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Westinghouse Astronuclear Laboratory

SATS

A COMPUTER PROGRAM FOR PLANE
THERMAL STRESS ANALYSIS BY SERIES SOLUTION

MASTER

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ABSTRACT

This report describes a two-dimensional thermal stress computer program which calculates the stresses and deflections for problems of plane stress or plane strain. This program, called SATS (Series Analysis of Thermal Stress), was developed at the Westinghouse Astronuclear Laboratory in support of the NERVA (Nuclear Engine for Rocket Vehicle Application) Program (Contract NP-1). The program, which is based on the earlier work of Dr. L. E. Hulbert, calculates the temperature and stress fields for plane two-dimensional bodies with boundary conditions including prescribed displacements, surface pressures, temperature and convective boundary conditions. The solution is obtained by "best-fitting" a truncated series solution of the harmonic equation to the defined temperature boundary conditions and a truncated series solution of the biharmonic equation to the defined stress or displacement boundary conditions.

Included in this report is a description of the required input data for the SATS program and a contour plotting program which will yield contour plots of the stress and temperature results, an example problem illustrating the application of the program to a simple thermal stress problem, and a listing of the SATS program and the plotting program.

SATS is written in FORTRAN IV for the CDC 6600 computer. A core size of 135000₈ is required.

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1. INTRODUCTION

In this report a computer program (SATS) for determining the stress field and/or the temperature distribution in a plane body by a series solution (point-matching) technique is described.

The details of this technique are described in Reference 1, and only an outline of the method is given in this report.

The program was designed to be a general purpose program for solving linear stress-strain problems, thermal stress and temperature fields. It is restricted to materials for which the thermal conductivity, the modulus of elasticity, the internal heat generation rate, the coefficient of thermal expansion and the Poisson's ratio are independent of position and temperature.

In this program a continuous region is defined by a set of boundary points which are sufficient to define the region being analyzed. For convenience in problem definition, these points are assumed to lie on a set of boundary curves, with one or more points on each curve.

The program uses a truncation of the polar series solution to the harmonic equation for the temperature solution and the biharmonic equation for the stress solution, and thus gives best solutions when applied to bodies containing circular holes.

There is also included a stress plotting program which will produce contour plots of the stresses and temperatures calculated by the SATS program.

The input data and outputs desired are specified on the control cards described in this report. Included are examples on the use of the program and comparison with other numerical and theoretical solutions.

2. ANALYSIS FORMULATION

A detailed description of the point-matching method of solution of two-dimensional elasticity problems is given in Reference 1, so no detail is given in this report. A brief outline of the method is presented so that the program instructions and operation can be understood.

2.1 GENERAL SOLUTION

The general solution to the two-dimensional (biharmonic) stress equation for the stress function Φ is given in Reference 2 as:

$$\begin{aligned}
 \Phi = & a_0 \log r + b_0 r^2 + c_0 r^2 \log r + d_0 r^2 \theta + a_0 \theta \\
 & + \frac{a_1}{2} r \theta \sin \theta + (b_1 r^3 + a_1' r^{-1} + b_1' r \log r) \cos \theta \\
 & - \frac{c_1}{2} r \theta \cos \theta + (d_1 r^3 + c_1' r^{-1} + d_1' r \log r) \sin \theta \\
 & + \sum_{n=2}^{\infty} (a_n r^n + b_n r^{n+2} + a_n' r^{-n} + b_n' r^{-n+2}) \cos n\theta \\
 & + \sum_{n=2}^{\infty} (c_n r^n + d_n r^{n+2} + c_n' r^{-n} + d_n' r^{-n+2}) \sin n\theta
 \end{aligned} \tag{2-1}$$

Omitted from Equation 2-1 are terms which do not contribute to the stresses which are related to the second derivatives of the stress function Φ . For completeness,

$$\Phi = \Phi_0 + e_1 r \cos \theta + e_2 r \sin \theta + \dots \tag{2-2}$$

Equation 2-2 is the complete solution to the biharmonic equation. The solution to the harmonic equation is similar, but has several terms deleted. The solution to the equation $\nabla^2 T = 0$ is:

$$\begin{aligned}
T = & T_o + e_1 r \cos \theta + e_2 r \sin \theta \\
& + a_o \log r + a'_o \theta + a'_1 r^{-1} \cos \theta \\
& + c'_1 r^{-1} \sin \theta + \sum_{n=2}^{\infty} (a_n r^n + a'_n r^{-n}) \cos n\theta \\
& + \sum_{n=2}^{\infty} (c_n r^n + c'_n r^{-n}) \sin n\theta
\end{aligned} \tag{2-3}$$

The relationship of these series solution terms in the SATS code is given in Table 2-1.

For certain symmetry conditions or positions of the origin (pole) about which the series is expanded, the coefficients of several of the terms in this series can be shown to be zero, and thus not included in the series. Several classes of pole locations are shown in Table 2-2.

Tables 2-3 and 2-4 give the permissible terms for the temperature and stress solutions for these pole locations. These terms are the ones selected by subroutines TEQSEL and SEQSEL in the program for the specified pole types.

2.2 COMPUTER PROGRAM LOGIC

The following steps describe the procedure used in the SATS code. The steps are similar for both the temperature solution and the stress solution.

2.2.1 Data Input

The body to be analyzed is described by defining a set of boundary points. These points are assumed to lie on a set of boundary curves. The equations for the curves are defined and the position of the point on the curve is specified. The allowable curves are circles and straight lines. Angles in degrees counterclockwise from the x axis are used to define the boundary point locations on the circles, and the x position is used to define the boundary point positions on the straight lines (y position for lines parallel to the y axis).

Also defined are the locations of the pole(s) about which the series solution is expanded. Only one central (main) pole should be used in each problem, but several auxiliary poles can also be used. The maximum order of the expansion about each pole must be specified.

TABLE 2-1
 LABELS FOR SERIES TERMS IN SATS

<u>NA</u>	<u>KA</u>	<u>TERM</u>
0	1	$\log r$
0	2	r^2
0	3	$r^2 \log r$
0	4	$r^2 \theta$
0	5	θ
0	6	T_o
0	7	$r \cos \theta$
0	8	$r \sin \theta$
1	1	$r \theta \sin \theta$
1	2	$r^3 \cos \theta$
1	3	$r^{-1} \cos \theta$
1	4	$r \log r \cos \theta$
1	5	$r \theta \cos \theta$
1	6	$r^3 \sin \theta$
1	7	$r^{-1} \sin \theta$
1	8	$r \log r \sin \theta$
N	1	$r^n \cos n\theta$
N	2	$r^{n+2} \cos n\theta$
N	3	$r^{-n} \cos n\theta$
N	4	$r^{-n+2} \cos n\theta$
N	5	$r^n \sin n\theta$
N	6	$r^{n+2} \sin n\theta$
N	7	$r^{-n} \sin n\theta$
N	8	$r^{-n+2} \sin n\theta$

TABLE 2-2
POSSIBLE POLE LOCATIONS

<u>Location</u>	<u>Description</u>
1	Central (Main) pole, in a hole
2	Central (Main) pole, in solid material
3	Auxiliary pole, on symmetry line, within body
4	Auxiliary pole, off symmetry line, within body
5	Auxiliary pole, on symmetry line, outside body
6	Auxiliary pole, off symmetry line, outside body

TABLE 2-3
 ALLOWABLE TEMPERATURE SERIES TERMS

<u>Pole Type (Table 2-2)</u>	<u>Number of Symmetry Lines Thru Body**</u>	<u>0</u> <u>1</u>	<u>0</u> <u>5</u>	<u>0</u> <u>6</u>	<u>0</u> <u>7</u>	<u>0</u> <u>8</u>	<u>1</u> <u>3</u>	<u>1</u> <u>7</u>	<u>N</u> <u>1</u>	<u>N</u> <u>3</u>	<u>N</u> <u>5</u>	<u>N</u> <u>7</u>
1	0	X		X	X	X	X	X	X	X	X	X
1	1	X		X	X				X	X		
1	M	X		X			X		M*	M*		
2	0			X	X	X			X		X	
2	1			X	X				X			
2	M			X					M*			
3	1 or M	X					X			X		
4	0, 1, or M	X					X	X		X		X
5	1 or M	X					X			X		
6	0, 1, or M	X	X				X	X		X		X

* Only for N as multiples of M

** The x axis is always a symmetry line if there are any symmetry lines in the body.

TABLE 2-4
ALLOWABLE STRESS SERIES TERMS

<u>Pole Type</u>	<u>Number of Symmetry Lines**</u>	<u>0</u> <u>1</u>	<u>0</u> <u>2</u>	<u>0</u> <u>5</u>	<u>1</u> <u>2</u>	<u>1</u> <u>3</u>	<u>1</u> <u>6</u>	<u>1</u> <u>7</u>	<u>N</u> <u>1</u>	<u>N</u> <u>2</u>	<u>N</u> <u>3</u>	<u>N</u> <u>4</u>	<u>N</u> <u>5</u>	<u>N</u> <u>6</u>	<u>N</u> <u>7</u>	<u>N</u> <u>8</u>
1	0	X	X		X	X	X	X	X	X	X	X	X	X	X	X
1	1	X	X		X	X			X	X	X	X				
1	M	X	X						M*	M*	M*	M*				
2	0		X		X		X		X	X			X	X		
2	1		X		X				X	X						
2	M		X						M*	M*						
3	1 or M	X				X					X	X				
4	0, 1, or M	X				X		X			X	X			X	X
5	1 or M	X				X					X	X				
6	0, 1, or M	X		X		X		X			X	X			X	X

* Only for N as multiples of M

** The X axis must be symmetry line if there are any symmetry lines in the body.

The type of symmetry is also defined. Three types are allowed: (a) no symmetry, (b) rotational (polar) symmetry, and (c) translational symmetry. The number of symmetry lines defines the number of lines which divide up the region for the polar symmetry and the number of region repeats for the translational symmetry. In the rotational symmetry the smallest symmetry section (geometrical and loading) must be used.

Other input data required are the boundary conditions at each boundary point. For the temperature solution one condition is allowed at each boundary point: either a specified temperature or a convection condition. For the stress solution two conditions are allowed at each point: normal stress or displacement and tangential stress or displacement. The number of specified boundary conditions must be equal or greater than the number of terms used in the series. Best results are obtained if the number of boundary conditions exceeds the number of series terms by at least a factor of 1.5.

2.2.2 Solution for Series Coefficients

One equation in the unknown series coefficients is set up for each boundary condition, resulting in a matrix equation:

$$A X = C$$

where X is a vector of the unknown coefficients for the series terms, C is the load vector from the specified boundary conditions, and A is a matrix resulting from the boundary condition equation. A is, in general, not square, so X is overspecified.

The transformation:

$$A^T A X = A^T C$$

yields a set of simultaneous equations in which the solution vector X is a "best-fit" solution to the original set of simultaneous equations. This then gives the "best" set of coefficients for the truncated series which was chosen to represent the stress or temperature field.

2.2.3 Output of Results

Once the coefficients for the terms in the series have been determined, the entire stress or temperature field is defined and various output options are available to give printed boundary point stresses, temperatures or displacements, and interior stresses, or to obtain plotted results. Options are also available to obtain punched output of the series solution.

coefficients for further calculations.

2.2.4 Plotting Program

The stress and/or temperature contours are plotted for a rectangular array of points which are defined by the data for the subroutine SIGPLT in the SATS program. The plotting program can be run directly after the SATS run, or TAPE 11 (the tape on which the plotting data is stored) may be reserved and the plotting program run after the printed output from the SATS run has been examined. The stress/temperature contour lines desired must be input to the plotting program.

The plotting of the contour lines in this rectangular array of points is a much simpler process than it is often made out to be. There is no necessity for tracing of contours, checking for closed contours, etc., if the following procedure is used.

For each rectangle defined by four (4) adjacent points in the array, for each contour line, for each side, determine if the contour line lies between the values at the end points of that side. If it does not, go to the next side. If it does, find the point where the contour line meets that edge by linear interpolation. Then examine each remaining side of the rectangle to see which side the contour line also intersects (which it must). Again determine the exact point of crossing. Draw the line connecting the two points as a portion of that contour line.

After this procedure is completed, a complete contour plot in the rectangular array is obtained, with continuous contour lines ending at the edges of the rectangle or closing on themselves.

Just as the stress function is defined both within and outside the body, the stress plots will appear both within and outside the body boundaries. Portions of the stress plots appearing outside the region boundaries can be ignored or deleted with the aid of scissors.

3. TEMPERATURE AND STRESS PROGRAM

3.1 PROGRAM ORGANIZATION AND LIMITATIONS

The SATS digital computer program was developed for the solution of thermal stress problems but can also be used for obtaining steady state conduction temperature solutions and stress solutions in the absence of thermal loads.

The SATS program is divided into three major sections: GEOMETRY INPUT, TEMPERATURE CALCULATION, and STRESS CALCULATION. An overall execution flow chart is shown in Figure 3-1.

There are storage limits on several of the parameters used in the SATS program. These limits are tabulated in Table 3-1.

3.2 INPUT DATA

The input data for the SATS program is given in Table 3-2. The symbol (F) represents a floating point number (punched with a decimal point), and (I) represents an integer (right justified in the field).

The program allows multiple cases to be run by stacking the cards in sequence. The entire input data deck should end with a transfer to a new problem followed by two blank cards.

3.3 OUTPUT DATA

The output data is completely labeled and will not be discussed in detail. The example problem in Section 5 shows the output from a simple thermal stress problem.

Figure 3-1 SATS Computer Program Flow Diagram

TABLE 3-1
SATS PROGRAM STORAGE LIMITS

<u>PARAMETER</u>	<u>LIMIT</u>
Number of Boundary Curves	40
Number of Boundary Points	300
Number of Expansion Poles in Each Symmetry Section	40
Total Number of Poles in Entire Body	240
Number of Series Terms	140
Number of Boundary Conditions	500
SATS Program Storage	130000 ₈
Plotting Program Storage	105000 ₈

TABLE 3-2
SATS INPUT DATA

I. GEOMETRY DEFINITION

All dimensions are expressed in inches.

Card A Identification - Any desired title (72H)

Card B Control Card (713)

Columns	1 - 3	I	NOCUR	Number of boundary curves (40 maximum)
	4 - 6	I	NOCON	Number of boundary curve parameters (4 x NOCUR)
	7 - 9	I	IET	Number of boundary points (300 maximum)
	10 - 12	I	NPOLE	Number of expansion poles in symmetry section (40 maximum)
	13 - 15	I	ISYM	Type of symmetry 1 - No symmetry 2 - Polar symmetry 3 - Translational symmetry
	16 - 18	I	NSYM	Number of symmetry lines
	19 - 21	I	INKEY	Input routine option 0 - Use normal input 1 - Use INPUTA or INPUTI routines where indicated (See Tables 3-3 and 3-4)

Card(s) C Boundary Point Assignment to Boundary Curves (2413)

I	NOCUR	Numbers defining the highest boundary point number on each curve. (Sequential numbers from the highest boundary point number on this curve are assumed to lie on the same curve.)
---	-------	---

TABLE 3-2
(Continued)

Card(s) D Boundary Curve Equations (NOCUR cards) (4E12.2)

Columns			<u>Circle</u>	<u>Line</u>	<u>Line Parallel to X Axis</u>
1 - 12	F		X at center	Slope	X intercept
13 - 24	F		Y at center	Y intercept	0.0
25 - 36	F		Radius	0.0	0.0
37 - 48	F		+1. for hole, -1. for an exterior boundary	+1., y component of outward normal positive -1., y component of outward normal negative	+1., positive outward normal -1., negative outward normal

Card(s) E Boundary Point Locations (6E12.2) (or use INPUTA)

F

IET numbers defining the position of
 the boundary points on the boundary
 curves
 For circles, the angle in degrees
 measured counterclockwise from the
 X axis
 For lines, the X coordinate of the
 boundary point
 For lines parallel to the Y axis, the
 Y coordinate of the boundary point

Card F Scale Factor (2E12.2)

Columns 1 - 12 F

Scale factor for problem. This is a
 divisor for all dimensions in the problem,
 used to avoid very large or very small
 values for r^n or r^{-n} . It should be an
 average dimension for the body. An
 optimum value is $\sqrt{R_{\max} \times R_{\min}}$,
 where $R_{\max}$ and $R_{\min}$ are the maximum
 and minimum distances from any pole to
 any boundary point.

TABLE 3-2

(Continued)

13 - 24	F	For translational symmetry, the distance between symmetry lines. 0.0 for other symmetry types.
Card(s) G	<u>Pole Locations</u> (6E12.2)	
	F	This set of cards contains the X, Y coordinates of all the poles in the smallest symmetry section of the body.
Card(s) H	<u>Location of Poles Relative to Symmetry Lines</u> (24I3)	
	I	A number is entered for each pole, determined as follows 0 - Pole on a symmetry line or no symmetry line in body 1 - Pole off the symmetry line(s)
Card(s) I	<u>Types of Pole</u> (24I3)	
	I	A number is entered for each pole, determined as in Table 2-2, as follows: 1 - Central (main) pole, in a hole 2 - Central (main) pole, no hole 3 - Auxiliary pole, on symmetry line, within body 4 - Auxiliary pole, off symmetry line, within body 5 - Auxiliary pole, on symmetry line, outside body 6 - Auxiliary pole, off symmetry line, outside body For polar symmetry, the main pole must be at the center of symmetry.
Card(s) J	<u>Series Order About Pole</u> (24I3)	
	I	A number is entered for each pole, giving the maximum order of series term about each pole. All allowable series terms up to and including this order are used.

TABLE 3-2
(Continued)

Card K	<u>KEY Option Card</u> (1013)			
	Columns	1 - 3	1	KEY(1)
				1, Do temperature solution 3, More temperature output from input temperature series coefficients (punched in a prior run) 4, Do stress solution, with no temperature distribution 6, More stress output from input stress series coefficients (punched in a prior run)
		4 - 6	1	KEY(2)
				-1, Call Subroutine TEMINT after temperature solution (see Table 3-5) 0, Go to new problem after temperature solution 1, Proceed to stress solution after temperature solution 2, Read in a new Identification Card (A) and Key Card (K) after temperature solution to do a new problem with the same geometry 3, Call Subroutine SIGINT after temperature solution to print out a temperature distribution (see Table 3-6) 4, Call Subroutine SIGPLT after temperature solution to prepare a tape of the temperature output for the plotting program (see Table 3-5)
		7 - 9	1	KEY(3)
				-2, Call Subroutine DISINT after stress solution to print out interior displacements (see Table 3-5) -1, Print out calculated boundary displacements (BDYDIS) after stress solution 0, Print out calculated boundary stresses (BDYSIG) after stress solution 1, Call Subroutine SIGINT after stress solution to print out stress distributions (see Table 3-6) 2, Go to new problem 3, Read in a new Identification Card (A) and Key Card (K) after stress solution to do a new problem with the same geometry

TABLE 3-2
(Continued)

			4, Call Subroutine SIGPLT after stress solution to prepare a tape of the stress and temperature distributions over a grid of points for the plotting program (see Table 3-5)
9 - 12	I	KEY(4)	0, Do not print the temperature equations 1, Print the temperature equations (used for debugging only)
13 - 15	I	KEY(5)	0, Do not print the stress equations 1, Print the stress equations (used for debugging only)
16 - 18	I	KEY(6)	0, Plane strain solution 1, Plane stress solution
19 - 21	I	KEY(7)	0, Let the Subroutine TEQSEL select the temperature series terms from the pole definitions 1, Read in the required temperature series terms (not a normal operating mode)
22 - 24	I	KEY(8)	0, Let the Subroutine SEQSEL select the stress series terms from the pole definitions 1, Read in the required stress series terms (not a normal operating mode)
25 - 27	I	KEY(9)	Not used
28 - 30	I	KEY(10)	0, Do not punch out the series coefficients from the stress and/or temperature solutions 1, Punch out the series coefficients for future use (not usually used)

Card L Material Property Card (5E12.2)

Columns	1 - 12	F	QGEN	Internal heat generation rate (BTU/hr in ³)
	13 - 24	F	THERMK	Thermal conductivity (BTU/hr in °F)
	25 - 36	F	YOUNG	Modulus of elasticity (psi)
	37 - 48	F	ALPHA	Coefficient of thermal expansion (in/in °F)
	49 - 60	F	POSSON	Poisson's ratio

TABLE 3-2

(Continued)

II. TEMPERATURE SOLUTION CARDS

This set of cards can be omitted if a temperature solution is not required (if KEY(1)

= 4)

Card(s) M Temperature Boundary Condition Equations (2413)

(or use INPUTI Subroutine)

I

IET numbers defining the equation to be used at each boundary point for the temperature solution

1 - Temperature = RTSIDE

2 - Convection boundary condition

Card(s) N Boundary Temperature Specification (6E12.2)

(or use INPUTA Subroutine)

F

IET numbers defining the boundary temperatures (RTSIDE) (if temperature specified) or 0.0 (for convection condition)

Card(s) O Convection Coefficients (6E12.2)

F

NOCUR values of convection coefficients for the boundary curves (use 0.0 if no convection conditions are specified on this boundary curve)

Card(s) P Coolant Temperature (6E12.2)

F

NOCUR values of coolant temperatures at the boundary curves (use 0.0 if no convection conditions are specified on this boundary curve)

Card Q KEY Option (13)

I KEY(2)

This card contains a new value of KEY(2) to be used if subroutine TEMINT, SIGINT, or SIGPLT was called by the original value of KEY(2) on Card K. If one of these routines was not called this card is not required. Repeated calls to TEMINT, SIGINT, or SIGPLT are allowed.

TABLE 3-2

(Continued)

III. STRESS SOLUTION CARDS

Card R Number of Stress Boundary Conditions (I3)

I IES

This is the number of stress boundary condition equations to be specified. It is less than or equal $2.0 \times \text{IET}$. It can be less because shear boundary conditions need not be specified at boundary points lying on symmetry lines.

Card(s) S Stress Boundary Condition Equations (24I3)

(or use INPUTI Subroutine)

I

IES numbers defining the boundary condition equations to be used at each boundary point for the stress solution

1 - Normal stress = RTSIDE

2 - Shear stress = RTSIDE

3 - Normal displacement = RTSIDE

4 - Shear displacement = RTSIDE

Use condition 1 or 3 first, 2 or 4 second (if required) at each boundary point, in boundary point order.

Card(s) T Stress Boundary Condition Values (6E12.2)

(or use INPUTA Subroutine)

F

IES values of RTSIDE for the stress boundary conditions. These will be either stresses in psi or displacements in inches. The sign convention is shown in Figure 3-2.

Card U KEY Option (I3)

I KEY(3)

This card contains a new value of KEY(3), to be used after return from DISINT, BDYDIS, BDYSIG, or SIGPLT if such were specified by the previous value of KEY(3). Repeated calls to any of these subroutines are allowed, until a value of KEY(3) which transfers control to another part of the program is encountered.

Figure 3-2 Boundary Condition Sign Convention

TABLE 3-3

INPUT INSTRUCTIONS FOR SUBROUTINE INPUTA(X)

A Subroutine to Store Numbers in a One-Dimensional Array X

FORMAT (2(2I6, 2E12.2))

Columns 1 - 6 I I1
(or 37 - 42)

If I1 is 0, ignore this set of 4 numbers and go to the next set.

If I1 is positive, it defines a starting point in the X array.

Columns 7 - 12 I I2
(or 43 - 48)

If 0, set X (I1) to A1, go to next set.

If I2 is positive, put the value A1 in X(I1), A1+A2 in X(I1+1), A1+NxA2 in X(I1+N), until X(I2) is reached (I2 must be greater than I1).

If I2 is negative, put the value A1 in X(I1), and in every A2th space thereafter until X(-I2) is reached (-I2 must be greater than I1, A2 must be greater than 0).

Columns 13 - 24 F A1
(or 49 - 60)

Columns 25 - 36 F A2
(or 16 - 72)

TABLE 3-4

INPUT INSTRUCTIONS FOR SUBROUTINE INPUT1(IX)

A Subroutine to Store Numbers in a One-Dimensional Integer Array IX

FORMAT (3(4I6))

Columns 1 - 6 I I1
 (or 25 - 30)
 (or 49 - 54)

If I1 is 0, ignore this set of 4 numbers and go to the next set.

If I1 is -1, return to the calling program.

If I1 is positive, it defines a starting point in the IX array.

Columns 7 - 12 I I2
 (or 31 - 36)
 (or 55 - 60)

If 0, set IX(I1) to I3, go to next set.

If I2 is positive, put the value I3 in IX(I1), I3+I4 in IX(I1+1), I3+NxI4 in IX(I1+N), until IX(I2) is reached. (I2 must be greater than I1).

If I2 is negative, put the value I3 in IX(I1), and in every 14th space thereafter until IX(-I2) is reached. (-I2 must be greater than I1, I4 must be greater than 0).

Columns 13 - 18 I I3
 (or 37 - 42)
 (or 61 - 66)

Columns 19 - 24 I I4
 (or 43 - 48)
 (or 67 - 72)

TABLE 3-5

INPUT FOR SUBROUTINES TEMINT, DISINT, SIGPLT

These Routines Print Out Results Over a Specified Grid of Points
(See Figure 3-3)

FORMAT (2I3, 6X, E18.6, 3E12.6)

Column	1 - 3	I	NX	Number of X grid lines
	4 - 6	I	NY	Number of Y grid lines
	13 - 24	F	XMIN	Minimum X value in grid
	25 - 36	F	YMIN	Minimum Y value in grid
	37 - 48	F	DELX	X increment for grid
	49 - 60	F	DELY	Y increment for grid

NOTE: For SIGPLT, NX x NY must be less than 2500.

Figure 3-3 Form for Interior Grids

TABLE 3-6

INPUT FOR SUBROUTINE SIGINT (MATRIX PRINT)

This subroutine prints out the stress values over a rectangular grid in the form of an array of numbers so that a visualization of the stress field can be obtained from the printer output.

Card A Grid Definition (I3, 9X, E12. 2)

Columns	1 - 3	I	NUMBDY	Number of boundary curves
	13 - 24	F	GRIDSZ	Size of the squares in a grid over a region of the body

Card(s) B Boundary Curve Definitions (NUMBDY cards) (3E12. 2, I3)

<u>Columns</u>				<u>Type</u>
<u>1 - 12</u>	<u>13 - 24</u>	<u>25 - 36</u>	<u>37 - 39</u>	
XC	YC	R	1	
XC	YC	R	2	
X	0.0	0.0	3	
X	0.0	0.0	4	
Slope	Y-intercept	0.0	5	
Slope	Y-intercept	0.0	6	

Card C Grid Location and Output Options (2I3, 6X, 2E12. 2, 7I3)

Columns	1 - 3	I	NX	Number of X lines (see Figure 3-3)
	4 - 6	I	NY	Number of Y lines
	13 - 24	F	XMIN	Minimum X value
	25 - 36	F	YMAX	Maximum Y value

TABLE 3-6

(Continued)

In the following fields a) will print the respective grids, a 1 will suppress the printing of the grid.

Columns	37 - 39	1	Maximum stress
	40 - 42	1	Minimum stress
	43 - 45	1	Maximum shear stress
	46 - 48	1	X stress
	49 - 51	1	Y stress
	52 - 54	1	XY shear stress
	55 - 57	1	Axial stress (plane strain only)

NOTE: NX x NY must be less than 1000.

4. PLOTTING PROGRAM

4.1 PROGRAM ORGANIZATION AND LIMITATIONS

The plotting program which is designed to be run following the running of a SATS program obtains from the SATS output tape all the information that is needed to prepare stress and/or temperature contour plots except information as to the plots to be formed, the scale to be used in the plots, and the contour values desired. This information is required as input data to the plotting program.

The plots obtainable from the SATS plotting program are listed in Table 4-1.

The maximum size of the grid which the SATS plotting program will plot is 2500 points. The storage required for the plotting program is 105000₈ locations.

4.2 INPUT DATA

The input data for the SATS plotting program is given in Table 4-2. The plotting program will plot data from different problems if these problems were run in sequence before the call to the plotting program.

4.3 OUTPUT DATA

The printed output from the SATS plotting program gives the problem title, the scales used in the SATS program to set up the grid, the scales used in the plotting program to plot the stresses, and tables of the isostress lines used for each of the contour plots.

The plotted output gives the contour lines for the selected stress or temperature plot. The zero stress line, if plotted, will appear as a dashed line. Any boundary curves appearing in the field of the plot are also plotted, with extra heavy lines to distinguish them from the contour lines.

Since the stress function is defined both inside and outside the boundaries of the region, contour lines will often cross lines and tend to congregate in the holes. A little effort with a pair of scissors will eliminate this effect.

TABLE 4-1
CONTOUR PLOTS AVAILABLE FROM SATS

<u>Plot Number</u>	<u>Plot</u>
1	Temperature
2	X stress
3	Y stress
4	XY shear stress
5	Maximum stress
6	Minimum stress
7	Maximum shear stress

TABLE 4-2

SATS PLOTTING PROGRAM INPUT

I. NUMBER OF RUNS

Card A (214)

Columns	1 - 4	I	NUMRUN	Number of sets of SIGPLT data on TAPE 11
	5 - 8	I	KPRINT	Debug key - Use 0

II. PLOT DEFINITIONS

Repeat this set of cards NUMRUN times

Card B Scale Definition Card (6F12.2)

Columns	1 - 12	F	XMIN	Minimum X value to be plotted
	13 - 24	F	XMAX	Maximum X value to be plotted
	25 - 36	F	YMIN	Minimum Y value to be plotted
	37 - 48	F	YMAX	Maximum Y value to be plotted
	49 - 60	F	XINCH	Length of X scale (inches)
	61 - 72	F	YINCH	Length of Y scale (inches)

Card(s) C Plot Definition Card (11, 13, 14, 4X, 5E12.2)

Columns	1	I	KK	0, Read in all Isoline values 1, Read in only first and last values, space other lines at uniform intervals
	2 - 4	I	IPLOTS	Plot number from Table 4-1
	5 - 8	I	NUMISO	Number of Isolines
	13 - 24, etc.	F	VALUES	The first 5 Isoline values. If KK is 1, VALUE (1) is the first line, VALUE (2) is the last line, and NUMISO-1 lines are generated at equal spacing between these two limits.

TABLE 4-2
(Continued)

Card(s) C (6E12.2)

F VALUES

If KK is 0 and NUMISO is greater than 5, these additional cards are used to define the remaining Isolines

5.0 EXAMPLE PROBLEM

5.1 PROBLEM DEFINITION

The sample problem illustrated in this section consists of a square plate, 10 inches on each side, with a 1.0 inch hole in the center. The loading consists of only thermal stress, with the outside temperature of the plate fixed at 1000° and the hole wall temperature at 500° . Plane stress solution is used. All the boundaries are assumed to be stress free.

This sample problem violates the requirement that the smallest symmetry region should be used, but sufficient boundary points (more than twice as many boundary conditions than terms in the temperature or stress series) were specified so that a good solution resulted. For this particular loading a solution could also have been obtained with a 45° symmetry section and 4 symmetry lines.

A plot of the region being analyzed is shown in Figure 5-1. This is an output plot from the SATS program, and is plotted for each run, forcing a visual check of the region definition.

5.2 EXAMPLE PROBLEM DATA

The input data for this example problem is shown in Figure 5-2. The INPUTA and INPUTI routines have been used to minimize the amount of input data. The card letters from Table 3-2 are indicated in the left margin of the Figure 5-2.

5.3 EXAMPLE PROBLEM OUTPUT DATA

The output from the sample problem is shown in Table 5-1. The various items in the printout are discussed below.

5.3.1 Input Boundary Point Parameters

This is a table of the boundary point definition parameter as defined on card(s) E in Table 3-2.

5.3.2 Region Specification

Given in this set of output are the number of boundary curves (NOCUR), the number of curve constants (NOCCON), the number of boundary points (IET), the number of expansion poles (MMAX), the type of symmetry (INSYM), the number of symmetry lines (NOSYM), the boundary point-boundary curve assignments (CUR), the input boundary equations (CURCON), a table of the calculated boundary point locations and their normal directions, the scale factor, the expansion pole data, the values from the KEY option card, and the material properties.

5.3.3 Thermal Solution Output

This section of the output contains the terms used in the temperature series as determined by TEQSEL, the boundary condition equations at each boundary point, the given value term which is calculated by the program from the internal heat generation rate, the convection boundary conditions for each boundary curve, and the calculated coefficients for each term in the truncated series for this temperature distribution (SOLUTION VECTOR). Also given is a table of the boundary values of temperature and gradient. This table gives a means of checking the accuracy of the solution. The calculated temperature should be close to the input temperature for those boundary points having specific temperatures and the gradient should be close to zero for boundary points with convection boundary conditions and a zero film coefficient (adiabatic boundary).

5.3.4 Stress Solution Output

This section of the output contains the terms used in the stress series as determined by the subroutine SEQSEL, the boundary condition equations at each boundary point, and the calculated coefficients for the terms in the truncated series solution.

5.3.5 Output from the Subroutine BDYSIG

The next section of the output is produced by the subroutine BDYSIG. It consists of the three components of the stress relative to the x-y coordinate system and relative to the s-n coordinate system. For boundary points with stress specifications for the boundary conditions, the accuracy of the solution can be checked by comparing the specified values

of the normal and shear stresses with the calculated values. Differences which are too large may require adjustment of the boundary point set or the pole specifications to obtain a satisfactory solution.

5.3.6 Output from the Subroutine BDYDIS

The next section of the output is produced by the subroutine BDYDIS. It consists of the region displacements referred to the x-y coordinate system and to the s-n coordinate system. From this table the degree of fit of the solution to imposed displacement boundary conditions can be checked.

5.3.7 Output from the Subroutine SIGPLT

This output consists of a table of the stresses and temperature calculated from the stress function over a specified grid of points. This is the set of data which is written onto tape to be used by the SATS plotting program. Because the grid of the defined points may fall outside the region being analyzed, some of the values in this table may be very large in areas outside the region, and especially in the vicinity of the poles. Only one page of this table is shown to illustrate its form.

5.4 EXAMPLE PROBLEM PLOTTING DATA

The input data for the SATS plotting program is shown in Figure 5-3.

5.5 EXAMPLE PROBLEM PLOTTING OUTPUT DATA

The output from the SATS plotting program consists of both printed output in the form of the tables of values for the iso-lines, as shown in Table 5-2, and the output plots. The output plots from the example problem are shown in Figures 5-4 through 5-10. The plots for the x stress and y stress were replotted to a better scale and thus do not agree with the lines in Table 5-2. An increment of 150. is used in these 2 plots.

5.6 COMPARISON WITH OTHER SOLUTIONS

The results from this example problem were compared with the results obtained by another technique, the finite element method. The finite element mesh that was set up for the FEATS (Finite Element Analysis - Temperature and Stress) Code (Reference 3) is shown in Figure 5-11. The FEATS calculated temperature distribution is shown in Figure 5-12 and

and is the same as that calculated by the SATS code (Figure 5-4). In Figure 5-13 the maximum stress plot from the FEATS code is shown. It is in excellent agreement with the SATS code result shown in Figure 5-8.

The numerical agreement between the two solutions is shown in Table 5-3. The displacements are in excellent agreement, the stresses differ only by the degree of approximation in the FEATS finite element model.

Figure 5-1 Example Problem Geometry

Figure 5-2 Example Problem SATS Data

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Figure 5-4 SATS Example Problem Temperature Plot

Figure 5-5 SATS Example Problem X Stress Plot

Figure 5-6 SATS Example Problem Y Stress Plot

Figure 5-7 SATS Example Problem XY Shear Stress Plot

Figure 5-8 SATS Example Problem Maximum Stress Plot

Figure 5-9 SATS Example Problem Minimum Stress Plot

Figure 5-10 SATS Example Problem Maximum Shear Stress Plot

Figure 5-11 FEATS Mesh for SATS Comparison

Figure 5-12 FEATS Example Problem Temperature Plot

Figure 5-13 FEATS Example Problem Maximum Stress Plot

TABLE 5-1
OUTPUT FROM SATS EXAMPLE PROBLEM

SATS - PLANE STRESS CODE J. SWANSON

SATS THERMAL STRESS EXAMPLE

INPUT BOUNDARY POINT PARAMETERS

0.000000	3.000000	6.000000	9.000000	12.000000	15.000000
18.000000	21.000000	24.000000	27.000000	30.000000	33.000000
36.000000	39.000000	42.000000	45.000000	48.000000	51.000000
54.000000	57.000000	60.000000	63.000000	66.000000	69.000000
72.000000	75.000000	78.000000	81.000000	84.000000	87.000000
90.000000	0.000000	.250000	.500000	.750000	1.000000
1.250000	1.500000	1.750000	2.000000	2.250000	2.500000
2.750000	3.000000	3.250000	3.500000	3.750000	4.000000
4.250000	4.500000	4.750000	5.000000	5.000000	4.750000
4.500000	4.250000	4.000000	3.750000	3.500000	3.250000
3.000000	2.750000	2.500000	2.250000	2.000000	1.750000
1.500000	1.250000	1.000000	.750000	.500000	.250000
0.000000					

TABLE 5-1
(Continued)

S TS = PLANE STRESS CODE J. SWANSON

SATS THERMAL STRESS EXAMPLE

REGION SPECIFICATION

NOCUR = 3 NOCCUN = 12 IET = 73 VMAX = 1 INSYM = 2 NOSYM = 2
ICUR = 31 52 73

THE INPUT BOUNDARY EQUATIONS (CURCON) WERE

0.	0.	1.00000000E+00	1.0
5.00000000E+00	0.	0.	1.0
0.	5.00000000E+00	0.	1.0

THE BOUNDARY POINTS ARE THE FOLLOWING

I	X	Y	X NORMAL	Y NORMAL
1	1.00000000E+00	0.	-1.00000000E+00	-0.
2	9.94529535E- 1	5.23359562E-02	-9.98629535E-01	-5.23359562E-02
3	9.94521545E- 1	1.04528463E-01	-9.94521895E-01	-1.04528463E-01
4	9.87588341E-01	1.56434465E-01	-9.87588341E-01	-1.56434465E-01
5	9.78147601E- 1	2.07911641E-01	-9.78147601E-01	-2.07911691E-01
6	9.65925826E-01	2.58919045E-01	-9.65925826E-01	-2.58919045E-01
7	9.5156716E- 1	3.09014994E- 1	-9.51056516E-01	-3.09014994E- 1
8	9.33590427E-01	3.58367949E-01	-9.33590427E-01	-3.58367949E-01
9	9.13545453E- 1	4.06736643E-01	-9.13545453E-01	-4.06736643E-01
10	8.9170524E-01	4.53991439E-01	-8.91006524E-01	-4.53992049E-01
11	8.6625404E-01	4.99490999E-01	-8.65025404E-01	-4.99029994E-01
12	8.38571569E- 1	5.44639034E-01	-8.38670562E-01	-5.44639034E-01
13	8.0916995E-01	5.87785252E-01	-8.09016995E-01	-5.87785252E-01
14	7.77145462E- 1	6.29320390E-01	-7.77145462E-01	-6.29320390E-01
15	7.43144426E- 1	6.69130616E-01	-7.43144426E-01	-6.69130606E-01
16	7.07105782E- 1	7.07105781E- 1	-7.07105782E-01	-7.07105781E- 1
17	6.69130607E- 1	7.43144425E-01	-6.69130607E-01	-7.43144425E-01
18	6.29320392E- 1	7.77145461E-01	-6.29320392E-01	-7.77145461E-01
19	5.87785253E-01	8.09016994E-01	-5.87785253E-01	-8.09016994E-01
20	5.44639034E- 1	8.38670567E-01	-5.44639034E-01	-8.38670567E-01
21	5.00000001E- 1	8.66025403E-01	-5.00000001E-01	-8.66025403E-01
22	4.53990511E- 1	8.91016524E-01	-4.53990511E-01	-8.91016524E- 1
23	4.06736644E-01	9.13545457E-01	-4.06736644E-01	-9.13545457E-01

TABLE 5-1
(Continued)

24	3.58367951E- 1	9.33540426E-01	-3.58367951E-01	-9.33540426E- 1
25	3.09016906E- 1	9.51156516E-01	-3.09016906E-01	-9.51156516E-01
26	2.58819047E-01	9.65925826E- 1	-2.58819047E-01	-9.65925826E- 1
27	2.07911132E-01	9.78147600E- 1	-2.07911132E-01	-9.78147600E- 1
28	1.56434467E- 1	9.87648340E-01	-1.56434467E-01	-9.87648340E-01
29	1.04524465E-01	9.94521895E- 1	-1.04524465E-01	-9.94521895E- 1
30	5.23353540E- 2	9.98629535E- 1	-5.23353540E-02	-9.98629535E- 1
31	1.79483318E- 4	1.00000000E+00	-1.79483318E-04	-1.00000000E+00
32	5.00000000E+00	0.	1.00000000E+00	0.
33	5.00000000E+ 0	2.50000000E- 1	1.00000000E+00	0.
34	5.00000000E+00	5.00000000E-01	1.00000000E+00	0.
35	5.00000000E+00	7.50000000E- 1	1.00000000E+00	0.
36	5.00000000E+ 0	1.00000000E+00	1.00000000E+00	0.
37	5.00000000E+00	1.25000000E+00	1.00000000E+00	0.
38	5.00000000E+00	1.50000000E+00	1.00000000E+00	0.
39	5.00000000E+00	1.75000000E+ 0	1.00000000E+00	0.
40	5.00000000E+00	2.00000000E+ 0	1.00000000E+00	0.
41	5.00000000E+ 0	2.25000000E+00	1.00000000E+00	0.
42	5.00000000E+00	2.50000000E+00	1.00000000E+00	0.
43	5.00000000E+00	2.75000000E+00	1.00000000E+00	0.
44	5.00000000E+ 0	3.00000000E+00	1.00000000E+00	0.
45	5.00000000E+00	3.25000000E+00	1.00000000E+00	0.
46	5.00000000E+00	3.50000000E+00	1.00000000E+00	0.
47	5.00000000E+00	3.75000000E+00	1.00000000E+00	0.
48	5.00000000E+00	4.00000000E+ 0	1.00000000E+00	0.
49	5.00000000E+ 0	4.25000000E+ 0	1.00000000E+00	0.
50	5.00000000E+00	4.50000000E+00	1.00000000E+00	0.
51	5.00000000E+00	4.75000000E+ 0	1.00000000E+00	0.
52	5.00000000E+00	5.00000000E+00	1.00000000E+00	0.
53	5.00000000E+00	5.00000000E+ 0	-0.	1.00000000E+00
54	4.75000000E+00	5.00000000E+00	-0.	1.00000000E+00
55	4.50000000E+00	5.00000000E+00	-0.	1.00000000E+00
56	4.25000000E+00	5.00000000E+00	-0.	1.00000000E+00
57	4.00000000E+ 0	5.00000000E+00	-0.	1.00000000E+00
58	3.75000000E+ 0	5.00000000E+00	-0.	1.00000000E+00
59	3.50000000E+00	5.00000000E+00	-0.	1.00000000E+00
60	3.25000000E+00	5.00000000E+00	-0.	1.00000000E+00
61	3.00000000E+00	5.00000000E+00	-0.	1.00000000E+00
62	2.75000000E+00	5.00000000E+00	-0.	1.00000000E+00
63	2.50000000E+00	5.00000000E+00	-0.	1.00000000E+00
64	2.25000000E+00	5.00000000E+00	-0.	1.00000000E+00
65	2.00000000E+00	5.00000000E+00	-0.	1.00000000E+00
66	1.75000000E+00	5.00000000E+00	-0.	1.00000000E+00
67	1.50000000E+00	5.00000000E+00	-0.	1.00000000E+00
68	1.25000000E+00	5.00000000E+00	-0.	1.00000000E+00
69	1.00000000E+00	5.00000000E+00	-0.	1.00000000E+00
70	7.50000000E- 1	5.00000000E+00	-0.	1.00000000E+00

TABLE 5-1
(Continued)

71	5.00000000E-01	5.00000000E+00	-0.	1.00000000E+00
72	2.50000000E-01	5.00000000E+00	-0.	1.00000000E+00
73	0.	5.00000000E+00	-0.	1.00000000E+00

HCK. THE SCALE FACTOR, = 2.00000000E+00 PD CYCL = -0.

THE INPUT EXPANSION POLE DATA WAS

POLE	X	Y	POLE TYPE	ORDER	TP0S1A
1	0.	0.	1	20	0

KEY = 1 1 0 0 0 0 0 0 0 0

HEAT GENERATION RATE = 0. THERMAL CONDUCTIVITY = 1.00000000E+00 E = 1.50000000E+06

ALPHA = 2.50000000E-16 POISSON RATIO = .2000

TABLE 5-1
(Continued)

SATS - PLANE STRESS CODE J. SWANSON

SATS THERMAL STRESS EXAMPLE

TEMP TERMS

ICT = 22

I	MAT	NAT	KAT	I	MAT	NAT	KAT	I	MAT	NAT	KAT	I	MAT	NAT	KAT	I	MAT	NAT	KAT
1	1	0	1	2	1	0	6	3	1	2	1	4	1	2	3	5	1	4	1
6	1	4	3	7	1	6	1	8	1	6	3	9	1	8	1	10	1	8	3
11	1	10	1	12	1	10	3	13	1	12	1	14	1	12	3	15	1	14	1
16	1	14	3	17	1	16	1	18	1	14	3	19	1	18	1	20	1	18	3
21	1	20	1	22	1	20	3												

BOUNDARY CONDITIONS

IET = 73

IBA	EQN	RTSIDE	IBA	EQN	RTSIDE	IBA	EQN	RTSIDE	IBA	EQN	RTSIDE	IBA	EQN	RTSIDE
1	1	5.000000E+02	2	1	5.000000E+02	3	1	5.000000E+02	4	1	5.000000E+02	5	1	5.000000E+02
6	1	5.000000E+02	7	1	5.000000E+02	8	1	5.000000E+02	9	1	5.000000E+02	10	1	5.000000E+02
11	1	5.000000E+02	12	1	5.000000E+02	13	1	5.000000E+02	14	1	5.000000E+02	15	1	5.000000E+02
16	1	5.000000E+02	17	1	5.000000E+02	18	1	5.000000E+02	19	1	5.000000E+02	20	1	5.000000E+02
21	1	5.000000E+02	22	1	5.000000E+02	23	1	5.000000E+02	24	1	5.000000E+02	25	1	5.000000E+02
26	1	5.000000E+02	27	1	5.000000E+02	28	1	5.000000E+02	29	1	5.000000E+02	30	1	5.000000E+02
31	1	5.000000E+02	32	1	1.000000E+03	33	1	1.000000E+03	34	1	1.000000E+03	35	1	1.000000E+03
36	1	1.000000E+03	37	1	1.000000E+03	38	1	1.000000E+03	39	1	1.000000E+03	40	1	1.000000E+03
41	1	1.000000E+03	42	1	1.000000E+03	43	1	1.000000E+03	44	1	1.000000E+03	45	1	1.000000E+03
46	1	1.000000E+03	47	1	1.000000E+03	48	1	1.000000E+03	49	1	1.000000E+03	50	1	1.000000E+03
51	1	1.000000E+03	52	1	1.000000E+03	53	1	1.000000E+03	54	1	1.000000E+03	55	1	1.000000E+03
56	1	1.000000E+03	57	1	1.000000E+03	58	1	1.000000E+03	59	1	1.000000E+03	60	1	1.000000E+03
61	1	1.000000E+03	62	1	1.000000E+03	63	1	1.000000E+03	64	1	1.000000E+03	65	1	1.000000E+03
66	1	1.000000E+03	67	1	1.000000E+03	68	1	1.000000E+03	69	1	1.000000E+03	70	1	1.000000E+03
71	1	1.000000E+03	72	1	1.000000E+03	73	1	1.000000E+03						

GIVEN VALUE TERMS

I	MAT	NAT	KAT	GIVEN VALUE
1	1	0	2	0.

BOUNDARY CONDITIONS

BOUNDARY	CONVECTION COEFFICIENT	COOLANT TEMPERATURE
1	0.	0.00

TABLE 5-1
(Continued)

2	0.			0.00	
3	0.			0.00	
SOLUTION VECTOR					
1	2.96700815E+02	2	7.05657333E+02	3	-4.57099845E-13
5	5.60981158E-01	6	-2.19133263E-03	7	3.01549047E-14
9	3.53556541E-04	10	-5.39483509E-09	11	1.75823833E-15
13	4.10869235E-07	14	-2.84448201E-14	15	2.48721842E-17
17	4.67724809E-11	18	-2.33533984E-16	19	1.04347941E-19
21	4.31610210E-13	22	-1.56975548E-17	4	3.15631781E-13
				8	-1.70720159E-14
				12	1.08089100E-15
				16	1.23393178E-17
				20	8.61954863E-19

TABLE 5-1
(Continued)

SATS THERMAL STRESS EXAMPLE

BOUNDARY VALUES OF TEMPERATURE AND GRADIENT

	XB	YB	CALCULATED TEMPERATURE	INPUT TEMPERATURE	GRADIENT	HEAT TRANSFER RESIDUAL
1	1.0000	0.0000	500.000	500.000	-29.69813278E+01	0.
2	.9946	.0523	500.000	500.000	-29.69751965E+01	0.
3	.9945	.1045	500.000	500.000	-29.69570708E+01	0.
4	.9877	.1564	500.000	500.000	-29.69277436E+01	0.
5	.9781	.2079	500.000	500.000	-29.68884977E+01	0.
6	.9659	.2583	500.000	500.000	-29.68410494E+01	0.
7	.9511	.3090	500.000	500.000	-29.67874736E+01	0.
8	.9336	.3584	500.000	500.000	-29.67301128E+01	0.
9	.9135	.4067	500.000	500.000	-29.66714743E+01	0.
10	.8910	.4540	500.000	500.000	-29.66141209E+01	0.
11	.8660	.5000	500.000	500.000	-29.65605588E+01	0.
12	.837	.5444	500.000	500.000	-29.65131280E+01	0.
13	.8030	.5873	500.000	500.000	-29.64739003E+01	0.
14	.7771	.6293	500.000	500.000	-29.64445891E+01	0.
15	.7431	.6691	500.000	500.000	-29.64264742E+01	0.
16	.7071	.7071	500.000	500.000	-29.64203467E+01	0.
17	.6691	.7431	500.000	500.000	-29.64264742E+01	0.
18	.6293	.7771	500.000	500.000	-29.64445890E+01	0.
19	.5873	.8090	500.000	500.000	-29.64739003E+01	0.
20	.5444	.8387	500.000	500.000	-29.65131280E+01	0.
21	.5000	.8660	500.000	500.000	-29.65605588E+01	0.
22	.4540	.8910	500.000	500.000	-29.66141209E+01	0.
23	.4067	.9135	500.000	500.000	-29.66714743E+01	0.
24	.3544	.9336	500.000	500.000	-29.67301128E+01	0.
25	.3090	.9511	500.000	500.000	-29.67874736E+01	0.
26	.2583	.9659	500.000	500.000	-29.68410494E+01	0.
27	.2079	.9781	500.000	500.000	-29.68884977E+01	0.
28	.1564	.9877	500.000	500.000	-29.69277436E+01	0.
29	.1045	.9945	500.000	500.000	-29.69570708E+01	0.
30	.0523	.9986	500.000	500.000	-29.69751965E+01	0.
31	.0000	1.0000	500.000	500.000	-29.69813278E+01	0.
32	5.0000	0.0000	1000.000	1000.000	77.79646139E+00	0.
33	5.0000	.2500	1000.000	1000.000	77.46296184E+00	0.
34	5.0000	.5000	1000.000	1000.000	76.47193077E+00	0.
35	5.0000	.7500	1000.000	1000.000	74.84514818E+00	0.
36	5.0000	1.0000	1000.000	1000.000	72.62491490E+00	0.

TABLE 5-1
(Continued)

37	5.0000	1.2500	1000.000	1000.000	69.84130830E+00	0.
38	5.0000	1.5000	1000.000	1000.000	66.61380401E+00	0.
39	5.0000	1.7500	1000.000	1000.000	62.94463256E+00	0.
40	5.0000	2.0000	1000.000	1000.000	58.92523431E+00	0.
41	5.0000	2.2500	1000.000	1000.000	54.61312176E+00	0.
42	5.0000	2.5000	1000.000	1000.000	50.04936863E+00	0.
43	5.0000	2.7500	1000.000	1000.000	45.34643851E+00	0.
44	5.0000	3.0000	1000.000	1000.000	40.40115878E+00	0.
45	5.0000	3.2500	1000.000	1000.000	35.54035454E+00	0.
46	5.0000	3.5000	1000.000	1000.000	30.52499363E+00	0.
47	5.0000	3.7500	1000.000	1000.000	25.46866730E+00	0.
48	5.0000	4.0000	1000.000	1000.000	20.38464627E+00	0.
49	5.0000	4.2500	1000.000	1000.000	15.20660722E+00	0.
50	5.0000	4.5000	1000.000	1000.000	10.10042013E+00	0.
51	5.0000	4.7500	1000.000	1000.000	5.000000324E-01	0.
52	5.0000	5.0000	1000.000	1000.000	-99.18779770E-05	0.
53	5.0000	5.0000	1000.000	1000.000	-99.18784540E-05	0.
54	4.7500	5.0000	1000.000	1000.000	51.000000394E-01	0.
55	4.5000	5.0000	1000.000	1000.000	10.10042013E+00	0.
56	4.2500	5.0000	1000.000	1000.000	15.20660722E+00	0.
57	4.0000	5.0000	1000.000	1000.000	20.38464627E+00	0.
58	3.7500	5.0000	1000.000	1000.000	25.46866730E+00	0.
59	3.5000	5.0000	1000.000	1000.000	30.52499363E+00	0.
60	3.2500	5.0000	1000.000	1000.000	35.54035454E+00	0.
61	3.0000	5.0000	1000.000	1000.000	40.40115878E+00	0.
62	2.7500	5.0000	1000.000	1000.000	45.34643851E+00	0.
63	2.5000	5.0000	1000.000	1000.000	50.04936863E+00	0.
64	2.2500	5.0000	1000.000	1000.000	54.61312176E+00	0.
65	2.0000	5.0000	1000.000	1000.000	58.92523431E+00	0.
66	1.7500	5.0000	1000.000	1000.000	62.94463256E+00	0.
67	1.5000	5.0000	1000.000	1000.000	66.61380401E+00	0.
68	1.2500	5.0000	1000.000	1000.000	69.84130830E+00	0.
69	1.0000	5.0000	1000.000	1000.000	72.62491490E+00	0.
70	.7500	5.0000	1000.000	1000.000	74.84514818E+00	0.
71	.5000	5.0000	1000.000	1000.000	76.47093077E+00	0.
72	.2500	5.0000	1000.000	1000.000	77.46296184E+00	0.
73	0.0000	5.0000	1000.000	1000.000	77.70546139E+00	0.

TABLE 5-1
(Continued)

S TS - PLANE STRESS CODE J. SWANSON

SATS THERMAL STRESS EXAMPLE

STRESS TERMS ICS = 42

I	MAS	NAS	KAS	I	MAS	NAS	KAS	I	MAS	NAS	KAS	I	MAS	NAS	KAS	I	MAS	NAS	KAS
1	1	0	1	2	1	0	2	3	1	2	1	4	1	2	2	5	1	2	3
6	1	2	4	7	1	4	1	8	1	4	2	9	1	4	3	10	1	4	4
11	1	6	1	12	1	6	2	13	1	6	3	14	1	6	4	15	1	8	1
16	1	8	2	17	1	8	3	18	1	8	4	19	1	10	1	20	1	10	2
21	1	10	3	22	1	10	4	23	1	12	1	24	1	12	2	25	1	12	3
26	1	12	4	27	1	14	1	28	1	14	2	29	1	14	3	30	1	14	4
31	1	16	1	32	1	16	2	33	1	16	3	34	1	16	4	35	1	18	1
36	1	18	2	37	1	18	3	38	1	18	4	39	1	20	1	40	1	20	2
41	1	20	3	42	1	20	4												

BOUNDARY CONDITIONS IES = 146

IBS EQN	RTSIDE	IBS EQN	RTSIDE	IBS EQN	RTSIDE	IBS EQN	RTSIDE	IBS EQN	RTSIDE
1	1 0.	2	2 0.	3	1 0.	4	2 0.	5	1 0.
6	2 0.	7	1 0.	8	2 0.	9	1 0.	10	2 0.
11	1 0.	12	2 0.	13	1 0.	14	2 0.	15	1 0.
16	2 0.	17	1 0.	18	2 0.	19	1 0.	20	2 0.
21	1 0.	22	2 0.	23	1 0.	24	2 0.	25	1 0.
26	2 0.	27	1 0.	28	2 0.	29	1 0.	30	2 0.
31	1 0.	32	2 0.	33	1 0.	34	2 0.	35	1 0.
36	2 0.	37	1 0.	38	2 0.	39	1 0.	40	2 0.
41	1 0.	42	2 0.	43	1 0.	44	2 0.	45	1 0.
46	2 0.	47	1 0.	48	2 0.	49	1 0.	50	2 0.
51	1 0.	52	2 0.	53	1 0.	54	2 0.	55	1 0.
56	2 0.	57	1 0.	58	2 0.	59	1 0.	60	2 0.
61	1 0.	62	2 0.	63	1 0.	64	2 0.	65	1 0.
66	2 0.	67	1 0.	68	2 0.	69	1 0.	70	2 0.
71	1 0.	72	2 0.	73	1 0.	74	2 0.	75	1 0.
76	2 0.	77	1 0.	78	2 0.	79	1 0.	80	2 0.
81	1 0.	82	2 0.	83	1 0.	84	2 0.	85	1 0.
86	2 0.	87	1 0.	88	2 0.	89	1 0.	90	2 0.
91	1 0.	92	2 0.	93	1 0.	94	2 0.	95	1 0.
96	2 0.	97	1 0.	98	2 0.	99	1 0.	100	2 0.
101	1 0.	102	2 0.	103	1 0.	104	2 0.	105	1 0.
106	2 0.	107	1 0.	108	2 0.	109	1 0.	110	2 0.
111	1 0.	112	2 0.	113	1 0.	114	2 0.	115	1 0.

TABLE 5-1
(Continued)

116	2	0.	117	1	0.	118	2	0.	119	1	0.	120	2	0.
121	1	0.	122	2	0.	123	1	0.	124	2	0.	125	1	0.
126	2	0.	127	1	0.	128	2	0.	129	1	0.	130	2	0.
131	1	0.	132	2	0.	133	1	0.	134	2	0.	135	1	0.
136	2	0.	137	1	0.	138	2	0.	139	1	0.	140	2	0.
141	1	0.	142	2	0.	143	1	0.	144	2	0.	145	1	0.
146	2	0.												

SOLUTION VECTOR

1	-2.40321282E+02	2	6.19721054E+02	3	5.79259616E-11	4	-3.59360183E-12
5	3.65352294E-12	6	-2.81735345E-11	7	2.92084250E+00	8	-4.03183701E-01
9	3.26540255E-02	10	-1.74679781E-01	11	-4.87464606E-15	12	-9.22462435E-16
13	-2.80836755E-15	14	1.30616350E-14	15	3.47481002E-04	16	-4.16495477E-04
17	2.44752167E-04	18	-1.12705050E-07	19	-4.38189169E-16	20	6.15872658E-17
21	1.12239406E-16	22	-4.94253347E-16	23	-3.43143668E-06	24	-3.42151070E-08
25	-9.03921753E-12	26	4.19254795E-11	27	-1.66804370E-17	28	1.46206058E-18
29	-2.34623440E-14	30	1.04921443E-17	31	2.55389585E-08	32	-2.99186235E-09
33	-3.26048849E-13	34	1.47834130E-12	35	-3.24047157E-20	36	4.66482374E-21
37	-4.64840467E-19	38	1.95633112E-18	39	-2.40490703E-12	40	-4.00013723E-12
41	-1.6504187E-14	42	7.29658272E-14				

SATS THERMAL STRESS EXAMPLE TABLE 5-1
(Continued)

BOUNDARY POINT STRESSES

SIGX	SIGY	TANXY	IBA	SIGN	SIGT	TANG.SHEAR	X	Y
.00	1399.29	.00	1	.00	1399.29	0.00	1.0000	0.0000
3.83	1394.74	-73.10	2	.00	1398.57	-.00	.9986	.0523
15.26	1381.18	-145.17	3	.00	1396.44	-.00	.9945	.1045
34.09	1358.89	-215.23	4	.00	1392.94	-.00	.9877	.1564
60.02	1328.35	-282.35	5	.00	1388.36	-.00	.9781	.2079
92.63	1290.14	-345.69	6	.00	1382.77	-.00	.9659	.2588
131.44	1245.02	-404.53	7	-.00	1376.46	-.00	.9511	.3090
175.91	1193.80	-458.26	8	-.00	1369.71	-.00	.9336	.3584
225.45	1137.35	-506.38	9	-.00	1362.80	-.00	.9135	.4067
279.49	1076.56	-548.53	10	-.00	1356.05	-.00	.8910	.4540
337.43	1012.30	-584.45	11	-.00	1349.74	-.00	.8660	.5000
398.72	945.43	-613.97	12	-.00	1344.15	-.00	.8387	.5446
462.80	876.73	-636.98	13	-.00	1339.53	-.00	.8090	.5878
529.15	806.93	-653.44	14	-.00	1336.08	-.00	.7771	.6293
597.25	736.69	-663.32	15	-.00	1333.94	-.00	.7431	.6691
666.61	666.61	-666.61	16	-.00	1333.22	-.00	.7071	.7071
736.69	597.25	-663.32	17	-.00	1333.94	.00	.6691	.7431
806.93	529.15	-653.44	18	-.00	1336.08	.00	.6293	.7771
876.73	462.80	-636.98	19	-.00	1339.53	.00	.5878	.8090
945.43	398.72	-613.97	20	-.00	1344.15	.00	.5446	.8387
1012.30	337.43	-584.45	21	-.00	1349.74	.00	.5000	.8660
1076.56	279.49	-548.53	22	-.00	1356.05	.00	.4540	.8910
1137.35	225.45	-506.38	23	-.00	1362.80	.00	.4067	.9135
1193.80	175.91	-458.26	24	-.00	1369.71	.00	.3584	.9336
1245.02	131.44	-404.53	25	-.00	1376.46	.00	.3090	.9511
1290.14	92.63	-345.69	26	.00	1382.77	.00	.2588	.9659
1328.35	60.02	-282.35	27	.00	1388.36	.00	.2079	.9781
1358.89	34.09	-215.23	28	.00	1392.94	.00	.1564	.9877
1381.18	15.26	-145.17	29	.00	1396.44	.00	.1045	.9945
1394.74	3.83	-73.10	30	.00	1398.57	.00	.0523	.9986
1399.29	.00	-.00	31	.00	1399.29	.00	.0000	1.0000
-.33	-762.54	.00	32	-.33	-762.54	0.00	5.0000	0.0000
-.25	-757.53	-.10	33	-.25	-757.53	-.10	5.0000	.2500
-.05	-742.65	-.18	34	-.05	-742.65	-.18	5.0000	.5000
.19	-718.39	-.22	35	.19	-718.39	-.22	5.0000	.7500
.36	-685.49	-.19	36	.36	-685.49	-.19	5.0000	1.0000
.39	-644.89	-.09	37	.39	-644.89	-.09	5.0000	1.2500
.25	-597.65	.06	38	.25	-597.65	.06	5.0000	1.5000

TABLE 5-1
(Continued)

-544.89	.22	39	-544.89	.22	5.0000	1.7500
-487.71	.32	40	-487.71	.32	5.0000	2.0000
-427.23	.29	41	-427.23	.29	5.0000	2.2500
-364.56	.11	42	-364.56	.11	5.0000	2.5000
-300.99	-.14	43	-300.99	-.18	5.0000	2.7500
-238.03	-.46	44	-238.03	-.46	5.0000	3.0000
-177.59	-.55	45	-177.59	-.55	5.0000	3.2500
-122.01	-.29	46	-122.01	-.29	5.0000	3.5000
-73.92	.28	47	-73.92	.28	5.0000	3.7500
-35.94	.45	48	-35.94	.85	5.0000	4.0000
-10.06	.83	49	-10.06	.83	5.0000	4.2500
3.15	-.21	50	3.15	-.21	5.0000	4.5000
5.28	-1.55	51	5.28	-1.55	5.0000	4.7500
.32	.71	52	.32	.71	5.0000	5.0000
.32	.71	53	.32	-.71	5.0000	5.0000
5.28	-1.55	54	5.28	1.55	4.7500	5.0000
3.15	-.21	55	3.15	.21	4.5000	5.0000
-10.06	.43	56	-10.06	-.83	4.2500	5.0000
-35.94	.45	57	-35.94	-.85	4.0000	5.0000
-73.92	.28	58	-73.92	-.28	3.7500	5.0000
-122.01	-.29	59	-122.01	.29	3.5000	5.0000
-177.59	-.55	60	-177.59	.55	3.2500	5.0000
-238.03	-.46	61	-238.03	.46	3.0000	5.0000
-300.99	-.18	62	-300.99	.18	2.7500	5.0000
-364.56	.11	63	-364.56	-.11	2.5000	5.0000
-427.23	.29	64	-427.23	-.29	2.2500	5.0000
-487.71	.32	65	-487.71	-.32	2.0000	5.0000
-544.89	.22	66	-544.89	-.22	1.7500	5.0000
-597.65	.06	67	-597.65	-.06	1.5000	5.0000
-644.89	-.19	68	-644.89	.09	1.2500	5.0000
-685.49	-.19	69	-685.49	.19	1.0000	5.0000
-718.39	-.22	70	-718.39	.22	.7500	5.0000
-742.65	-.18	71	-742.65	.18	.5000	5.0000
-757.53	-.10	72	-757.53	.10	.2500	5.0000
-762.54	-.10	73	-762.54	.00	0.0000	5.0000

TABLE 5-1
(Continued)

SATS THERMAL STRESS EXAMPLE

BOUNDARY POINT DISPLACEMENTS

X DISPLACEMENT	Y DISPLACEMENT	NORMAL DISPLACEMENT	TANGENTIAL DISPLACEMENT	XB	YB	IBX
21.5334058E-04	13.8777878E-18	-21.5334058E-04	-13.8777878E-18	1.00000	0.00000	1
21.5047280E-04	11.4238015E-05	-21.5350441E-04	-15.3440504E-07	.99846	.0523	2
21.4187520E-04	22.0138434E-05	-21.5398874E-04	-30.0174558E-07	.99465	.1045	3
21.2756408E-04	34.1305149E-05	-21.5477240E-04	-43.3788868E-07	.9877	.1564	4
21.0757099E-04	45.3583005E-05	-21.5582113E-04	-54.8443644E-07	.9781	.2079	5
21.8193389E-04	56.4469243E-05	-21.5708010E-04	-63.9127863E-07	.9650	.2588	6
20.5070644E-04	67.3694897E-05	-21.5852080E-04	-70.1878303E-07	.9511	.3090	7
20.1395340E-04	78.0946131E-05	-21.6005392E-04	-73.3952729E-07	.9336	.3584	8
19.7175396E-04	88.0915503E-05	-21.6162117E-04	-73.3949701E-07	.9135	.4067	9
19.2419846E-04	98.8305147E-05	-21.6315417E-04	-70.1849745E-07	.8910	.4540	10
18.7139081E-04	10.8782785E-04	-21.6458591E-04	-63.9115266E-07	.8660	.5000	11
18.1345089E-04	11.4420805E-04	-21.6585282E-04	-54.8429195E-07	.8387	.5446	12
17.5051127E-04	12.7718264E-04	-21.6690248E-04	-43.3775165E-07	.8090	.5878	13
16.8271949E-04	13.6650174E-04	-21.6768608E-04	-30.0163788E-07	.7771	.6293	14
16.1023792E-04	14.5192940E-04	-21.6817037E-04	-15.3434615E-07	.7431	.6691	15
15.3324381E-04	15.3324381E-04	-21.6833410E-04	-26.8951528E-15	.7071	.7071	16
14.5192940E-04	16.1023791E-04	-21.6817037E-04	15.3434610E-07	.6691	.7431	17
13.6650177E-04	16.8271949E-04	-21.6768608E-04	30.0163783E-07	.6293	.7771	18
12.7718264E-04	17.5051127E-04	-21.6690248E-04	43.3775165E-07	.5878	.8090	19
11.8420805E-04	18.1345089E-04	-21.6585282E-04	54.8429191E-07	.5446	.8387	20
10.8782786E-04	18.7139081E-04	-21.6458591E-04	63.9115263E-07	.5000	.8660	21
98.8305151E-05	19.2419806E-04	-21.6315417E-04	70.1849743E-07	.4540	.8910	22
88.5915507E-05	19.7175396E-04	-21.6162117E-04	73.3949700E-07	.4067	.9135	23
78.0946134E-05	20.1395380E-04	-21.6005392E-04	73.3952730E-07	.3584	.9336	24
67.3694900E-05	20.5070643E-04	-21.5852080E-04	70.1878305E-07	.3090	.9511	25
56.4469246E-05	20.8193389E-04	-21.5708010E-04	63.9127866E-07	.2588	.9659	26
45.3585008E-05	21.0757092E-04	-21.5582113E-04	54.8443647E-07	.2079	.9781	27
34.1365153E-05	21.2756409E-04	-21.5477240E-04	43.3788872E-07	.1564	.9877	28
22.8138438E-05	21.4187520E-04	-21.5398874E-04	30.0174562E-07	.1045	.9945	29
11.4238019E-05	21.5047280E-04	-21.5350441E-04	15.3440509E-07	.0523	.99846	30
39.1795624E-13	21.5334058E-04	-21.5334058E-04	52.9399028E-15	.00000	1.00000	31
10.7246934E-13	16.533454E-17	10.7246934E-13	16.6523454E-17	5.00000	0.00000	32
10.7272910E-13	03.4672897E-05	10.7272910E-13	63.8672897E-05	5.00000	.2500	33
10.7349266E-13	12.7911831E-04	10.7349266E-13	12.7911831E-04	5.00000	.5000	34
10.7471424E-13	19.2302198E-04	10.7471424E-13	19.2302198E-04	5.00000	.7500	35
10.7632180E-13	25.7120265E-04	10.7632180E-13	25.7120265E-04	5.00000	1.00000	36

TABLE 5-1
(Continued)

10.7822248E-03	32.2704416E-04	10.7822248E-03	32.2704416E-04	5.0000	1.2500	37
10.8030845E-03	34.1944414E-04	10.8030845E-03	34.8944414E-04	5.0000	1.5000	38
10.8246343E-03	45.5974120E-04	10.8246343E-03	45.5974120E-04	5.0000	1.7500	39
10.8456514E-03	52.3430931E-04	10.8456514E-03	52.3430931E-04	5.0000	2.0000	40
10.8649069E-03	59.2531471E-04	10.8649069E-03	59.2531470E-04	5.0000	2.2500	41
10.8811788E-03	65.2016724E-04	10.8811788E-03	65.2016724E-04	5.0000	2.5000	42
10.8932886E-03	73.2231634E-04	10.8932886E-03	73.2231634E-04	5.0000	2.7500	43
10.9001477E-03	80.3017224E-04	10.9001477E-03	80.3017224E-04	5.0000	3.0000	44
10.9008338E-03	87.4395717E-04	10.9008338E-03	87.4395717E-04	5.0000	3.2500	45
10.8946904E-03	94.5014141E-04	10.8946904E-03	94.6014141E-04	5.0000	3.5000	46
10.8815050E-03	10.1700444E-03	10.8815050E-03	10.1700444E-03	5.0000	3.7500	47
10.8615920E-03	10.0913106E-03	10.8615920E-03	10.0913106E-03	5.0000	4.0000	48
10.8360649E-03	11.6000299E-03	10.8360649E-03	11.6000299E-03	5.0000	4.2500	49
10.8070414E-03	12.2994129E-03	10.8070414E-03	12.2994129E-03	5.0000	4.5000	50
10.7780173E-03	12.9858624E-03	10.7780173E-03	12.9858624E-03	5.0000	4.7500	51
10.7544772E-03	13.6562283E-03	10.7544772E-03	13.6562283E-03	5.0000	5.0000	52
10.7544772E-03	13.6562283E-03	10.7544772E-03	-10.7544772E-03	5.0000	5.0000	53
10.2644169E-03	13.6426968E-03	10.2644169E-03	-10.2644169E-03	4.7500	5.0000	54
97.5447472E-04	13.6347505E-03	10.6347505E-03	-97.5447472E-04	4.5000	5.0000	55
92.2771801E-04	13.6270201E-03	10.6270201E-03	-92.2771801E-04	4.2500	5.0000	56
86.8767090E-04	13.6161416E-03	10.6161416E-03	-86.8767090E-04	4.0000	5.0000	57
81.3791244E-04	13.6001470E-03	10.6001470E-03	-81.3791244E-04	3.7500	5.0000	58
75.8176142E-04	13.5780991E-03	10.5780991E-03	-75.8176142E-04	3.5000	5.0000	59
70.2209878E-04	13.5494467E-03	10.5494467E-03	-70.2209878E-04	3.2500	5.0000	60
64.6131118E-04	13.5158328E-03	10.5158328E-03	-64.6131118E-04	3.0000	5.0000	61
59.0131328E-04	13.4769306E-03	10.4769306E-03	-59.0131328E-04	2.7500	5.0000	62
53.4360480E-04	13.4343037E-03	10.4343037E-03	-53.4360480E-04	2.5000	5.0000	63
47.8932974E-04	13.3892957E-03	10.3892957E-03	-47.8932974E-04	2.2500	5.0000	64
42.3931989E-04	13.3433503E-03	10.3433503E-03	-42.3931989E-04	2.0000	5.0000	65
36.9411803E-04	13.2979576E-03	10.2979576E-03	-36.9411803E-04	1.7500	5.0000	66
31.5398508E-04	13.2546166E-03	10.2546166E-03	-31.5398508E-04	1.5000	5.0000	67
26.1890012E-04	13.2148009E-03	10.2148009E-03	-26.1890012E-04	1.2500	5.0000	68
20.8856270E-04	13.1799177E-03	10.1799177E-03	-20.8856270E-04	1.0000	5.0000	69
15.6240516E-04	13.1512546E-03	10.1512546E-03	-15.6240516E-04	.7500	5.0000	70
10.3961947E-04	13.1299150E-03	10.1299150E-03	-10.3961947E-04	.5000	5.0000	71
51.9199909E-05	13.1107508E-03	10.1107508E-03	-51.9199909E-05	.2500	5.0000	72
-92.3958132E-03	13.1123011E-03	10.1123011E-03	92.3958132E-03	0.0000	5.0000	73

TABLE 5-1
(Continued)

SATS THERMAL STRESS EXAMPLE

INTERIOR STRESSES FOR PLOTTING

NUMSX =	21	NUMSY =	21					
XMIN =	.00010	YMIN =	.00010	DELX =	.25000	DELY =	.25000	
X	Y	TEMP	SIGX	SIGY	TAUXY	SIGMAX	SIGMIN	TAUMAX
.0001	.0001	*92772.1*6907281.1*9108104.3*7738071.0				*8116914.2*8743217.3*7738071.0		
.2501	.0001	-1.7*3397508.6*9753179.3 4191063.8				*3415036.6*9751607.3*6593772.0		
.5001	.0001	293.8 -4275.2 6942.3 -3.6				6942.3 -4275.2 5608.8		
.7501	.0001	414.6 -667.8 2459.8 -.5				2459.8 -667.8 1563.8		
1.0001	.0001	500.0 .1 1399.0 -.1				1399.0 .1 699.4		
1.2501	.0001	566.3 218.5 911.8 -.1				911.8 218.5 346.6		
1.5001	.0001	620.5 296.3 622.8 -.0				622.8 296.3 163.2		
1.7501	.0001	666.4 315.5 426.9 -.0				426.9 315.5 55.7		
2.0001	.0001	706.2 306.8 282.2 .0				306.8 282.2 12.3		
2.2501	.0001	741.5 284.0 168.3 .0				284.0 168.3 57.9		
2.5001	.0001	773.2 254.0 73.8 .0				254.0 73.8 90.1		
2.7501	.0001	802.2 220.5 -8.2 .0				220.5 -8.2 114.4		
3.0001	.0001	828.8 185.8 -82.7 .0				185.8 -82.7 134.2		
3.2501	.0001	853.6 151.3 -153.2 .0				151.3 -153.2 152.2		
3.5001	.0001	877.0 118.2 -222.6 .0				118.2 -222.6 170.4		
3.7501	.0001	899.2 87.3 -293.5 .0				87.3 -293.5 190.4		
4.0001	.0001	920.4 59.4 -368.4 .0				59.4 -368.4 213.9		
4.2501	.0001	940.9 35.5 -449.8 .0				35.5 -449.8 242.7		
4.5001	.0001	960.4 16.7 -540.5 .0				16.7 -540.5 278.6		
4.7501	.0001	980.5 4.2 -643.6 .0				4.2 -643.6 323.9		
5.0001	.0001	1000.0 -.3 -762.6 -.0				-.3 -762.6 381.1		
.0001	.2501	61.7*9752834.4*3397168.5 4191061.1				*3415596.5*9771262.4*6593429.5		
.2501	.2501	193.9 3240.7 3241.1 -202168.8				205400.7 -168927.9 202168.8		
.5001	.2501	327.6 233.4 1684.0 -2599.6				3657.6 -1740.1 2698.8		
.7501	.2501	430.3 -155.4 1807.3 -832.4				2112.7 -461.3 1287.0		
1.0001	.2501	509.0 113.4 1235.2 -295.8				1308.4 40.2 634.1		
1.2501	.2501	572.1 252.0 852.0 -112.8				872.5 231.5 320.5		
1.5001	.2501	624.5 306.2 590.4 -35.5				600.9 301.7 149.6		
1.7501	.2501	669.3 317.1 414.0 -.4				414.0 317.1 48.4		
2.0001	.2501	708.5 305.3 275.5 17.9				313.7 267.1 23.3		

TABLE 5-2
PRINTED OUTPUT FROM SATS PLOTTING PROGRAM

SATS THERMAL STRESS EXAMPLE

RMIN = .0001 RMAX = 5.0001 ZMIN = .0001 ZMAX = 5.0001 RINCH = 10.0000 ZINCH = 10.0000
XMIN = .0001 YMIN = .0001 NUMSX = 21 NUMSY = 21 DELXB = .2500 DELYB = .2500

TEMPERATURE

VALUES OF ISOSTRESS LINES

487.000000	520.000077	560.000154	600.000231	640.000308
680.000345	720.000462	760.000578	800.000615	840.000692
880.000749	920.000846	960.000923	1000.001000	

X STRESS

VALUES OF ISOSTRESS LINES

-1000.000000	-833.333333	-666.666667	-500.000000	-333.333333
-166.666667	.000000	166.666667	333.333333	500.000000
666.666667	833.333333	1000.000000	1166.666667	1333.333333
1500.000000	1666.666667	1833.333333	2000.000000	

Y STRESS

VALUES OF ISOSTRESS LINES

-1000.000000	-833.333333	-666.666667	-500.000000	-333.333333
-166.666667	.000000	166.666667	333.333333	500.000000
666.666667	833.333333	1000.000000	1166.666667	1333.333333
1500.000000	1666.666667	1833.333333	2000.000000	

XY SHEAR STRESS

VALUES OF ISOSTRESS LINES

-800.000000	-750.000000	-700.000000	-650.000000	-600.000000
-550.000000	-500.000000	-450.000000	-400.000000	-350.000000
-300.000000	-250.000000	-200.000000	-150.000000	-100.000000
-50.000000	0.000000			

TABLE 5-2
(Continued)

MAXIMUM STRESS

VALUES OF ISOSTRESS LINES

0.000000	80.000000	160.000000	240.000000	320.000000
400.000000	480.000000	560.000000	640.000000	720.000000
800.000000	880.000000	960.000000	1040.000000	1120.000000
1200.000000	1280.000000			

MINIMUM STRESS

VALUES OF ISOSTRESS LINES

-720.000000	-640.000000	-560.000000	-480.000000	-400.000000
-320.000000	-240.000000	-160.000000	-80.000000	0.000000
80.000000	160.000000	240.000000	320.000000	400.000000

MAXIMUM SHEAR

VALUES OF ISOSTRESS LINES

0.000000	40.000000	80.000000	120.000000	160.000000
200.000000	240.000000	280.000000	320.000000	360.000000
400.000000	440.000000	480.000000	520.000000	560.000000
600.000000	640.000000	680.000000	720.000000	

PLEASE PLOT. 7 PLOTS.

TABLE 5-3
Comparison of SATS and FEATS Results

<u>Parameter</u>	<u>SATS</u>	<u>FEATS</u>	<u>Percent Difference</u>
Radial Displacement at hole wall ($x = 1, y = 0$)	.002153	.002152	0.0%
Radial displacement at outer boundary ($x = 5, y = 0$)	.001072	.001063	0.8%
Y stress at hole wall ($x = 1, y = 0$)	1399.	1393.*	0.4%
Y stress at outer boundary ($x = 5, y = 0$)	-762.	-749.*	1.7%

* Linearly extrapolated to surface.

6. REFERENCES

1. Hulbert, L. E., "The Numerical Solution of Two-Dimensional Problems of the Theory of Elasticity," Bulletin 198, Engineering Experiment Station, Ohio State University.
2. Timoshenko, S. and Goodier, J. N., Theory of Elasticity, McGraw-Hill Book Company, Inc., New York, 1951.
3. Swanson, J. A., "FEATS - A Computer Program for the Finite Element Thermal Stress Analysis of Plane or Axisymmetric Solids," WANL-TME-1888, December, 1968.

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      PROGRAM SATS(INPUT,OUTPUT,PUNCH,TAPE5=INPUT,TAPE6=OUTPUT,TAPE7=
1    PUNCH,TAPE11)
C DCF THIS PROGRAM IS SATS  DATE IS 11/10/69
C DCF DENAME PROGRAM SATSA
C DCF SUBMITTED BY STRESS
C REVISION D-3 OF SATS STRESS AND TEMPERATURE CODE
CSATS      SDPH1  SIGOUTBCIND INPUTXPIOTS
C
C*****
C
C          *****  NOTICE *****          DATE    7 NOVEMBER 1969
C
C  THIS COMPUTER CODE IS BASED ON AN EARLIER CODE DEVELOPED BY J. H. L. SAT
C  AT OHIO STATE UNIVERSITY.  MANY CHANGES, ADDITIONS, AND IMPROVEMENTS
C  HAVE BEEN INCORPORATED.
C
C  THIS COMPUTER CODE IS NOT GUARANTEED TO BE FREE OF ERRORS.
C
C  AUTHOR -  JOHN A. SWANSON
C
C  LOCATION - WESTINGHOUSE ASTRONUCLEAR LABORATORY
C              P.O. BOX 10464
C              PITTSBURGH, PA. 15236
C              PHONE 412-892-5600 X6249
C
C  REFERENCES TO THIS CODE SHOULD BE OF THE FORM
C
C  SWANSON, J. A., SATS - A COMPUTER PROGRAM FOR PLANE THERMAL STRESS ANAL
C  BY SERIES SOLUTION.  WNL-TMF-1957.  NOVEMBER, 1969.
C
C          ***** DO NOT REMOVE THIS NOTICE. *****
C
C*****
C
C  REQUIRED SUBROUTINES (BONDY,TEGSEI,BODY,DPHI,DPHT,MATEQF,BDYTF4,SEJSSAT
C  TEMINT,ANGLE,RHERR,RC1,HC2,BC3,RC4,IVDIS,TDIS,DPHT,BDYSIG,SIGINT,
C  BDYDIS,DISINT)
C      DIMENSION      PHI(140),TVALIF(140),COND(40),CONDH(40),TITLE(154
18),ISYPOL(42),BETA(40),ICUR(40),IPOSIA(40),ITYPOL(40),KEY(10),VORDSAT
2ER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CJ
3RCUN(160),XSYPOL(240),YSYPOL(240),XHA(300),YXHA(300),YHA(300),YXHASAT

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4(300),IRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALSAT 420
5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( SAT 430
6120),DXIC(141),DX2C(141),DYIC(141),DY2C(141),OUT(141),DPAC(141),DXSAT 440
7YC(141),R(50),SOCN(50),ENTSN(50),A(10010),R(1000,R),BDYC(60,2), SAT 450
RKRDY(60),IP(1000,R) SAT 460
COMMON DXIC , DYIC , A , RIOT , QGEN , CONDH SAT 470
COMMON PHI , TVALUE , IET , ICT , IGT , ICI SAT 480
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON SAT 490
COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA SAT 500
COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IPNSIA SAT 510
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLE , YPOLE SAT 520
COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL SAT 530
COMMON XRA , XNRA , YRA , YNRA , IRA , IEQNO SAT 540
COMMON RTSIDE , MGT , NGT , KGT , GVALUIT , JES SAT 550
COMMON MAS , NAS , KAS , MG , NG , KG SAT 560
COMMON GVALUE , OUT , DPAC , DXYC , R , SOCN SAT 570
COMMON ENTSN , IR , IEQNO , IR , M , DELTHT SAT 580
COMMON RSURX , RSURX , THET , XR , XNR , YR SAT 590
COMMON YNR SAT 600
EQUIVALENCE (DXIC,DY2C),(DYIC,DY2C),(A,R,IP),(A(9001),BDYC), SAT 610
1 (A(8181),KRDY),(RIOT,YOUNG) (SORCE,QGEN),(COND,CONDH) SAT 620
DIMENSION GEOM(2) SAT 630
DATA GEOM / 4HGFORM,4HETRY/ SAT 640
C SAT 650
REWIND 11 SAT 660
CALL PDVICE(3) SAT 670
1 READ (5,5001)TITLE SAT 680
C SAT 690
WRITE (6,5002)TITLE SAT 700
C SAT 710
READ (5,4001) NOCUR,NOCCON,IET,MMAX,INSYM,NOSYM,KINPT SAT 720
C KINPT = 0, STANDARD INPUT = 1, USE INPUTA OR INPUTJ SAT 730
IF (NOCUR .LE. 0) CALL PLOT3 SAT 740
IF (NOCUR .LE. 0) CALL EXIT SAT 750
C SAT 760
IF (IET = 300) 2,2,3 SAT 770
3 WRITE (6,5003)IET SAT 780
CALL EXIT SAT 790
C SAT 800
2 READ (5,4001)(ICUR(I), I = 1, NOCUR) SAT 810
READ (5,4002)(CURCON(I), I = 1, NOCCON) SAT 820
IF (KINPT .EQ. 1) GO TO 5 SAT 830

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READ (5,4003)(XRA(I), I = 1, IFT)	SAT 840
GO TO 4	SAT 850
5 CALL INPUTA(XRA)	SAT 860
4 WRITE (6,5021) (XRA(I), I = 1, IFT)	SAT 870
CALL BONDY	SAT 880
READ (5,4003)HCK,POCYCL	SAT 890
READ (5,4003)(XPOLE(I),YPOLE(I), I = 1, MMAX)	SAT 900
READ (5,4001) (IPOSIA(I), I = 1, MMAX)	SAT 910
READ (5,4001) (ITYPOL(I), I = 1, MMAX)	SAT 920
READ (5,4001)(NORDEF(I), I = 1, MMAX)	SAT 930
	SAT 940
	SAT 950
	SAT 960
XMIN = 1.0E20	SAT 970
YMIN = 1.0E20	SAT 980
XMAX = -1.0E20	SAT 990
YMAX = -1.0E20	SAT 1000
DO 810 I = 1,IFT	SAT 1010
IF (XRA(I) .LT. YMIN) XMIN = XRA(I)	SAT 1020
IF (XRA(I) .GT. XMAX) XMAX = XRA(I)	SAT 1030
IF (YRA(I) .LT. YMIN) YMIN = YRA(I)	SAT 1040
IF (YRA(I) .GT. YMAX) YMAX = YRA(I)	SAT 1050
810 CONTINUE	SAT 1060
CALL HESTSC (XMIN,XMAX,10.0)	SAT 1070
CALL HESTSC (YMIN,YMAX,10.0)	SAT 1080
DELX = XMAX - XMIN	SAT 1090
DELY = YMAX - YMIN	SAT 1100
IF (DELY .GT. DELX) DELY = DELX	SAT 1110
IF (DELY .GT. DELX) DELX = DELY	SAT 1120
XMAX = XMIN + DELX	SAT 1130
YMAX = YMIN + DELY	SAT 1140
CALL FRAME (XMIN, XMAX, YMIN, YMAX, 10.0, 10.0, 0, 1, 4H X, 1,	SAT 1150
1 4H Y, 14, TITLE, 2, GEOM, 4H JAS)	SAT 1160
	SAT 1170
DO 820 I = 1,NOCUR	SAT 1180
K2 = ICUR(I)	SAT 1190
K1 = ICUR(I-1) + 1	SAT 1200
IF (I .EQ. 1) K1 = 1	SAT 1210
N = K2 - K1 + 1	SAT 1220
820 CALL DASH1 (XRA(K1), YRA(K1), N, -1, 4H)	SAT 1230
	SAT 1240
DO 830 I = 1,MMAX	SAT 1250

AT = NORDER(T)	SAT 1260
CALL CONV (AI,RI,2,0)	SAT 1270
R30 CALL DASH1 (XPOLE(T), YPOLE(T), 1, -1, RT)	SAT 1280
C	SAT 1290
IF (INSYM .NE. 2) GO TO R50	SAT 1300
SYM = NOSYM	SAT 1310
ANGL = 3.14159/SYM	SAT 1320
RTSIDE(1) = 0.0	SAT 1330
RTSIDE(3) = 0.0	SAT 1340
RTSIDE(4) = 0.0	SAT 1350
RTSIDE(2) = XMAX	SAT 1360
CALL DASH1 (RTSIDE(1), RTSIDE(3), 2, 5, 4H)	SAT 1370
RTSIDE(2) = XMAX*COS(ANGL)	SAT 1380
RTSIDE(4) = XMAX*SIN(ANGL)	SAT 1390
CALL DASH1 (RTSIDE(1), RTSIDE(3), 2, 5, 4H)	SAT 1400
R50 CONTINUE	SAT 1410
C	SAT 1420
CALL BODY	SAT 1430
C	SAT 1440
701 READ (5,4001)KEY	SAT 1450
IF (KEY(1) .EQ. 0) GO TO 1	SAT 1460
C	SAT 1470
C KEY(1) = 0. PLOT GEOMETRY ONLY	SAT 1480
C KEY(1) = 1.2 - TEMPERATURE SOLUTION 3 - MORE TEMPERATURE RESULTS	SAT 1490
C 4.5 - STRESS SOLUTION ONLY 4 - MORE STRESS RESULTS	SAT 1500
C KEY(2) = -1 - CALL TEMINT, 0 - RETURN TO NEW PROBLEM, 1 - GO TO STRES	SAT 1510
C 2 - GO TO NEW KEY.SAME REGION, 3 - CALL SIGINT (MATRIX PRINT)	SAT 1520
C KEY(3) = -2 - CALL DISTINT, -1 - CALL HDYDIS, 0 - CALL HDYSIG,	SAT 1530
C 1 - CALL SIGINT, 2 - NEW PROBLEM, 3 - NEW KEY.SAME REGION	SAT 1540
C KEY(4) = 0 - NO TEMPERATURE EQUATION PRINT, 1 - PRINT EQUATIONS	SAT 1550
C KEY(5) = 0 - NO STRESS EQUATION PRINT, 1 - PRINT EQUATIONS	SAT 1560
C KEY(6) = 0 - PLANE STRESS SOLUTION, 1 - PLANE STRAIN SOLUTION	SAT 1570
C KEY(7) = 0 - USE TEOSL, 1 - READ IN REQUIRED TEMPERATURE TERMS	SAT 1580
C KEY(8) = 0 - USE SEOSL, 1 - READ IN REQUIRED STRESS TERMS	SAT 1590
C KEY(10) = 0 - DO NOT PUNCH SOLUTIONS, 1 - PUNCH SOLUTIONS	SAT 1600
C HEAT GENERATION IN BTU/HR IN**3 (OR OTHER CONSISTANT UNITS)	SAT 1610
C CONDUCTIVITY IN BTU/HR IN F (OR OTHER CONSISTANT UNITS)	SAT 1620
C YOUNG IN PSI	SAT 1630
C ALPHA IN /F	SAT 1640
C CONVECTION COEFFICIENTS IN BTU/HR IN**2 F (OR OTHER CONSISTANT UNITS)	SAT 1650
C	SAT 1660
READ (5,4003)QGEN,THERMK,YOUNG,ALPHA,POSSON	SAT 1670

```

C
IF (THERMK .LE. 0.0) THERMK = 1.0
WRITE (4,5002) TITLE
WRITE (4,5004) NOCUR,NOCCO,ITET,IMAX,INSYM,NOASYM
WRITE (4,5005) (ICUR(I), I = 1,NOCUR)
WRITE (4,5006) (CURCO(I), I = 1,NOCCO)
WRITE (4,5007) (I,XBA(I),YBA(I),XGBA(I),YNBA(I),I=1,ITET)
WRITE (4,5008) HCK,PCYCI
WRITE (4,5009) (I,XPOL(I),YPOL(I),ITPOL(I),NORDEF(I), IPCTA(I)
I, I = 1, MMAX)
WRITE (4,5010) (KEY(I), I=1,10)
WRITE (4,5011) QGEN,THERMK,YOUNG,ALPHA,POSSON
SOURCE = 0.25*QGEN/THERMK
C KEY(6) = 0 FOR PLANE STRESS KEY(6) = 1 FOR PLANE STRAIN
IF (KEY(6)) 706,705,706
705 YOUNG = YOUNG*(1.0+ 2.0*POSSON)/(1.0+ POSSON)**2)
ALPHA = ALPHA*(1.0+POSSON)/(1.0+2.0*POSSON)
POSSON = POSSON/(1.0+ POSSON)
706 SHEAR = YOUNG/(2.0*(1.0+POSSON))
RIGI = YOUNG*ALPHA/(1.0-POSSON)
ICT = 0
ICS = 0
ICL = 0
IGI = 0
IFS = 0
IG = 0
KXXX = *FY(1)
C
GO TO (100,100,300,401,401,600),KXXX
C
100 IF (KINPT = 1) 91,90,91
90 CALL INPUTI (IFQNO)
CALL INPUTA (RTSIDF)
GO TO 91
91 READ (5,4001) (IFQNO(I), I=1,IFT)
READ (5,4002) (RTSIDF(I), I=1,IFT)
92 DO 101 I = 1,IFT
101 TRA(I) = I
IF (KEY(7)) 102,103,102
102 READ (5,4001) ICT,IGI,IG
READ (5,4001) (MAT(I), I = 1, ICT)
READ (5,4001) (NAT(I), I = 1, ICT)

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SAT 1630
SAT 1690
SAT 1700
SAT 1710
SAT 1720
SAT 1730
SAT 1740
SAT 1750
SAT 1760
SAT 1770
SAT 1780
SAT 1790
SAT 1800
SAT 1810
SAT 1820
SAT 1830
SAT 1840
SAT 1850
SAT 1860
SAT 1870
SAT 1880
SAT 1890
SAT 1900
SAT 1910
SAT 1920
SAT 1930
SAT 1940
SAT 1950
SAT 1960
SAT 1970
SAT 1980
SAT 1990
SAT 2000
SAT 2010
SAT 2020
SAT 2030
SAT 2040
SAT 2050
SAT 2060
SAT 2070
SAT 2080
SAT 2090

READ (5,4001)(KAT(I), I = 1, ICT)	SAT 2100
IF (IG) 104,104,702	SAT 2110
702 READ (5,5019) (MGT(I),NGT(I),KGT(I),GVALUT(I), I = 1, IG)	SAT 2120
GO TO 104	SAT 2130
103 CALL TDSER	SAT 2140
IG = 1	SAT 2150
MGT(1) = 1	SAT 2160
NGT(1) = 0	SAT 2170
KGT(1) = 2	SAT 2180
GVALUT(1) = SORCF	SAT 2190
104 WRITE (6,5002)TITLE	SAT 2200
WRITE(6,5099)ICT,(I,MAT(I),NAT(I),KAT(I),I=1,ICT)	SAT 2210
WRITE(6,5098)IET,(I,IEQNO(I),RTSIDE(I),I=1,IET)	SAT 2220
5099 FORMAT(1H0,10X,27TEMP TERMS ICT = ,I4//2X,	SAT 2230
15(22H I MAT NAT KAT)//(2X,5(4I5,2X)))	SAT 2240
5098 FORMAT(1H0,10X,27BOUNDARY CONDITIONS IET = ,I4//2X,	SAT 2250
15(22H I EON RTSIDE)//(2X,5(2I3,F14,6,2X)))	SAT 2260
WRITE (6,5020) (I,MGT(I),NGT(I),KGT(I),GVALUT(I),I=1,IG)	SAT 2270
ICI = ICT + 1	SAT 2280
READ (5,4003)(CONDH(I),I = 1, NOCUR)	SAT 2290
READ (5,4003)(TCOOL(I),I = 1, NOCUR)	SAT 2300
WRITE (6,5013) (I,CONDH(I),TCOOL(I),I = 1,NOCUR)	SAT 2310
DO 105 I = 1, NOCUR	SAT 2320
105 CONO(I) = CONDH(I)/THERMK	SAT 2330
DO 201 K = 1,ICT	SAT 2340
201 TVALUE(K) = 0.0	SAT 2350
NX = ((ICT + 3)*ICT)/2	SAT 2360
DO 204 I = 1,NX	SAT 2370
204 A(L) = 0.0	SAT 2380
IX = ICT + 1	SAT 2390
106 IR = 1	SAT 2400
107 IR = IHA(IR)	SAT 2410
TI = - ICT	SAT 2420
XR = XHA(IR)	SAT 2430
YR = YHA(IR)	SAT 2440
XNH = XHA(IR)	SAT 2450
YNH = YHA(IR)	SAT 2460
IEQN = IEQNO(IR)	SAT 2470
IF (IEQ = 2) 108,109,109	SAT 2480
108 CALL DPHIO	SAT 2490
	SAT 2500
	SAT 2510

DO 112 I = 1, ICI	SAT 2520
112 OUT(J) = DROC(J)	SAT 2530
GO TO 113	SAT 2540
109 T = 0	SAT 2550
114 T = I + 1	SAT 2560
IF (ICD(I) - IR) 114, 115, 115	SAT 2570
115 CALL DP4I	SAT 2580
DO 116 I = 1, ICI	SAT 2590
116 OUT(J) = (DXIC(J)*XNH + DYIC(J)*YNH)/HCK	SAT 2600
OUT(IC1) = DXIC(IC1)*XNH + DYIC(IC1)*YNH	SAT 2610
IF (CON(I)) 117, 113, 117	SAT 2620
117 CALL DP4ID	SAT 2630
DO 118 J = 1, ICI	SAT 2640
118 OUT(J) = OUT(J) + CON(I)*DROC(J)	SAT 2650
OUT(IC1) = OUT(IC1) + ICODL(I)*CON(I)	SAT 2660
113 OUT(IC1) = WTSIDE(IR) + OUT(IC1)	SAT 2670
IF (KEY(4)) 119, 202, 119	SAT 2680
119 WRITE (5,5014) IR, (I, OUT(I), I=1, ICI)	SAT 2690
C	SAT 2700
202 DO 203 K = 1, ICT	SAT 2710
II = II + NX - K	SAT 2720
DO 203 L = K, ICI	SAT 2730
J = II + L	SAT 2740
203 A(J) = A(J) + OUT(K)*OUT(L)	SAT 2750
IF (IP - IFT) 120, 205, 205	SAT 2760
C	SAT 2770
120 IR = IR + 1	SAT 2780
GO TO 107	SAT 2790
C	SAT 2800
205 CALL SYMAT (A(I), ICT, TVALUE(I))	SAT 2810
WRITE (5,5015) (J, TVALUE(J), J= 1, ICI)	SAT 2820
IF (KEY(10)) 301, 301, 306	SAT 2830
306 WRITE (7,4001) ICT, IGT, IG	SAT 2840
WRITE (7,4001) (MAT(I), I = 1, ICT)	SAT 2850
WRITE (7,4001) (NAT(I), I = 1, ICT)	SAT 2860
WRITE (7,4001) (KAT(I), I = 1, ICT)	SAT 2870
WRITE (7,4004) (TVALUE(I), I = 1, ICI)	SAT 2880
IF (IG) 301, 301, 308	SAT 2890
308 WRITE (7,5019) (MGT(I), NAT(I), KGT(I), GVALUE(I), I = 1, ICI)	SAT 2900
301 CALL BODYTEM	SAT 2910
GO TO 302	SAT 2920
C	SAT 2930

300 READ (5,4001) ICT,IGT,IG	S T 2940
READ (5,4001) (MAT(I),I = 1,ICT)	S T 2950
READ (5,4001) (NAT(I),I = 1,ICT)	S T 2960
READ (5,4001) (KAT(I),I = 1,ICT)	S T 2970
READ (5,4004) (TVALUE(I), I = 1,ICT)	S T 2980
IF (IG) 704,704,703	S T 2990
703 READ (5,5019) (MGT(I),NGT(I),KGT(I),GVALUE(I),I=1,IG)	S T 3000
WRITE (5,5020) (I,MGT(I),NGT(I),KGT(I),I=1,IG)	S T 3010
704 WRITE (5,5016) ICT,IGT,(I,MAT(I),NAT(I),KAT(I),	TVALUE(I) S T 3020
1, I = 1,ICT)	S T 3030
302 KK2 = KEY(2) + 2	S T 3040
GO TO (303,1,401,611,305,311),KK2	S T 3050
303 CALL TEINT	S T 3060
GO TO 304	S T 3070
305 CALL SIGINT	S T 3080
GO TO 304	S T 3090
310 CALL SIGPLT	S T 3100
C	S T 3110
304 READ (5,4001) KEY(2)	S T 3120
GO TO 302	S T 3130
C	S T 3140
401 READ (5,4001) IFS,KKK2	S T 3150
IF (KKK2) 428,429,424	S T 3160
428 READ (5,4001) (NORDER(I),I=1,MMAX)	S T 3170
429 IF (KINPT = 1) 441,440,441	S T 3180
440 CALL INPUTI (IFQNO)	S T 3190
CALL INPUTA (RTSIDE)	S T 3200
GO TO 442	S T 3210
441 READ (5,4001) (IEQNO(I),I=1,IFS)	S T 3220
READ (5,4003) (RTSIDE(I),I=1,IFS)	S T 3230
442 IBA(1) = 1	S T 3240
DO 430 I = 2,IES	S T 3250
IEQN = IEQNO(I)	S T 3260
GO TO (431,432,431,432),IEQN	S T 3270
431 IBA(J) = IBA(J-1) + 1	S T 3280
GO TO 430	S T 3290
432 IBA(J) = IBA(J-1)	S T 3300
430 CONTINUE	S T 3310
C	S T 3320
IF (KEY(8)) 402,403,402	S T 3330
402 READ (5,4001) ICS	S T 3340
READ (5,4001) (MAS(I),I = 1,ICS)	S T 3350

DEA) (5.4.01) (MAS(I).I = 1.ICS)	S T 3350
DEA) (5.4.01) (KAS(I).J = 1.ICS)	S T 3371
GO TO 4.4	S T 3380
403 CALL SEISHI	S T 3390
404 WRITE (-5002) TITLE	S T 3400
WRITE(6,5007) ICS, (I, MAS(I).MAS(I), KAS(I).I = 1.ICS)	S T 3410
5007 FORMAT(1H0.10X.27HSTRESS IE=AS ICS = .14//2X.	S T 3420
15(22H I MAS NIS KAS)// (2X.5(415.2X))	S T 3430
WRITE(6,5006) IFS, (I, IFWNO(I).RTSIDE(I).I = 1.IFS)	S T 3440
5006 FORMAT(1H0.10X.27HBOUNDARY CONDITION IS IFS = .14//2X.	S T 3450
15(22H IFS EQU RTSIDE)// (2X.2(213.F14.6.2X))	S T 3460
ICT = ICS + 1	S T 3470
IF (ICT) 414,414.405	S T 3480
405 DO 406 I = 1, ICT	S T 3490
406 GVALUE(I) = 0.0	S T 3500
IF (IGT) 414,414.407	S T 3510
407 DO 413 I = 1, IGT	S T 3520
IF (KAT(I) = 1) 409,408.411	S T 3530
408 MG(I) = MAT(I)	S T 3540
NG(I) = NAT(I)	S T 3550
KG(I) = 3	S T 3560
GVALUE(I) = 0.25*RTOT*TVALUE(I)	S T 3570
GO TO 413	S T 3580
409 IF (KAT(I) = 3) 411,410.411	S T 3590
410 MG(I) = MAT(I)	S T 3600
NG(I) = NAT(I)	S T 3610
KG(I) = 4	S T 3620
GVALUE(I) = 0.5*RTOT*TVALUE(I)*HCK	S T 3630
GO TO 413	S T 3640
411 IF (KAT(I) = 7) 413,412.413	S T 3650
412 MG(I) = MAT(I)	S T 3660
NG(I) = NAT(I)	S T 3670
KG(I) = 8	S T 3680
GVALUE(I) = 0.5*RTOT*TVALUE(I)*HCK	S T 3690
413 CONTINUE	S T 3700
414 DO 501 K = 1, ICS	S T 3710
501 PHI(K) = 0.0	S T 3720
NX = ((ICS + 3)*ICS)/2	S T 3730
DO 504 I = 1, NX	S T 3740
504 A(L) = 0.0	S T 3750
415 IR = 1	S T 3760
NX = ICT + 1	S T 3770

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      IF (INSYM = 2) 417, 416, 417
417 DELTHT = 0.0
416 IR = IRA(IR)
      II = - IC1
      XR = XRA(IR)
      YR = YRA(IR)
      XNR = XNRA(IR)
      YNR = YNRA(IR)
      IEQN = IEQNO(IR)
      GO TO (418,419,420,421),IEQN
418 CALL RC1
      GO TO 422
419 CALL RC2
      GO TO 422
420 CALL RC3
      GO TO 424
421 CALL RC4
      GO TO 424
422 OUT(IC1) = RTSIDE(IR) + OUT(IC1)
      GO TO 425
424 OUT(IC1) = RTSIDE(IR)*SHEAR + OUT(IC1)
425 IF (KEY(5)) 423,502,423
423 WRITE (6,5014)IR,(I,OUT(I),I = 1,IC1)
      C
502 DO 503 K = 1,ICS
      II = II + NX = K
      DO 503 L = K,IC1
      J = II + L
503 A(J) = A(J) + OUT(K)*OUT(L)
      IF (IR = IES) 427,505,505
427 IR = IR + 1
      GO TO 416
      C
505 CALL SYMMAT (A(1),ICS,PHI(1))
      WRITE (6,5015)(J,PHI(J),J = 1,ICS)
      IF (KEY(10)) 605,605,506
506 WRITE (7,4001)ICS,ICT,IGT,IG
      WRITE (7,4001)(MAS(I),I = 1,ICS)
      WRITE (7,4001)(NAS(I),I = 1,ICS)
      WRITE (7,4001)(KAS(I),I = 1,ICS)
      WRITE (7,4004)(PHI(I),I = 1,ICS)
      IF (ICT) 508,508,507

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SAT 3740
SAT 3790
SAT 3800
SAT 3810
SAT 3820
SAT 3830
SAT 3840
SAT 3850
SAT 3860
SAT 3870
SAT 3880
SAT 3890
SAT 3900
SAT 3910
SAT 3920
SAT 3930
SAT 3940
SAT 3950
SAT 3960
SAT 3970
SAT 3980
SAT 3990
SAT 4000
SAT 4010
SAT 4020
SAT 4030
SAT 4040
SAT 4050
SAT 4060
SAT 4070
SAT 4080
SAT 4090
SAT 4100
SAT 4110
SAT 4120
SAT 4130
SAT 4140
SAT 4150
SAT 4160
SAT 4170
SAT 4180
SAT 4190

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507	WRITE (7,4001) (MAT(I), I = 1, ICT)	SAT 4200
	WRITE (7,4001) (NAT(I), I = 1, ICT)	SAT 4210
	WRITE (7,4001) (KAT(I), I = 1, ICT)	SAT 4220
	WRITE (7,4004) (TVALUF(I), I = 1, ICT)	SAT 4230
508	IF (IGT) 510,510,509	SAT 4240
509	WRITE (7,4001) (MG(I), I = 1, IGT)	SAT 4250
	WRITE (7,4001) (NG(I), I = 1, IGT)	SAT 4260
	WRITE (7,4001) (KG(I), I = 1, IGT)	SAT 4270
	WRITE (7,4004) (GVALUF(I), I = 1, IGT)	SAT 4280
510	IF (IG) 605,605,511	SAT 4290
511	WRITE (7,5019) (MGT(I), NGT(I), KGT(I), GVALUT(I), I = 1, IG)	SAT 4300
	GO TO 605	SAT 4310
600	READ (5,4001) ICS, ICT, IGT, IG	SAT 4320
	READ (5,4001) (MAS(I), I = 1, ICS)	SAT 4330
	READ (5,4001) (NAS(I), I = 1, ICS)	SAT 4340
	READ (5,4001) (KAS(I), I = 1, ICS)	SAT 4350
	READ (5,4004) (PHI(I), I = 1, ICS)	SAT 4360
	IF (ICT) 602,602,601	SAT 4370
601	READ (5,4001) (MAT(I), I = 1, ICT)	SAT 4380
	READ (5,4001) (NAT(I), I = 1, ICT)	SAT 4390
	READ (5,4001) (KAT(I), I = 1, ICT)	SAT 4400
	READ (5,4004) (TVALUF(I), I = 1, ICT)	SAT 4410
602	IF (IGT) 612,612,603	SAT 4420
603	READ (5,4001) (MG(I), I = 1, IGT)	SAT 4430
	READ (5,4001) (NG(I), I = 1, IGT)	SAT 4440
	READ (5,4001) (KG(I), I = 1, IGT)	SAT 4450
	READ (5,4004) (GVALUF(I), I = 1, IGT)	SAT 4460
612	IF (IG) 604,604,613	SAT 4470
613	READ (5,5019) (MGT(I), NGT(I), KGT(I), GVALUT(I), I = 1, IG)	SAT 4480
604	WRITE (6,5018) ICS, ICT, IGT, (I, MAS(I), NAS(I), KAS(I),	PHI(I), MAT
	1(I), NAT(I), KAT(I), TVALUF(I), MG(I), NG(I), KG(I),	TVALUF(I),
	2 I = 1, ICS)	SAT 4500
605	KKK3= KEY(3) + 3	SAT 4510
	GO TO (406,607,608,609,1,611,801), KKK3	SAT 4520
606	CALL DISINT	SAT 4530
	GO TO 610	SAT 4540
607	CALL 3DYDIS	SAT 4550
	GO TO 610	SAT 4560
608	CALL 3DYSIG	SAT 4570
	GO TO 610	SAT 4580
609	CALL 3ISPLT	SAT 4590
		SAT 4600
		SAT 4610

A-11

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      GO TO 610
609 CALL SIGINT
610 READ (5,4001)KEY(3)
      GO TO 615
611 READ (5,5001)TITLE
      GO TO 711
4001 FORMAT(24I3)
4002 FORMAT(1F12.2)
4003 FORMAT(5F12.2)
4004 FORMAT(4E16.8)
5001 FORMAT(18A4)
5002 FORMAT(1H1,20X,37H SATS - PLANE STRESS CODE J.SWANSIN//18A4//) SAT 4730
5003 FORMAT(10H0 YOU HAVE,14,62H BOUNDARY POINTS. THE PROGRAM ALLOWS 4SAT 4740
      1 MAXIMUM OF 300 POINTS. ) SAT 4750
5004 FORMAT(1H0/10X,21H REGION SPECIFICATION//9H NOCUR =,I3,I3H SAT 4760
      1 OCCON =,I3,I0H TFI =,I4,I1H MMAX =,I3,I2H INSYM =,I2, SAT 4770
      2 I2H NOSYM =,I2) SAT 4780
5005 FORMAT(10H0 ICUR = ,20I4) SAT 4790
5006 FORMAT(14H0 THE INPUT BOUNDARY EQUATIONS (CURCON) WERE//(3F20.8, SAT 4800
      1 F20.1)) SAT 4810
5007 FORMAT(39H0 THE BOUNDARY POINTS ARE THE FOLLOWING// 4H I,12X, SAT 4820
      1 I1X,19X,1HY,15X,8HX NORMAL,12X,3HY NORMAL//(15,4F20.8)) SAT 4830
5008 FORMAT(1H0/26H HCK. THE SCALE FACTOR, =,F16.8, 13H PD CYCL =,SAT 4840
      1 E16.8//) SAT 4850
5009 FORMAT(35H0 THE INPUT EXPANSION POLE DATA WAS//6H POLE,11X,1HX, SAT 4860
      1 19X,1HY,12X,28HPOLE TYPE ORDER IP0S1A//(15,2E20.8,3I10)) SAT 4870
5010 FORMAT(1H0/7H KEY =,11I4) SAT 4880
5011 FORMAT(24H0 HEAT GENERATION RATE =,F16.8,27H THERMAL CONDUCTIVSAT 4890
      1 ITY =,F16.8,8H E =,F16.8//9H ALPHA =,F16.8,20H POISSON RASAT 4900
      2 TIO =,F4.4) SAT 4910
5013 FORMAT(21H0 BOUNDARY CONDITIONS//63H BOUNDARY CONVECTION CSAT 4920
      1 0EFFICIENT COOLANT TEMPERATURE//(19,E27.8,F21.2)) SAT 4930
5014 FORMAT(10H0 EQUATION,14//(5(I6,1PF16.7))) SAT 4940
5015 FORMAT(26H0 SOLUTION VECTOR//14(I7,F17.8)) SAT 4950
5016 FORMAT(1H0// 42H I MAT NAT KAT TVALUE ICT =,I4,9H SAT 4960
      1 IGT =,I4//(4I5,F16.6)) SAT 4970
5018 FORMAT(1H0// 8H ICS =,I3,10H ICT =,I2,10H IGT =,I2// SAT 4980
      1 1103H I MAS NAS KAS PHI MAT NAT KAT SAT 4990
      2 TVALUE MG NG KG GVALUE//(4I5,F17.8,18,2I5,F17.8SAT 5000
      3,18,2I5,F17.8)) SAT 5010
5019 FORMAT(2(3I3,F15.8)) SAT 5020
5020 FORMAT(20H0 GIVEN VALUE TERMS//43H I NGT NGI KGT SAT 5030

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      * GIVEN VALUE// (15.314,E20.8))
5021 FORMAT(37H)      INPUT BOUNDARY POINT PARAMETERS      //(6F12.6))
      END

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SAT 5040
SAT 5050
SAT 5060

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SUBROUTINE BODY
DIMENSION PHI(140), TVALUE(140), COND(40), CONDH(40), TITLE(140)
18), ISYPOL(42), BETA(40), ICUR(40), IP0S1A(40), ITYPOL(40), KEY(10), NORDAAK
2F2(40), TCOOL(40), XPOLF(40), YPOLE(40), MAT(140), NAT(140), KAT(140), CJA00
3RCON(160), XSYPOL(240), YSYPOL(240), XHA(300), YNRA(300), YRA(300), YNRAA00
4(300), IHA(500), IEQNO(500), RTSIDE(500), MGT(40), NGT(40), KGT(40), GVALAAK
5UT(40), MAS(140), NAS(140), KAS(140), MG(120), NG(120), KG(120), GVALUE( 40K
6120), DX1C(141), DX2C(141), DY1C(141), DY2C(141), OUT(141), DPOC(141), JXA00
7YC(141), R(50), SOCN(50), ENISN(50), A(10010), H(1000,8), BDYC(60,3),
AKRDY(60), IP(1000,8)
COMMON DX1C , DY1C , A , RIOT , OGEN , CONDH
COMMON PHI , TVALUE , IFT , ICT , IGT , ICI
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON
COMMON POCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA
COMMON HCK , TITLE , ISYPOL , BETA , ICUR , IP0S1A
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOLE
COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL
COMMON XHA , XNRA , YRA , YNRA , IHA , IEQNO
COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES
COMMON MAS , NAS , KAS , MG , NG , KG
COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN
COMMON ENISN , IR , IFQN , IR , M , DELTHT
COMMON RSURX , RSURY , THET , XH , XNH , YH
COMMON YNH
EQUIVALENCE (DX)C,DX2C), (DY)C,DY2C), (A,H,IP), (A(8001),BDYC),
1 (A(8181),AKRDY), (RIOT,YOUNG), (SORCE,OGEN), (COND,CONDH)
ISYPOL(1) = 0
ISYPOL(2) = NOSYM
LP = 0
IF (INSYM = 2) 1, 2, 3
1 DO 4 I = 1, MMAX
XSYPOL(I) = XPOLF(I)
YSYPOL(I) = YPOLE(I)
BETA(I) = 0.0
4 ISYPOL(I+1) = I
DELTHT = 0.0
GO TO 5
2 DELTHT = 6.2831853/FLOAT(NOSYM)
DO 6 I = 1, MMAX
RSURX = XPOLF(I)
RSURY = YPOLE(I)

```



```

      RHO = SQRT(RSURX*RSURX + RSURY*RSURY)
      IF (RHO) 7, 7, 8
7     LP = LP + 1
      XSYPOL(LP) = 0.0
      YSYPOL(LP) = 0.0
      BETA(I) = 0.0
      GO TO 9
8     CALL ANGLE
      BETA(I) = THET
10    LP = LP + 1
      XSYPOL(LP) = RHO*Cos(THET)
      YSYPOL(LP) = RHO*Sin(THET)
      THET = THET + DELTHT
      IF (LP = ISYPOL(I+1)) 10, 6, 6
9     ISYPOL(I+1) = LP
6     ISYPOL(I+2) = LP + NOSYM
      GO TO 5
3     DO 11 I = 1, MMAX
      DELTHT = 0.0
      IP = LP + 1
      XSYPOL(IP) = XPOLE(I)
      YSYPOL(IP) = YPOLE(I)
12    DELTHT = DELTHT + PCYCCL
      LP = LP + 1
      YSYPOL(IP) = YPOLE(I) + DELTHT
      XSYPOL(IP) = XPOLE(I)
      LP = LP + 1
      YSYPOL(IP) = YPOLE(I) - DELTHT
      XSYPOL(IP) = XPOLE(I)
      IF (LP = ISYPOL(I+1)) 12, 11, 11
11    ISYPOL(I+2) = LP + NOSYM
      DELTHT = 0.0
5     RETURN
      END

```

```

A2K 420
A4K 430
A6K 440
A8K 450
A10K 460
A12K 470
A14K 480
A16K 490
A18K 500
A20K 510
A22K 520
A24K 530
A26K 540
A28K 550
A30K 560
A32K 570
A34K 580
A36K 590
A38K 600
A40K 610
A42K 620
A44K 630
A46K 640
A48K 650
A50K 660
A52K 670
A54K 680
A56K 690
A58K 700
A60K 710
A62K 720
A64K 730
A66K 740
A68K 750

```

A-16

```

      K = LOC(L) + J
      F(3) = A(K)
53  F(1) = F(1) - F(2)*D(L)*F(3)
      F(1) = F(1)/D(I)
51  A(KK) = F(1)
C
C THE MATRIX IS NOW TRIANGULARIZED
C
C
C
      K = LOC(N) + N1
      X(N) = A(K)
C
      DO 60 IL = 2,N
      I = N1 - LI
      LS = I + 1
      KK = LOC(I) + N1
      F(1) = A(KK)
C
      DO 61 L = LS,N
      K = LOC(I) + L
      F(2) = A(K)
      K = LOC(L) + N1
      F(3) = A(K)
61  F(1) = F(1) - F(2)*F(3)
C
      A(KK) = F(1)
60  X(I) = F(1)
C
      RETURN
      END

```

BACK SUBSTITUTION

```

AOL 420
AOL 430
AOL 440
AOL 450
AOL 460
AOL 470
AOL 480
AOL 490
AOL 500
AOL 510
AOL 520
AOL 530
AOL 540
AOL 550
AOL 560
AOL 570
AOL 580
AOL 590
AOL 600
AOL 610
AOL 620
AOL 630
AOL 640
AOL 650
AOL 660
AOL 670
AOL 680
AOL 690
AOL 700
AOL 710
AOL 720

```

```

SUBROUTINE TEQSEL
SUBROUTINE TO SELECT TEMPERATURE FUNCTIONS
  DIMENSION PHI(140), TVALUE(140), COND(40), CONDH(40), TITLE(110),
  18), ISYPOL(42), HETA(40), ICUR(40), IP0SLA(40), ITYPOL(40), KEY(10), NORDER(20),
  2FER(40), TCOOL(40), XPOLE(40), YPOLE(40), MAT(140), NAT(140), KAT(140), CURCON
  3RCUN(160), XSYPOL(240), YSYPOL(240), XHA(300), YNRA(300), YRA(300), YVHATE(20),
  4(300), IRA(500), IFQNO(500), RTSIDE(500), MGT(40), NGT(40), KGT(40), GVALT(20),
  5OUT(40), MAS(140), NAS(140), KAS(140), MG(120), NG(120), KG(120), GVALUE(10),
  6120), DX1C(141), DX2C(141), DY1C(141), DY2C(141), OUT(141), DRHC(141), DXTH(20),
  7YC(141), R(50), SOCN(50), FNISN(50), A(10010), R(1000,8), RDYC(60,3),
  HKRDY(60), IP(1000,R)
  COMMON DX1C , DY1C , A , RIOT , OGEN , CONDH
  COMMON PHI , TVALUE , IET , ICT , IGT , ICI
  COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON
  COMMON PDYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA
  COMMON HCK , TITLE , ISYPOI , HETA , ICUR , IP0SLA
  COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLE , YPOLE
  COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOI
  COMMON XHA , YNRA , YRA , YNRA , IRA , IFQNO
  COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES
  COMMON MAS , NAS , KAS , MG , NG , KG
  COMMON GVALUE , OUT , DRHC , DXYC , R , SOCN
  COMMON FNISN , IR , IFQN , IR , M , DELTHT
  COMMON RSURX , RSURY , THFT , XH , XNR , YR
  COMMON YNR
  EQUIVALENCE (DX1C,DX2C), (DY1C,DY2C), (A,R,IP), (A(R001),RDYC),
  1 (A(R1R1),KRDY), (RIOT,YOUNG), (SORCE,OGEN), (COND,CONDH)
  II = 1
101 DO 1 I = 1, MMAX
102 IF (ITYPOL(I) = 2) 2, 1, 2
  2 MAT(II) = I
  NAT(II) = 0
  KAT(II) = 1
  II = II + 1
  1 CONTINUE
103 DO 3 I = 1, MMAX
104 IF (ITYPOL(I) = 2) 40, 3, 40
  40 IF (ITYPOL(I) = 1) 4, 5, 40
  5 IF (NOSYM = 1) 4, 4, 3
  4 MAT(II) = I
  NAT(II) = 1

```

```

TEQ 10
TEQ 20
TEQ 30
TEQ 40
TEQ 50
TEQ 60
TEQ 70
TEQ 80
TEQ 90
TEQ 100
TEQ 110
TEQ 120
TEQ 130
TEQ 140
TEQ 150
TEQ 160
TEQ 170
TEQ 180
TEQ 190
TEQ 200
TEQ 210
TEQ 220
TEQ 230
TEQ 240
TEQ 250
TEQ 260
TEQ 270
TEQ 280
TEQ 290
TEQ 300
TEQ 310
TEQ 320
TEQ 330
TEQ 340
TEQ 350
TEQ 360
TEQ 370
TEQ 380
TEQ 390
TEQ 400
TEQ 410

```

```

      KAT(II) = 3
      II = II + 1
3     CONTINUE
105    DO 6 I = 1, MMAX
106    ITYPE = ITYPOL(I)
      GO TO (7, 6, 6, 8, 6, 8), ITYPE
      7 IF (NOSYM) 6, 8, 6
      8 MAT(II) = 1
      NAT(II) = 1
      KAT(II) = 7
      II = II + 1
      6 CONTINUE
      IGI = II - 1
      MAT(II) = 1
      NAT(II) = 0
      KAT(II) = 6
      II = II + 1
107    IF (NOSYM - 1) 9, 10, 11
      9 MAT(II) = 1
      NAT(II) = 0
      KAT(II) = 8
      II = II + 1
      10 MAT(II) = 1
      NAT(II) = 0
      KAT(II) = 7
      II = II + 1
      11 DO 28 I = 1, MMAX
      N = NORDER(I)
      IF (N) 28, 28, 108
108    ITYPE = ITYPOL(I)
      GO TO (13, 13, 12, 12, 12, 12), ITYPE
      13 IF (NOSYM - 1) 15, 15, 14
      14 NN = NORDER(I)/NOSYM
      IF (NN) 20, 20, 109
109    DO 17 J = 1, NN
      K = J*NOSYM
      MAT(II) = I
      NAT(II) = K
      KAT(II) = 1
      II = II + 1
110    IF (ITYPOL(I) - 1) 17, 14, 17
      16 MAT(II) = 1

```

```

TEQ 420
TEQ 430
TEQ 440
TEQ 450
TEQ 460
TEQ 470
TEQ 480
TEQ 490
TEQ 500
TEQ 510
TEQ 520
TEQ 530
TEQ 540
TEQ 550
TEQ 560
TEQ 570
TEQ 580
TEQ 590
TEQ 600
TEQ 610
TEQ 620
TEQ 630
TEQ 640
TEQ 650
TEQ 660
TEQ 670
TEQ 680
TEQ 690
TEQ 700
TEQ 710
TEQ 720
TEQ 730
TEQ 740
TEQ 750
TEQ 760
TEQ 770
TEQ 780
TEQ 790
TEQ 800
TEQ 810
TEQ 820
TEQ 830

```

```

      NAT(II) = K
      KAT(II) = 3
      II = II + 1
17  CONTINUE
      GO TO 20
15  DO 18 I = 2, N
      MAT(II) = I
      NAT(II) = J
      KAT(II) = 1
18  II = II + 1
111 IF (ITYPO(I) = 2) 12, 20, 12
12  DO 19 I = 2, N
      MAT(II) = I
      NAT(II) = J
      KAT(II) = 3
19  II = II + 1
20  ITYPO = ITPOL(I)
      GO TO (21, 21, 24, 24, 28, 26), ITYPO
21  IF (NOSYM) 24, 22, 28
22  DO 23 I = 2, N
      MAT(II) = I
      NAT(II) = J
      KAT(II) = 5
23  II = II + 1
24  ITYPO = ITPOL(I)
      GO TO (25, 28, 28, 26, 28, 26), ITYPO
25  IF (NOSYM) 24, 26, 28
26  DO 27 I = 2, N
      MAT(II) = I
      NAT(II) = J
      KAT(II) = 7
27  II = II + 1
      IF (ITYPO = 6) 28, 31, 28
31  MAT(II) = I
      NAT(II) = 0
      KAT(II) = 6
      II = II + 1
28  CONTINUE
      ICT = II - 1
112 IF (ICT = 140) 29, 29, 30
30  WRITE (6, 201) ICT
201  FORMAT(19H TOO MANY TERMS (.13.59H) IN TEMPERATURE SERIES. THE

```

```

      TEO 840
      TEO 850
      TEO 860
      TEO 870
      TEO 880
      TEO 890
      TEO 900
      TEO 910
      TEO 920
      TEO 930
      TEO 940
      TEO 950
      TEO 960
      TEO 970
      TEO 980
      TEO 990
      TEO 1000
      TEO 1010
      TEO 1020
      TEO 1030
      TEO 1040
      TEO 1050
      TEO 1060
      TEO 1070
      TEO 1080
      TEO 1090
      TEO 1100
      TEO 1110
      TEO 1120
      TEO 1130
      TEO 1140
      TEO 1150
      TEO 1160
      TEO 1170
      TEO 1180
      TEO 1190
      TEO 1200
      TEO 1210
      TEO 1220
      TEO 1230
      TEO 1240
      TEO 1250

```

1 MAXIMUM ALLOWED IS 140 TERMS.)
CALL EXIT
29 RETURN
END

TFD 1260
TFD 1270
TFD 1280
TFD 1290

```

SUBROUTINE SEQSEL                                AAM 10
C SUBROUTINE TO SELECT STRESS FUNCTIONS          AAM 20
  DIMENSION PHI(140),TVALUE(140),COND(40),CONDH(40),TITLE(1AAM 30
  1R),ISYPOL(42),HETA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KE (10),NORDAAM 40
  2FER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CUAAM 50
  3RCUN(160),XSYPOL(240),YSYPOL(240),XHA(300),YNRA(300),YBA(300),YNHAAAM 60
  4(300),IRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALAAM 70
  5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( AAM 80
  6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXAAM 90
  7YC(141),R(50),SOCN(50),FNISN(50),A(10010),R(1000,8),RDYC(60,3), AAM 100
  HKRDY(60),IP(1000,8)                          AAM 110
  COMMON DX1C , DY1C , A , RIOT , QGEN , CONDH AAM 120
  COMMON PHI , TVALUE , IFT , ICT , IGT , ICJ AAM 130
  COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON AAM 140
  COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA AAM 150
  COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IP0S1A AAM 160
  COMMON ITYPOL , KEY , NORDEF , TCOOL , XPOLF , YPOL'E AAM 170
  COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYDOL AAM 180
  COMMON XHA , XNRA , YBA , YNHA , IRA , IEQNO AAM 190
  COMMON RTSIDE , MGT , NGT , KGT , GVALUIT , IFS AAM 200
  COMMON MAS , NAS , KAS , MG , NG , KG AAM 210
  COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN AAM 220
  COMMON FNISN , IR , IEQN , IR , M , DELTHT AAM 230
  COMMON RSHRX , RSHRY , THET , XH , XNR , YB AAM 240
  COMMON YNR AAM 250
  EQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,R,IP),(A(8001),RDYC), AAM 260
  1 (A(8181),KRDY),(RIOT,YOUNG),(SORCE,QGEN),(COND,CONDH) AAM 270
  II = 1 AAM 280
  DO 28 I = 1,MMAX AAM 290
  ITYP0 = ITYPOL(I) AAM 300
  GO TO (1,2,1,1,1,1),ITYPO AAM 310
1 MAS(II) = 1 AAM 320
  NAS(II) = 0 AAM 330
  KAS(II) = 1 AAM 340
  II = II + 1 AAM 350
2 GO TO (3,3,4,4,4,4),ITYPO AAM 360
3 MAS(II) = 1 AAM 370
  NAS(II) = 0 AAM 380
  KAS(II) = 2 AAM 390
  II = II + 1 AAM 400
4 IF (ITYPO = 6) 6,5,6 AAM 410

```



```

5  MAS(II) = I
   NAS(II) = 0
   KAS(II) = 5
   II = II + 1
6  GO TO ( 7, 7, 9, 9, 9, 9), ITYPE
7  IF (NOSYM = 1) 8, 8, 10
8  MAS(II) = I
   NAS(II) = 1
   KAS(II) = 2
   II = II + 1
   IF (ITYPE = 1) 10, 9, 10
9  MAS(II) = I
   NAS(II) = 1
   KAS(II) = 3
   II = II + 1
10 GO TO (11, 11, 14, 13, 14, 13), ITYPE
11 IF (NOSYM) 14, 12, 14
12 MAS(II) = I
   NAS(II) = 1
   KAS(II) = 6
   II = II + 1
   IF (ITYPE = 1) 14, 13, 14
13 MAS(II) = I
   NAS(II) = 1
   KAS(II) = 7
   II = II + 1
14 GO TO (15, 15, 16, 16, 16, 16), ITYPE
15 IF (NOSYM = 1) 16, 16, 17
16 KK = 1
   LL = 2
   GO TO 18
17 KK = NOSYM
   LL = 1
18 NN = NORDER(1)/KK
   IF (NN) 31, 31, 30
30 DO 20 J = LL, NN
   K = J*KK
   IF (ITYPE = 2) 21, 21, 22
21 MAS(II) = I
   NAS(II) = K
   KAS(II) = 1
   II = II + 1

```

```

A 1 1 420
A 0 1 430
A 4 1 440
A 0 1 450
A 0 1 460
A 1 1 470
A 1 1 480
A 1 1 490
A 1 1 500
A 1 1 510
A 1 1 520
A 1 1 530
A 1 1 540
A 1 1 550
A 1 1 560
A 1 1 570
A 1 1 580
A 1 1 590
A 1 1 600
A 1 1 610
A 1 1 620
A 1 1 630
A 1 1 640
A 1 1 650
A 1 1 660
A 1 1 670
A 1 1 680
A 1 1 690
A 1 1 700
A 1 1 710
A 1 1 720
A 1 1 730
A 1 1 740
A 1 1 750
A 1 1 760
A 1 1 770
A 1 1 780
A 1 1 790
A 1 1 800
A 1 1 810
A 1 1 820
A 1 1 830

```

```

      MAS(II) = I
      NAS(II) = K
      KAS(II) = 2
      II = II + 1
22  IF (ITYPO = 2) 19,20,19
19  MAS(II) = I
      NAS(II) = K
      KAS(II) = 3
      II = II + 1
      MAS(II) = I
      NAS(II) = K
      KAS(II) = 4
      II = II + 1
20  CONTINUE
31  IF (ITYPO = 2) 23,23,24
23  IF (NUSYM) 24,24,24
24  NN = NORDER(I)
      IF (NN = 2) 24,32,32
32  DO 35  J = 2,NN
      GO TO (25,25,24,26,28,26),ITYPO
25  MAS(II) = I
      NAS(II) = J
      KAS(II) = 5
      II = II + 1
      MAS(II) = I
      NAS(II) = J
      KAS(II) = 6
      II = II + 1
26  IF (ITYPO = 2) 27,35,27
27  MAS(II) = I
      NAS(II) = J
      KAS(II) = 7
      II = II + 1
      MAS(II) = I
      NAS(II) = J
      KAS(II) = 8
      II = II + 1
35  CONTINUE
28  CONTINUE
29  ICS = II - 1
      IF (ICS = 140) 2063,2063,2064
2064 WRITE (6,8032) ICS

```

```

AAM 840
AAM 850
AAM 860
AAM 870
AAM 880
AAM 890
AAM 900
AAM 910
AAM 920
AAM 930
AAM 940
AAM 950
AAM 960
AAM 970
AAM 980
AAM 990
AAM 1000
AAM 1010
AAM 1020
AAM 1030
AAM 1040
AAM 1050
AAM 1060
AAM 1070
AAM 1080
AAM 1090
AAM 1100
AAM 1110
AAM 1120
AAM 1130
AAM 1140
AAM 1150
AAM 1160
AAM 1170
AAM 1180
AAM 1190
AAM 1200
AAM 1210
AAM 1220
AAM 1230
AAM 1240
AAM 1250

```

8032	FORMAT(24H) TOO MANY STRESS TERMS(,13,31H). THE MAXIMUM ALLOWED	1260
	IS 160.)	1270
	CALL EXIT	1280
2063	RETURN	1290
	END	1300

	SUBROUTINE BONDY	AAA	10
C	BOUNDARY POINT PARAMETERS FOR CIRCULAR HOLES ONLY	AAA	20
	DIMENSION PHI(140), TVALUE(140), COND(40), CONDH(40), TITLE(140),	AAA	30
	ISYPOL(40), RFTA(40), ICUR(40), IP0S1A(40), ITYPOL(40), KEY(10), NORDER(40),	AAA	40
	TCOOL(40), XPOLE(40), YPOLE(40), MAT(140), NAT(140), KAT(140), CURCON(160),	AAA	50
	XSYPOL(240), YSYPOL(240), XRA(300), XNRA(300), YRA(300), YNRA(300),	AAA	60
	IEQNO(500), RTSIDF(500), MGT(40), NGT(40), KGT(40), GVALUE(40),	AAA	70
	OUT(40), DPNC(141), DX1C(141), DX2C(141), DY1C(141), DY2C(141),	AAA	80
	IR(50), SOCN(50), ENISN(50), A(10010), R(1000,R), HDYC(60,2),	AAA	90
	RKRDY(60), IP(1000,R)	AAA	100
	COMMON DX1C , DY1C , A , RIOT , QGEN , CONDH	AAA	120
	COMMON PHI , TVALUE , IFT , ICT , IGT , ICT	AAA	130
	COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON	AAA	140
	COMMON PDICYCL , MMAX , NOCCON , NOCJR , NOSYM , ALPHA	AAA	150
	COMMON HCK , TITLE , ISYPOL , RFTA , ICUR , IP0S1A	AAA	160
	COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLE , YPOLE	AAA	170
	COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL	AAA	180
	COMMON XRA , XNRA , YRA , YNRA , IEQNO	AAA	190
	COMMON RTSIDF , MGT , NGT , KGT , GVALUE , IFS	AAA	200
	COMMON MAS , NAS , KAS , MG , NG , KG	AAA	210
	COMMON GVALUE , OUT , DPNC , DXYC , R , SOCN	AAA	220
	COMMON ENISN , IR , IEQNO , IR , M , DELTHT	AAA	230
	COMMON RSURX , RSURY , THET , XH , XNR , YR	AAA	240
	COMMON YNR	AAA	250
	EQUIVALENCE (DX1C,DX2C), (DY1C,DY2C), (A,H,IP), (A(R001),HDYC),	AAA	260
	1 (A(R)R), RKRDY), (RIOT,YOUNG), (SOURCE,QGEN), (COND,CONDH)	AAA	270
	J=1	AAA	280
	K=0	AAA	290
	DO 1 I = 1, IFT	AAA	300
	2 IF (I-ICUR(J)) 4,4,3	AAA	310
	3 J=J+1	AAA	320
	K=4*(J-1)	AAA	330
	GO TO 2	AAA	340
	4 IF (CURCON(K+3)) 5,5,6	AAA	350
	5 IF (CURCON(K+2)) 6,7,8	AAA	360
	7 YRA(I)=XRA(I)	AAA	370
	XRA(I) = CURCON(K+1)	AAA	380
	XNRA(I)=CURCON(K+4)	AAA	390
	YNRA(I)=0.0	AAA	400
	GO TO 1	AAA	410

```

8  YRA(I) = CURCON(K+1)*XRA(I) + CURCON(K+2)
   DEN=SQRT(1.0+CURCON(K+1)**2)
   XNBA(I)=-CURCON(K+4)*CURCON(K+1)/DEN
   YNBA(I)= CURCON(K+4)/DEN
   GO TO 1
6  TEMP1=XRA(I)*.174532925E-01
   TEMP2=COS(TEMP1)
   TEMP3=SIN(TEMP1)
   YRA(I)=CURCON(K+2)+CURCON(K+3)*TEMP3
   XRA(I)=CURCON(K+1)+CURCON(K+3)*TEMP2
   XNBA(I)=-TEMP2*CURCON(K+4)
   YNBA(I)=-TEMP3*CURCON(K+4)
1  CONTINUE
   RETURN
   END

```

```

AAN 420
AAN 430
AAN 440
AAN 450
AAN 460
AAN 470
AAN 480
AAN 490
AAN 500
AAN 510
AAN 520
AAN 530
AAN 540
AAN 550
AAN 560

```

```

SUBROUTINE DPHIO
C REVISED PROGRAM FOR DPHIO
  DIMENSION PHT(140),TVALUE(140),COND(40),CONDH(40),TITLE(100),
  1R(1),ISYPOL(12),RFTA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NORJDPH
  2FER(40),TCOOL(40),XPOLF(40),YPOLE(40),MAT(140),NAT(140),KAT(140),CURCON
  3RCUN(160),XSYPOL(240),YSYPOL(240),XHA(300),XNHA(300),YHA(300),YNHADPH
  4(300),IRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALDPH
  5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE(100),
  6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXDPH
  7YC(141),R(50),SOCN(50),ENTSN(50),A(10010),R(1000,R),RDYC(60,2),
  8KRDY(60),IP(1000,R)
  COMMON DX1C , DY1C , A , RIOT , QGEN , CONDH
  COMMON PHT , TVALUE , IET , ICT , IGT , ICI
  COMMON IG , ICS , SHEAR , THERMX , INSYM , POSSON
  COMMON PDCYCL , MMAX , NOFCOM , NOCUR , NOSYM , ALPHA
  COMMON HCK , TITLE , ISYPOL , RFTA , ICUR , IP0S1A
  COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOLE
  COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL
  COMMON XHA , XNHA , YHA , YNHA , IRA , IEQNO
  COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES
  COMMON MAS , NAS , KAS , MG , NG , KG
  COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN
  COMMON ENTSN , IR , IEQN , IR , M , DELTHT
  COMMON RSURX , RSURY , THET , XH , XNR , YR
  COMMON YNR
  EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC),
  1 (A(R1R1),KRDY),(RIOT,YOUNG),(SORCE,QGEN),(COND,CONDH)
  GVSUM = 0.0
  ICI = ICT + 1
  DO 100 I = 1,ICI
100 DPOC(I) = 0.0
  DO 65 M = 1,MMAX
  NORJ = NORDER(M)
  IP0SY1 = IP0S1A(M)
  IDX1 = ISYPOL(M) + 1
  IDX2 = ISYPOL(M+1)
  DO 65 I = IDX1,IDX2
  CHCK = HCK
  RSURX = (XH - XSYPOL(I))/CHCK
  RSURY = (YH - YSYPOL(I))/CHCK

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```

TPSY = TPSY1
REFLEX = 1.0
ADELTH = DELTHT*(F1/NAT(1-IDX1)) + BETA(M)
1  RSURX2 = RSURX*RSURX
  RSURY2 = RSURY*RSURY
  IX = 0
  RH02 = -SURX2 + SURY2
  IG0 = 0
  IF (RH02) 7.8.7
8  CALL RHTPR
7  CALL ANGLE
  THAT = THET*REFLEX - ADELTH
  SOCN(1) = COS(THAT)
  ENISN(1) = SIN(THAT)
  DO 60 I = 1,NORD
    SOCN(J+1) = SOCN(J)*SOCN(1) - ENISN(J)*ENISN(1)
60  ENISN(J+1) = ENISN(J)*SOCN(1) + SOCN(J)*ENISN(1)
  RH0 = SQRT(RH02)
  R(1) = RH0
  DO 61 I = 1,NORD
61  R(J+1) = R(J)*RH0
62  IX = IX + 1
    IF (MAT(IX) = M) 9.63.9
63  N = NAT(IX)
    K = KAT(IX)
64  IF (1-N) 4.3.2
    2 GO TO (11,12,13,14,15,16,17,18).K
11  DPUC(IX)=DPUC(IX)+ALOG(RH02)*.5
    GO TO 9
12  DPUC(IX)=DPUC(IX)+RH02
    GO TO 9
13  DPUC(IX)=DPUC(IX)+0.5*RH02*ALOG(RH02)
    GO TO 9
14  CALL ANGLE
    THAT=THET*REFLEX-ADELTH
143 DPUC(IX)=DPUC(IX)+RH02*THAT
    GO TO 9
15  CALL ANGLE
    THAT=THET*REFLEX-ADELTH
153 DPUC(IX)=DPUC(IX)+THAT
    GO TO 9
16  DPUC(IX)=DPUC(IX)+1.0

```

```

JPL 420
JPL 430
JPL 440
JPL 450
JPL 460
JPL 470
JPL 480
JPL 490
JPL 500
JPL 510
JPL 520
JPL 530
JPL 540
JPL 550
JPL 560
JPL 570
JPL 580
JPL 590
JPL 600
JPL 610
JPL 620
JPL 630
JPL 640
JPL 650
JPL 660
JPL 670
JPL 680
JPL 690
JPL 700
JPL 710
JPL 720
JPL 730
JPL 740
JPL 750
JPL 760
JPL 770
JPL 780
JPL 790
JPL 800
JPL 810
JPL 820
JPL 830

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GO TO 9	DPH 840
17 DPOC(IX)=DPOC(IX)+RSURX	DPH 850
GO TO 9	DPH 860
18 DPOC(IX)=DPOC(IX)+RSURY	DPH 870
GO TO 9	DPH 880
3 SOCC=COS(ANDELTH)	DPH 890
ENISC=SIN(ANDELTH)	DPH 900
REFDX=RSURX*SOCC+RSURY*ENISC *RFFLEX	DPH 910
RENY=RSURY*SOCC*RFFLEX-RSURX*ENISC	DPH 920
GO TO (31,32,33,34,35,36,37,38).K	DPH 930
31 CALL ANGLE	DPH 940
THAT=THET*RFFLEX-ANDELTH	DPH 950
313 DPOC(IX)=DPOC(IX)+THAT*RENY	DPH 960
GO TO 9	DPH 970
32 DPOC(IX)=DPOC(IX)+RH02*REDX	DPH 980
GO TO 9	DPH 990
33 DPOC(IX)=DPOC(IX)+REFDX /RH02	DPH 1000
GO TO 9	DPH 1010
34 DPOC(IX)=DPOC(IX)+REFDX*0.5*ALOG(RH02)	DPH 1020
GO TO 9	DPH 1030
35 CALL ANGLE	DPH 1040
THAT=THET*RFFLEX-ANDELTH	DPH 1050
353 DPOC(IX)=DPOC(IX)+THAT*REDX	DPH 1060
GO TO 9	DPH 1070
36 DPOC(IX)=DPOC(IX)+RH02*RENY	DPH 1080
GO TO 9	DPH 1090
37 DPOC(IX)=DPOC(IX)+ RENY/RH02	DPH 1100
GO TO 9	DPH 1110
38 DPOC(IX)=DPOC(IX)+(RENY*0.5*ALOG(RH02))	DPH 1120
GO TO 9	DPH 1130
4 FN = N	DPH 1140
IF (K=4) 42,42,43	DPH 1150
42 SOCN1= SOCN(N)	DPH 1160
GO TO 44	DPH 1170
43 SOCN1= FNISN(N)	DPH 1180
44 GO TO (51,52,53,54,51,52,53,54).K	DPH 1190
51 DPOC(IX) = DPOC(IX) + R(N)*SOCN1	DPH 1200
GO TO 9	DPH 1210
52 DPOC(IX) = DPOC(IX) + R(N)*R(2)*SOCN1	DPH 1220
GO TO 9	DPH 1230
53 DPOC(IX) = DPOC(IX) +SOCN1/R(N)	DPH 1240
GO TO 9	DPH 1250


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54 DPOC(IX) = DPOC(IX) + SOCNI*RHO2/R(N)
  9 IF (ICT - IX) 6, 6, 62
  6 IF (IG) 10, 10, 68
68 IF (IGG) 66, 66, 76
66 CHCK = 1.0
   RSUX = RSUX*HCK
   RSUY = RSUY*HCK
   RSUX2 = RSUX*RSUX
   RSUY2 = RSUY*RSUY
   RHU = RHO*HCK
   RHO2 = RHU*RHO
   R(1) = RHO
   DO 67 J = 1, NORD
67 R(J+1) = R(J)*RHO
   GO TO 72
76 GVSUM = DPOC(IC1)*GVALUT(IGG) + GVSUM
72 IGG = IGG + 1
   IX = IC1
   IF (IGG - IG) 73, 73, 10
73 DO 75 J = IGG, IG
   IF (MGT(J) - M) 75, 74, 75
74 IGG = J
   N = NGT(IGG)
   K = KGT(IGG)
   DPOC(IC1) = 0.0
   GO TO 64
75 CONTINUE
10 IF (IPSY) 91, 65, 91
91 CHCK = HCK
   RSUY = (YK + YSYDOL(I))/CHCK
   RSUX = (XK - XSYDOL(I))/CHCK
   RFFLEX = -1.0
   IPSY = 1
   GO TO 1
65 CONTINUE
77 DPOC(IC1) = GVSUM
   RETURN
END

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004 1260
004 1270
004 1280
004 1290
004 1300
004 1310
004 1320
004 1330
004 1340
004 1350
004 1360
004 1370
004 1380
004 1390
004 1400
004 1410
004 1420
004 1430
004 1440
004 1450
004 1460
004 1470
004 1480
004 1490
004 1500
004 1510
004 1520
004 1530
004 1540
004 1550
004 1560
004 1570
004 1580
004 1590
004 1600
004 1610
004 1620
004 1630

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SUBROUTINE DPHI
C REVIS'D PROGRAM FOR FIRST DERIVATIVE
DIMENSION PHI(140),TVALUE(140),COND(40),CONDH(40),TITLE(140),
1R(18),ISYPOL(42),BETA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NORDER(40),
2FCUR(40),TCUOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(110),CURCON
3RCUN(160),XSYPOL(240),YSYPOL(240),XBA(300),YNBA(300),YBA(300),YVBA(400),
4(300),IHA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALUE(40),
5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE(40),
6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPROC(111),DXYC(
7YC(141),R(50),SOCN(50),ENISN(50),A(10010),B(1000,8),RDYC(50,3),
8KBDY(60),IP(1000,8)
COMMON DX1C , DY1C , A , RIOT , QGEN , CONDH
COMMON PHI , TVALUE , ICT , ICT , IGT , ICI
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON
COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA
COMMON HCK , TITLE , ISYPOL , BETA , ICUR , IP0S1A
COMMON ITYPOL , KEY , NORDER , TCUOL , XPOLF , YPOLF
COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL
COMMON XBA , XNBA , YBA , YNBA , IHA , IEQNO
COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IFS
COMMON MAS , NAS , KAS , MG , NG , KG
COMMON GVALUE , OUT , DPROC , DXYC , R , SOCN
COMMON ENISN , IR , IEQN , IR , M , DELTHT
COMMON RSURX , RSURY , THET , XH , XNR , YR
COMMON YNR
EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,B,IP),(A(8001),RDYC),
1 (4(8181),KBDY),(RIOT,YOUNG),(SORCE,QGEN),(COND,CONDH)
C
GVSUMX = 0.0
GVSUMY = 0.0
ICI = ICT + 1
DO 100 I = 1,ICI
DX1C(I) = 0.0
100 DY1C(I) = 0.0
DO 65 I = 1,MMAX
NORD = NORDER(M)
IPSY1 = IP0S1A(M)
IDX1 = ISYPOL(M) + 1
IDX2 = ISYPOL(M+1)
DO 65 I = IDX1,IDX2
CHK = HCK

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RSJRX = (XK - XSYPOI(1))/CHCK
RSJRY = (YK - YSYPOI(1))/CHCK
IPSY = IPUSY]
REFLEX = 1.0
ADELTH = DELTHT*(FLOAT(1-IPX1)) + BETA(M)
SOCC = COS(ADELTH)
1  RSURX2 = RSURX*RSURX
   RSURY2 = RSURY*RSURY
   ENISC = SIN(ADELTH)*REFLEX
   IX = 0
   RHO2 = RSURX2 + RSURY2
   IGG = 0
   IF (RHO2) 7,8,7
8  CALL RHOFR
7  CALL ANGLE
   THAT = THET*REFLEX - ADELTH
   SOCN(1) = COS(THAT)
   ENISN(1) = SIN(THAT)
   DO 60 J = 1,NORD
   SOCN(J+1) = SOCN(J)*SOCN(1) - ENISN(J)*ENISN(1)
60  ENISN(J+1) = ENISN(J)*SOCN(1) + SOCN(J)*ENISN(1)
   RHO = SORT(RHO2)
   R(1) = RHO
   DO 61 J = 1,NORD
61  R(J+1) = R(J)*RHO
62  IX = IX + 1
   IF (MAT(IX) - M) 9,53,9
63  N = NAT(IX)
   K = KAT(IX)
64  IF (1-N) 4,3,2
   2 GO TO (11,12,13,14,15,9,17,18),K
11  DXIC(IX)=DXIC(IX)+RSURX/RHO2
   DYIC(IX)=DYIC(IX)+RSURY/RHO2
   GO TO 9
12  DXIC(IX)=DXIC(IX)+2.0*RSURX
   DYIC(IX)=DYIC(IX)+2.0*RSURY
   GO TO 9
13  DXIC(IX)=DXIC(IX)+RSURX*(1LOG(RHO2)+1.0)
   DYIC(IX)=DYIC(IX)+RSURY*(1.0+ALOG(RHO2))
   GO TO 9
14  CALL ANGLE
   THAT=THET*REFLEX-ADELTH

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```

A 1  420
A 2  430
A 3  440
A 4  450
A 5  460
A 6  470
A 7  480
A 8  490
A 9  500
A 10 510
A 11 520
A 12 530
A 13 540
A 14 550
A 15 560
A 16 570
A 17 580
A 18 590
A 19 600
A 20 610
A 21 620
A 22 630
A 23 640
A 24 650
A 25 660
A 26 670
A 27 680
A 28 690
A 29 700
A 30 710
A 31 720
A 32 730
A 33 740
A 34 750
A 35 760
A 36 770
A 37 780
A 38 790
A 39 800
A 40 810
A 41 820
A 42 830

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143 DX1C(IX)=DX1C(IX)+ 2.0*RSUBX*THAT-RSUBY*REFLEX      A47  840
    DY1C(IX)=DY1C(IX)+ 2.0*RSUBY*THAT+REFLEX*RSUBX      A47  850
    GO TO 9                                                A47  860
15  DX1C(IX)=DX1C(IX)-(RSUBY/RH02)*REFLEX              A47  870
    DY1C(IX)=DY1C(IX)+RSUBX*REFLEX/RH02                A47  880
    GO TO 9                                                A47  890
17  DX1C(IX)=DX1C(IX)+1.0                                A47  900
    GO TO 9                                                A47  910
18  DY1C(IX)=DY1C(IX)+1.0                                A47  920
    GO TO 9                                                A47  930
3   GO TO (31,32,33,34,35,36,37,38).X                  A47  940
31  CALL ANGLE                                           A47  950
    THAT=THFT*REFLEX-ANFLTH                              A47  960
313 DX1C(IX)=DX1C(IX)-(RSUBY2/RH02)*SOCC+((RSUBX*RSUBY/RH02)-REFLEX*THA    A47  970
    1AT)*ENISC                                           A47  980
    DY1C(IX)=DY1C(IX)+(RSUBX*RSUBY/RH02+THAT*REFLEX)*SOCC-RSUBX2*ENISCA    A47  990
    1/RH02                                              A47 1000
    GO TO 9                                              A47 1010
32  DX1C(IX)=DX1C(IX)+(3.0*RSUBX2+RSUBY2)*SOCC+2.0*RSUBX*RSUBY*ENISC    A47 1020
    DY1C(IX)=DY1C(IX)+2.0*RSUBX*RSUBY*SOCC+(3.0*RSUBY2+RSUBX2)*ENISC    A47 1030
    GO TO 9                                              A47 1040
33  DX1C(IX)=DX1C(IX)+((RSUBY2-RSUBX2)*SOCC-2.0*RSUBX*RSUBY*ENISC)/RH0    A47 1050
    12**2                                              A47 1060
    DY1C(IX)=DY1C(IX)+(-2.0*RSUBX*RSUBY*SOCC+(RSUBX2-RSUBY2)*ENISC)/RH    A47 1070
    102**2                                              A47 1080
    GO TO 9                                              A47 1090
34  DX1C(IX)=DX1C(IX)+(RSUBX2/RH02+.5*ALOG(RH02))*SOCC+(RSUBX*RSUBY/RA    A47 1100
    1H02)*ENISC                                           A47 1110
    DY1C(IX)=DY1C(IX)+RSUBX*RSUBY*SOCC/RH02+(RSUBY2/RH02+.5*ALOG(RH02)    A47 1120
    1))*ENISC                                           A47 1130
    GO TO 9                                              A47 1140
35  CALL ANGLE                                           A47 1150
    THAT=THFT*REFLEX-ANFLTH                              A47 1160
353 DX1C(IX)=DX1C(IX)+((REFLEX*THAT-RSUBX*RSUBY/RH02)*SOCC-RSUBY2*ENIS    A47 1170
    1C/RH02)*REFLEX                                           A47 1180
    DY1C(IX)=DY1C(IX)+(RSUBX2*SOCC/RH02+(RSUBX*RSUBY/RH02+THAT*REFLEX)    A47 1190
    1*ENISC)*REFLEX                                           A47 1200
    GO TO 9                                              A47 1210
36  DX1C(IX)=DX1C(IX)+(2.0*RSUBX*RSUBY*SOCC-(3.0*RSUBX2+RSUBY2)*ENISC)    A47 1220
    1*REFLEX                                           A47 1230
    DY1C(IX)=DY1C(IX)+((3.0*RSUBY2+RSUBX2)*SOCC-2.0*RSUBX*RSUBY*ENISC)    A47 1240
    1*REFLEX                                           A47 1250

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```

      GO TO 9
37 DX1C(IX)=DX1C(IX)+(-2.0*RSURX*RSURX*SOCC+(RSURX2-RSURY2)*ENTSC)*REFLEX/RHO2**2
      DY1C(IX)=DY1C(IX)+((RSURX2-RSURY2)*SOCC+2.0*RSURX*RSURX*ENTSC)*REFLEX/RHO2**2
      GO TO 9
38 DX1C(IX)=DX1C(IX)+(2*RSURX*RSURX*SOCC/RHO2-(RSURX2/RHO2+0.5*ALOG(RHO2)))*ENTSC)*REFLEX
      DY1C(IX)=DY1C(IX)+((RSURY2/RHO2+0.5*ALOG(RHO2))*SOCC-RSURX*RSURX*ENTSC)*REFLEX
      GO TO 9
4 ENI = IN
      IF (K=4) 42,42,43
42 SOCN1 = SOCN(N)
      ENISN1 = ENISN(N)*REFLEX
      GO TO 41
43 SOCN1 = ENISN(N)
      ENISN1 = - SOCN(N)*REFLEX
44 GO TO (51,52,53,54,51,52,53,54).K
51 DX1C(IX)=DX1C(IX)+R(N)*FN*(RSURX*SOCN1+RSURX*ENISN1)/RHO2
      DY1C(IX)=DY1C(IX)+R(N)*FN*(RSURX*SOCN1-RSURY*ENISN1)/RHO2
      GO TO 9
52 DX1C(IX)=DX1C(IX)+R(N)*((EN+2.0)*RSURX*SOCN1+FN*RSURX*ENISN1)
      DY1C(IX)=DY1C(IX)+R(N)*((EN+2.0)*RSURX*SOCN1-FN*RSURX*ENISN1)
      GO TO 9
53 DX1C(IX)=DX1C(IX)+F*((-RSURX*SOCN1+RSURX*ENISN1)/(R(N)*RHO2)
      DY1C(IX)=DY1C(IX)-F*((RSURX*SOCN1+RSURX*ENISN1)/(R(N)*RHO2)
      GO TO 9
54 DX1C(IX)=DX1C(IX)+((2.0-EN)*RSURX*SOCN1+FN*RSURX*ENISN1)/R(N)
      DY1C(IX)=DY1C(IX)+((2.0-EN)*RSURX*SOCN1-FN*RSURX*ENISN1)/R(N)
9 IF (ICT = IX) 6, 6, 52
6 IF (IG) 10,10,59
59 IF (IGG) 66,66,76
66 CHECK = 1.0
      RSURX = RSURX*HCK
      RSURY = RSURY*HCK
      RSURX2 = RSURX*RSURX
      RSURY2 = RSURY*RSURY
      RHO = RHO*HCK
      RHO2 = RHO*RHO
      R(1) = RHO
      DO 67 I = 1,NORD

```

A40 1260
 A40 1270
 A40 1280
 A40 1290
 A40 1300
 A40 1310
 A40 1320
 A40 1330
 A40 1340
 A40 1350
 A40 1360
 A40 1370
 A40 1380
 A40 1390
 A40 1400
 A40 1410
 A40 1420
 A40 1430
 A40 1440
 A40 1450
 A40 1460
 A40 1470
 A40 1480
 A40 1490
 A40 1500
 A40 1510
 A40 1520
 A40 1530
 A40 1540
 A40 1550
 A40 1560
 A40 1570
 A40 1580
 A40 1590
 A40 1600
 A40 1610
 A40 1620
 A40 1630
 A40 1640
 A40 1650
 A40 1660
 A40 1670

67 R(J+1) = R(J)*RHQ	AAA 1680
GO TO 73	AAA 1690
76 GVSUMX = DXIC(IC1)*GVALUT(IGG) + GVSUMX	AAA 1700
GVSUMY = DYIC(IC1)*GVALUT(IGG) + GVSUMY	AAA 1710
72 IGG = IGG + 1	AAA 1720
IX = IC1	AAA 1730
IF (IGG - IG) 73,73,10	AAA 1740
73 DO 75 J = IGG,IG	AAA 1750
IF(MGT(J) - M) 75,74,75	AAA 1760
74 IGG = J	AAA 1770
N = NGT(IGG)	AAA 1780
K = KGT(IGG)	AAA 1790
DX C(IC1) = 0.0	AAA 1800
DYIC(IC1) = 0.0	AAA 1810
GO TO 64	AAA 1820
75 CONTINUE	AAA 1830
10 IF (IPSY) 91,65,91	AAA 1840
91 CHCK = HCK	AAA 1850
RSUBY = (Y3 + YSYPOI(T))/CHCK	AAA 1860
RSURX = (X3 - XSYPOI(T))/CHCK	AAA 1870
REFLEX = - 1.0	AAA 1880
IPSY = 1	AAA 1890
GO TO 1	AAA 1900
65 CONTINUE	AAA 1910
77 DXIC(IC1) = GVSUMX	AAA 1920
DYIC(IC1) = GVSUMY	AAA 1930
RETURN	AAA 1940
END	AAA 1950

```

      SUBROUTINE D2PHI                                     020 10
C  REVISED PROGRAM FOR D2PHI                             020 20
      DIMENSION PHI(140),TVALUE(140),COND(40),CONDH(40),TITLE(1000 020 30
      (4),ISYPOL(42),HETA(40),ICUR(40),IPOSIA(40),ITYPOL(40),KEY(10),NOR 020 40
      DER(40),ICODL(40),XPOLE(40),YPOLE(40),MAT(140),NAT(140),KAT(140),C 020 50
      IRCON(160),XSYPOL(240),YSYPOL(240),XHA(300),XNHA(300),YHA(300),Y 020 60
      NHA(300),IEQN(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALUE 020 70
      (40),AS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( 020 80
      6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(1 020 90
      7YC(141),R(50),SOCN(50),FNISN(50),A(10010),R(1000,8),RDYC(50,3), 020 100
      KRDY(50),IP(1000,8)                                020 110
      COMMON DX1C , DY1C , A , MGT , NGEN , CONDH 020 120
      COMMON PHI , TVALUE , IET , ICI , IGT , ICI 020 130
      COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON 020 140
      COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA 020 150
      COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IPOSIA 020 160
      COMMON ITPOL , KEY , NORBER , ICODL , XPOLE , YPOLE 020 170
      COMMON MAT , NAT , KAT , CIRCON , XSYPOL , YSYPOL 020 180
      COMMON XHA , XNHA , YHA , YNHA , TRA , IEQN 020 190
      COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES 020 200
      COMMON MAS , NAS , KAS , MG , NG , KG 020 210
      COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN 020 220
      COMMON FNISN , TR , IEQN , IR , M , DELTHT 020 230
      COMMON RSHX , RSHY , THET , XH , YNR , YB 020 240
      COMMON YNR 020 250
      EQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC), 020 260
      I (A(R181),KRDY),(R10T,YOUBJ),(SORCE,QGEN),(COND,CONDH) 020 270
C  020 280
      GVSUMX = 0.0 020 290
      GVSUMY = 0.0 020 300
      GVSUMZ = 0.0 020 310
      ICI = ICS + 1 020 320
      DO 100 I = 1,ICI 020 330
      DX2C(I) = 0.0 020 340
      DY2C(I) = 0.0 020 350
      100 DXYC(I) = 0.0 020 360
      DO 65 J = 1,MMAX 020 370
      NORJ = ORDER(M) 020 380
      IP SYI = IPOSIA(M) 020 390
      IDX1 = ISYPOL(M) + 1 020 400
      IDX2 = ISYPOL(M+1) 020 410

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DO 65 I = 1,IX1,IX2	020 420
CHCK = HCK	020 430
RSURX = (X1 - XSYPOI(I))/CHCK	020 440
RSURY = (Y1 - YSYPOI(I))/CHCK	020 450
TPSY = TP0SY1	020 460
REFLEX = 1.0	020 470
ADELTH = DELTHT*(FLOAT(1-IX1)) + BETA(M)	020 480
SOCN = COS(ADELTH)	020 490
1 RSURX2 = RSURX*RSURX	020 500
RSURY2 = RSURY*RSURY	020 510
FNISC = SIN(ADELTH)*REFLEX	020 520
IX = 0	020 530
RHO2 = RSURX2 + RSURY2	020 540
IGG = 0	020 550
IF (RHO2) 7,8,7	020 560
8 CALL WHERR	020 570
7 CALL ANGLE	020 580
THAT = THET*REFLEX - ADELTH	020 590
SOCN(1) = COS(THAT)	020 600
FNISN(1) = SIN(THAT)	020 610
DO 60 I = 1,NORD	020 620
SOCN(J+1) = SOCN(J)*SOCN(1) - FNISN(J)*FNISN(1)	020 630
60 FNISN(J+1) = FNISN(J)*SOCN(1) + SOCN(J)*FNISN(1)	020 640
RHO = SQRT(RHO2)	020 650
R(1) = RHO	020 660
DO 61 I = 1,NORD	020 670
61 R(J+1) = R(J)*RHO	020 680
62 IX = IX + 1	020 690
IF (MAS(IX) - M) 9,63,9	020 700
63 N = NAS(IX)	020 710
K = KAS(IX)	020 720
64 IF (1-N) 4,3,2	020 730
2 GO TO(11,12,13,14,15,9,9,9).K	020 740
11 DX2C(IX)=DX2C(IX)+(RSURY2-RSURX2)/RHO2**2	020 750
DY2C(IX)=DY2C(IX)+(RSURX2-RSURY2)/RHO2**2	020 760
DXYC(IX)=DXYC(IX)-2.0*RSURX*RSURY/RHO2**2	020 770
GO TO 9	020 780
12 DX2C(IX)=DX2C(IX)+2.0	020 790
DY2C(IX)=DY2C(IX)+ 2.0	020 800
GO TO 9	020 810
13 DX2C(IX)=DX2C(IX)+2.0*RSURX2/RHO2+1.0+ALOG(RHO2)	020 820
DY2C(IX)=DY2C(IX)+2.0*RSURY2/RHO2+ALOG(RHO2)+1.0	020 830

DXYC(IX)=DXYC(IX)+2.0*RSUBX*RSUBY/RHO2	020	040
GO TO 9	020	050
14 DXYC(IX)=DXYC(IX)+(RSUBX2-RSUBY2)*REFLEX/RHO2	020	060
CALL ANGLE	020	070
THAT=THET*REFLEX-ADFLTH	020	080
141 IF(THAT) 142,143,143	020	090
142 THAT =6.2831853+THAT	020	100
GO TO 141	020	110
143 DX2C(IX)=DX2C(IX)+2.0*(THAT-RSUBX*RSUBY*REFLEX/RHO2)	020	120
DY2C(IX)=DY2C(IX)+2.0*(RSUBX*RSUBY*REFLEX/RHO2+THAT)	020	130
GO TO 9	020	140
15 DX2C(IX)=DX2C(IX)+2.0*RSUBX*RSUBY*REFLEX/RHO2**2	020	150
DY2C(IX)=DY2C(IX)-2.0*RSUBX*RSUBY*REFLEX/RHO2**2	020	160
DXYC(IX)=DXYC(IX)+(RSUBY2-RSUBX2)*REFLEX/RHO2**2	020	170
GO TO 9	020	180
3 GO TO (31,32,33,34,35,36,37,38).X	020	190
31 DX2C(IX)=DX2C(IX)+2.0*RSUBY2*(RSUBX*SOCC+RSUBY*ENTSC)/RHO2**2	020	200
DY2C(IX)=DY2C(IX)+2.0*RSUBX2*(RSUBX*SOCC+RSUBY*ENTSC)/RHO2**2	020	210
DXYC(IX)=DXYC(IX)-2.0*RSUBY*RSUBX*(RSUBX*SOCC+RSUBY*ENTSC)/RHO2**2	020	220
GO TO 9	020	230
32 DX2C(IX)=DX2C(IX)+6.0*RSUBX*SOCC+2.0*RSUBY*ENTSC	020	240
DY2C(IX)=DY2C(IX)+2.0*RSUBX*SOCC+6.0*RSUBY*ENTSC	020	250
DXYC(IX)=DXYC(IX)+2.0*RSUBY*SOCC+2.0*RSUBX*ENTSC	020	260
GO TO 9	020	270
33 DX2C(IX)=DX2C(IX)+(-2.0*RSUBX*(3.0*RSUBY2-RSUBX2)*SOCC+2.0*(3.0*RSUBX2-RSUBY2)*ENTSC*RSUBY)/RHO2**2	020	280
DY2C(IX)=DY2C(IX)+2.0*(RSUBX*(3.0*RSUBY2-RSUBX2)*SOCC-RSUBY*(3.0*RSUBX2-RSUBY2)*ENTSC)/RHO2**2	020	290
DXYC(IX)=DXYC(IX)+2.0*(RSUBY*(3.0*RSUBX2-RSUBY2)*SOCC+RSUBX*(3.0*RSUBY2-RSUBX2)*ENTSC)/RHO2**2	020	300
GO TO 9	020	310
34 DX2C(IX)=DX2C(IX)+(RSUBX*(RSUBX2+3.0*RSUBY2)*SOCC+RSUBY*(RSUBY2-RSUBX2)*ENTSC)/RHO2**2	020	320
DY2C(IX)=DY2C(IX)+(RSUBX*(RSUBX2-RSUBY2)*SOCC+RSUBY*(RSUBY2+3.0*RSUBX2)*ENTSC)/RHO2**2	020	330
DXYC(IX)=DXYC(IX)+(RSUBY2-RSUBX2)*(RSUBY*SOCC-RSUBX*ENTSC)/RHO2**2	020	340
GO TO 9	020	350
35 DX2C(IX)=DX2C(IX)-2.0*RSUBY2*(RSUBY*SOCC-RSUBX*ENTSC)*REFLEX/RHO2**2	020	360
1*2	020	370
DY2C(IX)=DY2C(IX)-2.0*RSUBX2*(RSUBY*SOCC-RSUBX*ENTSC)*REFLEX/RHO2**2	020	380
1*2	020	390
DXYC(IX)=DXYC(IX)+2.0*RSUBX*RSUBY*(RSUBY*SOCC-RSUBX*ENTSC)*REFLEX/RHO2**2	020	400

1	RH02**2	020	1260
	GO TO 9	020	1270
36	DX2C(IX)=DX2C(IX)+(2.0*RSUBY*S0CC-6.0*RSUBX*FNISC)*REFLEX	020	1280
	DY2C(IX)=DY2C(IX)+(6.0*RSUBY*S0CC-2.0*RSUBX*FNISC)*REFLEX	020	1290
	DXYC(IX)=DXYC(IX)+2.0*(RSUBX*S0CC-RSUBY*FNISC)*REFLEX	020	1300
	GO TO 9	020	1310
37	DX2C(IX)=DX2C(IX)+(2.0*RSUBY*(3.0*RSUBX2-RSUBY2)*S0CC+2.0*RSUBX*(3.0*RSUBY2-RSUBX2)*FNISC)*REFLEX/RH02**3	020	1320
	DY2C(IX)=DY2C(IX)-2.0*(RSUBY*(3.0*RSUBX2-RSUBY2)*S0CC+RSUBX*(3.0*RSUBY2-RSUBX2)*FNISC)*REFLEX/RH02**3	020	1330
	DXYC(IX)=DXYC(IX)+2.0*(RSUBX*(3.0*RSUBY2-RSUBX2)*S0CC-RSUBY*(3.0*RSUBX2-RSUBY2)*FNISC)*REFLEX/RH02**3	020	1340
	GO TO 9	020	1350
38	DX2C(IX)=DX2C(IX)+(RSUBY*(RSUBY2-RSUBX2)*S0CC-RSUBX*(RSUBX2+3.0*RSUBY2)*FNISC)*REFLEX/RH02**2	020	1360
	DY2C(IX)=DY2C(IX)+(RSUBY*(RSUBY2+3.0*RSUBX2)*S0CC-RSUBX*(RSUBX2-RSUBY2)*FNISC)*REFLEX/RH02**2	020	1370
	DXYC(IX)=DXYC(IX)+(RSUBX2-RSUBY2)*(RSUBX*S0CC+RSUBY*FNISC)*REFLEX/RH02**2	020	1380
	GO TO 9	020	1390
4	FN = N	020	1400
	RSUBXY = RSUBX*RSUBY	020	1410
	IF (K-4) 42,42,43	020	1420
42	SOCN1 = SOCN(N)	020	1430
	FNISN1 = FNISN(N)*REFLEX	020	1440
	GO TO 44	020	1450
43	SOCN1 = FNISN(N)	020	1460
	FNISN1 = -SOCN(N)*REFLEX	020	1470
44	GO TO (51,52,53,54,51,52,53,54).X	020	1480
51	FNK = FN	020	1490
	RHUN = R(N)/(RH02*RH02)	020	1500
	GO TO 46	020	1510
52	ENK = EN + 2.0	020	1520
	RHUN = R(N)/RH02	020	1530
	GO TO 46	020	1540
53	FNK = -FN	020	1550
	RHUN = 1.0/(R(N)*RH02*RH02)	020	1560
	GO TO 46	020	1570
54	FNK = -FN + 2.0	020	1580
	RHUN = 1.0/(RH02*R(N))	020	1590
46	DX2C(IX)=DX2C(IX)+RH0N*((ENK*((FNK-1.0)*RSUBX2+RSUBY2)-FN*FN*RSUBXY2)*SOCN1+2.0*FN*(FNK-1.0)*RSUBXY*FNISN1)	020	1600
		020	1610
		020	1620
		020	1630
		020	1640
		020	1650
		020	1660
		020	1670

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      DY2C(IX) = DY2C(IX) + RHOX * ((FNK * ((F - X - 1.0) * RSURX2 + RSURX2) - EN * F * RSURX2) *
12) * SOCN1 - 2.0 * FN * (FNK - 1.0) * EN * ISN) * RSURXY)
      DXYC(IX) = DXYC(IX) + RHOX * ((FNK * (FNK - 2.0) * EN * F * RSURXY * SOCN1 - F * (FNK) *
1 - 1.0) * (RSURX2 - RSURX2) * EN * ISN)
      9 IF (IGS = IX) 6, 6, 62
      6 IF (IGT) 13, 10, 68
      68 IF (IGG) 66, 66, 76
      66 CHCK = 1.0
      RSURX = RSURX * HCK
      RSURY = RSURY * HCK
      RSURXY = RSURX * RSURY
      RSURX2 = RSURX * RSURX
      RSURY2 = RSURY * RSURY
      RHO = RHO * HCK
      RHO2 = RHO * RHO
      R(1) = RHO
      DO 67 J = 1, NORD
      67 R(J+1) = R(J) * RHO
      GO TO 72
      76 GVSJMX = DX2C(IX) * GVALUE(IGG) + GVSJMX
      GVSJMY = DY2C(IX) * GVALUE(IGG) + GVSJMY
      GVSJMZ = DXYC(IX) * GVALUE(IGG) + GVSJMZ
      72 IGG = IGG + 1
      IX = IC1
      IF (IGG - IGT) 73, 73, 10
      73 DO 75 J = IGG, IGT
      IF (MG(J) - M) 75, 74, 75
      74 IGG = J
      N = NG(IGG)
      K = KG(IGG)
      DX C(IC1) = 0.0
      DY2C(IC1) = 0.0
      DXYC(IC1) = 0.0
      GO TO 64
      75 CONTINUE
      10 IF (IPSY) 91, 65, 91
      91 CHCK = HCK
      RSURY = (YH + YSYNOL(T)) / CHCK
      RSURX = (XH - XSYNOL(T)) / CHCK
      REFLEX = -1.0
      IPSY = 1
      GO TO 1

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65 CONTINUE
77 DX2C(IC1) = GVSUMX
   DY2C(IC1) = GVSUMY
   DXYC(IC1) = GVSUMZ
   RETURN
END
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020 2100
020 2110
020 2120
020 2130
020 2140
020 2150
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SUBROUTINE UVDIS                                JVN  10
C  REVISED PROGRAM FOR U AND V DISPLACEMENTS  JVN  20
  DIMENSION PHI(14),TVALUE(140),CONND(40),CONNH(40),TITLE(1 JVN  30
  18),ISYPOL(42),HETA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NOR0 JVN  40
  2ER(40),TCOOL(40),XPOLF(40),YPOLE(40),MAT(140),NAT(140),KAT(140),CU JVN  50
  3RCUN(160),XSYPOL(240),YSYPOL(240),XRA(300),YNRA(300),YRA(300),YNRA JVN  60
  4(300),IRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVAL JVN  70
  5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( JVN  80
  6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(1,1),D JVN  90
  7YC(141),R(50),SOCN(50),ENISN(50),A(10010),R(1000,R),RDYC(60,3), JVN 100
  HKRDY(60),IP(1000,R)                        JVN 110
  COMMON DX1C , DY1C , A , RIOT , QGEN , CONNH JVN 120
  COMMON PHI , TVALUE , IFT , ICT , IGT , ICT JVN 130
  COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON JVN 140
  COMMON PDCYCL , MMAX , NOCCON , NOCJR , NOSYM , ALPHA JVN 150
  COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IP0S1A JVN 160
  COMMON ITYPOL , KEY , NOR0ER , TCOOL , YPOLE , YPOLE JVN 170
  COMMON MAT , NAT , KAT , CURCUN , XSYPOL , YSYPOL JVN 180
  COMMON XRA , XNRA , YRA , YNRA , IRA , IEQNO JVN 190
  COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES JVN 200
  COMMON MAS , NAS , KAS , MG , NG , KG JVN 210
  COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN JVN 220
  COMMON ENISN , IR , IFUN , IR , M , DELTHT JVN 230
  COMMON RSURX , RSURY , THFT , XR , XNR , YR JVN 240
  COMMON YNR JVN 250
  IEQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC), JVN 260
  1 (A(R1R1),KRDY),(RIOT,YOUNG),(SORCE,QGEN),(CONND,CONNH) JVN 270
  CHI1 = 2.)- 4.0*POSSON JVN 280
  CHI2 = 2.0+ CHI1 JVN 290
  CHI = 1.0+ CHI1 JVN 300
  GVSJMX = 0.0 JVN 310
  GVSJMY = 0.0 JVN 320
  IC1 = ICS + 1 JVN 330
  DO 100 I = 1,IC1 JVN 340
  DX2C(I) = 0.0 JVN 350
100 DY2C(I) = 0.0 JVN 360
  DO 65 M = 1,MMAX JVN 370
  NOR0 = NOR0ER(M) JVN 380
  IP0SY1 = IP0S1A(M) JVN 390
  IDX1 = ISYPOL(M) + 1 JVN 400
  IDX2 = ISYPOL(M+1) JVN 410

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DO 65 I = 1DX1,1DX2	JVN 420
CHCK = HCK	JVN 430
RSURX = (XH - XSYPOI(1))/CHCK	JVN 440
RSURY = (YH - YSYPOI(1))/CHCK	JVN 450
TPSY = TPJSY1	JVN 460
REFLEX = 1.0	JVN 470
ADELTH = DELTHT*(FLOAT(1-1DX1)) + BETA(M)	JVN 480
1 RSURX2 = RSURX*RSURX	JVN 490
RSURY2 = RSURY*RSURY	JVN 500
IX = 0	JVN 510
RHO2 = RSURX2 + RSURY2	JVN 520
TGG = 0	JVN 530
IF (RHO2) 7.8,7	JVN 540
8 CALL RHEFH	JVN 550
7 CALL ANGLE	JVN 560
THAT = THET*REFLEX - ADELTH	JVN 570
SOCN(1) = COS(THAT)	JVN 580
FNISN(1) = SIN(THAT)	JVN 590
DO 60 I = 1,NORD	JVN 600
SOCN(J+1) = SOCN(J)*SOCN(1) - FNISN(J)*FNISN(1)	JVN 610
60 FNISN(J+1) = FNISN(J)*SOCN(1) + SOCN(J)*FNISN(1)	JVN 620
RHO = SQRT(RHO2)	JVN 630
R(1) = RHO	JVN 640
DO 61 I = 1,NORD	JVN 650
61 R(J+1) = R(J)*RHO	JVN 660
62 IX = IX + 1	JVN 670
IF (MAS(IX) - M) 9,63,9	JVN 680
63 N = NAS(IX)	JVN 690
K = KAS(IX)	JVN 700
64 IF (1=N) 4,3,2	JVN 710
2 GO TO (11,12,13,13,15,16,17,18),K	JVN 720
11 DX2C(IX)=DX2C(IX)+(-RSURX/RHO2)	JVN 730
DY2C(IX)=DY2C(IX)+(-RSURY/RHO2)	JVN 740
GO TO 9	JVN 750
12 DX2C(IX)=DX2C(IX)+CHI1*RSURX	JVN 760
DY2C(IX)=DY2C(IX)+CHI1*RSURY	JVN 770
GO TO 9	JVN 780
13 CALL ANGLE	JVN 790
IF(2*(1-1DX1)-NOSYM) 131,132,132	JVN 800
131 THAT=THET*REFLEX-ADELTH-REFLEX*3.1415927	JVN 810
GO TO 133	JVN 820
132 THAT=THET*REFLEX-ADELTH-REFLEX*3.1415927+6.2831853	JVN 830

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133 IF (X-3) 134,134,14          JVN 1340
134 DX2C(IX)=DX2C(IX)+CHI1*RSURX*0.5*ALOG(RH02)-RFFLEX*CHI2*RSURX*THATJVN 1350
    I=RSURX                      JVN 1360
    DY2C(IX)=DY2C(IX)+CHI1*RSURX*0.5*ALOG(RH02)+RFFLEX*CHI2*RSURX*THATJVN 1370
    I=RSURY                      JVN 1380
    GO TO 9                      JVN 1390
14 DX2C(IX)=DX2C(IX)+RFFLEX*(CHI2*RSURX*0.5*ALOG(RH02)+RSURX)+CHI1*RSJVN 1400
    I=RSURX*THAT                JVN 1410
    DY2C(IX)=DY2C(IX)-RFFLEX*(CHI2*RSURX*0.5*ALOG(RH02)+RSURX)+CHI1*RSJVN 1420
    I=RSURY*THAT                JVN 1430
    GO TO 9                      JVN 1440
15 DX2C(IX)=DX2C(IX)+RFFLEX*RSURX/RH02          JVN 1450
    DY2C(IX)=DY2C(IX)-RFFLEX*RSURX/RH02          JVN 1460
    GO TO 9                      JVN 1470
16 DX2C(IX)=DX2C(IX)-RSURX                      JVN 1480
    DY2C(IX)=DY2C(IX)+RSURX                      JVN 1490
    GO TO 9                      JVN 1500
17 DX2C(IX)=DX2C(IX)+1.0                      JVN 1510
    GO TO 9                      JVN 1520
18 DY2C(IX)=DY2C(IX)+1.0                      JVN 1530
    GO TO 9                      JVN 1540
3  SOCC=COS(ANFLTH)                      JVN 1550
    FNISC=SEN(ANFLTH)                      JVN 1560
    GO TO (30,32,33,30,30,36,37,30).K      JVN 1570
30 CALL ANGLE                      JVN 1580
    IF (2*(1-IDX1)-NOSYM) 301,302,302      JVN 1590
301 THAT=THET*RFFLEX-ANFLTH-RFFLEX*3.1415927 JVN 1600
    GO TO 303                      JVN 1610
302 THAT=THET*RFFLEX-ANFLTH-RFFLEX*3.1415927+6.2831853 JVN 1620
303 GO TO (31,32,33,34,35,36,37,38).K      JVN 1630
31 DX2C(IX)=DX2C(IX)+(CHI2*0.5*ALOG(RH02) - (RSURX2-RSURY2)/RH02)*SJVN 1640
    10CC/2.0-(CHI1*THAT+2.0*RSURX*RSURY*RFFLEX/RH02)*FNISC/2.0 JVN 1650
    DY2C(IX)=DY2C(IX)+(CHI2*0.5*ALOG(RH02) + (RSURX2-RSURY2)/RH02)*EJVN 1660
    1NISC*RFFLEX/2.0+(CHI1*THAT*RFFLEX-2.0*RSURX*RSURY/RH02)*SOCC/2.0 JVN 1670
    GO TO 9                      JVN 1680
32 DX2C(IX)=DX2C(IX)+ CHI*((RSURX2-RSURY2)*SOCC+2.0*RSURX*RSURYJVN 1690
    1*FNISC*RFFLEX)-2.0*RH02*SOCC JVN 1700
    DY2C(IX)=DY2C(IX)+ CHI*(2.0*RSURX*RSURY*SOCC-(RSURX2-RSURY2)JVN 1710
    1*FNISC*RFFLEX)-2.0*RH02*FNISC*RFFLEX JVN 1720
    GO TO 9                      JVN 1730
33 DX2C(IX)=DX2C(IX)+((RSURX2-RSURY2)*SOCC+2.0*RFFLEX*RSURX*RSURY*FNISJVN 1740
    ISC)/RH02**2 JVN 1750

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      DY2C(IX)=DY2C(IX)+((RSURX2-RSUBX2)*FNISC*REFLEX+2.0*RSURX*RSURHY*SOUVN 1260
1000)/RH02**2 JVN 1270
      GO TO 9 JVN 1280
34 DX2C(IX)=DX2C(IX)+(CHI1*0.5*ALOG(RH02) -(RSURX2-RSUBX2)/RH02)*SOUVN 1290
1000/2.0-(CHI2*THAT+2.0*RSUBX*RSURHY*REFLEX/RH02)*FNISC/2.0 JVN 1300
      DY2C(IX)=DY2C(IX)+(CHI1*0.5*-LOG(RH02) +(RSURX2-RSUBX2)/RH02)*EJVN 1310
1000*REFLEX/2.0+(CHI2*THAT*REFLEX-2.0*RSUBX*RSURHY/RH02)*S0CC/2.0 JVN 1320
      GO TO 9 JVN 1330
35 DX2C(IX)=DX2C(IX)+(CHI1*THAT+2.0*REFLEX*RSUBX*RSURHY/RH02)*S0CC/2.0JVN 1340
1+(CHI2*0.5*ALOG(RH02) -(RSURX2-RSUBX2)/RH02)*FNISC/2.0 JVN 1350
      DY2C(IX)=DY2C(IX)+(CHI1*THAT*REFLEX-2.0*RSUBX*RSURHY/RH02)*FNISC/2.0JVN 1360
10-(CHI2*0.5*ALOG(RH02) +(RSURX2-RSUBX2)/RH02)*S0CC*REFLEX/2.0 JVN 1370
      GO TO 9 JVN 1380
36 DX2C(IX)=DX2C(IX)+ CHI*(2.0*REFLEX*RSURX*RSURHY*S0CC-(RSUBX2-JVN 1390
1RSURHY2)*FNISC)+2.0*RH02*ENISC JVN 1400
      DY2C(IX)=DY2C(IX)- CHI*(2.0*RSUBX*RSURHY*FNISC+REFLEX*(RSURX2JVN 1410
1-RSUBY2)*S0CC)-2.0*RH02*REFLEX*S0CC JVN 1420
      GO TO 9 UVN 1430
37 DX2C(IX)=DX2C(IX)+(2.0*RSUBX*RSURHY*S0CC*REFLEX+(RSURHY2-RSURX2)*ENIJVN 1440
1SC)/RH02**2 UVN 1450
      DY2C(IX)=DY2C(IX)-(2.0*RSUBX*RSURHY*ENISC-REFLEX*(RSURHY2-RSURX2)*SOUVN 1460
1000)/RH02**2 JVN 1470
      GO TO 9 JVN 1480
38 DX2C(IX)=DX2C(IX)-(CHI2*THAT+2.0*REFLEX*RSURX*RSURHY/RH02)*S0CC/2.0JVN 1490
1-(CHI1*0.5*ALOG(RH02) -(RSURX -RSURHY2)/RH02)*FNISC/2.0 JVN 1500
      DY2C(IX)=DY2C(IX)-(CHI2*THAT*REFLEX-2.0*RSUBX*RSURHY/RH02)*FNISC/2.0JVN 1510
10+(CHI1*0.5*ALOG(RH02) +(RSURX2-RSUBY2)/RH02)*S0CC*REFLEX/2.0 JVN 1520
      GO TO 9 UVN 1530
4 EN = N UVN 1540
      IF (K-4) 42,42,43 JVN 1550
42 SOCNU = RSURX*S0CN(N) JVN 1560
      SOCNV = RSURHY*S0CN(N) JVN 1570
      FNISNU = RSURHY*ENISN(N)*REFLEX JVN 1580
      FNISNV = -RSURX*ENISN(N)*REFLEX JVN 1590
      GO TO 44 JVN 1600
43 SOCNU = RSURX*FNISN(N) JVN 1610
      SOCNV = RSURHY*FNISN(N) JVN 1620
      FNISNU = -RSURHY*S0CN(N)*REFLEX JVN 1630
      FNISNV = RSURX*S0CN(N)*REFLEX JVN 1640
44 GO TO (51,52,53,54,51,52,53,54),K JVN 1650
51 DX2C(IX)=DX2C(IX) - EN*(SOCNU + FNISNU)*R(N)/R(2) JVN 1660
      DY2C(IX)=DY2C(IX) - EN*(SOCNV + FNISNV)*R(N)/R(2) JVN 1670

```


GO TO 9	JVN 1640
52 DX2C(IX)=DX2C(IX)+((CHI1-EN)*SOCNV1-(CHI2+FN)*FNISNV1)*R(N)	JVN 1640
DY2C(IX)=DY2C(IX)+((CHI1-EN)*SOCNV1-(CHI2+FN)*FNISNV1)*R(N)	JVN 1700
GO TO 9	JVN 1710
53 DX2C(IX)=DX2C(IX) + EN*(SOCNV1 - FNISNV1)/(R(N)*P(2))	JVN 1720
DY2C(IX)=DY2C(IX) + EN*(SOCNV1 - FNISNV1)/(R(N)*P(2))	JVN 1730
GO TO 9	JVN 1740
54 DX2C(IX)=DX2C(IX)+((CHI1+EN)*SOCNV1+(CHI2-FN)*FNISNV1)/R(N)	JVN 1750
DY2C(IX)=DY2C(IX)+((CHI1+EN)*SOCNV1+(CHI2-FN)*FNISNV1)/R(N)	JVN 1760
9 IF (ICS - IX) 6, 6, 62	JVN 1770
6 IF (IGT) 10, 10, 68	JVN 1780
68 IF (IGG) 66, 66, 76	JVN 1790
66 CHCK = 1.0	JVN 1800
RSUBX = RSUBX*HCK	JVN 1810
RSUBY = RSUBY*HCK	JVN 1820
RSUBX2 = RSUBX*RSUBX	JVN 1830
RSUBY2 = RSUBY*RSUBY	JVN 1840
RHO = RHO*HCK	JVN 1850
RHO2 = RHO*RHO	JVN 1860
R(1) = RHO	JVN 1870
DO 67 I = 1, NORD	JVN 1880
67 R(J+1) = R(J)*RHO	JVN 1890
GO TO 72	JVN 1900
76 GVSUMX = DX2C(IC1)*GVALUE(IGG) + GVSUMX	JVN 1910
GVSUMY = DY2C(IC1)*GVALUE(IGG) + GVSUMY	JVN 1920
72 IGG = IGT + 1	JVN 1930
IX = IC1	JVN 1940
IF (IGG - IGT) 73, 73, 10	JVN 1950
73 DO 75 I = IGG, IGT	JVN 1960
IF (MG(I) - M) 75, 74, 75	JVN 1970
74 IGG = J	JVN 1980
N = NG(IGG)	JVN 1990
K = KG(IGG)	JVN 2000
DX2C(IC1) = 0.0	JVN 2010
DY2C(IC1) = 0.0	JVN 2020
GO TO 64	JVN 2030
75 CONTINUE	JVN 2040
10 IF (IPSY) 91, 65, 91	JVN 2050
91 CHCK = HCK	JVN 2060
RSUBY = (YR + YSYPOI(I))/CHCK	JVN 2070
RSUBX = (XR + XSYPOI(I))/CHCK	JVN 2080
REFLEX = -1.0	JVN 2090

```
TPSY =  
GO TO 1  
65 CONTINUE  
77 DX2C(IC1) = GVSJMX  
DY2C(IC1) = GVSJMY  
RETURN  
END
```

```
JVN 2100  
JVN 2110  
JVN 2120  
JVN 2130  
JVN 2140  
JVN 2150  
JVN 2160
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SUBROUTINE TUIS                                T=I 10
C REVISED SUBROUTINE FOR THERMAL DISPLACEMENTS T=I 20
  DIMENSION PHT(140),TVALUE(140),CONDM(40),CONDH(40),TITLE(100) T=I 30
  (18),[SYMBOL(42),HETA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NORDER T=I 40
  2ER(40),TCOOL(40),XPOLE(40),YPOLE(40),MAT(140),NAT(140),KAT(140),CIT T=I 50
  3RCON(160),XSYPOL(240),YSYPOL(240),XHA(300),YHRA(300),YHA(300),YSHAT T=I 60
  4(300),IHA(500),IFQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVAL T=I 70
  5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVAL T=I 80
  6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXT T=I 90
  7YC(141),R(50),SOCN(50),ENISN(50),A(10010),R(1000,R),RDYCY(60,R), T=I 100
  KRDY(60),IP(1000,R) T=I 110
  COMMON DX1C , DY1C , A , RIOT , QGEN , CONDM T=I 120
  COMMON PHT , TVALUE , IET , ICT , IGT , ICI T=I 130
  COMMON IG , ICS , SHEAR , THERMK , INSYM , NOSSON T=I 140
  COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA T=I 150
  COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IP0S1A T=I 160
  COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLE , YPOLE T=I 170
  COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL T=I 180
  COMMON XHA , XHRA , YHA , YHRA , IHA , IFQNO T=I 190
  COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IFS T=I 200
  COMMON MAS , NAS , KAS , MG , NG , KG T=I 210
  COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN T=I 220
  COMMON ENISN , IR , IFWN , YR , M , DELTHT T=I 230
  COMMON RSURX , RSURY , THET , XR , XNR , YR T=I 240
  COMMON YNR T=I 250
  EQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYCY), T=I 260
  1 (A(B1B1),KRDY),(RIOT,YOUNG),(SORCE,QGEN),(CONDM,CONDH) T=I 270
C T=I 280
  ICI = ICS + 1 T=I 290
  DO 100 I = 1,ICI T=I 300
    DX2C(I) = 0.0 T=I 310
  100 DY2C(I) = 0.0 T=I 320
    CHCK = HCK T=I 330
    DO 65 M = 1,MMAX T=I 340
      NORD = NORDER(M) T=I 350
      IP0SY1 = IP0S1A(M) T=I 360
      IDX1 = ISYPOL(M) + 1 T=I 370
      IDX2 = ISYPOL(M+1) T=I 380
      DO 65 I = IDX1,IDX2 T=I 390
        RSURX = (XR - XSYPOL(I))/CHCK T=I 400
        RSURY = (YR - YSYPOL(I))/CHCK T=I 410

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      TPSY = TP0SY1
      REFLEX = 1.0
      ADELTH = DELTHT*(FLOAT(I-IDX1)) + BETA(M)
      RSURX2 = RSURX*RSURX
1    RSUBY2 = RSUBY*RSURY
      TX = 0
      RH02 = RSURX2 + RSURY2
      IF (RH02) 7,8,7
8    CALL RHFERR
7    CALL ANGLE
      THAT = THET*REFLEX - ADELTH
      SOCN(1) = COS(THAT)
      FNISN(1) = SIN(THAT)
      DO 60 J = 1,NORD
      SOCN(J+1) = SOCN(J)*SOCN(1) - FNISN(J)*FNISN(1)
60   FNISN(J+1) = FNISN(J)*SOCN(1) + SOCN(J)*FNISN(1)
      RH0 = SQRT(RH02)
      R(1) = RH0
      DO 61 I = 1,NORD
61   R(J+1) = R(J)*RH0
62   IX = IX + 1
      IF (MAT(IX) - M) 9,63,9
63   N = .NAT(IX)
      K = KAT(IX)
64   IF (1-N) 4,3,2
      2 GO TO(13, 9, 9, 9, 9,16,17,19).K
13  CALL ANGLE
      IF(2*(I-IDX1)-NOSYM) 131,132,132
131 THAT=THET*REFLEX-ADELTH-REFLEX*3.1415927
      GO TO 11
132 THAT=THET*REFLEX-ADELTH-REFLEX*3.1415927+6.2831853
11  DX2C(IX)=DX2C(IX)+RSURX*(0.5*ALOG(RH02)-1.0)-REFLEX*RSURY*THAT
      DY2C(IX)=DY2C(IX)+RSURY*(0.5*ALOG(RH02)-1.0)+REFLEX*RSURX*THAT
      GO TO 9
16  DX2C(IX)=DX2C(IX)+RSURX
      DY2C(IX)=DY2C(IX)+RSURY
      GO TO 9
17  DX2C(IX)=DX2C(IX)+RSURX2-RSURY2
      DY2C(IX)=DY2C(IX)+2.0*RSURX*RSURY
      GO TO 9
18  DX2C(IX)=DX2C(IX)+2.0*RSURX*RSURY
      DY2C(IX)=DY2C(IX)-RSURX2+RSURY2

```

```

TBT 420
TBT 430
TBT 440
TBT 450
TBT 460
TBT 470
TBT 480
TBT 490
TBT 500
TBT 510
TBT 520
TBT 530
TBT 540
TBT 550
TBT 560
TBT 570
TBT 580
TBT 590
TBT 600
TBT 610
TBT 620
TBT 630
TBT 640
TBT 650
TBT 660
TBT 670
TBT 680
TBT 690
TBT 700
TBT 710
TBT 720
TBT 730
TBT 740
TBT 750
TBT 760
TBT 770
TBT 780
TBT 790
TBT 800
TBT 810
TBT 820
TBT 830

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GO TO 9	TOT	840
3 SOCC=COS(ADELTH)	TOT	850
ENISC=SIN(ADELTH)	TOT	860
GO TO (2,4,30,9,9,9,30,9)*K	TOT	870
30 CALL ANGLE	TOT	880
IF (2*(I-IDX1)-NOSYM) 301,302,302	TOT	890
301 THAT=THEI*REFLEX-ADELTH-REFLEX*3.1415927	TOT	900
GO TO 303	TOT	910
302 THAT=THEI*REFLEX-ADELTH-REFLEX*3.1415927+6.2831853	TOT	920
303 IF(K-4) 33,33,37	TOT	930
33 DX2C(IX)=DX2C(IX)+0.5*ALOG(RHO2)*SOCC-THAT*ENISC	TOT	940
DY2C(IX)=DY2C(IX)+REFLEX*(0.5*ALOG(RHO2)*ENISC+THAT*SOCC)	TOT	950
GO TO 9	TOT	960
37 DX2C(IX)=DX2C(IX)-0.5*ALOG(RHO2)*ENISC-THAT*SOCC	TOT	970
DY2C(IX)=DY2C(IX)+REFLEX*(0.5*ALOG(RHO2)*SOCC-THAT*ENISC)	TOT	980
GO TO 9	TOT	990
4 EN = N	TOT	1000
SOCN1 = SOCN(N)*RHO	TOT	1010
ENISN1 = ENISN(N)*RHO	TOT	1020
44 GO TO (51,9,53,9,55,9,57,9)*K	TOT	1030
51 DX2C(IX)=DX2C(IX)+(RSUBX*SOCN1-RSUBY*ENISN1*REFLEX)*R(N)/(EN+1.0)	TOT	1040
DY2C(IX)=DY2C(IX)+(RSUBY*SOCN1+RSUBX*ENISN1*REFLEX)*R(N)/(EN+1.0)	TOT	1050
GO TO 9	TOT	1060
53 DX2C(IX)=DX2C(IX)+(RSUBX*SOCN1+RSUBY*ENISN1*REFLEX)/(R(N)*(1.0-EN))	TOT	1070
1)	TOT	1080
DY2C(IX)=DY2C(IX)+(RSUBY*SOCN1-RSUBX*ENISN1*REFLEX)/(R(N)*(1.0-EN))	TOT	1090
1)	TOT	1100
GO TO 9	TOT	1110
55 DX2C(IX)=DX2C(IX)+(RSUBX*ENISN1+RSUBY*SOCN1*REFLEX)*R(N)/(EN+1.0)	TOT	1120
DY2C(IX)=DY2C(IX)+(RSUBY*ENISN1-RSUBX*SOCN1*REFLEX)*R(N)/(EN+1.0)	TOT	1130
GO TO 9	TOT	1140
57 DX2C(IX)=DX2C(IX)-(RSUBX*ENISN1-RSUBY*SOCN1*REFLEX)/(R(N)*(1.0-EN))	TOT	1150
1)	TOT	1160
DY2C(IX)=DY2C(IX)-(RSUBY*ENISN1+RSUBX*SOCN1*REFLEX)/(R(N)*(1.0-EN))	TOT	1170
1)	TOT	1180
9 IF (ICT = IX) 10,10,62	TOT	1190
10 IF (IPSY) 11,65,01	TOT	1200
91 RSUBY = (YH + YSYDOL(I))/CHCK	TOT	1210
REFLEX = -1.0	TOT	1220
IPSY =	TOT	1230
GO TO 1	TOT	1240
65 CONTINUE	TOT	1250
RETURN		
END		

```

SUBROUTINE ANGLE                                AAP 10
C SUBROUTINE TO CALCULATE ANGLE                  AAP 20
DIMENSION PHI(140),TVALUE(140),CONDD(40),CONDDH(40),TITLE(140P 30
1R),ISYPOL(42),BETA(40),TCUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NORDAAP 40
2PER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CUAAP 50
3RCOOL(160),XSYPOL(240),YSYPOL(240),XRA(300),YNRA(300),YRA(300),YNRAAAP 60
4(300),IRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALAAP 70
5UT(40),NAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( AAP 80
6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPNC(1,1),DXAAP 90
7YC(141),R(50),SOCN(50),ENISN(50),A(10010),R(1000,R),RDYC(60,3), AAP 100
4KRDY(60),IP(1000,R) AAP 110
COMMON DX1C , DY1C , A , RIOT , UGEN , CONDDH AAP 120
COMMON PHI , TVALUE , IFT , TCT , TGT , ICT AAP 130
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON AAP 140
COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA AAP 150
COMMON HCK , TITLE , ISYPOL , BETA , TCUR , IP0S1A AAP 160
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOLF AAP 170
COMMON MAT , NAT , KAT , CURCUM , XSYPOL , YSYPOL AAP 180
COMMON XRA , XNRA , YRA , YNRA , IRA , IEQNO AAP 190
COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES AAP 200
COMMON MAS , NAS , KAS , MG , NG , KG AAP 210
COMMON GVALUE , OUT , DPNC , DXYC , R , SOCN AAP 220
COMMON ENISN , IR , IEQN , IR , M , DELTHT AAP 230
COMMON RSURX , RSURY , THET , XR , XNR , YR AAP 240
COMMON YNR AAP 250
EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,H,IP),(A(R001),RDYC), AAP 260
1 (A(8181),KRDY),(RIOT,YOUNG),(SORCE,UGEN),(CONDD,CONDDH) AAP 270
IF(RSURX) 42,43,44 AAP 280
42 IF(RSURY) 421,422,423 AAP 290
421 THET=3.1415927+ATAN(RSURY/RSURX) AAP 300
GO TO 45 AAP 310
422 THET=3.1415927 AAP 320
GO TO 45 AAP 330
423 THET=3.1415927-ATAN(-RSURY/RSURX) AAP 340
GO TO 45 AAP 350
44 IF(RSURY) 441,442,443 AAP 360
441 THET=6.2831853-ATAN(-RSURY/RSURX) AAP 370
GO TO 45 AAP 380
442 THET=0.0 AAP 390
GO TO 45 AAP 400
443 THET=ATAN(RSURY/RSURX) AAP 410

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      GO TO 45
43  IF (RSUBY) 431,45,432
431 THET=4.7123890
      GO TO 45
432 THET=1.5707963
45  RETURN
     END

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A4D  420
A4D  430
A4D  440
A4D  450
A4D  460
A4D  470
A4D  480

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SUBROUTINE PHERR                                AAQ 10
C SUBROUTINE TO WRITE OUT ERROR MESSAGE          AAQ 20
  DIMENSION PHI(140),TVALUE(140),COND(40),CONDH(40),TITLE(140) 30
  1R),ISYPOL(42),HETA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NORDAAQ 40
  2ER(40),TCOOL(40),XPOLF(40),YPOLE(40),MAT(140),NAT(140),KAT(140),CUAAQ 50
  3RCOV(160),XSYPOL(240),YSYPOL(240),XHA(300),XNRA(300),YBA(300),YNHAAQ 60
  4(300),TRA(500),IEQND(500),RTSIDF(500),MGT(40),NGT(40),KGT(40),GVALAAQ 70
  5UIT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( AAQ 80
  6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXAAQ 90
  7YC(141),R(50),SOCN(50),ENISN(50),A(10010),R(1000,R),RDYC(60,3), AAQ 100
  HKRDY(60),IP(1000,R) AAQ 110
  COMMON DX1C , DY1C , A , HIOT , QGEN , CONDH AAQ 120
  COMMON PHI , TVALUE , IFT , ICT , IGT , IC1 AAQ 130
  COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON AAQ 140
  COMMON PDCYCL , MMAX , NOCON , NUCUR , NOSYM , ALPHA AAQ 150
  COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IP0S1A AAQ 160
  COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOLE AAQ 170
  COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL AAQ 180
  COMMON XHA , XNRA , YBA , YNRA , TRA , IEQND AAQ 190
  COMMON RTSIDF , MGT , NGT , KGT , GVALUIT , IES AAQ 200
  COMMON MAS , NAS , KAS , MG , NG , KG AAQ 210
  COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN AAQ 220
  COMMON ENISN , IR , IEQN , IR , M , DELTHT AAQ 230
  COMMON RSURX , RSURY , THET , XH , XNR , YB AAQ 240
  COMMON YNR AAQ 250
  EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC), AAQ 260
  1 (A(R1R1),KRDY),(HIOT,YOUNG),(SORCE,QGEN),(COND,CONDH) AAQ 270
  WRITE (6,1)IR,M,IP AAQ 280
  CALL EXIT AAQ 290
1 FORMAT(45H *****ERROR.....YOU CHOSE BOUNDARY POINT[4,1] IN COINAQ 300
  INCIDENT WITH /25H EXPANSION POINT[5,39H.THE PROGRAM DOES NAQ 310
  NOT ALLOW THIS.CHANGE/25H BOUNDARY POINT[5,2HH AND RETRY AAQ 320
  3YOUR PROBLEM*****[/H1/)) AAQ 330
  RETURN AAQ 340
  ENQ AAQ 350

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SUBROUTINE TEMINT                                     A 2  10
C SUBROUTINE FOR INTERIOR TEMPERATURES               A 2  20
DIMENSION PHI(141),TVALUE(140),CONC(40),CONDH(40),TITLE(141) A 2  30
18),ISYPOL(42),HETA(40),ICUR(40),IPOSIA(40),ITYPOL(40),KEY(10),NORDER A 2  40
2ER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(141),NAT(140),KAT(140),CJAB A 2  50
3RCUN(161),XSYPOL(241),YSYPOL(240),XRA(300),YNRA(300),YRA(300),YNRAA A 2  60
4(300),IRA(500),IFQNO(500),RTSINF(500),MGT(40),NGT(41),KGT(40),GVAL A 2  70
5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( A 2  80
6(120),DXIC(141),DX2C(141),DYIC(141),DY2C(141),OUT(141),DPOC(141),DX A 2  90
7YC(141),R(50),SOCN(50),ENIS(50),A(10010),R(1000,R),B(100,3), A 2 100
XKRDY(60),IR(1000,R)                                A 2 110
COMMON DXIC , DYIC , A , RIOT , GEN , CONDH A 2 120
COMMON PHI , TVALUE , IFT , ICT , IGT , ICT A 2 130
COMMON IG , ICS , SHEAR , THERMK , TASYM , POSSON A 2 140
COMMON POCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA A 2 150
COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IPOSIA A 2 160
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOLF A 2 170
COMMON MAT , NAT , KAT , CURCUN , XSYPOL , YSYPOL A 2 180
COMMON XRA , XNRA , YRA , YNRA , IRA , IFQNO A 2 190
COMMON RTSINF , MGT , NGT , KGT , GVALUT , IFS A 2 200
COMMON MAS , NAS , KAS , MG , NG , KG A 2 210
COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN A 2 220
COMMON ENISN , IR , IFQN , IR , " , DELTHT A 2 230
COMMON RSURX , RSURY , THT , XR , XNR , YR A 2 240
COMMON YNR A 2 250
EQUIVALENCE (DXIC,DX2C),(DYIC,DY2C),(A,H,TP),(A(R001),RDYIC), A 2 260
1 (A(B1R1),KRDY),(RIOT,YOUNG),(SOURCE,GEN),(CONC,CONDH) A 2 270
READ (5,131)NUMSX,NUMSY,XMIN,YMIN,DELEX3,DELYR A 2 280
WRITE (6,101)TITLE A 2 290
WRITE (6,24)XMIN,YMIN,NUMSX,NUMSY,DELEX3,DELYR A 2 300
ICT = ICT + 1 A 2 310
YR=YMIN A 2 320
DO 21 K=1,NUMSY A 2 330
XR=XMIN A 2 340
DO 22 J=1,NUMSX A 2 350
CALL DP=I A 2 360
TEMP=0. A 2 370
DO 1 I = 1,ICT A 2 380
1 TEMP = TEMP + DPOC(I)*TVALUE(I) A 2 390
TEMP = TEMP - DPOC(ICI) A 2 400
WRITE (6,24)XR,YR,TEMP A 2 410

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22	XR=XB+DELX	A42	427
21	YH=YH+DELY	A42	430
	RETURN	A42	440
101	FORMAT (1H1,20X,1R44)	A42	450
29	FORMAT(1H .F4.4,F9.4,F13.3)	A42	460
28	FORMAT(55H0 INTERIOR TEMPERATURES OVER A GIVEN LATTICE OF POINTS/A42		470
	1// 8H XMIN =F16.8,8H YMIN =F16.8,11H NUMSX =I4.9H NUMSY =I4.8H		480
	2//9H DELX =F16.8,9H DELY =F16.8,///32H XR YB TEMP		490
	PERATURE///)	A42	500
131	FORMAT(2I3,F18.6,3F12.6)	A42	510
	END	A42	520

	SUBROUTINE BODYTEM	A.S	10
C	SUBROUTINE FOR BOUNDARY TEMPERATURES AND GRADIENTS	A.S	20
	DIMENSION IHT(140),TV(LHE(140),CONC(40),CONDH(40),TITLE(140),	A.S	30
	IR),ISYPOL(42),HETA(40),ICUR(40),IP051A(40),ITYPOL(40),KEY(10),NORDEF	A.S	40
	2FR(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CURCON	A.S	50
	3RCON(160),XSYPOL(240),YSYPOL(240),XRA(300),YRA(300),YHA(300),YHRA(300),	A.S	60
	4(300),IRA(300),IEQND(500),RTSDEF(500),MGT(40),NGT(40),KGT(40),GVALA(5	A.S	70
	5UT(40),NAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE(	A.S	80
	6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXA(5	A.S	90
	7YC(141),R(50),SOEN(50),ENTSN(50),A(10010),W(1000,R),RDYC(60,3),	A.S	100
	XKRDY(60),IP(1000,R)	A.S	110
	COMMON DX1C, DY1C, A, RIOT, UGEN, CONDH	A.S	120
	COMMON PHI, TVLHE, IET, ICT, TGT, ICI	A.S	130
	COMMON IG, ICS, SHEAR, THERMK, INSYM, ROSSON	A.S	140
	COMMON PDICYL, MMAX, NOCCON, NOCUR, NOSYM, ALPHA	A.S	150
	COMMON HCK, TITLE, ISYPOL, HETA, ICUR, IP051A	A.S	160
	COMMON ITYPOL, KEY, NORDEF, TCOOL, XPOLF, YPOLF	A.S	170
	COMMON MAT, NAT, KAT, CURCON, XSYPOL, YSYPOL	A.S	180
	COMMON XRA, XNRA, YRA, YHRA, IRA, IEQND	A.S	190
	COMMON RTSDEF, MGT, NGT, KGT, GVALUT, IFS	A.S	200
	COMMON NAS, NAS, KAS, MG, NG, KG	A.S	210
	COMMON GVALUE, OUT, DPOC, DXYC, R, SOEN	A.S	220
	COMMON ENTSN, IR, IFJN, IR, W, DELTHT	A.S	230
	COMMON RSURX, RSURY, THET, XR, XNR, YR	A.S	240
	COMMON YNR	A.S	250
	EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,R,IP),(A(8001),RDYC),	A.S	260
	1 (A(8181),KRDY),(RIOT,YOUNG),(SORCE,UGEN),(CONC,CONDH)	A.S	270
	I=0	A.S	280
	WRITE (6,101)TITLE	A.S	290
	WRITE (6,38)	A.S	300
	ICI = ICT + 1	A.S	310
	DO 4 IR = 1, IET	A.S	320
	XR=XRA(IR)	A.S	330
	YR=YHA(IR)	A.S	340
	XNR=XNRA(IR)	A.S	350
	YNR=YHRA(IR)	A.S	360
	CALL DPHIO	A.S	370
	CALL DPHI	A.S	380
	TEMP=0.0	A.S	390
	GRAD=0.0	A.S	400
	8 IF(ICUR(I)-IR) 1,2,2	A.S	410

1 I=I+1	A S	420
GO TO 8	A S	430
2 DO 3 J = 1,ICT	A S	440
TEMP = TEMP + DPOC(J)*TVALUE(J)	A S	450
3 GRAD = GRAD + (DXIC(J)*XNR + DYIC(J)*YNR)*TVALUE(J)/HCK	A S	460
TEMP=TEMP-DPOC(1C1)	A S	470
GRAD=GRAD-(DXIC(1C1)*XNR+DYIC(1C1)*YNR)	A S	480
IF(COND(I)) 5,7,5	A S	490
5 DTEMP=GRAD+COND(I)*(TEMP-TCOOL(I))	A S	500
GO TO 6	A S	510
7 DTEMP=0.0	A S	520
6 IF (IEQ10(IR) - 1) 901,901,902	A S	530
901 WRITE (6.39) IR,XR,YR,TEMP,RTSINF(IR),GRAD,DTEMP	A S	540
GO TO 4	A S	550
902 WRITE (6.40) IR,XR,YR,TEMP,GRAD,DTEMP	A S	560
4 CONTINUE	A S	570
RETURN	A S	580
101 FORMAT (1H1,20X,18A4)	A S	590
39 FORMAT(14,2F9.4,F13.3,F13.3,1PF22.8,F17.8)	A S	600
40 FORMAT(14,2F9.4,F13.3,1PE35.8,F17.8)	A S	610
380FORMAT(1H0/55H	A S	620
1ENT///84H	A S	630
2	A S	640
3F	A S	650
END)	A S	660

```

SUBROUTINE RDYSIG                                AAT 10
SUBROUTINE FOR BOUNDARY STRESSES                AAT 20
DIMENSION PHI(140),TVALUE(140),COND(40),CONDM(40),TITLE(140) AAT 30
1R),ISYPOL(42),HETA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NORDAAT 40
2FER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CUAAT 50
3RCUN(160),XSYPOL(240),YSYPOL(240),XRA(300),XNRA(300),YRA(300),YNRAAAT 60
4(300),IRA(500),IEQND(500),RTSIDF(500),MGT(40),NGT(40),KGT(40),GVALAAT 70
5UT(40),NAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( AAT 80
6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(1 AAT 90
7YC(141),R(50),SOCN(50),FNISM(50),A(10010),R(1000,R),BDYC(60,2), AAT 100
4KRDY(60),IP(1000,R)                            AAT 110
COMMON DX1C , DY1C , A , HIOT , QGEN , CONDM AAT 120
COMMON PHI , TVALUE , IFT , ICT , IGT , ICT AAT 130
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON AAT 140
COMMON PDCYCL , MMAX , NOCCON , NOCJR , NOSYM , ALPHA AAT 150
COMMON HCK , TITLE , ISYPOL , HETA , ICUR , IP0S1A AAT 160
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOL'E AAT 170
COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL AAT 180
COMMON XRA , XNRA , YRA , YNRA , TRA , IEQND AAT 190
COMMON RTSIDF , MGT , NGT , KGT , GVALUT , IES AAT 200
COMMON MAS , NAS , KAS , MG , NG , KG AAT 210
COMMON GVALUF , OUT , DPOC , DXYC , R , SOCN AAT 220
COMMON FNISM , IR , IEQN , IR , M , DELTHT AAT 230
COMMON RSHX , RSHRY , THET , XH , XNR , YH AAT 240
COMMON YNR AAT 250
EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,H,IP),(A(R001),BDYC), AAT 260
1 (A(H1R1),KRDY),(HIOT,YOUNG),(SORCE,QGEN),(COND,CONDM) AAT 270
WRITE (4,101)TITLE AAT 280
WRITE (4,34) AAT 290
IC1 = ICS + 1 AAT 300
DO 4 IR = 1,IFT AAT 310
XR=XBA(IR) AAT 320
YH=YRA(IR) AAT 330
XNR=XNR1(IR) AAT 340
YNR=YNR1(IR) AAT 350
CALL D2PHI AAT 360
SIGX=0.0 AAT 370
SIGY=0.0 AAT 380
TAUXY=0.0 AAT 390
DO 31 J=1,ICS AAT 400
SIGX=SIGX+PHI(J)*DY2C(J) AAT 410

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SIGY=SIGY+PHI(J)*DX2C(J)	AAT	420
0031 TAUXY=TAUXY-PHI(J)*DXYC(J)	AAT	430
TEMP1=0.25*H(0)*SORCE	AAT	440
XR2=TEMP1*XR**2	AAT	450
YR2=TEMP1*YR**2	AAT	460
SIGX = SIGX - DY2C(IC1) + XR2 +3.0*YR2	AAT	470
SIGY = SIGY - DX2C(IC1) + YR2 +3.0*XR2	AAT	480
TAUXY= TAUXY +DXYC(IC1) - TEMP1*2.0*XR*YR	AAT	490
XNR2=XNR**2	AAT	500
YNR2=YNR**2	AAT	510
SIGN=XNR2*SIGX+YNR2*SIGY+2.0*XNR*YNR*TAUXY	AAT	520
SIGT=YNR2*SIGX+XNR2*SIGY-2.0*XNR*YNR*TAUXY	AAT	530
TAUT=(XNR2-YNR2)*TAUXY+XNR*YNR*(SIGY-SIGX)	AAT	540
WRITE (4,39)SIGX,SIGY,TAUXY,IR,SIGN,SIGT,TAUT,XR,YR	AAT	550
4 CONTINUE	AAT	560
RETURN	AAT	570
101 FORMAT (1H1,20X,1RA4)	AAT	580
3R9FORMAT(1H0/44X,23HBOUNDARY POINT STRESSES///7X,4HSIGX,8X,4HSIGY,	AAT	590
1 8X,5HTAUXY,6X,3HIRA,8X,4HSIGN,8X,4HSIGT,5X,10HTANG,SHEAR,5X,	AAT	600
2 1HX,9X,1HY//)	AAT	610
39 FORMAT(1H .F11.2,F12.2,F13.2,1R,F13.2,F12.2,F13.2,2F10.4)	AAT	620
END	AAT	630

	SUBROUTINE UVDYIS	AAI	10
C	SUBROUTINE FOR BOUNDARY DISPLACEMENTS	AAI	20
	DEFINITION PHJ(140),TVALUE(140),COND(40),CONDH(40),TITLE(140),	AAI	30
	IC(18),ISYPOI(42),RETA(40),ICUR(40),IPOSIA(40),ITYPOL(40),KEY(10),NORDER	AAI	40
	TCOOL(40),XPOLE(40),YPOLE(40),MAT(140),NAT(140),KAT(140),CJAJ	AAI	50
	RCUR(160),XSYPOI(240),YSYPOI(240),XRA(300),YNRA(300),YRA(300),YNRAA	AAI	60
	IFQNO(40),RTSIDE(40),MGT(40),NGT(40),KGT(40),GVALA	AAI	70
	OUT(40),NAS(140),MAS(140),KAS(140),MG(120),NG(120),KGT(120),GVALUE	AAI	80
	OUT(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXAA	AAI	90
	ZYC(141),R(40),SOCN(40),ENISN(50),A(10010),H(1000,8),RDYC(40,3),	AAI	100
	KRDY(60),IP(1000,8)	AAI	110
	COMMON DX1C, DY1C, A, RIOT, OGEN, CONDH	AAI	120
	COMMON PHJ, TVALUE, ICT, ICT, ICT, ICT	AAI	130
	COMMON IG, ICS, SHEAR, THERMK, INSYM, POSSON	AAI	140
	COMMON RUCYCL, MMAX, NOCCON, ICUR, NDSYM, ALPHA	AAI	150
	COMMON HCK, TITLE, ISYPOI, RETA, ICUR, IPOSIA	AAI	160
	COMMON ITYPOL, KEY, NORDER, TCOOL, XPOLE, YPOLE	AAI	170
	COMMON MAT, NAT, KAT, CURCON, XSYPOI, YSYPOI	AAI	180
	COMMON XRA, XNRA, YRA, YNRA, TRA, IFQNO	AAI	190
	COMMON RTSIDE, MGT, NGT, KGT, GVALUT, IES	AAI	200
	COMMON MAS, NAS, KAS, AG, NG, KG	AAI	210
	COMMON GVALUE, OUT, DPOC, RXYC, R, SOCN	AAI	220
	COMMON ENISN, TR, IFQN, TR, M, DELTHT	AAI	230
	COMMON RSHRX, RSHRY, THET, XR, XNR, YR	AAI	240
	COMMON YNR	AAI	250
	EQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC),	AAI	260
	IP(4(R181),KRDY),(RIOT,YOUBJ),(SORCE,OGEN),(COND,CONDH)	AAI	270
	ALPH2=SHEAR*2.0	AAI	280
	ALPH1=RIOT*(1.0-POSSON)*HCK/(ALPH2)	AAI	290
	TEMP1=0.25*RIOT*SORCE/ALPH2	AAI	300
	WRITE (6,101)TITLE	AAI	310
	WRITE (6,38)	AAI	320
	ICI = ICS + 1	AAI	330
	DO 4 JR=1,ICT	AAI	340
	XR=XRA(1R)	AAI	350
	YR=YRA(1R)	AAI	360
	XNR=XNRA(1R)	AAI	370
	YNR=YNRA(1R)	AAI	380
	CALL UVDIS	AAI	390
	SIGX=0.0	AAI	400
	SIGY=0.0	AAI	410

TSIGX=0.0	AAJ	420
TSIGY=0.0	AAJ	430
DO 31 J=1,IC5	AAJ	440
SIGX=SIGX+PHI(J)*DX2C(J)	AAJ	450
31 SIGY=SIGY+PHI(J)*DY2C(J)	AAJ	460
SIGY=SIGY*HCK/ALPH2	AAJ	470
SIGX=SIGX*HCK/ALPH2	AAJ	480
SIGX = SIGX - DX2C(IC1)/ALPH2	AAJ	490
SIGY = SIGY - DY2C(IC1)/ALPH2	AAJ	500
IF (IC1) 33,33,32	AAJ	510
32 CALL TOTS	AAJ	520
DO 52 J=1,ICT	AAJ	530
TSIGX=TSIGX+TVALUE(J)*DX2C(J)	AAJ	540
52 TSIGY=TSIGY+TVALUE(J)*DY2C(J)	AAJ	550
TSIGX=TSIGX*ALPH1	AAJ	560
TSIGY=TSIGY*ALPH1	AAJ	570
SIGX=SIGX+TSIGX	AAJ	580
SIGY=SIGY+TSIGY	AAJ	590
33 XH2=TEMP1*XH**2	AAJ	600
YH2=TEMP1*YH**2	AAJ	610
SIGX=SIGX-XH*(XH2+YH2)	AAJ	620
SIGY=SIGY-YH*(XH2+YH2)	AAJ	630
SIGN=SIGX*XNH+SIGY*YNH	AAJ	640
SIGT=-SIGX*YNH+SIGY*XNH	AAJ	650
WRITE (4,39) SIGX,SIGY,SIGN,SIGT,XH,YH,IR	AAJ	660
4 CONTINUE	AAJ	670
RETURN	AAJ	680
101 FORMAT (1H),20X,1RA4)	AAJ	690
38 FORMAT(1H0/,20X,2RHBOUNDARY POINT DISPLACEMENTS///,RX,1HX,1GX,1HY,AAJ	700	
113X,6HNORMAL,9X,10HTANGENTIAL/R3H DISPLACEMENT DISPLACEMENT	AAJ	710
2 DISPLACEMENT DISPLACEMENT XH YH,7X,3H1RA///)	AAJ	720
39 FORMAT(1P4E17.7,0P2F9.4,16)	AAJ	730
END)	AAJ	740


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SUBROUTINE DISINT                                A  V  10
SUBROUTINE FOR INTERIOR DISPLACEMENTS          A  V  20
DIMENSION PHI(140),TVALUE(140),COND(40),CONDH(40),TITLE(140) A  V  30
1R),ISYPOL(42),BETA(40),TCUR(40),IPOS1A(40),ITYPOL(40),KEY(10),NORDER A  V  40
2ER(40),TCOOL(40),XPOL(40),YPOL(40),MAT(140),NAT(140),KAT(140),CJ A  V  50
3RCUN(160),XSYPOL(240),YSYPOL(240),XRA(300),YNRA(300),YRA(300),Y A  V  60
4(300),IRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),G A  V  70
5UJT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),G A  V  80
6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(1 A  V  90
7YC(141),R(50),SOCN(50),ENTSN(50),A(10010),R(1000,R),RDYC(60,2), A  V  100
8KRDY(60),IP(1000,R)                                A  V  110
COMMON DX1C , DY1C , A , RIOT , UGEN , CONDH A  V  120
COMMON PHI , TVALUE , IFT , ICT , IGT , ICT A  V  130
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON A  V  140
COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA A  V  150
COMMON HCK , TITLE , ISYPOL , BETA , TCUR , IPOS1A A  V  160
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOL , YPOL A  V  170
COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL A  V  180
COMMON XRA , XNRA , YRA , YNRA , IRA , IEQNO A  V  190
COMMON RTSIDE , MGT , NGT , KGT , GVALIIT , IFS A  V  200
COMMON MAS , NAS , KAS , MG , NG , KG A  V  210
COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN A  V  220
COMMON ENTSN , IR , IEQN , IR , A , DELTHT A  V  230
COMMON RSHRX , RSHRY , THET , XR , XNR , YH A  V  240
COMMON YNR A  V  250
EQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,H,IP),(A(R001),RDYC), A  V  260
1 (A(8181),KRDY),(RIOT,YOUNG),(SORCE,UGEN),(COND,CONDH) A  V  270
READ (5,131)NUMSX,NUMSY,XMIN,YMIN,DEFLX3,DEFLY3 A  V  280
WRITE (5,101)TITLE A  V  290
WRITE (5,28)XMIN,YMIN,NUMSX,NUMSY,DEFLX3,DEFLY3 A  V  300
ALPH2=SHEAR*2.0 A  V  310
ALPH1=RIOT*(1.0-POSSON)*HCK/(ALPH2) A  V  320
TEMP1=0.25*RIOT*SORCE/ALPH2 A  V  330
ICT = ICS + 1 A  V  340
YH=YMIN A  V  350
DO 21 I=1,NUMSY A  V  360
XR=XMIN A  V  370
DO 22 J=1,NUMSX A  V  380
CALL UVDIS A  V  390
SIGX =0.0 A  V  400
SIGY =0.0 A  V  410

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SUBROUTINE SIGINT                                     A65 10
C SUBROUTINE TO PLOT STRESS AND/OR TEMPERATURE RESULTS A65 20
C POSSIBLE GRIDS INCLUDE TEMPERATURE, MAXIMUM STRESS, MINIMUM STRESS, A65 30
C MAXIMUM SHEAR STRESS, X STRESS, Y STRESS, TAUXY, Z STRESS A65 40
C DIMENSION PHT(140), TVALUE(140), COND(40), CONDH(40), TITLE(140) A65 50
C (18), ISYPOL(42), BETA(40), TCUR(40), IPOSIA(40), ITYPOL(40), KEY(10), NORDER A65 60
C PER(40), TCOOL(40), XPOLF(40), YPOLE(40), MAT(140), NAT(140), KAT(140), C140 A65 70
C 3RCOM(160), XSYPOL(240), YSYPOL(240), XRA(300), XNRA(300), TRA(300), YNRA A65 80
C 4(300), IRA(500), IEQND(500), RTSIDE(500), MGT(40), NGT(40), KGT(40), GVAL A65 90
C 5UT(40), KAS(140), NAS(140), KAS(140), MG(120), NG(120), KG(120), GVALU A65 100
C 5120), DX1C(141), DX2C(141), DY1C(141), DY2C(141), OUT(141), DPOC(141), DXAA A65 110
C 7YC(141), R(50), SOCN(50), ENISN(50), A(10010), R(1000,R), RDYCY(60,3), A65 120
C KKHBY(60), IP(1000,R) A65 130
C COMMON DX1C , DY1C , A , RIOT , QGEN , CONDH A65 140
C COMMON PHT , TVALUE , I-T , ICT , IGT , ICT A65 150
C COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON A65 160
C COMMON DPOCYC , MMAX , NOCCON , NOCUR , NOSYM , ALPHA A65 170
C COMMON HCK , TITLE , ISYPOL , BETA , TCUR , IPOSIA A65 180
C COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOLE A65 190
C COMMON MAT , NAT , KAT , CURCOM , XSYPOL , YSYPOL A65 200
C COMMON XRA , XNRA , TRA , YNRA , IRA , IEQND A65 210
C COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IFS A65 220
C COMMON MAS , NAS , KAS , MG , NG , KG A65 230
C COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN A65 240
C COMMON ENISN , IR , IFQND , TR , M , FLTHT A65 250
C COMMON RSURX , RSURY , THET , XP , XNR , YR A65 260
C COMMON YNR A65 270
C EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYCY), A65 280
C (A(R1R1),KKBY),(RIOT,YOUNG),(SORCE,QGEN),(COND,CONDH) A65 290
C READ (5,100)NUMRDY,GRIDS/ A65 300
C A65 310
C A65 320
C 100 FORMAT (I3,E21.2) A65 330
C A65 340
C DO 11 I = 1,NUMRDY A65 350
C A65 360
C 11 READ (5,101)(RDYCY(I,J),J = 1,3),XSDY(I) A65 370
C 101 FORMAT (3F12.2,I3) A65 380
C A65 390
C READ (5,102)NX,NY,XMIN,YMAX,MAXSTR,MINSTR,XYSHR,KXSTR, KYSTR,KXAA A65 400
C 1YSHR,KXSTR A65 410

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C
102 FORMAT (2I3,E18.2,F12.2,7I3)
      NPT = NX*NY
      IF (NPT - 1000) 1001,1001,1002
1002 WRITE (6,1003)NPT
10030FORMAT(45H1 THE TOTAL NUMBER OF GRID POINTS REQUESTED(,14, 22H)
      11S GREATER THAN 1000//)
      RETURN
1001 VOL = GRIDSZ*GRIDSZ
      LOC = 1
      NUMX = 1
      NUMY = 1
      XR = XMIN
      YR = YMAX
      INDEX = 0
C KEY(9) = -1 TEMP ONLY KEY(9) = 0 STRESS ONLY
C KEY(9) = 1 BOTH STRESS AND TEMP
      IF (KEY(2) - 3) 505,501,505
501 KEY(9) = -1
      GO TO 514
505 IF (ICT) 502,502,503
502 KEY(9) = 0
      GO TO 504
503 KEY(9) = 1
504 AVETEM = 0.0
      TMAX = 0.0
      SMAX = 0.0
      SMIN = 0.0
      TEMMAX = 0.0
      II = 0
      SXMAX = 0.0
      SYMAX = 0.0
      TXYMAX = 0.0
      SZMAX = 0.0
      SUMSZ = 0.0
C EVALUATION OF GRID POINTS (IF IN,GO TO 200) (IF OUT,GO TO 300)
12 KKK = 0
      L = 0
9989 L = L + 1
      LL = KBODY(L)
      GO TO (1,2,3,4,5,6),LL
13 CONTINUE

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A.1 420
A.1 430
A.1 440
A.1 450
A.1 460
A.1 470
A.1 480
A.1 490
A.1 500
A.1 510
A.1 520
A.1 530
A.1 540
A.1 550
A.1 560
A.1 570
A.1 580
A.1 590
A.1 600
A.1 610
A.1 620
A.1 630
A.1 640
A.1 650
A.1 660
A.1 670
A.1 680
A.1 690
A.1 700
A.1 710
A.1 720
A.1 730
A.1 740
A.1 750
A.1 760
A.1 770
A.1 780
A.1 790
A.1 800
A.1 810
A.1 820
A.1 830

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      IF (L .LT. NUMHDY) GO TO 9999
      KKK = 0
      GO TO 200
110  XH = XH + GRIDSZ
      NUMX = NUMX + 1
      LOC = LOC + 1
      IF (NUMX - NX) 17,17,16
16  YH = YH - GRIDSZ
      NUMY = 1
      NUMY = NUMY + 1
      XZ = XMTN
      IF (NUMY - NY) 17,17,400
17  KKKP1 = KKK + 1
      GO TO (12,1,2,3,4,5,6),KKKP1

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      1 RCALC2 = (XH - HDYC(L,1))**2 + (YH - HDYC(L,2))**2
      IF (RCALC2 - HDYC(L,3)**2) 50,51,51
50  KKK = 1
      GO TO 300
51  IF (KKK - 1) 13,12,13
      2 RCALC2 = (XH - HDYC(L,1))**2 + (YH - HDYC(L,2))**2
      IF (RCALC2 - HDYC(L,3)**2) 53,53,53
52  KKK = 2
      GO TO 300
53  IF (KKK-2) 13,12,13
      3 IF (XH - HDYC(L,1)) 54,55,55
54  KKK = 3
      GO TO 300
55  IF (KKK -3) 13,12,13
      4 IF (XH - HDYC(L,1)) 57,57,56
56  KKK = 4
      GO TO 300
57  IF (KKK-4) 13,12,13
      5 IF (YH - XH*HDYC(L,1) - HDYC(L,2)) 59,59,58
58  KKK = 5
      GO TO 300
59  IF (KKK - 5) 13,12,13
      6 IF (YH - XH*HDYC(L,1) - HDYC(L,2)) 60,61,61
60  KKK = 6
      GO TO 300
61  IF (KKK - 6) 13,12,13

```

```

AAV 840
AAW 850
AAV 860
AAW 870
AAW 880
AAW 890
AAW 900
AAV 910
AAW 920
AAV 930
AAV 940
AAW 950
AAV 960
AAV 970
AAW 980
AAW 990
AAW 1000
AAW 1010
AAW 1020
AAV 1030
AAW 1040
AAW 1050
AAW 1060
AAW 1070
AAW 1080
AAV 1090
AAV 1100
AAW 1110
AAV 1120
AAW 1130
AAW 1140
AAW 1150
AAW 1160
AAW 1170
AAV 1180
AAW 1190
AAV 1200
AAV 1210
AAW 1220
AAW 1230
AAV 1240
AAW 1250

```

```

300 DO 301 I = 1,8
301 R(LOC,I) = 0.0
GO TO 119

200 INDEX = INDEX + 1
IF (KEY(9)) 201,994,201
994 R(LOC,1) = 0.0
GO TO 214
201 ICT = ICT + 1
CALL DPWIO
R(LOC,1)=0.0
DO 202 I = 1,ICT
202 R(LOC,1) = R(LOC,1) + DPOC(I)*TVALUF(I)
R(LOC,1) = R(LOC,1) - DPOC(ICT)
AVETEM = AVETEM + R(LOC,1)
IF (R(LOC,1) - TEMMAX) 204,204,203
203 TEMMAX = R(LOC,1)
204 IF (KEY(9)) 119,205,205
205 ICT = ICS + 1
CALL DPWFI
SIGX = 0.0
SIGY = 0.0
TAUXY = 0.0
DO 206 K = 1,ICS
SIGX = SIGX + PHI(K)*DY2C(K)
SIGY = SIGY + PHI(K)*DX2C(K)
206 TAUXY = TAUXY - PHI(K)*XYC(K)
TEMP1 = 0.25*RIOT*SOURCE
XR2 = TEMP1*XH*XR
YR2 = TEMP1*YH*YR
SIGY = SIGY - DX2C(ICT) + YR2 + 3.0*XR2
SIGX = SIGX - DY2C(ICT) + XR2 + 3.0*YR2
TAUXY = TAUXY + DXYC(ICT) - TEMP1*2.0*XR*YR
RSURX = TAUXY
RSURY = (SIGX - SIGY)/2.0
TAUMAX = SURT(RSURX**2 + RSURY**2)
SIGM = (SIGX + SIGY)/2.0
SIGMAX = SIGM + TAUMAX
SIGMIN = SIGM - TAUMAX
R(LOC,2) = SIGMAX
R(LOC,3) = SIGMIN
R(LOC,4) = TAUMAX

```

```

AAV 1260
AAV 1270
AAW 1280
AAW 1290
AAV 1300
AAW 1310
AAV 1320
AAW 1330
AAV 1340
AAV 1350
AAV 1360
AAV 1370
AAV 1380
AAW 1390
AAW 1400
AAW 1410
AAV 1420
AAW 1430
AAV 1440
AAW 1450
AAW 1460
AAW 1470
AAW 1480
AAV 1490
AAW 1500
AAW 1510
AAW 1520
AAW 1530
AAW 1540
AAW 1550
AAW 1560
AAV 1570
AAW 1580
AAV 1590
AAW 1600
AAW 1610
AAW 1620
AAW 1630
AAV 1640
AAV 1650
AAV 1660
AAW 1670

```

R(LJC,5) = SIGX	AA 1630
R(LJC,6) = SIGY	AA 1640
R(LJC,7) = TAUXY	AAW 1700
IF (KEY(6)) 210,210,207	AAW 1710
207 IF (KEY(9)) 210,208,209	AAW 1720
208 R(LJC,8) = POISSON*(SIGX + SIGY)	AAW 1730
SUMSZ = SUMSZ + R(LJC,8)	AAW 1760
GO TO 210	AAW 1750
209 R(LJC,8) = - HINT*(1.-POISSON)*R(LJC,1) + POISSON*(SIGX + SIGY)	AAW 1760
SUMSZ = SUMSZ + R(LJC,8)	AAW 1770
210 IF (ABS(SIGMIN) = SMIN) 214,214,213	AAW 1780
213 SMIN = ABS(SIGMIN)	AAW 1790
214 IF (ABS(SIGMAX) = SMAX) 216,216,215	AAW 1800
215 SMAX = ABS(SIGMAX)	AAW 1810
216 GO TO 119	AAW 1820
C CONCLUSION	AAW 1830
400 ATINDEX = INDEX	AAW 1840
AREA = AINDEX*VOL	AAW 1850
IF (KEY(9)) 401,402,401	AAW 1860
401 AVETEM = AVETEM/ATINDEX	AAW 1870
WRITE (6,1004) AVETEM, AREA, INDEX, GRIDSZ, XMIN, YMAX	AAW 1880
10040 FORMAT(28H0 THE AVERAGE TEMPERATURE IS, F10.2, 11H	AAW 1890
1 12H INDEX =, I4//17H GRID SPACING =, F12.5, 10H	AAW 1900
2 F12.5, 10H YMAX =, F12.5)	AAW 1910
WRITE (6,1015) TITLE	AAW 1920
1015 FORMAT(11H, 20X, 18A4)	AAW 1930
WRITE (6,1016)	AAW 1940
1016 FORMAT(35H0 THE TEMPERATURE DISTRIBUTION IS ///	AAW 1950
CALL MPLOT (NX, NY, R(1,1), 1.)	AAW 1960
IF (KEY(9)) 400,402,402	AAW 1970
402 IF (KEY(6)) 500,407,403	AAW 1980
403 SUMSZ = SUMSZ/AINDEX	AAW 1990
DO 404 I = 1, NPT	AAW 2000
IF (R(I,8)) 428,404,428	AAW 2010
428 R(I,8) = R(I,8) - SUMSZ	AAW 2020
IF (ABS(R(I,8)) = SZMAX) 404,404,405	AAW 2030
405 SZMAX = ABS(R(I,8))	AAW 2040
404 CONTINUE	AAW 2050
IF (SZMAX = SMAX) 407,406,406	AAW 2060
406 SMAX = SZMAX	AAW 2070
407 IF (SMAX = SMIN) 408,408,429	AAW 2080
408 SMAX = SMIN	AAW 2090

C		AAW 2100
429	DO 409 I = 1,10	AAW 2110
	II = I	AAW 2120
	IF (SMAX / (1000.0 * 10.0 * II) - 1.0) 410,409,409	AAW 2130
409	CONTINUE	AAW 2140
	WRITE (6,1005) SMAX	AAW 2150
1005	FORMAT(24H0 THE MAXIMUM STRESS IS,F16.8,64H WHICH IS UNREASONABLE	AAW 2160
	1. THEREFORE NO STRESS GRIDS WERE PRINTED.)	AAW 2170
	GO TO 500	AAW 2180
410	II = II - 1	AAW 2190
	SF = 10 * II	AAW 2200
C		AAW 2210
	IF (MAXSTR) 414,415,414	AAW 2220
415	WRITE (6,1015) TITLE	AAW 2230
	WRITE (6,1007)	AAW 2240
1007	FORMAT(27H0 THE MAXIMUM STRESSES ARE)	AAW 2250
	WRITE (6,1006) II	AAW 2260
	CALL MPLOT (NX,NY,R(1,2),SF)	AAW 2270
414	IF (MINSTR) 416,417,416	AAW 2280
417	WRITE (6,1015) TITLE	AAW 2290
	WRITE (6,1008)	AAW 2300
1008	FORMAT(27H0 THE MINIMUM STRESSES ARE)	AAW 2310
	WRITE (6,1006) II	AAW 2320
	CALL MPLOT (NX,NY,R(1,3),SF)	AAW 2330
416	IF (MXSHR) 418,419,418	AAW 2340
419	WRITE (6,1015) TITLE	AAW 2350
	WRITE (6,1009)	AAW 2360
1009	FORMAT(23H0 THE MAXIMUM SHEAR STRESSES ARE)	AAW 2370
	WRITE (6,1006) II	AAW 2380
	CALL MPLOT (NX,NY,R(1,4),SF)	AAW 2390
418	IF (KXSTR) 420,421,420	AAW 2400
421	WRITE (6,1015) TITLE	AAW 2410
	WRITE (6,1010)	AAW 2420
1010	FORMAT(38H0 THE STRESSES IN THE X DIRECTION ARE)	AAW 2430
	WRITE (6,1006) II	AAW 2440
	CALL MPLOT (NX,NY,R(1,5),SF)	AAW 2450
420	IF (KYSTR) 422,423,422	AAW 2460
423	WRITE (6,1015) TITLE	AAW 2470
	WRITE (6,1011)	AAW 2480
1011	FORMAT(38H0 THE STRESSES IN THE Y DIRECTION ARE)	AAW 2490
	WRITE (6,1006) II	AAW 2500
	CALL MPLOT (NX,NY,R(1,6),SF)	AAW 2510

422 IF (KXYGHR) 424,425,424	A 2520
425 WRITE (6,1015)TITLE	A 2530
WRITE (6,1012)	A 2540
1012 FORMAT(29H THE X-Y SHEAR STRESSES ARE)	A 2550
WRITE (6,1006)II	A 2560
CALL MPLOT (NX,NY,R(1,7),SF)	A 2570
424 IF (KEY(6)) 500,500,413	A 2580
413 IF (KAXSTR) 426,427,426	A 2590
427 WRITE (6,1015)TITLE	A 2600
WRITE (6,1013)	A 2610
1013 FORMAT(23H THE AXIAL TENSILE STRESSES ARE)	A 2620
WRITE (6,1006)II	A 2630
CALL MPLOT (NX,NY,R(1,8),SF)	A 2640
426 WRITE (6,1014)SUMSZ	A 2650
10140FORMAT(52H THE AVERAGE AXIAL STRESS BEFORE NORMALIZATION WAS,	A 2660
1 E16.8,// 80H THIS CONTAINS THE AVERAGE THERMAL STRAIN AS VELAA	A 2670
2L AS THE AVERAGE AXIAL STRESS.)	A 2680
10060FORMAT(53H ALL STRESSES PRINTED HAVE BEEN DIVIDED BY 10 TO THE,	A 2690
1 12.34H POWER TO BE PRINTED CONVENIENTLY.//)	A 2700
500 RETURN	A 2710
END	A 2720

```

      SUBROUTINE MPLOT (NX,NY,4,SF)
C  SUBROUTINE TO PLOT RESULTS WHICH ARE STORED IN  R
      DIMENSION R(2000)
      NPXM1 = NX/20
      NPYM1 = NY/20
      NYREM = NY - 20*NPYM1
      NXREM = NX - 20*NPXM1
      IF (NPXM1) 33,33,32
32  DO 20  I = 1, NPXM1
      IF (NPYM1) 30,30,31
31  DO 41  J = 1, NPYM1
      M = 1 + NX*20*(J-1) + 20*(I-1) - NX
      DO 21  K = 1,20
      M = M + NX
      N = M + 19
21  CALL WRITE (R(1),M,N,SF)
      41  WRITE (6,103)
103  FORMAT (1H1)
      30  IF (NYREM) 20,20,22
      22  M = 1 + NX*20*NPYM1 - NX + 20*(I-1)
      DO 23  K = 1,NYREM
      M = M + NX
      N = M + 19
23  CALL WRITE (R(1),M,N,SF)
      WRITE (6,103)
      20  CONTINUE
      33  IF (NXREM) 26,26,24
      24  IF (NPYM1) 35,35,34
      34  DO 42  J = 1, NPYM1
      M = 1 + NX*20*(J-1) - NX + 20*NPXM1
      DO 25  K = 1,20
      M = M + NX
      N = M + NXREM - 1
25  CALL WRITE (R(1),M,N,SF)
      42  WRITE (6,103)
      35  IF (NYREM) 26,26,27
      27  M = 1 + NX*20*NPYM1 - NX + 20*NPXM1
      DO 28  K = 1,NYREM
      M = M + NX
      N = M + NXREM - 1
28  CALL WRITE (R(1),M,N,SF)

```

```

MP1  10
MP1  20
MP1  30
MP1  40
MP1  50
MP1  60
MP1  70
MP1  80
MP1  90
MP1 100
MP1 110
MP1 120
MP1 130
MP1 140
MP1 150
MP1 160
MP1 170
MP1 180
MP1 190
MP1 200
MP1 210
MP1 220
MP1 230
MP1 240
MP1 250
MP1 260
MP1 270
MP1 280
MP1 290
MP1 300
MP1 310
MP1 320
MP1 330
MP1 340
MP1 350
MP1 360
MP1 370
MP1 380
MP1 390
MP1 400
MP1 410

```

26 RETURN
END

ML 420
ML 430

A-73

```

      SUBROUTINE WRITE (R,M,N,SF)
C  SUBROUTINE TO WRITE A LINE
      DIMENSION R(1000),FMT(22),II(20)
      DATA Q000HL/6H15.  /
      X = Q000HL
      DATA Q001HL/6H5x.  /
      Y = Q001HL
      DATA Q002HL/6H(2H0 . /
      FMT(1) = Q002HL
      K = N - M + 3
      DATA Q003HL/6H)      /
      FMT(K) = Q003HL
      I = 0
      K = 1
      DO 2 I = M,N
      K = K + 1
      IF (R(I)) 3,4,3
4     FMT(K) = Y
      GO TO 2
3     J = J + 1
      II(J) = R(I)/SF
      FMT(K) = X
2     CONTINUE
      IF (J) 5,5,6
5     WRITE (5,101)
      RETURN
6     WRITE (6,FMT)(II(I),I=1,J)
      RETURN
101  FORMAT(1H0)
      END

```

NEXT	10
NEXT	20
NEXT	30
NEXT	40
NEXT	50
NEXT	60
NEXT	70
NEXT	80
NEXT	90
NEXT	100
NEXT	110
NEXT	120
NEXT	130
NEXT	140
NEXT	150
NEXT	160
NEXT	170
NEXT	180
NEXT	190
NEXT	200
NEXT	210
NEXT	220
NEXT	230
NEXT	240
NEXT	250
NEXT	260
NEXT	270
NEXT	280
NEXT	290
NEXT	300

```

SUBROUTINE SIGPLT
DIMENSION PHI(140),TVALUE(140),COND(40),CONDH(40),TITLE(140),
14),ISYPOL(40),BETA(40),TCUR(40),TPOS1A(40),ITYPOL(40),KEY(10),NORDAAX
2FER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CJAA
3RCUN(160),XSYPOL(240),YSYPOL(240),XRA(300),YNRA(300),YRA(300),YNHAA
4(300),TRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALA
5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE(
6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),
7YC(141),R(50),SOCN(50),ENTSN(50),A(10010),B(1000,8),BDYC(60,3),
8KRDY(60),IR(1000,8)
COMMON DX1C , DY1C , A , RIOT , QGEN , CONDH
COMMON PHI , TVALUE , IET , ICT , IGT , ICT
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON
COMMON PDCYCL , MMAX , NOCCON , NOCUR , NOSYM , ALPHA
COMMON HCK , TITLE , ISYPOL , BETA , ICUR , IP0S1A
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOLF
COMMON MAT , NAT , KAT , CURCUN , XSYPOL , YSYPOL
COMMON XRA , XNRA , YRA , YNRA , TRA , IEQNO
COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES
COMMON MAS , NAS , KAS , MG , NG , KG
COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN
COMMON ENTSN , IR , IEQN , IR , M , DELTHT
COMMON RSHRX , RSHRY , THET , XR , XNR , YR
COMMON YNR
EQUIVALENCE (DX1C,DX2C), (DY1C,DY2C), (A,R,IP), (A(9001),BDYC),
1 (A(8181),KRDY), (RIOT,YOUNG), (SORCE,QGEN), (COND,CONDH)
READ (5,1000) NUMSX,NUMSY,XMIN,YMIN,DEFLXR,DEFLYR,TREF,KSDR
WRITE (4,2000) TITLE
WRITE (4,2001) NUMSX,NUMSY,XMIN,YMIN,DEFLXR,DEFLYR
WRITE (11) TITLE,XMIN,YMIN,NUMSX,NUMSY,DEFLXR,DEFLYR,IET,NOCHD,
1(ICUR(I),I=1,NOCUR) , (XRA(I),YRA(I),I=1,IET)
TPAGE = 30
SIGX = 0.0
SIGY = 0.0
TAUXY = 0.0
TAUMAX = 0.0
SIGMAX = 0.0
SIGMIN = 0.0
TEMP1 = 0.25*RIOT*SORCE

```

```

AAX 10
AAX 20
AAX 30
AAX 40
AAX 50
AAX 60
AAX 70
AAX 80
AAX 90
AAX 100
AAX 110
AAX 120
AAX 130
AAX 140
AAX 150
AAX 160
AAX 170
AAX 180
AAX 190
AAX 200
AAX 210
AAX 220
AAX 230
AAX 240
AAX 250
AAX 260
AAX 270
AAX 280
AAX 290
AAX 300
AAX 310
AAX 320
AAX 330
AAX 340
AAX 350
AAX 360
AAX 370
AAX 380
AAX 390
AAX 400
AAX 410

```

	YR = YMIN	AAx	420
	ICOUNT = 0	AAx	430
	DO 20 K = 1,NUMSY	AAx	440
	XB = XMIN	AAx	450
	DO 10 J = 1,NUMSX	AAx	460
	IF (ICT .GT. 0) GO TO 30	AAx	470
	TEMP = TREF	AAx	480
	GO TO 40	AAx	490
30	IC1 = ICT + 1	AAx	500
	CALL DPBIO	AAx	510
	TEMP = TREF	AAx	520
	DO 35 I = 1,ICT	AAx	530
35	TEMP = TEMP + DPOC(I)*TVALUE(I)	AAx	540
	TEMP = TEMP - DPOC(IC1)	AAx	550
40	IF (KEY(2) .EQ. 3) GO TO 70	AAx	560
		AAx	570
	IC1 = ICS + 1	AAx	580
	CALL DPBIO	AAx	590
	SIGX = 0.0	AAx	600
	SIGY = 0.0	AAx	610
	TAUXY = 0.0	AAx	620
	DO 50 I = 1,ICS	AAx	630
	SIGX = SIGX + PHI(I)*DY2C(I)	AAx	640
	SIGY = SIGY + PHI(I)*DX2C(I)	AAx	650
50	TAUXY = TAUXY - PHI(I)*DXYC(I)	AAx	660
	XR2 = TEMP1*XR**2	AAx	670
	YR2 = TEMP1*YR**2	AAx	680
	SIGY = SIGY - DY2C(IC1) + YR2 + 3.0*XR2	AAx	690
	SIGX = SIGX - DX2C(IC1) + XR2 + 3.0*YR2	AAx	700
	TAUXY = TAUXY + DXYC(IC1) - TEMP1*2.0*XR*YR	AAx	710
	RSUBY = TAUXY	AAx	720
	RSUBX = (SIGX - SIGY)*0.5	AAx	730
	TAUMAX = SORT (RSUBX**2 + RSUBY**2)	AAx	740
	SIGM = (SIGX + SIGY)*0.5	AAx	750
	SIGMAX = SIGM + TAUMAX	AAx	760
	SIGMIN = SIGM - TAUMAX	AAx	770
		AAx	780
		AAx	790
70	ICOUNT = ICOUNT + 1	AAx	800
	IF (ICOUNT .LE. 5) GO TO 60	AAx	810
	ICOUNT = 1	AAx	820
	WRITE (6,2002)	AAx	830
80	IF (K SUPR .EQ. 0)	AAx	840

1	WRITE (6,2003) XH,YH,TEMP,SIGX,SIGY,TAUXY,SIGMAX,SIGMIN,	AAx	940
2	TAUMAX	AAx	950
	WRITE (11) TEMP,SIGX,SIGY,TAUXY,SIGMAX,SIGMIN,TAUMAX	AAx	960
	IPAGE = IPAGE + 1	AAx	970
	IF (IPAGE .GT. 4) GO TO 10	AAx	980
	WRITE (6,2004)	AAx	990
	ICOUNT = 0	AAx	900
	IPAGE = 35	AAx	910
10	X4 = XH + DELXH	AAx	920
20	YH = YH + DELYH	AAx	930
	RETURN	AAx	940
1000	FORMAT (2I3,E18.6,4F12.6,I8)	AAx	950
2000	FORMAT (1H1,20X,18A1/)	AAx	960
2001	FORMAT (32H0 INTERIOR STRESSES FOR PLOTTING// 9H NUMSX =.14.	AAx	970
1	10H NUMSY =.14/ 8H XMIN =.F10.5*10H YMIN =.F10.5.	AAx	980
2	10H DELX =.F10.5. 10H DELY =.F12.5// 90H	AAx	990
3	Y TEMP SIGX SIGY TAUXY SIGMAX SIGMIN	AAx	1000
4	TAUMAX /)	AAx	1010
2002	FORMAT (1H)	AAx	1020
2003	FORMAT (1X,2F4.4,F8.1,3F10.1,2X,3F11.1)	AAx	1030
2004	FORMAT (1H1)	AAx	1040
	END	AAx	1050

```

SUBROUTINE RC1                                BC1  10
C  NORMAL STRESS NORMAL TO THE BOUNDARY      BC1  20
DIMENSION PHI(140),TVALUE(140),COND(40),CONDH(40),TITLE(180) BC1  30
1R),ISYPOL(42),BETA(40),ICUR(40),IP0S1A(40),ITYPOL(40),KEY(10),NORDR BC1  40
2ER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CURC BC1  50
3RCUN(160),XSYPOL(240),YSYPOL(240),XHA(300),XNRA(300),YRA(300),YNBAR BC1  60
4(300),TRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALRC BC1  70
5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( BC1  80
6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXRC BC1  90
7YC(141),R(50),SOCN(50),ENTSN(50),A(10010),R(1000,R),RDYC(60,3), BC1 100
8KRDY(60),IP(1000,R)                        BC1 110
COMMON DX1C , DY1C , A , RIOT , QGEN , CONDH BC1 120
COMMON PHI , TVALUE , IFT , ICT , IGT , ICI BC1 130
COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON BC1 140
COMMON PDCYCL , MMAX , NOCCON , NOCJR , NOSYM , ALPHA BC1 150
COMMON HCK , TITLE , ISYPOI , BETA , ICUR , IP0S1A BC1 160
COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOL E BC1 170
COMMON MAT , NAT , KAT , CURCUN , XSYPOL , YSY5OL BC1 180
COMMON XHA , XNRA , YRA , YNRA , TRA , IEQNO BC1 190
COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES BC1 200
COMMON MAS , NAS , KAS , MG , NG , KG BC1 210
COMMON GVALUF , OUT , UPOC , DXYC , R , SOCN BC1 220
COMMON ENTSN , IB , IFQN , IR , M , DELTHT BC1 230
COMMON RSURX , RSURY , THET , XH , XNR , YR BC1 240
COMMON YNR BC1 250
EQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC), BC1 260
1 (A(8181),KRDY),(RIOT,YOUNG),(SORCE,QGEN),(COND,CONDH) BC1 270
ICI = ICS + 1 BC1 280
CALL D2PHI BC1 290
XNR2=XNR**2 BC1 300
YNR2=YNR**2 BC1 310
XYN3=2.*XNR*YNR BC1 320
DO 2 I=1,ICI BC1 330
2 OUT(I)=DY2C(I)*XNR2+DX2C(I)*YNR2-XYNR3*XYC(I) BC1 340
OUT(ICI)=OUT(ICI)-0.25*RIOT*SORCE*((XH**2+3.*YR**2)*XNR2+(YR**2+3 BC1 350
1.*XH**2)*YNR2-2.*XH*YR*XYNR) BC1 360
RETURN BC1 370
END BC1 380

```



```

SUBROUTINE RC2                                302 10
C TANGENTIAL BOUNDARY SHEAR (PREFER CALCULATION OF NORMAL STRESS FIRST) 302 20
  DIMENSION PHI(141),TVALUE(140),CONDI(40),CONDI4(40),TITLE(140) 302 30
  1R),ISYPOL(42),BETA(40),TCUR(40),IPASS1A(40),ITYPOL(40),KEY(10),NORDEF 302 40
  2ER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CIRCON 302 50
  3RC(16),XSYPOL(240),YSYPOL(240),XRA(300),YNRA(300),YRA(300),YNRA(300) 302 60
  4(300),IRA(500),IFQND(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVAL 302 70
  5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE( 302 80
  6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DX 302 90
  7YC(141),R(50),SOCN(50),ENISN(50),A(10010),R(1000,R),HLYC(60,3), 302 100
  HKRDY(60),IP(1000,R) 302 110
  COMMON DX1C , DY1C , A , RIOT , YGEN , CONDH 302 120
  COMMON PHI , TVALUE , IFT , ICT , IGT , ICT 302 130
  COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON 302 140
  COMMON POCYCL , MMIX , NOCCON , NOCJR , NOSYM , ALPHA 302 150
  COMMON HCK , TITLE , ISYPOL , BETA , TCUR , IPASS1A 302 160
  COMMON ITYPOL , KEY , NORDEF , TCOOL , XPOLF , YPOLF 302 170
  COMMON MAT , NAT , KAT , CIRCON , XSYPOL , YSYPOL 302 180
  COMMON XRA , YNRA , YRA , YNRA , IRA , IFQND 302 190
  COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES 302 200
  COMMON MAS , NAS , KAS , MG , NG , KG 302 210
  COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN 302 220
  COMMON ENISN , IR , IFQND , IR , M , DELTHT 302 230
  COMMON RSURX , RSURY , TNET , XM , YNR , YR 302 240
  COMMON YNR 302 250
  EQUIVALENCE (DX1C,DY2C),(DY1C,DY2C),(A,R,IP),(A(R001),R0YC), 302 260
  (A(R1R1),KRDY),(RIOT,YOUNG),(SOURCE,YGEN),(CONDI,CONDH) 302 270
  ICT = ICS + 1 302 280
  IF (IR = 1) 1, 1, 6 302 290
6 IF (IR = IRA(IR-1)) 1, 3, 1 302 300
3 IF (IEQND(IR-1) = 1) 1, 4, 1 302 310
1 CALL DPHI 302 320
4 XNR2=YNR**2-XNR**2 302 330
  YNR2=XN1*YNR 302 340
  DO 2 I=1,IC1 302 350
2 OUT(I)=IXYC(I)*XNR2+YNR2*(DY2C(I)-DY2C(I)) 302 360
  OUT(IC1)=OUT(IC1)-0.50*RIOT*SOURCE*(XN*YR*XNR2+YNR2*(XN**2-YR**2)) 302 370
  RETURN 302 380
END 302 390

```

```

SUBROUTINE HCR3                                RC3    10
C  NORMAL DISPLACEMENT SPECIFIED              RC3    20
  DIMENSION PHI(140),TVALUE(140),CONO(40),CONDH(40),TITLE(140) RC3    30
  1R),ISYPOL(40),HETA(40),ICJR(40),IPASIA(40),ITYPOL(40),KEY(10),NORHCR3    40
  2FER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CHCR3    50
  3RCOV(160),XSYPOL(240),YSYPOL(240),XHA(300),YHRA(300),YRA(300),YHRAHCR3    60
  4(300),IRA(500),IEQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALHCR3    70
  5UT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVHLUF( HCR3    80
  6120),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPHC(141),DXBCR3    90
  7YC(141),R(50),SOCN(50),FNISN(50),A(10010),H(1000,R),RDYC(60,R), HCR3   100
  8KRDY(60),IP(1000,R)                        RC3   110
  COMMON DX1C , DY1C , A , RIOT , YOUNG , CONDH HCR3   120
  COMMON PHI , TVALUE , ICT , ICT , ICT , ICT , ICT HCR3   130
  COMMON IG , ICS , SHEAR , THERMK , INSYM , POSSON HCR3   140
  COMMON PDCYCL , MMAX , NOCCOM , NOCJR , NOSYM , ALPHA HCR3   150
  COMMON HCK , TITLE , ISYPOL , HETA , ICJR , IPASIA HCR3   160
  COMMON ITYPOL , KEY , NORHCR , TCOOL , XPOLF , YPOLF HCR3   170
  COMMON MAT , NAT , KAT , CURCOM , XSYPOL , YSYPOL HCR3   180
  COMMON XHA , XHRA , YRA , YHRA , IRA , IEQNO HCR3   190
  COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES HCR3   200
  COMMON MAS , NAS , KAS , MG , NG , KG HCR3   210
  COMMON GVALUE , OUT , , DPHC , DXYC , R , SOCN HCR3   220
  COMMON FNISN , IR , IEQN , IR , M , DELTHT HCR3   230
  COMMON RSURX , RSURY , THFT , XR , XNR , YH HCR3   240
  COMMON YNR HCR3   250
  1EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC), HCR3   260
  1 (A(R1R1),KRDY),(RIOT,YOUNG),(SORCE,YOUNG),(COND,CONDH) HCR3   270
  ICT = ICS + 1 HCR3   280
  ALPH2 = 2.0 HCR3   290
  ALPH1=RIOT*(1.0-POSSON)*HCK/ALPH2 HCR3   300
  TEMP1=0.25*RIOT*SORCE/ALPH2 HCR3   310
  CALL UVDIS HCR3   320
  DO 2 I=1,ICS HCR3   330
  2 OUT(I)=(DX2C(I)*XNR+DY2C(I)*YNR)*HCK/ALPH2 HCR3   340
  OUT(ICI)=(DX2C(ICI)*XNB+DY2C(ICI)*YNR)/ALPH2+TEMP1*(X4**2+Y2**2)*(RC3   350
  1 XH*XNB+YH*YNR) HCR3   360
  IF(ICT) 33,33,32 HCR3   370
  32 CALL TOT5 HCR3   380
  TSIGX=0.0 HCR3   390
  TSIGY=0.0 HCR3   400
  DO 52 I=1,ICT HCR3   410

```

```

      TSIGX=TSIGX+TVALUE(I)*DX2C(I)
52  TSIGY=TSIGY+TVALUE(I)*DY2C(I)
      OUT(IC1)=OUT(IC1)-ALPH1*(TSIGX*X+3+TSIGY*Y+6)
33  RETURN
      END

```

```

202  420
203  430
302  440
402  450
203  460

```

```

SUBROUTINE RC4
C  TANGENTIAL DISPLACEMENT SPECIFIED
  DIMENSION PHI(140),TVALUE(140),CONV(40),CONDH(40),TITLE(140),ISYPOL(40),BETA(40),ICUR(40),IPOS1A(40),ITYPOL(40),KEY(10),NORDER(40),TCOOL(40),XPOLF(40),YPOLF(40),MAT(140),NAT(140),KAT(140),CURCON(160),XSYPOL(240),YSYPOL(240),XRA(300),YNRA(300),YRA(300),YVRA(400),IEQNO(400),IRA(500),IFQNO(500),RTSIDE(500),MGT(40),NGT(40),KGT(40),GVALUE(400),OUT(40),MAS(140),NAS(140),KAS(140),MG(120),NG(120),KG(120),GVALUE(400),DX1C(141),DX2C(141),DY1C(141),DY2C(141),OUT(141),DPOC(141),DXYC(141),R(50),SOCN(50),ENISN(50),A(10010),R(1000,8),RDYC(60,3),RKBDY(60),IP(1000,8)
  COMMON DX1C , DY1C , A , RIOT , NGEN , CONDH
  COMMON PHI , TVALUE , IFT , ICT , IGT , ICI
  COMMON IG , ICS , SHEAR , THERMK , INSYM , POISSON
  COMMON PDCYCL , MMAX , NOCON , NOCUR , NOSYM , ALPHA
  COMMON HCK , TITLE , ISYPOL , BETA , ICUR , IPOS1A
  COMMON ITYPOL , KEY , NORDER , TCOOL , XPOLF , YPOL'E
  COMMON MAT , NAT , KAT , CURCON , XSYPOL , YSYPOL
  COMMON XRA , XNRA , YRA , YNRA , IRA , IEQNO
  COMMON RTSIDE , MGT , NGT , KGT , GVALUT , IES
  COMMON MAS , NAS , KAS , MG , NG , KG
  COMMON GVALUE , OUT , DPOC , DXYC , R , SOCN
  COMMON ENISN , IR , IFQN , IR , M , DELTHT
  COMMON RSJRX , RSJRY , THET , XR , XNR , YR
  COMMON YNR
  EQUIVALENCE (DX1C,DX2C),(DY1C,DY2C),(A,R,IP),(A(R001),RDYC),
1 (A(R1R1),RKBDY),(RIOT,YOUNG),(SORCE,NGEN),(CONV,CONDH)
  ICI = ICS + 1
  IF (IR - 1) 1, 1, 6
6 IF (IR-IRA(IR-1)) 1,3,1
3 IF (IEQNO(IR-1)-3) 1,4,1
4 IF (ICT) 1,5,1
1 CALL UVDIS
5 ALPH2 = 2.0
  ALPH1=RIOT*(1.0-POISSON)*HCK/ALPH2
  TEMP1=0.25*RIOT*SORCE/ALPH2
  DO 2 I=1,ICS
2 OUT(I)=(DY2C(I)*XNB-DX2C(I)*YNB)*HCK/ALPH2
  OUT(ICI)=(DY2C(ICI)*XNB-DX2C(ICI)*YNB)/ALPH2+TEMP1*(X4**2+Y4**2)*(
1 YB*XNB-XB*YNB)
  IF (ICT) 33,33,32

```

```

32 CALL TDIS
   TSIGX=0.0
   TSIGY=0.0
   DO =2 I=1,ICT
   TSIGX=TSIGX+TVALUE(I)*DX2C(I)
52 TSIGY=TSIGY+TVALUE(I)*DY2C(I)
   OUT(ICI)=OUT(ICI)-ALPH1*(TSIGY*XNA-TSIGX*YNA)
33 RETURN
END

```

```

BC4 420
BC4 430
BC4 440
BC4 450
BC4 460
BC4 470
BC4 480
BC4 490
BC4 500

```

```

      SUBROUTINE INPUTA(VAR)
CINPUT = FOR FLOATING POINT VARIABLES
      DIMENSION VAR(1),I1(2),I2(2),A3(2),A4(2)
      2  READ (5,1001) (I1(I),I2(I),A3(I),A4(I),I=1,2)
1001  FORMAT (2(2I6,2F12.2))
      3  DO 10 II = 1,2
         A4=1
         IF (I1(II)) 30,10,11
11      IF (I2(II)) 40,12,13
30      RETURN
C
12      J = I1(II)
         VAR(J) = A3(II)
         GO TO 10
C
40  I2(II) = -I2(II)
         N4 = A4(II)+0.1
         A4(II) = 0.0
13      N1 = I1(II)
         N2 = I2(II)
         DO 16 I = N1,N2,N4
            J = I - N4
            VAR(I) = VAR(J) + A4(II)
            IF (I=N1) 16,17,16
17      VAR(I) = A3(II)
16      CONTINUE
10      CONTINUE
         GO TO 2
      END

```

```

      INP 10
      INP 20
      INP 30
      INP 40
      INP 50
      INP 60
      INP 70
      INP 80
      INP 90
      INP 100
      INP 110
      INP 120
      INP 130
      INP 140
      INP 150
      INP 160
      INP 170
      INP 180
      INP 190
      INP 200
      INP 210
      INP 220
      INP 230
      INP 240
      INP 250
      INP 260
      INP 270
      INP 280
      INP 290

```

```

      SUBROUTINE INPUT1(IVAR)
CINPUT1= FOR INTEGERS
      DIMENSIONIVAR(1),I1(3),I2(3),I3(3),I4(3)
      2  READ (5,1001) (I1(I),I2(I),I3(I),I4(I),I=1,3)
1001  FORMAT (3(4I0))
      3  DO 10 II = 1,3
          N4 = 1
          IF (I1(II)) 30,10,11
      11  IF (I2(II)) 40,12,13
      30  RETURN
C
      12  J = I1(II)
          IVAR(J) = I3(II)
          GO TO 10
C
      40  I2(II) = -I2(II)
          N4 = I4(II)
          I4(II) = 0
      13  N1 = I1(II)
          N2 = I2(II)
          DO 16 I = N1,N2,N4
              J = I - N4
              IVAR(I) = IVAR(J) + I4(II)
              IF (I-N1) 14,17,16
      17  IVAR(I) = I3(II)
      16  CONTINUE
      10  CONTINUE
          GO TO 2
      END

```

```

      AAY 10
      AAY 20
      AAY 30
      AAY 40
      AAY 50
      AAY 60
      AAY 70
      AAY 80
      AAY 90
      AAY 100
      AAY 110
      AAY 120
      AAY 130
      AAY 140
      AAY 150
      AAY 160
      AAY 170
      AAY 180
      AAY 190
      AAY 200
      AAY 210
      AAY 220
      AAY 230
      AAY 240
      AAY 250
      AAY 260
      AAY 270
      AAY 280
      AAY 290

```

```

CSATP T
PROGRAM SATPLT (INPUT,OUTPUT, TAPE5=INPUT,TAPE6=OUTPUT,TAPE11)
C
C PLOTTING PROGRAM FOR SATS RESULTS
C REQUIRED SUBROUTINES =FRAME,SCALE,DASH)
C
C DIMENSION X(5),Z( 5),SIG(2500,7), VALUE(50),TITLE(18),
C TYPE(4,7), S(5),RH(2),ZZ(2),XBA(300),YBA(300),ICUR(40)
C DATA TYPE /
C 4HTEMP,4HFRAT,4HIRE,4H ,4HST,4HRESS,4H ,4H ,
C 4HYSI,4HRESS,4H ,4H ,4HYSI,4HFRAT,4HSTR,4HRESS,
C 4HMAXI,4HMINI,4HSTRE,4HSS ,4HMINI,4HMINI,4HSTRE,4HSS /
C
C REWIND 11
CALL PDIC- (3)
PLICNT = 0.0
1 READ (5,1000) NUMRHS,KPRINT,IUSER READ
DO 300 I=1,1,NUMRHS
READ (5,1001) RMIN,RMAX,ZMIN,ZMAX,RINCH,ZINCH READ
READ (11) TITLE,XMIN,YMIN,NUMSX,NUMSY,DELX,DELY,DET,NOCIR, READ(11)
ICUR(I),I=1,ICUR),(XBA(I),YBA(I),I=1,DET)
WRITE (5,2001) TITLE
WRITE (5,2001) RMIN,RMAX,ZMIN,ZMAX,RINCH,ZINCH,XMIN,YMIN,NUMSX,
NUMSY,DELX,DELY
JUMP = NUMSX*NUMSY
IF (JUMP .LT. 2500) GO TO 20
WRITE (5,2002)
CALL EXIT
20 DO 40 I = 1,NUMRHS
30 READ (11) (SIG(I,J),J=1,7) READ(11)
C
50 READ (5,1002) KK,IPLOTS,NUMISO,(VALUE(I),I=1,5) READ
IF (IPLOTS .LE. 0) GO TO 200
IF ((KK .LE. 0) .AND. (NUMISO .GT. 5)) READ(5,1001) (VALUE(I),I=6,NUMISO) READ
IF (KK .LE. 0) GO TO 55
NUMISO = NUMISO + 1
CON = NUMISO - 1
CON = (VALUE(2) - VALUE(1))/CON
DO 52 I = 2,NUMISO
52 VALUE(I) = VALUE(I-1) + CON

```

B-1

SATS PLOTTING PROGRAM

APPENDIX B


```

55      WRITE(6,2003) (TYPE(I,IPLOTS),J=1,4),(VALUE(I),I=1,NUMISO)
      CALL FRAME (RMIN,RMAX,ZMIN,ZMAX,RINCH,ZINCH,1,1,4H X , 1.      FRAME
      4H Z ,1,3,TITLE,4,TYPE(1,IPLOTS),4H JAS)
      PLTCNT = PLTCNT + 1.0
      NCOL = NUMSY - 1
      NROW = NUMSX - 1
      AROW = ROW
      ACOL = COL
      R(1) = XMIN
      Z(1) = YMIN
      R(2) = XMIN + AROW*DELXH
      Z(2) = YMIN
      R(3) = R(2)
      Z(3) = YMIN + ACOL*DELYH
      R(4) = R(1)
      Z(4) = Z(3)
      CALL DASH1 (R,Z,4,-1.1H )      DASH1
      DO 60 I = 1,NCOL
        K2 = ICUR(I)
        K1 = ICUR(I-1) + 1
        IF (I.EQ. 1) K1 = 1
        N = K2 - K1 + 1
        DO 60 J = 1,N
          60      CALL DASH1 (XHA(K1),YHA(K1),N,0,4H      DASH1
          DO 200 ICOL = 1,NCOL
            AICOL = ICOL
            R(1) = XMIN - DELXB
            R(4) = XMIN - DELXB
            R(3) = XMIN
            R(2) = XMIN
            Z(1) = ZMIN + (AICOL - 1.0)*DELYB
            Z(2) = Z(1)
            Z(3) = Z(2) + DELYB
            Z(4) = Z(1) + DELYH
            I1 = NUMSX*(ICOL-1)
            I2 = I1 + NUMSX
            DO 100 IROW = 1,NROW
              DO 101 I = 1,4
                101      R(I) = R(I) + DELXH
                I1 = I1 + 1
                I2 = I2 + 1
                S(I) = SIG(I1,IPLOTS)

```

```

      S(2) = SIG(I1+1,IPLOTS)
      S(3) = SIG(I2+1,IPLOTS)
      S(4) = SIG(I2,IPLOTS)
      S(5) = S(1)
      R(5) = R(1)
      Z(5) = Z(1)
      IF (KPRINT.GE.1)WRITE(6,2005) (R(I),Z(I),S(I),I=1,4)
2005  FORMAT(4(1X,2F9.5,F3.2))
      DO 169 J = 1,NUMISO
        V = VALJE(J)
        KK = 0
        DO 165 K = 1,3
          IF((KK.EQ.1).AND.(K.EQ.2)) GO TO 165
          IF (((S(K+1).GE.V).AND.(S(K).LT.V)).OR.
             ((S(K+1).LT.V).AND.(S(K).GE.V))) GO TO 161
          GO TO 165
161    RATIO = (V - S(K))/(S(K+1)-S(K))
        RR(1) = R(K) + RATIO*(R(K+1)-R(K))
        ZZ(1) = Z(K) + RATIO*(Z(K+1)-Z(K))
        DO 164 L = K,3
          IF (((S(L+2).GE.V).AND.(S(L+1).LT.V)).OR.
             ((S(L+2).LT.V).AND.(S(L+1).GE.V))) GO TO 163
164    CONTINUE
        GO TO 169
163    RATIO = (V - S(L+1))/(S(L+2)-S(L+1))
        RR(2) = R(L+1) + RATIO*(R(L+2)-R(L+1))
        ZZ(2) = Z(L+1) + RATIO*(Z(L+2)-Z(L+1))
        KKK = 0
        IF (V.EQ.0.) KKK = 1
        CALL DASH1 (RR,ZZ,2,KKK,1H )
        IF ((K.EQ.1).AND.(L.EQ.1)) KKK = 1
165    CONTINUE
169  CONTINUE
100  CONTINUE
200  CONTINUE

      GO TO,50

400  WRITE (6,2004) P1CONT
      CALL PLOT3

500  CONTINUE

```

C

RE*IND 11
CALL EXIT
GO TO 1

C

C

1000 FORMAT (2I4,4X,A4)
1001 FORMAT (6E12.2)
1002 FORMAT (11,13,14,4X,5E12.2)

C

2000 FORMAT (1H),20X,1PA4//)
2001 0FORMAT (10H RMIN =,F8.4,10H RMAX =,F8.4,
1 10H ZMIN =,F8.4,10H ZMAX =,F8.4,10H RINCH =,F8.4,
2 10H ZINCH =,F8.4/10H XMIN =,F8.4,10H YMIN =,F8.4,
3 10H NUMSX =,I4 ,10H NUMSY =,I4 ,10H DELXB =,F8.4,
4 10H DELYB =,F8.4/)
2002 0FORMAT (60H1 NUMSX*NUMSY MUST NOT EXCEED 2500. PROBLEM TERMINATE
10. //)
2003 0FORMAT (1H0 // 40X,4A4// 30H VALUES OF ISO STRESS LINES /
1 (1X,5F20.6))
2004 FORMAT(15H) PLEASE PLOT. ,F5.0, 10H PLOTS. //)

C

END

CSTOP

```

      SUBROUTINE FRAME (X,T1,XMAX,Y,T1,YMAX,XINCH,YINCH,KEY,NXLAB,NLAB,
      NYLAB,YLAB,NT1,TITLE1,NT2,TITLE2,USER)
      CFRAME 1) CALL PLOT1 AND WRITE LABELS
      DIMENS(30) TITLE(30),A(2),XLAB(1),YLAB(1),TITLE1(1),TITLE2(1),TITLE
      (30)
      DATA BLANK/4H /
      C
      C XMIN = MIN. X VALUE      YMIN = MIN. Y VALUE      XINCH = X LENGTH (INCHES)
      C XMAX = MAX. X VALUE      YMAX = MAX. Y VALUE      YINCH = Y LENGTH (INCHES)
      C KEY   = 0 = PLOT SCALES,LABELS,TITLES
      C KEY   = 1 = PLOT TITLES ONLY
      C KEY   = 2 = PLOT NOTHING
      C KEY   = -1 = USE GRID OF 1 LINE PER INCH
      C NXLAB = NUMBER OF WORDS IN XLAB
      C NYLAB = NUMBER OF WORDS IN YLAB
      C NT1   = NUMBER OF WORDS IN TITLE1
      C NT2   = NUMBER OF WORDS IN TITLE2
      C
      DELX = XMAX - XMIN
      DELY = YMAX - YMIN
      XPERIN = DELX / XINCH
      YPERIN = DELY / YINCH
      XL = XMIN - XPERIN
      XR = XMAX + 0.5*XPERIN
      YR = YMIN - 0.5*YPERIN
      YT = YMAX + 0.25*YPERIN
      XI = XINCH + 1.5
      YI = YINCH + 0.75
      IF (XI .LE. 10.0) GO TO 10
      YI = YI*10.0/XI
      XI = 10.0
      10 IF (YI .LE. 10.0) GO TO 20
      XI = XI*10.0/YI
      YI = 10.0
      20 CALL PLOT1 (XL,XR,YR,YT,XI,YI,USER)
      IF (KEY = 2) 1,500,500
      C
      C TITLE
      C
      1 YPRINT = YMIN - 0.42*YPERIN
      IF (NT1 .LE. 0) GO TO 2

```

PLOT1

	CALL WXACNV (TITLE1,TITLE1,NT1,4)	WXACNV
	CALL WXLABL (XL,YPRINT,0.0,0.09,4*NT1,TITLE1)	WXLABL
2	IF (NT2 .LE. 0) GO TO 3	
	ANT1 = NT1	
	XPRINT = XL + 0.36*ANT1*XPERIN	
	CALL WXACNV (TITLE2,TITLE1,NT2,4)	WXACNV
	CALL WXLABL (XPRINT,YPRINT,0.0,0.09,4*NT2,TITLE1)	WXLABL
3	ANT1 = NT1 + NT2	
	XPRINT = XL + 0.36*ANT1*XPERIN	
	CALL WXLABL (XPRINT,YPRINT,0.0,0.09,4,JSFR)	WXLABL
C		
	IF (KEY = 1) 4,500,500	
C		
C XAXIS		
4	CALL LINE	LINE
	CALL PLOT2 (XMAX,YMIN)	PLOT2
	CALL PLOT2 (XMIN,YMIN)	PLOT2
C YAXIS		
	CALL PLOT2 (XMIN,YMAX)	PLOT2
	CALL RAISE	RAISE
C YSCALE		
	CALL SCALE1 (YMIN,YMAX,FORM,SYMB)	SCALE1
	XPRINT = XMIN - 0.04*XPERIN*(SYMB + 2.)	
	I1 = YINCH + 1.	
	X1 = XMIN + 0.05*XPERIN	
	IF (KEY .EQ. -1) X1 = XMAX	
	YPRINT = YMAX	
	NN = SYMB	
	A(1) = BLANK	
	A(2) = BLANK	
	DO 5 I = 1,I1	
	CALL CONV (YPRINT,A,FORM)	CONV
	CALL WXLABL (XPRINT,YPRINT,0.0,0.1,NN,A)	WXLABL
	CALL LINE	LINE
	CALL PLOT2 (XMIN,YPRINT)	PLOT2
	CALL PLOT2 (X1,YPRINT)	PLOT2
5	YPRINT = YPRINT - YPERIN	
C XSCALE		
C		
	CALL SCALE1 (XMIN,XMAX,FORM,SYMB)	SCALE1
	YPRINT = YMIN - 0.12*YPERIN	
	I1 = XINCH + 1.	

```

NN = SY*H
Y1 = YMIN + 0.05*YPERIN
IF (KEY .EQ. -1) Y1 = YMAX
XPRINT = XMIN
XINDEX = XMIN - 0.04*SY*H*XPERT
A(1) = BLANK
A(2) = BLANK
DO 6 I = 1,11
    CALL CONV(XPRINT,A,FORM)
    CALL XLABL(XINDEX,YPRINT,0.0,0.1,NN,A)
    CALL LINE
    CALL PLOT2 (XPRINT,YMIN)
    CALL PLOT2 (XPRINT,Y1)
    XPRINT = XPRINT + XPERIN
    XINDEX = XINDEX + XPERTIN

```

```

CONV
XLABL
LINE
PLOT2
PLOT2

```

```

6
C
C XLABEL
C
    YPRINT = YMIN - 0.27*YPERIN
    CALL XACNV (XLAB,TITL1,NXLAB,4)
    CALL XLABL(XMIN,YPRINT,0.0,0.1,NXLAB*4,TITL1)

```

```

XACNV
XLABL

```

```

C
C YLABEL
C
    XPRINT = XMIN - 0.04*XPERIN*(SY*HY + 2.5)
    CALL XACNV (YLAB,TITL1,NYLAB,4)
    CALL XLABL(XPRINT,YMIN,1.570796,0.1,NYLAB*4,TITL1)

```

```

XACNV
XLABL

```

```

C
500 RETURN
END

```

```

      SUBROUTINE DASH1(X,Y,N,ND,LABL)
C DASH1= A SUBROUTINE TO PLOT A DASHED LINE WITH LABEL AT END
      DIMENSION X(1),Y(1)
C
C THE TOTAL NUMBER OF DASHES IS TO BE ND, TO TAKE UP HALF THE SPACE.
C
      NM1 = N
      NM2 = 2
      IF (ND.NE.0) RATIO = 1.0/(2.0*NM1)
      NM2 = 2*NM1
      NM1 = N - 1
      CALL LINE LINE
      IF (ND) 8,5,6
      8 CALL POINT
      IF (ND.EQ.-10) GO TO 11
      5 DO 7 I = 1,N
          IF (I.EQ.1) CALL RAISE RAISE
          7 CALL PLOT2 (X(I),Y(I)) PLOT2
          GO TO 9
C
      6 DO 1 I = 1,NM1
          K = 1
          CALL RAISE RAISE
          R = -RATIO/2.0
          DO 2 J = 1,NM2
              R = R + RATIO
              XX = X(I) + R*(X(I+1) - X(I))
              YY = Y(I) + R*(Y(I+1) - Y(I))
              CALL PLOT2 (XX,YY) PLOT2
              K = K + 1
              IF (K) 3,3,4
          4 K = -1
              GO TO 2
          3 CALL RAISE RAISE
          2 CONTINUE
          1 CONTINUE
      9 CALL WXLABL(X(N),Y(N),0.0,0.1,4,LABL) WXLABL
      10 RETURN
      11 DO 12 I = 1,N
          12 CALL WXLABL(X(I),Y(I),0.0,0.07,4,LABL) WXLABL
          GO TO 10
      END

```

SUBROUTINE SCALE1(S1,S2,F,SYMB)

SM = ABS(S1)

S11= ABS(S2)

IF (SM1 - SM) 1,2,2

2 S1 = SM1

1 IF (SM - 1000.) 3,4,4

4 XM = 0.

DO 5 I = 3,10

XI = 10.0**(I)

IF (S1 - XI) 10,5,6

6 CONTINUE

10 NSYMB = I + 2

GO TO 11

5 NSYMB = I + 3

11 XN = NSYMB

GO TO 9

3 DO 7 J = 1,13

I = J - 3

XI = 10.0**(-I)

IF (SM - XI) 7,8,8

7 CONTINUE

8 XM = I + 2

XM = 0.1*XM

NSYMB = I + 5

IF (I .LE. 0) NSYMB = 5

XN = NSYMB

9 F = XN + XM

SYMB = NSYMB

RETURN

END


```

SUBROUTINE CONV(A,R,F)
  INTEGER AT,A,FLDWITH,FMT(1),R(1)
  EQUIVALENCE(AT,AT1)
  DATA INT/01000000000000000000/
  AT=A
  IF (ABS(AT).LT.INT) AT1=AT
  FLDWITH=F
  IF (FLDWITH .LT. 11) GO TO 6
  ADIF = FLDWITH - 10
  F = F - ADIF
6 IF (FLOAT(FLDWITH).EQ.F) GO TO 3
  ENCODE(7,1,FMT)F
1  FORMAT(2H(FF4.1,1H))
2  ENCODE(FLDWITH,FMT,R)AT
  IF (FLDWITH .LE. 6) RETURN
  DECODE (10,5,R(1)) R(2)
5  FORMAT (6X,A4)
  RETURN
3  ENCODE(5,4,FMT)FLDWITH
4  FORMAT(2H(112,1H))
  AT=AT1
  GO TO 2
END

```

```

SUBROUTINE RSTSC (R1,R2,SIZE)
DIMENSION RANGE(7)
DATA RANGE/1.0, 1.5, 2.0, 2.5, 4.0, 5.0, 8.0/
C
S = SIZE
DFLR = R2 - R1
V = 1.0E-10
D = ABS (DFLR/S)
C
DO 1 I = 1,20
  V = V*10.0
  DO 1 J = 1,7
    VJ = V*RANGE(J)
    IF (D .LE. VJ) GO TO 5
  1 CONTINUE
  RETURN
C
5 SCAL = VJ*SIZE
  CON = R1*SIZE/SCAL
  IR1 = CON
  IF (CON .LT. 0.0) IR1 = IR1 - 1
  R1 = IR1
  R1 = R1*VJ
  R2 = R1 + SCAL
  RETURN
END

```