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RAXBOD: A FORTRAN PROGRAM FOR INVISCID TRANSONIC

FLOW OVER AXISYMMETRIC BODIES

NASA TM X-72831

By James D. Keller and Jerry C. South, Jr.

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RAXBOD: A FORTRAN PROGRAM FOR INVISCID TRANSONIC FLOW OVER AXISYMMETRIC BODIES

By James D. Keller and Jerry C. South, Jr. Langley Research Center

SUMMARY

A program called RAXBOD is presented for the analysis of steady, inviscid, irrotational, transonic flow over axisymmetric bodies in free air. Instructions on program usage and listings of the program and sample cases are given.

INTRODUCTION

The program described in this report is for the analysis of steady, inviscid, irrotational, transonic flow over axisymmetric bodies in free air. It solves the exact equation for the disturbance velocity potential and uses the exact surface boundary condition. Most of the background about the equations solved and the difference scheme used is given in reference 1. This report gives instructions on the use of the computer program and also some additional details which were not given in reference 1.

The next section gives a general description of the problem and the method of solution. Then the instructions for using the computer program and a description of the inputs and outputs are given. The appendices contain additional details about some specific parts of the program as well as listings of the program and the sample cases.

GENERAL DESCRIPTION

One of the important considerations when trying to solve the full potential equation is the choice of a coordinate system. For complex three-dimensional shapes cartesian coordinates may be best; however, for simpler two-dimensional or axisymmetric shapes the use of a coordinate transformation such that the body lies along a coordinate line can greatly simplify the application of the exact boundary condition at the body surface. The program described in this paper uses a body-normal coordinate system for closed bodies. For open bodies (i.e. bodies with a sting or simulated wake) it uses a body-normal system on the forebody up to the first horizontal tangent and a sheared cylindrical coordinate system aft of that point. This coordinate system is suitable for closed bodies which are blunt on both ends and convex and smooth over the entire body or for open bodies which are blunt-nosed and convex and smooth up to the first horizontal tangent. It is possible to treat pointed bodies and bodies with slope discontinuities but the coordinate system is not well-suited for them and their solution may not be as accurate as the blunt-body solutions.

A stretching is applied to both the normal and tangential coordinates such that the infinite physical space is mapped to a finite computational space. Thus, the boundary condition at infinity can be applied directly and there is no need for an asymptotic far-field solution. Details about the stretching functions are given in appendix A.

The general method of solution is to replace the governing second-order partial differential equation with a system of finite difference equations, including Jameson's "rotated" difference scheme (ref. 2) at supersonic points.

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The difference equations are solved by a commun relaxation method. In order to get both rapid convergence and sufficient resolution, the relaxation is generally done on three different grids. The difference equations are first solved on a crude grid (about 400 grid points) which yields rapid convergence. Interpolation of this solution is used as an initial condition for a refined grid. This procedure can be repeated to any desired refinement within computer time and storage limitations.

The boundary condition at the body surface is applied through the use of dummy points inside the body. Details of this computation are given in appendix B.

PROGRAM USAGE

The program was written in the FORTRAN programming language for use on a CDC 6600 computer operating under the NOS 1.0 operating system at Langley Research Center. The program is overlaid in order to reduce the computer storage required. One of the overlays uses several subroutines from the Langley Research Center graphics library to create a plot vector file which can then be post-processed in order to obtain plotted output. Some modifications to the program might be required in order to obtain plots on a different computer system.

The input cards for each case are summarized in the following table:

Read Order	Variables	Format
1	DESC	8A10
2	IXY	1615
3	XO(I), I = 1, IXY	8E10.3
4	YO(I), I = 1, IXY	8E10.3
5	DYDXN, DYDXT, YMAX, XREF	8E10.3
6	IMAX, JMAX, MIT, MHALF, KLOSE, NPLOT	1615
7	RF1, COVERG, QF3	8E10.3
8	DNDYO, ALF, DXIDXO, XM, CXM, DXIDXM	8E10.3
9	GAM, AMINF	8E10.3

The definitions of these input variables are as follows:

DESC	-	Description of case. Up to 80 alphanumeric characters. Appears on printed and plotted output.
IXY	-	The number of coordinate pairs used to describe the body. Pre- sently limited to 100.
XO	-	Input coordinates in the axial direction - 8 per card.
YO	-	Input coordinates in the radial direction - 8 per card.
DYDXH	-	Body slope, $\frac{dy}{dx}$, at the nose. If it is infinite (as it is for blunt bodies) put in a value greater than 900.
DYDXT	-	Body slope at the tail (with proper sign). If it is infinite put in a value greater than 900.
YMAX	-	Maximum body radius. Used to calculate the reference area in computing the drag coefficient.

XREF	-	Body reference length. Used for scaling plots. XREF will scale to 5 inches on plots.
IMAX	-	Number of grid lines in the tangential direction. I = 1 is the forward stagnation line. I = IMAX is the rear stagnation line for closed bodies and downstream infinity for open bodies. For each grid refinement IMAX is increased such that IMAX _{NEW} = 2 (IMAX _{OLD}) -1. The present limit on IMAX is 81.
J MAX	-	Number of grid lines in the normal direction. $J = 1$ corresponds to an infinite distance from the body and $J = JMAX$ is on the body. The same formula and limit that apply to IMAX also apply to JMAX.
MIT	-	Maximum number of iterations (complete relaxation cycles) allowed on the first grid. MIT is doubled for each grid refinement.
MHALF	-	Number of grid refinements to be done.
KLOSE	-	Body type.
		= 0 for open body (i.e. one with a sting or wake). = 1 for closed body.
NPLOT	-	Plot trigger. NPLOT = 1 causes write on disc for input to plot routines and calling of plot routines.
RF1	-	Relaxation factor for subsonic points. Usual value is about 1.4. Should be in the range 0 <rf1<2. automatically<br="" program="" the="">reduces RF1 by 10 percent if: (1) The maximum correction, averaged over 10 cycles, is greater than that for the previous 10 cycles, and (2) the last maximum residual occurred at a sub- sonic point.</rf1<2.>
COVERG	-	Convergence criterion control parameter. Usual value is 1. Iterations stop when the maximum residual is less than COVERG/(IMAX-1) ² . This criterion is the order of the finite difference truncation error for subsonic points. If this degree of accuracy is not required, COVERG can be made larger.
QF3	-	Supersonic damping factor for improving iterative stability (at the expense of a slower convergence rate). Usual value is 0.1, but many cases with subsonic free streams are successful with QF3 = 0. Definitely need some QF3 on fine meshes with supersonic free streams. Note that QF3 has no effect on the accuracy of the converged solution, only on the stability and convergence rate. QF3 is automatically increased if: (1) The maximum correction, averaged over 10 cycles, is greater than that for the previous 10 cycles, and (2) the last maximum residual is at a supersonic point.

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DNDYO - Derivative of the normal coordinate stretching function at the body, $\left(\frac{dn}{dY}\right)_{Y=0}$. The value of DNDYO can be determined by choosing the desired step size for the first grid next to the body, Δn_0 . Then $\left(\frac{dn}{dY}\right)_{Y=0} = \frac{\Delta n_0 (1-\Delta Y)^{\alpha}}{\Delta Y}$

where $\Delta Y = 1/(JMAX-1)$. See Appendix A,

ALF - Exponent in the normal coordinate stretching function, α . Usual value is 1.3. Larger values of ALF move the last finite value of η farther away from the body and smaller values move it closer. See Appendix A.

Derivative of the tangential coordinate stretching function at the nose, $\left(\frac{d\xi}{dX}\right)_{X} = 0$. Since $\Delta X = 1/(IMAX - 1)$ then $\Delta \xi_0 \approx DXIDXO/(IMAX - 1)$, which can be used to determine what value of DXIDXO to use. It is usually best to use $\Delta \xi_0 \approx \Delta n_0$. The above relation for $\Delta \xi_0$ is only approximate however, and it might be necessary to adjust DXIDXO to g t the desired $\Delta \xi_0$. See Appendix A.

XM

DXIDXO -

 Axial location, x_m, (in physical coordinates) of the junction (or matching point) between the two tangential stretching functions, for open bodies only. See Appendix A. Usual value about the same as the body length.

CXM - Value of the computational coordinate, X, at the matching point of the two stretching functions (for open bodies only). Since X varies from zero to one, CXM is the fraction of the total number of grid points which will be in the first stretching region (ahead of x_m). Usual value is about 0.75.

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DXIDXM - Derivative of the tangential stretching function at the matching point, $\left(\frac{d\xi}{dx}\right)_{\substack{\chi=\chi_m}}$. $(\Delta\xi)_{\substack{\chi=\chi_m}} \approx DXIDXM/(IMAX-1)$. Used only

for open bodies. See Appendix A.

- GAM Ratio of specific heats.
- AMINE Free stream Mach number.

The Program Output is Described Below:

- 1.) Listing of body geometry input.
- 2.) Other input values.
- 3.) Computed geometric parameters in tangential direction.
 - I Tangential grid index.
 - S Arc length along reference surface.

X - Axial coordinate.

Y - Radial coordinate.

THET - Angle of reference coordinate surface, θ . For closed bodies θ is the same as the body angle, θ_B . For open bodies $\theta = \theta_B$ on the forebody and $\theta = 0$ on the afterbody,

THETB - Body angle, θ_{B} .

AK - Surface curvature on closed bodies. For open bodies AK is the surface curvature on the forebody and $AK = -\frac{d^2y}{dx^2}$ on the afterbody.

F - Derivative of the tangential stretch function, $\frac{dx}{d\xi}$. Computed geometric parameters in normal direction.

J - Normal grid index.

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AN - Normal coordinate, n.

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G - Stretching function derivative, $G(J) = \left(\frac{dT}{dn}\right)_{i}$.

GH - Stretching function derivative at half intervals, $GH(J) = \left(\frac{dY}{d\eta}\right), \quad ,$ j + 1/2

5.) Iteration history.

IT - Iteration number.

DPMAX - Maximum ϕ correction, max $\begin{vmatrix} \phi_{ij}^{IT} - \phi_{ij}^{IT} - 1 \end{vmatrix}$

ID, JD - I, J location of DPMAX.

RMAX - Maximum residual, $\max_{ij} |R_{ij}|$, where R_{ij} is the right hand side of the difference equation (with ΔX^2 , ΔY^2 , etc. in denominator).

IR, JR - I, J location of RMAX.

ISUB, ISUP - Indicates if maximum residual occurred at a subsonic or supersonic point.

RAVG Average value of the residual.

RF1 - Relaxation factor for subsonic points.

QF3 - Damping factor for supersonic points.

NS - Number of supersonic points.

SEC/CY - Time for iteration cycle.

6.) Time for iterations.

7.) Tabulated values of C_p and Mach number on the body.

8.) Drag coefficient by trapezoidal and Simpson integration of the C_p 's.

- 9.) Rough plot of C_p along the body. This plot is distorted in the axial direction because it is for equal spacing in the computational space. The asterisks show the level of sonic C_p .
- 10.) Mach number chart of the flow field in the computational plane.

Numbers printed are the Mach number multiplied by 100. I values from top to bottom. J values from left to right. x and y coordinates of the sonic line.

11.)

APPENDIX A

COORDINATE STRETCHING FUNCTIONS

The normal coordinate stretching function is:

$$\eta = \frac{AY}{(1-Y)}\alpha$$

where n is the physical coordinate normal to the body and Y is the computational coordinate which varies from zero at the body to one at infinity. The constant A controls the physical step size at the body, $A = \left(\frac{dn}{dY}\right)_{Y} = 0$, and for a given value of A, the exponent α controls the size of the last finite value of n. Larger values of α move points farther away from the body.

The tangential coordinate stretching is a transformation between the physical arc length along the reference surface, ξ , and the computational coordinate, X, which varies from zero to one. For closed bodies the transformation is

$$\xi = \frac{5}{2} + (X - \frac{1}{2}) \left[A + B (X - \frac{1}{2})^2 \right]$$

where A and B are determined by specifying $\left(\frac{d\xi}{dX}\right)_{X} = 0$ and requiring that $\xi = \xi_{max}$ at X = 1. These conditions give A = $\frac{3 \xi_{max} - \left(\frac{d\xi}{dX}\right)_{X} = 0}{2}$ and B = 4 (ξ_{max} - A).

For open bodies the tangential coordinate stretching is divided into two regions with the physical location of the dividing point, x_m , being an input quantity. Also input is the value of the computational coordinate at the dividing point, x_m . Since the computational coordinate varies from zero to one, x_m is equivalent to the fraction of the coordinates which are upstream

of \boldsymbol{x}_m . The stretching function for the region from the nose up to \boldsymbol{x}_m is

$$\xi = a_1 x + a_2 x^3 + a_3 x^5 + a_4 x^7 \qquad 0 \le x \le x_m$$

In the region from x_{m} to infinity the stretching function is $(X-X_{m})$ (1-Xm)

$$\xi = \xi_{m} + b - \frac{(\lambda^{-} \Lambda_{m}) (1^{-} \Lambda_{m})}{1 - \chi} \qquad \chi_{m} \le \chi < 1$$

The coefficients in these expressions are determined by specifying $\xi_{m},$

 $\left(\frac{d\xi}{dX}\right)_{X = 0}$, and $\left(\frac{d\xi}{dX}\right)_{X = X_{m}}$ and requiring that $\frac{d\xi}{dX}$ and $\frac{d^{2}\xi}{dX^{2}}$ be continuous at $X = X_{m}$. These conditions give

$$a_{1} = \left(\frac{d\xi}{dX}\right)_{X} = 0$$

$$b_{2} = \left(\frac{d\xi}{dX}\right)_{X} = \lambda_{m}$$

$$a_{2} = \frac{70C_{1} - 22C_{2} + 2C_{3}}{16 \chi_{m}^{2}}$$

$$a_{3} = \frac{-84C_{1} + 36C_{2} - 4C_{3}}{16 \chi_{m}^{4}}$$

$$a_4 = \frac{30C_1 - 14C_2 + 2C_3}{16 x_m^6}$$

wnere

$$C_{1} = \frac{z_{m} - a_{1} X_{m}}{X_{m}}$$

$$C_2 = b - a_1$$

and

$$c_3 = \frac{2X_m b}{1 - X_m}$$

APPENDIX B

APPLICATION OF SURFACE BOUNDARY CONDITION IN REGION OF SHEARED CYLINDRICAL COURUINATES

The boundary condition ir the sheared cylindrical coordinates is

$$\mathbf{V} - \mathbf{y}_{\mathbf{R}}^{\prime} \mathbf{U} = \mathbf{0} \tag{B1}$$

where

$$= 1 + \phi_{\xi} - y_{B}^{\dagger} \phi_{\eta}$$
 (B2)

$$V = \phi_{\eta}$$
(B3)

and y'_B is the body slope.

U

This boundary condition (B1) can be rearranged to give:

$$\phi_{\eta} = \frac{y'_{B}}{y + y'_{B}^{2}} (\bar{i} \cdot \phi_{\zeta})$$
 (B4)

Let

$$\frac{y'_B}{y + y'_B^2} = w_2$$

and introduce ϕ_η = $g\phi_\gamma$ and ϕ_ξ = $f\phi_\chi$ to get:

 $g\phi_{Y} = w_{2}(1 + f\phi_{X})$ $w_{2} (1 + f\phi_{X}) = DPO$

Let

so that

 $g\phi_{\gamma} = DPO$

(B5)

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First consider "ordinary" dummy points which lie inside the body and above the axis (i.e. $\eta |_{y=-\Delta Y} > -y_B$ or $Y |_{\eta=-Y_B} < -\Delta Y$) as shown in the following sketch:



The values of the potential function at ordinary dummy points are computed by first letting $\phi_{\gamma} = \frac{\phi_{i, JMAX-1} - \phi_{i, JMAX+1}}{2\Delta Y}$

which can be put into the boundary condition (B5) to give

$$\phi_{i,JMAX+1} = \phi_{i,JMAX-1} - \frac{2\Delta Y}{g} DPO$$
 (B6)

This result can be expressed in the more general form (which will be needed later):

$$\phi_{i,JMAX+1} = W_3 \phi_{i,JMAX-1} + W_4 \phi_{i,JMAX} - W_5 DPO$$
 (B7)
by letting $W_3 = 1$, $W_4 = 0$, and $W_5 = \frac{2\Delta Y}{g}$

In cases where the physical location of the dummy point is below the axis, the boundary condition is handled differently. Because the flow field is axisymmetric, the potential at a point below the axis is the same as that for a point an equal distance above the axis, as shown in the following sketches:



Let Y_1 be the value of the computational coordinate at the dummy point whose potential is desired. A Taylor series expansion for ϕ at this point (which is the same as $\phi_{i,JMAX+1}$) yields:

Now since $\phi_{\gamma} = \frac{DPO}{g}$, this can be put into the form $\phi_{i,JMAX+1} = w_3 \phi_{i,JMAX-1} + w_4 \phi_{i,JMAX} - w_5 DPO$

where

$$w_3 = \left(\frac{Y_1}{\Delta Y}\right)^2$$
, $w_4 = 1 - \left(\frac{Y_1}{\Delta Y}\right)^2$, $w_5 = -\frac{Y_1}{g}\left(1 - \frac{Y_1}{\Delta Y}\right)$

If Y_a is the (negative) value of the computational coordinate that corresponds to the location of the axis, then $Y_1 = \Delta Y + 2Y_a$.

 Y_a can be found from the stretching function. The stretching function is $\eta = \frac{AY}{(1-Y)^{\alpha}}$ or $\frac{\eta}{A} = Y (1-Y)^{-\alpha}$ which can be expanded in a series for small Y to give:

 $\frac{n}{A} = \gamma + \alpha \gamma^2 + \alpha \frac{(\alpha+1)}{2} \gamma^3 + \frac{\alpha(\alpha+1)(\alpha+2)}{6} \gamma^4 + \dots$

A reversion of this series gives

$$Y = \frac{\eta}{A} - \alpha \left(\frac{\eta}{A}\right)^2 + \frac{\alpha(3\alpha-1)}{2} \left(\frac{\eta}{A}\right)^3 - \frac{\alpha(16\alpha^2 - 12\alpha + 2)}{6} \left(\frac{\eta}{A}\right)^4 + \dots$$

Putting $\eta = -y_B$ into this gives the value of Y_a .

APPENDIX C

PROGRAM LISTING

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JVERLAY (JERRY, 0, 0)
      PROGRAM RAXBODS(INPUT, OUTPUT, TAPES=INPUT, TAPE6=OUTPUT, TAPE4)
              *********************************
  RELAXATION SOLUTION OF EXACT EQUATION FOR DISTURBANCE VELOCITY
.
              POTENTIAL FOR AXISYMMETRIC TRANSONIC FLOW
              (COORDINATE INPUT VERSION)
      PROGRAMMED BY JERRY C. SOUTH, JR, AND JAMES D. KELLER
       *****************
      CALL OVERLAY(SHJERRY,1,0)
      CALL OVERLAY(5HJERRY, 2,0)
      STOP
     END
      (VERLAY(JERRY,1,0)
     FRUGRAM ONEN
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      IMPORTANT, WHEN I-DIMENSION IS CHANGED, ID MUST BE SET EQUAL TO
C
C C
     NEW I-DIMENSION.
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     FINAL VALUE OF IMAX, AFTER ALL GRID-HALVING IS COMPLETED, IS
      IHAX(FINAL)=(IHAX(INPUT)=1)+(2**HHALF)+1
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     SIMILARLY FOR JMIX(FINAL).
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     187 DIMENSIG OF P-ARRAY MUST BE AT LEAST AS BIG AS IMAX(FINAL)
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      12 JOANNAYS DIMENSIONED AT LEAST AS BIG AS JMAX(FINAL)
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     XS IND YS ARE SONIC PT. COORDS. NO NEED TO CHANGE DIMENSION UNLESS
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      MORE THAN 398 SONIC PTS ARE EXPECTED (VERY UNLIKELY). SUBROUTINE
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     SONLIN PREVENTS CALCULATION OF MORE THAN 398 SONIC PTS.
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      IXY IS THE NUMBER OF INPUT CODRDINATES USED TO DESCRIBE THE BODY.
1
     COMMUN BLUKS CONTAINS 9 ARRAYS DIMENSIONED AT LEAST AS BIG AS IXY.
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      PROGRAM ONEL CONTAINS & ARRAYS AT LEAST AS BIG AS IXY AND
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      5 ARRAYS AT LEAST AS BIG AS IXY+1.
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ORIGINAL PACE IS OF POOR QUALITY

45 COMMON P(81,82) COMMON X8(81), Y8(81), CP(81) 46 47 COMMON THET(61), THETR(61), ST(61), CT(81), W1(81), W2(81), W3(81) , W4(81), W5(81), Y8P(81), DPD(81), F(81), AK(81), S(81), L8(81), FM(81) 48 COMMON AN(81),G(81),GH(81),CB(81),D(81),X1(81),X2(81),H(81),HR(81) 49 50 1,HRP(81),HRM(81),HRMM(81) 51 COMMON X5(400) Y5(400) COMMON ID, ANMAX, DNDYO, YMAX, CD, RM80, JSKP, TSP 52 53 COMMON /BLOK1/ XST 54 COMMON /BLOK2/ PI,RAD 55 COMMON /BLOK3/ IMAX, JMAX, C2, RF1, DPM, IDP, JDP, RPM, IR, JR, NS, GM102 56 1, ADSO, DXSQ, DXDY, DYSQ, DX2, DY2, KLOSE 57 COMMON /BLOK4/ GMSQ,GOGH1,TUGMSU,CPD,KSTAH COMMON /BLOK5/ JM1, DY, I1, JSUP, JSON, GF3, ISUB, ISUP, SUMAP 58 59 COMMON /BLOK6/ XO(100), YO(100), XOP(100), XOPP(100), XOPPP(100), YOP(100), YOPP(100), YOPPP(100), SOO(100), IXY, OYDXN, DYDXT 60 COMMON /BLOK7/ SMAX,S1,XM,XIM,A4,DXIDX0,DXIDXM,A2,A3,X10,X11,CXM, 61 62 + DX.X10.XREF 63 COMMON /BLOKE/ ALF 64 COMMON /BLOK9/ N 65 DIMENSION DESC(8) 66 DATA PI/3.14159265358979/,RAD/57,2957795130823/ 67 68 ************** 69 WWW WARNING --- WARNING --- WARNING --- WARNING ---70 DON'T FORGET TO CHANGE ID WHEN I-DIMENSION IS CHANGED 71 72 73 ****************************** 74 75 ID=81 76 77 CALL SECOND (T1) 78 WRITE(6,270) T1 79 60 81 FOLLOWING 4 INSTRUCTIONS ESTABLISH TIME TO START CLEANUP OPERA-82 TIONS, WHEN CPU TIME (INCLUDING COMPILE TIME) COMES WITHIN TSAF 63 SECONDS OF THE TIME LIMIT, TL, ITERATION IS STOPPED AND CLEANUP BTARTS, JPARAMS IS AN LRC SUBROUTINE THAT RETURNS JOB TIME LIMIT 84 85 IN D(11), SECOND IS AN LRC SUBROUTINE USED TO MONITOR THE CURRENT 86 87 TIME. 88 89 ******************** 90 91 TSAF=30. 92 KTLAI 93 CALL JPARAHS(D) 94 TL=D(11) 95 10 READ(5,290) DESC 96 IF(COF(5)) 20,30 47 20 IF (NFLOT.EQ.1) RETURN ORIGINAL PAGE IS 98 STOP 99 OF POOR QUALTER 30 CONTINUE 100 READ(5,300)1XY 101 READ(5,330)(X0(1),1=1,1XY) 102 READ(5,330)(YO(I),1=1,IXY) 103 READ(5,330) NYDXN, DYDXT, YHAX, XREF READ(5, 300) IMAX, JMAX, HIT, MHALF, KLOSE, NPLOT 104

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105
   READ(5,330)RF1,COVERG,QF3
   READ(5,330) ONDYO, ALF, DXIDXO, XM, CXM, DXIDXM
                                                                         106
                                                                         107
  READ(5,330)GAM, AMINF
                                                                         108
  WRITE(6,280)DESC
   WRITE(6,720)(1,X0(1),Y0(1),I=1,IXY)
                                                                         109
                                                                         110
  WRITE(6,420)DYDXN,DYDXT,YMAX,XREF
   TSAF=TSAF+NPLDT+30.
                                                                         111
   THETAN=ATAN(DYDXN)
                                                                         112
                                                                         113
   THETAT=ATAN(DYDXT)
                                                                         114
   DYDSN#SIN(THETAN)
                                                                         115
   DXDSN=COS(THETAN)
                                                                         116
   DYDST=SIN(THETAT)
                                                                         117
   DXDST=COS(THETAT)
                                                                         118
   IF(DYDXN,LT,900,)G0 TO 31
   DYDSN=1.
                                                                         119
                                                                         120
   DXDSN#0.
                                                                         121
31 CONTINUE
   IF (ARS(DYDXT), LT. 900, ) GO TO 32
                                                                         155
                                                                         123
  DYDST==1.
  DXDST=0.
                                                                         124
                                                                         152
32 CONTINUE
   CALL FIT(1XY,X0,Y0,S00,X0P,X0PP,Y0P,Y0PP,UYDSN,DXDSN,DY0ST,DXDST)
                                                                         159
  CALL SPLIF(1, IXY, SDO, XU, XOP, XOPP, XOPPP, 1, OXDSN, 1, DXDST, INC.
                                                                         127
   CALL SPLIF (1, 1XY, SOO, YO, YOP, YOPP, YOPPP, 1, DYDSN, 1, DYDST, 1ND)
                                                                         159
                                                                         159
   NHALF=0
                                                                         130
   ANMAX#1.E+08
                                                                         131
   JSKP=1
   JPAGE=31
                                                                         132
                                                                         133
   N=0
40 IF (JMAX/JSKP, LE, JPAGE) GO TO 50
                                                                         134
                                                                         135
   JSKP#JSKP+1
                                                                         136
   GO TO 40
SO CONTINUE
                                                                         137
                                                                         138
   X1(1)=0.
                                                                         139
   X2(1)=X1(1)
                                                                         100
   RHSQ=YMAX++2
                                                                         141
   GM1=GAM=1.
   GM102=,5+GH1
                                                                         142
                                                                         143
   GOGM1=GAM/GM1
                                                                         144
   AMSQ=AMINF++2
                                                                         145
   GHSQ=GM102+AMSQ
   A050=64102+1,/AMSQ
                                                                         146
                                                                         147
   TOGMEQ=2,/(GAM+AMSQ)
   PSTAR=(2.*(1.+GMSQ)/(1.+GAM))*+GOGH1
                                                                         148
   CPSTAR=TOGMSQ+(PSTAR=1.)
                                                                         149
                                                                         150
   CPOHTOGHSQ+((1,+GMSQ)++GOGH1=1,)
   KSTAR=4.5+30.+(CPD=CPSTAR)
                                                                         151
                                                                         152
   IF (KSTAR,GT,100) KSTAR=100
                                                                         153
60 CALL SECOND (T1)
  WRITE(6,320)IHAX, JMAX, MIT, MHALF, KLOSE, NPLOT
                                                                         154
  * ,RF1,COVERG,QF3,DNDY0,ALF,DXIDX0,XM,CXM,DXIDXH,GAM,AMINF
                                                                         155
                                                                         156
   ************
                                                                         157
                                                                         158
  OVERLAY(1,1) SETS UP THE TANGENTIAL COORDINATES
                                                                         159
                                                                         160
                                                                         161
   ******
                                                                         162
   CALL OVERLAY (SHJERRY, 1, 1, 6HRECALL)
                                                                         163
                                                                         164
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	UVERLAY()/2) CALLS NIKANF AND HINZ

	CALL OVERLAY(5HJERRY,1,2,6HRECALL)
	DX8G=1,/DX++2
	RCHEK=100.+DX8G
	DXDY=_5/(DX+DY)
	DYSG=1./DY++2
1	DY28.S/DY
	UNITUTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTTT
	NC NC 4 NC NC 1 / C NC NC - 1 / D C C NC NC - 1 / D C C C C C C C C C C C C C C C C C C
	LAINIJERLA HAV
	DU AO IMI'NIWAX
	TD=THET(I)+RAD
	TBD=THETB(J)*RAD
	WRITE(6, 480) I,S(I),XB(I),YB(I),TD,TBD,AK(I),F(I)
	CONTINUE
	WRITE(6,451)ALF
	WRITE (6,457)
	WRITE(6, 400) (J.AN(J),G(J),GH(J),J=1,JMAX)
	9786 95997 117 787871
	1-1-14
	TE INNALE CT AN CO TO 100
	IF INFRIFIELD IN IN INTRA
	CALL TOILD (PAIDAIDAA)
	11=0
	DO 110 1=1,11
	DPO(1)=ST(1)
	IF (KLOSE,EQ.1) GO TO 130
	12=11+1
	ISHIMAX-1
	00 120 1=12,13
	DPO(1)=w2(1)+(1,+F(1)+DX2+(P(1+1,JMAX)-P(1=1,JMAX)))
	DPTES. +P(THAX.JMAX)-U. +P(IMAXH).JMAX)+P(IMAXH2.JHAX)
	DPD(TMAX) = DTMAX) + (1 + F(TMAX) + DX2 + DPT)
	00 140 14110421140071.1847413460714071-1847346571400071
	HOTELY WAY TERSTINE CINCHARTINE CINCHANERSCIPER (I)
	LALL SECUND (10)
	8UM1=1, L+U7
	5UM#0.
	COVR=COVERG/FLOAT(IMFX=1)**2
	CALL SECOND (T1)
	JSUP=0
	IF (AMINF.GE.1.) JSUP#1
	JSONEO
	IF (ABS(AMINF+1.).LE.1.E+06) JSON=1

	OVERLAY(1,3) IS THE MIXED FLOW POTENTIAL ITERATION LOOP

ORIGINAL PAGE IS

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CALL OVERLAY (SHJERRY, 1, 3, 6HRECALL) 225 17=17+1 226 RAVG=SUMRP/POINTS 227 CALL SECOND (T) 228 TI=T=T1 259 WRITE(6,500)IT,DPM,IDP,JDP,RPM,IR,JR,ISUB,ISUP,RAVG,RF1,UF3,NS,TI 230 C 231 C *************** 232 C 233 C CHECK FOR TIME LIMIT. 234 Ċ 235 ************************ 236 C 237 IF (TL-T.GT.TSAF) GO TO 160 238 WRITE(6,370)T, 1L, RPM, COVR 239 KTL#2 240 GO TO 180 241 160 CONTINUE 242 C 243 C *********** ******* 244 ç 245 C CHECK FOR DIVERGENCE. 246 C 247 С ****** 248 C 249 IF(RPH,LT,RCHEK) GO TO 161 250 WRITE(6,610) 251 GO TO 10 252 161 CONTINUE 253 C 254 C 255 č 256 C CHECK FOR CONVERGENCE OR ITERATION LIMIT 251 258 C **** 259 C 290 IF (RPM.GE.COVR)GO TO 171 261 WRITE(6,700)RPM,COVR 292 GO TO 180 263 171 CONTINUE 264 IF(IT,LT,MIT)GO TO 172 265 WRITE(6,310)MIT, RPM, COVR 599 GO TO 180 267 172 CONTINUE 268 C 269 Ç ********************** 270 C 271 C C INCREASE PHIOST DAMPING COEFFICIENT OR DECREASE RF1 IF AVERAGE 272 MAXIMUM CORRECTION OF LAST 10 CYCLES HAS INCREASED OVER PREVIOUS 1 273 C 274 C ************************* 275 C 276 SUM#SUM+DPM 277 IF (MOD(IT,10),NE,0) GO TO 150 278 IF (SUM1.GT.SUM) GO TO 173 279 QF3=0F3+,1+1SUP 280 RF1=RF1=(1,=,1=ISUB) 281 SUM1=1.E+07 282 IF(ISUP, EG, 1) WRITE(6, 680)QF3 563 IF(ISUH,EG, i)HRITE(6,710)RF1 284

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173 174	GO TO 174 8UM1=8UM SUM=6.
180	GO TO 150 Call Begond (T)

	THE FOLLOWING STATEMENTS CALL FOR PREPARATION AND PRINTING OF
	CP, MACH NO., DRAG, ROUGH CP PLOT, MACH NO. CHART OF FLOW FIELD,
	SONIC LINE CALCULATION, AND HPITING ON DISC FOR CALCOMP PLOTS.
	· · · · · · · · · · · · · · · · · · ·
	T1=T-T0
	WRITE(6, 510) T1,IT,NHALF
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
	OVERLAY(1,4) CALLS CPBODY, DRAG, AND CPPLOT.
	***************************************
	6411 DUEDLANGELIEDDN 4 4 400004113
	CALL UVERLAY (SHJERRY) 1,4,000 (LALL)
	*****
	OVERLAY(1,5) CALLS MCHART AND SONLIN.
	``````````````````````````````````````
	CALL OVERLAY (SHJERRY, 1, 5, 6HRECALL)
	CALL SECOND (T1)
	T1=T1=T
	WRITE(6,600)T1
	IF (NPLUIANCA)) GU IU 220 WRITF/4) DESC
	NRITE(4) INAX, JMAX, IT, KLOSE, N
	WRITE (4) CPSTAR, AMINF, DPM, XREF, DXIDXO, DNDYO, QF3
	IF(KLOSE,E0,1)GO TO 211
211	NHITE(4) CXM,XM,XIM,DXIDXM CONTINUE
E I I	WRITE(4)(AN(J),JR2,JMAX)
	WRITE(4)(ST(1), I=1, IMAX)
	WRITE(4)(CT(I), I=1, IMAX)
	WRITE(4) (XB(I),I=1,IMAX)
	WRITE(4) (YB(1),IB1,IMAX) Hotte/// /co/ty.tel.tmax/
	MMIIC(4) ((M(1))141)14A) TF (N.FD.O) GO TO 220
	WRITE(4) (XS(1), I=1,N)
	WRITE(4) (YS(1), 1=1,N)
220	CONTINUE
	IF(KTL_EQ.2)GO TO 20
	IT (NHRLFOTGONHALF) GU IU IU Nhaifrnhaifot
	uiteRt mussement 4
	***************************************
	OVERLAY(1,6) IS THE GHID REPINEMENT ROUTINE.

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345
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                                                          ......
                                                                           346
                                                                           347
    CALL OVERLAY (SHJERRY, 1, 6, 6HRECALL)
                                                                           348
    MITH2+MIT
                                                                           349
    DX=.5+DX
                                                                            350
250 IF (JMAX/JSKP, LE, JPAGE) GO TO 260
                                                                           351
    JSKP=JSKP+1
                                                                           352
    GO TO 250
260 CON'INUE
                                                                           353
                                                                           354
    GD TO 60
270 FORMAT (1H1///,16H COMPUTING TIME=,F6,1,8H SECONDS/)
                                                                           355
280 FORMAT (1H1,8A10)
                                                                           356
290 FORMAT (BA10)
                                                                            357
                                                                           358
300 FORMAT (1615)
310 FORMAT(/* ----DID NOT CONVERGE IN+14+ CYCLES,---- RMAXE+
                                                                           359
   * E9.2*, COVR=*E9.2/)
                                                                           360
320 FORMAT(6H11MAX=13/6H JMAX=13/5H MIT=14/7H MHALF=11
                                                                           361
   * /7H KLOSE#I1/7H NPLOT#I1/5H RF1#F5,3
                                                                           362
   ★ /BH COVERG=E9,2/5H QF3=E9,2/7H ONDY0=E10,3
                                                                           363
   + /SH ALF=F4,2/8H DXIDX0=E10,3/4H XM=E10,3
                                                                           364
   # /SH CXM#E10,3/8H DXIDXM#E10,3/5H GAM=F4,2
                                                                           365
    /7H AMINF=F6_4)
                                                                           366
330 FORMAT (8110.3)
                                                                            367
370 FORMAT(/* MUST STOP ITERATIONS, CLOSE TO TIME LIMIT.*/
                                                                           368
   • • COMPUTING TIME #*F6,1* TIME LIMIT#*F6,1/
                                                                            569
   * * RMAX=*E9,2*, COVR=*E9,2)
                                                                           370
420 FORMAT(/+ DYDXN#+F10,4,/+ DYDXT#+F10,4,/+ YMAX#+F10,4,/+ XREF=+
                                                                           371
                                                                           372
   * ,F10,4)
430 FORMAT (/,44H CPU SECONDS FOR BODY GEOMETRY COMPUTATIONS=,F6.3/)
                                                                           373
450 FORMAT (10X, 1HJ, 4X, 2HAN, 10X, 1HG, 11X, 2HGH/)
                                                                           374
451 FORMAT(/,+1===== NORMAL COORD, 5 ETCH FOR ALF=+F6,3+ ====+/)
                                                                           375
                                                                           376
460 FORMAT (112, 3E12.4)
470 FORMAT (1H1,9X,1HI,4X,1HS,11X,1HX,11X,1HY,10X,4HTHET,8X,5HTHET8,8
                                                                           377
                                                                           378
   1X,2HAK,10X,1HF//)
480 FORMAT (112,8E12.4)
                                                                           379
490 FORMAT(1H1,2X,2HIT, 3X5HOPMAK,5X2HID,2X2HJD,3X4HRMAX,6X2HIR,2X2HJR,
                                                                           380
   1 1X4HISUB, 1X4HISUP, 3X4HRAVG, 6X3HRF1, 4X3H9F3, 6X2HNS,
                                                                           381
   2 3x7HSEC/CYC/)
                                                                           382
500 FORMAT(15,E11,3,214,E11,3,214,215,E11,3,2F7,3,16,F9,3)
                                                                           383
510 FORMAT(13HOCPU SECONDS=, F7, 2, 4H FOR, 14, 19H ITERATIONS, NHALF=11/)
                                                                           384
600 FORMAT (47HOCPU SECONDS TO COMPUTE AND PLOT CP AND MCHART=, F7.3/)
                                                                           385
610 FORMAT(///* ---------DIVERGENCE, RMAX EXCEEDS RCHEK.*
                                                                           386
   $ * GO DIRECTLY TO "AIL, DO NOT PASS GO, DO NOT COLLECT $200,4--*
                                                                           387
   388
680 FORMAT(/+ OF3 INCREASED TO+F6.3+ BECAUSE 10+CYCLE AVERAGE UF*
                                                                           389
                                                                           390
  1 • RMAX INCREASED. #/)
700 FORMAT(/+ +++CONVERGENCE++++, RMAX=+E9,2+, COVR=+L9,2/)
                                                                           391
710 FORMAT(/* RF1 DECREASED TO+F6, 3* BECAUSE 10+CYCLE AVG FOR+
                                                                           392
   1 * RMAX INCREASED. #/)
                                                                           393
720 FORMAT(/+ INPUT COORDINATES+/4X1H14X1HX9X1HY/(15,2F10_6))
                                                                           394
                                                                           395
    FND
    SUBROUTINE FIT(N, X, Y, S, X1, X2, Y1, Y2, DY1, OK1, DY2, DX2)
                                                                           396
    DIMENSION X(1), Y(1), S(1), X1(1), X2(1), Y1(1), Y2(1)
                                                                           397
                                                                           398
    RES#1.0E=07
                                                                           100
    TOL=_0625+RES
                                                                           400
    K=0
    KMAX=500
                                                                           401
              = 0,
    5(1)
                                                                           402
                                                                           403
    М
              8 N
                   01
    DO 22 1=1,M
                                                                           404
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VAL x(1+1) = x(1) 405 = Y(I+1) =Y(1) DUM 406 ■ \$(1) +\$QRT(VAL++2 +DUH++2) 22 8(1+1) 407 31 CALL SPLIF(1, M, S, X, X1, X2, X2, 1, DX1, 1, DX2, IND) 408 SPLIF(1,N,S,Y,Y1,Y2,Y2,1,DY1,1,DY2,IND) CALL 409 = 0_. ERR 410 OUH. . 0. 411 00 32 I=1,H 412 \$0 = S(I+1) =DUM 413 DUM = S(I+1) 414 31 = \$(I+1) =5(I) 415 = (X2(1+1) =X2(1))/S1 = (Y2(1+1) =Y2(1))/S1 X3 416 ¥3 417 ARCL (\$1,50,X1(I),X2(I),X3,Y1(I),Y2(I),Y3,R,IND,TOL) CALL 418 VAL = A85(S1 =80) 419 IF (VAL -ERR) 32,32,33 420 33 ERR * VAL 421 32 5(1+1) = 3(1) +51 422 K=K+1 423 IF (K, LE, KMAX)GO TO 34 424 WRITE(6,9901) 425 RETURN 426 34 CONTINUE 427 IF (ERR =RES) 41,41,31 428 41 RETURN 429 9901 FORMAT(* FIT FAILED TO CONVERGE*) 430 END 431 SUBROUTINE SPLIF(M,N,S,F,FP,FPP,FPPP,KM,VM,KN,VN,INC) 432 SPLINE FIT - JAMESON 433 DIMENSION S(1), F(1), FP(1), FPP(1), FPPP(1) 434 IND = 0 435 ĸ 436 IF (K =1) 81,81,1 437 1 ĸ = (N =M)/K 438 1 3 M 439 J E M **♦**Κ 440 # \$(J) +8(I) 0S 441 = 0S D 442 IF (DS) 11,81,11 443 11 DF = (F(J) =F(I))/DS 444 IP (KH -2) 12,13,14 445 12 U **.**,5 446 = 3,*(DF = VM)/DS ۷ 447 60 TO 25 448 = 0, 13 U 449 v VH 450 GO TO 25 451 14 U = =1. 452 v ■ ●DS+VM 453 GO TO 25 454 21 # J 455 **≋ J →**K .1 456 DS = S(J) = S(I)457 (D*DS) 81,81,23 IF. 458 23 DF = (F(J) =F(I))/DS 459 = 1./(DS +DS +U) 0 460 υ 3 8≠D3 461 ۷ ■ 8+(6,+DF =V) 465 25 FP(I) 8 U 463 FPP(I) **H** V 464

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465 = (2, -U)=D8 = 6, +DF +DS+V U 466 467 1F (J =N) 21,31,21 468 31 IF (KN =2) 32,33,34 469 35 V # (6. #VN =V)/U 470 GO TO 35 471 33 V S VN 472 GO TO 35 473 # (DS+VN +FPP(I))/(1, +FP(I)) 34 V 474 35 8 # V 475 D . 09 476 = S(J) =S(I) 41 DS 477 s FPP(I) = FP(I) + V U 478 = (V =U)/DS FPPP(I) 479 FPP(1) = U 480 = (F(J) =F(I))/D8 =D5+(V +U +U)/6. FP(I) 481 = U v 482 J = I 483 • 1 • **K** 1 484 IF (J =M) 41,51,41 485 51 FPPP(N) = FPPP(N=1) 486 FPP(N) **=** 8 .87 # DF +D+(FPP(N=1) +B +B)/6. FP(N) 1 2 488 = 1 489 81 RETURN 490 END 491 SUBROUTINE ARCL (S.STEP, X1, X2, X3, Y1, Y2, Y3, M, N, TOL) CALCULATES ARE LENGTH USING FIRST THREE DERIVIATIVES OF X AND Y 492 493 = STEP DP 694 # ,5+DP P 195 N = 1 496 = SQPT(X1++2 +Y1++2) S 497 = X1 +STEP*(X2 +.5+STEP*X3) XX 498 # Y1 +STEP+(Y2 +,5+STEP+Y3) 44 495 # 5 +SQRT(XX##2 +YY##2) \$ 500 = X1 +P*(X2 + 5*P*X3) = Y1 +P*(Y2 + 5*P*Y3) XX 50: YY. 502 = SORT(XX#+2 +YY++2) 8UM 503 SUM # SUH+DP+2,/3; 504 = SUM +3+0P/6. 8 505 00 12 I=2,M 506 31 = 5 € ,5*(S ...,5*SUM) 507 8 508 OP = ,5+DP = .5+DP 509 P # X1 +P#(X2 +,5*P*X3) # Y1 +P*(Y2 +,5*P*Y3) 510 XX 511 YY = SORT(XX*+2 +YY+=2) 512 SUM 513 = 2+N N 514 = N =1 L 515 00 14 K#1/L 516 D 8 P +DP # X1 +P+(X2 +,5+P+X3) # Y1 +P+(Y2 +,5+P+Y3) 517 XX 518 YY = SUH +SORT(XX++2 +YY++2) 519 14 SUM 520 # SUM+DP+2,/3. SUM 521 # \$ +\$UM 5 522 = 5/31 =1. ERR 523 IF (ABS(FRR) -TOL) 21,21,12 524 12 CONTINUE

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21	RETURN END Subroutine Estim (P,ID,IMAX,JMAX)	52 52 52
	GIVES INITIAL ESTIMATE OF POTENTIAL AS ZERO PERTURBATION	52 52
	DIMENSION P(ID,1)	53 53
	DO 40 1=1,1PAX	53
	DD 40 J#1,JMAX 2(7.1)=0	73 51
40	PETURN	55
	END	53
	OVERLAY (JERRY, 1, 1)	53
	PROGRAM ONE1	53
	COMMON P(81,82)	53
	COMMON XH(81);70(81);CM(81) Common Theff/81);50(81);CT/81);CT/81);W1/81);W2/81);W3/81)	24
	★ .www.cal).w5(al).y8P(al).DPC(al).f(al).AK(al).S(al)	54
	COMMON /BLOK1/ XST	50
	COMMON /BLOK2/ PI,RAD	54
	COMMON /BLOK3/ IMAX, DUMMY(17), KLOSE	50
	COMMON /RLOK5/ JM1,DY,I1	54
	• VOR(100), VORP(100), VORPE(100), XOP(100), XOPP(100), XOPPE(100),	
	COMMON /BLOK7/ SMAX,S1,XM,XIM,A4,DXIDX0,DXIDXM,A2,A3,X'),XI1,CXM.	54
	+ DX,X1D,XREF	55
	DIMENSION X81(100), Y81(100), X82(100), YH2(100)	55
	DIMENSION D1(101), D2(101), D3(101), D4(101), D5(101)	55
	IF (KLOSE , EQ, 0) GD TO 100	55
	\$ MAY#\$^^`	22
	A=(3.+SHAX+DX1DX0)/2.	55
	B=4,+(SMAX=A)	5
	D%=1,/(IMAX=1)	55
	XX#0	25
	UU } ]#];[MAX 8/7)# Sedmava/vva Stalada/vva Stae31	56
		56
	F(I)=1./DXIDX	56
	XXXXX+DX	56
1	CONTINUE	56
	CALL INTPL(1, 1HAX, 5, X8, X81, XA2, 1, 1XY, 500, X0, X0P, X0PP, X0PPP)	56
	DO 4 TEL THAY	
	AK(1)=SQRT(X82(1)++2+Y82(1)++2)	56
	IF (XA1(I), LE, 1, )GO TO 2	57
	WRITE(6,9901)#81(1),1	57
•	XB1(1)=1.	57
2	CONTINUE	51
	WRITE(A.9902)VRI(I).T	51
	YB1(I)=\$1GN(1YU1(1))	57
3	CONTINUE	57
	THETX=SIGN(ACOS(XB1(I)),YB1(I))	57
	THE TYPASIN (YB)(I))	57
h	18871115 CONTINUE	5C 4 2
-	THET(1)8.50P1	50 58
	THET(IMAX)Be 5+PI	58
	RETURN DD.	58
	Op CIAL.	
	PONAD	ე
	VA CAGN	2
	NUAT TO DE	

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585 100 CONTINUE CALL HORTAN(IXY, XO, YO, SOO, XOP, XOPP, XOPP, YOP, YOPP, YOPP, SHT, XHT 586 + ,YHT,IOBHT) 587 588 XST=XO((XY) S1#SHT 589 590 X10=XHT 591 CALL SETUPO(IMAX,S1,XM,XIM,A4,DXIDXO,DXIDXM,A2,A3,CXM,DX,X10) DX=1./(IMAX=1) 592 XXHO. 593 594 DO 101 I=1, IMAX 595 CALL SDRIVO(XX,SS,DXIDX,XIM,A4,DXIDXO,DXIDXM,A2,A3,CXM) 596 S(1)=85 597 F(I)=1,/DXIDX 598 IF(S(I),LE,S1)II=I 500 XX = XX + DX101 CONTINUE 600 CALL IN (PL (1, 11, 5, X8, X81, X82, 1, 1XY, S00, X0, X0P, X0PP, X0PPP) 601 CALL INTPL(1,11,5,YB,YR1,Y82,1,1XY,S00,Y0,Y0P,Y0PP,Y0PP) 602 DO 104 I=1,I1 603 AK(I)=SQRT(X82(I)++2+Y82(I)++2) 604 IF(XB1(I).LE.1.)G0 T0 1(2 605 WRITE(6,9901)XB1(I),I 606 XB1(1)=1. 607 102 CONTINUE 608 IF(ABS(YB1(I)), LE, 1, )GD TO 103 609 WRITE(6,9902) YB1(7),1 610 YB1(I)=SIGN(1,,YB1(I)) 611 516 **103 CONTINUE** THETX=SIGN(ACOS(XB1(I)),YB1(J)) 613 THETY=ASIN(YB1(I)) 614 THET(1)= S+(THETX+THETY) 615 **104 CONTINUE** 616 THET(1)=,5+PI 617 IF (IOBHT.LT.IXY)GD TO 105 618 12=11 619 GO TO 111 620 105 CONTINUE 621 IOT#IOBHT+1 625 D1(IOT)=XHT 623 DS(IO1)=AH1 624 DO 107 I=IOT, IXY 625 D1(1+1)=XD(I) 626 D2(I+1)=YO(I) 627 **107 CONTINUE** 628 IXYP1=IXY+1 629 CALL SPLIF (IOT, IXYP1, D1, D2, D3, D4, D5, 1, 0, , 1, DYDX1, IND) 630 631 IMAXH1=IMAX=1 11P1=I1+1 632 DO 108 IFI1P1, IMAXM1 633 DS#5(1)-5HT 634 XB(I)=XHT+D8 635 IF(XB(I),GT,XO(IXY))GO TO 108 636 15=I 637 108 CONTINUE 638 CALL INTPL(11P1,12,X8,Y8,Y81,Y82,IOT,1XYP1,01,02,03,04,05) 639 DO 110 I=I1P1,I2 640 YK(1)==A85(1) 641 642 THETB(I)=ATAN(YB1(I)) 643 THET(1)=0. 110 CONTINUE 644

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645 111 CONTINUE 646 12P1=12+1 647 XAMI, 1912 INIZ 11 00 648 DS=S(I)=SHT 649 X8(I)=XHT+DS 650 YB(T)=YO(IXY) 651 AK(I)=0. 652 THET(I)=0. 653 THETB(I)=0. 654 112 CONTINUE 655 RETURN 656 9901 FORMAT(* X81=*E16,8* AT I=*I3) 657 9902 FORMAT(* Y81(I)=*E16.8* AT I=*I3) 658 END SUBROUTINE INTPL(MI,NI,SI,FI,FIP,FIPP,M,N,S,F,FP,FPP,FPPP) 659 660 INTERPOLATION USING TAYLOR SERIES - JAMESON DIMENSION SI(1), FI(1), FIP(1), FIPP(1), S(1), F(1), FP(1), FPP(1) 661 662 • ,FPPP(1) 663 = IARS(N =M) ĸ 664 = (N =M)/K ĸ 665 s M 1 666 a MI MIN 667 = NI NIN 668 = \$(N) -\$(M) 0 669 IF (D*(SI(NI) -SI(MI))) 11,13,13 670 11 MIN a NI 671 NIN z MI 672 = IABS(NIN =MIN) 13 KI 673 IF (KI) 21,21,15 674 ■ (NIN →MIN)/KI 15 KI 675 = MIN =KI 21 II 676 = II +KI 31 II 677 = SI(II) **S S** 678 = I +K 33 1 679 IF (I =N) 35,37,35 680 35 IF (D*(8(1) +SS)) 33,33,37 681 37 CONTINUE 682 = I =K = SS =S(I) 1 683 SS 684 FIPP(II)=FPP(I)+SS+FPPP(I) FIP(II)=FP(I)+SS*(FPP(I)+SS*FPPP(I)*.5) 685 FI(II)#F(I)+SS*(FP(I)+,5*SS*(FPP(I)+SS*FPPP(I)/3.)) 686 687 IF (II =NIN) 31,41,31 688 41 RETURN 689 END 690 SUBROUTINE SETUPO(IMAX, S1, XM, XIM, A4, A1, BB, A2, A3, CXM, DX, X10) 691 XIMES1+XMeX10 692 DX=1./(IMAX=1) 693 CISKJ4/CXH+A1 690 C2#88#A1 695 C3=2.+CXM+88/(1.+CXM) 696 X2#CXM##2 697 X4=X2**2 698 X6=X4+X2 699 A2=(70,+C1-22,+C2+2,+C3)/16,/X2 700 A3=(-84,+C1+36,+C2=4,+C3)/16,/X4 701 A4=(30,=C1=14,=C2+2,=C3)/16,/X6 702 RETURN 703 END 704 SUBROUTINE SDRIVO (XX,S,DXIDX,XIM,A4,A1,BB,A2,A3,CXM)

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705 -----CALCULATES & AND DXIDX AS FUNCTIONS OF X 706 707 708 IF (XX.GT.CXM) GO TO 10 709 X2=XX++2 710 X4#X2**2 711 X6=X4=X2 712 T1=A2+X2 713 12=A3+X4 714 T3=A4+X6 715 S=XX*(A1+T1+T2+T3) 716 DX1DX=A1+3.*11+5.*T2+7.*i3 717 RETURN 718 10 IF(AHS(XX=1,),LE,1,E=06) GO TO 20 719 T=XX=CXM 720 T1=1_/(1_=T/(1_=CXM)) 721 S=XIM+BB*T*T1 722 DXIDX=BB+T1++2 773 RETURN 724 20 S=1.E+30 725 DXIDX=1,E+30 726 RETURN 727 END SUBROUTINE HORTAN (N, X, Y, S, XP, XPP, XPPP, YP, YPP, YPPP, SHT, XHT, YHT, IH) 728 DIMENSION X(1), Y(1), S(1), XP(1), XPP(1), XPPP(1), YPP(1), YPP(1), YPP(1) 729 730 DIMENSION SH(1), XH(1), YH(1), DUM(1) 731 DO 1 1=1,N 732 IF(YP(I).LT.0.)G0 10 2 733 THEI 734 1 CONTINUE 735 2 CONTINUE SHT=S(IH)+YP(IH)/(YP(IH)=YP(IH+1))+(S(IH+1)=S(IH)) 736 737 SH(1)=SHT CALL INTPL(1,1,SH,XH,DUM,DUN,1,N,S,X,XP,XPP,XPPP) 738 CALL INTPL(1,1,SH,YH,DUH,DUM,1,N,S,Y,YP,YPP,YPPP) 739 740 XHT=XH(1) 741 VHT=VH(1) 742 RETURN 7:3 END 744 EVERLAY (JERRY, 1,2) 745 PROGRAM ONE2 746 COMMON P(81,82) 747 COMMON X8(81), Y8(81), CP(81) COMMON THET(81), THETP(81), ST(81), CT(81), H1(81), H2(81), H3(81) 748 * , W4(61), W5(81), Y6P(81), DPD(81), F(81), AK(61), S(81), LS(81), FM(81) 749 COMMON AV(81), G(61), GH(81), CB(81), D(81), X1(81), X2(81), M(81), HR(81) 750 751 1, HRP (81), HRM (81), HRMM (81) 752 COMMON XS(400), YS(400) 753 COMMON ID, ANMAX, DNDYO, YMAX, CD, HMSQ, JSKP COMMON /BLOK2/PI, RAD/BLOK3/IMAX, JMAX, C2, RF1, DPM, IDP, J 754 1DP, RPM, JR, JR, NS, GM102, A05Q, DXSQ, DXDY, DYSQ, DX2, DY2, KLOSE 755 COMMON /BLOK5/ JM1, DY, I1, JSUP, JSON, GF3, ISUB, ISUP, SUMRP 756 COMMON /BLOK7/ SMAX, S1, XM, XIM, A4, DXIDXD, DX1DXH, A2, A3, XIO, XI1, CXM, 757 758 * DX 759 COMMON/BLOK8/ALF 760 CALL NTRANF (AN, ANMAX, JHAX, DNDYD, DY, G, GH, ALF) CALL WIND(THET, THETB, YB, YBP, W1, W2, W3, W4, W5, ST, CT, G(JMAX), DNDYO 761 762 * ,DY,I1,IMAX,KLOSE,ALF) 763 RETURN 764 END

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	SUBROUTINE NTRANF (X,XMAX,JMAX,ONDYQ,DY,G,GM,ALF)	765
		766
		767
		768
		749
	DIMENATUN X(1), G(1), GH(1)	707
	B=1,/DNDY0	110
	IF (XMAX,GE,1,E+06) GO TO 10	771
	A=B=1./XMAX	772
	Kan	773
		774
		775
10	K=1	112
	A=B	176
20	DY=1./(JMAX=1)	777
	DO 50 JæleJMAX	778
	7FTAR1. =(Jet)=DY	779
		780
		781
	AAU(1ZEIA)KRAUP	101
	X (J)=ZETA/B/AA	185
	GO TO 40	783
30	G(1)=0.	784
		785
		784
40	$G[J] = D \times A K = [1] = 2 C + A J / (1) = (1) = A C + J \times 2 C + A J$	100
	IF (J_EQ_1) GO TO 50	/0/
	GH(J=1)=,5*(G(J)+G(J=1))	788
50	CONTINUE	789
• •		790
		791
		702
	GR (JMAX)= SR (GJP1+G(JMAX))	776
	RETURN	143
	END	794
	SUBROUTINE WINZ (THET, THETB, YB, YBP, N1, WZ, N3, W4, N5, ST, CT, G, DNDYD	795
	* - CY. TI. TMAX. KLOSF. ALF)	796
		797
		708
		736
		5.0.0
	DIMENSION THET(1), THETB(1), TH(1), THP(1), HI(1), HZ(1), HZ(1), H	600
	14(1), W5(1), ST(1), CT(1)	601
	DO 10 I=1,IMAX	802
	ST(I)=SIN(IHFI(I))	803
• •		804
10		805
		001
	YBP(I)=0.	CUB
	W1(I)=1.	807
	₩2(1)=0.	808
	W3(I)=1.	609
		810
		811
•	W5(1)=2,#U7/G	011
20	THE 18 (1) # THET (1)	012
	IF (KLOSE.EQ.1) RETURN	613
	1101011+1	814
	DO 30 1H11F1, IMAX	815
		816
	107 (J)-100 (100 (101 / 100 )	A17
	H3 \1 J = 1 4 4 10 F \1 J = 7 6	011
	NC(1)=TOM(1)/W1(1)	010
	Y1=DY	819
	IF(YB(I),GE,DNDYO)GO TO 25	820
	YBOA=YB())/DNDYD	821
	YAR Y BOA - AI F + YBDA + + 20 AI F + (3, + AI F + 1, 1/2, + YBDA + +3	622
		821
	# ##EF#{\$U\$###UF##E#IE\$##EF#E}/U\$*100#### ###EF#{\$U\$###UF##E#IE\$##EF#E}/U\$*100####	22 J
	$\mathbf{I}$ T T T T T A J A U A V T J U U U U C V	024

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		¥1=0¥+2, +¥4	
	2	5 CONTINUE	825
	-	Y100YTY1/DY	826
		W3(I)=Y10DY++2	627
		W4(1)=1.ew3(1)	028
		"5(I)==Y1+(1,=Y10DY)/G	029
	30	0 CONTINUE	874
		RETURN	813
		END	A71
		OVER'AY(JERRY,1,3)	834
		PROGRAM ONE3	835
C			836
C		BULITION OF POTENTIAL EGN, BY CULUMN RELAXATION	837
Ç			e.7.9
		COMMIDN * (81,82)	839
		CREMUN X1(81), YB(81), CP(81)	840
		LUPMON THET (81), THETE(81), ST(81), CT(81), W1(81), W2(81), W3(81)	841
		<pre>* # 4 (01),* 5 (01),* 6 (01), 00 (01), F (01), AK (01), S (01), LS (01), FM (01)</pre>	842
		L.HOPANA HEMPSILA MOMPSILA	843
		COMMON /REDUKT THAY IMAY CO OFT DOW TOD TOD DOW TO TO TO THE TO	844
		AADSO, DISO, DISO, LI WAJG WAJCZARIJ, DER IDP, JDP, HPM, IR, JR, NS, GM102	845
		EDMMON /ALOKS/ JM1.DV.TI.JSUP.IBON.053.TRUP.TSUD.SUMDD	846
		SUMRPEO.	847
		OF1=1./RF1	848
		JOHZAJSUP	850
		IF (J0,E0,2) JC=2+JSON	650
		JP1=JMAX+1	852
		XAME=L	852
		DO 10 I=1,I1	854
	10	DPO(1)=ST(1)	855
		IF (KLOSE EG, 1) GO TO 30	856
		11P1=11+1	857
			858
	3.0	DU 20 IIIIPI,IMAXMI	859
	20	<pre>OPU(j)=##(I)*(I,+F(1)*DX2*(P(I+1,J)=P(I=1,J)))</pre>	860
		UPITALY=====(IMAX,JMAX)=4.444(IMAX=1,JMAX)+P(IMAX=2,JMAX)	861
	30	CUTTARJ=W2(1-8x)=(',+*(IMAX)+DX2+DV1)	862
r	30	CONTANC	863
č		PPPPPPTART & CYCLE AT INVESTAGE RT NOTON	864
č			865
•		DPM=0.	000
		RPMaDPM	007
		1=1	840
		J=]0	870
		NS=Q	871
		KS=0	872
		IIN1=I1=1	873
		A6=0,	874
		B1=0.	875
		84E0.	876
			877
	40	12 (1 20 2) 100+3 1004165	878
c		st frachter funte	879
č		PRESECOMPLITE CHANTITIES DEPENDING ON I HONE	880
č			881
-		FD=F(1)+0x2	882
		FD1=F(J)+DXSQ	663
			014

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885
  F02=F(I)+DX0Y
                                                                              886
  KS=0
                                                                              887
  CC=0.
                                                                              888
  DOUCC
                                                                              889
                                                                              890
   ----- COMPUTE QUANTITIES DEPENDING ON 1 AND J -----
                                                                              891
                                                                              892
50 CONTINUE
                                                                              893
   HRMM(J)=HRM(J)
                                                                              894
   HRM(J) = HR(J)
                                                                              895
  HR(J)=HRP(J)
                                                                              896
   IF (I.GT.IIM1) GO TO 60
                                                                              897
   HRP(J)=1./(1.+AK(I+1)*AN(J))
                                                                              898
   GO TO 70
                                                                              899
60 HRP(J)=1.
                                                                              900
   A5=0,
                                                                              901
TO CONTINUE
                                                                              902
   S1=PD1+HR(J)
                                                                              903
   S2=FD2+G(J)+HR(J)
                                                                              904
   $3=G(J) +0Y5Q
                                                                              905
   $4#G(J) +DY2
                                                                              906
   S5=FD+HR(J)
                                                                              907
   HF = F(I) + HR(J)
                                                                              908
   TIM=F(I=1) +HRM(J)
                                                                              909
   FHM=,5+(HF+TIM)
                                                                              910
   AKH=AK(I)+HR(J)
                                                                              911
   RR#1./(YB(I)+AN(J)*CT(I))
                                                                              912
                                                                              913
   ----COMPUTE PHI-DIFFERENCES FOR VELOCITY COMPONENTS, NOTE
   INCREASING J MEANS DECREASING NORMAL (ZETA OR N) COORDINATE.----
                                                                              914
                                                                              915
                                                                              916
   DPI = P(I+1, J) = X1(J)
                                                                              917
   DPJ=P(I,J=1)=P(I,J+1)
                                                                              918
   PPJJ=GH(J=1) + (P(I,J=1)=P(I,J))=GH(J) + (P(I,J)=P(I,J+1))
                                                                              919
   U=CT(I)+DPI+85=YHP(I)+DPJ+84
                                                                              920
   v = -ST(I) + DPJ + S4
                                                                              159
   VB=V=Y8P(I)+U
                                                                              922
   L=1
                                                                              923
   IF (V,LT,0,) L==1
                                                                              924
   IF (J.EQ.JMAX) L==1
                                                                              925
   T=L
                                                                              926
   UU=U+U
                                                                              927
   VVEVAV
                                                                              859
   QQ=UU+VV
                                                                               929
   AA=AOSQ=GM102+QQ
                                                                              930
   AR=1./AA
                                                                               931
   74=1.=UU+AR
                                                                              932
   UV=U+V
                                                                               933
   UVAREUV+AR
                                                                               934
   A4=[AKH+T4+RR+CT(I)]+84
                                                                               935
   IF (I.GT.II) GO TO 80
                                                                               936
   A5=(2.*AKH+UVAR+RR+ST(I))*55
                                                                               937
80 CONTINUE
                                                                               938
   FH=,5*(HF+F(I+1)*HRP(J))
                                                                               939
   DPIJ = P(I+1, J-1) = P(I+1, J+1) + P(I-1, J+1) = P(I-1, J-1)
                                                                               940
   DP1I=FH*(P(I+1,J)=P(I,J))=FHM*(P(I,J)=P(I=1,J))
                                                                               941
   B1=0,
                                                                               942
   04×0,
                                                                               943
    A6#0.
                                                                               944
    IF (DG.LT.AA) GO TO 120
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	BACKWARD SECOND DIFFS FOR SUPERSONIC FLOW	945 946
		947
	NJ=NJ+1 (P=1 /00	948
	S1=S1+OR	949
	S2=S2+QR	951
	\$3#\$3+0R	952
	AUU=UU+S1	953
	AVV=VV+91	954
	UB=U+YBP(I)+V	955
		456
		957
	15 /DE3 (E 1 E_0A) CO 70 91	958
	FAC#SORT(ABS(1, =00/AA))	959 94 0
	B1##GF3+FAC+ABS(VB)+G(J)+DXDY	960
	B4mQF3+FAC+U+FD1	942
	A6=B4*(P(1=1,J)=X1(J))	963
91	CONTINUE	964
	DPNN#AVV*DPII#8UVN*DPIJ+CUU*DPJJ	965
	KM=(J+J=1+L)/2	966
	JW=`J•	967
	IF (JM,GT.1) 50 TO 100	968
	Jum 21	969
	KMM#] CO TO 110	970
100	REMARMAN	971
100		9/2
110	CONTINUE	97/
•••	FHMM=,5+(TIM+F(IMM)+HRMM(J))	975
	DPII=FHM+(P(I,J)=P(I=1,J))=FHMM+(P(I=1,J)=x2(J))	976
	$DPIJ=P(I,J^{H})=P(I,J)+P(I=1,J)=X1(J^{H})$	977
	BUVSaw4.+S2+T+U+VB	978
	A29=GH(KMM)+GH(KM)	979
	DPJJ = GH(KMM) + P(1, JMM) = A2S + P(1, JM) + GH(KM) + P(1, J)	980
	DPSSEAUU+CPII/RUVS+DPIJ+CVV+DPJJ	981
	A13=18=9958AR D3= 5+110+(130+000-00000)	982
	D2=, J#A13*(423*(VV=DUV3) RlsR(1A2	ز 89
	A=(1.=T)+H3=CHH+GH(J=1)=A4	964
	C=(1.+T)+83=CUU+GH(J)+A4	986
	B==A=C+A1S+(HUVS=2.+AUU+FHM)+AVV+FHM+B4	987
	RP=A1S+DPSS+DPNN+A4+DPJ+A5+DPI+A6	988
	ARP=ABS(RP=Ab)	989
	8UMRP=SUMRP+ARP	990
	IF (ARP, LE, RPM) GD TO 140	991
		992
		993
	1D e 1	994
	KPN=ARP	995
	GO TO 140	440
120	A1=T4+S1	997
•	A2#(14#YBP(1)+UVAR)+S2	990
	A3=(+1(1`+AR+VB++2)+S3	1000
	RP=A1+UPII=A2+DPIJ+A3+DPJJ+A4+DPJ+A5+DPI	1001
	ARPEABS (RP)	1002
	SUMRPESUMRP+ARP	1003
	IF (ARP,LE,RPM) GO TO 130	1004

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19U8=1 1005 ISUP=0 1006 1007 IR#I **JRJ** 1008 RPMBARP 1009 C C 1010 1011 ----COMPUTE TRIDIAGONAL COEFFS-----C 1012 1013 130 A==A3+GH(J=1)=A4 1014 C = A 3 + G H (J) + A 41015 B==A=C+QF1+A1+(FH+FHM) 140 CONTINUE 1016 B=1,/(B+A+CC) 1017 CC=8+C 1018 DD=B+(RP=A+DD) 1019 IF (J.EQ.JMAX) GD TO 150 1020 CB(J)=CC1021 D(J)=DD 1022 J#J+1 1023 GO TO 50 1024 150 DP=00 1025 IF (ABS(DP), LE, DPM) GU TO 160 1059 CPM=ABS(DP) 1027 IDP=I 1028 JOP=J 1029  $160 \times 2(J) = \times 1(J)$ 1030  $X1(J)=P(I_J)$ 1031 P(1, J)=P(1, J)+DP 1032 DD 190 JJ=J0,J*1 1033 J=J=1 1034 DP=D(J)=CB(J)+DP1035 IF (ABS(DP).LE.DPM) GO TO 180 1036 DPM=ABS(DP) 1037 IDP=1 1038 JDP#J 1039  $180 \times 2(J) = \times 1(J)$ 1040 1041 X1(J) = P(I,J)190 P(1,J)=P(1,J)+DP 1042 1043 **J=J**0 LS(I)=KS 1044 1045 NS#NS+KS P(1, JMAX+1)=W3(1)+P(1, JMAX+1)+W4(1)+P(1, JMAX)+W5(1)+DPO(1) 1046 1047 Ç AXIS, IF BODY IS OPEN, I=IMAX IS EITHER NOT COMPUTED (SUBSONIC FREE ¢ 1048 C 1049 C STREAM, P(IMAX, J)=0.) OR EXTRAPOLATED(SUPERSONIC FREE STREAM)=----1050 C 1051 IF (I.EQ.IMAX) RETURN 1052 1=1+1 1053 IF (I.EQ.IMAX) GO TO 200 1054 1055 GO TO 40 200 IF (KLOSF,EQ.1) GO TO 230 1056 IF (JSON+JSUP,LT,1) GO TO 220 1057 191,01#1 015 00 1058 210  $P(I,J)=3,\pm(P(I=1,J)=P(I=2,J))+P(I=3,J)$ 1059 220 RETURN 1060 1061 C C C -----SPECIAL EQNS FOR SYMMETRY AXIS, I=1 OR IMAX------1062 1063 230 CC=0, 1064

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		DO=CC	1065
		\$1#2,*DX\$Q#F(])**2	1066
		83=AK(I)+DY2	1067
		IF (1.E0.1) GD TO 250	1068
	540	DO 240 JJ=2, JMAX	1069
	240	THE (JJ) HEE (JJ)	1070
		14141 14141	1071
			1072
		TC=1.	1075
		IF (1.EQ.14AX) GO TO 270	1074
	250	1M#2	1076
		1=1	1077
		TAE1.	1078
		TC=0,	1079
		DD 260 JJ=2, JMAX	1080
		MR(JJ)=},/(1,+AK(1)+AN(JJ))	1081
		NRT(JJ)=1;/(;;+AR(C)#AN(JJ)) HDM/111=HDD/111	1042
	260	x1(1)=P(2,1)	1083
	270	DP115P(TM.1)=P(T.1)	1064
		DPJ=P(I,J=1)=P(1,J+1)	1056
		V=+ST(1)+DY2+G(J)+DPJ	1087
		VVzVaV	1048
		AA#AOSQ=GM102±VV	1069
C			1090
C		PRANEWOUTE COEFFS OF DIFF EQ, AT SYMMETRY AXIS	1091
C		41#3 AUD/11	1092
		*3*6/*0010) 43±93+41+6/13	1093
		A1#A1+S1+HR(J)	1044
		A2=(1.=VV/A4)*G(J)+DYSQ	1095
		B1=0,	1097
		KSUP=0	1098
		KSUB=0	1099
		IF (J.EQ.JM1, AND. J.EQ. IMAX) GO TO 290	1100
	200	$\frac{1}{100} \left( \frac{1}{100} + 1$	1101
	240	CD TO 11A	1105
	300	CONTINUE	1103
		IF (QF3.LE.1.E-06) GO TO 301	1104
		FAC=SORT(ABS(1=VV/AA))	1105
		81=+485(V)+FAC+G(J)+2,+0X0Y+0F3	1107
	301	CONTINUE	1108
		KSUP#1	1109
			1110
		KAN-KA-1 KAE(J+J=J=F)/5	1111
		.1Mm 1	1112
		JHMAJMel	1113
		A2S=GH(KHM)+GH(KM)	1114
		DPJJ = GH(KMM) + P(I, JMM) = A2S + P(I, JM) + GH(KM) + P(I, J)	1116
		B#A25+A7+B1	1117
		A=TA+8-A3	1118
			1119
		D==D[A]	1150
	310		1151
		C==A2+GH(J)+A3	1122
		B==A=C+QF1=A1	1173
			1164

1125 KSU8=1 1126 320 RPHA1+DPII+A2+DPJJ+A3+DPJ 1127 ARP=ABS(RP) 1128 SUMRPESUMRP+ARP IF (ARP.LT.RPH) GO TO 330 1154 1130 RPM=ABS(RP) 1131 ISUB=KSUB 1132 ISUPEKSUP 1133 IREI 1134 JR=J 1135 330 CONTINUE 1136 B=1./(B=A+CC) 1137 CC=B+C 1138 DD=B+(RP=A+DO)1139 IF (J. EQ. JMAX) GO TO 150 1140 CB(J)=CC 1141 D(J)=00 1142 J=J+1 1143 GO TO 270 1144 END 1145 OVERLAY (JERRY, 1, 4) 1146 PROGRAM ONE4 1147 COMMON P(81,82) 1148 COMMON X8(81), Y8(81), CP(81) COMMON THET(81), THETB(81), ST(81), CT(81), W1(81), W2(81), W3(81) 1149 # , #4(81), #5(81), Y8P(81), DPO(81), F(81), AK(81), S(81), LS(81), FM(81) 1150 COMMON AN(81),G(81),GH(81),CB(81),D(81),X1(81),X2(81),M(81),HR(81) 1151 1152 1, HRP(81), HRM(81), HRMM(81) COMMON X8(400), Y8(400) 1153 1154 COMMON ID, ANMAX, ONDYO, YMAX, CD, RMSD, JSKP, TSP COMMON /BLOK3/IMAX, JMAX, C2, RF1, DPM; IDP, J 1155 :DP, RPH, IR, JR, NS, GH102, AOSQ, DXSG, DXDY, DYSG, DX2, DY2, KLOSE 1156 COMMON /BLOK4/ GMSA, GOGM1, TOGMSG, CPO, KSTAR 1157 COMMON /BLOK7/ SMAX, S1, XM, XIM, A4, DX10X0, OX10XM, A2, A3, X10, X11, CXM, 1158 1159 DX,X10,XREF CALL CPBODY (P,F,W1,YBP,DPO,CT,LS,CP,FM,ID,IMAX,JMAX,GM102 1160 + ,ADSQ,DX2,KLOSE,GMSQ,GOG41,TOGNSQ) 1161 1162 WRITE(6,570) WRITE(6, 580) (I,S(I),XB(I),YB(I),CP(I),FM(I),I=1,IMAX) 1163 1164 CALL DRAG(CP, YB, THET, THETB, F, RHSQ, IMAX, DX) CALL CPPLOT (S, XR, YB, CP, IMAX, CPO, KSTAR) 1165 1166 RETURN 570 FORMAT (1H1,8X,1H1,6X,2HSB,8X,2HXB,8X,2HYB,8X,2HCP,8X,1HM/) 1167 1168 580 FORMAT (110,3F10,3,2F10,5) 1169 END 1170 SUBROUTINE CPBODY (P,F,W1,Y8P,DPO,CT,LS,CP,FM,ID,IMAX,JMAX,GM102 + ,AOSQ, DX2, KLOSE, GMSQ, GOGM1, TOGMSQ) 1171 1172 ----COMPUTES SURFACE PRESSURE COEFFICIENT AND MACH NO. -----1173 1174 DIMENSION P(ID,1), F(1), W1(1), YBP(1), DPO(1), CT(1), LS(1), CP(1 1175 1176 1), PM(1) 1177 1178 JEJMAX 1174 Q=0, 1180 DO 60 1#1, THAX 1181 IP=I+1 1182 IPP=I+2 1183 IF (I.EQ.IMAX=1) IPP=I 1184 IMGI=1

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INM#1#2 1185 IF(I.EQ.1)GO TO 40 1186 IF (I,EG,IMAX) GO TO 50 1187 IF (1,EQ,2) 1HH#2 1188  $D_{J} = P(IM, J) = P(IM, J)$ 1189 GO TO 30 1190 20 CONTINUE 1191 DJ#3.*P(1,J)=4.*P(IM,J)+P(IMM,J) 1192 -----COMPUTE SURFACE VELOCITY-----C 1193 30 U=CT(I)+DJ+F(I)+DX2=Y8P(I)+DPO(I) 1194 Q=SQRT(W1(I))+U 1195 40 00=0+0 1196 AARAOSQ=GM102+00 1197 C 1198 -----BURFACE MACH NO. -----Ç 1199 FM(I)=SORT(00/AA) 1200 C 1201 C ----PRESSURE RATIO-----1202 PDPINF=(1.+GMSQ+(1.=GQ))++GOGM1 1503 C 1204 C ----- COEFF, -----1205 CP(I)=TOGMSQ+(PQPINF=1_) 1206 GO TO 60 1207 Ĉ 120A C -----IF I=IMAX IS NOT A SYMMETRY AXIS,USE BCKWD DIFF FOR DPSB----1209 50 IF (KLOSE, EQ. 0) GO TO 20 1210 C 1211 C ---- AXIS-----1212 Q=0. 1213 GO TO 40 1214 60 CONTINUE 1215 RETURN 1216 END 1217 SUBROUTINE DRAG(CP,R,THET,THETB,F,RMSQ,IMAX,DX) 1218 C 1219 *****COMPUTES DRAG COEFFICIENT BY INTEGRATION OF SURFACE PRESSURE Ĉ 1550 ¢ 1221 DIMENSION CP(1), R(1), THET(1), THETB(1), F(1) 1222 C 1553 Ĉ 1224 ---- TRAPEZOIDAL INTEGRATION-----C 1225 C 1559 SUM=0. D0 10 1=2,IMAX 1227 1258 10 SUM=SUM+(CP(I)+R(I)+CP(I+1)+R(I=1))+(R(I)=R(I=1)) 1229 COTRAP=SUM/RHSQ 1230 WRITE(6,540)CDTRAP 1231 IF (MOD(1MAX,2),NE,0) GO TO 15 1232 WRITE(6,9901) 1233 RETURN 1234 15 CONTINUE 1235 C 1236 -----SIMPSON INTEGRATION (ONLY IF IMAX ODD) -----C 1237 C 1539 SUME0. 1239 IMAXH1=IHAX=1 1240 2*1WXYW1*2#1 02 00 1241 20 SUM=SUM+CP(1)+R(1)+SIN(THETB(1))/(F'1)+COS(THET(1)+THETB(1))) 1242 SUME2.+SUM 1243 IHAXH201HAX+2 1244

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5.5WXAM1,5=1 00 00
                                                                                 1245
  30 8UM=8UM+CP(I)+R(I)+8IN(THETB(I))/(F(I)+COS(THET(I)-THETB(I)))
                                                                                 1246
                                                                                 1247
     COSIMP=4, +DX+SUM/(3, +RMSQ)
     WRITE(6,550)CDSIMP
                                                                                 1248
                                                                                 1249
     RETURN
 540 FORMAT (////47H
                         DRAG COEFFICIENT BY TRAPEZOIDAL INTEGRATION=.F8.
                                                                                 1250
    15)
                                                                                 1251
 550 FORMAT (//43H DRAG COEFFICIENT BY SIMPSON INTEGRATION=,FA.5)
                                                                                 1252
9901 FORMAT(/* NO DRAG BY SIMPSON INTEGRATION BECAUSE IMAX IS EVEN*)
                                                                                 1253
                                                                                 1254
     END
     SUBROUTINE CPPLOT (S,X8,Y8,CP,IMAX,CPO,KSTAR)
                                                                                 1255
                                                                                 1256
     DIMENSION S(1), XB(1), YA(1), CP(1), KODE(4), LINE(100)
     DATA KODE/1H , 1H+, 1H0, 1H+/
                                                                                 1257
                                                                                 1258
     WRITE(6,50)
                                                                                 1259
     DO 10 L=1,100
  10 LINE(L)=KODE(1)
                                                                                 1240
     LINE(KSTAR)=KODE(4)
                                                                                 1591
     DO 40 IEI, IMAX
                                                                                 1595
     K=4,5+30, +(CPO=CP(I))
                                                                                 1593
                                                                                 1264
     IF(K,GT,100) GO TO 30
                                                                                 1265
     LINE(K)#KODE(2)
                                                                                 1266
  30 WRITE(6,70) 1, %B(1), YB(1), CP(1), LINE
     LINE(K)=KUDE(1)
                                                                                 1267
  40 LINE(KSTAR)=KODE(4)
                                                                                 1265
                                                                                 1269
     RETURN
                                                                                 1270
                                                                                 1271
  50 FORMAT (33H1PLOT OF CP AT UNEQUAL INCREMENTS///3x,1H1,5x,2HxB
                                                                                 1272
                                                                                 1273
    + ,8X,2HYB,6X,2HCP//)
  70 FORMAT (14,2F10,3,F8,4,100A1)
                                                                                 1274
                                                                                 1275
     END
     OVERLAY (JERRY, 1, 5)
                                                                                 1276
     PROGRAM ONES
                                                                                 1277
                                                                                 127A
     COMMON P(81,82)
     COMMON X8(81), V8(81), CP(81)
                                                                                 1529
     COMMON THET(R1), THETA(81), ST(81), CT(81), +1(81), +2(81), +3(81)
                                                                                 1280
    ▲ , ₩4(81), ₩5(81), YAP(81), DPO(81), F(81), AK(81), S(81), LS(81), FM(81)
                                                                                 1281
     COMMON AN(81),G(81),GH(61),CB(81),D(81),X1(81),X2(81),M(81),HR(81)
                                                                                1262
    1, HRP(81), HRM(81), HRMM(81)
                                                                                 1283
                                                                                 1284
     COMMON X5(400), Y5(400)
     COMMUN ID, ANMAX, DNDYD, YMAX, CD, RMSQ, JSKP
                                                                                 1285
                                                                                 1286
     COMMON /BLOK2/PI,RAD
                                                                                 1287
     COMMON /HLOK3/ IMAX, JMAX, CZ, RF1, DPM, IDP, JDP, RPM, IR, JR, NS, GM102
    1, AOSR, DXS0, DXDY, DYS0, DX2, DY2, KLOSE
                                                                                 12A8
     COMMON /BLOKS/ JM1, DY, I1, JSUP, JSON, QF3, ISUB, ISUP, SUMRP
COMMON /BLOK7/ SMAX, S1, XM, XIM, A4, DXIDXO, DXIDXM, A2, A3, XIO, XI1, CXM,
                                                                                 1598
                                                                                 1290
    • DX
                                                                                 1291
                                                                                 1292
     COMMON /BLOK9/ N
     CALL MCHART (P, AK, AN, F, G, YEP, DPO, ST, CT, LS, M, ID, JSKP
                                                                                 1293
    # ,IMAX,JMAX,GM102,A0S0,DX2,DY2,KLOSE,I1)
                                                                                 1294
     CALL SONLIN (P,F,ST,CT,XR,YR,AK,FM,YRP,D,AN,G,M,XS,YS,ID,N
                                                                                 1295
    INAX, JMAX, GM102, AUSQ, DX2, DY2, KLOSE, I1, JSUP, JSUN)
                                                                                 1296
     IF (N.EQ.0) RETURN
                                                                                 1297
                                                                                 1298
     WRITE (6, 50)N
                                                                                 1299
     WRITE(6,60)
     WRITE(6,80) (XS(I),I#1,N)
                                                                                 1300
     WRITE(6,70)
                                                                                 1301
                                                                                 1302
     WRITE(6,80) (YS(I),I#1,N)
     WHITE (6,40)
                                                                                 1303
     RETURN
                                                                                 1304
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40	FORMAT (//)	1305
50	FORMAT (7H1 N=,13//)	1304
60	FORMAT (18H X8(K), K=1,, N/)	1307
70	FORMAT (////6H YS(K), KE1	1308
80	FORMATCINA REID. 3)	1309
00		1310
	END Historiuttic Memipt /2 AK.AN.S.G.YBP.DPO.ST.CT.LS.M.TD.JSKP	1311
	SUGRUUTINE MENANT (FIRIFIRIFIG) OF OF OF CITED FIRIFIC	1312
1	; [MAI, JMAI, GM] UZ, AUGU, UAZ, UTZ, AUGU, ETTI	1313
	CLATE OWNER OF LOCAL MACH NUMBER MORTZONTAL ROWS ARE 1200NS	1314
	SEASEPTOIS CHARL OF LOCAL MACH HONDER, HOMITONICE HOND THE FICE O	1315
	AND AND AN AREA AND ALL CALL AND AREAN AREAN AREAN AREAN AREAN	1316
	DIMENSION P(10,1), AR(1), AN(1), F(1), G(1), TOP(1), OFO(1), OFO(1),	1210
1	, CT(1), LS(1), M(1)	1317
		1110
	WRITE(6,170)	1374
	1=1	1374
	DO 10 K#1,JMAX,JSKP	1201
10	M(K)AJHAX+1-K	1366
	WRITE(6,200) (M(K),K=1,JMAX,JSKP)	1363
	M(JMAX)=100,/SGRT(ADSG=GM102)	1324
	WRJTE(6,180)	1355
20	JAME	1326
	IF (1.EQ.1) GO TU 30	1327
	Insi-1	1326
	1MH=1=2	1326
	1F (I_EQ_2) IMM#2	133(
	FD#F(1)+DX2	1331
	1 F (1, FG, TMAX) GO TO 30	1332
		1333
		1330
	IF AT EN IMARIA IDET	1335
7.0	17 (1974), TAAV1/ 177-1	1336
20		133
		133/
		1330
	1F (1,EQ,1) GD 10 140	134
	IF (I.E.W.IMAX) GO TO 150	114
		134
40	Obla2*#b(1*1)#4*#b(1w*1)+b(1w*1)	1 2 1 1
	GO TO 70	134
60	DF1=F(1F,J)=F(1H,J)	134
70	IF (1,GT,I1) CO TO 80	134
	UECT(I)+FD+DPI/(1++AK(I)+AN(J))	2 944
	GO TO 90	134
80	UR1,+FD+DPIxYBP(I)+DPJ	134
90	V==ST(I)+OPJ	134
	UUEUeU	135
	VVs/*V	135
		135
	AA=ADSQ=GH102+0Q	135
	IF (AA.(T.O.) GD TD 100	135
	WRITE (6, 160) 1, J, UU, VV, QQ, AA	135
	RETURN	135
100	CONTINUE	135
100	калиятана Калиятана	135
	M(K)=100 + 40RT(CO/AA)	135
	76 /1 FO D1 60 TO 110	136
	ar tuaruani uu iu aav tetenised	136
	UTUTUURF 16 () 17 38 60 10 110	136
	JF (Jakiac) 00 (0 Jav no to to	136
		136
110		

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HRITE(6,190) I, (M(K), K+1, JMAX, JSKP) 1365 IF (I.EG.IMAX) GO TU 120 1366 1367 1=1+1 GO TO 20 1368 1369 120 CONTINUE 1370 WRITE(6,180) DO 130 K=1, JMAX, JSKP 1371 130 M(K)#JMAX+1=K 1372 1373 #RITE(6,200) (M(K),K=1,JMAX,JSKP) 1374 RETURN 1375 140 U=0. GO TO 90 150 IF (NLOSE,E0,0) GO TO 40 1376 1377 GO TO 140 137A :379 C 1380 C NEGATIVE SPEED OF SOUND OCCURRED IN MCHART ATA 1381 160 FORMAT (////* 1+ POINT 1=+14,4H, J=,14//6H UU=,E11,4,4H VV=F11,4 1382 2 * QG=*,F11.4,4H AA=,E11.4////) 1383 1384 170 FORMAT(/+1 MACH NO. CHART+/) 180 FORMAT (/) 1385 190 FORMAT (14,4H// ,3114) 1386 1 3 A 7 200 FORMAT (8x, 3114) 1388 END BUBROUTINE SONLIN (P,F,ST,CT,XB,YB,AK,FM,YAP,FJM,AN,G,M,XS,YS,TD,N 1389 * , IHAX, JHAX, GH102, ADSQ, DX2, DY2, KLOSE, I1, JSUP, JSON) 1390 1391 C ----CALCULATES XS, YS CUDRDINATES OF SONIC LINE------1392 C 1393 ¢ 1394 DIMENSION P(ID, 1), F(1), ST(1), CT(1), XB(1),  $YB(1) = A^{*}(1)$ ,  $F^{*}(1)$ , 1 FJM(1), XS(1), YS(1), YBP(1), AN(1), G(1), M(1) 1395 1396 C D(QQ)=A05Q=GH102+00 1397 AMACH(DQ)=SURT(UD/D(QQ)) 1398 1399 Ç DO 10 J=1, JMAX 1400 1401 10 M(J)=0 N=0 1402 1403 JEJMAX 1404 20 I=1 30 DPI=0. 1405 GO TO 50 1406 40 DPI=(P(1+1,J)=P(1=1,J))*F(I)*DX2 1407 50 DPJ=(P(I,J=1)=P(\,J+1))*G(J)*DY2 1408 HR=1,/(1,+AK(1)+AN(J)) 1409 IF (1.GT.11) HR=1. 1410 U=CT(I)+DPJ+HR+DPJ+YBP(I) 1411 V==ST(I)+DPJ 1412 1413 OGELIAUAVAV DAED(NR) 1414 IF (DA. CT. 0.) GD TO 60 1415 WRITE(6,190) I, J, N, P(1+1, J), P(1=1, J), DPI, P(I, J=1), P(I, J+1), DPJ, U, V 1416 + ,QQ,DA 1417 RETURN 1418 60 CONTINUE 1419 FH(I)=AHACH(DQ) 1420 IF (I.EQ.1) GO TO 110 1421 H1=FM(I=1)=1. 1422 HEFMET)=1. 1423 HSSHANS 1423

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IF (H8.GE.0.) GD TO 100 1425 IF (JSON, EQ, 0) GO TO 70 1426 IF (I.EQ.IMAX, AND.KLOSE.EQ. 0) GU TO 120 1427 TO CONTINUE 1428 NEN+1 1429 IF (N.LE.398) GO TO 90 1430 83 WRITE(6,200) 1431 RETURN 1432 90 CONTINUE 1433  $X = X \oplus (I) = A N (J) + 3 T (I)$ 1434 X1=XB(I=1)=AN(J)+ST(I=1)1435 Y=YB(I)+AN(J)+CT(I) 1436 Y1=YB(I=1)+AN(J)+CT(I=1) 1437 H2==H1/(H=H1) 1438 XS(N)=X1+H2*(X=X1) 1439 YS(N)=Y1+H2+(Y=Y1) 1440 M(J) = M(J) + 11441 IF(N.EQ.398)GO TO 80 1442 100 IF (I.EQ.IMAX) GO TO 120 1443 110 I=I+1 1444 IF (I.EQ.IMAX) GO TO 130 1445 GO TO 40 1446 120 IF (M(J), E0,0) GO TU 140 1447 J=J=1 1448 IF (J,EQ.1) GO TO 140 1449 IF (J.GT.2) GO TO 20 1450 IF (JSON, EQ. 1) RETURN 1451 GO TO 20 1452 130 IF (KLUSE, ER. 1) 60 TO 30 1453 DP1=(3,*P(1,J)=d,*P(1=1,J)*P(1=2,J))*F(1)*DX2 1454 GO TO 50 1455 140 IF (JSUP,EQ,0) RETURN 1456 I=1 1457 150 JEJMAX 1458 160 V==ST(I)+G(J)+DY2+(P(I,J=1)+F(I,J+1)) 1459 QQ=V+V 1460 DA=D(QQ) 1461 IF (DA.GT.0.) GO TO 170 1462 WRITE(6,190) I,J,N,P(1,J-1),P(1,J+1),V,QQ,DA 1463 RETURN 1464 170 FJM(J)=AMACH(QQ) 1465 IF (J.EQ. JHAX) GO TO 180 1466 H1#FJM(J+1)=1. 1467 H=FJH(J)=1 1468 HS=H+H1 1469 IF (HS.GE.0.) GO TO 180 1470 IF (N.GE.398) GO TO 80 1471 NEN+1 1472  $X = XB(I) = AN(J) \pm ST(I)$ 1473 X1=XB(J)=AN(J+1)+ST(I)1474 H530H1/(H6H?) 1475 XS(N)=X1+H2+(X=X1) 1476 YS(N)=0. 1477 IF (KLOSE, EG. 0) RETURN 1478 IF (I.EQ.IMAX) GO TO 180 1479 IDIMAX 1480 GO TO 150 1481 160 J=J=1 1482 IF (J.GT.1) GO TO 160 1483 IF (I.EQ.IMAX) RETURN 1484

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1485 INIMAX. GO TO 150 1486 1487 C 190 FORMAT (/,+ NEGATIVE SQUARE OF SOUND SPEED CALCULATED IN SUBRO* 1488 1+UTINE SONLIN+//1X,313,10E12,4/) 1489 NO. OF SONIC PTS. EXCEEDS 398. SONIC PT. CALCULA. 1490 200 FORMAT (/,+ 1+TIONS TERMINATED. +) 1491 1492 END OVERLAY(JERRY,1,6) 1493 PROGRAM ONES 1494 COMMON P(81,82) 1495 COMMON /BLOK3/IMAX, JMAX, DUM(16), KLOSE 1496 1497 C ----- HALVES MESH SIZE IN BOTH DIRECTIONS AND USES 4TH-ORDER 1498 C INTERPOLATION TO DISTRIBUTE POTENTIAL OVER NEW MESH-----C 1490 1500 C 1501 C -----RENUMBER 1-INDEX SUCH THAT I-ODDEKNOWN P, I-EVENEUNKNOWN P---1502 C IP=IMAX+1 1503 ME2+IMAX+1 1504 00 10 J=1, JMAX 1505 1506 DO 10 Kal, IMAX M1=M=2+K 1507 M2=IP=K 1508 10 P(M1, J)=P(M2, J) 1509 1510 IMAX=2+1MAX=1 1511 Ç C ----RENUMBER J-INDEX SIMILARLY-----1512 IMAX=M=2 15'3 JP#JMAX+1 1514 N=2+JHAX+1 1515 DO 20 1=1,1M4X,2 1516 DO 20 K=1, JMAX 1517 N1=N+2±K 1518 N2=JP=K 1519 20 P(I,N1)=P(I,N2) 1520 1521 JMAX=N=2 HEIMAXe1 1522 N=JMAX=1 1523 C 1524 -----ENOW FILL IN ODD J-RGWS,BUT TREAT I=2 AND I=IMAX+1 FIRST TO C 1525 ACCOUNT FOR SYMMETRY OR END CONDITION-----1526 C C 1527 DO 30 J=1, JMAX, 2 1528 30 P(2,J)=,5625*P(1,J)+,5*P(3,J)=,0625*P(5,J) 1529 IF (KLOSE_EQ.1) GO TO 50 1530 C 1531 IS NOT A SYMMETRY AXIS, SO USE NONCENTRAL INTERP, =-C **====I=IM&X 1532 DO 40 J=1, JMAX, 2 1533 40 P(M,J)=,"175*(P(M+1,J)=P(M=3,J))+,9375*P(N=1,J)+,0625*P(M=5,J) 1534 GO TO 70 1535 1536 C **==*=IsINVX IS A SYMMETRY AXIS-----1537 C. 50 DO 60 J=1, JMAX, 2 1538 60 P(M,J)=,5625*P(M+1,J)+,5*P(H=1,J)=,0625*P(M=3,J) 1539 70 MaH=2 1540 5, XAML, 1#L 08 00 1541 1542 DO 80 I=4,M,2 80 P(I,J)=,5625+(P(I+1,J)+P(I=1,J))=,0625+(P(I+3,J)+P(I=3,J)) 1543 C 1544

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----- ALL I-INDICES ARE KNOWN ON ALL ODD J. FILL IN ALL EVEN J 1545 C AFTER FIRST TREATING J=2 AND JHAX-1 BY NONCENTRAL INTERP, -----C 1546 C 1547 PO 90 1=1, IMAX 1548 90 P(1,2)=,3125+(P(1,1)=P(1,5))+,9375+P(1,3)+,0625+P(1,7) 1549 DO 100 I=1, IMAX 1550 100 P(I,N)=,3125+(P(I,N+1)=P(I,N=3))+,9375+P(I,N=1)+,0625+P(I,N=5) 1551 N=N=2 1552 DO 110 I=1, IMAX 1553 00 110 J=4,N,2 1554 110 P(I,J)=,5625+(P(I,J+1)+P(I,J=1))=,0625+(P(I,J+3)+P(I,J=3)) 1555 RETURN 1556 END 1557 OVERLAY (JERRY, 2,0) 1558 PROGHAM THOO 1559 DIMENSION X8(200), Y8(200), CP(200), DESC(8) 1560 DIMENSION XS(400), YS(400) 1561 DIMENSION AN(100), ST(200), CT(200), D1(200), D2(200) 1562 CALL PSEUDO 1563 CALL LEROY 1564 REWIND 4 1565 10 READ (4) DESC 1266 IF(EOF(4)) 20,30 1567 20 CALL CALPLY (0,0,999) 1568 RETURN 1569 30 CONTINUE 1570 READ (4) IMAX, JMAX, IT, KLOSE, NSL 1571 READ(4)CPSTAR, AMINE, NPH, XREE, DXIDXN, DNDYO, 0F3 1572 IF (KLOSE, EQ, 1)GO TO 31 1573 READ(4)CXH, XH, XIM, DXIDXM 1574 31 CONTINUE 1575 READ (4) (AN(J), J=2, JMAX) 1576 READ (4)(ST(I),I=1,IMAX) 1577 READ (4)(CT(1),1=1,1MAX) 1578 READ (4) (XB(1), I=1, IMAX) 1579 READ (4) (YB(1), I=1, IMAX) READ (4) (CP(1), I=1, IMAX) 1580 1581 IF (NSL,EQ,0) GO TO 40 1582 READ (4) (XS(1),1=1,NSL) 1583 READ (4) (YS(I), I=1, NSL) 1584 40 CONTINUE 1585 CALL GRID(IMAX, JMAX, X8, Y8, ST, CT, AN, D1, D2, XREF, KLOSE) 1586 CALL PLOT (IMAX, JMAX, KLOSE, XB, YH, CP, DESC, IT, AMINF, CPSTAR, DPM, XR 15A7 SEF, DXIDXA, DNDYO, CXM, XH, XIM, DXIDXM, RF3) 1588 1F (NSL,EQ,0) GO TO 10 1589 CALL SONPLT (XH, YB, XS, YS, NSL, IMAX, XREF, KLOSE) 1590 GO TO 10 1591 END 1592 SUBROUTINE GRID(IMAX, JMAX, XB, YB, ST, CT, AN, D1, D2, XREF, KLOSE) 1593 DIMENSION X8(1), Y8(1), AN(1), D1(1), D2(1), ST(1), CT(1) 1594 DXRE5./XREF 1595 XSHIFT=3. 1596 YSHIFT=2.5 1597 IH#IHAX+1+KLOSE 1598 XAME, S-L S OO 1599 DO 1 1=1,1M 1600 D1(1)=(XB(1)=AN(J)+ST(1))+DXR + XSFIFT 1601 D2(I)=(YB(I)+AN(J)+CT(I))+DXP + YSHIFT 1602 1 CONTINUE 1603 CALL DRAW(D1,D2,IH) 1604

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		1605
2	CONTINUE	1003
	DO 3 1=1,1M	1000
	D2(I)==YB(I)=DXR+YSHIFT	1607
- 3	CONTINUE	1608
-	CALL DRAW(D1-D2-IM)	1609
		1610
		1611
	DO 4 JE2, JMAX	1011
	$D_{J}(J=J) = (XB(I) = AN(J) + ST(I)) + DXR + XSHIPT$	1015
	D2(J=1)=(YB(I)+AN(J)+CT(I))+DXR + YSHIFT	1613
4	CONTINUE	1614
•	CALL DRAW(D1.D2.JMAX=1)	1615
•		1616
2	CONTINUE	1617
	CALL NERAME	1017
	RETURN	1010
	END	1619
	SUBROUTINE PLOT (IMAX, JMAX, KLOSE, XB, YB, CP, DESC, IT, AMINF, CPSTAR,	1620
	1 DPM, XREF, DXTDXD, DNDYD, CXM, XM, XTM, DXTDXM, QF3)	1621
		1622
		1623
	DIMENSION XA(I), TH(I), CP(I), DESC(I)	1623
	DATA NREAD/0/	1074
	DATA NAME/2HM=,7H, IMAX=,7H, JMAX=,5H, IT=,6H, DPM=,7HDXIDXO=,	1625
	1 BH. DNDYDI,5H CXMI,5H, XMI,6H, XIMI,9H, DXIDXMI,6H CDI	1626
	- ANA 0531/	1677
		1628
	NREAUENREAUEI	1620
	IF (NREAD.GT.1) GO TO TO	1024
	CALL JPARAMS(T)	1030
	YPG=7。	1631
	YDV=0.	1632
	VTICE=1	1633
		1634
10		1616
	LALL LALPLI(2,0,2,-),-3)	1035
	IW2IWAX=1+×TD2E	1030
	X8(IM+1)=0,	1637
	YB(IM+1)=XB(IM+1)	1638
	XB(TH+2)=.2	1639
		1640
	TULIPYCJ-ADLINYEJ	1641
	YHAXEU,	1041
	DXR=1./XREF	1042
	DO 20 I=1,IM	1643
	XB(I)=XB(I)=DXR	1644
	YB(I)=YB(I)+DXR	1645
	TE (VB(T)=VMAX (E.O.) GD TD 20	1646
	ar tracar from ser system to be an	1647
• •		1444
<b>2</b> 0	CONTINUE	1040
	NBOD#Q	1644
	IF (YMAX+5,,GE,1,3+1,E=06) NBOD=2	1650
	IF (YMAX*5GE,2.5+1.E=06) NBOD≈1	1651
	CP(1H+1)=1-5	1652
		1653
	vrsanteitetta Die Roltmit	1664
	DL=LF11P413	1034
	TLBUL+YPGPCP(IM+2)	1075
	PYD#(8L=CPSTAR)/CP(IM+2)	1656
	₽⋎⋓⋜╼₽⋎⋈	\$657
	DO 40 1=1.IM	1658
	DE(CD(1)=CD(1H+1))/CD(1H+2)+2.5	1659
	$ \begin{array}{c} \nabla = \left\{ \left\{ \left\{ 1, 2 \right\} \right\} = \left\{ 0, 1 \right\} \in \left\{ 0, 2 \right\} \right\} \\ T = \left\{ 0, 1 \right\} \in \left\{ 0, 2 \right\} \in \left\{ 0, 2 \right\} \\ \end{array} \right\} $	1660
		1000
	CH(1)=CH(1M+1)+7,5+CH(1M+2)	1001
	GO TO 40	1005
30	IF (D.GE.O.) GD TU 40	1663
	CP(1)=CP(IH+1)=2.5±CP(IM+2)	1664

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40 CONTINUE
                                                                                  1665
      NSYM=22
                                                                                  1666
      NLINE#1
                                                                                  1667
      CALL AXES (=,5,0,,90,,YPG,CP(IM+1),CP(IM+2),YTIC,YDV,2HCP,,20,
                                                                                  1668
     1+21
                                                                                  1669
      IF (CPSTAR_LT_TL_OR_CPSTAR_GT_BL) GO TO 50
                                                                                  1670
                                                                                  1671
Ĉ
Ç
      DRAW LINE FOR CPSTAR
                                                                                  1672
                                                                                  1673
Ç
      CALL CALPLT (=.5,PYU,3)
                                                                                  1674
                                                                                  1675
      CALL CALPLT (,28,PYU,2)
                                                                                  1676
C
                                                                                  1677
      PLOT CP
C
C
                                                                                  1678
   SO CALL LINPLT (XB,CP,IM,1,NLINE,NSYM,1,0)
                                                                                  1679
      IF (NBOD_EQ_1) GO TO 70
                                                                                  1680
                                                                                  1681
C
C
      PLOT BODY
                                                                                  1682
                                                                                  1683
C
      CALL LINPLT (X8, Y8, IH, 1, 0, 0, 1, 0)
                                                                                  1684
                                                                                  1685
      IF (NBOD, EQ.2) GO TO 70
                                                                                  1686
      DO 60 I=1,IM
                                                                                  1687
   60 YB(I) = -YB(I)
      CALL LINPLT (X8, Y8, IM, 1, 0, 0, 1, 0)
                                                                                  1668
                                                                                  1689
   70 CONTINUE
                                                                                  1690
Ć
                                                                                  1691
Ç
      ADD LABELS
Ċ
                                                                                  1692
      'CALL NOTATE(-,5,-1,39,,14,DESC,0,,80)
                                                                                 1693
      ENCODE (50, 80, LALES AME (1), AMINE, NAME (2), IMAX, NAME (3), JMAX, NAME (4),
                                                                                 1694
                                                                                  1695
     1IT, NAME (5), DPM
      CALL NOTATE(-, 5; -1, 64, .14, LBLE, 0, .50)
                                                                                  1696
      ENCODE(39,90, LBLE)NAME(6), DXIDX0, NAME(7), DNDY0, NAME(13), QF3
                                                                                  1697
      CALL NOTATE (-, 5, -1, 89, , 14, LBLE, 0, , 39)
                                                                                  1698
      IF(KLOSE,ER.0)GU TO 72
                                                                                  1699
                                                                                  1700
      DY==2.14
                                                                                 1701
   71 ENCOUE(17,100,LBLE)T(1),T(23)
                                                                                  1702
      CALL NUTATE(=,5, DY, 14, LBLE, 0, 17)
                                                                                 1703
      GO TO 73
   72 ENCODE(54,110,LBLE)NAME(8),CXM,NAME(9),XM,NAME(10),XIM,NAME(11),
                                                                                  1704
                                                                                  1705
     10XIOXM
                                                                                  1706
      CALL NOTATE(-.5,-2,14,.14,LBLE,0.,54)
                                                                                  1707
      DY==2.39
                                                                                  1708
      GO TO 71
                                                                                  1709
   73 CONTINUE
      CALL NERAME
                                                                                  1710
      RETURN
                                                                                 1711
                                                                                 1712
C
                                                                                 1713
   80 FORMAT(A2,F5,3,A7,13,A7,13,A5,14,A6,E8,2)
   90 FORMAT(A7,F5,2,A8,E8,2,A6,F5,2)
                                                                                 1714
  100 FORMAT(A7, A10)
                                                                                 1715
  110 FORMAT(A5, E8, 2, A5, E8, 2, A6, E8, 2, A9, F5, 2)
                                                                                 1716
      END
                                                                                 1717
                                                                                 1718
      SUBROUTINE SONPLT (XB, YB, XS, YS, NSL, IMAX, XREF, KLOSE)
C
                                                                                 1719
      ---- SCALES AND PLOTS BODY AND SONIC LINES-----
                                                                                 1720
C
                                                                                 1721
C
      DIMENSION X8(200), Y8(200), XS(400), Y5(400)
                                                                                 1722
                                                                                 1723
С
                                                                                 1724
      IM=IMAX=1+KLOSE
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DXR#1./XREP DO 10 I=1,NSL 1725 1726 XS(1)=XS(1)+DXR 1727 10 YS(1)=YS(1)+DXR 1728 CALL DSCALE (XS,NSL,X8MAX,X8MIN) 1729 CALL DSCALE (YS,NBL,YOMAX,YSMIN) 1730 XMAX=XSMAX 1731 IF (X8(IM)_GT,XMAX) XMAX=X8(IM) 1732 XHINHO. 1733 IF (XSMIN, LT. 0, ) XMIN=XSMIN 1734 MI+1#1 05 00 1735 20 YB(I)=ABS(YB(I)) 1736 CALL OSCALE (YB, IM, YBMAX, YBMIN) 1737 DX=XMAX=XMIN 1738 DYEYSHAX 1739 L#1 1740 DXR#1. 1741 30 IF (DX+DXR,LE,2,4+1,E+08) GO TO 60 1742 C #***** **************** 1743 C 1744 C---- FOLLOWING CARD GIVES FURTHER SIZE REDUCTION IF YOU REMOVE COMMENT 1745 ¢ GO TO (40,50), L 1745 Ĉ 1147 C *************************** 1748 IF(L,EQ.2) GO TO 60 1749 40 DXR=,5+DXR 1750 r=5 1751 GO TO 30 1752 50 DXR=_4+DXR 1753 L=3 1754 60 IF (DY*DXR,LE,1,5+1,E=08) GD TO 90 1755 GO TO (70,80.90), L 1756 70 DXR=,5+DXR 1757 C=5 1758 GO TO 60 1759 80 DXR=_4+DXR 1760 L=3 1761 GO TO 60 1762 90 KEO 1763 DO 110 I=1,NSL IF (L.EG.1) GD TO 100 1764 1765 XS(I)=XS(I)+DXR 1766 **YS(1)=YS(1)**+DXR 1767 100 IF (YS(I)=1.5.GT.1.E=08) GO TO 110 1768 K≡K+1 1769 XS(K)=XS(I) 1770 YS(K)=YS(I) 1771 110 CONTINUE 1772 IF (L.E9.1) GO TO 130 1773 NO 120 I=1,IM 1774 X8(I)=DXR+X8(I) 1775 120 YB(1)=DXR+YB(I) 1776 XMIN=XMIN+DXR 1777 YBMAXEVIMAX+DXR 1778 XMAX=XMAX=DXQ 1779 130 X8(IM+1)=0. 1780 Y8(IM+1)=X8(IM+1) 1781 XS(K+1)=XB(IM+1) 1782 YS(K+1)=XB(IM+1) 1783 ORIGINAL PAGE IS XB(IM+2)=.2 1784 OF POOR QUALITY 45

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	Y8(1M+2)=X8(1M+2)	1785
	X8(K+2)#X8(1M+2)	1786
	Y8(K+2)=x8(1H+2)	1787
	SKIPES. #ARS(XMIN)+2.	1788
	NSKIPESKIP	1789
	SKTPENSKTP	1790
	CALL CALPLT(SKTP.2.5.=3)	1791
	CALL   INPLY (XB. YB. IM. 1. 0. 0. 1. 0)	1792
	TE (VRMAX+5GT.2.5+1.E+08) GO TO 150	1793
		1794
140	VA(T)==VR(T)	1795
	CALL   INPLT (XB.YB.IM.1.0.0.1.0)	1796
150	CALL LINPLY (XS. YS. K. 1. = 1.22.1.0)	1797
4 2 4	CALL NERAME	1798
	RETURN	1799
	END	1800
	SUBROUTINE DSCALE (X.N.XMAX.XMIN)	1801
•		1802
	****COMPUTES MAX AND MIN OF X=ARRAY===**	1603
		1804
•	DIMENSION X(1)	1805
•		1806
•	XMIN=X(1)	1807
	XMAX=XMIN	1808
	DO 20 I=1,N	1809
	IF (X(I), GE, XMIN) GO TO 10	1810
	XMIN=X(I)	1611
	GO TO 20	1812
10	IF (X(I),LE,XMAX) GO TO 20	1813
•	XMAX=X(I)	1814
20	CONTINUE	1815
	RETURN	1816
	END	1817

#### APPENDIX D

## SAMPLE CASES

The input for the sample cases is listed below. The output for these cases is on the following pages. Note that the sample cases are for only 25 cycles on the crude grid. In actual usage there might be more cycles and some grid refinements. The plotted output is shown in figures 1 to 8.

21 21	1.0					
21 21		•				
	1 25 (	0 1				
140J TC TU	.26795	2. 8.5		. 11433(400	· • • • • > 3t • (i)	₩ <b>£</b> ¢0767 <b>€</b> "
1.6191400	0 1.1100407	/ 1,50000790 1,600404 1 1,7595400 1,61954	00 1.873540 00 1.873540	0 1.9577400 0 1.9518400		9 3457584" 6 2 676541
0 1/3C+01	1 4 <b>9</b> 3646493	1 1 9096400 1 90000 1 1 9096400 1 90000	96 1 1499849 66 1 141474	0 1,00000400 A 1 11414A	) 140402491   4 6465 4	U 1.075848 A 1.675848
4,4535-01	1 4 <b>.</b> 90°t=31	1 3,2941+01 5,741t+	01 6.2420+0	1 6,7978=01	. 7,4765.0	1 8.0965-0
.0	4.0431-02	6,539E+02 1,312E+	ni 1.6545+n	1 2.4678-01	5.13AP-0	1 3,6276-0
6 + HR4E + N	0 6,9101+10	7,1335+00 7,3576+	00 7,54ut +r	0 7,856E+0g	1 0.156E.n	0 8.5114+1
4.406F+0	0 4.7346+00	5.053E+00 5.361E+	00 5,655F+A	0 5.934E+00	6,198E+1	0 6.436f+1
1.8421+0	0 2.1536+00	7.471E+00 2.730E+	00 3.0655+0	0 3.398E+00	1 3,735E.n	6 0,072F+
2.7271-0	1 3,9691-01	5.430F +01 7.10+E+	01 8.9705=0	1 1,105€+00	1,3326.0	0 1.5761+0
.0	1.6375-03	5 7.003E+03 1.751E-	02 3.5H4F=r	2 6.5098-02	- 1.147E_0	1 1.7#2F+0
armere/19	SADER ENVEY	VEALENDERVIAHLEC NE	T H 5			
	,995	INTERNET				
,5	1,3	.084 1.979795	9,75	s.		
<b>j_4</b>	1.0	0.				
51 51	1 25 0	0 1				
	.48989795	5.1 2.				
024765	.020000					
080906	075424	.069766 .003360	056030	049047	.041241	.033100
099911	099214	099221 .097837	295770	093029	089627	085560
.074949	.080047	.085280 .069440	.092610	095711	.097809	1000/9/
000000	1.4/4/454	037360 0373##	00.0312	054405	0.41977	
1 39//	1,0743	1.734 1.737	1.5222	140715	1.4110	1,4430
0.45784	1.00140	1,1246 1,2069	1.2676	1 3666	1,4435	1,5173
0,33799	0,40601	0.47777 0.55274	0,63041	71027	0,79181	1.67652
0.0000	0.012311	0.03A155 0.072346	0,113710	A.161530	0.21521	0,27421
34						
10-1 ELLT	P8010 4114	20+PERCENT STING				
	995	• •				
.5	1.3	.384				
1.4	1.0	0.				
21 2	1 25	ιι <b>ε</b> ι Ο 1 1				
.U/4/03	.017543	"e 1 3				
000906	075626	+069768 +003360	+056639	.049047	.041241	.033100
099911	.046019	,099221 ,097437	.095770	.093059	.089627	.055580
.074949	.080447	,085280 ,059440	.095010	.095711	.097609	044510
.00000	015643	.027300 .037344	.040312	.054495	.061977	,068792
1,9658	1.987689	2,			•••	•••
1.5877	1.6543	1.7164 1.7737	1.8255	1.4715	1.9110	1.943c
0.95789	1.04140	1.1246 1.2069	1.2676	1.3668	1.4435	1.5173
A 11700	0.012311	0 03177 0 55274	0 0 1 1 3 / 1 U	0,101330	0 201001	0.67421
0_000000						
0.00000						

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INPUT COORDINATES	
I X Y	
	000
3 .038155 .027	360
4 .072346 .0?7	344
5 .113710 .046.	312
<ul><li>161530 .054</li></ul>	495
7 ,215210 ,061	977
8 ,274210 ,066	792
	499
11 477770 .085	280
12 .552740 .089	440
13 ,630410 ,092	919
14 ,710270 ,095	711
15 ,791810 ,097	509
	210
18 1-041400 -099	914
19 1.124600 .099	221
20 1.204900 .097	837
21 1,287800 .045	770
22 1,366800 ,093	929
23 1,443500 ,089	627
	580
	*UO 626
27 1.716400 .069	768
28 1.773700 .005	360
29 1,825500 ,056	439
30 1.871500 .049	047
31 1,911000 ,041	241
32 1.945800 .033	765
14 1.987689 .015	643
35 2.000000 0.000	000
· · · · · ·	
DYDXN= 999,0000	
DADX1= 844 0000	
YHAX 1000	
AREF = 2,0000	
INAX= 21	
JHAXE 21	
MIT= 25	
MHALF #0	
NPLOTEI	
RF1=1.400	
COVERGE .10E+01	
QF3= 0,	
DNDY0# .500E+00	
ALT=1,30	
XH2+0.	
C1#=-0.	
DXIDXH=-0.	
CAHE1,40	
AMINF= .9950	

1	8	8 X Y		X Y THET		THETO	AK	Ŧ	
5	٥.	0.	0.	,90008+02	50+30004,	.89+Jt+02	.1190E+42		
Ž	.10328-01	1011E=01	1422E+01	3252E+02	.32525+02	,1901E+02	15041+01		
Ĵ	.62956+01	S111E=01	3153E-01	.10766+02	10765+02	,26416+41	.8403£+00		
	1310E+40	.1174E+00	4701E=01	.1073E+02	10735+02	.4574E+00	,6352E+00		
5	2194E+00	2048E+00	.0063E+01	,74851+01	.7468E+41	43802+00	5117E+00		
	.3254E+00	3101E+00	72398-01	54442+01	54445+01	261#E+00	4 5941 + 90		
7	4460E+00	.4303E+00	8219E-01	.3966E+01	,39062+01	1795E+00	, 3939£+00		
	.5783E+00	,5624E+00	10-35998	,2787E+01	2707E+01	,1370£+00	,30456+40		
	.7194E+00	7033E+00	.95502+01	1780E+01	.1780E+01	,1147E+00	,3401E+00		
10	.8663E+00	8502E+00	9887E+01	8682E+03	8682E+00	,1036E+00	33596+00		
11	.1016E+01	.1000E+01	1000E+00	.5874E-02	.5879F=02	.9904E+01	,3326t+00		
iż	1166E+01	1150E+01	9887E+01	=,8677E+00	. 8677E+00	1035E+00	3359E+00		
13	-1313E+01	1297E+01	4550E=01	-,1780E+01	-,1760E+01	,11516+00	,3461£+00		
14	.14542+01	1438E+01	8992E+01	=,2786£+01	-,27865+01	.1567E+00	, 1r45t+00		
15	1586E+01	1570E+01	82181-01	=,3966E+01	-,3900E+01	+1766E+00	39396+00		
16	1707E+01	1690E+01	72396+01	- 5449E+01	-,5449E+U1	,2580E+u0	,419JE+U0		
17	,1813E+01	1795E+01	6063E-01	- 7477E+01	+.7477E+U1	.4404E+00	.5117E+VO		
18	.1901E+01	1883E+01	4702E-01	= 1059E+02	1059E+02	.93112+00	.6352E+VO		
19	1969E+01	1949E+01	,3156E=01	= 1636E402	-,1630F+02	.2813£+u1	,4403L+60		
20	2014E+01	.1990E+01	.14236-01	<ul><li>3254E+02</li></ul>	+ 3254E+U2	,19366+02	,1564É+Ul		
ŽÌ	\$032E+01	10+30005	1432E=13	• 9000E+02	*********	8982L+02	.1190E+U2		

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Niras - Altari

---- NORNAL CUORD, STRETCH FOR ALFR 1,300 -----

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J	AN	Ģ	GH
1	0,	0.	,79206-03
Ż	.2334E+02	1584E+02	4738L+02
3	.8979E+01	.7893E=02	14096-01
4	.5006E+01	2030E-01	3005E-01
5	.3241E+01	3981E+01	\$357E=01
6	.2274E+01	.0752E-01	8549E-01
7	.16746+01	1037E+00	1266F+00
ė	127261-1	14966+00	,1778E+00
	.9873E+00	206-E+00	,2396E+00
10	.7755E+00	2735E+00	.3134t+00
11	6156E+00	.35321+00	.3993E+00
1-	4895E+00	. 4 1 5E+06	.49851+00
13	38451+00	.5515E+00	.6116E+00
14	. 30642+00	.6720E+00	.73998+00
15	2385E+00	8078E+00	.8839E+00
16	18176400	90001+00	.1045E+01
17	13376+00	1129E+01	+14.7 3E+01
18	92646901	1317E+01	1465E+01
10	57146-01	15246+01	16151+01
20	26721 001	17516+01	1876E+01
21		20005+01	21368401
<b>E</b> 1	×.	1	12.200.00

CPU SECONDS FOR BODY GEOMETRY COMPUTATIONS# .109

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244 - 144

11	DPHAX	10	JD	RMAX	IR	JH	ISUB	18UP	RAVG	RF1	OFJ	N8	8EC/CYC
1	,917E=02	3	21	,738E+03	21	21	1	0	,249E+01	1.400	0.000	0	.216
2	,562E=02	4	21	668E+03	1	21	1	0	326E+01	1.400	0,000	57	239
3	• 399E = 95	5	21	,550E+03	1	- 21	1	0	,201E+01	1.400	0,000	117	.250
4	*5699E+05	5	21	.463E+03	1	51	1	0	233E+01	1.400	0.000	156	.257
5	,2396-02	17	21	353E+03	1	51	1	0	.1848+01	1,400	0.000	149	,261
•	198E=02	17	21	2701+03	1	51	5	0	147E+01	1.400	0,000	153	.200
7	165E=02	17	21	217E+03	1	51	1	Ų	1555+01	1.400	0.000	156	. 201
8	,141E=02	16	21	101E+03	1	51	1	0	,103E+01	1,400	0,000	157	.262
9	124E-02	16	21	1556+03	1	15	1	0	891E+00	1.400	0.000	158	.268
10	108E-02	10	21	135E+03	1	51	1	0	7761+U0	1.400	0.000	160	.261
11	952E-03	16	21	118E+03	1	51	1	0	681E+00	1.400	0.000	158	, 207
12	840E-03	16	21	105E+03	1	51	1	0	603E+00	1.400	0.000	159	260
13	.741E=03	16	51	9331+02	1	15	1	0	5351400	1.400	0.000	161	.260
14	650E=03	16	51	836t+02	1	15	1	0	416E+00	1.400	0.000	161	.263
15	570E-03	16	21	756E+02	1	51	1	Q	4261+00	1.400	0.000	161	.267
16	512 =03	8	21	686t+02	1	51	1	0	3831+00	1.400	0.000	161	204
17	450t=03	6	21	625E+02	1	21	1	O	3451+00	1.400	0.000	161	250
18	413E=03	8	51	571E+02	1	21	1	0	.3176+00	1.400	0.000	101	. 203
19	3736-03	8	21	524E+02	1	15	1	0	284E+00	1.400	0.000	102	
20	.339E=03	8	21	4821+02	1	21	1	Ú.	258E+00	1.400	0.0.0	163	.204
21	30 dE = 03	9	21	4446+02	1	21	i	Ď	.235E+00	1.400	0.000	164	205
22	+63E+03	9	21	411E+02	ī	21	i	ŏ	.211E+00	1.400	0.000	164	.214
23	- 260E+03	9	21	381E+02	i	21	1	ò	1926+00	1.000	0.000	164	270
24	-238E-03	9	21	1546+02	ī	ži	i	Ō	174E+00	1.400	0 000	164	
25	219E-03	9	21	3296+02	i	21	i	ŏ	159E+00	1.400	0.600	164	.265

----DID NOT CONVERGE IN 25 CYCLES,---- RMAX= ,33E+02, CUVR= ,25E+02

CPU SECUNUSE 6.61 FUR 25 ITERATIONS, NHALFED

1	58	XB	Y B	CF	M
1	0.000	0.000	0.000	1,27261	0.00000
ž	.018	010	.014	52903	69183
3	063	051	032	.23656	,85794
4	.131	.117	.047	.04816	96649
5	.219	205	061	-,01530	1.00414
6	325	310	072	04232	1,02038
7	446	430	082	. 05810	1.02994
8	578	562	090	-,06862	1,03646
9	719	.70.5	095	-,07636	1,04106
10	,865	,850	,099	-,06163	1,04428
11	1.010	1,000	.100	• .08578	1,04682
12	1,100	1,150	.099	• 08945	1,04907
15	1,313	1,297	,095	-,09318	1,05137
14	1.454	1,438	.090	• 09961	1,05532
15	1,586	1,570	,082	•,09859	1,05469
16	1,707	1,690	,072	+,06725	1,03550
17	1,613	1,795	,061	01765	1,00567
18	1,901	1,883	047	04978	,96554
19	1,969	1,949	,032	,23052	.86150
50	2,014	1,990	.014	.51904	,69755
51	2,032	2,000	.000	1,27261	0,00000

DRAG COEFFICIENT BY TRAPEZOIDAL INTEGRATIONE .01635

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PLOT OF CP AT UNEQUAL INCHEMENTS

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1	XB		۲I	6	C	P															
	0.0	••	•														•				
;		10	v	.014	••	5290	•						•				-				
3		51		. 032	•	2363							•		•						
ĩ		17		.047		0482											• *				
5	2	05		061		0153															
6		10		072		0423															
7	. 4	30		082	- <b>.</b>	0581															
8	5	62		090		0688															
9		03		095	•	0764															
10		50		099	•	0816												•			
11	1,0	00		100		0858												•			
12	1,1	50		.099		0894											۰ 🛊	•			
13	1,2	97		.095	•.	0935								•				•			
14	3.4	38		,090	••	0996											*	•			
15	1,5	70		.082	••	0986												•			
16	1,6	90		,072	•••	5190											* *				
17	1.7	95		.061	•••	01/9											* +				
18	1,00	63		.047	•	3106											••				
14	3.99	44		.032	•	2343									•						
20	3.9	¥U 50		014		2121							•								
K 1	<b>E</b> • V		1		4.44		•										•				
MA	CH NO	, ÇH	AHT																		
	21	20	19	15	17	16	15	14	13	12	11	10	9	6	7	6	5	4	3	2	1
			• ·	• •	• ·	• •	• -	•	•	••	•••	• •	-		•	-	-		-	-	-
1//	٥	65	96	93	95	96	97	97	95	98	98	98	99	99	99	99	99	99	49	<b>4</b> 4	49
211	69	84	90	93	95	96	97	97	98	98	98	98	99	99	99	99	99	44	49	49	49
3//	85	86	85	90	91	93	94	95	96	96	97	97	98	98	98	99	99	44	99	49	49
4//	96	95	95	95	95	95	95	95	96	96	97	97	97	98	98	95	99	40	<b>49</b>	<b>9</b> 9	49
5//	100	99	98	98	98	98	97	97	97	97	97	97	98	98	98	98	99	44	49	44	49
6//	102	101	100	160	100	100	ę y	99	99	49	98	98	98	66	4 R	98	99	59	99	9 Q	49
7//	102	102	102	101	101	101	100	100	100	100	100	94	99	94	99	99	99	99	49	90	60
8//	103	103	105	105	102	105	10:	101	101	161	100	100	100	100	99	99	ųυ	99	59	44	43
9//	104	103	103	103	105	102	105	102	1 V 1	101	101	101	100	100	100	100	99	99	<b>ç</b> ç	44	49
10//	104	104	103	103	103	103	102	102	102	105	101	101	101	101	100	100	100		44	44	49
	104	104	104	103	103	105	153	102	102	102	102	102	101	101	101	160	10.5	1.1	44	44	44
12//	104	104	104	104	103	163	103	103	103	100	102	102	102	101	101	101	100	1.9	44	44	44
13//	105	104	104	104	104	103	103	103	103	100	102	102	102	105	101	101	101	100	44	<b>4</b> 4	44
14//	103	105	104	100	104	105	103	103	102	103	101	102	102	100	101	101	100	.00	47	40	
13//	101	102	100	102	104	101	101	100	100	100	100	101	101	90	400	100	90			99	00
17//	100	105	60	1 V C	4 V 1 Д.Д.	A P	94	97	97	97	97	9.4	94	94	Q.A.	94	94		49	90	44
18//	49	05	05	64	95	95	95	95	96	96	47	97	QA	9.6	QH	99	99	çq	40	49	ųų
9//	84	87	A Q	90	92	93	<b>ę</b> u	95	96	96	97	98	98	98	99	99	Q.4	69	99	99	49
20//	69	85	90	93	95	96	97	97	98	98	9.0	99	ų ų	44	99	99	<b>6</b> 0	69	44	64	44
21//	0	85	91	93	95	96	97	97	9.0	98	98	99	99	99	99	97	99	49	44	V Q	69
- • • •	•			-	,																
	•							• •					~	-	•						
	<b>c</b> 1	€0	14	10	17	10	12	14	13	12	11	10	4	-		6	2	4	2	۲	1

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N# 34

X8(K), H=1.....N

,195E+00	.181E+01	.228E+00	.179L+01	\$52E+00	,176E+01	.269E+00	.1778+01
281E+00	.176E+01	,292E+00	.176E+01	.313E+00	176E+01	.332E+00	175t+h1
,350E+00	.175E+01	.368E+00	.175f+01	387E+00	,175f+01	.417E.00	1751+01
448E+00	,1758+01	.484E+00	.176t+U1	535E+0U	1771+01	.0021.00	.178t+01
704L+00	.178E+01	.002E+00	175E+01		• • • •	•	•

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YS(K), K#1,.....

.591E=01	.587t=01	,902E=01	.8836=01	.124E+00	150E+00	.141E+00	.157t+0u
.2048+00	.199E+00	.253E+00	.248E+00	312E+00	.305E+00	. 3Mct+ AU	373E+0U
.465E+00	.456E+00	568E+00	.55FE+00	,696E+00	.085t+00		.6471+00
.107E+01	.1061+01	130E+01	.134E+01	176E+01	175E+01	.2371+01	2351+91
334E+01	332E+01	510E+01	.508E+01	-	•		•

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10+1 ELLIPSOID HITH 20+PERCENT STING

INPUT COORDINATES

ĩ	0.000000	0.000000
Ś	.012311	.015643
5	038155	027360
4	072346	037344
5	.113710	046312
	161530	254695
7	215210	061477
8	274210	068792
9	337490	074569
10	.406010	000447
11	<b>.</b> <i>47777</i> 0	.085780
12	.552740	069440
13	.630410	092419
14	.710270	.095711
15	.791A10	.097619
10	.874520	044510
17	,957690	,099411
18	1.041402	.099914
19	1.124600	.043551
20	1.200900	097837
21	1.287800	095770
22	1.366800	.093159
23	1.443500	.069627
24	1.517300	065560
25	1.507700	041400
20	1.654300	.0/5026
21	1,716400	.004/60
20	1.//3/00	.003300
24	1.023300	1000434
30	140/1000	004007
12	1.411000	001101
11	1 645800	033100
3.4	1 970704	1020600
	11-1-1-10	
DYDANE	9994.0000	
DYDXT		
YHAIR	.1000	
XREFs	2,0000	

IMAX3 21 JMAX8 21 MIXA 25 MMALF80 KLOSE80 NPLU781 RF181,400 COVERG8,102+01 OF380. DNDY08,5062+00 ALF81,30 DX10X08,6462=01 XM8,7501+00 DX10XN8,2002+01 GAM81,40 AMINF8,9950

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1	θ.	0.	٥.	.9000E+02	.9000F+02	. 6967t+v2	,1140E+02
ż	.6441E+12	15616-02	5874E-02	.5921E+02	.59211+02	.0304t+02	. 45d7L+v1
3	2604E=01	1699L-U1	1057E-01	.27611+02	.27611+02	.11818+02	1+51t+v1
ų	7056E+01	5843E=01	.336tE=01	15531+02	15335+422	25261+01	. #247E+US
5	1490E+00	13516+00	5020E=01	97656+01	, 9765E+01	74451+00	51246+00
6	.2.66L+00	.2516E+00	6+376=01	6431F+01	.64311+01	.3361L+UP	.34301400
7	42361+00	4062E+00	.80L1E-01	41941+01	41446+01	.100/1+10	.2-401+00
ė	.6163E+00	.6004E+00	.9167E-01	24961+01	.24.05+11	1.175t+0C	2-116+40
9	#34=E+00	6187E+00	. 9H36t +01	10576+ 11	,10571+01	,1051t+10	, P: 18+17
10	1066E+01	1050E+01	946ME+01	0	- 284 SE + UC	.100dL+L0	+e1506+14
11	12-3E+61	12776+01	9609E+01	0	-,1651E+01	11326+10	. rd74t + ut
12	15CUE+01	1404E+01	.8750E+01	0	-,3167F+01	:1503E+60	**********
13	.1674t+01	16566+01	.7534E-Q1	0.	-,4991E+V1	.2376E+LC	.58556+10
14	1007E+01	1791E+01	.01201-01	0.	■.7572t+01	.4417FE+00	
15	1906L+U1	1840E+01	45e2t=01	٥,	-,11056+02	1080E+01	.5+02L+U(
÷	19968+01	1980E+01	.∠∩v0E+01	υ.	**50106+05	.125×L+v2	•516(1£+v(
17	2121E+01	2105E+.1	10=30005,	0	٥.	Ο.	.326CE+ve
18	2324E+01	,2313E+01	.200CE=01	υ.	Ο,	Ο,	1+_CE+_C
19	2746t+01	27 JUE+01	,20000-01	0.	٥.	٥.	, tourthul
50	399AL+U1	34001+01	,2°00E=01	٥.	Ø.	Q.	.2000t-01
51	1000E+31	.1066E+31	.20105-01	٥.	θ.	0.	,1000L-29

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----- NORMAL COURD, STRETCH FOR ALFE 1,300 -----

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J	4N	6	GH
1	٥.	٥.	.7920E=03
2	2334E+02	1584E=02	4738E+02
3	8979E+01	7893E-02	,1409E=01
4	5006E+01	2030E=01	.3005E=01
5	3241E+01	3981E=01	.5357E+01
6	2274E+01	6732E=01	.8549E=01
7	1674E+01	1037E+00	.1266E+00
8	1272E+01	1496E+00	1778E+00
9	9873£+00	2060E+00	,2398E+00
10	7765E+00	2736E+00	,3134£+00
11	6156E+00	3532E+00	.3993E+00
12	48951+00	4455E+00	4985E+00
13	3885E+00	5515E+00	.6118E+00
14	3064E+00	6720E+00	,7399E+00
15	2385E+00	.5078f+00	,8A39E+00
16	1817E+00	.9600E+00	.1045E+01
17	1337E+00	,1129E+01	1553E+01
18	9264E=01	.1317E+01	,1420E+ 1
19	,5734E=01	,1524E+01	,1638t+01
20	.2672E-01	,1751E+01	,1876E+01
21	0	10+3000£	.2136E+01

CPU SECONDS FOR HODY GEOMETRY CUMPUTATIONS= .112

17	OPHAX	10	JD	RMAX	IR	JR	1508	ISUP	R▲√G	KF 1	QFS	·• S	SECICIC
1	.914E=02	4	21	,939E+02	1	21	1	0	.627F+00	1.000	0,000	o	.209
2	579E+02	15	21	703E+03	1	51	1	Ũ	202E+01	1.400	0,000	55	. < 27
3	519E-02	2	21	572E+03	1	21	1	U	186E+01	1_4^0	0,000	101	.237
4	577E=02	1	21	950E+03	1	21	1	0	276E+01	1.400	0 00)	113	.234
5	417E-02	1	51	678E+03	1	21	1	Q	199E+01	1.400	0.000	114	.242
6	285E+02	1	20	,256E+03	i	21	1	0	,870E+00	1.400	0,000	115	,230
7	.135E-02	1	20	606E+02	1	21	1	0	.321E+00	1.400	0.000	114	,245
8	138E-02	7	51	794E+02	1	-21	1	0	334E+00	1.400	0,000	113	• 5 4 4
9	-120E-02	7	21	143E+03	1	21	1	0	474E+00	1.400	0.000	113	.247
10	104E-02	7	15	154E+03	1	- 21	1	0	489E+00	1,400	0,000	115	. 247
11	899E-03	7	21	122E+03	1	21	1	0	3971+00	1.400	0.000	113	• 241
12	778E-03	7	21	\$80E+02	1	-21	1	0	.300E+0C	1.400	0.000	112	.245
13	6758-03	7	51	708E+02	1	21	1	ç	247E+00	1.400	0,000	113	.240
14	.601E+03	e	21	659E+02	1	21	1	Q	559F+00	1.400	0.000	114	.246
15	539E=03	8	21	625E+02	1	- 21	1	0	210E+00	1.400	0.001	115	.246
16	481E-03	8	21	564E+02	i	21	1	Ó	189E+00	1.400	0,000	113	247
17	430E=03	8	21	4916+05	1	15	1	U	166E+00	1.400	0.001	113	.242
18	.383E3	8	21	430E+02	1	21	1	0	146E+00	1.000	0.000	113	.242
19	.341E=03	6	21	384E+02	1	21	1	0	131E+00	1.400	0.000	113	243
20	.304E-03	8	15	349E+02	1	21	1	υ	118E+00	1.400	0.000	114	,247
21	.271E=03	8	21	316E+02	1	15	1	0	107E+00	1,400	0.000	114	246
22	242E+03	9	21	205E+02	1	21	1	0	959E+01	1.400	0.000	114	240
23	.221E-03	9	21	257E+02	1	15	1	0	.862E=01	1.430	0.000	114	240
24	200E-03	9	51	2321+02	i	21	1	Q	7776+01	1.400	0.000	114	241
25	,182E=03	9	21	\$10E+05	1	21	1		.704E=01	1.400	0,000	114	.244
D]	D NOT CONV	ERGE	IN	25 CYCLES,		RH.	A X =	21E+02	2, COVRE ,	25E-02			

CPU SECONDS# 6.10 FOR 25 ITERATIONS, NHALFRO

1	86	XB	Y B	CP	м
1	0.000	0.000	0.000	1,27261	0.00000
2	006	.002	006	1,18736	21394
3	026	.017	,018	58442	,65988
4	071	,058	.034	20426	87617
5	149	,135	,050	58960	97140
6	267	252	066	- 02344	1.00902
7	424	408	081	+ 05237	1.02646
8	616	600	.092	.06930	1.03675
9	.835	819	098	• 07896	1.04265
0	1.066	1,050	100	- 08511	1.04641
1	1.293	1.277	096	-,09114	1.05011
2	1.500	1.484	087	+.09826	1.05449
3	1.674	1,658	075	• 06614	1.03483
4	1 807	1.791	061	00611	99136
5	1,906	1.890	046	.12420	92216
6	1 996	1 980	020	38754	77228
7	2.121	2,105	020	11500	92748
8	2,329	2,313	020	02152	15586
9	2.746	2.730	.020	00480	.99214
ð	3,996	3,980	020	.00046	99472
1.4.8	*********	******	.020	0.00000	99500

DRAG COEFFICIENT BY TRAPEZOIDAL INTEGRATION= .03738

I	XB	48	CP	
1	0.000	000,000	1,2726	
5	.002	006	1,1874	
3	017	.018	5844	
4	058	.034	2043	
5	135	.050	0396	
6	252	066	0234	
7	408	081	+ 0524	
8		590	• 0693	
9	.819	.098	.0790	
10	1.050	100	.0851	
11	1.277	.096	v.0911	
12	1.484	087	.0983	
13	1.658	.075	.0661	
14	1.791	.061	0061	
15	1.890	045	1242	
16	1.980	020	3875	
17	2.105	. 020	1150	
18	2.313	. 020	0215	
19	2.730	. 020	.0048	
20	3.980	. 020	0005	
21444		. 020	0.0000	

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MACH ND, CHART _ .

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<pre>1// 0 88 91 94 95 96 97 98 98 98 98 99 99 99 99 99 99 99 99 99</pre>		21	20	19	18	17	10	15	14	13	15	11	10	9	8	7	6	5	4	3	S	1
2// 21 85 90 93 95 96 97 97 98 98 98 99 99 99 99 99 99 99 99 99 99	1//	o	88	91	94	95	96	97	98	98	98	99	99	49	99	99	49	99	99	99	99	99
3// 65 80 86 89 92 93 95 96 97 97 98 98 98 98 98 98 98 98 98 98 98 98 98	2//	21	85	90	43	95	96	97	97	98	98	98	99	99	99	99	99	99	99	99	99	49
4//       87       87       89       90       91       92       93       94       95       96       96       97       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98       98 <t< td=""><td>3//</td><td>65</td><td>80</td><td>86</td><td>89</td><td>95</td><td>93</td><td>95</td><td>96</td><td>97</td><td>97</td><td>98</td><td>98</td><td>98</td><td>99</td><td>99</td><td>99</td><td>99</td><td>99</td><td>99</td><td>99</td><td>99</td></t<>	3//	65	80	86	89	95	93	95	96	97	97	98	98	98	99	99	99	99	99	99	99	99
5// 97 96 95 95 95 96 96 98 98 98 98 98 98 98 98 98 98 98 98 99 99	4//	87	87	89	90	91	92	93	94	95	96	96	97	98	98	98	99	99	99	99	99	99
6// 100 100 69 99 99 98 98 98 98 98 98 98 98 98 98 98	5//	97	96	95	95	95	95	95	96	96	96	96	97	97	98	98	9 B	94	99	49	44	99
7// 102 102 101 101 101 100 100 100 100 100	6//	100	100	<b>99</b>	99	99	98	98	98	98	98	98	98	98	98	98	98	99	99	99	99	99
<pre>5// 103 102 102 102 102 102 102 102 102 102 102</pre>	7//	102	105	101	101	101	100	160	100	100	99	99	94	99	99	99	99	99	99	99	99	99
9// 104 103 103 103 103 103 102 102 102 102 102 101 101 101 101 101	5//	103	103	105	102	102	105	101	101	101	101	100	100	100	100	99	99	99	99	49	99	99
10// 104 104 103 103 103 103 103 102 102 102 102 101 101 101 100 100 109 99 99 99 11// 105 104 104 104 103 103 103 103 103 102 102 102 102 101 101 101 100 100 99 99 99 99 12// 105 105 104 104 104 104 103 105 103 105 102 102 102 102 101 101 101 100 100 99 99 99 13// 103 102 102 102 102 101 101 101 101 101 101	9//	104	103	103	103	103	105	105	105	102	101	101	101	101	100	100	100	99	99	99	49	44
11// 105 104 104 103 103 103 103 103 103 103 103 102 102 102 102 102 101 101 100 100 99 99 99 99 91 12// 105 105 104 104 104 103 105 103 105 102 102 102 101 101 101 100 99 99 99 91 13// 103 102 102 102 102 101 101 101 101 101 100 100	10//	104	104	104	103	103	103	103	102	102	105	102	102	101	101	101	100	100	100	99	49	99
12// 105 105 104 104 104 104 104 105 105 105 105 102 102 102 102 101 101 100 99 99 99 13// 103 102 102 102 102 101 101 101 101 101 101	11//	105	104	104	104	103	103	103	103	103	105	102	102	105	101	101	101	100	100	99	99	44
13// 103 102 102 102 102 102 101 101 101 101 101	12//	105	105	104	104	104	104	103	105	103	105	105	102	105	102	101	101	101	100	94	99	99
14// 92 92 92 93 94 94 95 95 96 96 97 97 97 97 97 97 98 98 98 98 98 99 99 94 99 99 15// 92 92 92 93 94 95 95 96 96 95 95 96 97 97 97 98 98 98 99 99 99 99 99 99 17// 92 93 94 95 95 96 96 96 97 97 97 97 98 98 98 98 99 99 99 99 99 18// 98 98 98 98 98 98 98 98 98 98 98 98 98	13//	103	102	102	102	102	101	101	101	101	101	101	101	100	100	160	160	100	100	44	49	49
15// 42 42 42 42 43 44 44 45 45 46 46 46 47 47 48 48 48 48 49 49 49 49 49 16// 78 84 57 89 91 42 43 44 45 95 96 46 97 97 97 98 98 99 99 99 49 99 49 49 17// 92 93 94 95 95 96 96 96 97 97 97 97 98 98 48 98 99 99 99 99 49 18// 98 98 98 98 98 98 98 98 98 98 98 98 98	14//	99	96	98	97	47	47	97	97	97	97	97	9 M	98	98	98	48	99	99	49	94	94
16// 78 84 87 84 41 42 43 44 45 45 45 46 47 47 47 47 48 48 49 49 49 49 17// 92 93 94 95 95 96 96 96 97 97 97 97 98 98 48 98 98 99 99 99 99 99 99 99 99 99 99 99	15//	45	5.6		43	94	44	45	45	90	96	96	97	97	98	98	98	99	99	99	99	49
17// 92 93 94 95 95 95 95 95 96 98 97 97 97 97 98 98 98 98 98 99 99 99 99 99 99 99 99	10//	78	84	67	84	41	42	47	94	95	42	96	97	97	97	98	98	99	99	99	99	99
18// 98 98 98 98 98 98 98 98 98 98 98 98 98	17//	92	95	94	95	95	46	96	46	97	97	97	97	98	98	98	98	99	99	99	99	49
10// 99 99 99 99 99 99 99 99 99 99 99 99 9	18//	98	98	98	98	98	48	98	98	98	98	98	98	98	98	95	99	99	99	99	99	49
21// 99 99 99 99 99 99 99 99 99 99 99 99 9	14//	99	44	44	44	99	44	44	44		44	99	44	99	99	44	99	99	99	49	99	99
21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 N= 36 XS(K), K=1,,N .224E+00 .176E+01 .244E+00 .175E+01 .269E+00 .174E+01 .292E+00 .173E+01 .311E+00 .172E+01 .326E+00 .172E+01 .350E+00 .172E+01 .353E+00 .171E+01 .367E+00 .171E+01 .367E+00 .171E+01 .414E+00 .171E+01 .441E+00 .170E+01 .469E+00 .170E+01 .502E+00 .171E+01 .549E+00 .170E+01 .631E+00 .171E+01 .469E+00 .170E+01 .925E+00 .169E+01	20//	44	44		44	44	44	44	44	44	44	44	44	44	94	99	99	99	44	99	99	99
21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 N= 36 XS(K), K=1,,N .224E+00 .176E+01 .244E+00 .175E+01 .269E+00 .174E+01 .292E+00 .173E+01 .311E+00 .172E+01 .326E+00 .172E+01 .340E+00 .172E+01 .353E+00 .171E+01 .367E+00 .171E+01 .387E+00 .171E+01 .414E+00 .171E+01 .441E+00 .170E+01 .469E+00 .17(E+01 .502E+00 .171E+01 .414E+00 .170E+01 .631E+00 .171E+01 .469E+00 .17(E+01 .925E+00 .170E+01 .549E+00 .170E+01 .631E+00 .171E+01 .469E+00 .17(E+01 .925E+00 .169E+01	21//	44	44	44	44	99	44	44	44	44	44	44	94	99	94	ġ ġ	49	99	99	49	90	49
N= 36 XS(K), K=1,,N ,224E+00 ,176E+01 ,244E+00 ,175E+01 ,269E+00 ,174E+01 ,292E+00 ,173E+01 ,311E+00 ,172E+01 ,326E+00 ,172E+01 ,340E+00 ,172E+01 ,353E+00 ,171E+01 ,367E+00 ,171E+01 ,387E+00 ,171E+01 ,414E+00 ,171E+01 ,441E+00 ,170E+01 ,469E+00 ,17CE+01 ,502E+00 ,171E+01 ,549E+00 ,170E+01 ,631E+00 ,171E+01 ,759F+00 ,17TE+01 ,925E+00 ,169E+01		51	20	19	18	17	16	15	14	13	15	11	10	9	8	7	6	5	4	3	2	1
XS(K), K=1,,N .224E+00 .176E+01 .244E+00 .175E+01 .269E+00 .174E+01 .292E+00 .173E+01 .311E+00 .172E+01 .326E+00 .172E+01 .340E+00 .172E+01 .353E+00 .171E+01 .367E+00 .171E+01 .387E+00 .171E+01 .414E+00 .171E+01 .441E+00 .170E+01 .469E+00 .17CE+01 .502E+00 .170E+01 .549E+00 .170E+01 .631E+00 .171E+01 .759F+00 .17CE+01 .925E+00 .169E+01	NE	30																				
.224E+00 .176E+01 .244E+00 .175E+01 .269E+00 .174E+01 .292E+00 .173E+01 .311E+00 .172E+01 .326E+00 .172E+01 .340E+00 .172E+01 .353E+00 .171E+01 .367E+00 .171E+01 .387E+00 .171E+01 .414E+00 .171E+01 .441E+00 .170E+01 .469E+00 .171E+01 .502E+00 .171E+01 .549E+00 .170E+01 .631E+00 .171E+01 .759F+00 .171F+01 .925F+00 .169F+01	X5(K)	, <u>k</u> zi,		, N																		
311E+00 ,172E+01 ,326E+00 ,172E+01 ,340E+00 ,172E+01 ,353E+00 ,171E+01 367E+00 ,171E+01 ,387E+00 ,171E+01 ,414E+00 ,171E+01 ,441E+00 ,170E+01 469E+00 ,171E+01 ,502E+00 ,170E+01 ,549E+00 ,170E+01 ,631E+00 ,171E+01 759F+00 ,171F+01 ,925E+00 ,169E+01	. 2201	F + 0 0	. 17	5F + 01		244F 4	100	.17	5E+01		- 19 d	0.0	.174	1E+01		926	.00	. 17	1.6 + 0.1			
367E+00 ,171E+01 ,387E+00 ,171E+01 ,414E+00 ,171E+01 ,441E+00 ,170E+01 469E+00 ,17CE+01 ,502E+00 ,170E+01 ,549E+00 ,170E+01 ,631E+00 ,171E+01 759F+00 ,171F+01 ,925E+00 ,169E+01	311	E + 0 0	. 17	26 4 0 1		3266	00	17	2E+01		540E	00	.17	2E+01		538	0.0	.17	1 E + 01			
469E+00 ,17(E+01 ,502E+00 ,170E+01 ,549E+00 ,170E+01 ,631E+00 ,171E+01 ,759E+00 ,171E+01 ,925E+00 ,169E+01	. 3671	F + 0.0	. 17	1 - + 0 1		LA74	0.0	. 17	E + 01		114F	00	.171	18 + 0 1		141F	00	.170	DF + 01			
7595400 1715401 9255400 1695401	4691	E + 0 0	170	E+01		15021	00	.170	12+01		UNE	00	.170			ALF.	00	.17	F+01			
	.759	F + 0 0	17	1 = + 0 1		25F	00	.169	9E+01	•••												

YS(K), K=1, .....

,625E=01	,640E+01	,922E=01	.927E+01	152F+00	,124E+00	,163E+00	,160E+0U
206E+00	1205F+30	256E+00	250E+00	.314E+00	.3082+00	.383E.00	3705+00
467E+00	458E+00	\$70E+00	560E+00	697E+00	.086E+00	.860E+00	.847E+00
.107E+01	106E+01	136E+01	134E+01	176E+01	1746+01	237E+01	234E+01
334E+01	.331E+01	510E+01	,505E+01				•

CPU SECONDS TO COMPUTE AND PLOT CP AND MCMARTE ,383

#### SPHERE/15-DEG CONE/CYLINDER/15-DEG FLARE

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INPUT	COORDINATES	
1	a.000000 0.0000	00
Ż	001637 0404	30
3	007003 0833	90
ŝ	.035640 .1854	00
	.065090 .2467	00
6	178200 .3827	00
•	272700 ,4453	00
10	-396900 -4900 -543800 -5294	00
iż	,710600 ,5741	0.0
13	.897600 .6242	00
14	1.332000 .7406	00
16	1.578000 .6066	00
17	1,842000 ,8773	00
19	2.421000 1.0000	00
20	2.738000 1.0000	00
21	3,065000 1,0000	00
23	3,735000 1,0000	00
24	4,072000 1,0000	00
25	4,406000 1.0280 4.734000 1.1160	00
2Ť	5.053000 1.2020	00
28	5.361000 1.2840	00
30	5.934000 1.4380	60
31	6.198000 1.5090	00
32	6,448000 1,5750 6 680000 1 6390	00
34	6,910000 1,6990	00
35	7,133000 1,7590	00
30	7.594000 1.5830	00
38	7.856000 1.9530	0.0
39	8,156000 2,0330	00
DYDXNI	999.0000	
YMAX=	2.0000	
XREF	8,5000	
IMAXE	21	
JMAX=	21	
MITE	25	
KLOSE	õ	
NPLOT	1	
COVER(	400 * .10E+01	
QF3= (	•	
DNDY01	,286E+01	
DXIDX	= ,200E+01	
XMM .	8001+01	
DXIDX	+ /JUL+UU # .150E+02	
GAME1	40	
AMINF	.8000	

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1	8	X	۲	THET	THETH	AK	F
1	٥.	٥.	٥.	,9000E+02	*4000E+05	.1999E+U1	.5000E+00
2	1074L+00	,1148E=01	,1065E+00	7771E+02	7771E+02	2000E+01	4098E+U0
3	.2580E+00	.6508E=01	.2467£+00	.6046E+02	+0046E+02	1994E+U1	26432+00
4	4903E+00	.2217E+00	.4156E+00	3393E+02	·3363E+05	.21201+01	1761L+U0
5	<b>8336</b> £+00	+5437E+00	\$294E+00	1481E+02	.1481F+02	.8703E=01	1233E+00
6	,1305E+01	99861+00	+6512£+00	1498E+02	*1486E+05	21255F+05	9419E=01
7	1904E+01	+1578E+01	.8066E+00	.1489E+02	•1484E+05	.2955E=U1	7568E=01
8	.2618E+01	*5540E+01	9821E+00	,9323E+01	.9323E+01	.5403E+00	.6563E+01
9	.3416E+01	.3066E+01	1000E+01	0.	.4194E+00	.8329L+Ú1	.6055E=01
10	,4254E+01	.3904E+01	.9991E+00	0.	=,1835E+00	+,6287E=01	,5953E=01
11	.5084E+01	+4735E+01	,1116E+01	0.	•1950E+05	.2172E+00	.0173E-01
12	•2800E+01	_5510±+01	.1324E+01	0.	.1505E+02	.1912t-03	.6798E-U1
13	e6548E+01	,6199E+01	.1509E+01	0.	+1485E+02	.5006E-01	.7802E-01
14	.7148E+01	.6798E+01	,1669E+01	٥.	.1481E+05	.8646E=U2	.8835E=01
15	.7707E+01	.7357E+01	1819E+01	0.	+1515E+02	5544E-01	.0751E=U1
16	_B350E+01	.8000E+01	1996E+01	Ο,	1619E+02	.4508E+00	.0667E-01
17	.9287£+01	.8937E+01	10+34742	0.	Ο.	Ο,	.4207E=01
18	_1085E+02	.1050E+02	.2074E+01	Ο.	0.	0.	.2400E+01
19	.1397E+02	*1395E+05	.2074E+01	Ο.	0.	٥.	,1067E-01
20	2335E+02	*5300F+05	.2074E+01	Ο,	۰.	0.	.2667E=02
51	,1000E+31	1000E+31	.2074E+01	٥.	0.	٥.	.1000E=29

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----- NORMAL COURD, STRETCH FOR ALF= 1,300 -----

J		LN	G	6H
1	٥,		ο,	.1386E+03
2		1334E+03	2772E+03	.8242E-03
3		51311+02	1301E=02	.2406E=02
4		28601+02	3552E=02	5259E=02
5		18526+02	6967E=02	9374E=02
6		12998+02	1178E=01	1496E=01
7		9567E+01	1814E=01	2216E-01
8		7270E+01	2619E-01	3112E=01
9		5642E+01	3605E=01	4196E=01
10		4437E+C1	.4786E=01	.5484E-01
11		3518E+01	6100E=01	6908E=01
12		2797E+01	.7797E-01	.8724E=01
13		2220E+01	9652E=01	.1071E+00
14		1751E+01	.1176E+00	1295E+00
15		1363E+01	.1414E+00	1547E+00
16		10366+01	1680E+00	1828E+00
17		7637E+00	1976E+00	21418+00
18		5294F+00	2405E+00	24861+00
19		3277F+00	26676+00	28666+00
20	1	15271+00	30651400	.32826+00
21	പ്	112010100	35000+00	1718F+00
F 1			133000000	121206400

CPU SECONDS FOR BODY GEOMETRY COMPUTATIONS= ,110

11	OPMAX	10	Jþ	RMAX	18	JK	1208	ISUP	RAVG	RF1	0F 3	NS.	SEC/CYC
1	,102E+00	4	21	,128E+02	2	51	1	٥	,209E+00	1.000	0.000	0	,204
2	.690E-01	2	51	248E+02	1	21	1	0	2066400	1.400	0.000	t)	,213
3	607E=01	1	21	2048+02	1	21	1	0	197E+00	1.400	0,000	0	.214
4	594E+01	1	20	146E+02	1	21	1	0	188E+00	1.400	0,000	0	.211
5	.#62E-01	1	21	1526+02	1	21	1	0	169E+00	1.400	0,000	0	.210
6	345E=01	1	21	116E+02	1	21	1	0	132E+00	1.400	0.000	ð	.513
7	283E+01	14	21	717E+01	1	21	1	0	987E=01	1.400	0,000	0	.211
8	256E=01	14	21	485E+01	1	21	1	0	780E=01	1.400	0.000	0	.216
9	10+3522	14	51	391E+01	1	51	1	0	668E=01	1.400	0.000	0	*515
10	211E=01	14	21	344E+01	1	21	1	0	603E=01	1.400	0,000	0	.210
11	193E-01	14	51	312E+01	1	51	1	0	557E=01	1.400	0,000	0	.214
12	1761-01	14	21	286E+01	1	21	1	0	517E-01	1,400	0,000	0	.214
13	162E=01	14	51	260E+01	1	21	1	0	479E=01	1,400	0,000	0	.219
14	148E-01	14	21	235E+01	1	15	1	0	,441E=01	1,000	0,000	0	.214
15	137E-01	14	51	215E+01	1	21	1	0	404E=01	1.400	0,000	0	.217
16	,126E=01	14	51	,192E+01	1	51	1	0	371E-01	1.400	0,000	0	.214
17	117E-01	14	21	174E+01	1	15	1	0	3426-01	1,400	0,000	0	,210
18	108E-01	14	21	159E+01	1	51	1	0	318E=01	1.400	0,000	0	,211
19	100E+01	14	21	147E+01	1	51	1	0	2976-01	1.400	0,000	0	.217
20	934E=02	14	51	137E+01	1	51	1	0	280E-01	1,400	0.000	0	.218
21	870E-02	14	21	129E+01	1	51	1	0	265E=01	1.400	0,000	0	. 217
22	812E-02	14	51	123E+01	1	15	1	0	251E=01	1,400	0.000	0	.210
23	759E-02	14	21	117E+01	1	51	1	0	238E=01	1.400	0,000	0	.<16
24	710E-02	14	21	112E+01	1	51	1	0	2256-01	1.400	0,000	0	.216
25	665E+02	14	21	106E+01	1	51	1	0	,213E+01	1.400	0,000	0	115.

---- DID NUT CONVERGE IN 25 CYCLES,---- RMAX= ,11E+01, COVR= ,25E+02

CPU SECUNDSE 5,42 FOR 25 ITERATIONS, NHALFED

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1	5 <del>8</del>	XB	YB	CP	м
1	0.000	0.000	0,000	1,17040	0.00000
2	107	.011	107	1,09484	,17941
3	258	065	247	72935	44980
4	490	222	.416	09728	75609
5	.834	544	\$29	+ 00286	60129
6	1.305	949	651	10179	,75405
7	1.904	1,578	807	- 02264	.81022
8	2.618	2,270	982	• 19547	.88861
9	3.416	3,000	1,000	- 08256	,83729
10	4.254	3,904	949	,26338	68051
11	5,084	4,735	1,116	, 30698	.63244
12	5,860	5,510	1,324	,18223	.71760
13	6.548	6,199	1,509	.12378	74411
14	7,148	6,798	1,669	08965	75954
15	7.707	7,357	1,819	03537	.78404
16	8,350	8,000	1,946	42017	,99311
17	9,287	8,937	2.074	*,38472	,97633
18	10,850	10,500	2.074	-,06093	82751
19	13,975	13,625	2,074	-,01423	.80642
20	23,350	23,000	2.074	-,00138	.80062
21+4	**********	******	£.074	0.00000	80000

DRAG COEFFICIENT BY TRAPEZOIDAL INTEGRATION= .04600

DRAG COEFFICIENT BY SIMPSON INTEGRATION= +,01718

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PLOT OF CP AT UNEQUAL INCREMENTS

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1	XB		۲	8	c	P															
1	· 0,0	٥	.000	۱.	1704	•												•			
2	.011			.107 1		0948		•											٠		
3	.005			.247		.7293					•								•		
È		26		410 520	_'	0473									+				*		
6		99		. 651	- <b>T</b> •	1018										•					
ĩ	1.5	78		807		0226									•						
8	2,270		,982		•,1955											•		•	-		
9	3,0	66	1	000	•	0826		•									+		*		
10	3,9	04		999		2634								+							
11	4,7	35	1	116	•	3670							+						•		
12	5.510		1,500		1022										•						
14	6.7	QR.		660	•	APAN									•						
15	7,357		1.819		0354										•	•			-		
10	8,000		1 996		+,4202											•			-		
17	8.9	2	074		3847																
18	10,500 2.0		074	-,(	0609										•	•					
19	13,6	25	Z,	074	••	0142										•			٠		
20	62.0	00	2	074		0014										+			•		
51			2	,074	0,0	0000										•			•		
MA	CH N0	. EH	LRT .																		
	51	20	19	18	17	16	15	14	13	15	11	10	Ŷ	8	7	6	5	4	3	٤	1
	•	16	51	<b>A</b> 2	6.	72	7.0	7.		7.	7.6	-		10		70		•••	•		
2//	17	38	53	61	68	72	74	76	27	78	78	79	79	70	70	70	70	79	79	74	
3//	44	48	57	64	68	12	74	75	17	77	78	78	79	79	79	79	79	79	79	79	00
4//	75	68	68	70	72	73	75	76	77	78	78	79	79	79	79	79	79	79	74	79	80
5//	80	76	74	74	70	74	74	75	76	76	77	78	78	79	79	79	79	79	80	60	
6//	75	75	75	15	76	76	76	77	77	77	78	78	76	79	79	79	79	79	79	60	F ()
8//	61	80	79	79	78	78	78	78	78	78	78	78	76	79	79	79	79	79	79	60	- 0
9//	50 51	82		80	70	79	78	78	78	75	78	78	79	79	19	14	19	74	79	19	e C 
10//	68	69	70	72	73	74	75	76	77	76	78	79	79	79	79	80	80	80	00	80	- 60 - 80
11//	63	65	00	65	70	71	73	74	15	76	77	78	79	79	79	79	80	ŇÖ	60	0.0	
11211	71	72	72	72	73	74	75	75	76	77	78	78	79	79	79	79	80	60	60	00	00
13//	74	74	74	75	75	76	76	77	78	78	79	79	79	79	79	79	79	14	60	00	<b>ь</b> 0
14//	75	76	76	77	77	78	78	79	79	80	50	80	80	60	79	79	79	79	74	19	60
15//	78	79	80	81	81	62	62	82	52	81	81	80	80	60	80	79	79	79	79	79	60
10//	44	41	01	92	90	64	87	85	84	82	61	81	80	80	79	79	79	79	79	79	60
18//	82	82	82	82	87	82	82	82	40	81	0 Ľ 8 1	81	80	60	80	80	14	79	74	79	60
19//	80	80	80	80	80	80	80	80	80	80	80	80	80	60	80	80	80	80	79	79	- 60
20//	80	80	80	60	80	80	80	80	80	80	80	80	80	80	60	80	60	80	80	60	- 60 - 60
21//	80	60	80	60	80	60	80	60	80	80	80	80	80	60	80	80	80	80	80	90	80
	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	ş	1
CPU SE	CONDS	10 C	OHPU	TE A	ND P	LOT	C P . A	ND M	CHAR	t =	.27	9									

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## REFERENCES

- South, Jerry C. Jr.; and Jameson, Antony: Relaxation Solutions for Inviscid Axisymmetric Transonic Flow Over Blunt or Pointed Bodies. AIAA Computational Fluid Dynamics Conference (Palm Springs, Calif., July 1973, pp. 8-17).
- Jameson, Antony: Iterative Solution of Transonic Flows Over Airfoils and Wings, Including Flows at Mach 1. Commun. Pure & Appl. Math., vol. 27, no. 3, May 1974, pp. 283-309.

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Figure 1. - Frame 1 of plotted output.



IÚ-1 ELLIPSOID M= .995, IMAX= 21, JMAX= 21, IT= 25, DPM= .22E-03 DXIDX0= .08, DNDY0= .50E+00, QF3= 0.00 CXRQEHI 76/03/25.

Figure 2. - Frame 2 of plotted output.

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## ORIGINAL PAGE IS OF POOR QUALITY

Figure 3. - Frame 3 of plotted output.

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Figure 4. - Frame 4 of plotted output.

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10-1 ELLIPSOID HITH 20-PERCENT STING H= .995. IMRX= 21. JMRX= 21. IT= 25. DPM= .10E-03 DXIDX0= .00. DNDYD= .50E+00. GF3= 0.00 CXM= .75E+00. XM= .20E+01. XIM= .20E+01. DXIDXM= 2.00 CXRGEWI 76/03/25.

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Figure 5. - Frame 5 of plotted output.



## DRIGINAL PAGE IS DE POOR QUALITY

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Figure 6. - Frame 6 of plotted output.

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Figure 7. - Frame 7 of plotted output.

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Figure 8. - Frame 8 of plotted output.

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