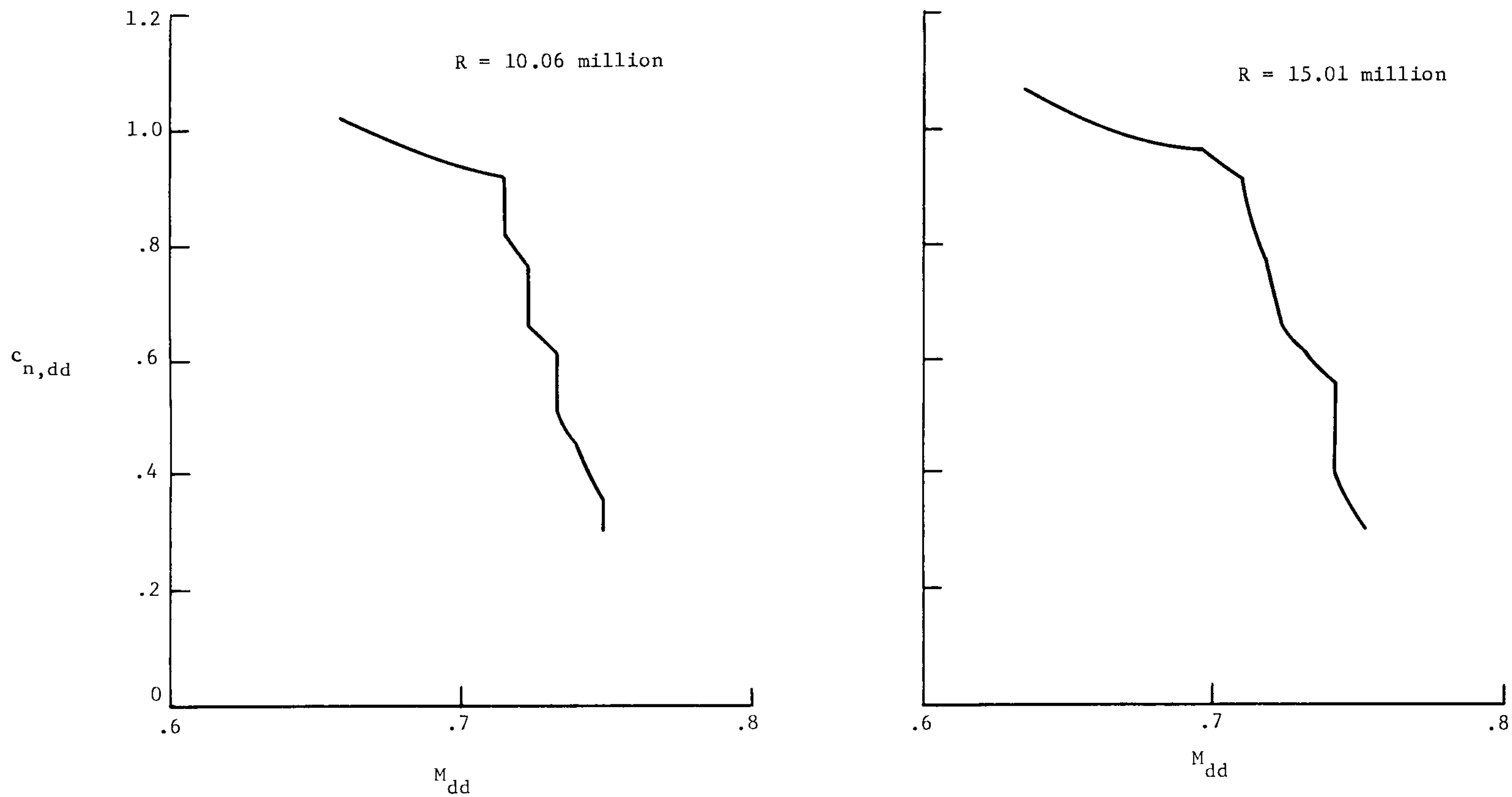



Figure 13.- Continued.

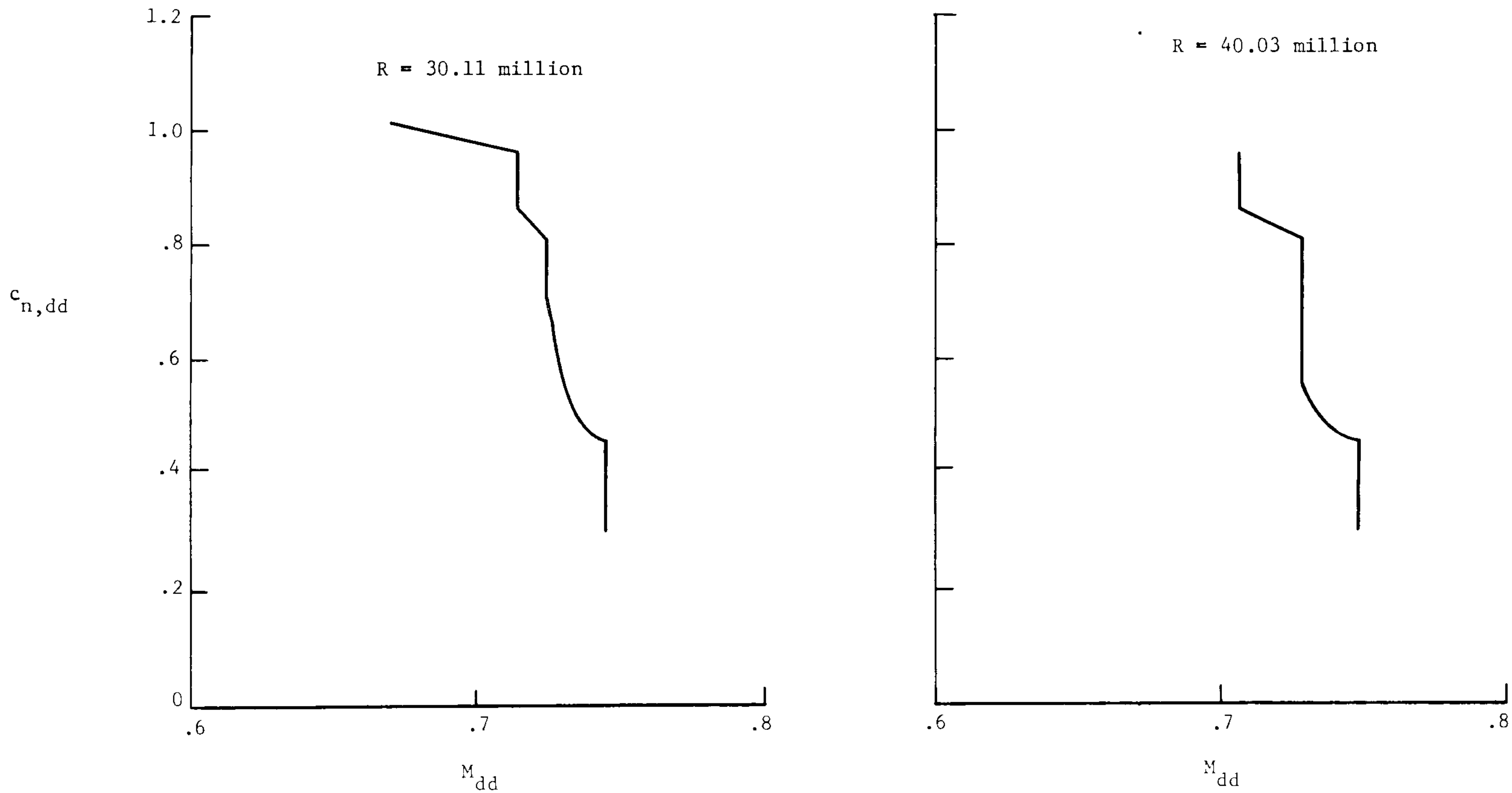



Figure 13.- Concluded.

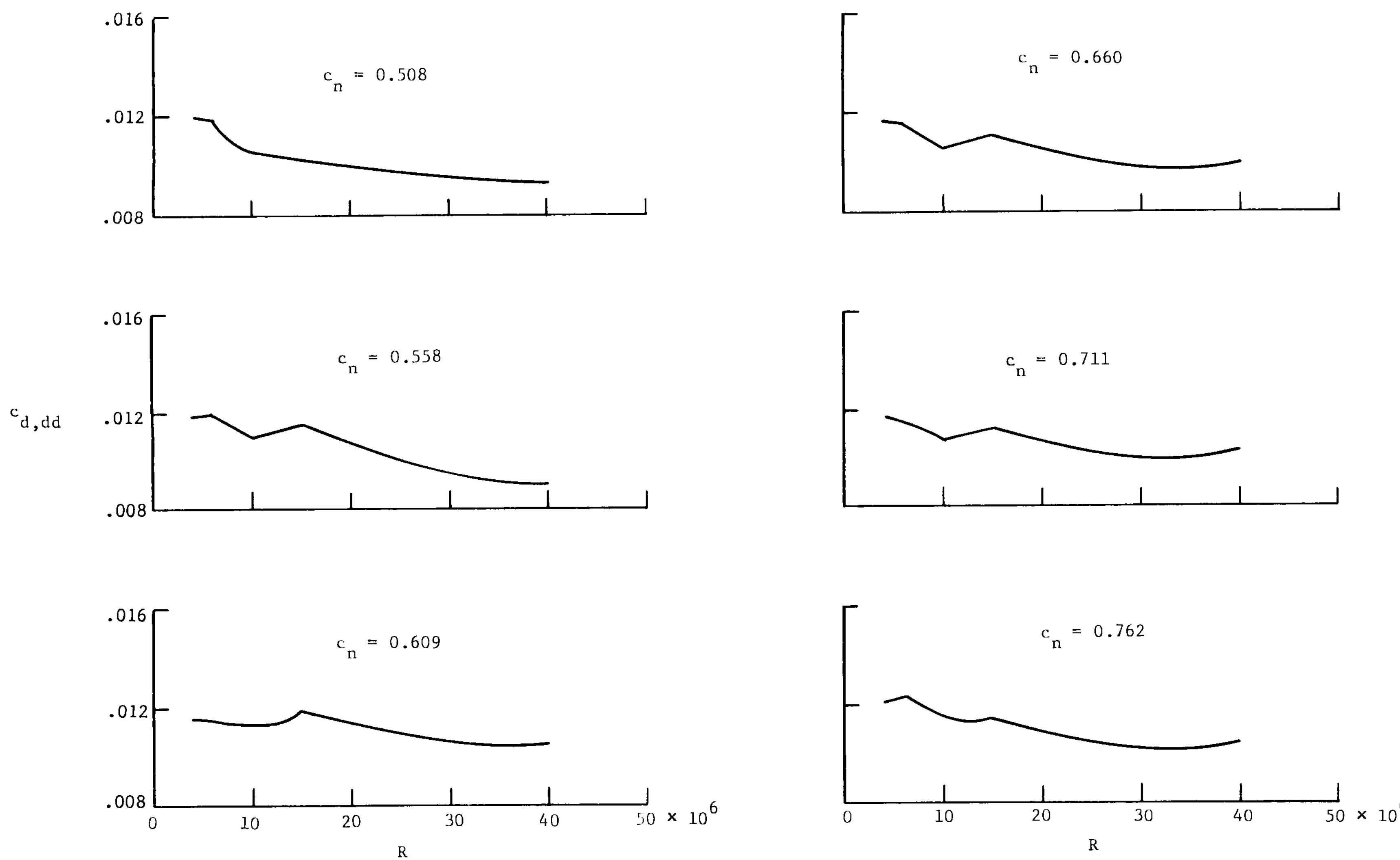



Figure 14.- Drag-divergence profile-drag coefficient versus Reynolds number for various normal-force coefficients. All data corrected for sidewalls (ref. 9).

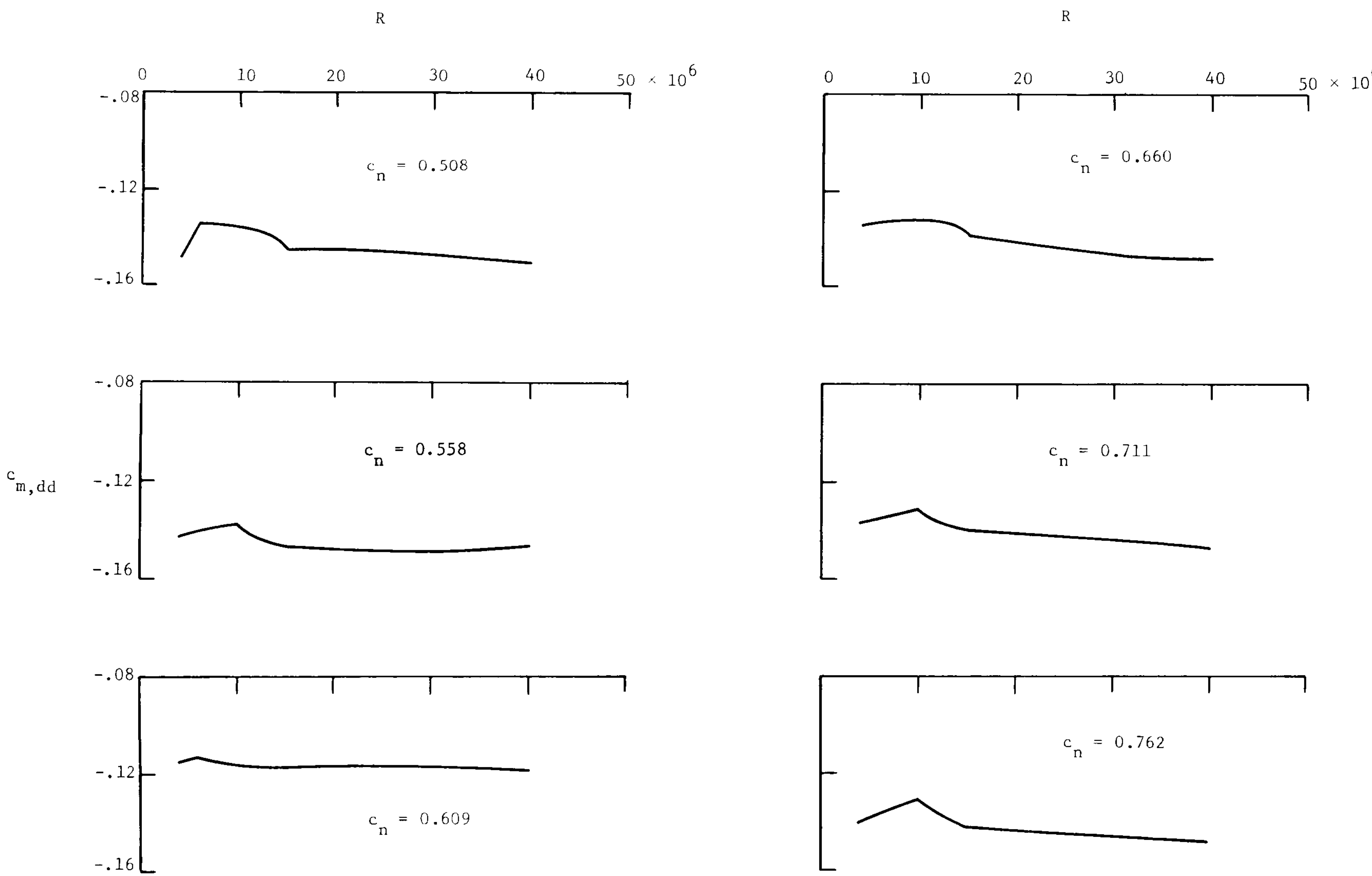



Figure 15.- Drag-divergence quarter-chord pitching-moment coefficient versus Reynolds number for various normal-force coefficients. All data corrected for sidewalls (ref. 9).

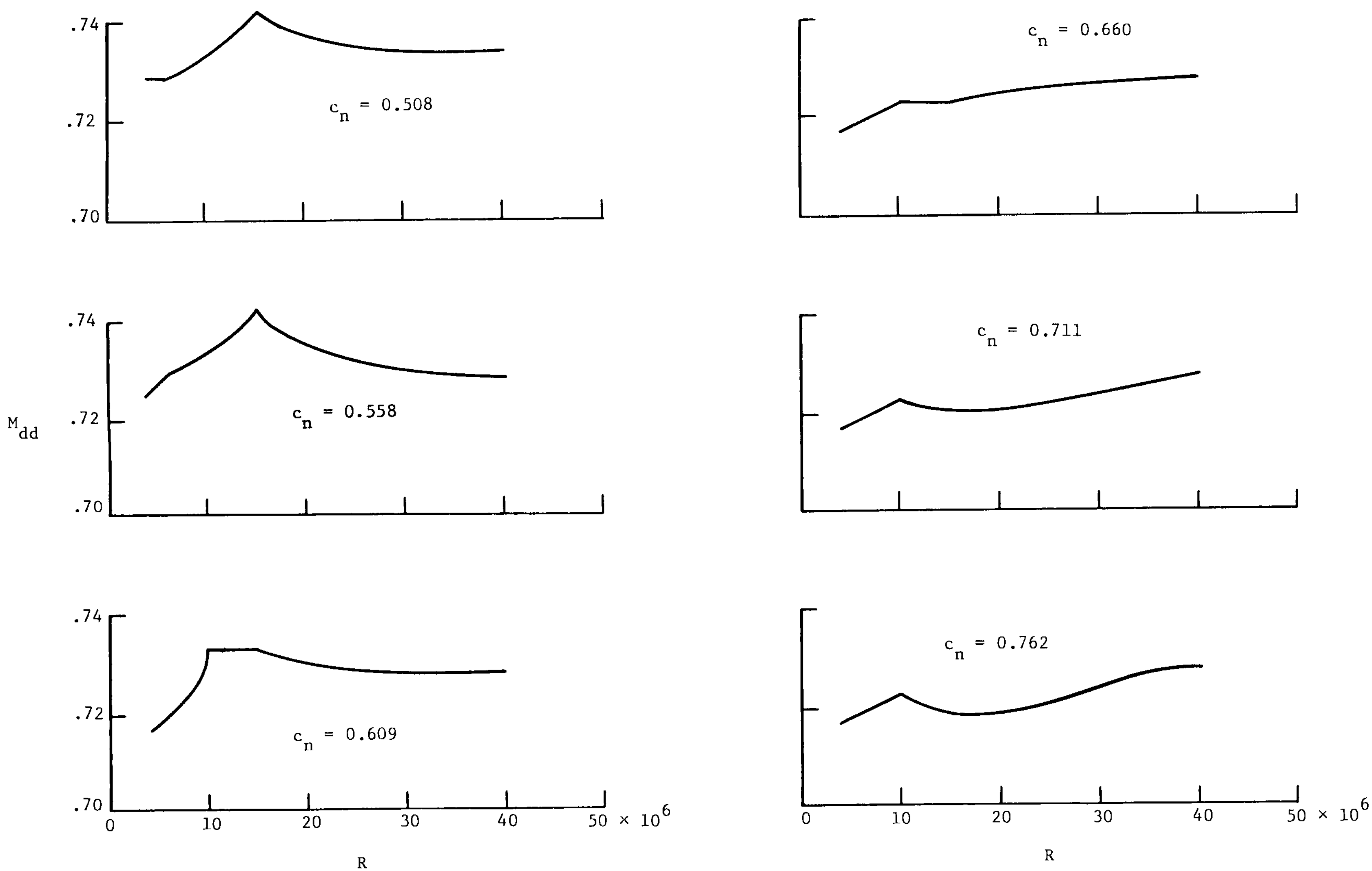



Figure 16.- Drag-divergence Mach number versus Reynolds number for various normal-force coefficients. All data corrected for sidewalls (ref. 9).

| 1. Report No. NASA TP-2565 | 2. Government Accession No. | 3. Recipient's Catalog No. |
|---|---|---|
| 4. Title and Subtitle R4 Airfoil Data Corrected for Sidewall Boundary-Layer Effects in the Langley 0.3-Meter Transonic Cryogenic Tunnel | | 5. Report Date May 1986 |
| | | 6. Performing Organization Code 505-61-01-02 |
| 7. Author(s) Renaldo V. Jenkins | | 8. Performing Organization Report No. L-16066 |
| 9. Performing Organization Name and Address NASA Langley Research Center Hampton, VA 23665-5225 | | 10. Work Unit No. |
| | | 11. Contract or Grant No. |
| 12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546-0001 | | 13. Type of Report and Period Covered Technical Paper |
| | | 14. Sponsoring Agency Code |
| 15. Supplementary Notes | | |

16. Abstract

This report presents corrected aerodynamic data for the R4 airfoil at Mach numbers from 0.60 to 0.78 and angles of attack from -2.0° to 4.5°. The test Reynolds numbers were 4 million, 6 million, 10 million, 15 million, 30 million, and 40 million based on the 152.32-mm chord of the airfoil. Corrections for the effects of the sidewall boundary layer have been made. The uncorrected data were previously published in NASA Technical Memorandum 85739. The design goal of a normal-force coefficient of 0.65 at a Mach number of 0.73 and a Reynolds number of 30 million was successfully obtained with this airfoil.

| 17. Key Words (Suggested by Authors(s)) | 18. Distribution Statement |
|---|---|
| DFVLR R4 airfoil<br>Flight Reynolds number<br>Corrected for sidewalls | Unclassified - Unlimited<br><br>Subject Category 02 |

| 19. Security Classif.(of this report) | 20. Security Classif.(of this page) | 21. No. of Pages | 22. Price |
|---|---|---|---|
| Unclassified | Unclassified | 112 | A06 |

For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1986

National Aeronautics and
Space Administration
Code NIT-4

Washington, D.C.
20546-0001