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COMPUTER PROGRAM FOR CALCULATING FLOW FIELDS IN SUPERSONIC INLETS

by Virginia L. Sorensen

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Moffett Field, Calif.

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COMPUTER PROGRAM FOR CALCULATING FLOW FIELDS

IN SUPERSONIC INLETS

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SUMMARY

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A Fortran IV computer program for calculating the flow fields in three-dimensional axisymmetric or two-dimensional inlets has been written. The program has been written to handle inlets designed with smooth compression surfaces and for which the attached bow shock falls outside the cowl lip. The method of characteristics has been used to calculate a uniform field of points and at each of these points the total pressure, Mach number, local flow angle, and static pressure ratio are printed. The numerical procedures used are fully described and a test case is presented.

Author

INTRODUCTION

The mathematical tools for calculating flow fields in supersonic inlets have been available for many years. The complexity of the mathematical procedures, however, has been a major obstacle in effectively and rapidly designing inlets other than those with simple two-dimensional compression surfaces. A Fortran IV computer program employing the method of characteristics for a perfect gas has therefore been written to assist in the design of three-dimensional axisymmetric or two-dimensional inlets. The program is limited in application to designs in which the bow shock wave does not intersect the cowl so that internal shock wave intersections do not occur (see fig. 1). In addition, no viscous effects are considered. Within these limitations the flow fields of inlets with theoretical efficiencies up to 100 percent (100-percent total-pressure recovery) can be described.

This program has been made available to a number of organizations and the purpose of this report is to aid those organizations and any others using this program. The basic equations are presented and the program is described fully in this report. This description includes the program listing, program usage, flow charts, and a sample case.

The input to the program consists of the surface contours, the free-stream Mach number, and other pertinent parameters which are described in appendix A. The output consists of a uniform field of points, at each of which the total pressure, Mach number, local flow angle, and static pressure ratio are printed.

This program will be distributed in card form by the Ames Research Center upon written request. This distribution also includes complete sample cases, program listings, and a complete set of output.

SYMBOLS

		Program label
a	speed of sound	---
$\frac{c}{r}$	dimensionless incremental distance along a characteristic	CΦR1, CΦR2
M	Mach number	EM, EMIN
P	pressure	P1, P2, P3, P4
r	radial distance	R
S	entropy divided by universal gas constant	S
V	velocity	---
W	ratio of local velocity to stagnation speed of sound, V/a_t	W
x	axial distance	X
γ	ratio of specific heats	GAMMA
δ	stream angle, radians	DEL, DELTA
μ	Mach angle, radians	U
θ	shock-wave angle, radians	THETA

Subscripts

1	calculation along a first-family characteristic line
2	calculation along a second-family characteristic line
l	local conditions
t	stagnation conditions
u	upstream conditions for a shock wave
∞	free-stream conditions

PROGRAM DESCRIPTION

The method of characteristics is a standard procedure used in the study of supersonic flow fields. It is fully described in references 1 and 2. The basic equations used here are essentially those developed in reference 3, but with modifications made by Mr. Leroy Presley of Ames Research Center. The numerical techniques used in this program are described below. Appendix A contains the program usage, a description of the required input, a list of error messages, the program listing, and a test case. Because flow diagrams are often helpful in remedying program difficulties, a complete set of diagrams is presented in appendix B.

Basic Equations

The basic equation used in the program is the compatibility equation

$$d\delta = \pm A \; dW \mp C \pm D \; dS \tag{1a}$$

where

$$W = \frac{V}{a_t}$$

$$A = \frac{1}{W} \cot \mu$$

$$C = \frac{c}{r} \sin \mu \sin \delta$$

$$D = \frac{1}{2\gamma} \sin 2\mu$$

The upper signs in equation (1a) are used along the first-family characteristic lines defined by equation (1b). The lower signs in equation (1a) are used along the second-family characteristic lines defined by equation (1c).

$$\frac{dr}{dx} = \tan(\mu + \delta) \tag{1b}$$

$$\frac{dr}{dx} = -\tan(\mu - \delta) \tag{1c}$$

The equation for the two-dimensional characteristics program is obtained by setting the term C equal to zero.

Basic Computational Techniques

In order to facilitate the computation, the flow field behind the bow shock wave is broken into several regions bounded by shock waves as shown in figure 1. A second-family region exists behind a down-shock (regions 2 and 4 in fig. 1) and a first-family region behind an up-shock (regions 1 and 3 in fig. 1). If the signs in equation (1) are reversed, the same computation schemes may be used for both the first- and second-family regions. Thus, in the equations to follow, a double sign implies that the upper sign is to be used in first-family regions and the lower sign in second-family regions.

In each region successive rays are computed from a surface to a shock wave until the shock wave intersects a surface or falls outside the cowl lip, as in the case of the first region. As soon as the intersection occurs a new region is started and the previous region continued only in the area in which it is needed, thereby eliminating unnecessary calculations. This is described more fully in the section on Shock Point Calculation.

A numbering scheme has been set up such that each point in the flow field is defined uniquely by a region number, i, a ray number, j, and a point number, k. (See fig. 2.) In this figure, $j' = j - 1$, where j is the current ray number, and j' is the previous ray number. The subscript k is the current point number in the current ray. The subscript $k' = k - 1$ if j is odd and $k' = k$ if j is even. In a first-family region, k' is a first-family point; that is, it is located on the first-family characteristic to the point k, and $k' + 1$ is located on the second-family characteristic. In a second-family region the k' and $k' + 1$ points are interchanged. Each odd-numbered ray contains a body point. Each ray contains a shock point until such time as a body-shock or cowl-shock intersection occurs in the region. Three adjacent vertical computation rays are shown in figure 1 with their connecting characteristic lines.

Field Point Calculation

In computing a flow-field point, the geometrical location of the point is at the intersection of the first- and second-family characteristic lines. The x coordinate is found from equation (2):

$$x_k = \frac{r_{k'+1} - r_{k'} \pm \left[x_{k'} \tan(\mu \pm \delta)_{k'} + x_{k'+1} \tan(\mu \mp \delta)_{k'+1}\right]}{\pm\left[\tan(\mu \pm \delta)_{k'} + \tan(\mu \mp \delta)_{k'+1}\right]} \qquad (2)$$

The r coordinate is found by equation (3):

$$r_k = r_{k'} \pm (x_k - x_{k'})\tan(\mu \pm \delta)_{k'} \qquad (3)$$

The distance along the characteristic lines is found from equations (4):

$$\left.\begin{aligned}\left(\frac{c}{r}\right)_1 &= \left(\frac{c}{r}\right)_{k'\to k} = \left|\frac{r_k - r_{k'}}{r_{k'}\,\sin(\mu \pm \delta)_{k'}}\right| \\ \left(\frac{c}{r}\right)_2 &= \left(\frac{c}{r}\right)_{k'+1\to k} = \left|\frac{r_k - r_{k'+1}}{r_{k'+1}\,\sin(\mu \mp \delta)_{k'+1}}\right|\end{aligned}\right\} \qquad (4)$$

In order to find the stream angle, entropy, and velocity, the compatibility equation, equation (1), is put into finite difference form, equations (5):

$$\left.\begin{aligned}\delta_k - \delta_{k'} &= \pm A_{k'}(W_k - W_{k'}) \mp C_{k'} \pm D_{k'}(S_k - S_{k'}) \\ \delta_k - \delta_{k'+1} &= \mp A_{k'+1}(W_k - W_{k'+1}) \pm C_{k'+1} \mp D_{k'+1}(S_k - S_{k'+1})\end{aligned}\right\} \qquad (5)$$

This set of two equations in three unknowns may be solved for δ_k in terms of S_k, equation (6):

$$\delta_k = \frac{\left(\frac{\delta}{A}\right)_{k'} + \left(\frac{\delta}{A}\right)_{k'+1} \mp W_{k'} \pm W_{k'+1} \mp \left(\frac{C}{A}\right)_{k'} \pm \left(\frac{C}{A}\right)_{k'+1} \pm \left(\frac{D}{A}\right)_{k'}\left(S_k - S_{k'}\right) \mp \left(\frac{D}{A}\right)_{k'+1}\left(S_k - S_{k'+1}\right)}{\frac{1}{A_{k'}} + \frac{1}{A_{k'+1}}} \qquad (6)$$

By assuming a linear variation in entropy along a normal to the streamline through the point k, we may obtain an additional equation. Equations (7) are derived geometrically and are shown schematically in figure 3.

$$\left.\begin{aligned}S_k &= S_{k'} + \frac{a}{a+b}\left(S_{k'+1} - S_{k'}\right) \\ a &= \left(\frac{c}{r}\right)_1 \sin[(\mu \pm \delta)_{k'} \mp \delta_k] \\ b &= \left(\frac{c}{r}\right)_2 \sin[(\mu \mp \delta)_{k'+1} \pm \delta_k]\end{aligned}\right\} \qquad (7)$$

An initial value of δ may be computed by assuming no entropy loss along the characteristic lines; that is, the terms $(S_k - S_{k'})$ and $(S_k - S_{k'+1})$ in equation (6) are zero. Equations (6) and (7) are then solved iteratively until successive values of δ converge. The velocity W_k may be obtained from equations (5). The remaining properties are then computed from standard relationships found in reference 4 and are presented in equations (8) through (13).

$$M_k = \sqrt{\frac{W_k^2}{1 - \frac{1}{2}(\gamma - 1)W_k^2}} \tag{8}$$

$$\mu_k = \sin^{-1}\left(\frac{1}{M_k}\right) \tag{9}$$

$$\frac{P_{t_k}}{P_{t_\infty}} = e^{-(S_k - S_\infty)} \tag{10}$$

$$\frac{P_k}{P_{t_k}} = \left[1 - \frac{1}{2}(\gamma - 1)W_k^2\right]^{\gamma/(\gamma-1)} \tag{11}$$

$$\frac{P_{t_\infty}}{P_\infty} = \left[1 + \frac{1}{2}(\gamma - 1)M_\infty^2\right]^{\gamma/(\gamma-1)} \tag{12}$$

$$\frac{P_k}{P_\infty} = \left(\frac{P_k}{P_{t_k}}\right)\left(\frac{P_{t_k}}{P_{t_\infty}}\right)\left(\frac{P_{t_\infty}}{P_\infty}\right) \tag{13}$$

Shock Point Calculation

In computing a shock point, the point $\bar{k}$ is first located geometrically on the shock wave, as in figure 4. In a region in which the upstream conditions are free stream, this point is found simply by adding a constant to the x coordinate of the previous shock point. In a region of variable upstream properties the shock point is located geometrically at the intersection of the shock wave and the opposite family characteristic line in the upstream region. The upstream properties are then found simply by linear interpolation. It should be noted that characteristics in the upstream region are dropped when they are no longer required in the solution (such as line AB in fig. 4). Some computing time is thereby saved.

In order to find the properties of the shock point, $\bar{k}$, another point k is computed as the intersection of the shock wave and the characteristic line from the point $k - 1$ (see fig. 5). This intersection point is determined by substituting the shock-wave angle θ for μ and the upstream region stream angle δ_u for δ in equations (2) and (3). For very weak shock waves, the angle $\mu \pm \delta$ is almost the same as the shock-wave angle and an intersection point k can occur upstream of the previous shock point or extremely far downstream. In this case the shock point properties at $\bar{k}$ are set equal to the upstream properties of the point. A regular shock-wave point will be computed if the intersection point occurs downstream of the previous shock wave.

The next step in the procedure for computing the shock point normally is to find a new point $\bar{k}'$. A line is constructed parallel to the first-family Mach line through the points k and $k - 1$. The line passes through the point $\bar{k}$. The point of intersection of this line with the second-family Mach line through the points $k' + 1$ and $k - 1$ is the new k' point for the shock calculation and is designated by $\bar{k}'$ in figure 5. The properties at the point $\bar{k}'$ are formed by linear interpolation between the points $k' + 1$ and $k - 1$.

The computation for the shock-wave point then proceeds by an iterative solution. The equations involved are equations (14) through (16) which were obtained from reference (4), and equation (17).

$$\left.\begin{aligned} &\sin^6\theta + b\sin^4\theta + c\sin^2\theta + d = 0 \\ &b = -\frac{M_u^2 + 2}{M_u^2} - \gamma\sin^2\delta \\ &c = \frac{2M_u^2 + 1}{M_u^4} + \left[\frac{(\gamma + 1)^2}{4} + \frac{\gamma - 1}{M_u^2}\right]\sin^2\delta \\ &d = -\frac{\cos^2\delta}{M_u^4} \end{aligned}\right\} \tag{14}$$

$$S_k = S_u + \frac{1}{\gamma - 1}\left\{ln\left[\frac{2\gamma M_u^2\sin^2\theta - (\gamma - 1)}{\gamma + 1}\right] - \gamma\, ln\left[\frac{(\gamma + 1)M_u^2\sin^2\theta}{(\gamma - 1)M_u^2\sin^2\theta + 2}\right]\right\} \tag{15}$$

$$W_k = W_u\sqrt{1 - \frac{4(M_u^2\sin^2\theta - 1)(\gamma M_u^2\sin^2\theta + 1)}{(\gamma + 1)^2 M_u^4\sin^2\theta}} \tag{16}$$

$$\delta_k = \delta_{k'} \pm A_{k'}(W_k - W_{k'}) \mp C_{k'} \pm D_{k'}(S_k - S_{k'}) \tag{17}$$

As a first approximation to δ_k, equation (17) is computed assuming the terms involving W and S are zero. A value of $\sin^2\theta$ is then obtained from equations (14) by solving the cubic by a trigonometric method. This trigonometric method is described in reference 5. Of the three roots obtained, the middle root is the desired weak shock solution. Equations (15) and (16) are then used to compute new values for S_k and W_k. With these values a new value of δ_k may be obtained from equation (17). If this value of δ_k agrees well with the previous δ_k computed the iteration is terminated. If it does not, the new value of δ_k is averaged with the previous δ_k and the iteration continues by recomputing $\sin^2\theta$, S_k, and W_k as before.

Body Point Calculation

The first step in computing a body point is to locate it geometrically as the intersection of a characteristic line and the body. The body may be either the centerbody or the cowl. If the body is supplied in tabular form a search is performed in the table and the location is found by the simultaneous solution of two linear equations in x and r and the stream angle δ_k is obtained from the table. When the body is supplied in the form of a function, the location of the point is found by combining the equation for the body, equation (18), and the characteristic line equation, equation (19), to form equation (20):

$$r_k = f(x_k) \tag{18}$$

$$r_k = r_{k'+1} \mp (x_k - x_{k'+1})\tan(\mu \mp \delta)_{k'+1} \tag{19}$$

$$g(x_k) = f(x_k) - r_{k'+1} \pm (x_k - x_{k'+1})\tan(\mu \mp \delta)_{k'+1} = 0 \tag{20}$$

Equation (19) may then be solved for x_k by means of the Newton-Raphson technique (ref. 6). The stream angle δ_k is set equal to the arc-tangent of the slope of the body at the intersection point.

The remaining properties are easily found since the entropy S_k remains constant on the surface between shock wave impingements. Thus, given δ_k and S_k, W_k may be found from the compatibility equation, equations (5). Equations (8) through (13) furnish the remainder of the calculation.

Starting the Solution

The calculation may be initiated in two ways. The first method is to approximate a conical flow at the nose. The second method is to use some other procedure to calculate several points along a vertical input ray.

In the first case, the stream angle and the Mach number on the body and at the shock must be supplied to the program. From these quantities the remaining properties may be found. As few as two points may be used to start the flow field. However, three points are better when the Mach number is low (below Mach 2) or the centerbody angle is small (e.g., $\theta_c = 5^{\circ}$). The third point is the average of the first two.

In the latter case, any method may be used to compute a vertical ray consisting of a number of points at any station on the centerbody ahead of the cowl lip. The quantities, entropy, S_k, velocity, W_k, and stream angle, δ_k, at each point are the required input parameters.

Starting a New Region

A new region is started after a shock wave has impinged on a body or after the flow field in the initial region has intersected the cowl lip. A two-dimensional flow is assumed in the immediate area of the intersection for the purpose of computing the starting ray. The initial ray has two points, a shock point and a body point both with the same x coordinate. The x coordinate is determined by adding a constant to the x coordinate of the intersection point. This constant is determined by taking a percentage of the constant used in starting the previous region. The r coordinate at the body is determined from the body equation or table, as is the slope of the body. The slope of the body determines the stream angle at both points. The shock wave angle is computed by equations (14). The entropy and the velocity may then be computed from equations (15) and (16). The r coordinate of the shock point is then computed using the shock-wave angle.

A means of controlling accuracy in the program is by modifying the distance from the cowl lip to the initial ray in the second region. This distance is computed as a percentage of the bow shock wave spacing. The percentage used is an input quantity. However, if none is provided, a value of 0.50 is used. The accuracy of the solution has been improved by use of a spacing compatible with the local mesh size.

Control of the Mesh Size

Control of the mesh spacing has been found to be desirable in order to maintain a good distribution of output at the throat of the inlet. The characteristic mesh size in the initial region is controlled by the spacing on the input line and by spacing the shock points evenly along the bow shock wave. The latter technique is employed to limit spreading of the mesh. The spacing along the bow shock wave is controlled by an input quantity. The horizontal distance along the shock wave is computed as the product of this input quantity and the distance from the nose of the centerbody to the initial point on the input ray.

The characteristic mesh in subsequent regions is controlled by the way in which the shock wave points are computed. The points are located geometrically as the point of intersection of a characteristic line in the upstream region and the shock wave. The mesh size is thus controlled by the mesh size of the previous region.

A means has been provided for discarding intermediate points in a vertical ray when it is desired to expand the mesh rapidly. This expanding provides for increasing the accuracy in the nose region without substantially decreasing the speed of the solution. The discarding of points is under the control of the user by input quantities.

Refining the Solution

When the distance between points along a characteristic line exceeds a value specified by the user, a means has been provided for improving the accuracy of the solution as in reference 3 without increasing the number of points in the mesh. The values of x, r, S, W, and δ at the points k and k' are averaged together and the k' point is replaced by the averaged values. The same is done with the $k' + 1$ point. The k point is then recomputed. If the new value of W_k agrees closely with the previous value of W_k the iteration is complete. If not, the points are again averaged and the point k recomputed. This is done until the value of W_k does not change appreciably.

Coalescence

The coalescence of characteristic lines to form a shock wave is a serious problem, for it indicates that the inlet design is not a very good one. The user must then redesign the body contours and recalculate the flow field until the coalescence has been avoided.

When two characteristic lines coalesce, the user is notified and a test is made in the program to determine whether or not the two lines have actually crossed. If they have, the downstream characteristic line is dropped, a message is printed, and the flow-field calculation continues. The user can then determine if the shock wave is in fact building up or if the coalescence occurred because of inaccuracies arising from some of the approximations used in the program.

When two characteristic lines become arbitrarily close to each other, the accuracy of the solution tends to decrease. There is a significant loss in the number of digits of accuracy. To avoid this problem, it is assumed, in this case that coalescence has actually occurred and the downstream characteristic line is dropped.

CONCLUDING REMARKS

A Fortran IV computer program to calculate the flow fields in three-dimensional axisymmetric or two-dimensional inlets has been written.

In writing the program, every effort has been made to keep the computation as rapid as possible. The calculation of the upstream and downstream regions has been carried on concurrently to avoid the computation of extraneous flow-field points and the necessity of saving all the points in the upstream region. In this way the use of external storage devices has been avoided. Extensive search techniques and elaborate curve-fitting schemes have been avoided as well as high-order interpolation formulas. As a further aid, several cases may be stacked to be run at the same time.

The program is flexible since the flow field may be initiated in two ways and the surface input may be tabular or analytical. When tabular input is used the compression surfaces can be defined by both coordinates and local surface angles. The input of surface angles is redundant; however, coordinates alone cannot usually be calculated for input accurately enough or smoothly enough to give a uniform mesh of characteristics. It is suggested that the surface angles be plotted and faired before they are used as input.

The rapidity with which a case may be computed (from 0.5 to 2.0 minutes per case) has been an advantage in designing inlets, since a trial and error design procedure involving many cases is often necessary.

The suitability and accuracy of the program for the design of supersonic inlets is illustrated by the inlet design shown in figure 6. The input and output for this case are presented in appendix A. This particular case was computed in less than one minute on an IBM 7094 computer.

Ames Research Center
National Aeronautics and Space Administration
Moffett Field, Calif., Mar. 25, 1965

APPENDIX A

PROGRAM USAGE

In this appendix, the program usage is detailed. An attempt has been made to keep the usage of the program simple. The program itself is listed in figure 7. A sample case is listed as figure 8. The input cards used to obtain the data in figure 8 are listed in figure 9. Figure 10 contains a listing of a sample plotting program and figure 11 contains listings of sample body contour programs.

DECK MAKE-UP

Deck label	Subroutine name	Description
EF3131	(main)	Control program.
EF3132	BODY	Computes a body point.
EF3133	FLOW	Computes a flow-field point.
EF3134	JUGGLE	Refines solution when mesh size is large, by averaging upstream points.
EF3135	PUNT	Output subroutine.
EF3136	CBODY	Dummy subroutine. If the centerbody ordinates are given in analytic form, this program should be replaced by a subprogram that computes the function and its first derivative. The function should be in the form, $r = f(x)$, where r is the distance along a line perpendicular to the body axis and x is the distance along the body axis. The CALL statement is "CALL CBODY (I,X,R,DR)" where $X = x$, $R = r$, and $DR = dr/dx$. At the beginning of the control program an entry is made to this subprogram with the control word $I = 1$ to allow for the initialization of the subprogram. For all other entries $I = 2$. On the initial entry X should be set equal to the last value of X on the centerbody.
EF3137	ABODY	Dummy subroutine. If the cowl is given by an analytic expression, this program should be replaced by a subprogram that computes the function as indicated under CBODY. In this case the CALL statement is "CALL ABODY (I,X,R,DR)." On the initial entry, when $I = 1$, the cowl lip ordinates should be returned in X and R.

Deck label*	Subroutine name	Description
EF3138	SHOCK	Computes a shock point.
EF3139	CONIC	Sets up a conical input ray.
EF3140	ERROR	When an error condition is encountered, this subprogram prints an error code which may be used to determine the type of failure. The next case is then read in under most circumstances. If the error is irrevocable, EXIT is usually called.
EF3141	ENDFIL	This subroutine is entered when the last stacked case has been completed. This condition is signalled by the input card with the word "DONE" in columns 1-4.
EF3142	FLINT	Computes with the point of intersection of the flow field with the cowl lip.
EF3143	SPLOT	Dummy subroutine. To be used if plotting is not wanted. (See EF3150.)
EF3144	ACRAY	Computes a two-dimensional input ray.
EF3145	CUBIC	Finds roots of a cubic and selects proper root for the shock angle equation.
EF3146	UPSC	Computes the upstream conditions for a shock point.
EF3147	BSINT	Computes the intersection of a shock wave with either the centerbody or cowl.
EF3148	CBODY	Sample subroutine for computing the centerbody analytically.
EF3149	ABODY	Sample subroutine for computing the cowl analytically.
EF3150	SPLOT	Constructs arrays for plotting. The user must supply a program that writes the plot tape.
EF3152	PAGE, TITLE	Controls page numbering and headings.

TAPES

Logical tape no.	Usage
5	INPUT
6	OUTPUT
7	PLOTTING OUTPUT (Optional)

INPUT CARDS

All input is in floating-point form, 7 values per card, 10 columns per value, except for the first card. (See fig. 9 for a sample case.)

Card no.	Columns	Contents
1	1-72	Case identification in Hollerith.
2	1-10	N = number of input points if initial ray is to be read in. N = 0, if initial input ray is to be computed as conical input ray. ($N \leq 50$)
	11-20	NOB = number of centerbody ordinate points if body is in tabular form. NOB = 0, if body is analytic. ($NOB \leq 50$)
	21-30	NOA = number of cowl ordinate points if cowl is in tabular form. NOA = 0, if cowl is analytic. ($NOA \leq 50$)
	31-40	MAXNP = maximum number of points allowed in a ray. If no value is specified, it is set to 50. ($MAXNP \leq 50$)
	41-50	NODIS = number of points to be discarded between the points kept. When the number of points in a vertical ray exceeds the value assigned to MAXNP, and NODIS = 1, every other point is discarded.
	51-60	IDIM = 2 or 3 determines whether the solution is to be two-dimensional or three-dimensional axisymmetric. If no value is assigned, a three-dimensional solution is assumed.
3	1-10	EMIN, M_∞ = free-stream Mach number.
	11-20	GAMMA, γ = free-stream ratio of specific heats.
	21-30	SING, S_∞ = free-stream entropy, dimensionless.

Card no.	Columns	Contents
	31-40	THETA, θ_{SH} = shock wave angle (in degrees)
4	1-10	TEST, convergence test for iterations (10^{-6} gives good results).
	11-20	CRMAX, maximum distance between mesh points. If this is exceeded, a refinement is attempted.
	21-30	COALT, coalescence is said to occur if the increments in x and r are both less than this test quantity.
	31-40	SPACE, controls spacing on the shock wave (in the x direction), as a percentage of the distance from the nose to the initial input ray.
	41-50	SPACC, controls distance from the cowl lip to the initial ray in the second region as a percentage of the bow shock spacing. If no value is given SPACC is assumed to be 0.50.
5a	(Optional - include if body is defined in tabular fashion.) x ordinates - NOB values on the centerbody.	
5b	(Optional - may be included or not if centerbody is defined by an analytic function.) User's format - Constants used in centerbody program.	
6	(Optional - include if body is defined in tabular fashion.) r ordinates - NOB values on the centerbody.	
7	(Optional - include if body is defined in tabular fashion.) δ angle (in degrees) that the line segment joining adjacent table values makes with the body center line. NB = NOB-1 values should be specified.	
8a	(Optional - include if body is defined in tabular fashion.) x ordinates - NOA values on the cowl.	
8b	(Optional - may be included or not if cowl is defined by an analytic function.) User's format - Constants used in cowl program.	
9	(Optional - include if body is defined in tabular fashion.) r ordinates - NOA values on the cowl.	
10	(Optional - include if body is defined in tabular fashion.) δ angle (in degrees) that the line segment joining adjacent table values makes with the body center line. NA = NOA-1 values should be specified.	

Card no.	Columns	Contents
11		(Optional - include if program is to compute the initial conical input ray, that is, N = 0.)
	1-10	XB, x_o, initial x value on the body at which the mesh is to start.
	11-20	RB, r_o, initial r value on the body.
	21-30	EMSH, M_{SHOCK}, Mach number on the shock wave.
	31-40	EMBODY, M_{BODY}, Mach number on the body.
	41-50	DELSH, δ_{SHOCK} (in degrees).
	51-60	DELBD, δ_{BODY} (in degrees).
	61-70	NOPIN, number of points in initial conical input ray.
11		(Optional - include N of these cards if the initial ray is to be read in, instead of being computed by the conical input subroutine.)
	1-10	$x_{j,k}$, local x
	11-20	$r_{j,k}$, local r
	21-30	$\delta_{j,k}$, local δ (in degrees)
	31-40	$W_{j,k}$, local W
	41-50	$S_{j,k}$, local S
12	1-4	The word "DONE." Any number of cases may be stacked before this card. This card is needed on the last case in order to complete the plotting arrays and terminate properly.

INPUT FOR PLOTTING

These cards may be in any format the user chooses. The sample program included uses a 7F10.6 format and is set to read 5 cards placed after card no. 1 and before card no. 2. These cards contain the origin of the plot, the scale factors, the maximum value for each variable, and the minimum value of the ordinate. The Mach number and pressure distribution along both bodies are plotted versus x. The mesh is also plotted.

ERRORS

When an error occurs during the computation of a case, an error message is usually printed and the program goes on to the next case.

The following is a list of error messages that may appear:

Error Conditions

Deck name	Subroutine name	Error code	Probable cause of error
EF3131	(main)	1	The number of points in a ray exceeds MN (an input quantity ≤ 50) or 50 if MAXNP is ≤ 0.
EF3132	BODY	2	The iteration scheme for finding the intersection of a Mach line and the body is not working. The subroutine for computing the function and its derivative may be incorrect.
EF3132	BODY	3	The local stream angle, δ, is greater than $\pi/2$.
EF3132	BODY	4	The iteration for a body point is not converging.
EF3133	FLOW	5	The iteration for the local stream angle, δ, is not converging.
EF3135	PUNT	6	There is an error in the computation of the local Mach number.
EF3135	PUNT	7	The recovery, P_t/P_{t_∞}, is greater than 1.0.
EF3138	SHOCK	8	There is an error in computing local entropy, S.
EF3138	SHOCK	9	There is an error in computing local velocity, W.
EF3138	SHOCK	10	There is an error in computing the shock wave angle, θ.
EF3139	CONIC	11	There is an error in computing the entropy, S.
EF3142	FLINT	12	The shock wave has fallen inside the lip.
EF3144	ACRAY	13	There is an error in computing the local entropy, S.

Deck name	Subroutine name	Error code	Probable cause of error
EF3144	ACRAY	14	There is an error in computing local velocity, W.
EF3144	ACRAY	15	There is an error in the shock wave angle, θ, or the Mach number, M, in the computation of a new region. The upstream Mach number is less than the local Mach number or the local Mach number is subsonic.
EF3146	UPSC	16	There are too few points in the upstream region.
EF3146	UPSC	17	There is an error in the computation of the upstream Mach number.
EF3147	BSINT	18	There is an error in finding the point of intersection of the body and the shock wave.

APPENDIX B

FLOW DIAGRAMS

A complete set of flow diagrams is included in figure 12 as a means of assisting the program user. These diagrams were drawn to conform to standard flowcharting techniques (ref. 7). Each diagram has been identified by the corresponding subroutine name and associated deck name.

REFERENCES

1. Ferri, Antonio: The Method of Characteristics. General Theory of High Speed Aerodynamics. Vol. VI of High Speed Aerodynamics and Jet Propulsion, sec. G, W. R. Sears, ed., Princeton Univ. Press, 1954, pp. 583-668.

2. Liepmann, H. W.; and Roshko, A.: Elements of Gas Dynamics. John Wiley and Sons, Inc., 1957.

3. Presley, Leroy L.; and Mossman, Emmet A.: A Study of Several Theoretical Methods for Computing the Zero-Lift Wave Drag of a Family of Open-Nosed Bodies of Revolution in the Mach Number Range of 2.0 to 4.0. NACA TN 4368, 1958.

4. Ames Research Staff: Equations, Tables, and Charts for Compressible Flow. NACA Rep. 1135, 1953.

5. Birkhoff, G.; and Mac Lane, S.: A Survey of Modern Algebra. Second ed., The MacMillan Co., 1953.

6. Nielsen, K. L.: Methods in Numerical Analysis. Second ed., The MacMillan Co., 1964.

7. Flowcharting Techniques. Form C20-8152, International Business Machines Corp.

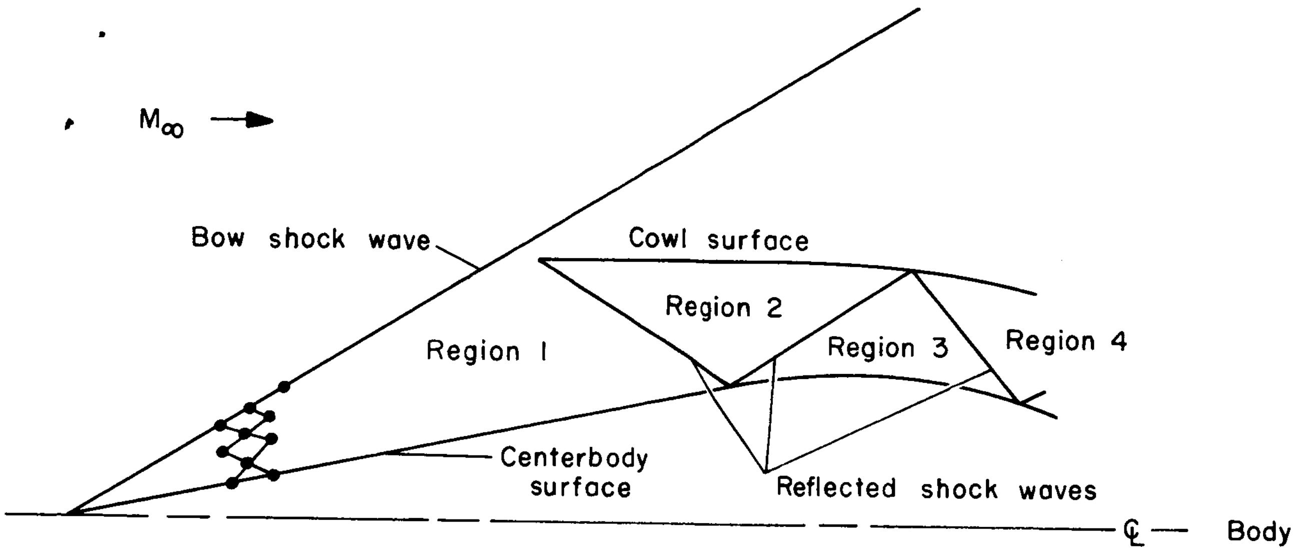

Figure 1.- Typical flow field.

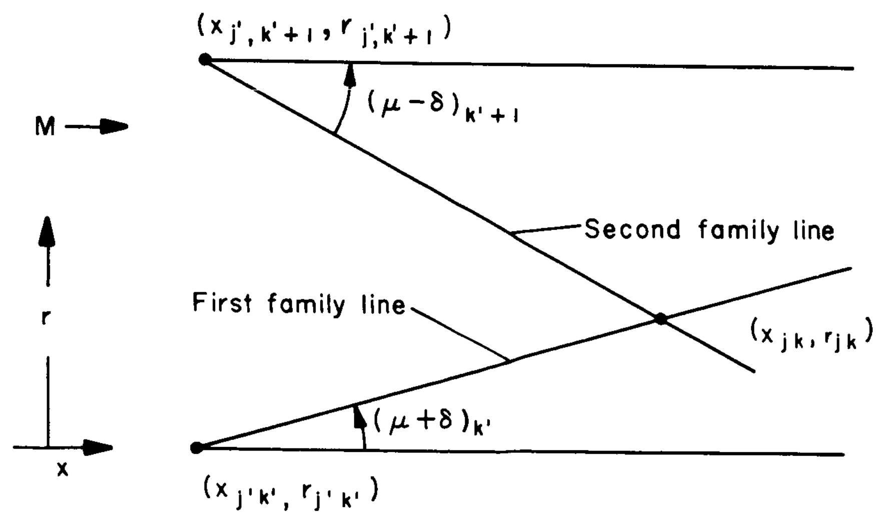

Figure 2.- Location of a flow-field point at the intersection of two characteristic lines.

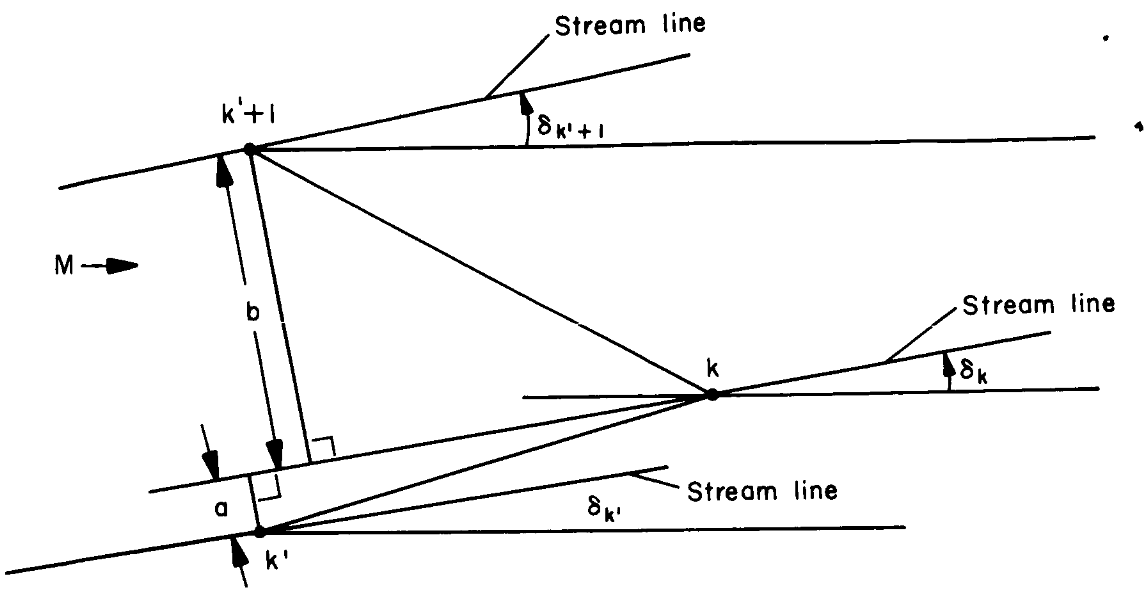

Figure 3.- Normals to the stream line used for the entropy calculation.

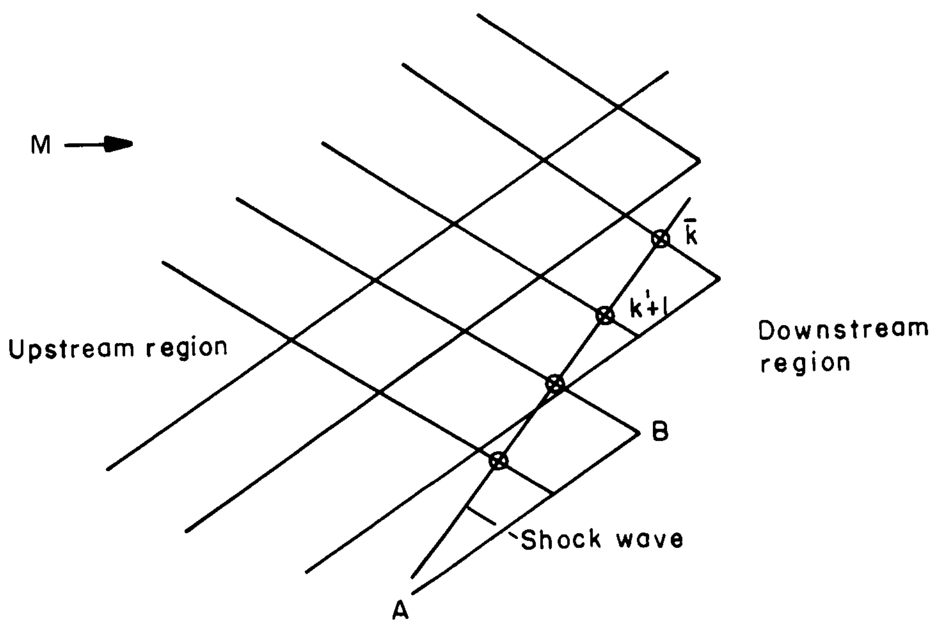

Figure 4.- Location of shock points in regions other than the first.

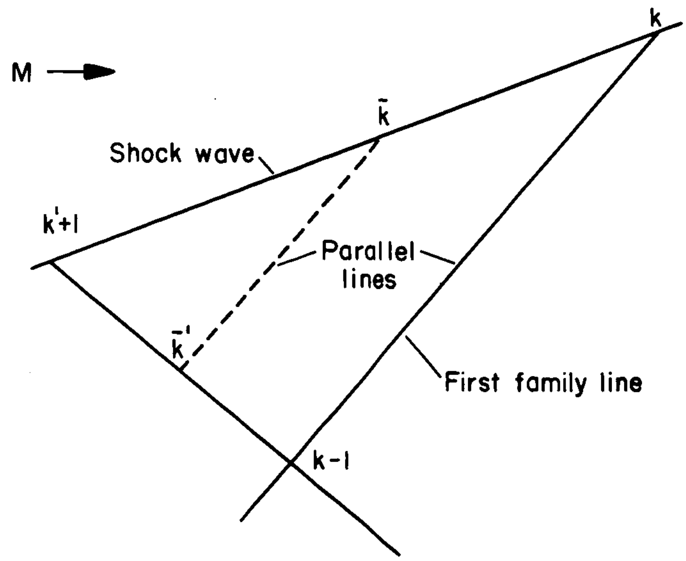

Figure 5.- Location of field point used in the shock point computation.

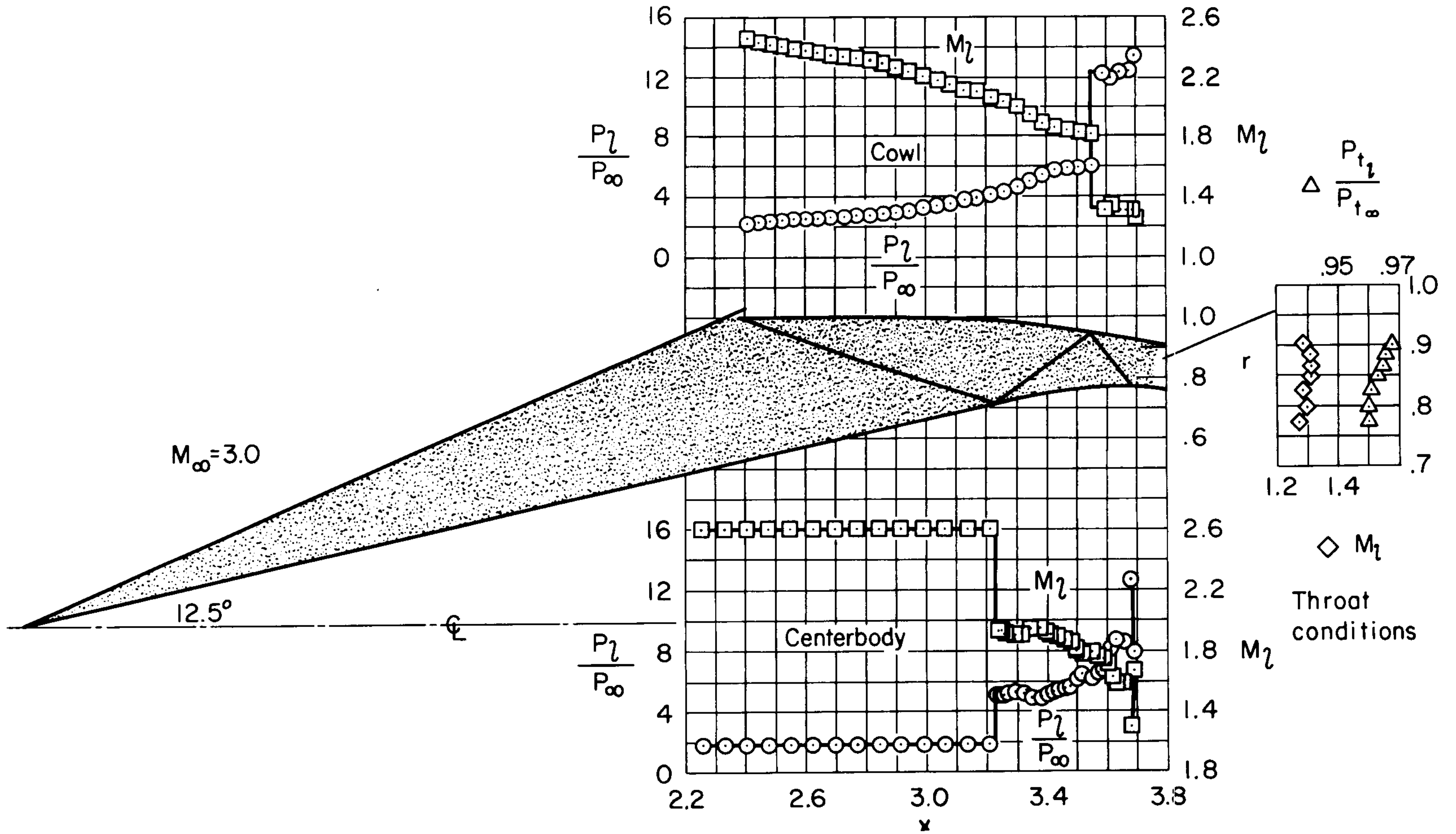

Figure 6.- Typical inlet design.

```
             EF3131                                                          03/12/65
          EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
$IBJOB
$IBFTC EF3131  NODECK                                                      MAIN0001
 C      MAIN PROGRAM.                                                      MAIN0002
 C      TWO-DIMENSIONAL OR THREE-DIMENSIONAL AXISYMMETRIC                  MAIN0003
 C      METHOD OF CHARACTERISTICS PROGRAM FOR A SUPERSONIC INLET.          MAIN0004
 C      VIRGINIA L. SORENSEN, COMPUTATION AND ANALYSIS BRANCH.             MAIN0005
 C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                  MAIN0006
        EXTERNAL  ABODY  , CBODY                                           MAIN0007
        DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                              MAIN0008
        DIMENSION  ATAB(3,50),CTAB(3,50)                                   MAIN0009
        DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),     MAIN0010
       1U(2,4,50)                                                          MAIN0011
        COMMON /SPACC/SPACC                                                MAIN0012
        COMMON /DIM/ IDIM                                                  MAIN0013
        COMMON  IRR                                                        MAIN0014
        COMMON  X      , R      , DEL    , W      , S      , U             MAIN0015
        COMMON  GAMMA  , TEST   , CRMAX  , SCB    , SAN    , P4            MAIN0016
        COMMON  SING   , XT     , THETA  , EMIN   , WIN    , ICON          MAIN0017
        COMMON  I      , NOP    , CTAB   , ATAB   , NOB    , NOA           MAIN0018
        COMMON  COALT  , LAST   , XIN    , THETB  , SPACE                  MAIN0019
        EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFAMAIN0020
       1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)       MAIN0021
        CALL SPLOT(1,A,B)                                                  MAIN0022    ,1
      1 CALL PUNT(5)                                                       MAIN0023    ,2
        LAST=0                                                             MAIN0024    ,3
        DIMENSION TEG(6)                                                   MAIN 025
        READ (5,101) (TEG(I),I=1,6)                                        MAIN 026    ,4    ,5    ,6    ,7    ,8
        N     =TEG(1)                                                      MAIN 027    ,9
        NOB   =TEG(2)                                                      MAIN 028    ,10
        NOA   =TEG(3)                                                      MAIN 029    ,11
        MAXNP=TEG(4)                                                       MAIN 030    ,12
        NODIS=TEG(5)                                                       MAIN 031    ,13
        IDIM =TEG(6)                                                       MAIN 032    ,14
         IF (IDIM .LE. 0) IDIM=3                                           MAIN0033    ,15   ,16   ,17
        READ  (5,101)EMIN,GAMMA,SING,THETA,XT                              MAIN0034    ,18   ,19   ,20
        THETA=0.01745329*THETA                                             MAIN0035    ,21
        IF (MAXNP) 86,86,72                                                MAIN0036    ,22
     86 MAXNP=50                                                           MAIN0037    ,23
     72 READ  (5,101)TEST,CRMAX,COALT,SPACE ,SPACC                         MAIN0038    ,24   ,25   ,26
        IF (NOB)12,12,13                                                   MAIN0039    ,27
     12 CALL CBODY(1,XT,R(1,1,1),DR)                                       MAIN0040    ,28
        GO TO 3                                                            MAIN0041    ,29
     13 READ  (5,101)(CTAB(1,J),J=1,NOB)                                   MAIN0042    ,30   ,31   ,32   ,33   ,34
```

Figure 7.- Program listing.

```
       EF3131                                                          03/12/65
    EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

       READ  (5,101)(CTAB(2,J),J=1,NOB)                              MAIN0043   ,35   ,36   ,37   ,38   ,39
       DO 75 J=1,NOB                                                 MAIN0044   ,40
    75 CALL SPLOT(3,CTAB(1,J),CTAB(2,J))                             MAIN0045   ,41   ,42
       CALL SPLOT(4,A,B)                                             MAIN0046   ,43
       NB=NOB-1                                                      MAIN0047   ,44
       READ  (5,101)(CTAB(3,J),J=1,NB )                              MAIN0048   ,45   ,46   ,47   ,48   ,49
       XT=CTAB(1,NOB)                                                MAIN0049   ,50
 3     IF (NOA)15,15,16                                              MAIN0050   ,51
    15 CALL ABODY(1,ATAB(1,1),ATAB(2,1),DR)                          MAIN0051   ,52
       GO TO 11                                                      MAIN0052   ,53
    16 READ  (5,101)(ATAB(1,J),J=1,NOA)                              MAIN0053   ,54   ,55   ,56   ,57   ,58
       READ  (5,101)(ATAB(2,J),J=1,NOA)                              MAIN0054   ,59   ,60   ,61   ,62   ,63
       DO 76 J=1,NOA                                                 MAIN0055   ,64
    76 CALL SPLOT(3,ATAB(1,J),ATAB(2,J))                             MAIN0056   ,65   ,66
       CALL SPLOT(4,A,B)                                             MAIN0057   ,67
       NA=NOA-1                                                      MAIN0058   ,68
       READ  (5,101)(ATAB(3,J),J=1,NA )                              MAIN0059   ,69   ,70   ,71   ,72   ,73
    11 IREG=1                                                        MAIN0060   ,74
       IRAY=1                                                        MAIN0061   ,75
       IFAM=1                                                        MAIN0062   ,76
       I=1                                                           MAIN0063   ,77
       J=1                                                           MAIN0064   ,78
       CALL PUNT(7)                                                  MAIN0065   ,79
       P4=(1.0+0.5*(GAMMA-1.0)*EMIN **2)**(GAMMA/(GAMMA-1.0))        MAIN0066   ,80
   200 WIN=EMIN**2/(1.0+0.5*(GAMMA-1.0)*EMIN**2)                     MAIN0067   ,81
       WIN=SQRT(WIN)                                                 MAIN0068   ,82
       IF (N) 70,70,71                                               MAIN0069   ,83
    70 IANN=1                                                        MAIN0070   ,84
       CALL CONIC                                                    MAIN0071   ,85
       IF (LAST) 24,24,1                                             MAIN0072   ,86
    71 IANN=1                                                        MAIN0073   ,87
       DO 2 K=1,N                                                    MAIN0074   ,88
       K=K                                                           MAIN0075   ,89
       READ  (5,101)X(I,J,K),R(I,J,K),DEL(I,J,K),W(I,J,K),S(I,J,K)   MAIN0076   ,90   ,91   ,92
       DEL(I,J,K)=0.01745329*DEL(I,J,K)                              MAIN0077   ,93
     2 CALL PUNT(1)                                                  MAIN0078   ,94   ,95
       IF (LAST) 30,30,1                                             MAIN0079   ,96
    30 SCB=S(I,J,1)                                                  MAIN0080   ,97
       XIN=X(i,1,1)                                                  MAIN0081   ,98
       ITYPE=1                                                       MAIN0082   ,99
       IN=N                                                          MAIN0083   ,100
       NOP(I,J)=IN                                                   MAIN0084   ,101
```

Figure 7.- Continued.

```
      EF3131                                                          03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
      K=N                                                MAIN0085   ,102
      GO TO 24                                           MAIN0086   ,103
   43 J=J                                                MAIN0087   ,104
      K=K                                                MAIN0088   ,105
      GO TO (57,58,57,58),J                              MAIN0089   ,106
   57 IN=IN+1                                            MAIN0090   ,107
   58 WUP=W(I,J,K)                                       MAIN0091   ,108
      DUP=DEL(I,J,K)                                     MAIN0092   ,109
      SUP=S(I,J,K)                                       MAIN0093   ,110
      XB=X(I,J,K)                                        MAIN0094   ,111
      RB=R(I,J,K)                                        MAIN0095   ,112
      IF (I-1) 40,40,41                                  MAIN0096   ,113
   41 I=1                                                MAIN0097   ,114
      IP=2                                               MAIN0098   ,115
      DO 53 M=1,9                                        MAIN0099   ,116
   53 ICON(IP,M)=IRR(M)                                  MAIN0100   ,117   ,118
      IFAM=1                                             MAIN0101   ,119
      IF (NB) 51,51,52                                   MAIN0102   ,120
   51 CALL CBODY( 2,XB,RB,DR)                            MAIN0103   ,121
      DAI=ATAN(DR)                                       MAIN0104   ,122
      GO TO 42                                           MAIN0105   ,123
   52 DO 45 L=2,NOB                                      MAIN0106   ,124
      IF (XB-CTAB(1,L)) 46,46,45                         MAIN0107   ,125
   46 DAI=0.01745329*CTAB(3,L-1)                         MAIN0108   ,126
      GO TO 42                                           MAIN0109   ,127
   45 CONTINUE                                           MAIN0110   ,128   ,129
      GO TO 1                                            MAIN0111   ,130
   40 I=2                                                MAIN0112   ,131
      IP=1                                               MAIN0113   ,132
      DO 54 M=1,9                                        MAIN0114   ,133
   54 ICON(IP,M)=IRR(M)                                  MAIN0115   ,134   ,135
      IFAM=2                                             MAIN0116   ,136
      IF (NA) 47,47,48                                   MAIN0117   ,137
   47 CALL ABODY( 2,XB,RB,DR)                            MAIN0118   ,138
      DAI=ATAN(DR)                                       MAIN0119   ,139
      GO TO 42                                           MAIN0120   ,140
   48 DO 49 L=2,NOA                                      MAIN0121   ,141
      IF (XB-ATAB(1,L)) 50,49,49                         MAIN0122   ,142
   50 DAI=0.01745329*ATAB(3,L-1)                         MAIN0123   ,143
      GO TO 42                                           MAIN0124   ,144
   49 CONTINUE                                           MAIN0125   ,145   ,146
      GO TO 1                                            MAIN0126   ,147
```

Figure 7.- Continued.

```
                EF3131                                                        03/12/65
       EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

  42 IREG=IREG+1                                                   MAIN0127   ,148
     ITYPE=1                                                       MAIN0128   ,149
     J=1                                                           MAIN0129   ,150
     IRAY=1                                                        MAIN0130   ,151
     IN=2                                                          MAIN0131   ,152
     CALL ACRAY(DAI,WUP,SUP,DUP,XB,RB)                             MAIN0132   ,153
  24 IRAY=IRAY+1                                                   MAIN0133   ,154
     IF (LAST) 39,39,1                                             MAIN0134   ,155
  39 IF (IN-1) 1,1,55                                              MAIN0135   ,156
  55 J=J+1                                                         MAIN0136   ,157
     JP=JP+1                                                       MAIN0137   ,158
     K=1                                                           MAIN0138   ,159
     KP=0                                                          MAIN0139   ,160
     GO TO (1,4,5,6,7),J                                           MAIN0140   ,161
   4 JP=1                                                          MAIN0141   ,162
   6 KP=KP+1                                                       MAIN0142   ,163
     GO TO 8                                                       MAIN0143   ,164
   7 J=1                                                           MAIN0144   ,165
   5 GO TO (9,10),IFAM                                             MAIN0145   ,166
   9 CALL BODY(CBODY,CTAB(1,1),NOB)                                MAIN0146   ,167
     GO TO 14                                                      MAIN0147   ,168
  10 CALL BODY(ABODY,ATAB(1,1),NOA)                                MAIN0148   ,169
  14 IF (X(I,J,K)-XT) 17,17,1                                      MAIN0149   ,170
  17 KP=KP+1                                                       MAIN0150   ,171
     K=K+1                                                         MAIN0151   ,172
     IF (LAST) 8,8,1                                               MAIN0152   ,173
   8 IF (K-IN+1) 18,18,19                                          MAIN0153   ,174
  18 CALL FLOW                                                     MAIN0154   ,175
     IF(IFAM) 33,33,17                                             MAIN0155   ,176
  33 JM=JP                                                         MAIN0156   ,177
     KM=KP+1                                                       MAIN0157   ,178
  34 X(I,J,K)=X(I,JM,KM)                                           MAIN0158   ,179
     R(I,J,K)=R(I,JM,KM)                                           MAIN0159   ,180
     W(I,J,K)=W(I,JM,KM)                                           MAIN0160   ,181
     S(I,J,K)=S(I,JM,KM)                                           MAIN0161   ,182
     U(I,J,K)=U(I,JM,KM)                                           MAIN0162   ,183
     DEL(I,J,K)=DEL(I,JM,KM)                                       MAIN0163   ,184
     KM=KM+1                                                       MAIN0164   ,185
     K=K+1                                                         MAIN0165   ,186
     IF (KM-NOP(I,JP)) 34,34,36                                    MAIN0166   ,187
  36 GO TO (35,37,35,37),J                                         MAIN0167   ,188
  37 NOP(I,J)=IN-1                                                 MAIN0168   ,189
```

Figure 7.- Continued.

```
          EF3131                                                              03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
         GO TO 38                                                           MAIN0169   ,190
   35    IN=IN-1                                                            MAIN0170   ,191
         NOP(I,J)=IN                                                        MAIN0171   ,192
   38    IFAM=-IFAM                                                         MAIN0172   ,193
         KP=KM-2                                                            MAIN0173   ,194
         K=K-1                                                              MAINA174   ,195
         GO TO 60                                                           MAIN0175   ,196
   19    NOP(I,J)=IN-1                                                      MAIN0176   ,197
         GO TO (20,32,20,32),J                                              MAIN0177   ,198
   32    IF (ITYPE-1) 24,29,24                                              MAIN0178   ,199
   29    NOP(I,J)=IN                                                        MAIN0179   ,200
         IN=IN+1                                                            MAIN0180   ,201
         IF (IN-50) 31,31,85                                                MAIN0181
C        ERROR CODE=1. THE NUMBER OF POINTS IN A RAY EXCEEDS 50.            MAINA182   ,202
   85    CALL ERROR(1)                                                      MAIN0183   ,203
         GO TO 1                                                            MAIN0184   ,204
   20    IF (ITYPE-2) 21,22,23                                              MAIN0185   ,205
   21    NOP(I,J)=IN                                                        MAIN0186   ,206
   31    CALL SHOCK(DUP)                                                    MAIN0187   ,207
         IF (LAST) 59,59,1                                                  MAIN0188   ,208
   59    IF (ITYPE-1) 43,44,43                                              MAIN0189   ,209
   44    IF (X(I,J,K)-XT) 60,25,25                                          MAIN0190   ,210
   60    GO TO (61,24),IANN                                                 MAIN0191   ,211
   61    IF (X(I,J,K) .LT. ATAB(1,1).AND. R(I,J,K) .LT. ATAB( 2,1)) GOTO80 MAIN0192   ,212   ,213   ,214
   62    CALL FLINT                                                         MAIN0193   ,215
         IF (LAST) 63,63,1                                                  MAIN0194   ,216
   63    IF (ITYPE-1) 64,80,64                                              MAIN0195   ,217
   64    IANN=2                                                             MAIN0196   ,218
         GO TO 43                                                           MAIN0197   ,219
   25    ITYPE=2                                                            MAIN0198   ,220
         GO TO 24                                                           MAIN0199   ,221
   22    IN=IN-1                                                            MAIN0200   ,222
         GO TO 24                                                           MAIN0201   ,223
   23    NOP(I,J)=IN                                                        MAIN0202   ,224
         GO TO (26,27),IFAM                                                 MAIN0203   ,225
   26    CALL BODY(ABODY,ATAB(1,1),NOA)                                     MAIN0204   ,226
         GO TO 28                                                           MAIN0205   ,227
   27    CALL BODY(CBODY,CTAB(1,1),NOB)                                     MAIN0206   ,228
   28    IF (X(I,J,K)-XT) 24,1,1                                            MAIN0207   ,229
   80    J=J                                                                MAIN0208   ,230
         GO TO (82,24,82,24),J                                              MAIN0209   ,231
   82    IF (IN-MAXNP) 24,83,81                                             MAIN0210
```

Figure 7.- Continued.

```
         EF3131                                                    03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

C       ERROR CODE=1. THE NUMBER OF POINTS IN A RAY EXCEEDS MAXNP=MAXIMUM MAINA211
C       NUMBER OF POINTS ALLOWED IN A RAY (INPUT QUANTITY).               MAINB212   ,232
     81 CALL ERROR(1)                                                     MAIN0213   ,233
        GO TO 1                                                           MAIN0214   ,234
    83  K=1                                                               MAIN0215   ,235
        IF (NODIS) 87,87,88                                               MAIN0216   ,236
     87 CALL ERROR(1)                                                     MAIN0217   ,237
        GO TO 1                                                           MAIN0218   ,238
     88 KP=2+NODIS                                                        MAIN0219   ,239
        IF (MOD(IN,NODIS+1) .NE. 1) GO TO 87                              MAIN0220   ,240  ,241  ,242
        DO 84 K=2,50                                                      MAIN0221   ,243
        X  (I,J,K)=X  (I,J,KP)                                            MAIN0222   ,244
        R  (I,J,K)=R  (I,J,KP)                                            MAIN0223   ,245
        DEL(I,J,K)=DEL(I,J,KP)                                            MAIN0224   ,246
        W  (I,J,K)=W  (I,J,KP)                                            MAIN0225   ,247
        S  (I,J,K)=S  (I,J,KP)                                            MAIN0226   ,248
        U  (I,J,K)=U  (I,J,KP)                                            MAIN0227   ,249
        NOP(I,J)=K                                                        MAIN0228   ,250
        KP=KP+NODIS+1                                                     MAIN0229   ,251
        IF (KP .GT. MAXNP) GO TO 89                                       MAIN0230   ,252  ,253  ,254
     84 CONTINUE                                                          MAIN0231   ,255  ,256
     89 SPACE=2.0**NODIS*SPACE                                            MAIN0232   ,257
        IN=NOP(I,J)                                                       MAIN0233   ,258
        GO TO 24                                                          MAIN0234   ,259
    100 FORMAT(7I10)                                                      MAIN0235
    101 FORMAT(7F10.6)                                                    MAIN0236
        END                                                               MAIN0237   ,260
```

Figure 7.- Continued.

```
                EF3132                                                                        03/12/65
          EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)
$IBFIC EF3132  NODECK                                                           BODY0001
C      BODY POINT SUBROUTINE.                                                   BODY 002
C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                        BODY0003
       SUBROUTINE BODY(FUN,TAB,MAX)                                             BODY0004
       COMMON /DIM/ IDIM                                                        BODY 005
       DIMENSION AA(1),TAB(3,50)                                                BODY0006
       DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                                    BODY0007
       DIMENSION  ATAB(3,50),CTAB(3,50)                                         BODY0008
       DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),           BODY0009
      1U(2,4,50)                                                                BODY0010
       COMMON  IRR                                                              BODY0011
       COMMON  X      , R      , DEL     , W      , S      , U                  BODY0012
       COMMON  GAMMA  , TEST   , CRMAX   , SCB    , SAN    , P4                 BODY0013
       COMMON  SING   , XT     , THETA   , EMIN   , WIN    , ICON               BODY0014
       COMMON  I      , NOP    , CTAB    , ATAB   , NOB    , NOA                BODY0015
       COMMON  COALT  , LAST   , XIN     , THETB  , SPACE                       BODY0016
       EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFABODY0017
      1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)             BODY0018
       TAN(X)=SIN(X)/COS(X)                                                     BODY0019
       KPP1=KP+1                                                                BODY0020    ,1
       IF  (K-1) 3,3,4                                                          BODY 021    ,2
     3 GO TO (5,6),IFAM                                                         BODY0022    ,3
     5 S(I,J,K)=SCB                                                             BODY0023    ,4
       T=1.0                                                                    BODY0024    ,5
       GO TO 7                                                                  BODY0025    ,6
     4 KP=KP-1                                                                  BODY0026    ,7
       KPP1=KP+1                                                                BODY0027    ,8
       GO TO (6,5),IFAM                                                         BODY0028    ,9
     6 S(I,J,K)=SAN                                                             BODY0029    ,10
       T=-1.0                                                                   BODY0030    ,11
     7 DO 8 ITER=1,25                                                           BODY0031    ,12
       X(I,J,K)=X(I,JP,KPP1)                                                    BODY0032    ,13
       IF (MAX) 10,10,11                                                        BODY0033    ,14
    11 DO 99 LP=2,MAX                                                           BODY0034    ,15
       IF (X(I,J,K)-TAB(1,LP)) 36,99,99                                         BODY0035    ,16
    36 A2=U(I,JP,KPP1)-      DEL(I,JP,KPP1)*T                                   BODY0036    ,17
       TANA2=TAN(A2)                                                            BODY0037    ,18
       T1=(TAB(2,LP)-TAB(2,LP-1))/(TAB(1,LP)-TAB(1,LP-1))                       BODY0038    ,19
       X(I,J,K)=(R(I,JP,KPP1)-TAB(2,LP-1)+      (X(I,JP,KPP1)*T)*TANA2+         BODY0039
      1TAB(1,LP-1)*T1)/(        TANA2*T +T1)                                    BODY0040    ,20
       IF (X(I,J,K)-TAB(1,LP)) 37,37,99                                         BODY0041    ,21
    99 CONTINUE                                                                 BODY0042    ,22    ,23
```

Figure 7.- Continued.

```
       EF3132                                                          03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

      CALL PUNT(3)                                              BODY0043   ,24
      RETURN                                                    BODY0044   ,25
   37 R(I,J,K)=R(I,JP,KPP1)-      TANA2*T *(X(I,J,K)-X(I,JP,KPP1))  BODY0045   ,26
      DEL(I,J,K)=TAB(3,LP-1)*.017453293                         BODY0046   ,27
      GO TO 1                                                   BODY0047   ,28
   10 A2=U(I,JP,KPP1)-      DEL(I,JP,KPP1)*T                    BODY0048   ,29
      TANA2=TAN(A2)                                             BODY0049   ,30
      DO 9 ICOW=1,25                                            BODY0050   ,31
   12 CALL FUN(2,X(I,J,K),R(I,J,K),DR)                          BODY0051   ,32
      T1=(X(I,J,K)-X(I,JP,KPP1))*TANA2                          BODY0052   ,33
      GAN=R(I,J,K)-R(I,JP,KPP1)+      T1*T                      BODY0053   ,34
      GPAN=DR+      TANA2*T                                     BODY0054   ,35
      IF (ABS(GPAN)-1.E-15) 2,2,14                              BODY 055   ,36
   14 RATIO=GAN/GPAN                                            BODY0056   ,37
      X(I,J,K)=X(I,J,K)-RATIO                                   BODY0057   ,38
      IF (ABS(RATIO)- TEST   ) 15,15,9                          BODY0058   ,39
   15 IF (X(I,J,K)-XT) 41,41,40                                 BODY0059   ,40
    9 CONTINUE                                                  BODY0060   ,41   ,42
      GO TO 2                                                   BODY 061   ,43
   40 CALL PUNT(3)                                              BODY0062   ,44
      RETURN                                                    BODY0063   ,45
   41 CALL FUN(2,X(I,J,K),R(I,J,K),DR)                          BODY0064   ,46
      DEL(I,J,K)=ATAN(DR)                                       BODY0065   ,47
    1 C2=0.0                                                    BODY 066   ,48
      COR2=(R(I,JP,KPP1)-R(I,J,K))/R(I,JP,KPP1)/SIN(A2)         BODY0067   ,49
      COR2=ABS(COR2)                                            BODY0068   ,50
      GO TO (33,33,31),IDIM                                     BODY 069   ,51
   31 C2=COR2*SIN(U(I,JP,KPP1))*SIN(DEL(I,JP,KPP1))             BODY0070   ,52
   33 RA2=W(I,JP,KPP1)*TAN(U(I,JP,KPP1))                        BODY0071   ,53
      D2=0.5*SIN(2.0*U(I,JP,KPP1))/GAMMA                        BODY0072   ,54
      IF (DEL(I,J,K)-1.570796) 17,17,16                         BODY0073   ,55
   16 CALL ERROR(3)                                             BODY 074   ,56
      RETURN                                                    BODY 075   ,57
 17   W(I,J,K)=W(I,JP,KPP1)+C2*RA2-D2*RA2*(S(I,J,K)-S(I,JP,KPP1))  BODY0076   ,58
      T1=(DEL(I,JP,KPP1)-DEL(I,J,K))*RA2                        BODY0077   ,59
      W(I,J,K)=W(I,J,K)+      T1*T                              BODY0078   ,60
      IF (ITER-1) 2,18,19                                       BODY0079   ,61
   18 IF (COR2-CRMAX) 20,20,21                                  BODY0080   ,62
   21 CALL JUGGLE(2)                                            BODY0081   ,63
      GO TO 22                                                  BODY0082   ,64
   19 IF (ABS(W(I,J,K)-WPREV)-TEST) 23,23,22                    BODY0083   ,65
   23 CALL JUGGLE(8)                                            BODY0084   ,66
```

Figure 7.- Continued.

```
             EF3132                                                          03/12/65
        EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

 20 IF (K .EQ. 1) GO TO 25                                   BODY 085    ,67    ,68    ,69
 26 KP=KP+1                                                  BODY0086    ,70
 25 IF (IFAM-1) 28,28,29                                     BODY0087    ,71
 28 CALL PUNT( 8)                                            BODY0088    ,72
    RETURN                                                   BODY0089    ,73
 29 CALL PUNT( 9)                                            BODY0090    ,74
    RETURN                                                   BODY0091    ,75
 22 WPREV=W(I,J,K)                                           BODY0092    ,76
    CALL JUGGLE(5)                                           BODY0093    ,77
  8 CONTINUE                                                 BODY0094    ,78    ,79
    CALL ERROR(4)                                            BODY 095    ,80
    RETURN                                                   BODY 096    ,81
  2 CALL ERROR(2)                                            BODY 097    ,82
    RETURN                                                   BODY 098    ,83
    END                                                      BODY0099    ,84
```

Figure 7.- Continued.

```
         EF3133                                                        03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3133  NODECK                                                   FLOW 001
C      SUBROUTINE FOR A FLOW FIELD POINT.                               FLOW 002
C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                FLOW0003
       SUBROUTINE FLOW                                                  FLOW0004
       COMMON /DIM/IDIM                                                 FLOW 005
       DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                            FLOW0006
       DIMENSION  ATAB(3,50),CTAB(3,50)                                 FLOW0007
       DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),   FLOW0008
      1U(2,4,50)                                                        FLOW0009
       COMMON  IRR                                                      FLOW0010
       COMMON  X      , R      , DEL    , W      , S      , U           FLOW0011
       COMMON  GAMMA  , TEST   , CRMAX  , SCB    , SAN    , P4          FLOW0012
       COMMON  SING   , XT     , THETA  , EMIN   , WIN    , ICON        FLOW0013
       COMMON  I      , NOP    , CTAB   , ATAB   , NOB    , NOA         FLOW0014
       COMMON  COALT  , LAST   , XIN    , THETB  , SPACE                FLOW0015
       EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFAFLOW0016
      1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)     FLOW0017
       CRFUN(Q000FL,Q001FL,Q002FL)=ABS((Q001FL-Q000FL)/(Q001FL*SIN(Q002FLFLOW0018
      1)))                                                              FLOW0019
       TAN(X)=SIN(X)/COS(X)                                             FLOW 020
       CFUN(Q003FL,Q004FL,Q005FL)=Q003FL*SIN(Q004FL)*SIN(Q005FL)        FLOW0021
       RAFUN(Q006FL,Q007FL)=Q006FL*TAN(Q007FL)                          FLOW0022
       DFUN(Q008FL)=SIN(2.0*Q008FL)/2.0/GAMMA                           FLOW0023
       DO 30 ITER=1,25                                                  FLOW0024    ,1
     1 GO TO(4,5),IFAM                                                  FLOW0025    ,2
     4 T=1.0                                                            FLOW0026    ,3
       GO TO 6                                                          FLOW0027    ,4
     5 T=-1.0                                                           FLOW0028    ,5
     6 A1=U(I,JP,KP)+      DEL(I,JP,KP)*T                               FLOW0029    ,6
       A2=U(I,JP,KP+1)-      DEL(I,JP,KP+1)*T                           FLOW0030    ,7
       TANA1=TAN(A1)                                                    FLOW0031    ,8
       TANA2=TAN(A2)                                                    FLOW0032    ,9
       T1=X(I,JP,KP)*TANA1+X(I,JP,KP+1)*TANA2                           FLOW0033    ,10
       T2=TANA1+TANA2                                                   FLOW0034    ,11
       X(I,J,K)=(R(I,JP,KP+1)-R(I,JP,KP)+      T1*T )/      (T2*T)      FLOW0035    ,12
       T1=(X(I,J,K)-X(I,JP,KP))*TANA1                                   FLOW0036    ,13
       R(I,J,K)=R(I,JP,KP)+      T1*T                                   FLOW0037    ,14
       C2=0.0                                                           FLOW 038    ,15
       COR2=CRFUN(R(I,J,K),R(I,JP,KP+1),A2)                             FLOW 039    ,16
       GO TO (26,26,25),IDIM                                            FLOW 040    ,17
    25 C2=CFUN(COR2,U(I,JP,KP+1),DEL(I,JP,KP+1))                        FLOW0041    ,18
    26 RA1=RAFUN(W(I,JP,KP),U(I,JP,KP))                                 FLOW0042    ,1[illegible]
```

Figure 7.- Continued.

```
        EF3133                                                          03/12/65
     EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
    RA2=RAFUN(W(I,JP,KP+1),U(I,JP,KP+1))                                 FLOW0043   ,20
    D1=DFUN(U(I,JP,KP))                                                  FLOW0044   ,21
    D2=DFUN(U(I,JP,KP+1))                                                FLOW0045   ,22
    IF (R(I,JP,KP)) 8,8,9                                                FLOW0046   ,23
  8 DEL(I,J,K)=(DEL(I,JP,KP+1)*RA2+W(I,JP,KP+1)-W(I,JP,KP)+C2*RA2)/      FLOW0047
   1(2.0*RA1+RA2)                                                        FLOW0048   ,24
    C1=0.                                                                FLOW 049   ,25
    COR1=0.0                                                             FLOW 050   ,26
    GO TO 3                                                              FLOW0051   ,27
  9 C1=0.0                                                               FLOW 052   ,28
 29 COR1=CRFUN(R(I,J,K),R(I,JP,KP),A1)                                   FLOW0053   ,29
    GO TO (28,28,27),IDIM                                                FLOW 054   ,30
 27 C1=CFUN(COR1,U(I,JP,KP),DEL(I,JP,KP))                                FLOW0055   ,31
 28 T1=W(I,JP,KP+1)-W(I,JP,KP)-C1*RA1+C2*RA2                             FLOW0056   ,32
    DEL(I,J,K)=(DEL(I,JP,KP)*RA1+RA2*DEL(I,JP,KP+1)+      T1*T )/        FLOW0057
   1(RA1+RA2)                                                            FLOW0058   ,33
  3 DELT=DEL(I,J,K)                                                      FLOW0059   ,34
    DO 33 ICOW=1,25                                                      FLOW0060   ,35
    DELTT=DEL(I,J,K)                                                     FLOW0061   ,36
    A=COR1*R(I,JP,KP)*SIN(A1-      DEL(I,J,K)*T )                        FLOW0062   ,37
    B=COR2*R(I,JP,KP+1)*SIN(A2+      DEL(I,J,K)*T )                      FLOW0063   ,38
    S(I,J,K)=S(I,JP,KP)+(S(I,JP,KP+1)-S(I,JP,KP))*A/(A+B)                FLOW0064   ,39
    BRAK=D1*RA1*(S(I,J,K)-S(I,JP,KP))-D2*RA2*(S(I,J,K)-S(I,JP,KP+1))     FLOW0065   ,40
    BRAK=BRAK/(RA1+RA2)                                                  FLOW0066   ,41
    DEL(I,J,K)=DELT+BRAK*T                                               FLOW0067   ,42
    IF (ABS(DEL(I,J,K)-DELTT)-TEST) 10,10,33                             FLOW0068   ,43
 33 CONTINUE                                                             FLOW0069   ,44   ,45
    CALL ERROR(5)                                                        FLOW 070   ,46
    RETURN                                                               FLOW 071   ,47
 10 T1=RA2*(DEL(I,J,K)-DEL(I,JP,KP+1))                                   FLOW0072   ,48
    W(I,J,K)=      -T1*T +W(I,JP,KP+1)+C2*RA2-D2*RA2*(S(I,J,K)-S(I,JP,FLOW0073
   1KP+1))                                                               FLOW0074   ,49
    IF (ITER-1) 11,11,12                                                 FLOW0075   ,50
 12 IF (ABS(DEL(I,J,K)-DPREV)-TEST) 13,13,2                              FLOW0076   ,51
 13 CALL JUGGLE(9)                                                       FLOW0077   ,52
 14 IF (X(I,J,K)-X(I,JP,KP+1)) 20,20,22                                  FLOW0078   ,53
 22 IF (ABS(X(I,J,K)-X(I,JP,KP+1))/XT-COALT) 23,21,21                    FLOW0079   ,54
 23 IF (ABS(R(I,J,K)-R(I,JP,KP+1))/XT-COALT) 20,21,21                    FLOW0080   ,55
 20 CALL PUNT(2)                                                         FLOW0081   ,56
    GO TO 15                                                             FLOW0082   ,57
 21 CALL PUNT(1)                                                         FLOW0083   ,58
 15 RETURN                                                               FLOW0084   ,59
```

Figure 7.- Continued.

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       EF3133                                                 03/12/65
     EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

11 IF (COR2-CRMAX) 17,17,18                              FLOW0085    ,60
17 IF (R(I,JP,KP)) 14,14,19                              FLOW0086    ,61
19 IF (COR1-CRMAX) 14,14,18                              FLOW0087    ,62
18 CALL JUGGLE(3)                                        FLOW0088    ,63
 2 DPREV=DEL(I,J,K)                                      FLOW0089    ,64
   CALL JUGGLE(6)                                        FLOW0090    ,65
30 CONTINUE                                              FLOW0091    ,66    ,67
   CALL ERROR(5)                                         FLOW 092    ,68
   RETURN                                                FLOW 093    ,69
   END                                                   FLOW0094    ,70
```

Figure 7.- Continued.

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              EF3134                                                          03/12/65
        EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

$IBFTC EF3134  NODECK                                                JUGGL000
 C JUGGLE     SORENSEN, COMP AND ANALYSIS BRANCH.                    JUGGL001
 C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.            JUGGL002
        SUBROUTINE JUGGLE(L)                                         JUGGL003
        DIMENSION AA(1),T(12)                                        JUGGL004
        DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                        JUGGL005
        DIMENSION  ATAB(3,50),CTAB(3,50)                             JUGGL006
        DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),   JUGGL007
       1U(2,4,50)                                                    JUGGL008
        COMMON  IRR                                                  JUGGL009
        COMMON  X       , R      , DEL    , W      , S      , U      JUGGL010
        COMMON  GAMMA   , TEST   , CRMAX  , SCB    , SAN    , P4     JUGGL011
        COMMON  SING    , XT     , THETA  , EMIN   , WIN    , ICON   JUGGL012
        COMMON  I       , NOP    , CTAB   , ATAB   , NOB    , NOA    JUGGL013
        COMMON  COALT   , LAST   , XIN    , THETB  , SPACE           JUGGL014
        EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFAJUGGL015
       1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)     JUGGL016
        ASIN(X)=ATAN(X/SQRT(1.0-X**2))                               JUGGL017
        UFUN(Q000FL)=ASIN(SQRT(1.0-(GAMMA-1.0)*0.5*Q000FL**2)/Q000FL)    JUGGL018
        KPP1=KP+1                                                    JUGGL019   ,1
        GO TO (1,2,1,4,5,4,7,8,7),L                                  JUGGL020   ,2
      1 T(1)=DEL(I,JP,KP)                                            JUGGL021   ,3
        T(2)=W(I,JP,KP)                                              JUGGL022   ,4
        T(3)=S(I,JP,KP)                                              JUGGL023   ,5
        T(4)=U(I,JP,KP)                                              JUGGL024   ,6
        T(5)=X(I,JP,KP)                                              JUGGL025   ,7
        T(6) =R(I,JP,KP)                                             JUGGL026   ,8
        IF (L .EQ. 1) RETURN                                         JUGGL027   ,9     ,10    ,11
      2 T(7)=DEL(I,JP,KPP1)                                          JUGGL028   ,12
        T(8)=W(I,JP,KPP1)                                            JUGGL029   ,13
        T(9)=S(I,JP,KPP1)                                            JUGGL030   ,14
        T(10)=U(I,JP,KPP1)                                           JUGGL031   ,15
        T(11)=X(I,JP,KPP1)                                           JUGGL032   ,16
        T(12)=R(I,JP,KPP1)                                           JUGGL033   ,17
     11 RETURN                                                       JUGGL034   ,18
      4 DEL(I,JP,KP)=0.5*(DEL(I,J,K)+DEL(I,JP,KP))                   JUGGL035   ,19
        W(I,JP,KP)=0.5*(W(I,J,K)+W(I,JP,KP))                         JUGGL036   ,20
        S(I,JP,KP)=0.5*(S(I,J,K)+S(I,JP,KP))                         JUGGL037   ,21
        U(I,JP,KP)=UFUN(W(I,JP,KP))                                  JUGGL038   ,22
        X(I,JP,KP)=0.5*(X(I,JP,KP)+X(I,J,K))                         JUGGL039   ,23
        R(I,JP,KP)=0.5*(R(I,JP,KP)+R(I,J,K))                         JUGGL040   ,24
        IF (L .EQ. 4) RETURN                                         JUGGL041   ,25    ,26    ,27
```

Figure 7.- Continued.

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                        EF3134                                                      03/12/65
                    EXTERNAL FORMULA NUMBER    -   SOURCE STATEMENT    -   INTERNAL FORMULA NUMBER(S)

5 X(I,JP,KPP1)=0.5*(X(I,JP,KPP1)+X(I,J,K))                        JUGGL042    ,28
  R(I,JP,KPP1)=0.5*(R(I,JP,KPP1)+R(I,J,K))                        JUGGL043    ,29
  DEL(I,JP,KPP1)=0.5*(DEL(I,JP,KPP1)+DEL(I,J,K))                  JUGGL044    ,30
  W(I,JP,KPP1)=0.5*(W(I,JP,KPP1)+W(I,J,K))                        JUGGL045    ,31
  S(I,JP,KPP1)=0.5*(S(I,JP,KPP1)+S(I,J,K))                        JUGGL046    ,32
  U(I,JP,KPP1)=UFUN(W(I,JP,KPP1))                                 JUGGL047    ,33
  RETURN                                                          JUGGL048    ,34
7 DEL(I,JP,KP)=T(1)                                               JUGGL049    ,35
  W(I,JP,KP)=T(2)                                                 JUGGL050    ,36
  S(I,JP,KP)=T(3)                                                 JUGGL051    ,37
  U(I,JP,KP)=T(4)                                                 JUGGL052    ,38
  X(I,JP,KP)=T(5)                                                 JUGGL053    ,39
  R(I,JP,KP)=T(6)                                                 JUGGL054    ,40
  IF (L .EQ. 7) RETURN                                            JUGGL055    ,41    ,42    ,43
8 R(I,JP,KPP1)=T(12)                                              JUGGL056    ,44
  X(I,JP,KPP1)=T(11)                                              JUGGL057    ,45
  DEL(I,JP,KPP1)=T(7)                                             JUGGL058    ,46
  W(I,JP,KPP1)=T(8)                                               JUGGL059    ,47
  S(I,JP,KPP1)=T(9)                                               JUGGL060    ,48
  U(I,JP,KPP1)=T(10)                                              JUGGL061    ,49
  RETURN                                                          JUGGL062    ,50
  END                                                             JUGGL063    ,51
```

Figure 7.- Continued.

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        EF3135                                                          03/12/65
     EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3135  NODECK                                                PUNT0001
C       OUTPUT-INPUT SUBROUTINE. SORENSEN, CAB.                      PUNT0002
C     NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.              PUNT0003
      SUBROUTINE PUNT(L)                                             PUNT0004
      DATA DONE /4HDONE    /                                         PUNT 005
      DIMENSION AA(1),SBHED(12)                                      PUNT0006
      DIMENSION  ATAB(3,50),CTAB(3,50)                               PUNT0007
      DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                          PUNT0008
      DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50), PUNT0009
     1U(2,4,50)                                                      PUNT0010
      COMMON /DIM/ IDIM                                              PUNT 011
      COMMON  IRR                                                    PUNT0012
      COMMON  X      , R      , DEL    , W      , S      , U         PUNT0013
      COMMON  GAMMA  , TEST   , CRMAX  , SCB    , SAN    , P4        PUNT0014
      COMMON  SING   , XT     , THETA  , EMIN   , WIN    , ICON      PUNT0015
      COMMON  I      , NOP    , CTAB   , ATAB   , NOB    , NOA       PUNT0016
      COMMON  COALT  , LAST   , XIN    , THETB  , SPACE              PUNT0017
      EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFAPUNT0018
     1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)   PUNT0019
      ASIN(X)=ATAN(X/SQRT(1.0-X**2))                                 PUNT 020
      GO TO (1,2,3,4,5,4,4,10,16,27),L                               PUNT 021    ,1
   16 IBOD=2                                                         PUNT0022    ,2
      GO TO 11                                                       PUNT0023    ,3
   10 IBOD=1                                                         PUNT0024    ,4
      GO TO 11                                                       PUNT0025    ,5
    1 IBOD=3                                                         PUNT0026    ,6
   11 TA=1.0-0.5*(GAMMA-1.0)*W(I,J,K)**2                             PUNT0027    ,7
      IF (TA .LE. 0.0) GO TO 23                                      PUNT 028    ,8     ,9     ,10
   21 TB=SQRT(TA)/W(I,J,K)                                           PUNT0029    ,11
      IF (TB-1.0) 22,22,23                                           PUNT0030    ,12
   23 CALL ERROR(6)                                                  PUNT 031    ,13
      RETURN                                                         PUNT 032    ,14
   22 U(I,J,K)=ASIN(TB)                                              PUNT0033    ,15
      EM=1.0/TB                                                      PUNT0034    ,16
      DELTA=DEL(I,J,K)*57.2957795                                    PUNT0035    ,17
      P1=EXP(SING-S(I,J,K))                                          PUNT0036    ,18
   12 P2=TA**(GAMMA/(GAMMA-1.0))                                     PUNT0037    ,19
      P3=P1*P2*P4                                                    PUNT0038    ,20
      WRITE (6,100)IREG,IRAY,K,X(I,J,K),R(I,J,K),P3,DELTA,   EM,P1   PUNT0039    ,21    ,22    ,23
      GO TO (17,18,19),IBOD                                          PUNT0040    ,24
   17 CALL SPLOT(6,X(I,J,K),EM)                                      PUNT0041    ,25
      CALL SPLOT(7,X(I,J,K),P3)                                      PUNT0042    ,26
```

Figure 7.- Continued.

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               EF3135                                                          03/12/65
         EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

     GO TO 19                                                        PUNT0043   ,27
  18 CALL SPLOT( 8,X(I,J,K),EM)                                      PUNT0044   ,28
     CALL SPLOT( 9,X(I,J,K),P3)                                      PUNT0045   ,29
  19 CALL SPLOT( 3,X(I,J,K),R(I,J,K))                                PUNT0046   ,30
     IF (P1-1.0) 9,9,24                                              PUNT0047   ,31
  24 IF (P1-1.0-TEST) 25,25,26                                       PUNT0048   ,32
  26 CALL ERROR(7)                                                   PUNT 049   ,33
     RETURN                                                          PUNT 050   ,34
  25 P1=1.0                                                          PUNT0051   ,35
   9 LINE=LINE+1                                                     PUNT0052   ,36
     IF (LINE-40) 13,13,14                                           PUNT0053   ,37
  14 CALL PAGE                                                       PUNT0054   ,38
  15 WRITE (6,102)(SBHED(M),M=1,12)                                  PUNT0055   ,39   ,40   ,41   ,42   ,43
     LINE=1                                                          PUNT0056   ,44
  13 RETURN                                                          PUNT0057   ,45
   2 WRITE (6,103)IREG,IRAY,K,X(I,J,K),R(I,J,K)                      PUNT0058   ,46   ,47   ,48
     IFAM=-IFAM                                                      PUNT0059   ,49
     GO TO  9                                                        PUNT0060   ,50
   3 WRITE (6,104)                                                   PUNT0061   ,51   ,52
      LAST=1                                                         PUNT 062   ,53
     RETURN                                                          PUNT 063   ,54
   4 GO TO (7,6,7),IDIM                                              PUNT 064   ,55
   6 CALL TITLE(57HTWO-DIMENSIONAL METHOD OF CHARACTERISTICS. INTERNAL PUNT 065
    1CASE.,0)                                                        PUNT 066   ,56
     GO TO 15                                                        PUNT0067   ,57
   7 CALL TITLE(72HTHREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISPUNT 068
    1TICS. INTERNAL CASE.,0)                                         PUNT 069   ,58
     GO TO 15                                                        PUNT0070   ,59
   5 READ  (5,105)(SBHED(J),J=1,12)                                  PUNT0071   ,60   ,61   ,62   ,63   ,64
     IF (SBHED(1) .EQ. DONE) CALL ENDFIL                             PUNT 072   ,65   ,66   ,67
     CALL SPLOT(2,SBHED,B)                                           PUNT 073   ,68
     RETURN                                                          PUNT0074   ,69
  27 SL= SING + ALOG(1.0/P1)                                         PUNT 075   ,70
     RHOL= (P3 *EXP((1.0-GAMMA)*(SING-SL)      ))**(1.0/GAMMA)       PUNT 076   ,71
     SL= 1716. *SL                                                   PUNT 077   ,72
     WRITE    (6,110) SL,RHOL                                        PUNT 078   ,73   ,74   ,75
 110 FORMAT( 23HOLIP INTERSECTION   SL=E15.7,2X,10HRHO/RHO L= E15.7) PUNT 079
     LAST=1                                                          PUNT 080   ,76
     RETURN                                                          PUNT 081   ,77
 100 FORMAT(6X,3I8,6F14.6)                                           PUNT0082
 105 FORMAT(12A6)                                                    PUNT0083
 102 FORMAT(1H0,24X,12A6/1H0,10X,3HREG,5X,3HRAY,3X,5HPOINT,8X,1HX,13X, PUNT0084
```

Figure 7.- Continued.

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         EF3135                                                                03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

     1lHR,12X,6HP/PINF,6X,10HDELTA(DEG),5X,8HMACH NO.,6X,8HPT/PTINF)    PUNT0085
 103 FORMAT(6X,3I8,2F14.6,60X,11HCOALESCENCE  )                         PUNT 086
 104 FORMAT(47HOEND OF BODY HAS BEEN REACHED. CASE TERMINATED.)          PUNT 087
 106 FORMAT(2F8.4)                                                       PUNT 088
     END                                                                 PUNT0089    ,78


         EF3136                                                                03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3136  NODECK                                                    CBODY001
CCBODY  DUMMY SUBROUTINE FOR CENTER-BODY. MUST BE FURNISHED IF TABLE    CBODY002
C      OF VALUES IS USED INSTEAD OF ANALYTIC FUNCTION.                   CBODY003
C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                 CBODY004
       SUBROUTINE CBODY( I,X,R,DR)                                       CBODY005
       R=0.0                                                             CBODY006    ,1
       DR=0.0                                                            CBODY007    ,2
       RETURN                                                            CBODY008    ,3
       END                                                               CBODY009    ,4


         EF3137                                                                03/12/65
      EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3137  NODECK                                                    ABODY001
CABODY  DUMMY ROUTINE FOR ANNULUS.                                       ABODY002
C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                 ABODY003
       SUBROUTINE ABODY( I,X,R,DR)                                       ABODY004
       R=0.0                                                             ABODY005    ,1
       DR=0.0                                                            ABODY006    ,2
       RETURN                                                            ABODY007    ,3
       END                                                               ABODY008    ,4
```

Figure 7.- Continued.

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           EF3138                                                                03/12/65
        EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

$IBFTC EF3138  NODECK                                                    SHOCK001
C          SORENSEN, CAB.  SHOCK POINT CALCULATION.                      SHOCK002
C       NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                SHOCK003
        SUBROUTINE SHOCK(DUP)                                            SHOCK004
        DIMENSION CO(4)                                                  SHOCK005
        DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                            SHOCK006
        DIMENSION  ATAB(3,50),CTAB(3,50)                                 SHOCK007
        DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),   SHOCK008
       1U(2,4,50)                                                        SHOCK009
        EXTERNAL  CBODY  , ABODY                                         SHOCK010
        COMMON /DIM/IDIM                                                 SHOCK011
        COMMON  IRR                                                      SHOCK012
        COMMON  X      , R      , DEL    , W      , S      , U           SHOCK013
        COMMON  GAMMA  , TEST   , CRMAX  , SCB    , SAN    , P4          SHOCK014
        COMMON  SING   , XT     , THETA  , EMIN   , WIN    , ICON        SHOCK015
        COMMON  I      , NOP    , CTAB   , ATAB   , NOB    , NOA         SHOCK016
        COMMON  COALT  , LAST   , XIN    , THETB  , SPACE                SHOCK017
        EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFASHOCK018
       1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)     SHOCK019
        ASIN(X)=ATAN(X/SQRT(1.0-X**2))                                   SHOCK020
        TAN(X)=SIN(X)/COS(X)                                             SHOCK021
        TP=THETA                                                         SHOCK022     ,1
        DUPRE=DUP                                                        SHOCK023     ,2
        JM=JP                                                            SHOCK024     ,3
        KP=KP-1                                                          SHOCK025     ,4
        KM=KP+1                                                          SHOCK026     ,5
    277 T=1.0                                                            SHOCK027     ,6
        GO TO (1,2),IFAM                                                 SHOCK028     ,7
      2 T=-1.0                                                           SHOCK029     ,8
      1 A2=TP+DUPRE*T                                                    SHOCK030     ,9
        A1=U(I,J,K-1)+      DEL(I,J,K-1)*T                               SHOCK031     ,10
        TANA1=TAN(A1)                                                    SHOCK032     ,11
        TANA2=TAN(A2)                                                    SHOCK033     ,12
      5 T1=X(I,J,K-1)*TANA1-X(I,JM,KM)*TANA2                             SHOCK034     ,13
        T2=TANA1-TANA2                                                   SHOCK035     ,14
        X(I,J,K)=(R(I,JM,KM)-R(I,J,K-1)+T1*T)/(T2*T)                     SHOCK036     ,15
      6 T3=(X(I,J,K)-X(I,J,K-1))*TANA1                                   SHOCK037     ,16
        R(I,J,K)=R(I,J,K-1)+       T3*T                                  SHOCK038     ,17
        CALL UPSC(DUP,WUP,SUP,EMUP,XB,RB)                                SHOCK039     ,18
        IF (LAST) 79,79,80                                               SHOCK040     ,19
     79 IF (ABS(T2) .LE. COALT) GO TO 62                                 SHOCKA40     ,20   ,21   ,22
        IF (X(I,J,K) .GT. X(I,JP,KP+1)) GO TO 9                          SHOCK041     ,23   ,24   ,25
```

Figure 7.- Continued.

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         EF3138                                                             03/12/65
      EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

   62 IF (IREG .LE. 1) GO TO 9                                  SHOCK042    ,26    ,27    ,28
      X(I,J,K)=XB                                               SHOCK043    ,29
      R(I,J,K)=RB                                               SHOCK044    ,30
      S(I,J,K)=SUP                                              SHOCK045    ,31
      W(I,J,K)=WUP                                              SHOCK046    ,32
      DEL(I,J,K)=DUP                                            SHOCK047    ,33
      GO TO 22                                                  SHOCK048    ,34
    9 G1=EMUP**2                                                SHOCK049    ,35
      G2=G1**2                                                  SHOCK050    ,36
      G3=(G1+2.0)/G1                                            SHOCK051    ,37
      G4=(2.0*G1+1.0)/G2                                        SHOCK052    ,38
      G5=(GAMMA+1.0)**2/4.0+(GAMMA-1.0)/G1                      SHOCK053    ,39
      CALL JUGGLE(1)                                            SHOCK054    ,40
      IF (IREG-1) 21,21,77                                      SHOCK055    ,41
   21 IF (IRAY-2) 10,10,23                                      SHOCK056    ,42
   10 IF (SPACE .LE. 0.) SPACE=0.5                              SHOCK057
C                                                               SHOCK058
C                                                               SHOCK059    ,43    ,44    ,45
   24 SPACE=    X(I,JM,KM) *SPACE                               SHOCK060    ,46
   23 XINT=X(I,JM,KM)+SPACE                                     SHOCK061    ,47
      RINT=R(I,JM,KM)+SPACE*TAN(TP)                             SHOCK062    ,48
      IF (XINT .GE. X(I,J,K-1)) GO TO 20                        SHOCK063    ,49    ,50    ,51
      SPACE=2.0*SPACE                                           SHOCK064    ,52
      GO TO 23                                                  SHOCK065    ,53
   77 IF (ITYPE-2) 27,78,27                                     SHOCK066    ,54
   27 XINT=XB                                                   SHOCK067    ,55
      RINT=RB                                                   SHOCK068    ,56
      GO TO 20                                                  SHOCK069    ,57
   78 XB=X(I,JM,KM)                                             SHOCK070    ,58
      RB=R(I,JM,KM)                                             SHOCK071    ,59
      SLOB=T*TANA2                                              SHOCK072    ,60
      IF (IFAM-1) 4,4,11                                        SHOCK073    ,61
    4 CALL BSINT(ABODY,ATAB(1,1),NOA,XB,RB,SLOB,XINT,RINT)      SHOCK074    ,62
      GO TO 20                                                  SHOCK075    ,63
   11 CALL BSINT(CBODY,CTAB(1,1),NOB,XB,RB,SLOB,XINT,RINT)      SHOCK076    ,64
   20 X(I,J,K)=XINT                                             SHOCK077    ,65
      R(I,J,K)=RINT                                             SHOCK078    ,66
      SK=(R(I,J,K-1)-R(I,J ,K ))/(X(I,J,K-1)-X(I,J ,K ))        SHOCK079    ,67
      SJ=(R(I,J,K-1)-R(I,JP,KM))/(X(I,J,K-1)-X(I,JP,KM))        SHOCK080    ,68
      X(I,JP,KP)=(SK*XINT-SJ*X(I,J,K-1)-RINT+R(I,J,K-1))/(SK-SJ) SHOCK081   ,69
      R(I,JP,KP)=RINT+(X(I,JP,KP)-XINT)*SK                      SHOCK082    ,70
      RL=(X(I,JP,KP)-X(I,JP,KM))/(X(I,J,K-1)-X(I,JP,KM))        SHOCK083    ,71
```

Figure 7.- Continued.

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              EF3138                                                              03/12/65
          EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
      DEL(I,JP,KP)=DEL(I,JP,KM)+RL*(DEL(I,J,K-1)-DEL(I,JP,KM))           SHOCK084   ,72
      W(I,JP,KP)=W(I,JP,KM)+RL*(W(I,J,K-1)-W(I,JP,KM))                   SHOCK085   ,73
      S(I,JP,KP)=S(I,JP,KM)+RL*(S(I,J,K-1)-S(I,JP,KM))                   SHOCK086   ,74
      U(I,JP,KP)=U(I,JP,KM)+RL*(U(I,J,K-1)-U(I,JP,KM))                   SHOCK087   ,75
      GO TO (7,3,7),IDIM                                                 SHOCK088   ,76
    3 COR1=0.0                                                           SHOCK089   ,77
      C1=0.0                                                             SHOCK090   ,78
      GO TO 25                                                           SHOCK091   ,79
    7 COR1=(R(I,J,K)-R(I,JP,KP))/R(I,JP,KP)/SIN(A1)                      SHOCK092   ,80
      COR1=ABS(COR1)                                                     SHOCK093   ,81
      C1=COR1*SIN(U(I,JP,KP))*SIN(DEL(I,JP,KP))                          SHOCK094   ,82
   25 RA1=W(I,JP,KP)*TAN(U(I,JP,KP))                                     SHOCK095   ,83
      D1=0.5*SIN(2.0*U(I,JP,KP))/GAMMA                                   SHOCK096   ,84
    8 DEL(I,J,K)=DEL(I,JP,KP)-C1*T                                       SHOCK097   ,85
      DO 99 IT=1,50                                                      SHOCK098   ,86
      DELTA=DUP-DEL(I,J,K)                                               SHOCK099   ,87
      SDS=SIN(DELTA)**2                                                  SHOCK100   ,88
      CO(4)=1.0                                                          SHOCK101   ,89
      CO(3)=-G3-GAMMA*SDS                                                SHOCK102   ,90
      CO(1)=(SDS-1.0)/G2                                                 SHOCK103   ,91
      CO(2)=G4+G5*SDS                                                    SHOCK104   ,92
      CALL CUBIC (CO,Z)                                                  SHOCK105   ,93
   12 T1=(2.0*GAMMA*G1*Z-GAMMA+1.0)/(GAMMA+1.0)                          SHOCK106   ,94
      IF (T1) 13,13,14                                                   SHOCK107   ,95
   13 CALL ERROR(8)                                                      SHOCK108   ,96
      RETURN                                                             SHOCK109   ,97
   14 T2=((GAMMA+1.0)*G1*Z)/((GAMMA-1.0)*G1*Z+2.0)                       SHOCK110   ,98
      IF (T2) 13,13,16                                                   SHOCK111   ,99
   16 S(I,J,K)=SUP+(ALOG(T1)-GAMMA*ALOG(T2))/(GAMMA-1.0)                 SHOCK112   ,100
      T1=1.0-4.0*(G1*Z-1.0)/(GAMMA+1.0)**2*(GAMMA*G1*Z+1.0)/(Z*G2)       SHOCK113   ,101
      IF (T1) 17,18,18                                                   SHOCK114   ,102
   17 CALL ERROR(9)                                                      SHOCK115   ,103
      RETURN                                                             SHOCK116   ,104
   18 W(I,J,K)=WUP*SQRT(T1)                                              SHOCK117   ,105
      DOLD=DEL(I,J,K)                                                    SHOCK118
C                                                                        SHOCK119   ,106
      T1=(W(I,J,K)-W(I,JP,KP))/RA1-C1+D1*(S(I,J,K)-S(I,JP,KP))           SHOCK120   ,107
      DEL(I,J,K)=DEL(I,JP,KP)+T1*T                                       SHOCK121   ,108
   31 IF (ABS(DEL(I,J,K)-DOLD) .LE. TEST) GO TO 19                       SHOCK122   ,109   ,110   ,111
      DEL(I,J,K)=0.5*(DEL(I,J,K)+DOLD)                                   SHOCK123   ,112
   99 CONTINUE                                                           SHOCK124   ,113   ,114
   19 ROOT=SQRT(Z)                                                       SHOCK125   ,115
      IF (ROOT .LE. 1.0) GO TO 26                                        SHOCK126   ,116   ,117   ,118
      CALL ERROR(10)                                                     SHOCK127   ,119
      RETURN                                                             SHOCK128   ,120
   26 THETA=ASIN(ROOT)                                                   SHOCK129   ,121
      CALL JUGGLE(7)                                                     SHOCK130   ,122
   22 CALL PUNT(1)                                                       SHOCK131   ,123
   80 RETURN                                                             SHOCK132   ,124
      END                                                                SHOCK133   ,125
```

Figure 7.- Continued.

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           EF3139                                                      03/12/65
        EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

$IBFTC EF3139  NODECK                                                 CONIC001
 C         SORENSEN, CAB. SUBROUTINE FOR STARTING NEW CONICAL REGION.   CONIC002
 C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.              CONIC003
        SUBROUTINE CONIC                                              CONIC004
        DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                         CONIC005
        DIMENSION  ATAB(3,50),CTAB(3,50)                              CONIC006
        DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50), CONIC007
       1U(2,4,50)                                                     CONIC008
        COMMON  IRR                                                   CONIC009
        COMMON  X      , R      , DEL    , W      , S      , U        CONIC010
        COMMON  GAMMA  , TEST   , CRMAX  , SCB    , SAN    , P4       CONIC011
        COMMON  SING   , XT     , THETA  , EMIN   , WIN    , ICON     CONIC012
        COMMON  I      , NOP    , CTAB   , ATAB   , NOB    , NOA      CONIC013
        COMMON  COALT  , LAST   , XIN    , THETB  , SPACE             CONIC014
        EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFACONIC015
       1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)    CONIC016
        TAN(X)=SIN(X)/COS(X)                                          CONIC017
        J=J                                                           CONIC018    ,1
        READ(5,101) XB,RB ,EMSH,EMBOD,DELSH,DELBD, OPIN               CONIC019    ,2     ,3     ,4
        NOPIN=OPIN                                                    CONIC020    ,5
        XIN=XB                                                        CONIC021    ,6
        IF (NOPIN) 8,8,9                                              CONIC022    ,7
      9 IN=NOPIN                                                      CONIC023    ,8
        GO TO 10                                                      CONIC024    ,9
      8 IN=2                                                          CONIC025    ,10
        NOPIN=2                                                       CONIC026    ,11
     10 NOP(I,J)=IN                                                   CONIC027    ,12
        ITYPE=1                                                       CONIC028    ,13
        K=1                                                           CONIC029    ,14
        X(I,J,K)=XB                                                   CONIC030    ,15
        R(I,J,K)=RB                                                   CONIC031    ,16
        DEL(I,J,K)=0.01745329*DELBD                                   CONIC032    ,17
        W(I,J,K)=EMBOD/SQRT(0.5*(GAMMA-1.0)*EMBOD**2+1.0)             CONIC033    ,18
        Z=SIN(THETA)**2                                               CONIC034    ,19
        G1=EMIN**2                                                    CONIC035    ,20
        T2=(2.0*GAMMA*G1*Z-GAMMA+1.0)/(GAMMA+1.0)                     CONIC036    ,21
      1 T3=(GAMMA+1.0)*G1*Z/((GAMMA-1.0)*G1*Z+2.0)                    CONIC037    ,22
        IF (T2) 2,2,3                                                 CONIC038    ,23
      3 IF (T3) 2,2,7                                                 CONIC039    ,24
      2 CALL ERROR(11)                                                CONIC040    ,25
        RETURN                                                        CONIC041    ,26
      7 DS=          (ALOG(T2)-GAMMA*ALOG(T3))/(GAMMA-1.0)            CONIC042    ,27
```

Figure 7.- Continued.

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        EF3139                                                              03/12/65
     EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

      IF (DS) 12,13,13                                          CONIC043    ,28
   12 DS=0.0                                                    CONIC044    ,29
   13 S(I,J,K)=SING+DS                                          CONIC045    ,30
      SCB=S(I,J,K)                                              CONIC046    ,31
      CALL PUNT(8)                                              CONIC047    ,32
      RM=XB*TAN(THETA)                                          CONIC048    ,33
      DIV=NOPIN-1                                               CONIC049    ,34
      DRM=(RM-R(I,J,K))/DIV                                     CONIC050    ,35
14    DM=0.01745329*DELSH                                       CONIC051    ,36
      WM=EMSH/SQRT(0.5*(GAMMA-1.0)*EMSH**2+1.0)                 CONIC052    ,37
      DDM=(DM-DEL(I,J,K))/DIV                                   CONIC053    ,38
      WDM=(WM-  W(I,J,K))/DIV                                   CONIC054    ,39
      DO 11 K=2,NOPIN                                           CONIC055    ,40
      K=K                                                       CONIC056    ,41
      X(I,J,K)=XB                                               CONIC057    ,42
      S(I,J,K)=S(I,J,K-1)                                       CONIC058    ,43
      W(I,J,K)=W(I,J,K-1)+WDM                                   CONIC059    ,44
      R(i,J,K)=R(I,J,K-1)+DRM                                   CONIC060    ,45
      DEL(I,J,K) =DEL(I,J,K-1)+DDM                              CONIC061    ,46
      CALL PUNT(1)                                              CONIC062    ,47
   11 CONTINUE                                                  CONIC063    ,48    ,49
      RETURN                                                    CONIC064    ,50
  101 FORMAT(7F10.6)                                            CONIC065
      END                                                       CONIC066    ,51
```

Figure 7.- Continued.

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              EF3140                                                              03/12/65
          EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3140  NODECK                                                       ERROR001
 C      ERROR SUBROUTINE                                                    ERROR002
        SUBROUTINE ERROR(LERR)                                              ERROR003
        COMMON DUMMY(2750),LAST,XIN,THETB,SPACE                             ERROR004
        WRITE (6,100) LERR                                                  ERROR005   ,1     ,2     ,3
   100 FORMAT(12HOERROR CODE I2)                                            ERROR006
        LAST=1                                                              ERROR007   ,4
        RETURN                                                              ERROR008   ,5
        END                                                                 ERROR009   ,6


              EF3141                                                              03/12/65
          EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3141  NODECK                                                       ENDFIL01
 C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                   ENDFI002
        SUBROUTINE ENDFIL                                                   ENDFI003
        CALL SPLOT(5,A,B)                                                   ENDFI004   ,1
        CALL EXIT                                                           ENDFI005   ,2
        RETURN                                                              ENDFI006   ,3
        END                                                                 ENDFI007   ,4
```

Figure 7.- Continued.

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                    EF3142                                                          03/12/65
                 EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

$IBFTC EF3142  NODECK                                                    FLINT001
 C FLINT  SORENSEN, EMC. INTERSECTION OF ANNULUS AND FLOW FIELD.         FLINT002
 C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                FLINT003
        SUBROUTINE FLINT                                                 FLINT004
        DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                            FLINT005
        DIMENSION  ATAB(3,50),CTAB(3,50)                                 FLINT006
        DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),   FLINT007
       1U(2,4,50)                                                        FLINT008
        COMMON  IRR                                                      FLINT009
        COMMON  X       , R       , DEL     , W       , S       , U      FLINT010
        COMMON  GAMMA   , TEST    , CRMAX   , SCB     , SAN     , P4     FLINT011
        COMMON  SING    , XT      , THETA   , EMIN    , WIN     , ICON   FLINT012
        COMMON  I       , NOP     , CTAB    , ATAB    , NOB     , NOA    FLINT013
        COMMON  COALT   , LAST    , XIN     , THETB   , SPACE            FLINT014
        EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFAFLINT015
       1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)     FLINT016
        IF (X(I,J,K) .GE. ATAB(1,1).AND. R(I,J,K) .LT. ATAB( 2,1)) GO TO 4FLINT017   ,1    ,2    ,3
      6 L=2                                                              FLINT018   ,4
     29 JM=J                                                             FLINT019   ,5
        KM=K                                                             FLINT020   ,6
        JN=J                                                             FLINT021   ,7
        KN=K-1                                                           FLINT022   ,8
        JQ=JP                                                            FLINT023   ,9
        KQ=KP+1                                                          FLINT024   ,10
      7 IF (KN) 1,1,8                                                    FLINT025   ,11
      8 CONTINUE                                                         FLINT026   ,12
     26 CALL DVCHK(ICHK)                                                 FLINT027   ,13
        S1=(R(I,JQ,KQ)-R(I,JM,KM))/(X(I,JQ,KQ)-X(I,JM,KM))               FLINT028   ,14
        S2=(R(I,JM,KM)-R(I,JN,KN))/(X(I,JM,KM)-X(I,JN,KN))               FLINT029   ,15
        S3=(R(I,JQ,KQ)-R(I,JN,KN))/(X(I,JQ,KQ)-X(I,JN,KN))               FLINT030   ,16
        CALL DVCHK(ICHK)                                                 FLINT031   ,17
        GO TO (14,10),ICHK                                               FLINT032   ,18
     10 T1=ATAB(2,1)-R(I,JM,KM)-S3*ATAB(1,1)                             FLINT033   ,19
        XA=(T1+S1*X(I,JM,KM))/(S1-S3)                                    FLINT034   ,20
        XB=(T1+S2*X(I,JM,KM))/(S2-S3)                                    FLINT035   ,21
        IF (XA-ATAB(1,1)) 12,12,13                                       FLINT036   ,22
     13 IF (XB-ATAB(1,1)) 15,15,14                                       FLINT037   ,23
     12 IF (XB-ATAB(1,1)) 14,15,15                                       FLINT038   ,24
     14 GO TO (16,17),L                                                  FLINT039   ,25
     16 JN=J                                                             FLINT040   ,26
        KQ=KN                                                            FLINT041   ,27
        KN=KM-1                                                          FLINT042   ,28
```

Figure 7.- Continued.

```
      EF3142                                                              03/12/65
   EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
      IF (R(I,JM,KM) .LT. ATAB(2,1)) GO TO 1                    FLINT043   ,29   ,30   ,31
      L=2                                                       FLINT044   ,32
      IF (KN) 1,1,8                                             FLINT045   ,33
 17   JN=JP                                                     FLINT046   ,34
      KM=KN                                                     FLINT047   ,35
      KN=KQ-1                                                   FLINT048   ,36
      IF (R(I,JQ,KQ) .LT. ATAB(2,1)) GO TO 1                    FLINT049   ,37   ,38   ,39
      L=1                                                       FLINT050   ,40
      GO TO 7                                                   FLINT051   ,41
 15   RA=R(I,JM,KM)+S1*(XA-X(I,JM,KM))                          FLINT052   ,42
      IF (RA-R(I,JN,KN)) 14,28,28                               FLINT053   ,43
 28   RB=R(I,JM,KM)+S2*(XB-X(I,JM,KM))                          FLINT054   ,44
      RATA=(XA-X(I,JM,KM))/(X(I,JQ,KQ)-X(I,JM,KM))              FLINT055   ,45
      RATB=(XB-X(I,JM,KM))/(X(I,JN,KN)-X(I,JM,KM))              FLINT056   ,46
      DA=DEL(I,JM,KM)+(DEL(I,JQ,KQ)-DEL(I,JM,KM))*RATA          FLINT057   ,47
      DB=DEL(I,JM,KM)+(DEL(I,JN,KN)-DEL(I,JM,KM))*RATB          FLINT058   ,48
      WA=W(I,JM,KM)+(W(I,JQ,KQ)-W(I,JM,KM))*RATA                FLINT059   ,49
      WB=W(I,JM,KM)+(W(I,JN,KN)-W(I,JM,KM))*RATB                FLINT060   ,50
      SA=S(I,JM,KM)+(S(I,JQ,KQ)-S(I,JM,KM))*RATA                FLINT061   ,51
      SB=S(I,JM,KM)+(S(I,JN,KN)-S(I,JM,KM))*RATB                FLINT062   ,52
      DEN=XA-XB                                                 FLINT063   ,53
      IF (ABS(DEN)-1.E-6) 18,18,19                              FLINT064   ,54
 19   RATC=(ATAB(1,1)-XB)/DEN                                   FLINT065   ,55
      GO TO (21,20),L                                           FLINT066   ,56
 20   K=KM                                                      FLINT067   ,57
      GO TO 22                                                  FLINT068   ,58
 21   J=JQ                                                      FLINT069   ,59
      K=KQ                                                      FLINT070   ,60
      IRAY=IRAY-1                                               FLINT      ,61
      JP=J-1                                                    FLINT071   ,62
      IF (JP .LE. 0) JP=4                                       FLINT072   ,63   ,64   ,65
 22   X(I,J,K)=ATAB(1,1)                                        FLINT073   ,66
      R(I,J,K)=ATAB(2,1)                                        FLINT074   ,67
      DEL(I,J,K)=DB+(DA-DB)*RATC                                FLINT075   ,68
      W(I,J,K)=WB+(WA-WB)*RATC                                  FLINT076   ,69
      S(I,J,K)=SB+(SA-SB)*RATC                                  FLINT077   ,70
      CALL PUNT(1)                                              FLINT078   ,71
      IF (LAST) 23,23,1                                         FLINT079   ,72
 23   NOP(I,J)=K                                                FLINT080   ,73
      J=J                                                       FLINT081   ,74
      GO TO (24,25,24,25),J                                     FLINT082   ,75
 24   IN=K                                                      FLINT083   ,76
```

Figure 7.- Continued.

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                EF3142                                                     03/12/65
          EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

      GO TO 5                                                      FLINT084     ,77
   25 IN=K+1                                                       FLINT085     ,78
    5 ITYPE=2                                                      FLINT086     ,79
      RETURN                                                       FLINT087     ,80
   18 RATC=0.0                                                     FLINT088     ,81
      K=KM                                                         FLINT089     ,82
      GO TO 22                                                     FLINT090     ,83
    4 CALL ERROR(12)                                               FLINT091     ,84
    1 RETURN                                                       FLINT092     ,85
      END                                                          FLINT093     ,86


                EF3143                                                     03/12/65
          EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

$IBFTC EF3143  NODECK                                              SPLOT001
C      DUMMY SUBROUTINE FOR SPLOT.                                 SPLOT002
       SUBROUTINE SPLOT(L,X,Y)                                     SPLOT003
       A=X                                                         SPLOT004     ,1
       AA=Y                                                        SPLOT005     ,2
       RETURN                                                      SPLOT006     ,3
       END                                                         SPLOT007     ,4
```

Figure 7.- Continued.

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          EF3144                                                                03/12/65
       EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3144  NODECK                                                  ACRAY001
CACRAY   SORENSEN, CAB. SUBROUTINE FOR  STARTING NEW REGION.           ACRAY002
C     NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                ACRAY003
      SUBROUTINE ACRAY(DAI,WUP,SUP,DUP,XB,RB)                          ACRAY004
      COMMON /SPACC/SPACC                                              ACRAY005
      DIMENSION CO(4)                                                  ACRAY006
      DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                            ACRAY007
      DIMENSION  ATAB(3,50),CTAB(3,50)                                 ACRAY008
      DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),   ACRAY009
     1U(2,4,50)                                                        ACRAY010
      COMMON  IRR                                                      ACRAY011
      COMMON  X      , R      , DEL    , W      , S      , U           ACRAY012
      COMMON  GAMMA  , TEST   , CRMAX  , SCB    , SAN    , P4          ACRAY013
      COMMON  SING   , XT     , THETA  , EMIN   , WIN    , ICON        ACRAY014
      COMMON  I      , NOP    , CTAB   , ATAB   , NOB    , NOA         ACRAY015
      COMMON  COALT  , LAST   , XIN    , THETB  , SPACE                ACRAY016
      EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFAACRAY017
     1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)     ACRAY018
      TAN(X)=SIN(X)/COS(X)                                             ACRAY019
      ASIN(X)=ATAN(X/SQRT(1.0-X**2))                                   ACRAY020
      K=1                                                              ACRAY021   ,1
      IF (IREG-2)37, 38,3                                              ACRAY022   ,2
   38 IF (SPACC .LE. 0.) SPACC=0.5                                     ACRAY023   ,3    ,4    ,5
      DX=SPACE*SPACC                                                   ACRAY024   ,6
      GO TO 39                                                         ACRAY025   ,7
   37 X(I,J,K)=XB                                                      ACRAY026   ,8
      DX=XB                                                            ACRAY027   ,9
      RB=0.0                                                           ACRAY028   ,10
      GO TO 34                                                         ACRAY029   ,11
    3 DX=.75*SPACE                                                     ACRAY030   ,12
   39 SPACE=DX                                                         ACRAY031   ,13
    4 X(I,J,K)=XB+DX                                                   ACRAY032   ,14
      IF (X(I,J,K)-XT) 34,34,35                                        ACRAY033   ,15
   35 CALL PUNT(3)                                                     ACRAY034   ,16
      RETURN                                                           ACRAY035   ,17
   34 T=1.0                                                            ACRAY036   ,18
      GO TO (1,2),IFAM                                                 ACRAY037   ,19
    2 T=-T                                                             ACRAY038   ,20
    1 R(I,J,K)=RB+DX*TAN(DAI)                                          ACRAY039   ,21
      TB =SQRT(1.0-0.5*(GAMMA-1.0)*WUP**2)/WUP                         ACRAY040   ,22
      UUP=ASIN(TB)                                                     ACRAY041   ,23
      EMUP=1.0/TB                                                      ACRAY042   ,24
```

Figure 7.- Continued.

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         EF3144                                                                03/12/65
       EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

        G1=EMUP**2                                                      ACRAY043    ,25
        G3=(G1+2.0)/G1                                                  ACRAY044    ,26
        G4=(2.0*G1+1.0)/G1**2                                           ACRAY045    ,27
        G5=(GAMMA+1.0)**2/4.0+(GAMMA-1.0)/G1                            ACRAY046    ,28
        DEL(I,J,K)=DAI                                                  ACRAY047    ,29
        T1=SIN(ABS(DUP-DAI  ))**2                                       ACRAY048    ,30
        CO(1)=(T1-1.0)/G1**2                                            ACRAY049    ,31
        CO(2)=G4+G5*T1                                                  ACRAY050    ,32
        CO(3)=-G3-GAMMA*T1                                              ACRAY051    ,33
        CO(4)=1.0                                                       ACRAY052    ,34
        CALL CUBIC (CO,Z)                                               ACRAY053
C                                                                       ACRAY054    ,35
      6 T2=(2.0*GAMMA*G1*Z-GAMMA+1.0)/(GAMMA+1.0)                       ACRAY055    ,36
        IF (T2) 7,7,8                                                   ACRAY056    ,37
      7 CALL ERROR(13)                                                  ACRAY057    ,38
        RETURN                                                          ACRAY058
C                                                                       ACRAY059    ,39
      8 T3=(GAMMA+1.0)*G1*Z/((GAMMA-1.0)*G1*Z+2.0)                      ACRAY060    ,40
        IF (T3) 7,7,10                                                  ACRAY061
C                                                                       ACRAY062
C                                                                       ACRAY063    ,41
     10 S(I,J,K)=SUP+(ALOG(T2)-GAMMA*ALOG(T3))/(GAMMA-1.0)              ACRAY064    ,42
        T4=1.0-4.0*(G1*Z-1.0)/Z*(GAMMA*G1*Z+1.0)/((GAMMA+1.0)*G1)**2    ACRAY065    ,43
        IF (T4) 11,12,12                                                ACRAY066    ,44
     11 CALL ERROR(14)                                                  ACRAY067    ,45
        RETURN                                                          ACRAY068    ,46
     12 W(I,J,K)=WUP*SQRT(T4)                                           ACRAY069    ,47
        TA=1.0-0.5*(GAMMA-1.0)*W(I,J,K)**2                              ACRAY070    ,48
        IF (TA) 11,11,36                                                ACRAY071    ,49
     36 EM=W(I,J,K)/SQRT(TA)                                            ACRAY072    ,50
        IF (EM .LE. 1.0) GO TO 13                                       ACRAY073    ,51    ,52    ,53
        IF (EM-EMUP) 33,13,13                                           ACRAY074    ,54
     13 CALL ERROR(15)                                                  ACRAY075    ,55
        RETURN                                                          ACRAY076    ,56
     33 IF (Z) 13,13,14                                                 ACRAY077    ,57
     14 T5=SQRT(Z)                                                      ACRAY078    ,58
        IF (T5-1.0) 15,15,13                                            ACRAY079    ,59
     15 THETA=ASIN(T5)                                                  ACRAY080    ,60
        RS=RB+T*DX*TAN(THETA+T*DUP)                                     ACRAY081    ,61
        DINK=IN-1                                                       ACRAY082    ,62
        DR=(RS-R(I,J,K))/DINK                                           ACRAY083    ,63
        GO TO (17,18),IFAM                                              ACRAY084    ,64
```

Figure 7.- Continued.

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                EF3144                                                   03/12/65
           EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

   17 SCB=S(I,J,K)                                               ACRAY085    ,65
      GO TO 16                                                   ACRAY086    ,66
   18 SAN=S(I,J,K)                                               ACRAY087    ,67
   16 CALL PUNT(1)                                               ACRAY088    ,68
      K=K+1                                                      ACRAY089    ,69
      X(I,J,K)=X(I,J,K-1)                                        ACRAY090    ,70
      R(I,J,K)=R(I,J,K-1)+DR                                     ACRAY091    ,71
      DEL(I,J,K)=DEL(I,J,K-1)                                    ACRAY092    ,72
      W(I,J,K)=W(I,J,K-1)                                        ACRAY093    ,73
      S(I,J,K)=S(I,J,K-1)                                        ACRAY094    ,74
      IF (K-IN) 16,19,19                                         ACRAY095    ,75
   19 NOP(I,J)=IN                                                ACRAY096    ,76
      CALL PUNT(1)                                               ACRAY097    ,77
      RETURN                                                     ACRAY098    ,78
      END                                                        ACRAY099    ,79
```

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                EF3145                                                   03/12/65
           EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

$IBFTC EF3145  NUDECK                                            CUBIC001
C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.         CUBIC002
       SUBROUTINE CUBIC(C,Z)                                     CUBIC003
       DIMENSION C(4),VLST( 7)                                   CUBIC004
       ACOS(X)=ATAN(SQRT(1.0-X**2)/X)                            CUBIC005
       P=-C(3)**2/3.0 + C(2)                                     CUBIC006    ,1
       Q=2.0*C(3)**3/27.0 - C(2)*C(3)/3.0 + C(1)                 CUBIC007    ,2
       RSQ =    -0.5*Q/ SQRT(-P**3/27.0)                         CUBIC008    ,3
        IF (ABS(RSQ) .GT. 1.0) RSQ=SIGN(1.0,RSQ)                 CUBIC009    ,4     ,5     ,6
       PHI=ACOS( RSQ)                                            CUBIC010    ,7
       TEM=2.0*SQRT(-P/3.0)                                      CUBIC011    ,8
       X1= TEM*COS(PHI/3.0)                                      CUBIC012    ,9
       X2= TEM*COS(PHI/3.0 + 2.09439510)                         CUBIC013    ,10
       X3= TEM*COS(PHI/3.0 + 4.18879020)                         CUBIC014    ,11
       IF (X2-X3) 150,150,160                                    CUBIC015    ,12
   150 Y1=AMAX1(X1,X2)                                           CUBIC016    ,13
       Y1=AMIN1(Y1,X3)                                           CUBIC017    ,14
       GO TO 175                                                 CUBIC018    ,15
   160 Y1=AMIN1(X1,X2)                                           CUBIC019    ,16
       Y1=AMAX1(Y1,X3)                                           CUBIC020    ,17
   175 Y1=Y1-C(3)/3.0                                            CUBIC021    ,18
     8 Z=Y1                                                      CUBIC022    ,19
       RETURN                                                    CUBIC023    ,20
       END                                                       CUBIC024    ,21
```

Figure 7.- Continued.

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          EF3146                                                          03/12/65
      EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

$IBFTC EF3146  NODECK                                                    UPSC0001
 C UPSC  SORENSEN, EMC. SPECIAL EVALUATION OF UPSTREAM CONDITIONS.       UPSC0002
 C      NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                UPSC0003
        SUBROUTINE UPSC(DB,WB,SB,EMUP,XB,RB)                             UPSC0004
        EXTERNAL  CBODY  , ABODY                                         UPSC0005
        DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                            UPSC0006
        DIMENSION  ATAB(3,50),CTAB(3,50)                                 UPSC0007
        DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),   UPSC0008
       1U(2,4,50)                                                        UPSC0009
        COMMON  IRR                                                      UPSC0010
        COMMON  X      , R      , DEL    , W      , S      , U           UPSC0011
        COMMON  GAMMA  , TEST   , CRMAX  , SCB    , SAN    , P4          UPSC0012
        COMMON  SING   , XT     , THETA  , EMIN   , WIN    , ICON        UPSC0013
        COMMON  I      , NOP    , CTAB   , ATAB   , NOB    , NOA         UPSC0014
        COMMON  COALT  , LAST   , XIN    , THETB  , SPACE                UPSC0015
        EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IRAY),(IRR(4),IFAUPSC0016
       1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)      UPSC0017
        IF (IREG-1) 67,24,25                                             UPSC0018    ,1
     24 DB=0.0                                                           UPSC0019    ,2
        WB=WIN                                                           UPSC0020    ,3
        SB=SING                                                          UPSC0021    ,4
        EMUP=EMIN                                                        UPSC0022    ,5
        RETURN                                                           UPSC0023    ,6
     25 XC=X(I,J,K)                                                      UPSC0024    ,7
        RC=R(I,J,K)                                                      UPSC0025    ,8
        JM=JP                                                            UPSC0026    ,9
        KM=KP+1                                                          UPSC0027    ,10
        XPREV=X(I,JM,KM)                                                 UPSC0028    ,11
      2 SL=(RC-R(I,JM,KM))/(XC-X(I,JM,KM))                               UPSC0029    ,12
        ASSIGN 5 TO ISWT                                                 UPSC0030    ,13
        GO TO 50                                                         UPSC0031    ,14
      5 IRAY=IRAY+1                                                      UPSC0032    ,15
        IF (IN-2) 67,13,71                                               UPSC0033    ,16
     13 J=J                                                              UPSC0034    ,17
        GO TO (67,16,67,16),J                                            UPSC0035    ,18
     16 IS=0                                                             UPSC0036    ,19
        GO TO 68                                                         UPSC0037    ,20
     67 CALL ERROR(16)                                                   UPSC 038    ,21
        RETURN                                                           UPSC0039    ,22
     71 J=J+1                                                            UPSC0040    ,23
        JP=JP+1                                                          UPSC0041    ,24
        K=1                                                              UPSC0042    ,25
```

Figure 7.- Continued.

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                EF3146                                                      03/12/65
           EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

     KP=0                                                    UPSC0043     ,26
  61 GO TO (56,56,57,70,59),J                                UPSC0044     ,27
  56 JP=1                                                    UPSC0045     ,28
  70 IN=IN-..                                                UPSC0046     ,29
  69 KP=KP+1                                                 UPSC0047     ,30
     GO TO65                                                 UPSC0048     ,31
  59 J=1                                                     UPSC0049     ,32
  57 IF (IFAM-1) 62,62,63                                    UPSC0050     ,33
  62 CALL BODY(CBODY,CTAB(1,1),NOB)                          UPSC0051     ,34
     GO TO 64                                                UPSC0052     ,35
  63 CALL BODY(ABODY,ATAB(1,1),NOA)                          UPSC0053     ,36
  64 K=K+1                                                   UPSC0054     ,37
     KP=KP+1                                                 UPSC0055     ,38
     IF (LAST) 11,11,501                                     UPSC0056     ,39
  11 IF (K-IN+1) 65,65,66                                    UPSC0057     ,40
  65 CALL FLOW                                               UPSC0058     ,41
     IF (IFAM) 1,1,64                                        UPSC0059     ,42
  1  X(I,J,K)=X(I,JP,KP+1)                                   UPSC0060     ,43
     R(I,J,K)=R(I,JP,KP+1)                                   UPSC0061     ,44
     W(I,J,K)=W(I,JP,KP+1)                                   UPSC0062     ,45
     S(I,J,K)=S(I,JP,KP+1)                                   UPSC0063     ,46
     U(I,J,K)=U(I,JP,KP+1)                                   UPSC0064     ,47
     DEL(I,J,K)=DEL(I,JP,KP+1)                               UPSC0065     ,48
     K=K+1                                                   UPSC0066     ,49
     KP=KP+1                                                 UPSC0067     ,50
     IF (KP-NOP(I,JP)) 1,3,3                                 UPSC0068     ,51
  3  IFAM=-IFAM                                              UPSC0069     ,52
     NOP(I,J)= K-1                                           UPSC0070     ,53
     IF (LAST) 5,5,501                                       UPSC0071     ,54
  66 NOP(I,J)=IN-1                                           UPSC0072     ,55
4    I=I                                                     UPSC0073     ,56
     J=J                                                     UPSC0074     ,57
     K=NOP(I,J)                                              UPSC0075     ,58
   6 KP=K-1                                                  UPSC0076     ,59
     GO TO (8,7,8,7),J                                       UPSC0077     ,60
   7 KP=K                                                    UPSC0078     ,61
   8 JN=JP                                                   UPSC0079     ,62
     IS=1                                                    UPSC0080     ,63
     KQ=KP+1                                                 UPSC0081     ,64
     KK=KP                                                   UPSC0082     ,65
  9  EM3=SL                                                  UPSC0083     ,66
  12 EM2=(R(I,JN,KK)-R(I,J,K))/(X(I,JN,KK)-X(I,J,K))         UPSC0084     ,67
```

Figure 7.- Continued.

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                 EF3146                                                         03/12/65
           EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
  15 T1=RC-R(I,J,K)-EM3*XC                                      UPSC0085   ,68
     XB=(T1+EM2*X(I,J,K))/(EM2-EM3)                             UPSC0086   ,69
     IF (XB-X(I,JN,KK)) 18,18,19                                UPSC0087   ,70
  18 IF (IN-2) 16,16,20                                         UPSC0088   ,71
  20 J=J                                                        UPSC0089   ,72
     JP=JP-1                                                    UPSC0090   ,73
     GO TO (22,27,26,21),J                                      UPSC0091   ,74
  22 J=5                                                        UPSC0092   ,75
  26 IN=IN-1                                                    UPSC0093   ,76
     GO TO 21                                                   UPSC0094   ,77
  27 JP=4                                                       UPSC0095   ,78
  21 J=J-1                                                      UPSC0096   ,79
  23 NOP(I,J)=NOP(I,J)-1                                        UPSC0097   ,80
     IRAY=IRAY-1                                                UPSC0098   ,81
     GO TO 4                                                    UPSC0099   ,82
  19 IF (XB- XPREV - COALT) 5,5,17                              UPSC0100   ,83
  17 CONTINUE                                                   UPSC0101   ,84
  14 RB=R(I,J,K)+EM2*(XB-X(I,J,K))                              UPSC0102   ,85
     EL2=(XB-X(I,J,K))/(X(I,JN,KK)-X(I,J,K))                    UPSC0103   ,86
     DB=DEL(I,J,K)+EL2*(DEL(I,JN,KK)-DEL(I,J,K))                UPSC0104   ,87
     WB=W(I,J,K)+EL2*(W(I,JN,KK)-W(I,J,K))                      UPSC0105   ,88
     SB=S(I,J,K)+EL2*(S(I,JN,KK)-S(I,J,K))                      UPSC0106   ,89
     TA=1.0-0.5*(GAMMA-1.0)*WB**2                               UPSC0107   ,90
     IF (TA) 44,44,45                                           UPSC0108   ,91
  45 EMUP= WB/SQRT(TA)                                          UPSC0109   ,92
  68 ASSIGN 48 TO ISWT                                          UPSC0110   ,93
     GO TO 50                                                   UPSC0111   ,94
  48 CONTINUE                                                   UPSC0112   ,95
 47  IF (IS) 500,500,501                                        UPSC0113   ,96
 500 ITYPE=2                                                    UPSC0114   ,97
 501 RETURN                                                     UPSC0115   ,98
  50 GO TO (51,52),I                                            UPSC0116   ,99
  51 I=2                                                        UPSC0117   ,100
     IP=1                                                       UPSC0118   ,101
     GO TO 53                                                   UPSC0119   ,102
  52 I=1                                                        UPSC0120   ,103
     IP=2                                                       UPSC0121   ,104
  53 DO 54 L=1,9                                                UPSC0122   ,105
     ICON(IP,L)=IRR(L)                                          UPSC0123   ,106
  54 IRR(L)=ICON(I,L)                                           UPSC0124   ,107   ,108
     GO TO ISWT,(5,48)                                          UPSC0125   ,109
  44 CALL ERROR(17)                                             UPSC 126   ,110
     RETURN                                                     UPSC 127   ,111
     END                                                        UPSC0128   ,112
```

Figure 7.- Continued.

```
         EF3147                                                          03/12/65
      EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

$IBFTC EF3147  NODECK                                                    BSINT001
 C BSINT  SORENSEN, CAB. SUBROUTINE FOR FINDING ORDINATES OF BODY-SHOCK  BSINT002
 C     INTERSECTION.                                                     BSINT003
 C     NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.                 BSINT004
       SUBROUTINE BSINT(VBODY,TAB,NO,XB,RB,SLOSH,XINT,RINT)              BSINT005
       DIMENSION TAB(3,50)                                               BSINT006
       DIMENSION ICON(2, 9),IRR( 9),NOP(2,4)                             BSINT007
       DIMENSION  ATAB(3,50),CTAB(3,50)                                  BSINT008
       DIMENSION X(2,4,50),R(2,4,50),DEL(2,4,50),W(2,4,50),S(2,4,50),    BSINT009
      1U(2,4,50)                                                         BSINT010
       COMMON  IRR                                                       BSINT011
       COMMON  X       , R      , DEL    , W      , S      , U           BSINT012
       COMMON  GAMMA   , TEST   , CRMAX  , SCB    , SAN    , P4          BSINT013
       COMMON  SING    , XI     , THETA  , EMIN   , WIN    , ICON        BSINT014
       COMMON  I       , NOP    , CTAB   , ATAB   , NOB    , NOA         BSINT015
       COMMON  COALT   , LAST   , XIN    , THETB  , SPACE                BSINT016
       EQUIVALENCE (IRR(1),ITYPE),(IRR(2),IREG),(IRR(3),IKAY),(IRR(4),IFABSINT017
      1M),(IRR(5),IN),(IRR(6),J),(IRR(7),JP),(IRR(8),K),(IRR(9),KP)      BSINT018
       IF (NO) 1,1,2                                                     BSINT019    ,1
     1 XV=XB                                                             BSINT020    ,2
       DO 3 IX=1,25                                                      BSINT021    ,3
       CALL VBODY(2,XV,RV,DRV)                                           BSINT022    ,4
       GX=RV-RB-(XV-XB)*SLOSH                                            BSINT023    ,5
       GPX=DRV-SLOSH                                                     BSINT024    ,6
       IF (ABS(GPX)-1.E-6) 4,4,5                                         BSINT025    ,7
     5 XV=XV-GX/GPX                                                      BSINT026    ,8
       IF (ABS(GX/GPX)-1.E-6) 6,6,3                                      BSINT027    ,9
     3 CONTINUE                                                          BSINT028    ,10   ,11
     4 CALL ERROR(18)                                                    BSINT029
 C                                                                       BSINT030    ,12
       RETURN                                                            BSINT031    ,13
     6 XINT=XV                                                           BSINT032    ,14
       RINT=RB+(XINT-XB)*SLOSH                                           BSINT033    ,15
       RETURN                                                            BSINT034    ,16
     2 DO 7 IP=2,NO                                                      BSINT035    ,17
       IP=IP                                                             BSINT036    ,18
       IF (XB-TAB(1,IP)) 8,8,7                                           BSINT037    ,19
     7 CONTINUE                                                          BSINT038    ,20   ,21
     8 SLOP1=(TAB(2,IP)-TAB(2,IP-1))/(TAB(1,IP)-TAB(1,IP-1))             BSINT039    ,22
       XINT=(SLOP1*TAB(1,IP)-XB*SLOSH-TAB(2,IP)+RB)/(SLOP1-SLOSH)        BSINT040    ,23
       IF (XINT-TAB(1,IP)) 9,9,10                                        BSINT041    ,24
    10 IP=IP+1                                                           BSINT042    ,25
       IF (IP-NO) 8,8,9                                                  BSINT043    ,26
     9 RINT=TAB(2,IP)+(XINT-TAB(1,IP))*SLOP1                             BSINT044    ,27
       RETURN                                                            BSINT045    ,28
       END                                                               BSINT046    ,29
```

Figure 7.- Continued

```
         EF3152                                                                03/12/65
      ASSEMBLED TEXT.

              $IBMAP EF3152   100,NUDECK
              $IBLDR EF3152                                                          03/12/65    EF315200
              $TEXT  EF3152                                                                      EF315201
                                       *PAGE  SUBROUTINE FOR PRINTING TITLE AND PAGE NUMBER AT THE                PAGE 002
                                       *      HEAD OF EACH SHEET OF OUTPUT. SORENSEN, EMC. AUGUST 7, 1961.        PAGE 003
                                              ENTRY     PAGE                                                      PAGE 004
                                              ENTRY     TITLE                                                     PAGE 005
                                              ENTRY     VTITLE          VARIABLE TITLE ENTRY                      PAGE 006

BINARY CARD (NOT PUNCHED)
        00000  0600 00 0 00141  10001  VTITLE STZ       TEST            PREPARE FOR RETURN FROM PAGE              PAGE 007
        00001  0020 00 0 00003  10001         TRA       TI2                                                       PAGE 008
        00002  4634 00 4 00141  10001  TITLE  SXD       TEST,4                                                    PAGE 009
        00003  0634 00 1 00066  10001  TI2    SXA       SV1,1                                                     PAGE 010
        00004  0634 00 4 00067  10001         SXA       SV4,4                                                     PAGE 011
        00005  0500 00 0 00132  10001         CLA       BLANK           NO. BLANK OUT BUFFER.                     PAGE 012
        00006  0774 00 1 00022  10000         AXT       18,1                                                      PAGE 013
        00007  0601 00 1 00000  10011         STO       BUFF+18,1                                                 PAGE 014
               0 00022 7 00106  10001
        00010  2 00001 1 41001  10011         TIX       *-1,1,1                                                   PAGE 015
        00011  4520 00 0 00141  10001         NZT       TEST                                                      PAGE 016
        00012  0020 00 0 00071  10001         TRA       VARY                                                      PAGE 017
        00013  4520 60 4 00004  10000         NZT*      4,4                                                       PAGE 018
        00014  0600 00 0 00137  10001         STZ       PAGNO           YES.                                      PAGE 019
        00015  0774 00 1 00000  10000  GET    AXT       0,1             GET TITLE                                 PAGE 020
        00016  0500 00 4 00003  10000         CLA       3,4                                                       PAGE 021
        00017  0774 00 4 00024  10000         AXT       20,4                                                      PAGE 022
        00020  0621 00 0 01001  10011         STA       *+1                                                       PAGE 023
        00021  4500 00 1 01000  10011  LOOP   CAL       *,1             TEST FOR END OF TITLE                     PAGE 024

BINARY CARD (NOT PUNCHED)
        00022  4340 00 0 00144  10001         LAS       =O777777777777                                            PAGE 025
        00023  0020 00 0 01002  10011         TRA       *+2                                                       PAGE 026
        00024  0020 00 0 04002  10011         TRA       PAGE+2          YES.                                      PAGE 027
        00025  0602 00 1 00106  10001         SLW       BUFF,1          NO. STORE IN BUFFER                       PAGE 028
        00026  1 77777 1 01001  10011         TXI       *+1,1,-1                                                  PAGE 029
        00027  2 00001 4 00021  10001         TIX       LOOP,4,1                                                  PAGE 030
        00030  0020 00 0 04002  10011         TRA       PAGE+2                                                    PAGE 031
        00031  0634 00 1 00066  10001  PAGE   SXA       SV1,1                                                     PAGE 032
        00032  0634 00 4 00067  10001         SXA       SV4,4                                                     PAGE 033
        00033  0534 00 1 00137  10001         LXA       PAGNO,1                                                   PAGE 034
        00034  3 00000 1 00050  10001         TXH       PAD,1,0                                                   PAGE 035
        00035  4500 00 0 00132  10001         CAL       BLANK           BRING IN DATE AND INSERT                  PAGE 036
```

Figure 7.- Continued.

```
         EF3152
      ASSEMBLED TEXT.                                                03/12/65

       00036  0560 00 0 06000  10011          LDQ    SYSDAT                          PAGE 037
       00037  4763 00 0 00014  10000          LGL    12                              PAGE 038
       00040  0602 00 0 00000  10011          SLW    BUFF+18                         PAGE 039
              0 00022 7 00106  10001
       00041  4500 00 0 00140  10001          CAL    SLASH                           PAGE 040
       00042  4763 00 0 00014  10000          LGL    12                              PAGE 041
       00043  0767 00 0 00006  10000          ALS    6                               PAGE 042

BINARY CARD (NOT PUNCHED)
       00044  4501 00 0 00140  10001          ORA    SLASH                           PAGE 043
       00045  4763 00 0 00014  10000          LGL    12                              PAGE 044
       00046  0602 00 0 00000  10011          SLW    BUFF+19                         PAGE 045
              0 00023 7 00106  10001
       00047  0140 00 0 01001  10011          TOV    *+1                             PAGE 046
       00050  1 00001 1 01001  10011   PAD    TXI    *+1,1,1                         PAGE 047
       00051  0634 00 1 00137  10001          SXA    PAGNO,1                         PAGE 048
       00052  000000000000     00010          CALL   .FWRD.(.UN06.,FORM)             PAGE 049
       00052  0074 00 4 05000  10011
       00053  1 00002 0 01004  10011
       00054  0 00142 0 00060  10100
       00055  0 00000 0 07000  10011
       00056  0 00000 0 00133  10001
       00057  0774 00 1 00024  10000          AXT    20,1                            PAGE 050
       00060  0500 00 1 00000  10011          CLA    BUFF+20,1                       PAGE 051
              0 00024 7 00106  10001
       00061  0074 00 4 10000  10011          TSX    .FCNV.,4                        PAGE 052
       00062  2 00001 1 41002  10011          TIX    *-2,1,1                         PAGE 053
       00063  0500 00 0 00137  10001          CLA    PAGNO                           PAGE 054

BINARY CARD (NOT PUNCHED)
       00064  0074 00 4 10000  10011          TSX    .FCNV.,4                        PAGE 055
       00065  0074 00 4 11000  10011          TSX    .FFIL.,4                        PAGE 056
       00066  0774 00 1 01000  10011   SV1    AXT    *,1                             PAGE 057
       00067  0774 00 4 01000  10011   SV4    AXT    *,4                             PAGE 058
       00070  0020 00 4 00001  10000          TRA    1,4                             PAGE 059
       00071  4520 60 4 00005  10000   VARY   NZT*   5,4                             PAGE 060
       00072  0600 00 0 00137  10001          STZ    PAGNO                           PAGE 061
       00073  0500 60 4 00004  10000          CLA*   4,4                             PAGE 062
       00074  0734 00 1 00000  10000          PAX    ,1                              PAGE 063
       00075  0400 00 4 00003  10000          ADD    3,4                             PAGE 064
       00076  0621 00 0 00100  10001          STA    VLOOP                           PAGE 065
       00077  0774 00 4 00000  10000          AXT    0,4                             PAGE 066
```

Figure 7.- Continued.

```
        EF3152                                                    03/12/65
      ASSEMBLED TEXT.

      00100  0500 00 1 01000  10011   VLOOP CLA    *,1             BRING IN ARRAY.                    PAGE 067
      00101  0601 00 4 00106  10001         STO    BUFF,4                                             PAGE 068
      00102  1 77777 4 01001  10011         TXI    *+1,4,-1                                           PAGE 069
      00103  7 77756 4 04002  10011         TXL    PAGE+2,4,-18                                       PAGE 070
      00104  2 00001 1 00100  10001         TIX    VLOOP,1,1                                          PAGE 071
      00105  0020 00 0 04002  10011         TRA    PAGE+2                                             PAGE 072
      00106  606060606060     10000   BUFF  BCI    9,                                                 PAGE 073

BINARY CARD (NOT PUNCHED)
      00107  606060606060     10000
      00110  606060606060     10000
      00111  606060606060     10000
      00112  606060606060     10000
      00113  606060606060     10000
      00114  606060606060     10000
      00115  606060606060     10000
      00116  606060606060     10000
      00117  606060606060     10000         BCI    9,                                                 PAGE 074
      00120  606060606060     10000
      00121  606060606060     10000
      00122  606060606060     10000
      00123  606060606060     10000
      00124  606060606060     10000
      00125  606060606060     10000
      00126  606060606060     10000
      00127  606060606060     10000
      00130  606060606060     10000         BCI    2,                                                 PAGE 075
      00131  606060606060     10000

BINARY CARD (NOT PUNCHED)
      00132  606060606060     10000   BLANK OCT    606060606060                                       PAGE 076
      00133  740130017302     10000   FORM  BCI    4,(1H1,20A6,3X,4HPAGE,I4)                          PAGE 077
      00134  002106730367     10000
      00135  730430472127     10000
      00136  257331043460     10000
      00137  0 00000 0 00000  10000   PAGNO PZE                                                       PAGE 078
      00140  000000000061     10000   SLASH OCT    61                                                 PAGE 079
      00141  0 00000 0 00000  10000   TEST  PZE                                                       PAGE 080
      00142  000000000000     10000         *LDIR
      00143  252603010502     10000
      00144  777777777777     10000         *LORG
                        00000 01111         END                                                       PAGE 081
```

Figure 7.- Continued.

```
        EF3152                                                                  03/12/65
      CONTROL DICTIONARY

              $CDICT EF3152                                                                           EF315208

BINARY CARD (NOT PUNCHED)
             000145000000              PREFACE        START=0,LENGTH=101,TYPE=7094,CMPLX=5
             000004000005
             252603010502       EF3152 DECK           LOC=0,LENGTH=101
             000145000000
             656331634325       VTITLE REAL           LOC=0,LENGTH=0
             000000000000
             633163432560       TITLE  REAL           LOC=2,LENGTH=0
             000000000002
             472127256060       PAGE   REAL           LOC=31,LENGTH=0
             000000000031
             332666512433       .FWRD. VIRTUAL        SECT. 5,CALL
             200000100000
             627062242163       SYSDAT VIRTUAL        SECT. 6
             200000000000
             336445000633       .UN06. VIRTUAL        SECT. 7
             200000000000
             332623456533       .FCNV. VIRTUAL        SECT. 8
             200000000000
             332626314333       .FFIL. VIRTUAL        SECT. 9
             200000000000

              $DKEND EF3152                                                                           EF315209

NO MESSAGES FOR THIS ASSEMBLY
```

Figure 7.- Continued.

```
        EF3152                                                        03/12/65
      CROSS REFERENCE DATA.

REFERENCES TO DEFINED SYMBOLS.

  CLASS  SYMBOL    VALUE   REFERENCES

         BLANK     00132   5,35
         BUFF      00106   7,25,40,46,60,101
         FORM      00133   56
         GET       00015
         LOOP      00021   27
         PAD       00050   34
         PAGE      00031   24,30,103,105
         PAGNO     00137   14,33,51,63,72
  LCTR    BLCTR
  QUAL    UNQS
  LCTR   //
         SLASH     00140   41,44
         SV1       00066   3,31
         SV4       00067   4,32
         TEST      00141   0,2,11
         TI2       00003   1
         TITLE     00002
         VARY      00071   12
         VLOOP     00100   76,104
         VTITLE    00000

REFERENCES TO VIRTUAL SYMBOLS.

         .FCNV.        8   61,64
         .FFIL.        9   65
         .FWRD.        5   52
         .UN06.        7   55
         SYSDAT        6   36
```

Figure 7.- Concluded.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	1	1	0.100000	0.022160	1.829847	12.499998	2.600000	0.994014	
1	1	2	0.100000	0.043067	1.452360	5.249999	2.750000	0.994014	
1	2	1	0.121087	0.036991	1.672694	8.233369	2.658124	0.994014	
1	2	2	0.150000	0.064600	1.487003	5.312679	2.734400	0.993671	
1	3	1	0.142810	0.031629	1.968664	12.500000	2.552813	0.994014	
1	3	2	0.162227	0.061062	1.497941	5.797173	2.729667	0.993737	
1	3	3	0.200000	0.086218	1.417778	4.650740	2.766831	0.995681	
1	4	1	0.177843	0.056675	1.689303	8.076803	2.651582	0.993806	
1	4	2	0.206976	0.084147	1.418565	4.800107	2.766314	0.995446	
1	4	3	0.250000	0.107296	1.370511	4.184130	2.789752	0.996818	
1	5	1	0.214447	0.047494	1.987871	12.500000	2.546557	0.994014	
1	5	2	0.218943	0.080627	1.574268	6.522618	2.698219	0.995114	
1	5	3	0.252751	0.106465					COALESCENCE
1	6	1	0.249193	0.072390	1.809782	9.478781	2.607548	0.994662	
1	6	2	0.261858	0.103711	1.506641	5.677774	2.727685	0.996473	
1	6	3	0.300000	0.128003	1.459558	5.053197	2.747104	0.994517	
1	7	1	0.287108	0.063587	1.947082	12.500000	2.559919	0.994014	
1	7	2	0.287596	0.096414	1.710110	8.026234	2.644951	0.995803	
1	7	3	0.305835	0.126297	1.458900	5.134191	2.747535	0.994726	
1	7	4	0.350000	0.149407	1.423552	4.706908	2.764076	0.995529	
1	8	1	0.321220	0.087913	1.837013	10.154383	2.598121	0.995009	
1	8	2	0.327868	0.119892	1.641465	7.146212	2.671048	0.995084	
1	8	3	0.351399	0.148993					COALESCENCE
1	9	1	0.359091	0.079529	1.917662	12.500000	2.569738	0.994014	
1	9	2	0.358329	0.111821	1.758043	8.835477	2.626562	0.995053	
1	9	3	0.370127	0.143444	1.590797	6.512144	2.691612	0.995393	
1	9	4	0.400000	0.170531	1.551223	5.905651	2.705405	0.991441	
1	10	1	0.392834	0.103510	1.841782	10.575611	2.596168	0.994580	
1	10	2	0.397955	0.135833	1.698852	7.937300	2.648879	0.995263	
1	10	3	0.413371	0.166750	1.548816	6.061395	2.706978	0.992299	
1	10	4	0.450000	0.192645	1.517765	5.599142	2.720387	0.992646	
1	11	1	0.430740	0.095398	1.893800	12.500000	2.577817	0.994014	
1	11	2	0.429823	0.127744	1.780256	9.336113	2.618387	0.994974	
1	11	3	0.438935	0.159604	1.649662	7.313833	2.666694	0.993366	
1	11	4	0.458165	0.190309	1.516499	5.678059	2.720898	0.992597	
1	11	5	0.500000	0.214501	1.490232	5.342962	2.732918	0.993567	
1	12	1	0.464861	0.119580	1.839649	10.813050	2.596887	0.994535	
1	12	2	0.468646	0.151804	1.727328	8.500481	2.637295	0.994011	
1	12	3	0.481665	0.183621	1.611498	6.805364	2.681553	0.992854	
1	12	4	0.503302	0.213547					COALESCENCE

Figure 8.- Sample output.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	13	1	0.503432	0.111497	1.880754	12.500000	2.582278	0.994014	
1	13	2	0.501445	0.143759	1.787577	9.710469	2.615254	0.994238	
1	13	3	0.509470	0.176124	1.685616	7.844671	2.652663	0.993291	
1	13	4	0.524914	0.207300	1.580026	6.403674	2.694672	0.993320	
1	13	5	0.550000	0.236144	1.554438	5.934829	2.703979	0.991320	
1	14	1	0.537481	0.135591	1.836305	11.051210	2.597802	0.994134	
1	14	2	0.540352	0.168251	1.744976	8.875940	2.630495	0.993677	
1	14	3	0.551038	0.200114	1.650889	7.337607	2.666175	0.993309	
1	14	4	0.568819	0.230829	1.551519	6.089848	2.705568	0.991879	
1	14	5	0.600000	0.258283	1.530028	5.712078	2.714865	0.992215	
1	15	1	0.576289	0.127633	1.863400	12.500000	2.588263	0.994014	
1	15	2	0.574281	0.160125	1.796224	9.991691	2.611899	0.993877	
1	15	3	0.580276	0.192449	1.708661	8.244847	2.643969	0.993454	
1	15	4	0.593417	0.223961	1.619324	6.944455	2.678093	0.992373	
1	15	5	0.613585	0.254413	1.528168	5.809903	2.715610	0.992142	
1	15	6	0.650000	0.280233	1.508868	5.516748	2.724416	0.992951	
1	16	1	0.610814	0.152013	1.831535	11.164071	2.599357	0.993941	
1	16	2	0.612445	0.184441	1.760188	9.208309	2.624849	0.993633	
1	16	3	0.621203	0.216525	1.675189	7.760577	2.656353	0.992781	
1	16	4	0.636758	0.247857	1.593313	6.601687	2.688509	0.992218	
1	16	5	0.658602	0.277764	1.507812	5.571530	2.724793	0.992831	
1	16	6	0.700000	0.302021	1.490269	5.343304	2.732901	0.993566	
1	17	1	0.650260	0.144015	1.857604	12.500000	2.590275	0.994014	
1	17	2	0.647129	0.176315	1.798886	10.197787	2.610872	0.993771	
1	17	3	0.651847	0.208684	1.725934	8.614437	2.637241	0.993127	
1	17	4	0.663205	0.240654	1.647380	7.347186	2.666976	0.992422	
1	17	5	0.680447	0.271517	1.570588	6.312946	2.698121	0.992638	
1	17	6	0.703833	0.300913					COALESCENCE
1	18	1	0.684471	0.168157	1.832294	11.307454	2.599053	0.993886	
1	18	2	0.684974	0.200627	1.765743	9.474916	2.622661	0.993404	
1	18	3	0.692466	0.232991	1.697074	8.117669	2.647884	0.992697	
1	18	4	0.705669	0.264550	1.622946	7.002891	2.676766	0.992562	
1	18	5	0.724419	0.294963	1.550565	6.064659	2.706867	0.993251	
1	18	6	0.750000	0.323664	1.533967	5.748213	2.713099	0.992074	
1	19	1	0.723755	0.160293	1.852881	12.500000	2.591919	0.994014	
1	19	2	0.720572	0.192449	1.802407	10.427276	2.609512	0.993623	
1	19	3	0.724205	0.225036	1.737103	8.881883	2.632975	0.992990	
1	19	4	0.733678	0.257080	1.671444	7.708818	2.657694	0.992613	
1	19	5	0.748499	0.288233	1.601333	6.709708	2.685770	0.993017	
1	19	6	0.768809	0.318313	1.531742	5.855652	2.714259	0.992402	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	19	7	0.800000	0.345645	1.516895	5.591093	2.720780	0.992676	
1	20	1	0.757974	0.184427	1.829549	11.434292	2.599972	0.993809	
1	20	2	0.758273	0.216895	1.775267	9.718620	2.619091	0.993267	
1	20	3	0.764183	0.249251	1.711170	8.399718	2.642569	0.992765	
1	20	4	0.775357	0.280961	1.648612	7.364169	2.666783	0.992869	
1	20	5	0.791815	0.311819	1.580987	6.463619	2.693809	0.992604	
1	20	6	0.813784	0.341700	1.515417	5.662563	2.721376	0.992616	
1	20	7	0.850000	0.367494	1.501516	5.448379	2.727760	0.993197	
1	21	1	0.797465	0.176617	1.843704	12.500000	2.595126	0.994014	
1	21	2	0.794055	0.208813	1.805912	10.591179	2.608185	0.993514	
1	21	3	0.796907	0.241191	1.749820	9.149521	2.628246	0.992978	
1	21	4	0.804746	0.273273	1.687778	7.997465	2.651530	0.992828	
1	21	5	0.817601	0.304752	1.627022	7.076044	2.675226	0.992699	
1	21	6	0.835766	0.335439	1.563280	6.239035	2.701137	0.992612	
1	21	7	0.858931	0.364924	1.500640	5.490672	2.728081	0.993108	
1	21	8	0.900000	0.389225	1.487556	5.317854	2.734146	0.993653	
1	22	1	0.831817	0.200819	1.826318	11.500708	2.601078	0.993752	
1	22	2	0.831288	0.233118	1.782228	9.922274	2.616526	0.993215	
1	22	3	0.836264	0.265321	1.726378	8.679737	2.636920	0.992890	
1	22	4	0.845964	0.297219	1.665457	7.662874	2.660109	0.992748	
1	22	5	0.860534	0.328575	1.608152	6.816135	2.682765	0.992642	
1	22	6	0.879939	0.358895	1.547229	6.040285	2.708076	0.992957	
1	22	7	0.904232	0.388000	1.487175	5.336271	2.734285	0.993610	
1	22	8	0.950000	0.410847	1.474806	5.197809	2.740022	0.994055	
1	23	1	0.871529	0.193021	1.840714	12.500000	2.596175	0.994014	
1	23	2	0.867579	0.225041	1.806135	10.717140	2.608072	0.993463	
1	23	3	0.869405	0.257300	1.759601	9.375874	2.624672	0.993030	
1	23	4	0.876387	0.289397	1.703663	8.291184	2.645444	0.992806	
1	23	5	0.887930	0.321199	1.645838	7.364364	2.667753	0.992681	
1	23	6	0.903745	0.352234	1.591001	6.587558	2.689868	0.992851	
1	23	7	0.924308	0.382199	1.532585	5.862677	2.714566	0.993417	
1	23	8	0.949672	0.410942					COALESCENCE
1	24	1	0.905669	0.217064	1.826049	11.582844	2.601157	0.993728	
1	24	2	0.904416	0.249204	1.785487	10.083679	2.615351	0.993224	
1	24	3	0.908413	0.281460	1.737105	8.926731	2.632915	0.992899	
1	24	4	0.917327	0.313514	1.683532	7.948246	2.653098	0.992730	
1	24	5	0.930238	0.345018	1.627925	7.103544	2.674926	0.992790	
1	24	6	0.947200	0.375742	1.575322	6.384400	2.696554	0.993233	
1	24	7	0.968853	0.405367	1.519149	5.702648	2.720599	0.993875	
1	24	8	1.000000	0.432370	1.507603	5.505000	2.724990	0.99[illegible]	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	25	1	0.945258	0.209350	1.838064	12.500000	2.597105	0.994014	
1	25	2	0.941107	0.241140	1.808651	10.848729	2.607169	0.993459	
1	25	3	0.942290	0.273392	1.764034	9.566375	2.623051	0.993041	
1	25	4	0.948320	0.305674	1.716920	8.534400	2.640419	0.992799	
1	25	5	0.958680	0.337477	1.665025	7.650604	2.660290	0.992767	
1	25	6	0.972840	0.368687	1.611495	6.873031	2.681700	0.993076	
1	25	7	0.990870	0.399111	1.560913	6.202220	2.702816	0.993671	
1	25	8	1.013641	0.428452	1.506412	5.560166	2.725632	0.993186	
1	25	9	1.050000	0.454147	1.495555	5.392768	2.730481	0.993394	
1	26	1	0.979202	0.233247	1.825631	11.651752	2.601304	0.993727	
1	26	2	0.977753	0.265307	1.789075	10.253198	2.614057	0.993230	
1	26	3	0.981158	0.297657	1.744406	9.119026	2.630202	0.992902	
1	26	4	0.988721	0.329748	1.698165	8.196179	2.647522	0.992780	
1	26	5	1.000387	0.361295	1.647963	7.389073	2.667098	0.992961	
1	26	6	1.015701	0.392218	1.596357	6.667342	2.688086	0.993466	
1	26	7	1.034815	0.422395	1.547246	6.040349	2.708317	0.993336	
1	26	8	1.058879	0.451586	1.494837	5.426202	2.730773	0.993362	
1	26	9	1.100000	0.475832	1.484409	5.288300	2.735592	0.993753	
1	27	1	1.018665	0.225608	1.835914	12.500000	2.597862	0.994014	
1	27	2	1.014552	0.257325	1.809080	10.968100	2.607018	0.993463	
1	27	3	1.015504	0.289584	1.770580	9.743195	2.620659	0.993047	
1	27	4	1.020608	0.321799	1.725869	8.736001	2.637072	0.992831	
1	27	5	1.029539	0.353684	1.680744	7.900736	2.654278	0.992891	
1	27	6	1.042400	0.384978	1.632181	7.156890	2.673553	0.993281	
1	27	7	1.058872	0.415666	1.581975	6.485046	2.693911	0.993380	
1	27	8	1.079239	0.445727	1.534804	5.889109	2.713584	0.993354	
1	27	9	1.104237	0.474604	1.484090	5.303201	2.735712	0.993722	
1	27	10	1.150000	0.497429	1.474052	5.190695	2.740371	0.994078	
1	28	1	1.052634	0.249516	1.823785	11.717343	2.601959	0.993728	
1	28	2	1.051137	0.281561	1.792522	10.388058	2.612815	0.993235	
1	28	3	1.053943	0.313767	1.752663	9.309498	2.627160	0.992924	
1	28	4	1.060551	0.345819	1.708452	8.403420	2.643666	0.992866	
1	28	5	1.070720	0.377492	1.664538	7.639796	2.660719	0.993132	
1	28	6	1.084766	0.408579	1.617146	6.951694	2.679602	0.993345	
1	28	7	1.102550	0.439159	1.568853	6.315745	2.699315	0.993363	
1	28	8	1.123809	0.468941	1.523242	5.750710	2.718677	0.993616	
1	28	9	1.149704	0.497515					COALESCENCE
1	29	1	1.092235	0.241901	1.831320	12.500000	2.599480	0.994014	
1	29	2	1.087989	0.273651	1.810131	11.059100	2.606645	0.993466	
1	29	3	1.088527	0.305742	1.775803	9.898107	2.618763	0.993062	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	29	4	1.092956	0.337846	1.735538	8.935175	2.633494	0.992891
1	29	5	1.100915	0.369718	1.692114	8.111222	2.649996	0.993026
1	29	6	1.112297	0.401223	1.649030	7.409902	2.666877	0.993266
1	29	7	1.127667	0.432227	1.603392	6.762247	2.685158	0.993357
1	29	8	1.146402	0.462535	1.556644	6.161369	2.704508	0.993535
1	29	9	1.168513	0.492047	1.512458	5.623417	2.723523	0.993949
1	29	10	1.200000	0.518947	1.503106	5.463190	2.727036	0.993144
1	30	1	1.126291	0.265858	1.821793	11.754562	2.602667	0.993731
1	30	2	1.124283	0.297781	1.795295	10.506715	2.611823	0.993246
1	30	3	1.126586	0.329846	1.759399	9.477750	2.624704	0.992965
1	30	4	1.132460	0.361819	1.719281	8.608045	2.639640	0.992970
1	30	5	1.141728	0.393550	1.676375	7.854661	2.656149	0.993172
1	30	6	1.154442	0.425001	1.634796	7.198855	2.672541	0.993324
1	30	7	1.170776	0.455757	1.590570	6.590138	2.690451	0.993474
1	30	8	1.190414	0.485800	1.545244	6.019830	2.709476	0.993819
1	30	9	1.213414	0.515088	1.502115	5.507788	2.727579	0.993318
1	30	10	1.250000	0.540689	1.493169	5.370459	2.731572	0.993472
1	31	1	1.166038	0.258247	1.829681	12.500000	2.600059	0.994014
1	31	2	1.161440	0.289880	1.809707	11.132923	2.606802	0.993474
1	31	3	1.161353	0.321872	1.780113	10.035568	2.617214	0.993091
1	31	4	1.165212	0.353863	1.743548	9.112333	2.630564	0.992968
1	31	5	1.172470	0.385736	1.703469	8.321832	2.645704	0.993090
1	31	6	1.183142	0.417432	1.661865	7.620440	2.661848	0.993266
1	31	7	1.196830	0.448664	1.621491	7.007846	2.677909	0.993420
1	31	8	1.214073	0.479178	1.578580	6.432856	2.695519	0.993704
1	31	9	1.234644	0.509000	1.534307	5.891426	2.713872	0.993472
1	31	10	1.258700	0.538177	1.492567	5.397718	2.731820	0.993449
1	31	11	1.300000	0.562355	1.483857	5.283116	2.735846	0.993771
1	32	1	1.199950	0.282098	1.821308	11.800877	2.602842	0.993736
1	32	2	1.197484	0.313910	1.796379	10.605742	2.611446	0.993267
1	32	3	1.199074	0.345902	1.765042	9.628145	2.622669	0.993022
1	32	4	1.204408	0.377840	1.727916	8.793798	2.636441	0.993040
1	32	5	1.213121	0.409709	1.688804	8.061965	2.651376	0.993196
1	32	6	1.224838	0.441202	1.648250	7.409273	2.667247	0.993362
1	32	7	1.239437	0.472218	1.609022	6.833875	2.683043	0.993604
1	32	8	1.257611	0.502531	1.567067	6.290384	2.700176	0.993548
1	32	9	1.279277	0.532248	1.524197	5.769740	2.718165	0.993456
1	32	10	1.304083	0.561172	1.483591	5.295198	2.735947	0.993746
1	32	11	1.350000	0.583948	1.475103	5.200621	2.739884	0.994045
1	33	1	1.239601	0.274539	1.828213	12.500000	2.600577	0.994014

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	33	2	1.234894	0.306020	1.810518	11.211240	2.606523	0.993490	
1	33	3	1.234275	0.337913	1.782566	10.152227	2.616350	0.993133	
1	33	4	1.237437	0.369912	1.749879	9.274333	2.628259	0.993032	
1	33	5	1.244289	0.401883	1.713300	8.506126	2.642003	0.993132	
1	33	6	1.254094	0.433576	1.674973	7.828587	2.656774	0.993298	
1	33	7	1.266784	0.464865	1.635451	7.217604	2.672406	0.993515	
1	33	8	1.282309	0.495707	1.597030	6.676554	2.687878	0.993568	
1	33	9	1.301571	0.525932	1.556408	6.155953	2.704574	0.993485	
1	33	10	1.324026	0.555399	1.514687	5.656667	2.722375	0.993661	
1	33	11	1.349557	0.584077					COALESCENCE
1	34	1	1.273383	0.298295	1.820797	11.841670	2.603029	0.993745	
1	34	2	1.270695	0.329960	1.798456	10.706558	2.610719	0.993298	
1	34	3	1.271789	0.361925	1.768239	9.759904	2.621534	0.993077	
1	34	4	1.276535	0.394001	1.735540	8.956465	2.633623	0.993090	
1	34	5	1.284539	0.425826	1.699417	8.248782	2.647339	0.993231	
1	34	6	1.295355	0.457339	1.661917	7.617495	2.661936	0.993432	
1	34	7	1.309026	0.488465	1.623113	7.044617	2.677344	0.993549	
1	34	8	1.325624	0.519242	1.585908	6.528735	2.692384	0.993513	
1	34	9	1.345668	0.549237	1.546372	6.031347	2.708862	0.993607	
1	34	10	1.368883	0.578460	1.505716	5.551231	2.726425	0.993937	
1	34	11	1.400000	0.605474	1.497930	5.414951	2.729395	0.993316	
1	35	1	1.312946	0.290783	1.826895	12.500000	2.601043	0.994014	
1	35	2	1.308145	0.322126	1.811102	11.280911	2.606328	0.993511	
1	35	3	1.307307	0.353944	1.785332	10.271649	2.615377	0.993177	
1	35	4	1.310093	0.386032	1.754469	9.409242	2.626598	0.993085	
1	35	5	1.316051	0.418001	1.721787	8.673217	2.638829	0.993173	
1	35	6	1.325114	0.449672	1.686241	8.016833	2.652463	0.993352	
1	35	7	1.336942	0.481044	1.649289	7.427378	2.666932	0.993504	
1	35	8	1.351729	0.512113	1.611646	6.882739	2.681933	0.993526	
1	35	9	1.369097	0.542681	1.575425	6.392069	2.696736	0.993576	
1	35	10	1.389891	0.572450	1.536900	5.915415	2.713011	0.993836	
1	35	11	1.413903	0.601467	1.497050	5.454087	2.729869	0.993454	
1	35	12	1.450000	0.627176	1.489514	5.336219	2.733248	0.993590	
1	36	1	1.346612	0.314453	1.820278	11.877912	2.603221	0.993756	
1	36	2	1.343817	0.346045	1.799639	10.799505	2.610316	0.993332	
1	36	3	1.344774	0.378045	1.772409	9.884872	2.620042	0.993126	
1	36	4	1.348871	0.410064	1.741081	9.097991	2.631589	0.993136	
1	36	5	1.355937	0.441912	1.708638	8.418815	2.643865	0.993280	
1	36	6	1.366051	0.473465	1.673436	7.808393	2.657465	0.993446	
1	36	7	1.379013	0.504797	1.637521	7.250178	2.671587	0.993518	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	36	8	1.394613	0.535665	1.600818	6.733471	2.686333	0.993559	
1	36	9	1.412715	0.566028	1.565519	6.265210	2.700952	0.993752	
1	36	10	1.434292	0.595607	1.527748	5.808690	2.716723	0.993568	
1	36	11	1.459234	0.624507	1.488961	5.360925	2.733475	0.993568	
1	36	12	1.500000	0.648814	1.481552	5.261429	2.736908	0.993844	
1	37	1	1.386095	0.306984	1.825699	12.500000	2.601466	0.994014	
1	37	2	1.381300	0.338265	1.811008	11.345801	2.606376	0.993534	
1	37	3	1.380416	0.370109	1.787916	10.373455	2.614469	0.993220	
1	37	4	1.382775	0.402089	1.759598	9.542897	2.624739	0.993132	
1	37	5	1.388065	0.434017	1.728150	8.819429	2.636470	0.993219	
1	37	6	1.396221	0.465777	1.695778	8.190734	2.648825	0.993379	
1	37	7	1.407495	0.497309	1.661466	7.614872	2.662150	0.993491	
1	37	8	1.421291	0.528456	1.626386	7.087220	2.676033	0.993544	
1	37	9	1.437664	0.559126	1.590573	6.595245	2.690587	0.993685	
1	37	10	1.456528	0.589319	1.555944	6.148539	2.704861	0.993627	
1	37	11	1.479018	0.618797	1.519196	5.706686	2.720378	0.993568	
1	37	12	1.504647	0.647466	1.481288	5.273265	2.737008	0.993820	
1	37	13	1.550000	0.670389	1.474004	5.190235	2.740393	0.994079	
1	38	1	1.419748	0.330641	1.819235	11.912702	2.603599	0.993768	
1	38	2	1.416995	0.362257	1.800892	10.877075	2.609888	0.993366	
1	38	3	1.417617	0.394140	1.775958	9.998198	2.618777	0.993171	
1	38	4	1.421244	0.426069	1.747051	9.237920	2.629404	0.993182	
1	38	5	1.427698	0.457934	1.715396	8.570296	2.641330	0.993314	
1	38	6	1.437038	0.489696	1.683708	7.979781	2.653499	0.993447	
1	38	7	1.449173	0.521060	1.650106	7.437387	2.666623	0.993524	
1	38	8	1.463757	0.552025	1.615831	6.936683	2.680320	0.993635	
1	38	9	1.480926	0.582531	1.580660	6.468267	2.694626	0.993647	
1	38	10	1.500679	0.612643	1.546986	6.037389	2.708591	0.993587	
1	38	11	1.523840	0.641906	1.511081	5.610869	2.723985	0.993749	
1	38	12	1.550138	0.670349					COALESCENCE
1	39	1	1.459275	0.323191	1.823587	12.500000	2.602215	0.994014	
1	39	2	1.454498	0.354523	1.811192	11.397661	2.606326	0.993557	
1	39	3	1.453367	0.386247	1.790100	10.465774	2.613706	0.993260	
1	39	4	1.455343	0.418125	1.764012	9.664712	2.623148	0.993177	
1	39	5	1.460199	0.450026	1.734531	8.965844	2.634109	0.993258	
1	39	6	1.467894	0.481912	1.703360	8.340736	2.645943	0.993393	
1	39	7	1.478117	0.513528	1.672210	7.786835	2.657973	0.993494	
1	39	8	1.491063	0.544724	1.639312	7.273833	2.670927	0.993594	
1	39	9	1.506453	0.575540	1.605602	6.798573	2.684450	0.993643	
1	39	10	1.524540	0.605968	1.571374	6.347676	2.698430	0.993607	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	39	11	1.544941	0.635885	1.538480	5.933171	2.712252	0.993699
1	39	12	1.568753	0.664937	1.503366	5.520623	2.727475	0.993987
1	39	13	1.600000	0.691906	1.496635	5.402857	2.729987	0.993358
1	40	1	1.493035	0.346918	1.818165	11.934760	2.603987	0.993780
1	40	2	1.490008	0.378439	1.801925	10.947358	2.609539	0.993399
1	40	3	1.490327	0.410212	1.779002	10.101518	2.617698	0.993215
1	40	4	1.493603	0.442101	1.751901	9.367959	2.627636	0.993223
1	40	5	1.499747	0.474050	1.722635	8.716071	2.638617	0.993337
1	40	6	1.508382	0.505806	1.691840	8.131349	2.650380	0.993454
1	40	7	1.519435	0.537274	1.661252	7.609477	2.662276	0.993556
1	40	8	1.533205	0.568335	1.628832	7.123989	2.675110	0.993625
1	40	9	1.549517	0.599086	1.596008	6.667810	2.688328	0.993619
1	40	10	1.568282	0.629323	1.562550	6.234821	2.702133	0.993669
1	40	11	1.589307	0.659048	1.530390	5.835176	2.715816	0.993901
1	40	12	1.613811	0.687924	1.495861	5.436695	2.730415	0.993497
1	40	13	1.650000	0.713599	1.489292	5.334137	2.733349	0.993597
1	41	1	1.532718	0.339457	1.822635	12.500000	2.602552	0.994014
1	41	2	1.527648	0.370723	1.810843	11.442289	2.606465	0.993581
1	41	3	1.526174	0.402359	1.791954	10.549905	2.613062	0.993299
1	41	4	1.527875	0.434188	1.767498	9.778217	2.621898	0.993220
1	41	5	1.532493	0.466155	1.740288	9.096520	2.631984	0.993289
1	41	6	1.539622	0.497996	1.711176	8.488876	2.642985	0.993406
1	41	7	1.549135	0.529618	1.680818	7.939363	2.654657	0.993516
1	41	8	1.561027	0.560970	1.650585	7.447226	2.666484	0.993599
1	41	9	1.575728	0.591979	1.618985	6.982537	2.679045	0.993622
1	41	10	1.592724	0.622551	1.586880	6.545672	2.692077	0.993652
1	41	11	1.612141	0.652599	1.554150	6.128890	2.705741	0.993826
1	41	12	1.633829	0.682166	1.522519	5.744087	2.718987	0.993616
1	41	13	1.659158	0.710951	1.488804	5.355604	2.733553	0.993581
1	41	14	1.700000	0.735234	1.482298	5.268445	2.736564	0.993820
1	42	1	1.566379	0.363111	1.817726	11.961638	2.604151	0.993793
1	42	2	1.562993	0.394566	1.802330	11.009042	2.609415	0.993431
1	42	3	1.562988	0.426312	1.781278	10.198045	2.616898	0.993255
1	42	4	1.566091	0.458253	1.756328	9.483542	2.626026	0.993259
1	42	5	1.571745	0.490140	1.729010	8.850297	2.636238	0.993357
1	42	6	1.579791	0.521867	1.700158	8.281089	2.647214	0.993472
1	42	7	1.590188	0.553386	1.670051	7.764012	2.658858	0.993567
1	42	8	1.603016	0.584701	1.640542	7.294506	2.670453	0.993613
1	42	9	1.618413	0.615542	1.609604	6.850675	2.682832	0.993641
1	42	10	1.636063	0.645937	1.578183	6.431232	2.695724	0.993767

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	42	11	1.656167	0.675830	1.545976	6.030488	2.709079	0.993683	
1	42	12	1.678652	0.705323	1.515112	5.656314	2.722147	0.993591	
1	42	13	1.704577	0.733907	1.482065	5.278722	2.736653	0.993800	
1	42	14	1.750000	0.756816	1.475624	5.205540	2.739644	0.994029	
1	43	1	1.605988	0.355684	1.821772	12.500000	2.602858	0.994014	
1	43	2	1.600856	0.386845	1.811029	11.489513	2.606415	0.993604	
1	43	3	1.599051	0.418471	1.792744	10.626470	2.612801	0.993336	
1	43	4	1.600514	0.450370	1.770731	9.878451	2.620741	0.993257	
1	43	5	1.604711	0.482261	1.745360	9.216973	2.630117	0.993315	
1	43	6	1.611325	0.514055	1.718094	8.625676	2.640384	0.993424	
1	43	7	1.620287	0.545698	1.689345	8.091624	2.651386	0.993529	
1	43	8	1.631656	0.577189	1.659889	7.599431	2.662835	0.993595	
1	43	9	1.645186	0.608352	1.630957	7.152422	2.674268	0.993631	
1	43	10	1.661246	0.639027	1.600654	6.727348	2.686508	0.993724	
1	43	11	1.679583	0.669278	1.569715	6.325002	2.699185	0.993711	
1	43	12	1.700504	0.699100	1.538275	5.935913	2.712288	0.993620	
1	43	13	1.723557	0.728410	1.508036	5.573205	2.725294	0.993741	
1	43	14	1.750065	0.756797					COALESCENCE
1	44	1	1.639558	0.379272	1.817303	11.986060	2.604310	0.993805	
1	44	2	1.636118	0.410675	1.802816	11.073651	2.609261	0.993463	
1	44	3	1.635867	0.442498	1.783033	10.280158	2.616285	0.993293	
1	44	4	1.638485	0.474383	1.760222	9.590125	2.624613	0.993290	
1	44	5	1.643690	0.506208	1.734656	8.974406	2.634141	0.993378	
1	44	6	1.651259	0.537938	1.707320	8.421214	2.644499	0.993486	
1	44	7	1.661217	0.569567	1.679110	7.914295	2.655352	0.993569	
1	44	8	1.673323	0.600914	1.650167	7.446622	2.666660	0.993618	
1	44	9	1.687520	0.631925	1.621799	7.019779	2.677962	0.993690	
1	44	10	1.704274	0.662468	1.591932	6.612960	2.690053	0.993716	
1	44	11	1.723424	0.692658	1.561729	6.223162	2.702462	0.993650	
1	44	12	1.744934	0.722299	1.530916	5.846489	2.715464	0.993704	
1	44	13	1.768539	0.751429	1.501268	5.494346	2.728361	0.993950	
1	44	14	1.800000	0.778345	1.495346	5.390805	2.730577	0.993401	
1	45	1	1.679099	0.371876	1.820982	12.500000	2.603139	0.994014	
1	45	2	1.673991	0.402996	1.810783	11.534457	2.606517	0.993627	
1	45	3	1.672192	0.434650	1.794164	10.698447	2.612312	0.993372	
1	45	4	1.673176	0.466497	1.773156	9.968566	2.619878	0.993292	
1	45	5	1.676854	0.498346	1.749850	9.328417	2.628471	0.993341	
1	45	6	1.683057	0.530129	1.724013	8.753999	2.638168	0.993442	
1	45	7	1.691648	0.561862	1.697083	8.230380	2.648428	0.993536	
1	45	8	1.702367	0.593361	1.669292	7.749982	2.659174	0.993599	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	45	9	1.715174	0.624564	1.640862	7.304230	2.670359	0.993663
1	45	10	1.730064	0.655456	1.612862	6.896862	2.681561	0.993707
1	45	11	1.747632	0.685947	1.583698	6.503569	2.693394	0.993672
1	45	12	1.767370	0.715966	1.554092	6.127008	2.705675	0.993687
1	45	13	1.789452	0.745429	1.523874	5.761749	2.718578	0.993875
1	45	14	1.813648	0.774408	1.494661	5.420395	2.730954	0.993521
1	45	15	1.850000	0.800028	1.488837	5.329880	2.733558	0.993612
1	46	1	1.712667	0.395460	1.816517	12.010082	2.604597	0.993816
1	46	2	1.709294	0.426893	1.803449	11.128302	2.609053	0.993492
1	46	3	1.708809	0.458617	1.785096	10.361754	2.615560	0.993328
1	46	4	1.710924	0.490459	1.763259	9.686448	2.623517	0.993319
1	46	5	1.715643	0.522293	1.739437	9.091049	2.632372	0.993399
1	46	6	1.722900	0.554097	1.713853	8.548844	2.642033	0.993498
1	46	7	1.732280	0.585714	1.687229	8.053913	2.652228	0.993574
1	46	8	1.743719	0.617082	1.659871	7.597161	2.662870	0.993639
1	46	9	1.757249	0.648172	1.631767	7.172413	2.673985	0.993691
1	46	10	1.772950	0.679025	1.604416	6.779591	2.684957	0.993685
1	46	11	1.791109	0.709355	1.575818	6.400437	2.696643	0.993682
1	46	12	1.811415	0.739206	1.546781	6.036012	2.708827	0.993816
1	46	13	1.834104	0.768519	1.516999	5.682315	2.721359	0.993627
1	46	14	1.859011	0.797422	1.488405	5.348662	2.733738	0.993598
1	46	15	1.900000	0.821660	1.482605	5.271338	2.736423	0.993811
1	47	1	1.752246	0.388076	1.819510	12.500000	2.603661	0.994014
1	47	2	1.747168	0.419250	1.810788	11.570804	2.606529	0.993648
1	47	3	1.745196	0.450806	1.795399	10.764777	2.611888	0.993404
1	47	4	1.745909	0.482563	1.775819	10.057663	2.618927	0.993323
1	47	5	1.749127	0.514417	1.753197	9.431036	2.627250	0.993365
1	47	6	1.754934	0.546293	1.729439	8.870696	2.636142	0.993457
1	47	7	1.763011	0.577997	1.704030	8.359519	2.645786	0.993543
1	47	8	1.773134	0.609496	1.677747	7.890097	2.655907	0.993614
1	47	9	1.785314	0.640763	1.650643	7.455840	2.666508	0.993671
1	47	10	1.799677	0.671820	1.623158	7.046941	2.677416	0.993687
1	47	11	1.815966	0.702523	1.596325	6.669198	2.688241	0.993683
1	47	12	1.834695	0.732693	1.568269	6.302973	2.699825	0.993772
1	47	13	1.855602	0.762405	1.539642	5.950752	2.711752	0.993685
1	47	14	1.879019	0.791644	1.510484	5.605427	2.724149	0.993606
1	47	15	1.904437	0.820374	1.482402	5.280236	2.736501	0.993793
1	47	16	1.950000	0.843244	1.476629	5.215021	2.739179	0.993998
1	48	1	1.785914	0.411726	1.815717	12.025312	2.604888	0.993827
1	48	2	1.782330	0.443084	1.803985	11.178620	2.608878	0.993519

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	48	3	1.781629	0.474716	1.786910	10.437250	2.614924	0.993360	
1	48	4	1.783503	0.506518	1.766226	9.782869	2.622447	0.993347	
1	48	5	1.787859	0.538435	1.743463	9.194561	2.630888	0.993418	
1	48	6	1.794516	0.570231	1.719720	8.667761	2.639826	0.993508	
1	48	7	1.803365	0.601831	1.694543	8.184101	2.649432	0.993586	
1	48	8	1.814250	0.633242	1.668434	7.738780	2.659540	0.993649	
1	48	9	1.827274	0.664485	1.641895	7.321628	2.669963	0.993681	
1	48	10	1.842250	0.695397	1.614901	6.929009	2.680726	0.993685	
1	48	11	1.859105	0.725953	1.588566	6.565016	2.691445	0.993742	
1	48	12	1.878434	0.755992	1.560894	6.211698	2.702852	0.993714	
1	48	13	1.900061	0.785638	1.532873	5.868397	2.714584	0.993631	
1	48	14	1.924006	0.814706	1.504231	5.532162	2.726938	0.993740	
1	48	15	1.949924	0.843266					COALESCENCE
1	49	1	1.825632	0.404329	1.818850	12.500000	2.603896	0.994014	
1	49	2	1.820308	0.435454	1.810427	11.602536	2.606670	0.993667	
1	49	3	1.818074	0.466938	1.796472	10.826107	2.611521	0.993434	
1	49	4	1.818599	0.498652	1.777923	10.141824	2.618181	0.993353	
1	49	5	1.821656	0.530542	1.756853	9.529111	2.625916	0.993387	
1	49	6	1.826910	0.562398	1.733934	8.977221	2.634470	0.993470	
1	49	7	1.834366	0.594106	1.710291	8.480087	2.643417	0.993554	
1	49	8	1.844000	0.625633	1.685194	8.022259	2.653043	0.993624	
1	49	9	1.855743	0.657030	1.659588	7.595397	2.663001	0.993669	
1	49	10	1.869392	0.688138	1.633492	7.195676	2.673294	0.993683	
1	49	11	1.884958	0.718907	1.606975	6.817871	2.683946	0.993722	
1	49	12	1.902406	0.749343	1.580983	6.467508	2.694543	0.993723	
1	49	13	1.922452	0.779324	1.553895	6.123711	2.705738	0.993657	
1	49	14	1.944601	0.808808	1.526372	5.790009	2.717401	0.993707	
1	49	15	1.969061	0.837707	1.498221	5.462249	2.729669	0.993925	
1	49	16	2.000000	0.864781	1.492978	5.368661	2.731660	0.993478	
1	50	1	1.859219	0.427921	1.815363	12.044383	2.605021	0.993837	
1	50	2	1.855342	0.459228	1.804105	11.223402	2.608852	0.993545	
1	50	3	1.854402	0.490838	1.788246	10.508731	2.614460	0.993390	
1	50	4	1.856158	0.522668	1.769027	9.869712	2.621438	0.993372	
1	50	5	1.860157	0.554520	1.747595	9.296360	2.629367	0.993434	
1	50	6	1.866253	0.586305	1.724637	8.776607	2.637984	0.993519	
1	50	7	1.874518	0.617955	1.700960	8.307153	2.646989	0.993596	
1	50	8	1.885027	0.649478	1.676294	7.869239	2.656494	0.993652	
1	50	9	1.897411	0.680750	1.651075	7.461046	2.666342	0.993678	
1	50	10	1.911659	0.711723	1.625415	7.077151	2.676528	0.993708	
1	50	11	1.927839	0.742377	1.599222	6.713922	2.687089	0.993723	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	50	12	1.945994	0.772766	1.573780	6.373694	2.697483	0.993679
1	50	13	1.966560	0.802593	1.547172	6.040057	2.708581	0.993691
1	50	14	1.989216	0.831917	1.520121	5.715284	2.720173	0.993861
1	50	15	2.014227	0.860673	1.492336	5.396268	2.732006	0.993579
1	50	16	2.050000	0.886445	1.487152	5.314064	2.734332	0.993666
1	51	1	1.898874	0.420551	1.818246	12.500000	2.604110	0.994014
1	51	2	1.893507	0.451591	1.810464	11.636703	2.606669	0.993686
1	51	3	1.891008	0.483071	1.796817	10.882677	2.611415	0.993462
1	51	4	1.891352	0.514831	1.779954	10.217128	2.617460	0.993380
1	51	5	1.894099	0.546648	1.760137	9.620630	2.624721	0.993407
1	51	6	1.898977	0.578448	1.738498	9.081930	2.632777	0.993483
1	51	7	1.905921	0.610190	1.715390	8.591985	2.641496	0.993565
1	51	8	1.915077	0.641850	1.692054	8.143997	2.650413	0.993630
1	51	9	1.926244	0.673258	1.667712	7.726079	2.659833	0.993668
1	51	10	1.939240	0.704404	1.642881	7.334801	2.669583	0.993697
1	51	11	1.954111	0.735271	1.617506	6.966374	2.679701	0.993718
1	51	12	1.971015	0.765880	1.591851	6.614102	2.690072	0.993694
1	51	13	1.989682	0.796126	1.566856	6.284606	2.700355	0.993687
1	51	14	2.010753	0.825801	1.540704	5.960398	2.711384	0.993808
1	51	15	2.033950	0.854990	1.514001	5.644780	2.722670	0.993661
1	51	16	2.059609	0.883664	1.486735	5.332063	2.734505	0.993652
1	51	17	2.100000	0.908064	1.481549	5.261401	2.736909	0.993844
1	52	1	1.932387	0.444089	1.815027	12.061969	2.605147	0.993847
1	52	2	1.928482	0.475356	1.804301	11.270977	2.608797	0.993568
1	52	3	1.927335	0.507022	1.789278	10.570384	2.614105	0.993418
1	52	4	1.928719	0.538799	1.771539	9.950737	2.620535	0.993395
1	52	5	1.932386	0.570587	1.751322	9.391587	2.627998	0.993450
1	52	6	1.938146	0.602362	1.729391	8.884852	2.636209	0.993531
1	52	7	1.946011	0.634124	1.706533	8.418175	2.644874	0.993604
1	52	8	1.955843	0.665681	1.683442	7.991595	2.653736	0.993653
1	52	9	1.967637	0.696973	1.659434	7.591755	2.663072	0.993686
1	52	10	1.981268	0.728022	1.634846	7.216902	2.672774	0.993710
1	52	11	1.996868	0.758852	1.609979	6.860193	2.682721	0.993703
1	52	12	2.014301	0.789321	1.584760	6.519423	2.692970	0.993690
1	52	13	2.033464	0.819424	1.560193	6.199863	2.703180	0.993769
1	52	14	2.055070	0.848972	1.534371	5.885263	2.713998	0.993706
1	52	15	2.078907	0.878088	1.508174	5.576296	2.725177	0.993654
1	52	16	2.105049	0.906600	1.481338	5.270535	2.736990	0.993826
1	52	17	2.150000	0.929640	1.476154	5.210544	2.739399	0.994013
1	53	1	1.971983	0.436742	1.817689	12.500000	2.604308	0.994014

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	53	2	1.966645	0.467752	1.810200	11.669691	2.606775	0.993703	
1	53	3	1.964158	0.499248	1.797669	10.936564	2.611126	0.993488	
1	53	4	1.964115	0.530963	1.781460	10.285654	2.616929	0.993405	
1	53	5	1.966461	0.562736	1.763096	9.706237	2.623646	0.993426	
1	53	6	1.971048	0.594519	1.742424	9.181358	2.631325	0.993496	
1	53	7	1.977755	0.626329	1.720633	8.699708	2.639524	0.993573	
1	53	8	1.986327	0.657998	1.697942	8.256073	2.648164	0.993633	
1	53	9	1.996800	0.689451	1.675118	7.848805	2.656963	0.993673	
1	53	10	2.009243	0.720654	1.651303	7.466417	2.666268	0.993701	
1	53	11	2.023609	0.751674	1.627189	7.104099	2.675818	0.993706	
1	53	12	2.039744	0.782371	1.602732	6.759604	2.685646	0.993694	
1	53	13	2.057690	0.812701	1.577932	6.429462	2.695811	0.993743	
1	53	14	2.077377	0.842687	1.553666	6.119963	2.705879	0.993726	
1	53	15	2.099618	0.872168	1.528336	5.812404	2.716539	0.993670	
1	53	16	2.123927	0.901130	1.502556	5.510722	2.727689	0.993778	
1	53	17	2.150543	0.929482					COALESCENCE
1	54	1	2.005496	0.460279	1.814427	12.079556	2.605366	0.993856	
1	54	2	2.001648	0.491565	1.804648	11.311822	2.608687	0.993590	
1	54	3	2.000328	0.523147	1.790576	10.632258	2.613653	0.993444	
1	54	4	2.001304	0.554885	1.773493	10.024808	2.619836	0.993417	
1	54	5	2.004608	0.586676	1.754484	9.482124	2.626841	0.993466	
1	54	6	2.010169	0.618509	1.733827	8.984270	2.634557	0.993541	
1	54	7	2.017608	0.650239	1.712105	8.527307	2.642766	0.993609	
1	54	8	2.026850	0.681813	1.689616	8.104419	2.651366	0.993658	
1	54	9	2.037985	0.713188	1.666923	7.715687	2.660154	0.993690	
1	54	10	2.051171	0.744371	1.643545	7.346709	2.669325	0.993704	
1	54	11	2.066080	0.775264	1.619810	6.997367	2.678764	0.993699	
1	54	12	2.082733	0.805829	1.595748	6.664135	2.688504	0.993726	
1	54	13	2.101219	0.836044	1.571240	6.344681	2.698567	0.993732	
1	54	14	2.121528	0.865973	1.547443	6.042611	2.708465	0.993688	
1	54	15	2.144237	0.895308	1.522518	5.742704	2.719073	0.993746	
1	54	16	2.169009	0.924117	1.497138	5.447843	2.730154	0.993947	
1	54	17	2.200000	0.951173	1.492400	5.363254	2.731925	0.993497	
1	55	1	2.045122	0.452941	1.816617	12.500000	2.604689	0.994014	
1	55	2	2.039804	0.483990	1.810144	11.696834	2.606805	0.993718	
1	55	3	2.037189	0.515404	1.798424	10.986787	2.610870	0.993512	
1	55	4	2.036941	0.547040	1.783191	10.353990	2.616316	0.993429	
1	55	5	2.038925	0.578820	1.765257	9.786038	2.622866	0.993445	
1	55	6	2.043233	0.610679	1.746111	9.272450	2.629965	0.993509	
1	55	7	2.049555	0.642447	1.725413	8.801038	2.637733	0.993581	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	55	8	2.057686	0.674094	1.703811	8.366257	2.645931	0.993638
1	55	9	2.067616	0.705600	1.681397	7.963168	2.654540	0.993678
1	55	10	2.079502	0.736962	1.659093	7.588769	2.663213	0.993699
1	55	11	2.093242	0.768026	1.636059	7.233584	2.672286	0.993701
1	55	12	2.108675	0.798794	1.612692	6.896183	2.681636	0.993716
1	55	13	2.125871	0.829251	1.588900	6.574207	2.691301	0.993730
1	55	14	2.144991	0.859412	1.564856	6.262734	2.701196	0.993703
1	55	15	2.165757	0.889204	1.541441	5.968680	2.711020	0.993728
1	55	16	2.188922	0.918393	1.516903	5.675925	2.721571	0.993888
1	55	17	2.214193	0.947074	1.491814	5.388229	2.732247	0.993598
1	55	18	2.250000	0.972833	1.487110	5.313674	2.734351	0.993667
1	56	1	2.078709	0.476526	1.813818	12.090966	2.605588	0.993863
1	56	2	2.074694	0.507751	1.804947	11.349863	2.608593	0.993610
1	56	3	2.073211	0.539253	1.791741	10.690097	2.613248	0.993468
1	56	4	2.074019	0.570958	1.775418	10.099620	2.619148	0.993438
1	56	5	2.077048	0.602825	1.757185	9.563101	2.625855	0.993481
1	56	6	2.082145	0.634637	1.737868	9.077821	2.633055	0.993551
1	56	7	2.089184	0.666334	1.717198	8.630123	2.640845	0.993614
1	56	8	2.098024	0.697924	1.695600	8.216397	2.649077	0.993662
1	56	9	2.108725	0.729423	1.673531	7.828731	2.657589	0.993691
1	56	10	2.121172	0.760676	1.651526	7.468980	2.666180	0.993700
1	56	11	2.135446	0.791621	1.628830	7.126461	2.675167	0.993711
1	56	12	2.151428	0.822289	1.605707	6.800924	2.684461	0.993725
1	56	13	2.169258	0.852697	1.582361	6.487422	2.693969	0.993712
1	56	14	2.188850	0.882723	1.558695	6.184487	2.703773	0.993720
1	56	15	2.210060	0.912379	1.535647	5.897908	2.713544	0.993839
1	56	16	2.233716	0.941446	1.511388	5.612626	2.723809	0.993682
1	56	17	2.259583	0.970060	1.486730	5.330005	2.734510	0.993656
1	56	18	2.300000	0.994452	1.482005	5.265695	2.736699	0.993830
1	57	1	2.118439	0.469178	1.816133	12.500000	2.604862	0.994014
1	57	2	2.112930	0.500186	1.809824	11.720798	2.606928	0.993733
1	57	3	2.110107	0.531539	1.799096	11.033707	2.610643	0.993535
1	57	4	2.109732	0.563142	1.784531	10.419258	2.615845	0.993451
1	57	5	2.111622	0.594956	1.767723	9.862590	2.621974	0.993462
1	57	6	2.115480	0.626792	1.749180	9.356484	2.628836	0.993521
1	57	7	2.121320	0.658548	1.729781	8.896543	2.636100	0.993588
1	57	8	2.129090	0.690200	1.709034	8.471239	2.643951	0.993643
1	57	9	2.138716	0.721793	1.687724	8.074012	2.652106	0.993680
1	57	10	2.150000	0.753189	1.665915	7.702001	2.660550	0.993697
1	57	11	2.162988	0.784332	1.644209	7.355677	2.669065	0.993707

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	57	12	2.177818	0.815183	1.621730	7.025669	2.678010	0.993720	
1	57	13	2.194437	0.845808	1.599033	6.709132	2.687161	0.993717	
1	57	14	2.212740	0.876087	1.576048	6.404635	2.696572	0.993717	
1	57	15	2.232789	0.905978	1.552747	6.109648	2.706313	0.993801	
1	57	16	2.254476	0.935522	1.529955	5.830841	2.715889	0.993729	
1	57	17	2.278722	0.964528	1.506117	5.550893	2.726072	0.993663	
1	57	18	2.305025	0.992995	1.481812	5.273992	2.736773	0.993813	
1	57	19	2.350000	1.016031	1.477074	5.219217	2.738974	0.993984	
1	58	1	2.151959	0.492715	1.813533	12.105185	2.605695	0.993871	
1	58	2	2.147716	0.523895	1.804954	11.384080	2.608603	0.993629	
1	58	3	2.146056	0.555384	1.792560	10.745486	2.612967	0.993490	
1	58	4	2.146803	0.587120	1.777298	10.167371	2.618476	0.993457	
1	58	5	2.149560	0.618923	1.760018	9.643254	2.624822	0.993495	
1	58	6	2.154197	0.650717	1.741278	9.164324	2.631792	0.993559	
1	58	7	2.160789	0.682442	1.721707	8.728196	2.639151	0.993620	
1	58	8	2.169363	0.714107	1.701183	8.320536	2.646949	0.993665	
1	58	9	2.179588	0.745605	1.680083	7.939957	2.655055	0.993690	
1	58	10	2.191432	0.776897	1.658540	7.582272	2.663432	0.993703	
1	58	11	2.204982	0.807955	1.637014	7.249138	2.671917	0.993715	
1	58	12	2.220453	0.838770	1.614939	6.928692	2.680733	0.993718	
1	58	13	2.237548	0.869271	1.592585	6.621657	2.689787	0.993717	
1	58	14	2.256310	0.899422	1.569949	6.325527	2.699129	0.993773	
1	58	15	2.276847	0.929203	1.546901	6.038747	2.708735	0.993752	
1	58	16	2.299110	0.958694	1.524512	5.765527	2.718179	0.993683	
1	58	17	2.323785	0.987559	1.501019	5.491546	2.728352	0.993772	
1	58	18	2.350517	1.015880					COALESCENCE
1	59	1	2.191633	0.485389	1.815690	12.500000	2.605020	0.994014	
1	59	2	2.186092	0.516326	1.809800	11.746640	2.606946	0.993747	
1	59	3	2.183077	0.547679	1.799218	11.077522	2.610613	0.993556	
1	59	4	2.182582	0.579329	1.785883	10.477944	2.615369	0.993472	
1	59	5	2.184235	0.611076	1.769968	9.934648	2.621163	0.993478	
1	59	6	2.187803	0.642855	1.752356	9.439565	2.627669	0.993532	
1	59	7	2.193227	0.674631	1.733343	8.986056	2.634772	0.993595	
1	59	8	2.200640	0.706381	1.713919	8.568782	2.642105	0.993647	
1	59	9	2.209830	0.737961	1.693548	8.178825	2.649874	0.993680	
1	59	10	2.220629	0.769363	1.672670	7.813456	2.657927	0.993698	
1	59	11	2.233054	0.800575	1.651277	7.469766	2.666285	0.993711	
1	59	12	2.247247	0.831603	1.630127	7.146780	2.674655	0.993717	
1	59	13	2.263199	0.862300	1.608373	6.836364	2.683379	0.993718	
1	59	14	2.280756	0.892679	1.586353	6.538145	2.692360	0.993754	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	59	15	2.300006	0.922725	1.563954	6.250602	2.701608	0.993759
1	59	16	2.321129	0.952455	1.541308	5.969798	2.711061	0.993705
1	59	17	2.343807	0.981814	1.519247	5.702784	2.720473	0.993746
1	59	18	2.368903	1.010541	1.496086	5.434423	2.730598	0.993925
1	59	19	2.400000	1.037571	1.491766	5.357317	2.732215	0.993517
1	60	1	2.225090	0.508880	1.813266	12.118441	2.605795	0.993878
1	60	2	2.220842	0.540033	1.804994	11.420635	2.608600	0.993647
1	60	3	2.219046	0.571577	1.793203	10.793489	2.612749	0.993511
1	60	4	2.219498	0.603263	1.779007	10.231133	2.617867	0.993476
1	60	5	2.221997	0.635005	1.762608	9.718844	2.623879	0.993509
1	60	6	2.226382	0.666782	1.744608	9.250800	2.630561	0.993568
1	60	7	2.232652	0.698594	1.725664	8.817527	2.637667	0.993625
1	60	8	2.240698	0.730269	1.706323	8.419069	2.644995	0.993667
1	60	9	2.250478	0.761761	1.686125	8.045261	2.652728	0.993691
1	60	10	2.261871	0.793091	1.665357	7.694669	2.660774	0.993706
1	60	11	2.274954	0.824278	1.644317	7.361832	2.669028	0.993715
1	60	12	2.289632	0.855196	1.623461	7.049425	2.677315	0.993717
1	60	13	2.306050	0.885776	1.602023	6.748302	2.685964	0.993742
1	60	14	2.324097	0.916056	1.580223	6.459077	2.694878	0.993758
1	60	15	2.343930	0.946056	1.558215	6.177841	2.703975	0.993723
1	60	16	2.365480	0.975656	1.535896	5.903613	2.713369	0.993733
1	60	17	2.388564	1.004885	1.514150	5.642434	2.722745	0.993873
1	60	18	2.414113	1.033495	1.491230	5.380031	2.732509	0.993609
1	60	19	2.450000	1.059226	1.486924	5.311926	2.734436	0.993673
1	60	18	2.375000	1.000000	1.513028	5.629099	2.723283	0.993957
2	1	1	2.400000	1.000000	2.227472	0.	2.469550	0.988128
2	1	2	2.400000	0.990817	2.227472	0.	2.469550	0.988128
2	2	1	2.410368	0.995408	2.227472	-0.	2.469550	0.988128
1	61	1	2.264711	0.501574	1.815280	12.500000	2.605165	0.994014
1	61	2	2.259208	0.532492	1.809534	11.771947	2.607049	0.993759
1	61	3	2.256231	0.563870	1.799752	11.119132	2.610434	0.993575
1	61	4	2.255433	0.595476	1.786871	10.531857	2.615024	0.993492
1	61	5	2.256768	0.627179	1.772018	10.002596	2.620425	0.993494
1	61	6	2.260116	0.658937	1.755101	9.519062	2.626663	0.993542
1	61	7	2.265370	0.690762	1.737077	9.072640	2.633383	0.993601
1	61	8	2.272302	0.722509	1.718147	8.659451	2.640510	0.993649
1	61	9	2.280952	0.754106	1.698920	8.278127	2.647822	0.993681
1	61	10	2.291340	0.785535	1.678788	7.919931	2.655561	0.993700
1	61	11	2.303400	0.816847	1.658341	7.580873	2.663516	0.993712
1	61	12	2.316983	0.847927	1.637574	7.259276	2.671696	0.993717

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	61	13	2.332129	0.878735	1.617009	6.956656	2.679911	0.993733	
1	61	14	2.349041	0.909221	1.595773	6.664960	2.688511	0.993752	
1	61	15	2.367670	0.939460	1.574352	6.382394	2.697283	0.993735	
1	61	16	2.387929	0.969336	1.552660	6.108050	2.706303	0.993730	
1	61	17	2.409896	0.998806	1.530657	5.839998	2.715657	0.993830	
1	61	18	2.377608	0.999256					COALESCENCE
1	62	1	2.298177	0.525070	1.812777	12.131942	2.605973	0.993885	
1	62	2	2.294001	0.556250	1.805186	11.452056	2.608542	0.993663	
1	62	3	2.292072	0.587721	1.794058	10.841816	2.612454	0.993531	
1	62	4	2.292203	0.619368	1.780330	10.289942	2.617397	0.993493	
1	62	5	2.294419	0.651107	1.764810	9.791254	2.623079	0.993521	
1	62	6	2.298661	0.682926	1.747766	9.330808	2.629396	0.993576	
1	62	7	2.304599	0.714699	1.729674	8.905740	2.636167	0.993629	
1	62	8	2.312160	0.746377	1.710799	8.510812	2.643299	0.993668	
1	62	9	2.321432	0.777920	1.691584	8.145975	2.650634	0.993693	
1	62	10	2.332498	0.809337	1.671737	7.800035	2.658295	0.993707	
1	62	11	2.345067	0.840548	1.651535	7.472855	2.666186	0.993715	
1	62	12	2.359133	0.871523	1.631041	7.161642	2.674297	0.993727	
1	62	13	2.374774	0.902244	1.610656	6.868896	2.682476	0.993746	
1	62	14	2.392270	0.932694	1.589784	6.584235	2.690946	0.993741	
1	62	15	2.411326	0.962813	1.568666	6.308901	2.699633	0.993732	
1	62	16	2.432000	0.992565	1.547279	6.041021	2.708606	0.993799	
1	62	17	2.399012	0.993153	1.529060	5.828263	2.716364	0.993872	
1	62	1	2.298177	0.525070	1.812777	12.131942	2.605973	0.993885	
1	62	2	2.294001	0.556250	1.805186	11.452056	2.608542	0.993663	
1	62	3	2.292072	0.587721	1.794058	10.841816	2.612454	0.993531	
1	62	4	2.292203	0.619368	1.780330	10.289942	2.617397	0.993493	
1	62	5	2.294419	0.651107	1.764810	9.791254	2.623079	0.993521	
1	62	6	2.298661	0.682926	1.747766	9.330808	2.629396	0.993576	
1	62	7	2.304599	0.714699	1.729674	8.905740	2.636167	0.993629	
1	62	8	2.312160	0.746377	1.710799	8.510812	2.643299	0.993668	
1	62	9	2.321432	0.777920	1.691584	8.145975	2.650634	0.993693	
1	62	10	2.332498	0.809337	1.671737	7.800035	2.658295	0.993707	
1	62	11	2.345067	0.840548	1.651535	7.472855	2.666186	0.993715	
1	62	12	2.359133	0.871523	1.631041	7.161642	2.674297	0.993727	
1	62	13	2.374774	0.902244	1.610656	6.868896	2.682476	0.993746	
1	62	14	2.392270	0.932694	1.589784	6.584235	2.690946	0.993741	
1	62	15	2.411326	0.962813	1.568666	6.308901	2.699633	0.993732	
1	62	16	2.432000	0.992565	1.547279	6.041021	2.708606	0.993799	
2	2	2	2.416903	0.984608	2.284229	0.383240	2.453237	0.987875	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
2	3	1	2.420736	1.000000	2.227472	0.	2.469550	0.988128
2	3	2	2.425714	0.988612	2.284115	0.382463	2.453328	0.987968
1	63	1	2.337831	0.517768	1.814431	12.500000	2.605468	0.994014
1	63	2	2.332354	0.548733	1.809456	11.792715	2.607085	0.993771
1	63	3	2.329280	0.580040	1.800233	11.158252	2.610273	0.993594
1	63	4	2.328323	0.611577	1.788045	10.585762	2.614612	0.993511
1	63	5	2.329377	0.643280	1.773491	10.066467	2.619897	0.993509
1	63	6	2.332513	0.675097	1.757723	9.592422	2.625703	0.993552
1	63	7	2.337465	0.706877	1.740518	9.154673	2.632105	0.993607
1	63	8	2.344053	0.738591	1.722411	8.748989	2.638907	0.993652
1	63	9	2.352259	0.770224	1.703496	8.371551	2.646080	0.993683
1	63	10	2.362217	0.801763	1.684523	8.019729	2.653351	0.993702
1	63	11	2.373804	0.833087	1.664888	7.686342	2.660960	0.993712
1	63	12	2.386864	0.864197	1.644934	7.370119	2.668790	0.993723
1	63	13	2.401439	0.895089	1.624603	7.069323	2.676873	0.993739
1	63	14	2.417664	0.925780	1.604562	6.784001	2.684936	0.993743
1	63	15	2.435588	0.956116	1.583981	6.506931	2.693319	0.993735
1	63	16	2.455059	0.986116	1.563158	6.238369	2.701951	0.993777
2	3	3	2.437932	0.976990	2.310110	0.559813	2.445973	0.987820
2	4	1	2.435949	0.993263	2.283983	0.381570	2.453407	0.988032
2	4	2	2.444908	0.980197	2.310070	0.558283	2.446010	0.987860
1	64	1	2.371374	0.541316	1.812282	12.140449	2.606154	0.993890
1	64	2	2.367054	0.572446	1.805355	11.481585	2.608491	0.993678
1	64	3	2.364999	0.603848	1.794836	10.887348	2.612185	0.993550
1	64	4	2.365006	0.635465	1.781641	10.349477	2.616932	0.993510
1	64	5	2.367014	0.667262	1.766709	9.856552	2.622391	0.993533
1	64	6	2.370884	0.699054	1.750676	9.406620	2.628324	0.993583
1	64	7	2.376508	0.730787	1.733377	8.989444	2.634785	0.993633
1	64	8	2.383761	0.762466	1.715168	8.602246	2.641648	0.993671
1	64	9	2.392672	0.794101	1.696454	8.238698	2.648772	0.993694
1	64	10	2.403161	0.825555	1.677653	7.900133	2.656005	0.993708
1	64	11	2.415249	0.856785	1.658237	7.578311	2.663561	0.993719
1	64	12	2.428827	0.887819	1.638421	7.273025	2.671371	0.993733
1	64	13	2.443995	0.918684	1.618423	6.980130	2.679349	0.993741
1	64	14	2.460649	0.949265	1.598655	6.702770	2.687329	0.993738
1	64	15	2.478990	0.979487	1.578356	6.432798	2.695650	0.993763
2	4	3	2.459763	0.969133	2.335453	0.731972	2.438938	0.987764
2	5	1	2.450777	1.000000	2.341238	0.	2.437588	0.988128
2	5	2	2.455082	0.984875	2.309876	0.556954	2.446102	0.987920
2	5	3	2.464847	0.971498	2.335427	0.730415	2.438958	0.987784

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	65	1	2.411215	0.533987	1.813975	12.500000	2.605630	0.994014	
1	65	2	2.405479	0.564934	1.809158	11.811124	2.607198	0.993781	
1	65	3	2.402227	0.596192	1.800669	11.195094	2.610127	0.993610	
1	65	4	2.401178	0.627700	1.788942	10.637625	2.614298	0.993528	
1	65	5	2.402170	0.659430	1.775224	10.127872	2.619274	0.993523	
1	65	6	2.404947	0.691217	1.759914	9.660636	2.624903	0.993561	
1	65	7	2.409512	0.722976	1.743696	9.232529	2.630928	0.993612	
1	65	8	2.415822	0.754685	1.726226	8.834891	2.637476	0.993655	
1	65	9	2.423795	0.786375	1.708168	8.462446	2.644307	0.993685	
1	65	10	2.433256	0.817931	1.689589	8.112971	2.651406	0.993703	
1	65	11	2.444255	0.849298	1.670971	7.786605	2.658597	0.993715	
1	65	12	2.456870	0.880457	1.651667	7.476266	2.666142	0.993728	
1	65	13	2.471046	0.911469	1.632165	7.179332	2.673858	0.993739	
1	65	14	2.486654	0.942227	1.612428	6.894856	2.681757	0.993739	
1	65	15	2.503724	0.972701	1.592926	6.624930	2.689672	0.993754	
2	5	4	2.482334	0.961064	2.360270	0.900787	2.432123	0.987706	
2	6	1	2.469583	0.991540	2.367805	0.173172	2.430277	0.988011	
2	6	2	2.474962	0.976201	2.335172	0.728645	2.439058	0.987830	
2	6	3	2.485474	0.962540					COALESCENCE
2	7	1	2.488171	1.000000	2.394384	0.	2.423198	0.988128	
2	7	2	2.489129	0.982787	2.393784	0.342571	2.423215	0.987907	
2	7	3	2.495530	0.967267	2.359939	0.897319	2.432245	0.987755	
1	66	1	2.444700	0.557493	1.811963	12.151454	2.606271	0.993896	
1	66	2	2.440092	0.588604	1.805289	11.508277	2.608524	0.993693	
1	66	3	2.437890	0.619996	1.795367	10.931278	2.612005	0.993567	
1	66	4	2.437860	0.651637	1.782955	10.403771	2.616465	0.993526	
1	66	5	2.439653	0.683375	1.768732	9.921300	2.621658	0.993544	
1	66	6	2.443155	0.715143	1.753142	9.477282	2.627417	0.993590	
1	66	7	2.448426	0.746890	1.736672	9.069821	2.633557	0.993637	
1	66	8	2.455472	0.778619	1.719297	8.687848	2.640092	0.993672	
1	66	9	2.464011	0.810237	1.701327	8.330280	2.646914	0.993695	
1	66	10	2.474000	0.841711	1.682900	7.993738	2.653982	0.993710	
1	66	11	2.485533	0.873016	1.664362	7.679424	2.661172	0.993723	
1	66	12	2.498752	0.904157	1.645351	7.377916	2.668633	0.993735	
1	66	13	2.513374	0.935068	1.626091	7.089831	2.676278	0.993739	
1	66	14	2.529409	0.965722	1.606611	6.813205	2.684112	0.993749	
2	7	4	2.505779	0.952737	2.383917	1.066666	2.425695	0.987648	
2	8	1	2.507500	0.991243	2.420601	0.167905	2.416146	0.988015	
2	8	2	2.509359	0.973767	2.419246	0.508877	2.416376	0.987817	
2	8	3	2.516909	0.958025	2.383871	1.061280	2.425731	0.987685	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	67	1	2.484578	0.550166	1.813463	12.500000	2.605813	0.994014
1	67	2	2.478731	0.581069	1.809025	11.831339	2.607252	0.993792
1	67	3	2.475225	0.612346	1.800670	11.229687	2.610137	0.993626
1	67	4	2.474078	0.643895	1.789880	10.684592	2.613970	0.993545
1	67	5	2.474883	0.675564	1.776821	10.186045	2.618701	0.993536
1	67	6	2.477429	0.707297	1.762209	9.728200	2.624066	0.993570
1	67	7	2.481666	0.739065	1.746284	9.306062	2.629971	0.993617
1	67	8	2.487689	0.770843	1.729844	8.915225	2.636122	0.993658
1	67	9	2.495317	0.802509	1.712507	8.548977	2.642664	0.993686
1	67	10	2.504397	0.834053	1.694650	8.205061	2.649468	0.993704
1	67	11	2.514938	0.865470	1.676273	7.881235	2.656545	0.993718
1	67	12	2.527080	0.896763	1.658001	7.576249	2.663661	0.993730
1	67	13	2.540751	0.927809	1.639213	7.284044	2.671060	0.993737
1	67	14	2.555806	0.958619	1.620193	7.004200	2.678642	0.993746
2	8	4	2.529885	0.944232	2.408035	1.232563	2.419199	0.987580
2	9	1	2.526613	1.000000	2.446812	0.	2.409318	0.988128
2	9	2	2.527512	0.982215	2.446304	0.332674	2.409311	0.987911
2	9	3	2.530393	0.964430	2.443880	0.670384	2.409833	0.987737
2	9	4	2.538900	0.948561	2.408005	1.227364	2.419227	0.987611
1	68	1	2.518007	0.573632	1.811580	12.161767	2.606411	0.993902
1	68	2	2.513316	0.604736	1.805187	11.537162	2.608569	0.993706
1	68	3	2.510909	0.636196	1.795762	10.969563	2.611874	0.993583
1	68	4	2.510631	0.667793	1.784165	10.455196	2.616035	0.993540
1	68	5	2.512219	0.699474	1.770598	9.982756	2.620983	0.993555
1	68	6	2.515526	0.731222	1.755556	9.548032	2.626530	0.993597
1	68	7	2.520538	0.763030	1.739594	9.143592	2.632471	0.993640
1	68	8	2.527159	0.794755	1.723133	8.769369	2.638650	0.993674
1	68	9	2.535344	0.826354	1.705864	8.417532	2.645189	0.993697
1	68	10	2.544988	0.857848	1.688020	8.086979	2.652014	0.993712
1	68	11	2.556151	0.889258	1.669887	7.773066	2.659025	0.993726
1	68	12	2.568752	0.920462	1.651813	7.477852	2.666090	0.993735
1	68	13	2.582862	0.951411	1.633247	7.194302	2.673430	0.993743
2	9	5	2.554600	0.935571	2.431772	1.396611	2.412864	0.987504
2	10	1	2.546409	0.990969	2.472742	0.163269	2.402494	0.988017
2	10	2	2.548328	0.972864	2.471186	0.492601	2.402768	0.987818
2	10	3	2.552032	0.954865	2.468740	0.833920	2.403299	0.987659
2	10	4	2.561458	0.938898	2.431757	1.391992	2.412885	0.987529
1	69	1	2.557836	0.566323	1.812994	12.500000	2.605980	0.994014
1	69	2	2.552027	0.597209	1.808628	11.851244	2.607400	0.993802
1	69	3	2.548478	0.628524	1.800943	11.262872	2.610049	0.993641

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	69	4	2.546982	0.660054	1.790536	10.727956	2.613743	0.993560	
1	69	5	2.547518	0.691683	1.778295	10.241255	2.618173	0.993548	
1	69	6	2.549894	0.723394	1.764194	9.793242	2.623342	0.993578	
1	69	7	2.553997	0.755193	1.749037	9.377295	2.628955	0.993622	
1	69	8	2.559631	0.786958	1.732993	8.990464	2.634946	0.993660	
1	69	9	2.566823	0.818625	1.716548	8.631448	2.641138	0.993688	
1	69	10	2.575586	0.850182	1.699254	8.293656	2.647711	0.993706	
1	69	11	2.585862	0.881675	1.681624	7.973580	2.654480	0.993721	
1	69	12	2.597498	0.913000	1.663667	7.669991	2.661449	0.993731	
1	69	13	2.610542	0.944112	1.645794	7.383860	2.668462	0.993740	
2	10	5	2.579892	0.926767	2.455165	1.559167	2.406677	0.987421	
2	11	1	2.565990	1.000000	2.498653	0.	2.395889	0.988128	
2	11	2	2.567009	0.981610	2.497854	0.321655	2.395955	0.987914	
2	11	3	2.569744	0.963284	2.496302	0.654488	2.396235	0.987732	
2	11	4	2.574232	0.945094	2.493234	0.995921	2.396923	0.987578	
2	11	5	2.584553	0.929051	2.455161	1.555563	2.406690	0.987440	
1	70	1	2.591273	0.589792	1.811039	12.172374	2.606608	0.993907	
1	70	2	2.586652	0.620920	1.805139	11.562111	2.608595	0.993719	
1	70	3	2.584055	0.652332	1.796278	11.008405	2.611698	0.993598	
1	70	4	2.583412	0.683914	1.785078	10.502882	2.615714	0.993554	
1	70	5	2.584764	0.715591	1.772185	10.041982	2.620410	0.993565	
1	70	6	2.587959	0.747365	1.757883	9.613881	2.625677	0.993603	
1	70	7	2.592704	0.779132	1.742576	9.216540	2.631365	0.993644	
1	70	8	2.598931	0.810847	1.726497	8.845808	2.637388	0.993676	
1	70	9	2.606715	0.842481	1.709979	8.501549	2.643630	0.993699	
1	70	10	2.616120	0.874043	1.692866	8.174830	2.650158	0.993715	
1	70	11	2.626879	0.905456	1.675386	7.865614	2.656894	0.993727	
1	70	12	2.638972	0.936694	1.657611	7.571609	2.663818	0.993737	
2	11	6	2.605874	0.917785	2.477950	1.718806	2.400700	0.987330	
2	12	1	2.586376	0.990637	2.523981	0.156885	2.389360	0.988018	
2	12	2	2.588205	0.972018	2.523210	0.481937	2.389425	0.987817	
2	12	3	2.591721	0.953494	2.521059	0.814789	2.389861	0.987647	
2	12	4	2.596965	0.935133	2.517395	1.156781	2.390690	0.987489	
2	12	5	2.608287	0.918979					COALESCENCE
2	13	1	2.606548	1.000000	2.549272	0.	2.383048	0.988128	
2	13	2	2.607355	0.981039	2.549560	0.315600	2.382836	0.987913	
2	13	3	2.609961	0.962214	2.548211	0.640581	2.383053	0.987725	
2	13	4	2.614229	0.943510	2.545490	0.973893	2.383629	0.987558	
2	13	5	2.620329	0.924940	2.540955	1.315096	2.384663	0.987392	
1	71	1	2.631129	0.582487	1.812190	12.500000	2.606267	0.994014	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	71	2	2.625346	0.613413	1.808400	11.867719	2.607488	0.993810
1	71	3	2.621720	0.644666	1.801113	11.294180	2.609997	0.993656
1	71	4	2.620013	0.676152	1.791295	10.771614	2.613479	0.993575
1	71	5	2.620222	0.707800	1.779315	10.293418	2.617809	0.993560
1	71	6	2.622414	0.739554	1.766124	9.853622	2.622640	0.993586
1	71	7	2.626274	0.771308	1.751596	9.445176	2.628011	0.993626
1	71	8	2.631631	0.803035	1.736193	9.064825	2.633753	0.993663
1	71	9	2.638470	0.834725	1.719994	8.709652	2.639841	0.993690
1	71	10	2.646905	0.866371	1.703620	8.377088	2.646050	0.993709
1	71	11	2.656805	0.897859	1.686626	8.061792	2.652556	0.993723
1	71	12	2.668030	0.929191	1.669304	7.762644	2.659256	0.993733
2	13	6	2.632441	0.908664	2.565002	1.486589	2.377686	0.985931
2	14	1	2.627313	0.990400	2.575055	0.157197	2.376536	0.988019
2	14	2	2.628893	0.971224	2.574791	0.472630	2.376468	0.987813
2	14	3	2.632247	0.952212	2.572894	0.797974	2.376823	0.987634
2	14	4	2.637367	0.933290	2.569326	1.130396	2.377601	0.987463
2	14	5	2.644287	0.914534	2.564980	1.477630	2.378009	0.986421
1	72	1	2.664633	0.606001	1.810505	12.179121	2.606801	0.993911
1	72	2	2.659891	0.637084	1.805096	11.585716	2.608618	0.993730
1	72	3	2.657195	0.668435	1.796674	11.045134	2.611565	0.993613
1	72	4	2.656373	0.700007	1.785933	10.551436	2.615413	0.993567
1	72	5	2.657452	0.731748	1.773551	10.095675	2.619918	0.993575
1	72	6	2.660332	0.763495	1.760046	9.676632	2.624886	0.993609
1	72	7	2.664823	0.795220	1.745356	9.286112	2.630335	0.993647
1	72	8	2.670810	0.826930	1.729779	8.922119	2.636159	0.993679
1	72	9	2.678318	0.858639	1.713687	8.579345	2.642228	0.993701
1	72	10	2.687258	0.890218	1.697396	8.258791	2.648427	0.993717
1	72	11	2.697633	0.921631	1.680534	7.954073	2.654906	0.993729
2	14	6	2.659325	0.899326	2.588540	1.646731	2.371758	0.985807
2	15	1	2.647862	1.000000	2.600793	0.	2.370241	0.988128
2	15	2	2.648636	0.980581	2.600495	0.312661	2.370175	0.987913
2	15	3	2.650959	0.961209	2.599709	0.628357	2.370241	0.987717
2	15	4	2.655162	0.941970	2.596989	0.952712	2.370796	0.987538
2	15	5	2.661091	0.922855	2.593642	1.291012	2.371181	0.986859
2	15	6	2.668654	0.903995	2.588536	1.638704	2.371871	0.985980
1	73	1	2.704579	0.598685	1.811773	12.500000	2.606415	0.994014
1	73	2	2.698643	0.629583	1.808013	11.882420	2.607631	0.993818
1	73	3	2.694871	0.660791	1.801270	11.323871	2.609950	0.993669
1	73	4	2.693096	0.692250	1.791773	10.813758	2.613315	0.993588
1	73	5	2.693171	0.723932	1.780512	10.343833	2.617381	0.993571

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/69

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
1	73	6	2.694966	0.755679	1.767723	9.910053	2.622060	0.993594
1	73	7	2.698498	0.787409	1.753981	9.509918	2.627133	0.993631
1	73	8	2.703638	0.819127	1.739059	9.136594	2.632687	0.993665
1	73	9	2.710307	0.850865	1.723545	8.785696	2.638507	0.993692
1	73	10	2.718336	0.882512	1.707501	8.455597	2.644577	0.993711
1	73	11	2.727762	0.914022	1.691310	8.146149	2.650760	0.993725
2	15	7	2.686697	0.889886	2.611866	1.806625	2.365930	0.985672
2	16	1	2.668968	0.990178	2.626439	0.153922	2.363891	0.988019
2	16	2	2.670486	0.970558	2.625628	0.466772	2.363953	0.987810
2	16	3	2.673653	0.950950	2.624046	0.781378	2.364215	0.987619
2	16	4	2.678656	0.931512	2.621575	1.111468	2.364516	0.987153
2	16	5	2.685226	0.912284	2.617493	1.450115	2.364988	0.986343
2	16	6	2.693469	0.893309	2.611875	1.800062	2.365971	0.985739
1	73	1	2.704579	0.598685	1.811773	12.500000	2.606415	0.994014
1	73	2	2.698643	0.629583	1.808013	11.882420	2.607631	0.993818
1	73	3	2.694871	0.660791	1.801270	11.323871	2.609950	0.993669
1	73	4	2.693096	0.692250	1.791773	10.813758	2.613315	0.993588
1	73	5	2.693171	0.723932	1.780512	10.343833	2.617381	0.993571
1	73	6	2.694966	0.755679	1.767723	9.910053	2.622060	0.993594
1	73	7	2.698498	0.787409	1.753981	9.509918	2.627133	0.993631
1	73	8	2.703638	0.819127	1.739059	9.136594	2.632687	0.993665
1	73	9	2.710307	0.850865	1.723545	8.785696	2.638507	0.993692
1	73	10	2.718336	0.882512	1.707501	8.455597	2.644577	0.993711
2	16	7	2.714652	0.880314	2.634781	1.965293	2.360244	0.985524
2	17	1	2.689860	1.000000	2.652029	0.	2.357758	0.988128
2	17	2	2.690602	0.980149	2.651782	0.306441	2.357677	0.987911
2	17	3	2.692964	0.960286	2.650186	0.618128	2.357931	0.987708
2	17	4	2.696922	0.940472	2.648884	0.938327	2.358020	0.987360
2	17	5	2.702562	0.920914	2.645702	1.268653	2.358353	0.986688
2	17	6	2.709808	0.901563	2.641137	1.609436	2.359002	0.985985
2	17	7	2.718821	0.882441	2.634796	1.960780	2.360261	0.985555
1	74	1	2.738032	0.622163	1.810188	12.187882	2.606917	0.993915
1	74	2	2.733114	0.653215	1.804881	11.607212	2.608702	0.993741
1	74	3	2.730300	0.684556	1.796892	11.080808	2.611495	0.993626
1	74	4	2.729452	0.716142	1.786748	10.595861	2.615125	0.993579
1	74	5	2.730271	0.747846	1.774977	10.149151	2.619404	0.993584
1	74	6	2.732745	0.779588	1.761871	9.735376	2.624219	0.993614
1	74	7	2.736943	0.811324	1.747829	9.353313	2.629421	0.993650
1	74	8	2.742780	0.843077	1.732920	8.993820	2.634986	0.993681
1	74	9	2.749986	0.874760	1.717415	8.656250	2.640821	0.993703

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
2	17	8	2.743133	0.870633	2.657924	2.126622	2.354546	0.985364	
2	18	1	2.711279	0.989969	2.677571	0.150973	2.351555	0.988018	
2	18	2	2.712862	0.969868	2.676556	0.456159	2.351659	0.987804	
2	18	3	2.716010	0.949795	2.675255	0.773325	2.351785	0.987519	
2	18	4	2.720602	0.929853	2.673271	1.093646	2.351912	0.986982	
2	18	5	2.726914	0.910164	2.669630	1.425988	2.352328	0.986279	
2	18	6	2.734925	0.890657	2.664373	1.768048	2.353230	0.985726	
2	18	7	2.744656	0.871418					COALESCENCE
2	19	1	2.732483	1.000000	2.703047	0.	2.345569	0.988128	
2	19	2	2.733324	0.979681	2.702549	0.299098	2.345544	0.987907	
2	19	3	2.735687	0.959365	2.701851	0.609635	2.345544	0.987652	
2	19	4	2.739468	0.939159	2.699879	0.926837	2.345733	0.987223	
2	19	5	2.744727	0.919077	2.697466	1.249050	2.345889	0.986581	
2	19	6	2.751799	0.899223	2.693160	1.582546	2.346504	0.985953	
2	19	7	2.760520	0.879592	2.687834	1.929647	2.347484	0.985513	
1	75	1	2.777931	0.614863	1.811389	12.500000	2.606552	0.994014	
1	75	2	2.771978	0.645707	1.807832	11.898666	2.607701	0.993826	
1	75	3	2.768062	0.676918	1.801095	11.351956	2.610021	0.993681	
1	75	4	2.766204	0.708407	1.792318	10.852178	2.613127	0.993601	
1	75	5	2.766129	0.740031	1.781551	10.391726	2.617011	0.993582	
1	75	6	2.767651	0.771744	1.769373	9.966123	2.621461	0.993601	
1	75	7	2.770817	0.803503	1.755895	9.571403	2.626430	0.993635	
1	75	8	2.775727	0.835283	1.741812	9.203937	2.631664	0.993668	
1	75	9	2.782116	0.866990	1.726868	8.858458	2.637260	0.993694	
2	19	8	2.772058	0.860876	2.711193	2.110882	2.341309	0.984526	
2	20	1	2.754317	0.989710	2.728219	0.146580	2.339568	0.988016	
2	20	2	2.755930	0.969171	2.728056	0.450903	2.339449	0.987773	
2	20	3	2.758922	0.948715	2.726705	0.761372	2.339537	0.987420	
2	20	4	2.763369	0.928364	2.724317	1.080367	2.339738	0.986866	
2	20	5	2.769383	0.908108	2.721270	1.403607	2.340035	0.986218	
2	20	6	2.777159	0.888122	2.716927	1.742202	2.340714	0.985691	
2	20	7	2.786554	0.868388	2.711253	2.093442	2.341529	0.984886	
1	76	1	2.811337	0.638305	1.809896	12.196181	2.607024	0.993919	
1	76	2	2.806428	0.669338	1.804709	11.630634	2.608770	0.993752	
1	76	3	2.803505	0.700717	1.797031	11.112137	2.611453	0.993639	
1	76	4	2.802450	0.732263	1.787507	10.638193	2.614859	0.993591	
1	76	5	2.803104	0.763912	1.776236	10.199992	2.618951	0.993592	
1	76	6	2.805341	0.795654	1.763607	9.794429	2.623585	0.993620	
1	76	7	2.809239	0.827466	1.750029	9.415169	2.628608	0.993654	
1	76	8	2.814715	0.859209	1.735859	9.062436	2.633890	0.993683	

Figure 8.- Continued.

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
2	20	8	2.801326	0.850993	2.734338	2.273182	2.335745	0.984329
2	21	1	2.775938	1.000000	2.753313	0.	2.333785	0.988128
2	21	2	2.776705	0.979195	2.753927	0.296762	2.333489	0.987890
2	21	3	2.778945	0.958509	2.753128	0.600919	2.333477	0.987585
2	21	4	2.782599	0.937903	2.751382	0.913063	2.333579	0.987116
2	21	5	2.787800	0.917372	2.748373	1.232984	2.333879	0.986500
2	21	6	2.794510	0.896976	2.745323	1.561176	2.334207	0.985910
2	21	7	2.802953	0.876880	2.740663	1.903563	2.334836	0.985205
2	21	8	2.812957	0.857079	2.734417	2.257718	2.335840	0.984504
1	77	1	2.851192	0.631020	1.811034	12.500000	2.606679	0.994014
1	77	2	2.845275	0.661851	1.807512	11.914834	2.607821	0.993834
1	77	3	2.841395	0.693075	1.801218	11.379098	2.609984	0.993693
1	77	4	2.839311	0.724531	1.792659	10.887893	2.613012	0.993613
1	77	5	2.839011	0.756117	1.782523	10.437399	2.616665	0.993592
1	77	6	2.840404	0.787810	1.770716	10.020257	2.620974	0.993608
1	77	7	2.843391	0.819616	1.757921	9.631015	2.625687	0.993639
1	77	8	2.847877	0.851400	1.744204	9.267296	2.630778	0.993671
2	21	9	2.831110	0.841014	2.757125	2.435096	2.330299	0.984115
2	22	1	2.798112	0.989484	2.779207	0.148611	2.327722	0.988007
2	22	2	2.799503	0.968526	2.779206	0.445106	2.327543	0.987731
2	22	3	2.802401	0.947684	2.778030	0.750824	2.327556	0.987333
2	22	4	2.806806	0.926891	2.775684	1.063772	2.327734	0.986774
2	22	5	2.812699	0.906215	2.772687	1.388526	2.328029	0.986162
2	22	6	2.820069	0.885700	2.769356	1.720362	2.328363	0.985493
2	22	7	2.829115	0.865528	2.764154	2.065525	2.329101	0.984777
2	22	8	2.839831	0.845621	2.757212	2.422346	2.330342	0.984213
1	78	1	2.884605	0.654467	1.809469	12.204787	2.607179	0.993923
1	78	2	2.879754	0.685515	1.804661	11.651094	2.608793	0.993761
1	78	3	2.876747	0.716838	1.797340	11.144118	2.611350	0.993651
1	78	4	2.875451	0.748351	1.788053	10.677667	2.614668	0.993602
1	78	5	2.875915	0.779996	1.777286	10.249297	2.618574	0.993601
1	78	6	2.878078	0.811764	1.765242	9.849372	2.622989	0.993625
1	78	7	2.881671	0.843552	1.752247	9.476477	2.627791	0.993657
2	22	9	2.861475	0.830924	2.780099	2.599969	2.324843	0.983884
2	23	1	2.820069	1.000000	2.805017	0.	2.321890	0.988128
2	23	2	2.820697	0.978812	2.804676	0.295339	2.321797	0.987865
2	23	3	2.822740	0.957690	2.804319	0.593281	2.321655	0.987520
2	23	4	2.826385	0.936656	2.802563	0.899684	2.321737	0.987027
2	23	5	2.831476	0.915711	2.800253	1.217321	2.321877	0.986430
2	23	6	2.838027	0.894912	2.796992	1.545603	2.322197	0.985775

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
2	23	7	2.845994	0.874312	2.793154	1.880069	2.322614	0.985065	
2	23	8	2.855747	0.854025	2.787288	2.227754	2.323546	0.984429	
2	23	9	2.867233	0.833995	2.780177	2.590744	2.324863	0.983943	
1	79	1	2.924485	0.647184	1.810398	12.500000	2.606906	0.994014	
1	79	2	2.918583	0.678046	1.807330	11.928343	2.607890	0.993840	
1	79	3	2.914641	0.709216	1.801334	11.404939	2.609949	0.993704	
1	79	4	2.912454	0.740615	1.793159	10.924028	2.612839	0.993625	
1	79	5	2.911952	0.772204	1.783141	10.480867	2.616447	0.993601	
1	79	6	2.913206	0.803936	1.772057	10.070649	2.620489	0.993614	
1	79	7	2.915995	0.835697	1.759750	9.687905	2.625017	0.993643	
2	23	10	2.892326	0.820757	2.802907	2.765847	2.319458	0.983636	
2	24	1	2.842438	0.989325	2.830676	0.145135	2.315982	0.987995	
2	24	2	2.843718	0.967970	2.829986	0.441839	2.315938	0.987685	
2	24	3	2.846505	0.946649	2.829072	0.740347	2.315865	0.987255	
2	24	4	2.850830	0.925457	2.827374	1.051300	2.315888	0.986697	
2	24	5	2.856573	0.904383	2.824823	1.372324	2.316050	0.986057	
2	24	6	2.863720	0.883493	2.821071	1.703122	2.316448	0.985360	
2	24	7	2.872387	0.862769	2.816606	2.039957	2.317019	0.984680	
2	24	8	2.882903	0.842351	2.810608	2.393642	2.318022	0.984126	
2	24	9	2.895081	0.822241					COALESCENCE
2	25	1	2.863014	0.999240	2.910116	-0.300000	2.298377	0.988128	
2	25	2	2.865243	0.978479	2.856182	0.289985	2.310145	0.987836	
2	25	3	2.867267	0.956920	2.854942	0.587172	2.310178	0.987458	
2	25	4	2.870727	0.935435	2.854111	0.890087	2.310036	0.986951	
2	25	5	2.875699	0.914108	2.852194	1.204289	2.310069	0.986339	
2	25	6	2.882033	0.892936	2.849175	1.527692	2.310303	0.985656	
2	25	7	2.889879	0.871916	2.844813	1.860738	2.310830	0.984958	
2	25	8	2.899300	0.851051	2.840258	2.203396	2.311453	0.984341	
2	25	9	2.910498	0.830544	2.833748	2.561264	2.312592	0.983836	
1	80	1	2.957949	0.670665	1.809047	12.210338	2.607332	0.993926	
1	80	2	2.952994	0.701675	1.804617	11.670560	2.608815	0.993770	
1	80	3	2.949905	0.732942	1.797631	11.174588	2.611253	0.993663	
1	80	4	2.948540	0.764434	1.788613	10.718134	2.614472	0.993613	
1	80	5	2.948854	0.796123	1.778194	10.294149	2.618249	0.993609	
1	80	6	2.950753	0.827860	1.766775	9.901985	2.622431	0.993631	
2	25	10	2.923579	0.810546	2.856704	2.758357	2.306659	0.982642	
2	26	1	2.885393	0.988281	2.936494	-0.158305	2.292511	0.987975	
2	26	2	2.888573	0.967421	2.881339	0.433612	2.304413	0.987639	
2	26	3	2.891269	0.945696	2.880191	0.735098	2.304374	0.987186	
2	26	4	2.895370	0.924069	2.879165	1.041123	2.304231	0.986613	

Figure 8.- Continued.

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
2	26	5	2.900929	0.902638	2.876803	1.357569	2.304327	0.985953
2	26	6	2.907958	0.881329	2.873200	1.683073	2.304672	0.985250
2	26	7	2.916553	0.860162	2.868769	2.021795	2.305230	0.984588
2	26	8	2.926650	0.839198	2.863744	2.368468	2.305986	0.984028
2	26	9	2.938493	0.818627	2.856929	2.732086	2.306886	0.983069
1	81	1	2.997899	0.663374	1.810075	12.500000	2.607021	0.994014
1	81	2	2.991872	0.694210	1.807015	11.940462	2.608006	0.993846
1	81	3	2.987804	0.725340	1.801444	11.429538	2.609916	0.993714
1	81	4	2.985568	0.756719	1.793496	10.959241	2.612725	0.993636
1	81	5	2.985042	0.788325	1.783986	10.522989	2.616147	0.993611
1	81	6	2.986027	0.820031	1.773156	10.118013	2.620092	0.993621
2	26	10	2.955211	0.800212	2.879467	2.926238	2.301396	0.982350
2	27	1	2.906359	0.998373	3.036792	-0.700000	2.271149	0.988128
2	27	2	2.908291	0.977103	2.962543	-0.017938	2.286751	0.987795
2	27	3	2.912354	0.956188	2.906797	0.579752	2.298636	0.987400
2	27	4	2.915690	0.934316	2.905463	0.884245	2.298589	0.986876
2	27	5	2.920375	0.912579	2.904019	1.192379	2.298499	0.986245
2	27	6	2.926623	0.891003	2.901096	1.510782	2.298692	0.985550
2	27	7	2.934394	0.869541	2.897453	1.841790	2.299047	0.984860
2	27	8	2.943662	0.848269	2.892570	2.184386	2.299728	0.984249
2	27	9	2.954393	0.827232	2.887285	2.536619	2.300364	0.983428
2	27	10	2.966887	0.806599	2.879697	2.903821	2.301486	0.982566
1	82	1	3.031318	0.686823	1.808796	12.217504	2.607423	0.993929
1	82	2	3.026218	0.717804	1.804434	11.688348	2.608886	0.993778
1	82	3	3.023034	0.749066	1.797769	11.204367	2.611210	0.993673
1	82	4	3.021662	0.780575	1.789228	10.755342	2.614257	0.993622
1	82	5	3.021831	0.812213	1.779224	10.339054	2.617879	0.993616
2	27	11	2.987332	0.789812	2.902476	3.097842	2.296109	0.982043
2	28	1	2.928757	0.987047	3.063962	-0.563358	2.265345	0.987954
2	28	2	2.931632	0.965744	2.988925	0.124822	2.280947	0.987580
2	28	3	2.936553	0.944796	2.932287	0.727041	2.292875	0.987120
2	28	4	2.940472	0.922811	2.930542	1.033542	2.292873	0.986530
2	28	5	2.945840	0.900921	2.928563	1.343488	2.292866	0.985853
2	28	6	2.952824	0.879186	2.925627	1.667225	2.293051	0.985150
2	28	7	2.961262	0.857611	2.921562	2.001943	2.293515	0.984496
2	28	8	2.971160	0.836261	2.916442	2.349941	2.294150	0.983747
2	28	9	2.982536	0.815152	2.910427	2.705577	2.294908	0.982884
2	28	10	2.995724	0.794448	2.902684	3.080322	2.296143	0.982165
1	83	1	3.071226	0.679546	1.809775	12.500000	2.607129	0.994014
1	83	2	3.065185	0.710335	1.806869	11.953820	2.608062	0.993852

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
1	83	3	3.061006	0.741470	1.801271	11.452968	2.609985	0.993723	
1	83	4	3.058711	0.772879	1.793903	10.991376	2.612585	0.993646	
1	83	5	3.058059	0.804434	1.784778	10.563309	2.615865	0.993619	
2	28	11	3.019856	0.779382	2.925468	3.271787	2.290858	0.981722	
2	29	1	2.951042	0.997740	3.167567	-1.100000	2.244211	0.988128	
2	29	2	2.951591	0.975533	3.091502	-0.424456	2.259499	0.987755	
2	29	3	2.955386	0.954221	3.015364	0.268617	2.275154	0.987325	
2	29	4	2.961110	0.933277	2.957588	0.874410	2.287178	0.986802	
2	29	5	2.965713	0.911135	2.955319	1.182618	2.287249	0.986155	
2	29	6	2.971809	0.889079	2.953357	1.497725	2.287218	0.985452	
2	29	7	2.979454	0.867224	2.950026	1.825010	2.287495	0.984767	
2	29	8	2.988516	0.845564	2.945754	2.164948	2.287952	0.984045	
2	29	9	2.999057	0.824136	2.939926	2.516199	2.288678	0.983214	
2	29	10	3.011117	0.802945	2.933806	2.879172	2.289497	0.982425	
2	29	11	3.024926	0.782210	2.925625	3.260295	2.290868	0.981791	
1	83	1	3.071226	0.679546	1.809775	12.500000	2.607129	0.994014	
1	83	2	3.065185	0.710335	1.806869	11.953820	2.608062	0.993852	
1	83	3	3.061006	0.741470	1.801271	11.452968	2.609985	0.993723	
1	83	4	3.058711	0.772879	1.793903	10.991376	2.612585	0.993646	
2	29	12	3.052787	0.768925	2.948465	3.448320	2.285636	0.981387	
2	30	1	2.973374	0.986084	3.196259	-0.964867	2.238328	0.987939	
2	30	2	2.974830	0.963849	3.119135	-0.284649	2.253663	0.987521	
2	30	3	2.979494	0.942564	3.041639	0.412385	2.269420	0.987030	
2	30	4	2.986125	0.921584	2.982597	1.021485	2.281566	0.986449	
2	30	5	2.991454	0.899272	2.980356	1.334721	2.281602	0.985760	
2	30	6	2.998205	0.877089	2.978030	1.653211	2.281645	0.985056	
2	30	7	3.006468	0.855142	2.974520	1.985539	2.281933	0.984339	
2	30	8	3.016166	0.833396	2.969572	2.328552	2.282478	0.983539	
2	30	9	3.027387	0.811881	2.963664	2.686961	2.283218	0.982721	
2	30	10	3.040060	0.790648	2.957156	3.056113	2.284165	0.982016	
2	30	11	3.054496	0.769888					COALESCENCE
2	31	1	2.996776	0.997282	3.304067	-1.500000	2.217256	0.988128	
2	31	2	2.996104	0.974251	3.225075	-0.828956	2.232454	0.987723	
2	31	3	2.998419	0.952023	3.146631	-0.144991	2.247880	0.987250	
2	31	4	3.004055	0.930726	3.067646	0.555738	2.263764	0.986697	
2	31	5	3.011637	0.909702	3.007876	1.171489	2.275929	0.986068	
2	31	6	3.017620	0.887259	3.005281	1.487983	2.276021	0.985360	
2	31	7	3.024981	0.864976	3.002809	1.811338	2.276078	0.984638	
2	31	8	3.033875	0.842937	2.998652	2.146565	2.276459	0.983861	
2	31	9	3.044245	0.821096	2.993660	2.496529	2.276989	0.983037	

Figure 8.- Continued.

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
2	31	10	3.056076	0.799533	2.987390	2.860943	2.277834	0.982277
2	31	11	3.069365	0.778264	2.980483	3.236728	2.278887	0.981623
1	84	1	3.104602	0.702964	1.808566	12.224300	2.607508	0.993932
1	84	2	3.099518	0.733931	1.804273	11.707793	2.608949	0.993786
1	84	3	3.096259	0.765231	1.797854	11.230536	2.611186	0.993683
2	31	12	3.086173	0.758433	3.003246	3.453164	2.273111	0.980218
2	32	1	3.019001	0.985311	3.334071	-1.367896	2.211351	0.987927
2	32	2	3.019179	0.962270	3.253785	-0.693315	2.226631	0.987473
2	32	3	3.022454	0.940009	3.173891	-0.005884	2.242167	0.986938
2	32	4	3.029104	0.918693	3.093961	0.701875	2.258068	0.986329
2	32	5	3.037571	0.897668	3.033051	1.322562	2.270346	0.985672
2	32	6	3.044162	0.875121	3.030324	1.643784	2.270450	0.984946
2	32	7	3.052149	0.852737	3.027237	1.969864	2.270604	0.984180
2	32	8	3.061707	0.830596	3.023068	2.311836	2.270954	0.983362
2	32	9	3.072680	0.808700	3.017750	2.667604	2.271561	0.982565
2	32	10	3.085124	0.787095	3.011110	3.038466	2.272510	0.981861
2	32	11	3.099108	0.765767	3.003692	3.421001	2.273304	0.980660
1	85	1	3.144469	0.695699	1.809501	12.500000	2.607226	0.994014
1	85	2	3.138468	0.726479	1.806595	11.967223	2.608164	0.993858
1	85	3	3.134333	0.757632	1.801354	11.475519	2.609961	0.993732
2	32	12	3.119941	0.747834	3.026584	3.635352	2.267912	0.979830
2	33	1	3.042058	0.996318	3.466457	-2.000000	2.186600	0.988128
2	33	2	3.041565	0.973185	3.363997	-1.236179	2.205493	0.987698
2	33	3	3.042693	0.950091	3.282289	-0.558362	2.220872	0.987186
2	33	4	3.046967	0.927790	3.201505	0.135844	2.236406	0.986588
2	33	5	3.054570	0.906500	3.120205	0.848950	2.252419	0.985939
2	33	6	3.063879	0.885506	3.058354	1.476077	2.264772	0.985262
2	33	7	3.071095	0.862853	3.055025	1.799890	2.264975	0.984502
2	33	8	3.079738	0.840361	3.051963	2.132509	2.265090	0.983693
2	33	9	3.089893	0.818157	3.047502	2.480082	2.265494	0.982876
2	33	10	3.101471	0.796211	3.041851	2.842085	2.266191	0.982124
2	33	11	3.114603	0.774540	3.034731	3.219487	2.267015	0.981089
2	33	12	3.129258	0.753170	3.026976	3.610257	2.267963	0.980035
1	86	1	3.177856	0.719124	1.808216	12.231459	2.607635	0.993935
1	86	2	3.172836	0.750111	1.804224	11.724738	2.608971	0.993793
2	33	13	3.154103	0.737230	3.049872	3.820314	2.262746	0.979418
2	34	1	3.064050	0.984019	3.497870	-1.872667	2.180696	0.987913
2	34	2	3.064563	0.960854	3.393748	-1.105287	2.199697	0.987434
2	34	3	3.066677	0.937702	3.311194	-0.420951	2.215058	0.986858
2	34	4	3.071891	0.915404	3.229087	0.278361	2.230679	0.986207

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
2	34	5	3.080404	0.894174	3.146612	0.998329	2.246770	0.985530	
2	34	6	3.090576	0.873212	3.083326	1.629805	2.259295	0.984828	
2	34	7	3.098445	0.850447	3.080037	1.959994	2.259458	0.984028	
2	34	8	3.107677	0.827883	3.076720	2.298009	2.259609	0.983201	
2	34	9	3.118430	0.805622	3.071962	2.651604	2.260085	0.982412	
2	34	10	3.130689	0.783602	3.065873	3.019912	2.260739	0.981469	
2	34	11	3.144487	0.761883	3.058448	3.405331	2.261595	0.980405	
2	34	12	3.159760	0.740503	3.050160	3.803824	2.262752	0.979520	
1	87	1	3.217750	0.711861	1.808971	12.500000	2.607416	0.994014	
1	87	2	3.211766	0.742675	1.806448	11.978385	2.608220	0.993863	
2	34	13	3.188660	0.726627	3.073111	4.008189	2.257605	0.978972	
2	35	1	3.086209	0.994552	3.635439	-2.500000	2.156178	0.988128	
2	35	2	3.086468	0.971507	3.529146	-1.746310	2.174848	0.987668	
2	35	3	3.088022	0.948305	3.423945	-0.972099	2.193840	0.987131	
2	35	4	3.091065	0.925137	3.340104	-0.282904	2.209268	0.986494	
2	35	5	3.097175	0.902877	3.256878	0.423030	2.224942	0.985803	
2	35	6	3.106621	0.881708	3.172719	1.147790	2.241212	0.985099	
2	35	7	3.117686	0.860776	3.108621	1.787410	2.253776	0.984366	
2	35	8	3.126142	0.837936	3.105092	2.122834	2.253965	0.983540	
2	35	9	3.135966	0.815307	3.101518	2.466657	2.254169	0.982723	
2	35	10	3.147391	0.792964	3.096360	2.826326	2.254649	0.981825	
2	35	11	3.160307	0.770887	3.090011	3.202402	2.255286	0.980789	
2	35	12	3.174720	0.749151	3.082087	3.595329	2.256298	0.979825	
2	35	13	3.190616	0.727770					COALESCENCE
2	36	1	3.108063	0.981867	3.668260	-2.378003	2.150280	0.987893	
2	36	2	3.109336	0.958768	3.560923	-1.617838	2.168938	0.987388	
2	36	3	3.111877	0.935573	3.454187	-0.838425	2.188000	0.986790	
2	36	4	3.115806	0.912424	3.369268	-0.142859	2.203459	0.986101	
2	36	5	3.122838	0.890202	3.284406	0.567629	2.219287	0.985375	
2	36	6	3.133245	0.869093	3.199194	1.300971	2.235606	0.984642	
2	36	7	3.145140	0.848234	3.133971	1.947636	2.248274	0.983885	
2	36	8	3.154185	0.825324	3.130202	2.288697	2.248502	0.983052	
2	36	9	3.164672	0.802605	3.126270	2.638365	2.248733	0.982172	
2	36	10	3.176747	0.780197	3.120893	3.005553	2.249183	0.981174	
2	36	11	3.190271	0.758095	3.114091	3.388888	2.249921	0.980168	
2	36	12	3.205300	0.736351	3.105625	3.789726	2.251085	0.979285	
1	88	1	3.251190	0.735321	1.807865	12.235949	2.607762	0.993938	
2	36	13	3.223670	0.716014	3.128307	4.029521	2.245322	0.977579	
2	37	1	3.130838	0.992650	3.833676	-3.100000	2.122224	0.988128	
2	37	2	3.130358	0.968947	3.701640	-2.254067	2.144317	0.987629	

Figure 8.- Continued.

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
2	37	3	3.132593	0.945838	3.592791	-1.489047	2.163036	0.987069
2	37	4	3.136079	0.922686	3.484726	-0.702910	2.182132	0.986415
2	37	5	3.140919	0.899555	3.398206	-0.003036	2.197722	0.985681
2	37	6	3.148897	0.877371	3.312359	0.715773	2.213578	0.984921
2	37	7	3.160206	0.856366	3.225766	1.456625	2.230010	0.984162
2	37	8	3.172938	0.835589	3.159388	2.110764	2.242796	0.983395
2	37	9	3.182643	0.812583	3.155281	2.457485	2.243059	0.982522
2	37	10	3.193771	0.789791	3.151174	2.814422	2.243261	0.981554
2	37	11	3.206447	0.767350	3.145388	3.188620	2.243772	0.980535
2	37	12	3.220578	0.745230	3.138093	3.579606	2.244642	0.979594
2	37	13	3.236310	0.723453	3.129031	3.989014	2.245512	0.978097
2	37	14	3.229116	0.714367	3.126958	4.036556	2.245623	0.977618
3	1	1	3.247866	0.718524	5.113204	12.499998	1.922596	0.965893
3	1	2	3.247866	0.728827	5.113204	12.499998	1.922596	0.965893
3	2	1	3.255782	0.726126	5.088972	12.487751	1.925665	0.965893
2	38	1	3.152495	0.979527	3.868955	-2.981100	2.116200	0.987876
2	38	2	3.153034	0.955828	3.735157	-2.129975	2.138360	0.987331
2	38	3	3.156189	0.932744	3.625011	-1.358588	2.157099	0.986714
2	38	4	3.160647	0.909634	3.515076	-0.567768	2.176326	0.986008
2	38	5	3.166422	0.886522	3.427625	0.140153	2.191924	0.985233
2	38	6	3.175289	0.864419	3.340458	0.866225	2.207870	0.984442
2	38	7	3.187505	0.843528	3.252448	1.615027	2.224427	0.983668
2	38	8	3.201146	0.822812	3.184790	2.276682	2.237342	0.982877
2	38	9	3.211489	0.799729	3.180529	2.630468	2.237584	0.981933
2	38	10	3.223210	0.776894	3.176059	2.994165	2.237821	0.980917
2	38	11	3.236485	0.754427	3.169825	3.375754	2.238435	0.979932
2	38	12	3.251309	0.732264	3.161987	3.775013	2.239154	0.978610
2	38	13	3.241152	0.721451	3.127954	3.996249	2.245647	0.977966
2	39	1	3.174763	0.990014	3.904070	-3.100000	2.110581	0.988128
2	39	2	3.174525	0.966195	3.904428	-2.862227	2.110177	0.987594
2	39	3	3.176041	0.942538	3.769079	-2.004383	2.132361	0.986996
2	39	4	3.180145	0.919477	3.657086	-1.228674	2.151213	0.986322
2	39	5	3.185596	0.896412	3.545962	-0.429443	2.170451	0.985570
2	39	6	3.192249	0.873360	3.457241	0.285480	2.186118	0.984758
2	39	7	3.202011	0.851348	3.368724	1.019255	2.202164	0.983946
2	39	8	3.215209	0.830551	3.279162	1.776054	2.218864	0.983150
2	39	9	3.229738	0.809918	3.210375	2.446648	2.231862	0.982310
2	39	10	3.240671	0.786788	3.205773	2.806987	2.232127	0.981309
2	39	11	3.252983	0.763918	3.200906	3.177813	2.232438	0.980296
2	39	12	3.266941	0.741399	3.194179	3.567383	2.232987	0.979077

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
2	39	13	3.256120	0.730247	3.160973	3.781765	2.239262	0.978462	
3	2	2	3.251966	0.731988	5.151339	12.190910	1.918609	0.967111	
3	3	1	3.266260	0.722559	5.064955	12.500000	1.928721	0.965893	
3	3	2	3.259250	0.729449	5.146537	12.240392	1.918710	0.966361	
2	40	1	3.196605	0.976691	3.939777	-2.982135	2.104578	0.987855	
2	40	2	3.196878	0.952685	3.940370	-2.742042	2.104108	0.987279	
2	40	3	3.199402	0.929067	3.802903	-1.879505	2.126404	0.986622	
2	40	4	3.204472	0.906032	3.689764	-1.095776	2.145249	0.985897	
2	40	5	3.210864	0.883054	3.577095	-0.289150	2.164561	0.985103	
2	40	6	3.218400	0.860072	3.487076	0.433209	2.180305	0.984262	
2	40	7	3.229129	0.838129	3.397078	1.174722	2.196471	0.983426	
2	40	8	3.243289	0.817450	3.306113	1.940952	2.213271	0.982592	
2	40	9	3.258663	0.796936	3.235974	2.620002	2.226394	0.981704	
2	40	10	3.270185	0.773766	3.230998	2.987251	2.226711	0.980682	
2	40	11	3.283170	0.750834	3.225693	3.365771	2.227004	0.979520	
2	40	12	3.271722	0.739366	3.193225	3.573670	2.233089	0.978940	
3	3	3	3.265224	0.742134	5.187274	11.937198	1.914598	0.967835	
3	4	1	3.269674	0.725825	5.122699	12.251738	1.921491	0.966034	
3	4	2	3.270560	0.740239	5.183944	11.972726	1.914752	0.967444	
2	40	1	3.196605	0.976691	3.939777	-2.982135	2.104578	0.987855	
2	40	2	3.196878	0.952685	3.940370	-2.742042	2.104108	0.987279	
2	40	3	3.199402	0.929067	3.802903	-1.879505	2.126404	0.986622	
2	40	4	3.204472	0.906032	3.689764	-1.095776	2.145249	0.985897	
2	40	5	3.210864	0.883054	3.577095	-0.289150	2.164561	0.985103	
2	40	6	3.218400	0.860072	3.487076	0.433209	2.180305	0.984262	
2	40	7	3.229129	0.838129	3.397078	1.174722	2.196471	0.983426	
2	40	8	3.243289	0.817450	3.306113	1.940952	2.213271	0.982592	
2	40	9	3.258663	0.796936	3.235974	2.620002	2.226394	0.981704	
2	40	10	3.270185	0.773766	3.230998	2.987251	2.226711	0.980682	
2	40	11	3.283170	0.750834	3.225693	3.365771	2.227004	0.979520	
3	4	3	3.279025	0.752631	5.221716	11.689152	1.910768	0.968508	
3	5	1	3.274105	0.724289	5.181279	12.500000	1.914047	0.965893	
3	5	2	3.280942	0.736560	5.160447	11.982349	1.917299	0.966861	
3	5	3	3.282365	0.751424					COALESCENCE
3	6	1	3.285241	0.735041	5.219326	12.227958	1.909816	0.966641	
3	6	2	3.292702	0.747688	5.196608	11.718637	1.913365	0.967730	
2	41	1	3.219076	0.987355	4.139135	-3.800000	2.073145	0.988128	
2	41	2	3.218768	0.963189	3.975960	-2.863006	2.098533	0.987557	
2	41	3	3.219577	0.938982	3.976267	-2.622760	2.098074	0.986925	
2	41	4	3.223124	0.915408	3.837397	-1.751838	2.120362	0.986212	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
2	41	5	3.229111	0.892442	3.722749	-0.961099	2.139262	0.985440	
2	41	6	3.236449	0.869562	3.608500	-0.146634	2.158654	0.984611	
2	41	7	3.244940	0.846627	3.517058	0.583183	2.174496	0.983742	
2	41	8	3.256616	0.824777	3.425735	1.333867	2.190742	0.982870	
2	41	9	3.271696	0.804252	3.333129	2.109066	2.207682	0.981992	
2	41	10	3.287917	0.783869	3.261570	2.796945	2.220954	0.981080	
2	41	11	3.300108	0.760632	3.256183	3.171645	2.221277	0.979955	
3	6	3	3.293465	0.763548	5.237077	11.388659	1.909453	0.969385	
3	7	1	3.299754	0.729946	5.259149	12.500000	1.904398	0.965893	
3	7	2	3.296865	0.746190	5.255752	11.961589	1.905888	0.967495	
3	7	3	3.305043	0.759289	5.230605	11.461815	1.909788	0.968689	
2	42	1	3.240531	0.973614	4.177662	-3.686690	2.067019	0.987836	
2	42	2	3.241276	0.949492	4.012104	-2.744816	2.092525	0.987227	
2	42	3	3.242627	0.925084	4.012915	-2.500909	2.091945	0.986533	
2	42	4	3.247151	0.901597	3.872260	-1.622580	2.114286	0.985767	
2	42	5	3.254059	0.878709	3.756072	-0.824398	2.133247	0.984953	
2	42	6	3.262415	0.855904	3.640111	-0.002071	2.152742	0.984094	
2	42	7	3.271841	0.833041	3.547408	0.736631	2.168645	0.983190	
2	42	8	3.284423	0.811320	3.454520	1.496039	2.185008	0.982275	
2	42	9	3.300425	0.790962	3.360195	2.280595	2.202106	0.981366	
2	42	10	3.317575	0.770687	3.287146	2.977842	2.215511	0.980386	
3	7	4	3.308413	0.774759	5.269716	11.147678	1.905867	0.970034	
3	8	1	3.311196	0.741063	5.296197	12.229127	1.900403	0.966713	
3	8	2	3.309069	0.757815	5.289969	11.702100	1.902325	0.968447	
3	8	3	3.317837	0.771235	5.264681	11.205689	1.906158	0.969544	
2	43	1	3.263961	0.984662	4.363294	-4.400000	2.039331	0.988128	
2	43	2	3.262322	0.959667	4.216214	-3.574527	2.060925	0.987518	
2	43	3	3.264133	0.935599	4.049004	-2.624115	2.086425	0.986861	
2	43	4	3.265973	0.911025	4.050003	-2.377676	2.085775	0.986103	
2	43	5	3.271480	0.887636	3.907526	-1.491490	2.108174	0.985290	
2	43	6	3.279379	0.864802	3.789669	-0.685866	2.127216	0.984438	
2	43	7	3.288734	0.842097	3.672153	0.145763	2.146782	0.983546	
2	43	8	3.299054	0.819341	3.577948	0.892910	2.162782	0.982600	
2	43	9	3.312546	0.797761	3.483424	1.661432	2.179275	0.981648	
2	43	10	3.329552	0.777549	3.387303	2.455882	2.196527	0.980682	
3	8	4	3.318797	0.782502	5.405630	10.594448	1.889775	0.970627	
3	9	1	3.326207	0.735741	5.048805	11.500000	1.930784	0.965893	
3	9	2	3.323216	0.752662	5.330984	11.965146	1.896775	0.967625	
3	9	3	3.321722	0.769787					COALESCENCE
3	10	1	3.338548	0.747127	5.083763	11.239714	1.926917	0.966776	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
3	10	2	3.335664	0.764592	5.366222	11.700758	1.893118	0.968536
3	10	3	3.326666	0.779425	5.401816	10.641674	1.889935	0.970182
2	44	1	3.285119	0.970518	4.403992	-4.292969	2.033176	0.987823
2	44	2	3.284450	0.945515	4.255615	-3.460090	2.054733	0.987167
2	44	3	3.287283	0.921544	4.086352	-2.502088	2.080282	0.986457
2	44	4	3.289613	0.896805	4.087571	-2.252830	2.079558	0.985636
2	44	5	3.296172	0.873490	3.943135	-1.358785	2.102037	0.984780
2	44	6	3.305043	0.850736	3.823777	-0.544291	2.121130	0.983893
2	44	7	3.315358	0.828168	3.704449	0.296222	2.140804	0.982963
2	44	8	3.326577	0.805530	3.608674	1.052206	2.156909	0.981975
2	44	9	3.341057	0.784068	3.512442	1.830368	2.173530	0.980968
3	10	4	3.328857	0.789927	5.576888	9.939851	1.869956	0.971239
3	11	1	3.354506	0.741311	4.938898	10.850000	1.944989	0.965893
3	11	2	3.351324	0.758835	5.119193	10.979037	1.923032	0.967677
3	11	3	3.344103	0.772625	5.506513	11.130676	1.876811	0.969168
3	11	4	3.335234	0.787300	5.574125	9.976870	1.870016	0.970847
2	45	1	3.307001	0.980800	4.674635	-5.300000	1.995062	0.988128
2	45	2	3.306604	0.956159	4.445620	-4.183873	2.026919	0.987488
2	45	3	3.306863	0.931191	4.295547	-3.344556	2.048493	0.986779
2	45	4	3.310726	0.907327	4.124188	-2.378506	2.074092	0.986016
2	45	5	3.313606	0.882391	4.125567	-2.126613	2.073304	0.985134
2	45	6	3.321199	0.859177	3.979335	-1.223260	2.095835	0.984238
2	45	7	3.331005	0.836538	3.858215	-0.400311	2.115016	0.983313
2	45	8	3.342285	0.814121	3.736997	0.449488	2.134806	0.982343
2	45	9	3.354479	0.791577	3.639589	1.214816	2.151017	0.981303
3	11	5	3.340616	0.798509	5.748511	9.290863	1.850707	0.971902
3	12	1	3.367428	0.752861	4.974632	10.590085	1.940938	0.966792
3	12	2	3.359821	0.766570	5.256222	10.410017	1.906359	0.968286
3	12	3	3.352246	0.780305	5.682742	10.459667	1.856782	0.969803
3	12	4	3.345315	0.796474	5.746703	9.317068	1.850719	0.971616
2	46	1	3.327643	0.966140	4.719559	-5.198305	1.988695	0.987797
2	46	2	3.328366	0.941621	4.487852	-4.073878	2.020609	0.987119
2	46	3	3.329559	0.916695	4.336055	-3.227707	2.042195	0.986353
2	46	4	3.334520	0.892915	4.162457	-2.253617	2.067862	0.985538
2	46	5	3.337925	0.867800	4.164246	-1.997828	2.066976	0.984598
2	46	6	3.346517	0.844723	4.015942	-1.085551	2.089597	0.983663
2	46	7	3.357261	0.822213	3.892986	-0.253759	2.108874	0.982697
2	46	8	3.369583	0.799921	3.769807	0.605835	2.128782	0.981678
3	12	5	3.353885	0.808086	5.922027	8.644814	1.831821	0.972609
3	13	1	3.383809	0.746762	4.833706	10.200000	1.958871	0.965893

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
3	13	2	3.375854	0.760342	5.110177	10.020095	1.923977	0.967387	
3	13	3	3.367964	0.773914	5.428191	9.739501	1.885912	0.968886	
3	13	4	3.361885	0.789308	5.859145	9.793166	1.837407	0.970569	
3	13	5	3.356754	0.806782					COALESCENCE
3	14	1	3.392153	0.753989	4.967767	9.628913	1.941617	0.966474	
3	14	2	3.383873	0.767395	5.280164	9.348141	1.903203	0.967965	
3	14	3	3.377645	0.782559	5.600567	9.073928	1.866119	0.969616	
3	14	4	3.372862	0.799461	6.037316	9.128974	1.818452	0.971422	
2	47	1	3.349044	0.976115	5.034227	-6.300000	1.947338	0.988128	
2	47	2	3.348553	0.951288	4.765200	-5.095994	1.982269	0.987437	
2	47	3	3.350404	0.926903	4.530739	-3.962783	2.014235	0.986712	
2	47	4	3.352596	0.901993	4.377093	-3.109817	2.035848	0.985886	
2	47	5	3.358637	0.878325	4.201420	-2.126235	2.061556	0.985023	
2	47	6	3.362526	0.853058	4.203426	-1.867107	2.060601	0.984026	
2	47	7	3.372122	0.830132	4.052963	-0.945500	2.083321	0.983050	
2	47	8	3.383880	0.807724	3.928108	-0.104383	2.102695	0.982036	
3	14	5	3.366573	0.817144	6.259494	8.279960	1.795259	0.972051	
3	15	1	3.401666	0.750267	4.914103	9.500000	1.948236	0.965893	
3	15	2	3.400034	0.760751	5.135780	8.955367	1.920512	0.967033	
3	15	3	3.393457	0.775740	5.450696	8.681312	1.883085	0.968669	
3	15	4	3.388701	0.792332	5.774888	8.411018	1.846756	0.970450	
3	15	5	3.383385	0.809100	6.254483	8.369623	1.795544	0.971695	
2	48	1	3.369047	0.960932	5.083772	-6.206008	1.940784	0.987767	
2	48	2	3.369725	0.936245	4.811614	-4.992876	1.975773	0.987042	
2	48	3	3.372772	0.911969	4.574242	-3.850878	2.007804	0.986264	
2	48	4	3.375945	0.887102	4.418933	-2.989709	2.029413	0.985381	
2	48	5	3.383034	0.863582	4.240889	-1.996991	2.055203	0.984472	
2	48	6	3.387405	0.838169	4.243115	-1.734306	2.054179	0.983416	
2	48	7	3.398079	0.815367	4.090427	-0.802882	2.077000	0.982394	
3	15	6	3.379146	0.826136	6.479809	7.548372	1.773085	0.972779	
3	16	1	3.409432	0.756872	5.081628	8.825023	1.926982	0.966467	
3	16	2	3.409509	0.768795	5.304470	8.287136	1.900065	0.967717	
3	16	3	3.404436	0.785203	5.623277	8.017306	1.863404	0.969486	
3	16	4	3.399232	0.801550	5.987194	7.652340	1.823611	0.971006	
3	16	5	3.393935	0.818671	6.476168	7.622778	1.773061	0.972198	
2	49	1	3.390469	0.970834	5.477542	-7.500000	1.892790	0.988128	
2	49	2	3.389302	0.945547	5.134230	-6.111542	1.934155	0.987378	
2	49	3	3.391216	0.920973	4.858771	-4.889281	1.969209	0.986607	
2	49	4	3.395442	0.896837	4.618641	-3.737005	2.001277	0.985775	
2	49	5	3.399564	0.872048	4.461384	-2.868016	2.022920	0.984836	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
2	49	6	3.407707	0.848691	4.280877	-1.865747	2.048802	0.983883
2	49	7	3.412627	0.823095	4.283356	-1.599229	2.047700	0.982763
3	16	6	3.392150	0.835333	6.741662	6.719050	1.747566	0.973547
3	17	1	3.418794	0.753007	5.254937	9.500000	1.904916	0.965893
3	17	2	3.418803	0.764760	5.249883	8.155394	1.906382	0.967153
3	17	3	3.420400	0.777948	5.475313	7.621888	1.880059	0.968513
3	17	4	3.414833	0.794074	5.833342	7.257032	1.840007	0.970160
3	17	5	3.409786	0.810695	6.204017	6.906011	1.800734	0.971534
3	17	6	3.404880	0.828511	6.739366	6.778835	1.747339	0.972880
2	50	1	3.409680	0.955058	5.533012	-7.415710	1.886004	0.987736
2	50	2	3.409860	0.929917	5.185579	-6.016970	1.927450	0.986952
2	50	3	3.412996	0.905490	4.906968	-4.784062	1.962538	0.986129
2	50	4	3.418375	0.881533	4.663745	-3.621790	1.994683	0.985245
2	50	5	3.423450	0.856834	4.504467	-2.744609	2.016368	0.984253
2	50	6	3.432720	0.833614	4.321425	-1.732315	2.042344	0.983253
3	17	7	3.409617	0.847540	6.777439	6.536884	1.744549	0.974240
3	18	1	3.427777	0.760861	5.427925	8.824619	1.884403	0.966586
3	18	2	3.429600	0.773753	5.420330	7.488784	1.886223	0.967947
3	18	3	3.430650	0.786474	5.683142	6.859827	1.856351	0.969228
3	18	4	3.425253	0.802873	6.047929	6.509091	1.816866	0.970768
3	18	5	3.420693	0.820056	6.461416	6.062096	1.774516	0.972136
3	18	6	3.419958	0.841940	6.775226	6.582487	1.744426	0.973740
2	51	1	3.431389	0.965000	5.740199	-8.000000	1.862408	0.988128
2	51	2	3.429177	0.939023	5.589560	-7.331772	1.879134	0.987314
2	51	3	3.430693	0.914064	5.238136	-5.921162	1.920628	0.986485
2	51	4	3.435028	0.889823	4.956012	-4.677847	1.955788	0.985608
2	51	5	3.441567	0.866060	4.709578	-3.505122	1.988020	0.984673
2	51	6	3.447665	0.841422	4.548233	-2.619337	2.009747	0.983625
3	18	7	3.423196	0.856996	7.083252	5.616896	1.715952	0.975026
3	19	1	3.439149	0.755981	5.398346	8.800000	1.887480	0.965893
3	19	2	3.438159	0.769847	5.602991	8.151798	1.864349	0.967394
3	19	3	3.439724	0.782100	5.627623	6.725093	1.862358	0.968674
3	19	4	3.440922	0.794928	5.895499	6.110092	1.832926	0.969895
3	19	5	3.435982	0.811845	6.302650	5.663089	1.790311	0.971381
3	19	6	3.436145	0.833189	6.498022	5.870035	1.771378	0.972979
3	19	7	3.431516	0.852187	7.082444	5.651333	1.715694	0.974534
2	51	1	3.431389	0.965000	5.740199	-8.000000	1.862408	0.988128
2	51	2	3.429177	0.939023	5.589560	-7.331772	1.879134	0.987314
2	51	3	3.430693	0.914064	5.238136	-5.921162	1.920628	0.986485
2	51	4	3.435028	0.889823	4.956012	-4.677847	1.955788	0.985608

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
2	51	5	3.441567	0.866060	4.709578	-3.505122	1.988020	0.984673	
3	19	8	3.438931	0.867819	7.358410	4.811986	1.691241	0.975825	
3	20	1	3.449361	0.764793	5.573787	8.124633	1.867263	0.966681	
3	20	2	3.447873	0.778170	5.815951	7.382150	1.840597	0.968145	
3	20	3	3.449872	0.790377	5.839450	5.973745	1.838793	0.969368	
3	20	4	3.451458	0.803514	6.147557	5.261805	1.806046	0.970546	
3	20	5	3.451617	0.824789	6.339793	5.472600	1.787041	0.972239	
3	20	6	3.447612	0.842894	6.798580	4.938302	1.742117	0.973678	
3	20	7	3.445050	0.864078	7.358080	4.834597	1.691022	0.975459	
2	52	1	3.450354	0.948817	5.799277	-7.920276	1.855479	0.987709	
2	52	2	3.448933	0.922747	5.647528	-7.247074	1.872138	0.986853	
2	52	3	3.451765	0.898013	5.291703	-5.824750	1.913716	0.985973	
2	52	4	3.457306	0.873974	5.005933	-4.570542	1.948956	0.985042	
3	20	8	3.452741	0.877221	7.763098	3.708198	1.656136	0.976625	
3	21	1	3.461472	0.759336	5.543739	8.100000	1.870243	0.965893	
3	21	2	3.458871	0.772917	5.787148	7.352201	1.843344	0.967425	
3	21	3	3.457621	0.786434	6.033458	6.625033	1.817154	0.968873	
3	21	4	3.460259	0.798764	6.090868	5.123566	1.811760	0.970044	
3	21	5	3.467274	0.816268	6.185209	5.072893	1.802663	0.971449	
3	21	6	3.462861	0.834057	6.637272	4.538264	1.757391	0.972893	
3	21	7	3.461152	0.854242	7.068753	4.121976	1.716979	0.974542	
3	21	8	3.456942	0.874448	7.763283	3.721506	1.655928	0.976344	
2	53	1	3.471797	0.958675	5.857356	-8.000000	1.849275	0.988128	
2	53	2	3.469569	0.932387	5.859875	-7.839983	1.848424	0.987260	
2	53	3	3.468913	0.906258	5.706711	-7.162258	1.865038	0.986348	
2	53	4	3.473071	0.881766	5.346321	-5.727664	1.906707	0.985413	
3	21	9	3.466711	0.886615	8.226813	2.513609	1.617803	0.977427	
3	22	1	3.470760	0.767246	5.757572	7.324509	1.846145	0.966632	
3	22	2	3.468419	0.780988	6.005064	6.592344	1.819754	0.968163	
3	22	3	3.467590	0.794803	6.291590	5.768939	1.790251	0.969587	
3	22	4	3.476123	0.811439	6.128767	4.934798	1.808341	0.970984	
3	22	5	3.478278	0.825104	6.479631	4.135738	1.772637	0.972090	
3	22	6	3.476254	0.844988	6.904973	3.720091	1.731900	0.973710	
3	22	7	3.472835	0.863957	7.465225	3.006926	1.681337	0.975344	
3	22	8	3.469057	0.884931					COALESCENCE
3	23	1	3.481045	0.762346	5.731884	7.300000	1.848557	0.965893	
3	23	2	3.480088	0.775108	5.975968	6.561640	1.822391	0.967374	
3	23	3	3.478159	0.789139	6.263664	5.733186	1.792697	0.968898	
3	23	4	3.483055	0.807654	6.329401	5.573826	1.787004	0.970590	
3	23	5	3.486951	0.820055	6.422453	3.995473	1.778139	0.971627	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
3	23	6	3.491510	0.835621	6.744879	3.315541	1.746800	0.972879
3	23	7	3.487611	0.854181	7.297419	2.601202	1.695830	0.974451
3	23	8	3.484679	0.873721	7.919171	1.801929	1.642535	0.976200
2	54	1	3.490847	0.942269	5.918475	-7.919299	1.842225	0.987679
2	54	2	3.489000	0.915737	5.921786	-7.759764	1.841264	0.986773
2	54	3	3.489111	0.889556	5.767165	-7.077285	1.857827	0.985795
3	23	9	3.481101	0.896180	8.478366	0.385840	1.599353	0.980108
3	24	1	3.490182	0.770027	5.950694	6.534506	1.824671	0.966656
3	24	2	3.489576	0.783024	6.235120	5.699114	1.795161	0.968120
3	24	3	3.493607	0.801936	6.301747	5.537059	1.789444	0.969957
3	24	4	3.493460	0.816263	6.630750	4.628659	1.756930	0.971256
3	24	5	3.500048	0.830367	6.687148	3.173500	1.752141	0.972411
3	24	6	3.502522	0.844299	7.133339	2.192536	1.710303	0.973573
3	24	7	3.499074	0.863376	7.746817	1.391624	1.656595	0.975246
3	24	8	3.496881	0.883710	8.482055	0.399980	1.597550	0.977920
2	55	1	3.512433	0.952315	5.978588	-8.000000	1.835941	0.988128
2	55	2	3.510112	0.925643	5.980924	-7.838638	1.835079	0.987207
2	55	3	3.508644	0.898868	5.985071	-7.679592	1.833991	0.986242
3	24	9	3.498706	0.907402	8.755548	-0.249388	1.578043	0.980768
3	25	1	3.500148	0.765015	5.923371	6.500000	1.827157	0.965893
3	25	2	3.499451	0.777740	6.210320	5.669042	1.797294	0.967418
3	25	3	3.505003	0.795764	6.273497	5.501841	1.791899	0.969236
3	25	4	3.503754	0.810304	6.603625	4.588552	1.759209	0.970642
3	25	5	3.506116	0.826630	6.901930	3.800503	1.731073	0.972061
3	25	6	3.510829	0.838782	7.074658	2.047626	1.715437	0.973085
3	25	7	3.513584	0.852933	7.578242	0.978059	1.670630	0.974311
3	25	8	3.510791	0.872704	8.304037	-0.016566	1.610856	0.976472
3	25	9	3.512241	0.896216	8.757196	-0.248658	1.576989	0.979429
2	56	1	3.531530	0.935712	6.041584	-7.918899	1.828798	0.987652
2	56	2	3.529588	0.908797	6.044761	-7.757988	1.827825	0.986699
3	25	10	3.517442	0.919302	8.812913	-0.369592	1.574026	0.981365
3	26	1	3.509201	0.772526	6.183392	5.631651	1.799638	0.966682
3	26	2	3.514859	0.790430	6.248952	5.470769	1.794024	0.968583
3	26	3	3.514867	0.803874	6.575999	4.549662	1.761489	0.969939
3	26	4	3.516192	0.820459	6.875332	3.757400	1.733213	0.971461
3	26	5	3.516465	0.835036	7.299449	2.668764	1.694480	0.972741
3	26	6	3.521631	0.847132	7.518506	0.829855	1.675549	0.973797
3	26	7	3.524792	0.861610	8.129909	-0.436666	1.624282	0.975270
3	26	8	3.526057	0.884785	8.577220	-0.666386	1.590073	0.978012
3	26	9	3.528896	0.909755	8.813152	-0.372851	1.573458	0.980571

Figure 8.- Continued.

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF
2	57	1	3.553217	0.945931	6.103568	-8.000000	1.822456	0.988128
2	57	2	3.550836	0.918890	6.105986	-7.837771	1.821555	0.987155
3	26	10	3.536482	0.931398	8.870533	-0.494375	1.570021	0.981971
3	27	1	3.519611	0.766961	6.454513	6.500000	1.770990	0.965893
3	27	2	3.524594	0.785165	6.222278	5.432450	1.796364	0.967905
3	27	3	3.524477	0.798316	6.551993	4.515383	1.763460	0.969302
3	27	4	3.527065	0.813801	6.848324	3.715209	1.735347	0.970782
3	27	5	3.526221	0.828579	7.273551	2.621566	1.696424	0.972134
3	27	6	3.526830	0.843381	7.754711	1.445063	1.654686	0.973454
3	27	7	3.532519	0.855479	8.068889	-0.589068	1.628918	0.974655
3	27	8	3.539956	0.873272	8.401164	-1.087836	1.603162	0.976681
3	27	9	3.542891	0.898081	8.633884	-0.788141	1.586574	0.979396
3	27	10	3.545846	0.923523	8.870720	-0.498088	1.569658	0.981468
2	58	1	3.572351	0.929134	6.168543	-7.918393	1.815214	0.987626
3	27	11	3.555794	0.943668	8.929529	-0.620068	1.565953	0.982603
3	28	1	3.534473	0.779825	6.493314	6.291726	1.767924	0.967172
3	28	2	3.533971	0.792828	6.525766	4.473904	1.765646	0.968640
3	28	3	3.536466	0.808046	6.824851	3.678046	1.737194	0.970167
3	28	4	3.536746	0.821613	7.247375	2.574882	1.698352	0.971455
3	28	5	3.536235	0.836613	7.729644	1.393296	1.656420	0.972830
3	28	6	3.537258	0.851714	8.319306	0.019841	1.608105	0.974281
3	28	7	3.547581	0.866946	8.339797	-1.241572	1.607625	0.975986
3	28	8	3.556968	0.886328	8.458529	-1.207110	1.599580	0.978145
3	28	9	3.560019	0.911600	8.692158	-0.910961	1.582794	0.980517
3	28	10	3.563063	0.937503	8.929664	-0.623761	1.565707	0.982262
3	28	11	3.558142	0.945160	8.929924	-0.619179	1.565922	0.982601
4	1	1	3.572204	0.943184	12.846466	-7.999999	1.306637	0.977806
4	1	2	3.572204	0.928909	12.846466	-7.999999	1.306637	0.977806
4	2	1	3.577926	0.934050	12.884805	-8.009601	1.304451	0.977806
3	29	1	3.552463	0.770197	5.933067	4.700000	1.826091	0.965893
3	29	2	3.543306	0.787433	6.807659	5.325401	1.737339	0.967935
3	29	3	3.545755	0.802361	6.799082	3.633736	1.739255	0.969531
3	29	4	3.545844	0.815592	7.224619	2.533788	1.700020	0.970845
3	29	5	3.546377	0.829314	7.704453	1.341595	1.658126	0.972139
3	29	6	3.546244	0.844583	8.295316	-0.037522	1.609577	0.973596
3	29	7	3.551907	0.863354	8.596011	-0.638112	1.586916	0.975592
3	29	8	3.564644	0.879909	8.397480	-1.360036	1.603994	0.977457
3	29	9	3.574273	0.899600	8.517500	-1.327461	1.595771	0.979424
3	29	10	3.577414	0.925324	8.751811	-1.034245	1.578811	0.981460
3	29	11	3.565161	0.939206	8.929887	-0.623113	1.565743	0.982339

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
3	30	1	3.561333	0.777103	6.230039	3.735604	1.794678	0.966617	
3	30	2	3.554519	0.796998	7.090180	4.476816	1.711119	0.968876	
3	30	3	3.554833	0.809642	7.199452	2.485584	1.701904	0.970215	
3	30	4	3.555141	0.823004	7.682551	1.296107	1.659604	0.971525	
3	30	5	3.555929	0.836894	8.271402	-0.095359	1.611015	0.972864	
3	30	6	3.560715	0.856041	8.572661	-0.697894	1.588227	0.974828	
3	30	7	3.568602	0.876597					COALESCENCE
3	31	1	3.570716	0.771657	6.541380	4.700000	1.762210	0.965893	
3	31	2	3.572768	0.785909	6.498040	2.891201	1.767692	0.967535	
3	31	3	3.563041	0.804210	7.504773	3.320839	1.673882	0.969588	
3	31	4	3.563802	0.816768	7.658105	1.243542	1.661298	0.970894	
3	31	5	3.564296	0.830247	8.250610	-0.146228	1.612268	0.972225	
3	31	6	3.570204	0.848157	8.549485	-0.758401	1.589507	0.974035	
3	31	7	3.577401	0.869232	8.631286	-0.823571	1.584637	0.976303	
3	31	8	3.582000	0.893086	8.456771	-1.479577	1.600173	0.978801	
3	31	9	3.591844	0.913072	8.577850	-1.448296	1.591757	0.980522	
3	31	10	3.579543	0.927003	8.752195	-1.033204	1.578858	0.981571	
4	2	2	3.577154	0.923190	12.613644	-8.519188	1.318920	0.976340	
4	3	1	3.585500	0.940878	12.921414	-8.000000	1.302368	0.977806	
4	3	2	3.582059	0.927422	12.617514	-8.480235	1.319192	0.977003	
3	31	1	3.570716	0.771657	6.541380	4.700000	1.762210	0.965893	
3	31	2	3.572768	0.785909	6.498040	2.891201	1.767692	0.967535	
3	31	3	3.563041	0.804210	7.504773	3.320839	1.673882	0.969588	
3	31	4	3.563802	0.816768	7.658105	1.243542	1.661298	0.970894	
3	31	5	3.564296	0.830247	8.250610	-0.146228	1.612268	0.972225	
3	31	6	3.570204	0.848157	8.549485	-0.758401	1.589507	0.974035	
3	31	7	3.577401	0.869232	8.631286	-0.823571	1.584637	0.976303	
3	31	8	3.582000	0.893086	8.456771	-1.479577	1.600173	0.978801	
3	31	9	3.591844	0.913072	8.577850	-1.448296	1.591757	0.980522	
4	3	3	3.588282	0.910341	12.414102	-8.947079	1.329700	0.975218	
4	4	1	3.589738	0.934053	12.654533	-8.469479	1.317387	0.977450	
4	4	2	3.591261	0.912824					COALESCENCE
4	5	1	3.595760	0.939272	12.395716	-8.000000	1.332704	0.977806	
4	5	2	3.599016	0.919290	12.454388	-8.909961	1.328082	0.976209	
3	32	1	3.581549	0.780515	6.819639	3.846823	1.735432	0.966838	
3	32	2	3.581137	0.792294	6.889893	1.734714	1.729606	0.968211	
3	32	3	3.571445	0.811263	7.979693	2.070842	1.633366	0.970291	
3	32	4	3.572563	0.823676	8.227111	-0.204147	1.613740	0.971579	
3	32	5	3.578400	0.841342	8.529336	-0.811604	1.590635	0.973361	
3	32	6	3.586879	0.861292	8.608416	-0.884102	1.585854	0.975468	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NU.	PT/PTINF
3	32	7	3.594378	0.882641	8.690424	-0.947601	1.581002	0.977732
3	32	8	3.599621	0.906460	8.517441	-1.599603	1.596158	0.979978
4	5	3	3.594812	0.902810	12.376172	-9.179201	1.331309	0.974392
4	6	1	3.605402	0.924638	12.199742	-8.433612	1.343454	0.976724
4	6	2	3.604415	0.910730	12.384283	-9.097837	1.331579	0.975393
3	33	1	3.594267	0.772771	6.717770	3.600000	1.744706	0.965893
3	33	2	3.589350	0.786840	7.227331	2.682386	1.697505	0.967532
3	33	3	3.589289	0.798450	7.338884	0.482860	1.688259	0.968876
3	33	4	3.579610	0.818071	8.569045	0.614656	1.585842	0.970989
3	33	5	3.586501	0.834600	8.506418	-0.871810	1.591993	0.972696
3	33	6	3.595066	0.854428	8.588535	-0.937314	1.586929	0.974762
3	33	7	3.603844	0.874647	8.667860	-1.008125	1.582192	0.976906
3	33	8	3.611619	0.896252	8.750954	-1.072030	1.577203	0.979040
4	6	3	3.605000	0.891026	12.738494	-8.692949	1.309342	0.973172
4	7	1	3.618716	0.935679	12.010200	-8.000000	1.355560	0.977806
4	7	2	3.610998	0.916172	12.130773	-8.617427	1.347020	0.976003
4	7	3	3.612636	0.897689	12.743721	-8.626003	1.309707	0.974057
3	34	1	3.601696	0.778695	7.123361	2.430724	1.706427	0.966537
3	34	2	3.596931	0.792930	7.694427	1.422487	1.656294	0.968215
3	34	3	3.597019	0.804234	7.895909	-0.977601	1.639906	0.969518
3	34	4	3.592999	0.829190	8.856654	-0.060654	1.564245	0.972138
3	34	5	3.603161	0.847636	8.565890	-0.997466	1.588238	0.974074
3	34	6	3.612021	0.867734	8.648246	-1.061321	1.583232	0.976195
3	34	7	3.621073	0.888200	8.728696	-1.132531	1.578396	0.978268
4	7	4	3.612914	0.881782	12.727371	-8.788451	1.309222	0.972164
4	8	1	3.624510	0.927238	11.942485	-8.179443	1.359142	0.977140
4	8	2	3.619338	0.903546	12.478941	-8.140574	1.325586	0.974784
4	8	3	3.619108	0.887168	12.732412	-8.734197	1.309502	0.972920
3	35	1	3.609730	0.773389	7.105662	2.400000	1.707634	0.965893
3	35	2	3.608859	0.784353	7.588111	1.165219	1.664868	0.967182
3	35	3	3.604066	0.798618	8.274073	-0.046505	1.608027	0.968871
3	35	4	3.610731	0.814416	8.170825	-1.647913	1.617704	0.970633
3	35	5	3.609161	0.842597	8.915478	-0.193009	1.560727	0.973548
3	35	6	3.620111	0.860890	8.625875	-1.121396	1.584501	0.975495
3	35	7	3.629239	0.881239	8.709351	-1.185697	1.579427	0.977586
4	8	4	3.619743	0.873791	12.718565	-8.873642	1.309058	0.971274
4	9	1	3.632263	0.933559	11.875321	-8.000000	1.363687	0.977806
4	9	2	3.632789	0.915169	12.281018	-7.698229	1.338169	0.976081
4	9	3	3.626030	0.893197	12.466908	-8.243603	1.325492	0.973718
4	9	4	3.624678	0.878071	12.722623	-8.829601	1.309296	0.971899

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
3	36	1	3.616584	0.778792	7.571336	1.130228	1.665881	0.966511	
3	36	2	3.615478	0.789540	8.164898	-0.310942	1.616227	0.967801	
3	36	3	3.617194	0.809026	8.558217	-0.724859	1.586038	0.970044	
3	36	4	3.627720	0.827003	8.231505	-1.768807	1.613666	0.971991	
3	36	5	3.625612	0.856233	8.974794	-0.323525	1.557229	0.975004	
3	36	6	3.637322	0.874343	8.687255	-1.245680	1.580674	0.976902	
4	9	5	3.626493	0.865878	12.705653	-8.965783	1.309131	0.970384	
4	10	1	3.640470	0.921766	12.209982	-7.517178	1.342902	0.976798	
4	10	2	3.639671	0.904944	12.268655	-7.795942	1.338186	0.975123	
4	10	3	3.631792	0.884249	12.456493	-8.334394	1.325380	0.972756	
4	10	4	3.630173	0.869060					COALESCENCE
4	11	1	3.650833	0.930652	12.551144	-8.000000	1.323638	0.977806	
4	11	2	3.647429	0.911584	12.197549	-7.612580	1.342960	0.975882	
4	11	3	3.645600	0.896104	12.257958	-7.881986	1.338170	0.974251	
4	11	4	3.637483	0.875379	12.442272	-8.432227	1.325468	0.971762	
3	37	1	3.623330	0.773933	8.064724	2.400000	1.623200	0.965893	
3	37	2	3.622836	0.783680	8.149331	-0.351189	1.617025	0.967103	
3	37	3	3.628451	0.799643	8.448186	-0.991510	1.594054	0.968987	
3	37	4	3.633629	0.822034	8.618195	-0.853067	1.582301	0.971466	
3	37	5	3.645002	0.839802	8.292722	-1.887987	1.609632	0.973371	
3	37	6	3.642324	0.870072	9.035522	-0.454278	1.553651	0.976460	
4	11	5	3.630945	0.860649	12.941442	-7.749989	1.295865	0.970700	
4	12	1	3.657570	0.920250	12.540044	-8.098147	1.323590	0.976876	
4	12	2	3.653425	0.902781	12.186795	-7.696564	1.342984	0.975053	
4	12	3	3.651461	0.887336	12.243569	-7.974956	1.338348	0.973346	
4	12	4	3.640973	0.869921	12.946298	-7.662913	1.296136	0.971422	
3	38	1	3.629002	0.778766	8.673935	0.909982	1.574442	0.966481	
3	38	2	3.635648	0.793636	8.433299	-1.034061	1.594765	0.968298	
3	38	3	3.644979	0.812492	8.508742	-1.118207	1.590237	0.970438	
3	38	4	3.650354	0.835264	8.678681	-0.979443	1.578560	0.972899	
3	38	5	3.662543	0.852792	8.355325	-2.007554	1.605526	0.974763	
4	12	5	3.647371	0.841557	12.003044	-9.372251	1.349171	0.968606	
4	13	1	3.666690	0.928170	12.528823	-8.000000	1.324935	0.977806	
4	13	2	3.663373	0.911256	12.530461	-8.184559	1.323532	0.976052	
4	13	3	3.659355	0.894048	12.172395	-7.787419	1.343200	0.974192	
4	13	4	3.654631	0.882580	12.733048	-7.205409	1.309449	0.972898	
4	13	5	3.654884	0.847525	12.012321	-9.309135	1.349166	0.969347	
3	39	1	3.634511	0.774381	8.710587	1.000000	1.571166	0.965893	
3	39	2	3.641126	0.789062	8.970513	0.217086	1.552455	0.967735	
3	39	3	3.652164	0.806446	8.494104	-1.160783	1.590938	0.969775	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
3	39	4	3.661800	0.825561	8.569811	-1.243060	1.586404	0.971882	
3	39	5	3.667339	0.848691	8.740570	-1.106085	1.574746	0.974342	
4	13	6	3.651843	0.836441	12.564994	-8.485009	1.315514	0.968049	
4	14	1	3.672526	0.919182	12.519378	-8.084775	1.324870	0.976982	
4	14	2	3.669112	0.902331	12.517143	-8.277864	1.323675	0.975206	
4	14	3	3.662329	0.889656	12.655986	-7.018246	1.314539	0.973760	
4	14	4	3.669725	0.859341	11.824344	-8.836235	1.361595	0.970778	
4	14	5	3.658376	0.842119	12.568720	-8.424502	1.315862	0.968797	
3	40	1	3.646464	0.784600	9.008872	0.304496	1.549146	0.967170	
3	40	2	3.656905	0.802453	9.030064	0.079855	1.549047	0.969305	
3	40	3	3.668971	0.819475	8.555422	-1.285638	1.587091	0.971236	
3	40	4	3.678879	0.838825	8.632281	-1.368183	1.582491	0.973327	
4	14	6	3.661468	0.825304	12.434318	-8.791702	1.322177	0.966764	
4	15	1	3.680416	0.926022	12.509682	-8.000000	1.326048	0.977806	
4	15	2	3.678300	0.910259	12.506226	-8.176397	1.325018	0.976153	
4	15	3	3.671719	0.898264	13.014253	-7.511233	1.294844	0.974809	
4	15	4	3.678014	0.865916	11.757640	-8.641531	1.366251	0.971578	
4	15	5	3.672839	0.854708	12.365241	-7.951543	1.328919	0.970336	
4	15	6	3.666335	0.829438	12.438693	-8.747576	1.322378	0.967372	
3	40	1	3.646464	0.784600	9.008872	0.304496	1.549146	0.967170	
3	40	2	3.656905	0.802453	9.030064	0.079855	1.549047	0.969305	
3	40	3	3.668971	0.819475	8.555422	-1.285638	1.587091	0.971236	
4	15	7	3.667495	0.818331	12.431188	-8.863994	1.321741	0.965943	
4	16	1	3.686220	0.917102	12.496668	-8.090208	1.326185	0.976973	
4	16	2	3.680654	0.906610	12.999884	-7.410350	1.296408	0.975803	
4	16	3	3.687292	0.873272	12.094694	-9.137396	1.346566	0.972489	
4	16	4	3.680903	0.861682	12.292214	-7.757320	1.333853	0.971177	
4	16	5	3.681145	0.842036	12.238160	-8.266235	1.335452	0.969038	
4	16	6	3.671288	0.821548					COALESCENCE
4	17	1	3.694065	0.923885	12.483435	-8.000000	1.327577	0.977806	
4	17	2	3.688356	0.913809	12.987384	-7.324762	1.297760	0.976658	
4	17	3	3.696784	0.880909	12.086829	-9.029906	1.347733	0.973427	
4	17	4	3.689814	0.869376	12.643646	-8.255698	1.314019	0.972119	
4	17	5	3.689363	0.848986	12.166416	-8.068279	1.340376	0.969923	
4	17	6	3.686255	0.834241	12.233881	-8.341615	1.335069	0.968189	
3	41	1	3.657946	0.775000	8.563772	-0.700000	1.582695	0.965893	
3	41	2	3.662168	0.798017	9.068486	0.166103	1.545772	0.968771	
3	41	3	3.672975	0.816075	9.090090	-0.055327	1.545611	0.970851	
4	17	7	3.670934	0.814344	12.981132	-7.287860	1.290156	0.966166	
4	18	1	3.695985	0.920943	12.971092	-7.235223	1.299332	0.977519	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
4	18	2	3.704966	0.887504	12.079858	-8.938573	1.348747	0.974233	
4	18	3	3.699025	0.877468	12.632047	-8.148877	1.315429	0.973101	
4	18	4	3.698037	0.856312	12.516635	-8.570317	1.320439	0.970849	
4	18	5	3.694534	0.841228	12.162043	-8.141472	1.340037	0.969121	
4	18	6	3.688409	0.830943	12.987540	-7.131029	1.291121	0.967908	
3	42	1	3.674167	0.787896	8.624804	-0.830671	1.579030	0.967530	
3	42	2	3.678161	0.811665	9.128572	0.029798	1.542367	0.970342	
4	18	7	3.675332	0.809250	13.043965	-7.213564	1.286114	0.965544	
4	19	1	3.698405	0.923206	13.480148	-8.000000	1.271086	0.977806	
4	19	2	3.713079	0.894054	12.069270	-8.843192	1.349973	0.975033	
4	19	3	3.706965	0.884452	12.621890	-8.058237	1.316649	0.973944	
4	19	4	3.707360	0.864319	12.506076	-8.460460	1.321800	0.971842	
4	19	5	3.703028	0.848387	12.513531	-8.646053	1.320024	0.970056	
4	19	6	3.696342	0.838506	12.906034	-6.932510	1.296474	0.968846	
4	19	7	3.691989	0.825236	13.055223	-7.071238	1.286877	0.967374	
3	43	1	3.690986	0.773721	7.885418	-2.600000	1.638287	0.965893	
3	43	2	3.690681	0.801015	8.686335	-0.959355	1.575315	0.969109	
4	19	8	3.685778	0.797120	12.437111	-8.247902	1.319935	0.964014	
4	20	1	3.714602	0.895286					COALESCENCE
4	21	1	3.740910	0.916553	11.725276	-8.000000	1.372811	0.977806	
4	21	2	3.714837	0.891383	12.607990	-7.963637	1.318081	0.974780	
4	21	3	3.715394	0.871230	12.496798	-8.367246	1.322977	0.972689	
4	21	4	3.712379	0.856404	12.503089	-8.534451	1.321395	0.971070	
4	21	5	3.704414	0.846177	13.278788	-7.439154	1.276180	0.969828	
4	21	6	3.699934	0.832888	12.972622	-6.871310	1.292262	0.968292	
4	21	7	3.701172	0.810504	12.453894	-8.115839	1.320315	0.965818	
3	44	1	3.708420	0.785937	7.948979	-2.715431	1.633971	0.967430	
4	21	8	3.700414	0.780327	11.431760	-10.074808	1.379197	0.961874	
4	22	1	3.741867	0.915199	12.237520	-7.124442	1.341920	0.977674	
4	22	2	3.723365	0.878094	12.483775	-8.270066	1.324362	0.973524	
4	22	3	3.720438	0.863323	12.493905	-8.439779	1.322576	0.971930	
4	22	4	3.713355	0.854858	13.262514	-7.329151	1.277919	0.970913	
4	22	5	3.707837	0.840474	13.348592	-7.380139	1.271840	0.969245	
4	22	6	3.709523	0.817795	12.379031	-7.910354	1.325420	0.966759	
4	22	7	3.714061	0.790388	11.450779	-9.950872	1.379211	0.963493	
4	22	8	3.707267	0.772564	11.461086	-10.126744	1.377290	0.961772	
5	1	1	3.717814	0.771697	15.092338	-4.699999	1.171103	0.959732	
5	1	2	3.717814	0.783049	15.092338	-4.699999	1.171103	0.959732	
5	2	1	3.721188	0.776330	15.120668	-4.704359	1.169645	0.959732	
4	23	1	3.743038	0.916220	12.773418	-8.000000	1.310815	0.977806	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
4	23	2	3.751040	0.901951	12.118232	-7.416397	1.348066	0.976407	
4	23	3	3.728435	0.870197	12.480959	-8.341146	1.323965	0.972774	
4	23	4	3.721061	0.862342	13.248368	-7.236027	1.279411	0.971832	
4	23	5	3.716761	0.849231	13.331781	-7.269046	1.273614	0.970339	
4	23	6	3.717307	0.824578	12.739288	-8.422084	1.305115	0.967638	
4	23	7	3.723053	0.797048	11.387960	-9.737108	1.383886	0.964498	
4	23	8	3.719768	0.781791	11.474140	-10.002898	1.377244	0.962806	
4	24	1	3.751698	0.902513					COALESCENCE
4	25	1	3.763932	0.912950	12.529530	-8.000000	1.324894	0.977806	
4	25	2	3.756378	0.894241	12.114742	-7.479299	1.347731	0.975672	
4	25	3	3.728707	0.869770	13.230290	-7.139087	1.281109	0.972732	
4	25	4	3.724451	0.856779	13.317177	-7.175034	1.275140	0.971271	
4	25	5	3.726610	0.832836	12.727409	-8.306312	1.306599	0.968694	
4	25	6	3.730726	0.802732	11.723351	-10.251980	1.363719	0.965335	
4	25	7	3.728817	0.788501	11.410999	-9.786302	1.381845	0.963690	
5	2	2	3.726602	0.791785	14.951492	-4.402714	1.180243	0.962048	
5	3	1	3.723557	0.771587	15.147164	-4.700000	1.168283	0.959732	
5	3	2	3.729034	0.787149	14.949492	-4.429820	1.179824	0.961399	
4	26	1	3.769063	0.905046	12.527482	-8.065436	1.324435	0.977031	
4	26	2	3.755381	0.895686	12.830937	-6.297386	1.305824	0.975542	
4	26	3	3.732083	0.864273	13.298610	-7.077230	1.276873	0.972183	
4	26	4	3.734627	0.839962	12.716984	-8.208223	1.307883	0.969597	
4	26	5	3.740635	0.810176	11.719041	-10.129045	1.364766	0.966388	
4	26	6	3.736282	0.794040	11.748451	-10.304380	1.361536	0.964468	
5	3	3	3.733412	0.798531	15.419003	-4.938016	1.156988	0.962919	
5	4	1	3.731454	0.782523	14.974759	-4.423581	1.178144	0.960936	
5	4	2	3.734985	0.795197					COALESCENCE
5	5	1	3.738149	0.769659	13.123069	-6.800000	1.277168	0.959732	
5	5	2	3.737249	0.790398	15.447000	-4.953687	1.154789	0.961962	
4	27	1	3.775993	0.911062	12.525072	-8.000000	1.325153	0.977806	
4	27	2	3.767581	0.907337	13.270198	-6.892715	1.281987	0.976825	
4	27	3	3.758824	0.890528	12.894596	-6.230755	1.301835	0.975069	
4	27	4	3.742587	0.847045	12.702705	-8.106250	1.309376	0.970483	
4	27	5	3.749175	0.816608	11.715059	-10.024688	1.365669	0.967274	
4	27	6	3.746211	0.801510	11.744172	-10.179174	1.362580	0.965518	
5	5	3	3.742307	0.807577	15.409559	-4.797203	1.158445	0.964124	
5	6	1	3.744160	0.775614	13.499349	-7.310636	1.256677	0.960459	
5	6	2	3.745128	0.801668	15.407169	-4.833509	1.158001	0.963427	
4	28	1	3.774204	0.913816	13.266460	-6.832323	1.282747	0.977552	
4	28	2	3.770830	0.902105	13.337234	-6.828249	1.277893	0.976348	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
4	28	3	3.770933	0.872289	12.330022	-7.236413	1.333272	0.973385	
4	28	4	3.757661	0.823014	11.707419	-9.916294	1.366778	0.968138	
4	28	5	3.754766	0.807965	11.740205	-10.072920	1.363489	0.966414	
5	6	3	3.749968	0.815382	15.374716	-4.708846	1.161072	0.965182	
5	7	1	3.748421	0.768221	13.893775	-6.800000	1.234468	0.959732	
5	7	2	3.753174	0.784760	13.482991	-7.190704	1.258489	0.961624	
5	7	3	3.751927	0.811335	15.373264	-4.732876	1.160754	0.964699	
4	29	1	3.772025	0.911683	14.059879	-8.000000	1.239575	0.977806	
4	29	2	3.777436	0.908633	13.333202	-6.767345	1.278668	0.977075	
4	29	3	3.782789	0.882726	12.756898	-7.836993	1.309346	0.974584	
4	29	4	3.788530	0.846368	11.383900	-9.011247	1.388947	0.971019	
4	29	5	3.763270	0.814397	11.732555	-9.962644	1.364610	0.967292	
5	7	4	3.757585	0.823137	15.335810	-4.616782	1.163889	0.966220	
5	8	1	3.757237	0.777776	13.873735	-6.678994	1.236477	0.960904	
5	8	2	3.760950	0.792653	13.468711	-7.089352	1.260081	0.962654	
5	8	3	3.758684	0.820898					COALESCENCE
5	9	1	3.763655	0.766361	13.004963	-8.000000	1.283865	0.959732	
5	9	2	3.764842	0.786016	13.856329	-6.576898	1.238242	0.961946	
5	9	3	3.768695	0.800516	13.450755	-6.984899	1.261886	0.963698	
4	29	1	3.772025	0.911683	14.059879	-8.000000	1.239575	0.977806	
4	29	2	3.777436	0.908633	13.333202	-6.767345	1.278668	0.977075	
4	29	3	3.782789	0.882726	12.756898	-7.836993	1.309346	0.974584	
4	29	4	3.788530	0.846368	11.383900	-9.011247	1.388947	0.971019	
5	9	4	3.785217	0.851248	11.559885	-8.677085	1.378322	0.971464	
5	10	1	3.771707	0.773912	12.994433	-7.894368	1.285209	0.960700	
5	10	2	3.772417	0.794220	13.835146	-6.471833	1.240226	0.963009	
5	10	3	3.799058	0.831340	13.103816	-6.176576	1.285170	0.968735	
4	30	1	3.774970	0.906195					COALESCENCE
4	31	1	3.779359	0.910535	14.175045	-8.000000	1.233421	0.977806	
4	31	2	3.789660	0.888904	12.755718	-7.772669	1.309942	0.975287	
4	31	3	3.800235	0.855201	11.785251	-9.615476	1.364958	0.972108	
5	10	4	3.795690	0.862371	12.035689	-9.152184	1.350294	0.972752	
5	11	1	3.777263	0.764673	12.981228	-8.000000	1.285216	0.959732	
5	11	2	3.779731	0.781445	12.980312	-7.785573	1.286763	0.961676	
5	11	3	3.802199	0.826454	13.464397	-5.661477	1.264510	0.968075	
5	11	4	3.809267	0.841518	13.567745	-6.797392	1.260462	0.970228	
4	32	1	3.790418	0.889586					COALESCENCE
4	33	1	3.808606	0.905957	13.007786	-8.000000	1.297470	0.977806	
4	33	2	3.807537	0.860803	11.788544	-9.545720	1.365260	0.972787	
5	11	5	3.802208	0.869180	12.073973	-9.017184	1.348580	0.973532	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
5	12	1	3.785325	0.772214	12.967293	-7.888978	1.286766	0.960715	
5	12	2	3.811627	0.811412	12.659593	-6.953248	1.308632	0.966209	
5	12	3	3.812035	0.836856	13.944015	-6.285607	1.239487	0.969635	
5	12	4	3.815852	0.848266	13.565497	-6.733840	1.261298	0.971154	
4	34	1	3.827113	0.875850	12.032796	-9.766949	1.352002	0.974823	
5	12	5	3.819839	0.887683	12.412716	-9.072492	1.330360	0.975994	
5	13	1	3.791080	0.762677	12.952485	-8.000000	1.286854	0.959732	
5	13	2	3.817544	0.802375	12.646550	-7.044602	1.308570	0.965131	
5	13	3	3.821439	0.820523	13.109481	-7.578275	1.283988	0.967607	
5	13	4	3.818470	0.843878	13.939765	-6.222071	1.240487	0.970627	
5	13	5	3.833355	0.866213	13.837452	-6.971139	1.248314	0.973587	
5	13	6	3.819839	0.887683	12.412716	-9.072492	1.330360	0.975994	
6	1	1	3.827749	0.886571	13.090233	-7.999999	1.291437	0.975979	
6	1	2	3.827749	0.874339	13.090233	-7.999999	1.291437	0.975979	
6	2	1	3.832506	0.878735	13.126015	-8.009051	1.289423	0.975979	
5	14	1	3.823638	0.793033	12.631828	-7.142751	1.308604	0.964052	
5	14	2	3.827092	0.811214	13.098219	-7.673572	1.283757	0.966473	
5	14	3	3.828240	0.826994	13.109716	-7.511306	1.284714	0.968575	
5	14	4	3.835502	0.862464					COALESCENCE
5	15	1	3.848787	0.754342	12.295726	-8.000000	1.325025	0.959732	
5	15	2	3.832912	0.801588	13.085313	-7.775920	1.283608	0.965326	
5	15	3	3.833916	0.817687	13.098619	-7.605087	1.284479	0.967447	
5	15	4	3.846083	0.843986	13.393777	-7.768913	1.270681	0.971011	
5	15	5	3.833355	0.866213	13.837453	-6.971138	1.248315	0.973588	
6	2	2	3.832938	0.865586	13.840330	-6.950117	1.248094	0.973504	
6	3	1	3.854168	0.898826	13.256631	-8.000000	1.282104	0.975979	
6	3	2	3.837540	0.870402	13.869984	-6.949370	1.247270	0.974520	
5	15	1	3.848787	0.754342	12.295726	-8.000000	1.325025	0.959732	
5	15	2	3.832912	0.801588	13.085313	-7.775920	1.283608	0.965326	
5	15	3	3.833916	0.817687	13.098619	-7.605087	1.284479	0.967447	
5	15	4	3.846083	0.843986	13.393777	-7.768913	1.270681	0.971011	
6	3	3	3.846557	0.844437	13.412735	-7.791398	1.269679	0.971076	
6	4	1	3.858196	0.892054	14.000219	-6.942050	1.241137	0.975678	
6	4	2	3.850302	0.848076					COALESCENCE
6	5	1	3.863234	0.897407	14.797046	-8.000000	1.199317	0.975979	
6	5	2	3.871410	0.868582	13.549711	-7.742582	1.264081	0.973648	
5	16	1	3.857038	0.761515	12.745988	-8.650226	1.299505	0.960781	
5	16	2	3.839760	0.808063	13.085897	-7.705812	1.284315	0.966293	
5	16	3	3.851627	0.834507	13.384123	-7.862546	1.270365	0.969900	
6	5	3	3.852094	0.834951	13.520220	-8.058646	1.262879	0.969965	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	COALESCENCE
6	6	1	3.875205	0.872317					
6	7	1	3.895557	0.892348	13.890482	-8.000000	1.247285	0.975979	
6	7	2	3.876865	0.859123	13.543282	-7.828744	1.263757	0.972763	
5	17	1	3.862551	0.752354	13.219163	-8.000000	1.271751	0.959732	
5	17	2	3.864104	0.767802	12.748928	-8.572507	1.300039	0.961701	
5	17	3	3.857337	0.824702	13.372900	-7.963104	1.270101	0.968743	
6	7	3	3.857756	0.825098	13.509364	-8.160408	1.262583	0.968801	
6	8	1	3.900852	0.882677	13.885889	-8.085477	1.246917	0.975179	
6	8	2	3.882550	0.849222	13.533310	-7.925395	1.263550	0.971778	
5	18	1	3.869441	0.758970	13.219723	-7.921240	1.272456	0.960684	
5	18	2	3.881390	0.783208	13.037706	-8.827837	1.285269	0.963977	
6	8	3	3.881605	0.783400	13.041317	-8.831012	1.285086	0.964005	
6	9	1	3.908443	0.890330	13.881247	-8.000000	1.247784	0.975979	
6	9	2	3.906374	0.872547	13.877820	-8.181347	1.246675	0.974298	
6	9	3	3.906992	0.806468	13.201665	-8.776307	1.278471	0.967178	
5	19	1	3.874294	0.750658	13.219679	-8.000000	1.271722	0.959732	
5	19	2	3.886133	0.775023	13.517396	-8.177639	1.257672	0.963024	
6	9	4	3.886197	0.775084	13.518543	-8.178620	1.257615	0.963033	
6	10	1	3.913993	0.880207	13.873341	-8.094040	1.247544	0.975111	
6	10	2	3.930476	0.828128	13.549061	-9.027382	1.261248	0.969912	
6	10	3	3.911003	0.799454	13.680879	-8.123921	1.251292	0.966399	
5	20	1	3.890853	0.766562	13.519009	-8.256285	1.256819	0.962041	
6	10	4	3.890968	0.766672	13.659170	-8.457939	1.249106	0.962058	
6	11	1	3.921950	0.888216	13.865481	-8.000000	1.248637	0.975979	
6	11	2	3.938350	0.835581	13.547224	-8.931385	1.262050	0.970823	
6	11	3	3.933735	0.822129	14.038361	-8.374992	1.234138	0.969296	
6	11	4	3.915610	0.791081	13.686923	-8.192576	1.250231	0.965459	
6	11	5	3.890968	0.766672	13.521094	-8.258062	1.256717	0.962058	
7	1	1	3.896900	0.765838	13.699739	-7.999999	1.246880	0.962058	
7	1	2	3.896900	0.772582	13.699739	-7.999999	1.246880	0.962058	
7	2	1	3.899275	0.768240	13.723915	-8.006380	1.245555	0.962058	
6	12	1	3.946582	0.843386	13.542120	-8.828251	1.263048	0.971756	
6	12	2	3.941402	0.829999	14.033499	-8.277911	1.235155	0.970267	
6	12	3	3.938180	0.813591	14.046533	-8.442839	1.232999	0.968399	
6	12	4	3.915689	0.790937	13.683725	-8.198524	1.250394	0.965443	
7	2	2	3.915560	0.791173	13.865114	-7.938595	1.240519	0.965470	
7	3	1	3.911811	0.745238	13.881674	-8.000000	1.236951	0.962058	
7	3	2	3.917799	0.787022	13.861349	-7.981919	1.240318	0.964950	
6	12	1	3.946582	0.843386	13.542120	-8.828251	1.263048	0.971756	
6	12	2	3.941402	0.829999	14.033499	-8.277911	1.235155	0.970267	

Figure 8.- Continued.

THREE-DIMENSIONAL AXISYMMETRIC METHOD OF CHARACTERISTICS. INTERNAL CASE. 03/12/65

CASE 14A 12.5 DEGREE CONE M=3.00

REG	RAY	POINT	X	R	P/PINF	DELTA(DEG)	MACH NO.	PT/PTINF	
6	12	3	3.938180	0.813591	14.046533	-8.442839	1.232999	0.968399	
7	3	3	3.938016	0.813906	14.228766	-8.190490	1.223267	0.968432	
7	4	1	3.930108	0.764149	14.021526	-7.968120	1.230523	0.963514	
7	4	2	3.940066	0.809879	14.225535	-8.231911	1.223097	0.967996	
6	13	1	3.983625	0.878563	13.263769	-8.000000	1.281705	0.975979	
6	13	2	3.949417	0.838235	14.025102	-8.173810	1.236375	0.971256	
6	13	3	3.945866	0.821482	14.041740	-8.343852	1.234034	0.969397	
7	4	3	3.945660	0.821875	14.223049	-8.091843	1.224358	0.969437	
7	5	1	3.942338	0.740829	14.159369	-8.000000	1.221965	0.962058	
7	5	2	3.951752	0.786868	14.394750	-8.216394	1.212508	0.965967	
7	5	3	3.947680	0.817935					COALESCENCE
7	6	1	3.963357	0.763306	14.541936	-8.246554	1.203307	0.964161	
7	6	2	3.959370	0.795137	14.387199	-8.109898	1.213657	0.966917	
6	14	1	3.985521	0.875371	13.719533	-7.343006	1.256326	0.975668	
6	14	2	3.953903	0.829743	14.033393	-8.237787	1.235273	0.970411	
7	6	3	3.953652	0.830218	14.403072	-7.731675	1.215601	0.970457	
7	7	1	3.976456	0.735901	14.940835	-8.000000	1.180803	0.962058	
7	7	2	3.970979	0.771759	14.533637	-8.133929	1.204411	0.965001	
7	7	3	3.967164	0.803605	14.374874	-7.997150	1.215086	0.967903	
6	15	1	3.987994	0.877879	14.195140	-8.000000	1.230938	0.975979	
6	15	2	3.990255	0.867142	13.726879	-7.395654	1.255307	0.974861	
7	7	4	3.989565	0.868342	14.080280	-6.388558	1.236298	0.974977	
7	8	1	3.983968	0.744814	14.929693	-7.379297	1.182050	0.962891	
7	8	2	3.978782	0.780423	14.520405	-8.015011	1.205824	0.965905	
7	8	3	4.003580	0.843189	14.045788	-7.120612	1.236245	0.972520	
6	16	1	3.992454	0.869373					COALESCENCE
7	8	4	3.997301	0.876422	14.091311	-6.373320	1.235707	0.974977	

END OF BODY HAS BEEN REACHED. CASE TERMINATED.

Figure 8.- Concluded.

		CASE	14A	12.5 DEGREE	CONE M=3.00		1
0.0	23.0	16.0			3.0		2
3.00	1.4	24.0	23.3				3
0.000001	5.	0.001					4
0.	2.375	3.300	3.325	3.350	3.375	3.400	5A
3.425	3.450	3.475	3.500	3.525	3.550	3.575	5A
3.600	3.625	3.650	3.675	3.700	3.725	3.750	5A
3.775	4.000						5A
0	.526	.730	.7355	.7405	.745	.750	6
.754	.7575	.7615	.765	.7675	.770	.772	6
.773	.774	.775	.775	.773	.7715	.768	6
.765	.7325						6
12.5	12.5	12.15	11.5	10.85	10.2	9.5	7
8.8	8.1	7.3	6.5	5.63	4.7	3.6	7
2.4	1.0	-.7	-2.6	-4.7	-6.8	-8.0	7
-8.0							7
2.375	2.775	2.825	2.875	2.925	2.975	3.025	8A
3.075	3.125	3.175	3.225	3.275	3.325	3.375	8A
3.425	4.000						8A
1.000	1.000	1.000	.999	.998	.9975	.997	9
.995	.993	.990	.987	.984	.979	.973	9
.966	.876						9
0	0	-.3	-.7	-1.1	-1.5	-2.0	10
-2.5	-3.1	-3.8	-4.4	-5.3	-6.3	-7.5	10
-8.0							10
0.1	0.02216	2.75	2.60	5.25	12.5	2.0	11

Figure 9.- Sample input.

```
            EF3150                                                          03/12/65
         EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

C SPLOT    SORENSEN, EMC.  SPECIAL PLOT SUBROUTINE.                     SPLOT002
C       NASA, AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.               SPLOT003
        SUBROUTINE SPLOT(L,XX,YY)                                       SPLOT004
        DIMENSION X(100),Y(100),               XC(500),XA(500),YMC(500), SPLOT005
       1          YPC(500),YMA(500),         YPA(500),ORGX( 5),ORGY( 5), SPLOT006
       2SFX( 5),SFY( 5),SZX( 5),SZY( 5)                                 SPLOT007
        DIMENSION YMIN(5)                                                    008
        GO TO (1,2,3,4,2,6,7,8,9,10),L                                  SPLOT009   ,1
     10 RETURN                                                          SPLOT010   ,2
      1 NTAPE=7                                                         SPLOT011   ,3
        REWIND NTAPE                                                    SPLOT012   ,4
        I=0                                                             SPLOT013   ,5
        K=0                                                             SPLOT014   ,6
        IC=0                                                            SPLOT015   ,7
        IA=0                                                            SPLOT016   ,8
        RETURN                                                          SPLOT017   ,9
      2 IF (I) 20,20,21                                                 SPLOT018   ,10
     21 CALL PLOTWS(ORGX(1),ORGY(1),SFX(1),SFY(1),X(1),Y(1),I,NTAPE,12,N) SPLOT019 ,11
        I=0                                                             SPLOT020   ,12
     20 IF (IC) 25,25,24                                                SPLOT021   ,13
     24 CALL PLOTWS(ORGX(2),ORGY(2),SFX(2),SFY(2),XC,YMC,IC,NTAPE,15,N) SPLOT022   ,14
        CALL PLOTWS(ORGX(3),ORGY(3),SFX(3),SFY(3),XC,YPC,IC,NTAPE,16,N) SPLOT023   ,15
        IC=0                                                            SPLOT024   ,16
     25 IF (IA) 22,22,26                                                SPLOT025   ,17
     26 CALL PLOTWS(ORGX(4),ORGY(4),SFX(4),SFY(4),XA,YMA,IA,NTAPE,15,N) SPLOT026   ,18
        CALL PLOTWS(ORGX(5),ORGY(5),SFX(5),SFY(5),XA,YPA,IA,NTAPE,16,N) SPLOT027   ,19
        IA=0                                                            SPLOT028   ,20
     22 IF (K) 23,23,27                                                 SPLOT029   ,21
     23 K=1                                                             SPLOT030   ,22
        GO TO 28                                                        SPLOT031   ,23
     27 END FILE NTAPE                                                  SPLOT032   ,24
        K=K+1                                                           SPLOT033   ,25
     28 IF (L .NE. 2) GO TO 31                                          SPLOT034   ,26   ,27   ,28
     30 READ  (5,100)(ORGX(J),ORGY(J),SFX(J),SFY(J),SZX(J),SZY(J),      SPLOT035
      1   YMIN(J),J=1,5)                                                     036   ,29   ,30   ,31   ,32   ,33
        CALLPLTAL(-3.0,-14.0,0.2,XX,72,NTAPE,1)                              037   ,34
        END FILE NTAPE                                                       038   ,35
        XMIN=0.                                                              039   ,36
        IF (ORGX(1) .GE.(-14.0))GO TO 50                                     040   ,37   ,38   ,39
        XMIN=(-14.0-ORGX(1))*SFX(1)                                          041   ,40
 50     J=1                                                             SPLOT042   ,41
```

Figure 10.- Sample plot program.

```
            EF3150                                                           03/12/65
      EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

      JX=(SZX(1)-XMIN)/SFX(1)                                         043    ,42
      CALL PSCALE(ORGX(J),ORGY(J),SFX(J),SFY(J),JX,0,XMIN,0,NTAPE) SPLOT044  ,43
      OXP=ORGX(1) + SZX(1)/SFX(1) +1.0                                045    ,44
      OXM=OXP+1.0                                                     046    ,45
      DO 49 J=2,4,2                                                   047    ,46
       OYM=ORGY(J  ) + YMIN(J  )/SFY(J  )                             048    ,47
      JYM=(SZY(J) - YMIN(J ))/SFY(J)                                  049    ,48
      JYP=(SZY(J+1)-YMIN(J+1))/SFY(J+1)                               050    ,49
      CALL PSCALE(OXP,ORGY(J+1),SFX(J+1),SFY(J+1),0,JYP,0,YMIN(J+1),  051
    1  NTAPE)                                                         052    ,50
      CALL PSCALE(OXM,OYM      ,SFX(J  ),SFY(J  ),0,JYM,0,YMIN(J  ),  053
    1  NTAPE)                                                         054    ,51
 49 CONTINUE                                                     SPLOT055    ,52    ,53
 32 RETURN                                                       SPLOT056    ,54
 31 K=K-1                                                        SPLOT057    ,55
    WRITE (6,101)K                                               SPLOT058    ,56    ,57    ,58
    CALL EXIT                                                    SPLOT059    ,59
  3 IF (XX-SZX(1)) 34,34,32                                      SPLOT060    ,60
 34 IF (YY-SZY(1)) 35,35,32                                      SPLOT061    ,61
 35 IF (XX .LT. XMIN ) GO TO 32                                       062    ,62    ,63    ,64
    I=I+1                                                        SPLOT063    ,65
    X(I)=XX                                                      SPLOT064    ,66
    Y(I)=YY                                                      SPLOT065    ,67
    IF (I-100) 32,36,36                                          SPLOT066    ,68
 36 CALL PLOTWS(ORGX(1),ORGY(1),SFX(1),SFY(1),X,Y,I,NTAPE,12,N)  SPLOT067    ,69
    I=0                                                          SPLOT068    ,70
    RETURN                                                       SPLOT069    ,71
  4 CALL PLOTWS(ORGX(1),ORGY(1),SFX(1),SFY(1),X,Y,I,NTAPE,17,N)  SPLOT070    ,72
    I=0                                                          SPLOT071    ,73
    RETURN                                                       SPLOT072    ,74
  6 IC=IC+1                                                      SPLOT073    ,75
    XC(IC)=XX                                                    SPLOT074    ,76
    IF (XX-SZX(2)) 33,33,38                                      SPLOT075    ,77
 38 XC(IC)=SZX(2)                                                SPLOT076    ,78
 33 YMC(IC)=YY                                                   SPLOT077    ,79
    IF (YY-SZY(2)) 32,32,40                                      SPLOT078    ,80
 40 YMC(IC)=SZY(2)                                               SPLOT079    ,81
    GO TO 32                                                     SPLOT080    ,82
  7 YPC(IC)=YY                                                   SPLOT081    ,83
    IF (YY-SZY(3)) 39,39,41                                      SPLOT082    ,84
 41 YPC(IC)=SZY(3)                                               SPLOT083    ,85
 39 IF (IC-500) 32,42,42                                         SPLOT084    ,86
```

Figure 10.- Continued.

```
      EF3150                                                                   03/12/65
    EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)

 42 CALL PLOTWS(ORGX(2),ORGY(2),SFX(2),SFY(2),XC,YMC,IC,NTAPE,15,N)    SPLOT085    ,87
    CALL PLOTWS(ORGX(3),ORGY(3),SFX(3),SFY(3),XC,YPC,IC,NTAPE,16,N)    SPLOT086    ,88
    IC=0                                                               SPLOT087    ,89
    GO TO 32                                                           SPLOT088    ,90
  8 IA=IA+1                                                            SPLOT089    ,91
    XA(IA)=XX                                                          SPLOT090    ,92
    IF (XX-SZX(4)) 43,43,44                                            SPLOT091    ,93
 44 XA(IA)=SZX(4)                                                      SPLOT092    ,94
 43 YMA(IA)=YY                                                         SPLOT093    ,95
    IF (YY-SZY(4)) 32,32,46                                            SPLOT094    ,96
 46 YMA(IA)=SZY(4)                                                     SPLOT095    ,97
    GO TO 32                                                           SPLOT096    ,98
  9 YPA(IA)=YY                                                         SPLOT097    ,99
    IF (YY-SZY(5)) 45,45,47                                            SPLOT098    ,100
 47 YPA(IA)=SZY(5)                                                     SPLOT099    ,101
 45 IF (IA-500) 32,48,48                                               SPLOT100    ,102
 48 CALL PLOTWS(ORGX(4),ORGY(4),SFX(4),SFY(4),XA,YMA,IA,NTAPE,15,N)    SPLOT101    ,103
    CALL PLOTWS(ORGX(5),ORGY(5),SFX(5),SFY(5),XA,YPA,IA,NTAPE,16,N)    SPLOT102    ,104
    IA=0                                                               SPLOT103    ,105
    GO TO 32                                                           SPLOT104    ,106
100 FORMAT(7F10.6)                                                          105
101 FORMAT(16HOTHERE IS (ARE) I1,25HFILE(S) ON THE PLOT TAPE.)         SPLOT106
    END                                                                SPLOT107    ,107
```

Figure 10.- Concluded.

```
                 EF3148                                                  03/12/65
              EXTERNAL FORMULA NUMBER   -   SOURCE STATEMENT   -   INTERNAL FORMULA NUMBER(S)
$IBJOB           NOGO
$IBFTC EF3148  NODECK                                                        001
       SUBROUTINE CBODY(I,X,R,DR)                                      EF314002
       DIMENSION XRC(14),RRC(14),THC(14),VV(23),JN(3)                  EF314003
       GO TO (1,2,3,4),I                                               EF314004   ,1
     1 J=1                                                             EF314005   ,2
       JJ=7                                                            EF314006   ,3
     5 READ (5,100) (XRC(K),K=J,JJ),RRC(J),(THC(K),K=J,JJ)             EF314007   ,4    ,5    ,6    ,7    ,8    ,9
                                                                                  ,10   ,11   ,12
     7 IF (XRC(JJ) .GT. 0.0) GO TO 6                                   EF314008   ,13   ,14   ,15
       JJ=JJ-1                                                         EF314009   ,16
       GO TO 7                                                         EF314010   ,17
     6 JN(I)=JJ                                                        EF314011   ,18
       X=XRC(JJ)                                                       EF314012   ,19
       IF (I .EQ. 3) X=XRC(8)                                          EF314013   ,20   ,21   ,22
       DO 9 K=J,JJ                                                     EF314014   ,23
       THC(K)=TAN(THC(K)*CV)                                           EF314015   ,24
       IF (K.EQ.1    .OR. K.EQ. 8 ) GO TO 9                                 016   ,25   ,26   ,27
       RRC(K)=0.5*(THC(K)+THC(K-1))*(XRC(K)-XRC(K-1))+RRC(K-1)         EF314017   ,28
       DX=0.2*(XRC(K)-XRC(K-1))                                        EF314018   ,29
       XX=XRC(K-1)                                                     EF314019   ,30
       DO 8 L=1,5                                                      EF314020   ,31
       RX= 0.5*(THC(K)-THC(K-1))/(XRC(K)-XRC(K-1))*(XX-XRC(K-1))**2    EF314021
      1  +(XX-XRC(K-1))*THC(K-1) + RRC(K-1)                            EF314022   ,32
       CALL SPLOT(3,XX,RX)                                             EF314023   ,33
     8 XX=XX+DX                                                        EF314024   ,34   ,35
     9 CONTINUE                                                        EF314025   ,36   ,37
       R=RRC(8)                                                             026   ,38
       CALL SPLOT(4,A,B)                                               EF314027   ,39
       RETURN                                                          EF314028   ,40
     2 J=2                                                             EF314029   ,41
       JJ=JN(1)                                                        EF314030   ,42
    13 DO 10 K=J,JJ                                                    EF314031   ,43
       M=K                                                             EF314032   ,44
       IF (X .LE. XRC(K)) GO TO 12                                     EF314033   ,45   ,46   ,47
    10 CONTINUE                                                        EF314034   ,48   ,49
    12 DD= (THC(M)-THC(M-1))/(XRC(M)-XRC(M-1))                         EF314035   ,50
       DD1=X-XRC(M-1)                                                  EF314036   ,51
       R=0.5*DD*DD1**2 + DD1*THC(M-1) + RRC(M-1)                       EF314037   ,52
       DR= DD*DD1 +  THC(M-1)                                          EF314038   ,53
       RETURN                                                          EF314039   ,54
     3 J=8                                                             EF314040   ,55
       JJ=14                                                           EF314041   ,56
```

Figure 11.- Sample body program.

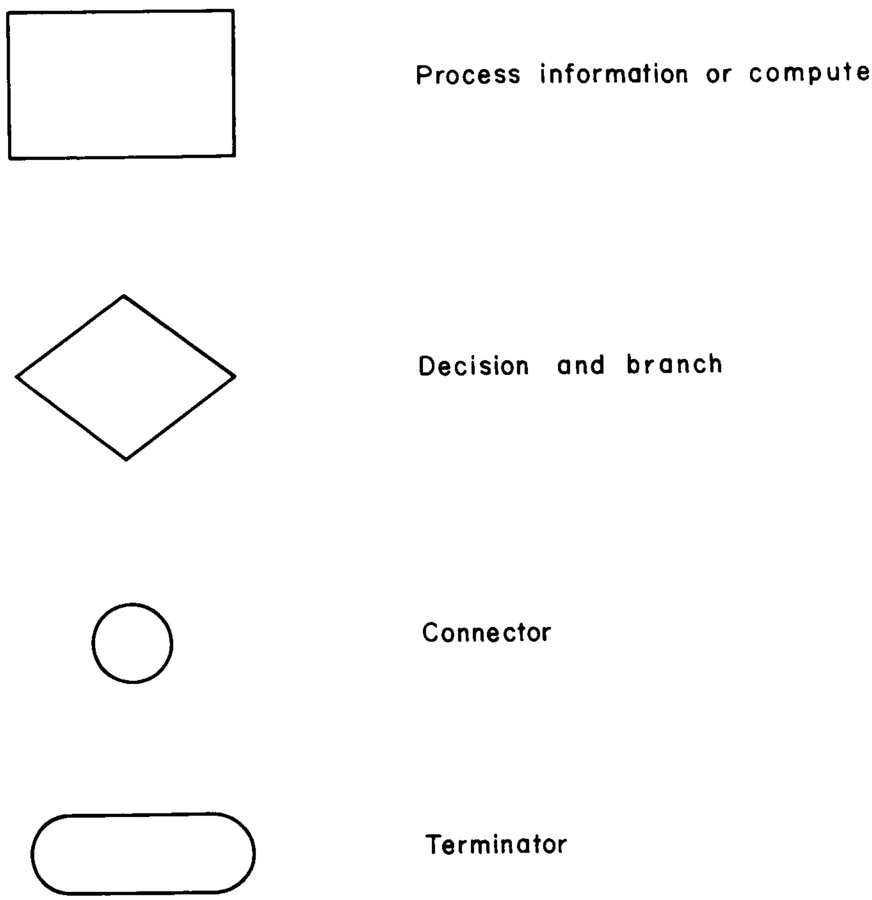
```
        EF3148                                                              03/12/65
     EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

     GO TO 5                                                         EF314042    ,57
   4 J=9                                                             EF314043    ,58
     JJ=JN(3)                                                        EF314044    ,59
     GO TO 13                                                        EF314045    ,60
 100 FORMAT(7F10.6 / F10.6 / 7F10.6)                                 EF314046
     END                                                                  047    ,61


        EF3149                                                              03/12/65
     EXTERNAL FORMULA NUMBER    -    SOURCE STATEMENT    -    INTERNAL FORMULA NUMBER(S)

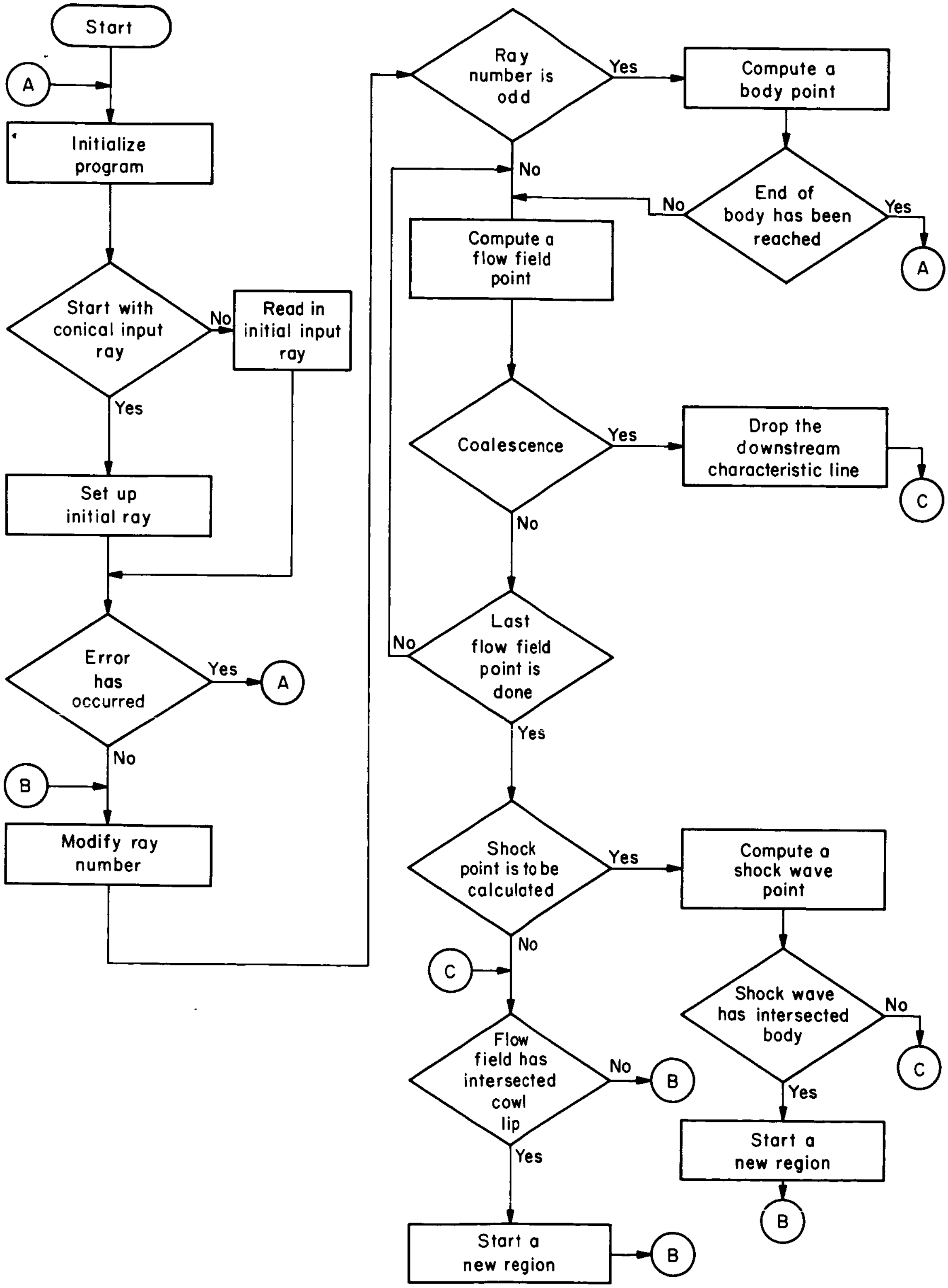
     SUBROUTINE ABODY(I,X,R,DR)                                      EF314002
     K=I+2                                                           EF314003    ,1
     CALL CBODY(K,X,R,DR)                                            EF314004    ,2
     RETURN                                                          EF314005    ,3
     END                                                             EF314006    ,4
```

Figure 11.- Concluded.



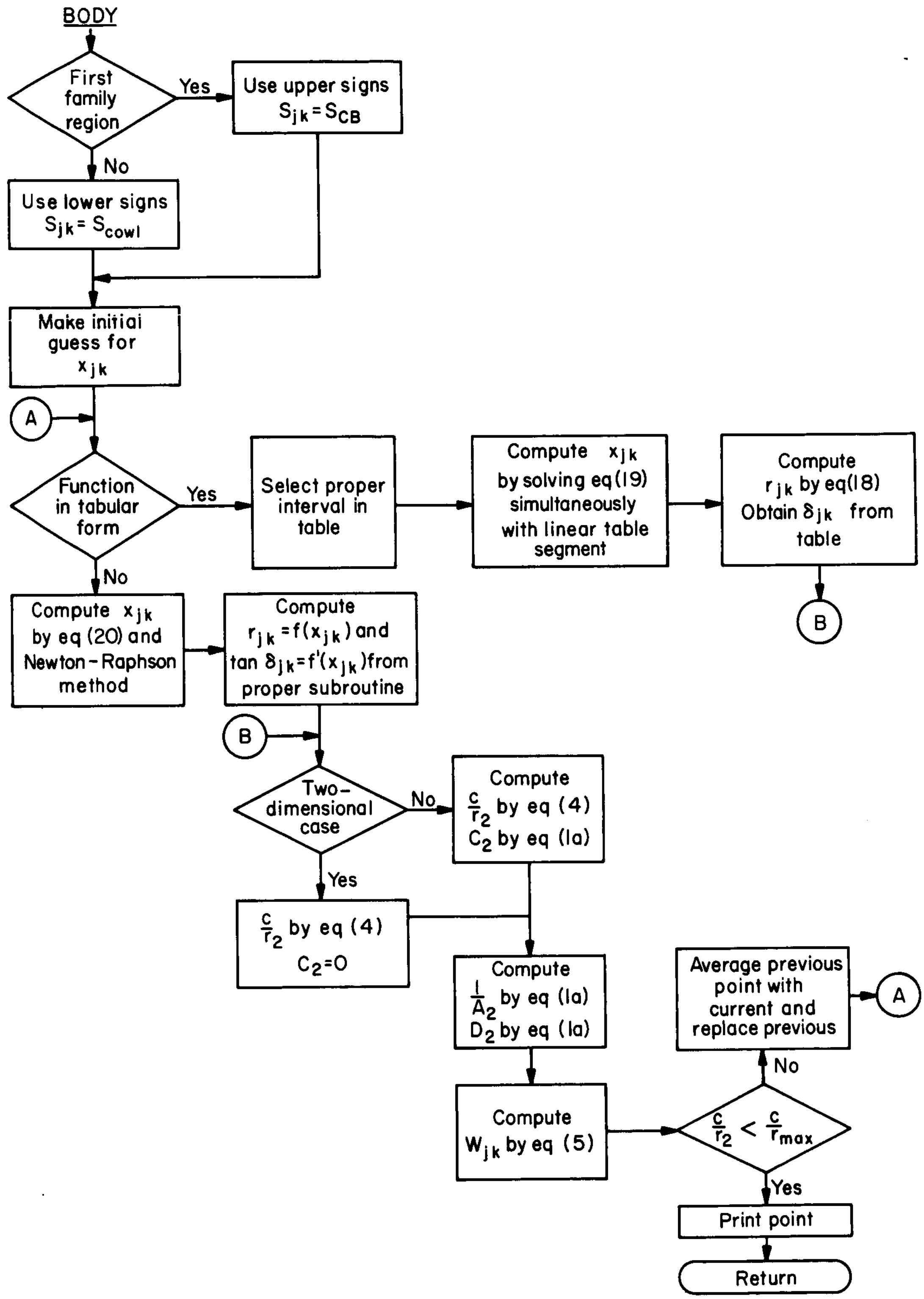
(a) Symbols used in flow charts.

Figure 12.- Flow charts.



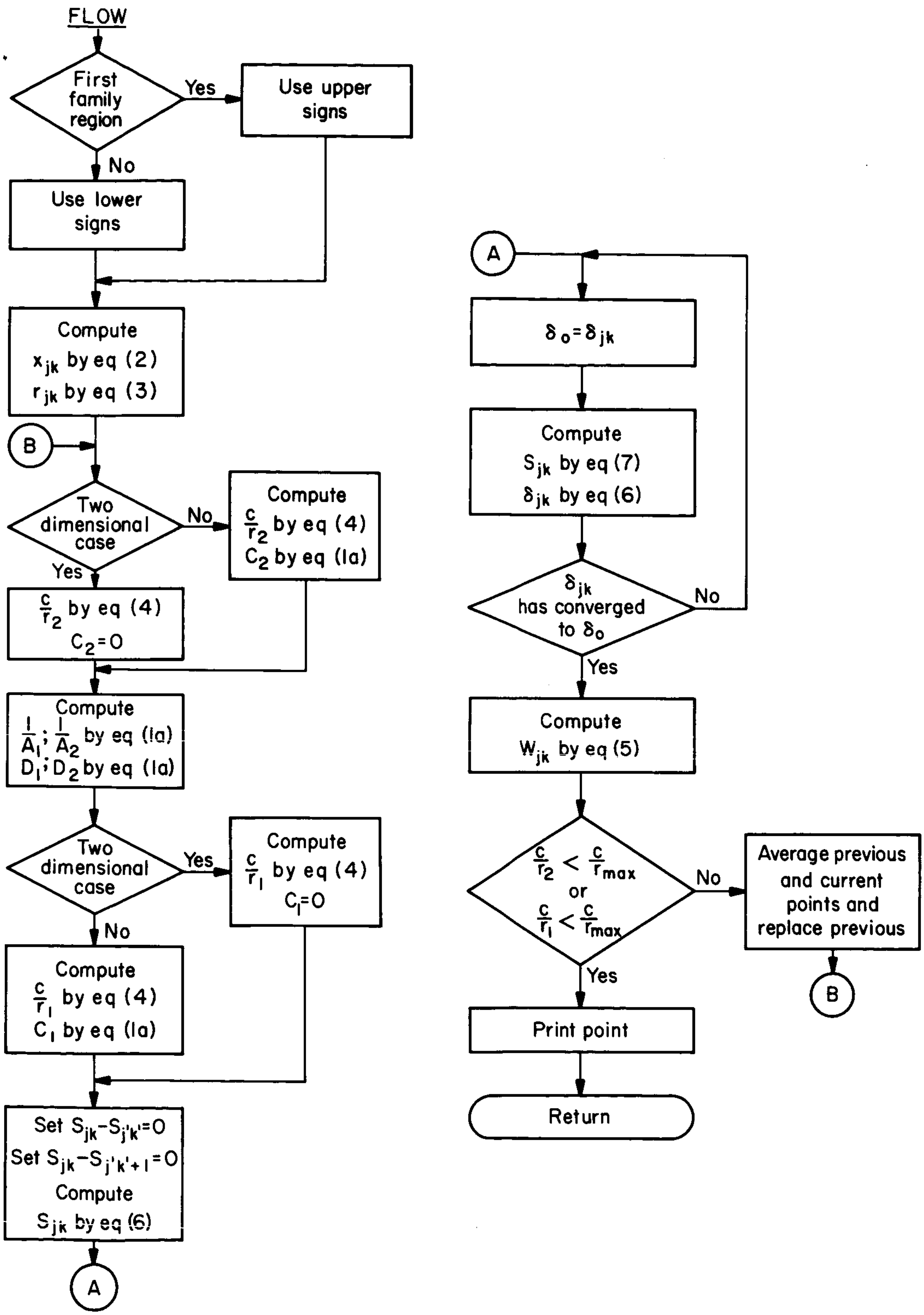
(b) Deck EF3131 main program.

Figure 12.- Continued.



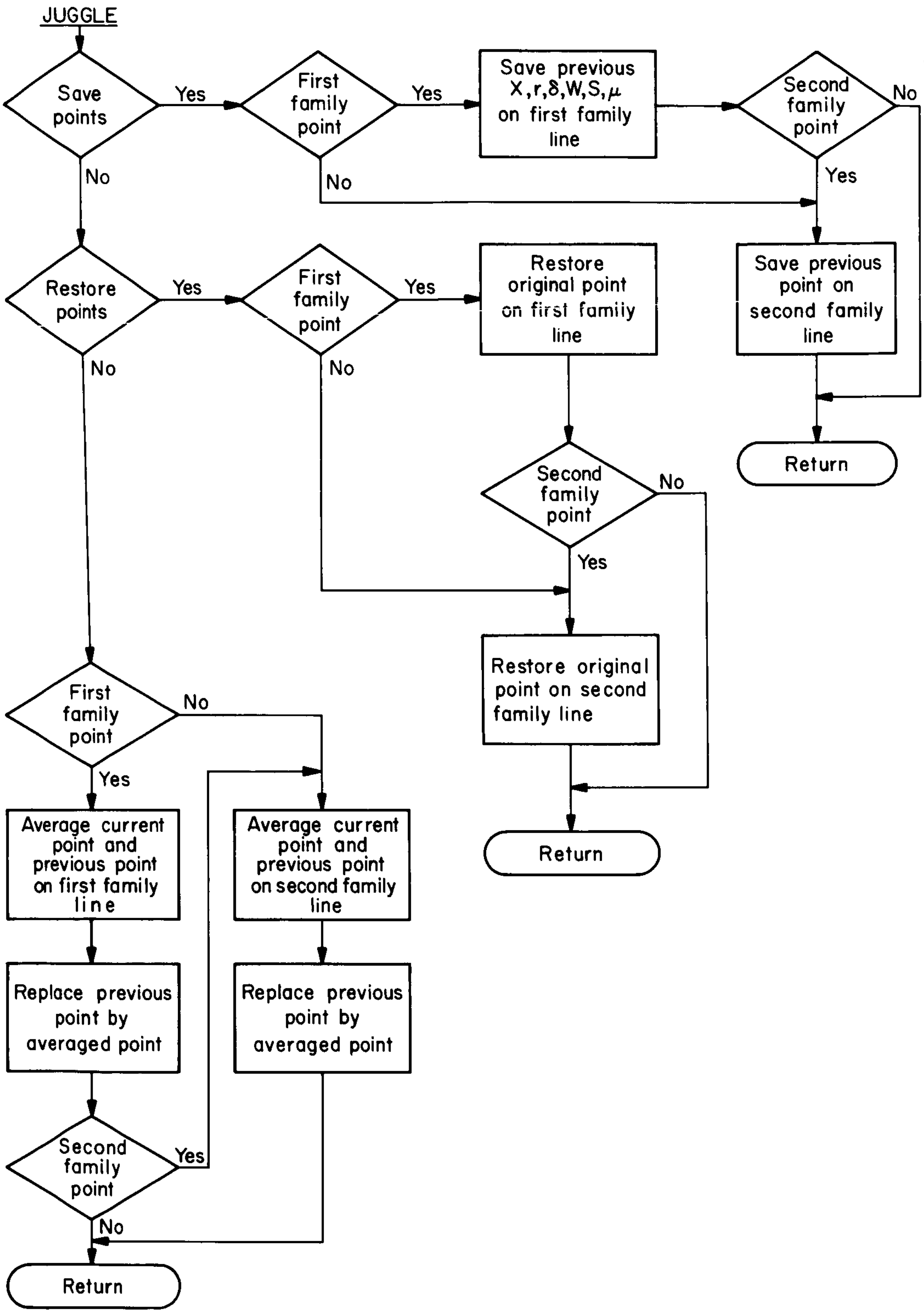
(c) Deck EF3132 subroutine BODY.

Figure 12.- Continued.



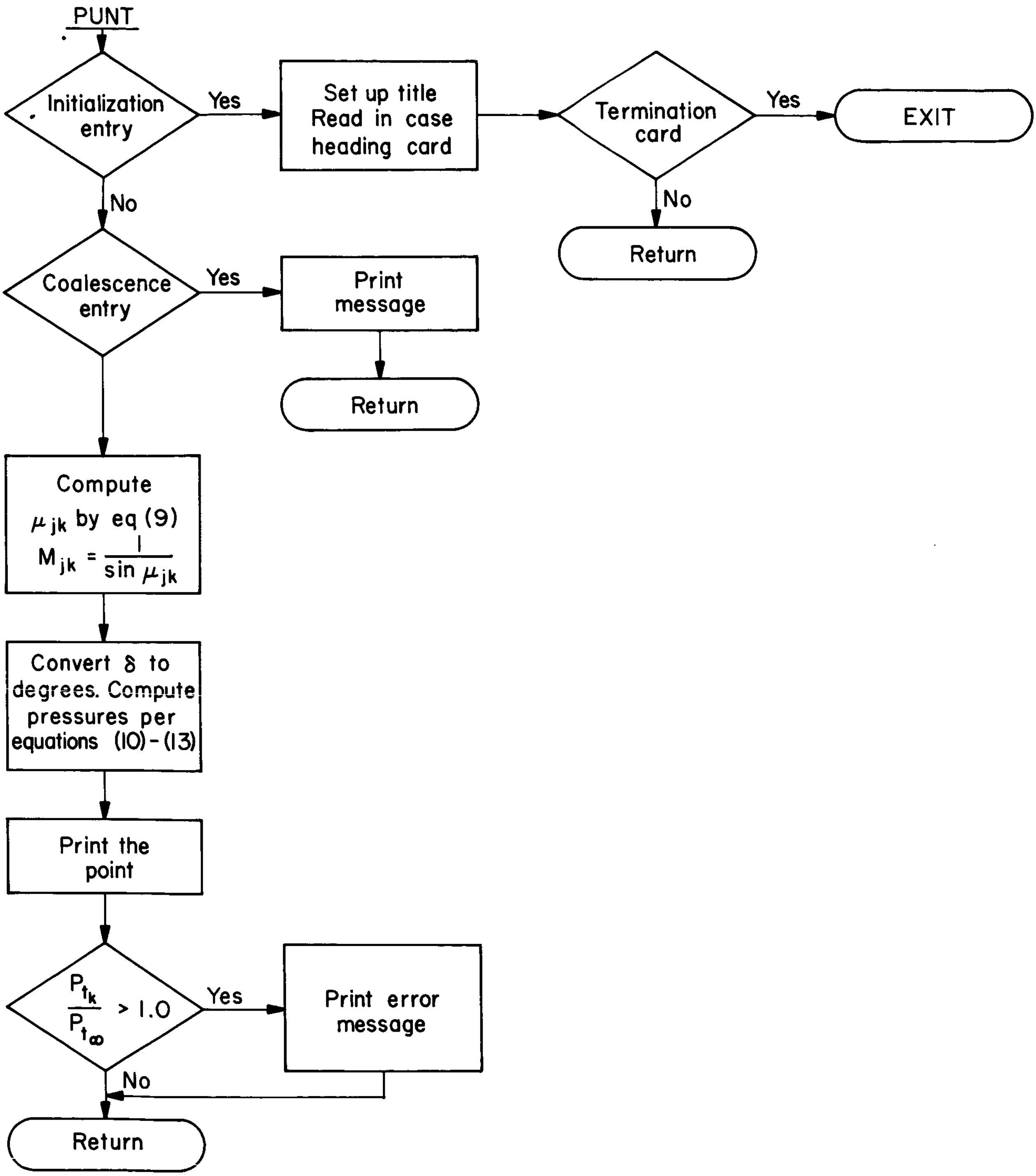
(d) Deck EF3133 subroutine FLOW.

Figure 12.- Continued.



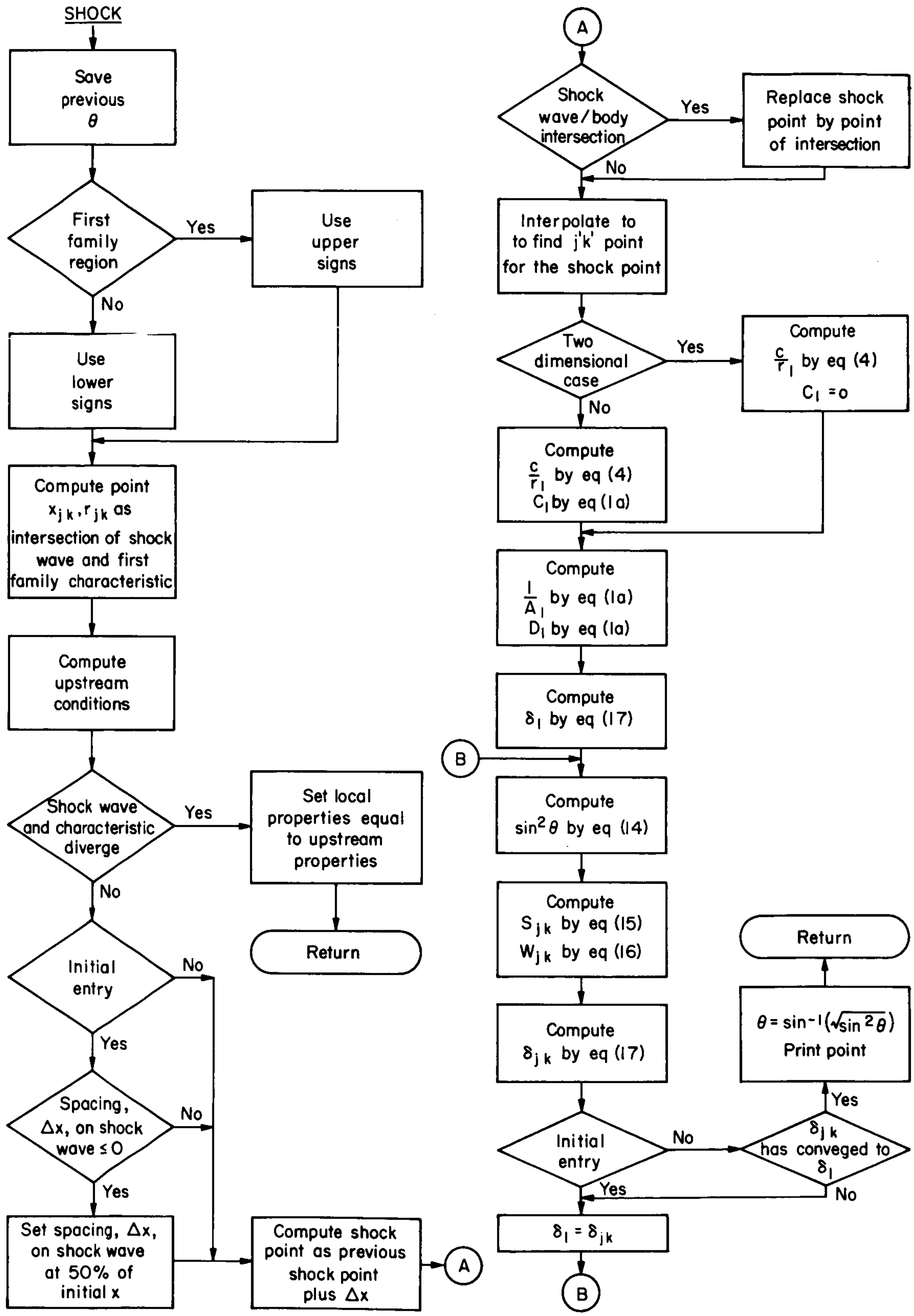
(e) Deck EF3134 subroutine JUGGLE.

Figure 12.- Continued.



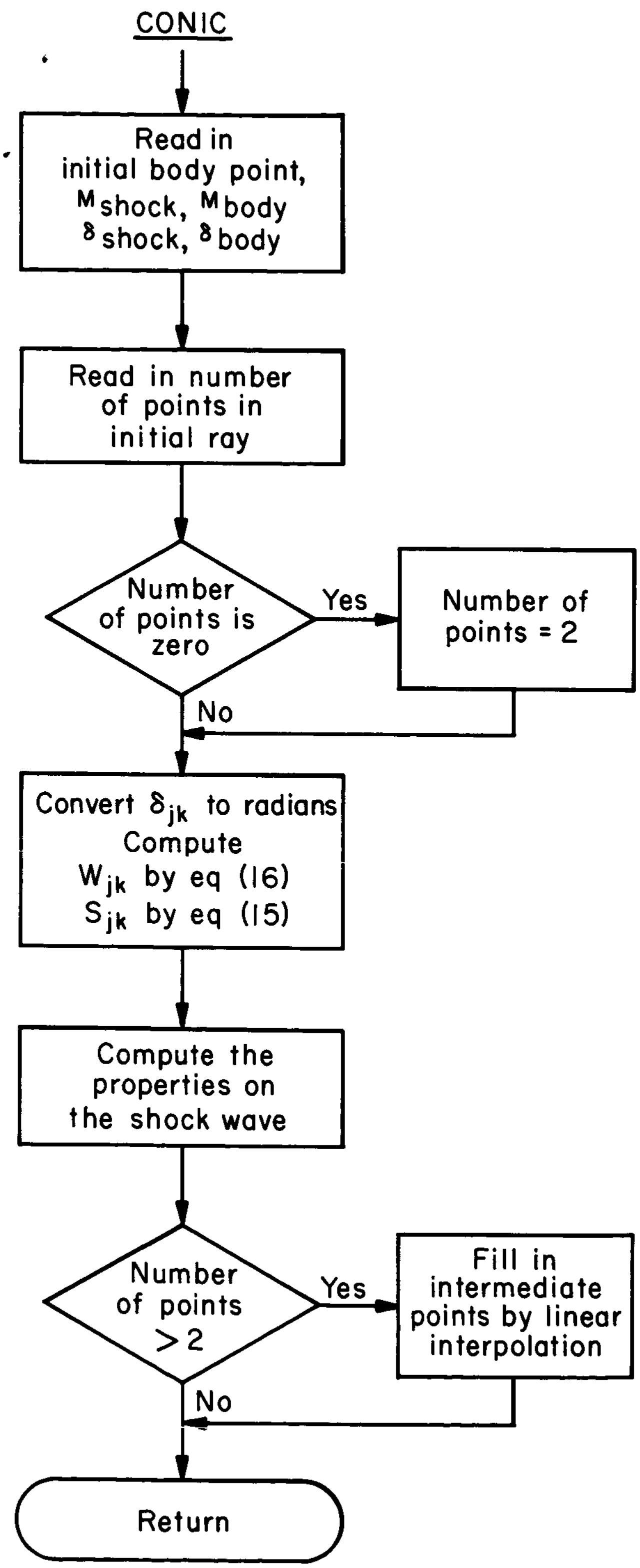
(f) Deck EF3135 subroutine PUNT.

Figure 12.- Continued.

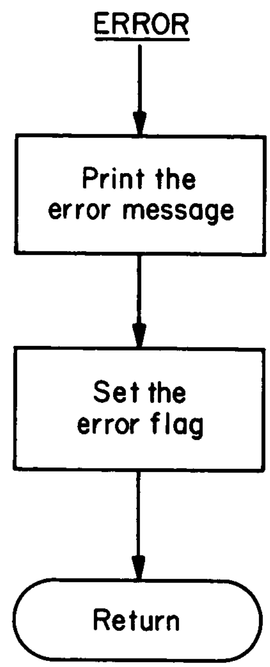


(g) Deck EF3138 subroutine SHOCK.

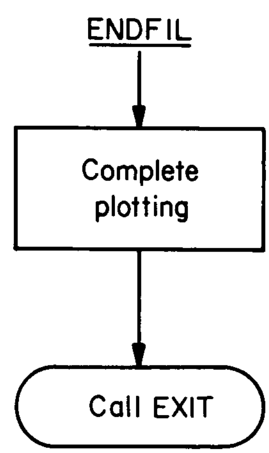
Figure 12.- Continued.



(h) Deck EF3139 subroutine CONIC.

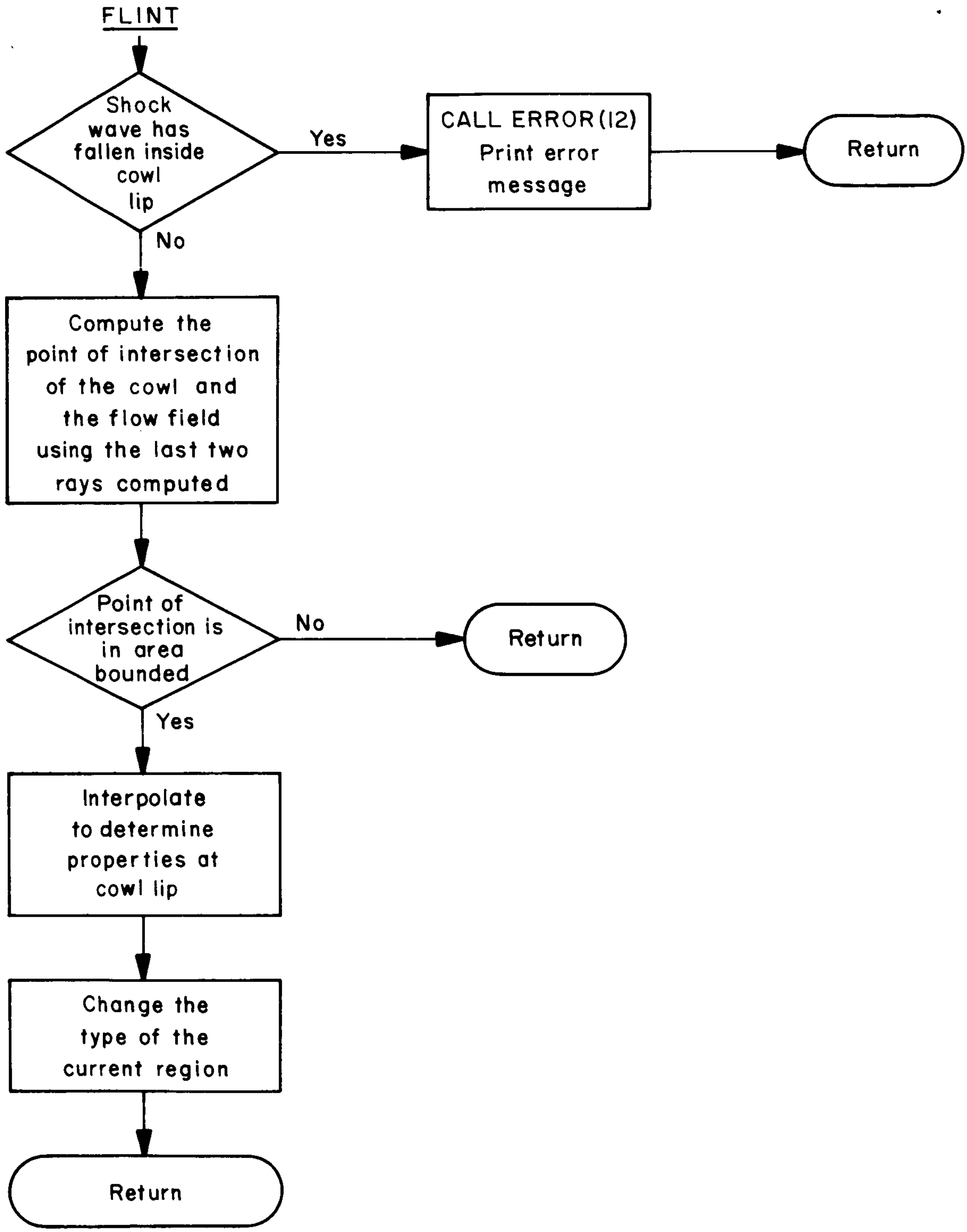


(i) Deck EF3140 Subroutine ERROR.



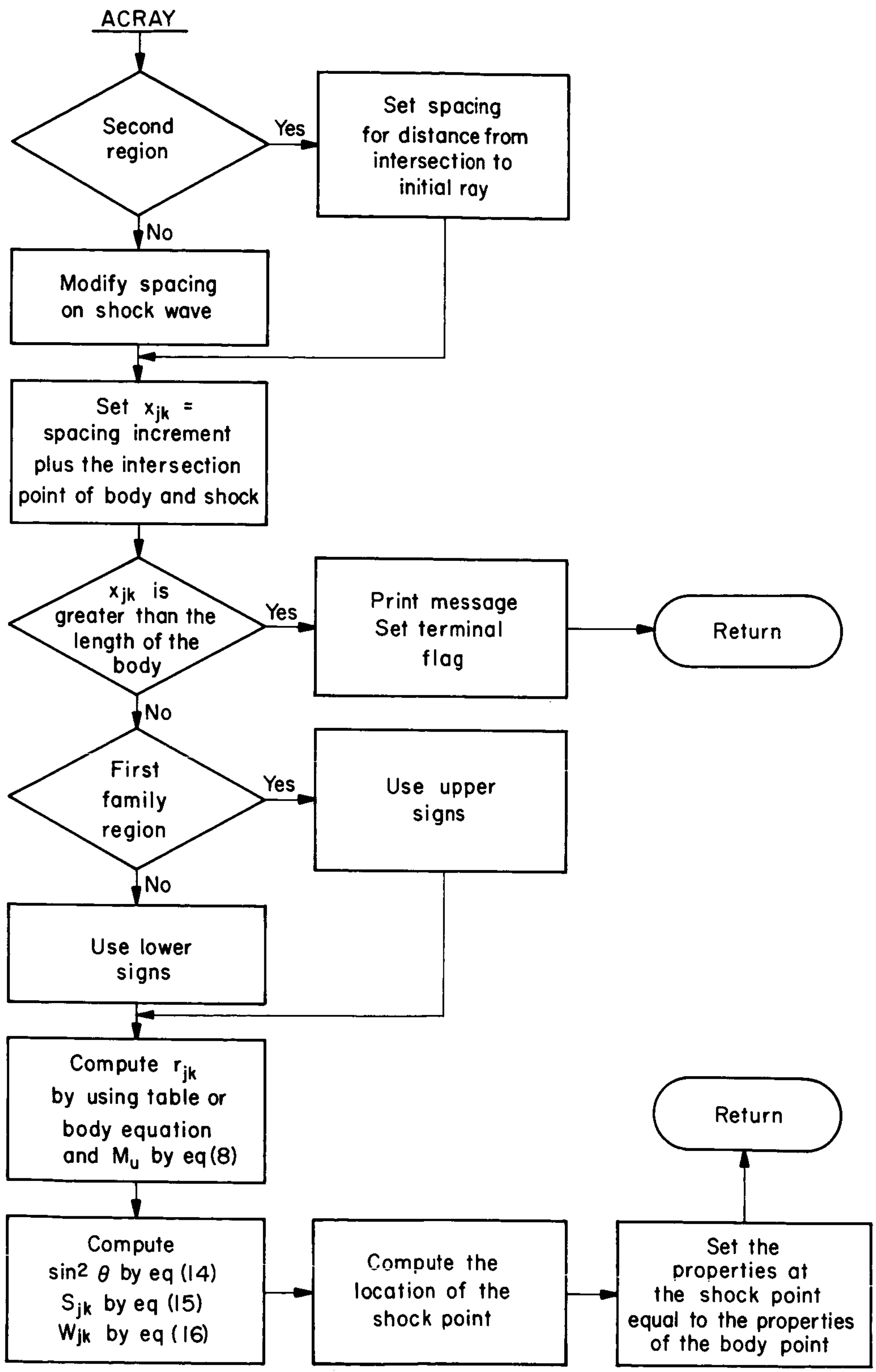
(j) Deck EF3141 subroutine ENDFIL.

Figure 12.- Continued



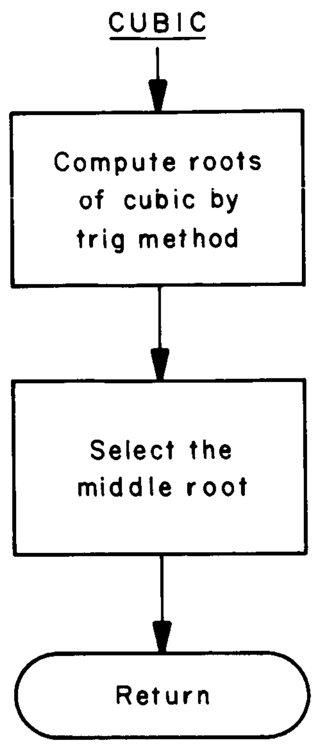
(k) Deck EF3142 subroutine FLINT.

Figure 12. Continued.



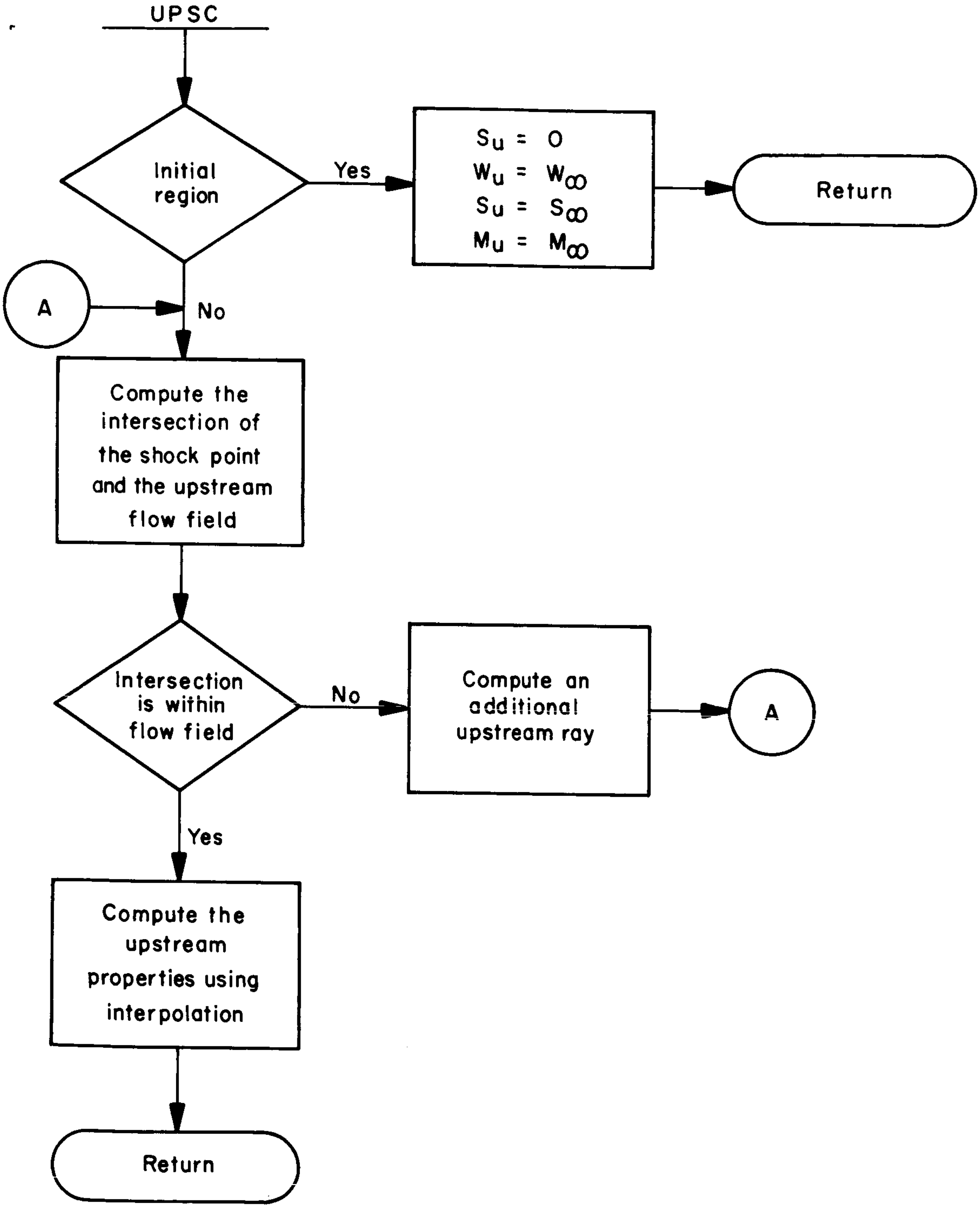
(l) Deck EF3144 subroutine ACRAY.

Figure 12.- Continued.



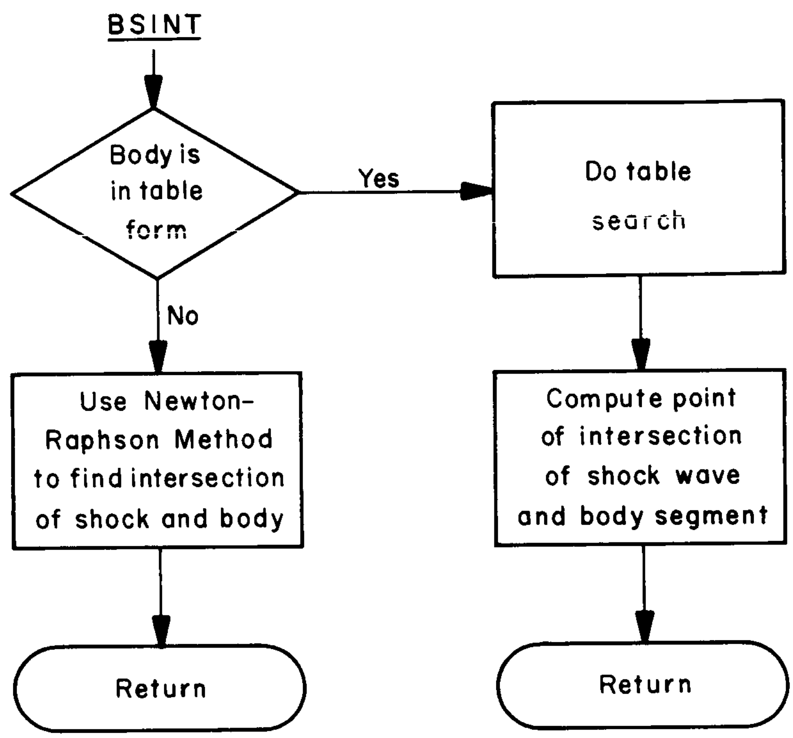
(m) Deck EF3145 subroutine CUBIC.

Figure 12.- Continued.



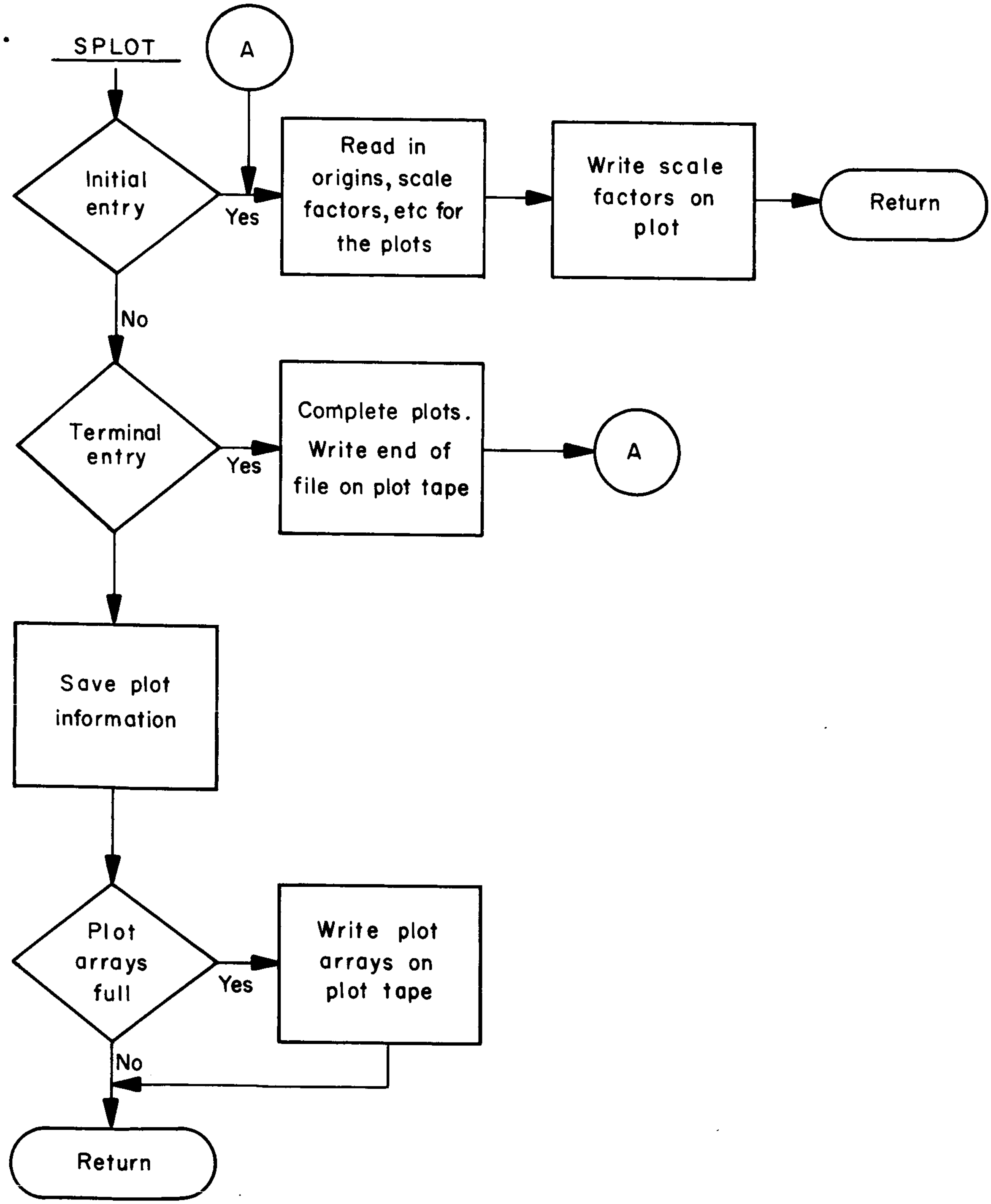
(n) Deck EF3146 subroutine UPSC.

Figure 12.- Continued.



(o) Deck EF3147 subroutine BSINT.

Figure 12.- Continued.



(p) Deck EF3150 subroutine SPLOT.

Figure 12.- Concluded.