NORTH CAROLINA STATE UNIVERSITY | AT RALEIGH

SCHOOL OF ENGINEERING

DEPARTMENT OF ENGINEERING SCIENCE AND MECHANICS
BOX 5130, ZIP 27607

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(NASA-CR-141949) [METHOD OF CHARACTERISTICS CALCULATIONS AND COMPUTER CODE FOR MATERIALS WITH ARBITRARY EQUATIONS OF STATE AND USING ORTHOGONAL POLYNOMIAL LEAST SQUARE SURFACE FITS] Final Report (North Carolina State

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Dr. Robert G. Thompson
Technical Representative of the
Contracting Officer (TRCO)
Mail Stop 230
NASA-Langley Research Center
Hampton, Virginia 23665

RE: Final Report, NASA Research Grant NGL 34-002-084

Dear Bob:

How are you?

I am enclosing two (2) copies of the Final Report of the above Research Grant. Three (3) additional copies have been forwarded directly to:

NASA Scientific and Technical
Information Facility
Post Office Box 33
College Park, Maryland 20740

This report is subdivided into three sections as follows:

Section I Journal Papers and Technical Reports of Research Projects directly related to and partially supported by the research grant.

I.1. "Stress Waves Resulting from Hypervelocity Impact," AIAA paper No. 69-355, Presented at the 1969 AIAA Hypervelocity Impact Conference in Cincinnati, Ohio (Authored by R. Madden and T. S. Chang) Results from a numerical scheme based on the method of characteristics are presented for the axially symmetric, hypervelocity impact of similar materials. The analysis is restricted to the early stages of the impact of a right circular cylinder on a halfspace. The resulting rarefaction and shock waves produced by the impact are considered as discrete wavefronts which divide the impacted zone into regions. Numerical diffusion is then controlled by requiring that the values of the dependent variables at a given point in the impacted zone to depend on only the calculated values at earlier times at points in the same region as the point in question. The numerical results give

accurate representations of the stress wave profiles (i.e., rarefaction and shock waves) which should be useful as inputs for a later stage elastoplastic analysis and/or spallation analysis. The effects of "numerical diffusion" on the calculated pressure and flow fields when the rarefaction wave is not considered as discrete is investigated and the "diffused" results are compared with the more exact analysis.

I.2. "Nonlinear Waves in a Rate-Sensitive, Elastoplastic Material," International Journal of Engineering Science, Volume 10, pp. 353-367, 1972. (Authored by E. E. Burniston and T. S. Chang).
Two classes of closed form solutions of one-dimensional, nonlinear waves in a rate-sensitive, elastoplastic material are reported. One class of these solutions is self-similar and the other class consists of constant speed propagations. Applications of these solutions to unsteady motions behind propagating discontinuities are also considered.

I.3. "Curved Characteristics Behind Blast Waves," The Physics of Fluids, Volume 15, pp. 502-504, 1972. (Authored by O. Laporte and T. S. Chang)
Exact solutions, expressed in closed form in terms of elementary functions, are presented for the three sets of curved characteristics behind a self-similar, strong blast wave.

I.4. "On Dispersion and Characteristic Motions of Temperature-Rate Dependent Materials," National Aeronautics and Space Administration Report CR-1795, 1971.
A general three-dimensional theory of a thermomechanical material which can be a metallic or polymeric medium, or a structured composite, is developed using the modern techniques of axiomatic continuum mechanics and the laws of thermodynamics. One-dimensional linear spatial gradient temperature-rate dependent theories are presented for both thermoviscoelastic and thermoelastic materials. The characteristic motions are considered and it is shown that, due to the presence of temperature-rate effects, thermal propagation speeds have finite values. A comprehensive study of the dispersion relations is presented and illustrated graphically for typical values of the material constants. Analytical expressions are obtained for both high and low frequency responses. It is demonstrated that the characteristic speeds coincide with the high frequency asymptotic phase velocities in both cases. Physical and numerical limitations on the material constants are obtained for stable wave propagations. A class of self-similar solutions is obtained for the temperature-rate dependent thermoelastic medium using the theory of continuous group of transformations.

I.5. "Comments on Application of Singular Eigenfunction Expansions to the Propagation of Periodic Disturbances in a Radiating Grey Gas," The Physics of Fluids, Volume 16, pp. 159-160, 1973. (Authored by T. S. Chang, K. H. Kim and M. N. Osizik)
Recently, we have been extending our analysis of sound propagation

in dissociative, radiative media to include the effects of scattering. It is of interest to note that the set of pertinent integrodifferential equations can also be solved exactly using the singular eigenfunction expansion technique.

Section II Computer Programs and Numerical Results of Hypervelocity Impact Calculations

II.1. Method of Characteristics Calculations and the Computer Code Using Orthogonal Polynomial Least Square Surface Fits.
Very recently, we have developed a new numerical scheme using the method of characteristics to calculate the flow properties and pressures behind decaying shock waves for materials under hypervelocity impact. This procedure is quite different from our earlier methods (see paper I.1). We are now able to replace the time-consuming double interpolation subroutines used in paper I.1 by a technique based on Orthogonal Polynomial Least Square Surface Fits. Typical calculated results are given and in Tables 1-19. These results are compared with the double-interpolation results. The complete computer program is also included.

II.2. Method of Characteristics Calculations and the Computer Code for Materials with Arbitrary Equations of State.
As reported in our earlier status reports, we have developed a numerical code capable of calculating flow properties and pressures behind decaying shock waves for materials under hypervelocity impact with arbitrary equations of state. For comparison purposes, we have made some sample calculations using the new code for impact conditions similar to those reported in I.1. These results are quite encouraging and are displayed graphically in Figures 1-3. A listing of the numerical code is also attached.

Section III Fundamental Research on Equations of State and Non-Equilibrium Statistical Mechanics Generated by the Research Grant.

Materials under hypervelocity impact experience extreme changes of stresses, strains, and thermodynamic states. We have looked into some basic research areas related to (1) the non-equilibrium statistical mechanical aspects of heat transfer with discontinuous velocity boundary conditions, and (2) the fundamental understanding of the equations of state, phase transitions, and critical phenomena of materials under extreme thermodynamic environments. Our research efforts along these directions are found in the following research papers:

III.1. "Elementary Solutions of Coupled Model Equations in the Kinetic Theory of Gases," International Journal of Engineering Science, Volume 12, pp. 441-470, 1974. (Authors: J. T. Kriese, T. S. Chang, and C. E. Siewert.)

The method of elementary solutions is employed to solve two coupled integrodifferential equations sufficient for determining temperature - density effects in a linearized BGK model in the kinetic theory of gases. Full-range completeness and orthogonality theorems are proved for the developed normal modes and the infinite-medium Green's function is constructed as an illustration of the full-range formalism. The appropriate homogeneous matrix Riemann problem is discussed, and half-range completeness and orthogonality theorems are proved for a certain subset of the normal modes. The required existence and uniqueness theorems relevant to the H matrix, basic to the half-range analysis, are proved, and an accurate and efficient computational method is discussed. The half-space temperature-slip problem is solved analytically, and a highly accurate value of the temperature-slip coefficient is reported.

III.2. "Tricritical Points in Multicomponent Fluid Mixtures," Physical Review, Volume A9, pp. 2573-2578, 1974. (Authors: A. Hankey, T. S. Chang, and H. E. Stanley)
In view of experimental considerations, we give a model-independent argument that the novel tricritical points in multicomponent fluid mixtures, where three phases simultaneously become critical, are points on the boundary of a single two-dimensional surface of critical points. This result is corroborated by the Landau model suggested by Griffiths. The relationship between these tricritical points and the complex "higher-order" critical points proposed to exist in certain magnetic systems is elucidated.

III.3. "Generalized Scaling Hypothesis in Multicomponent Systems. I. Classification of Critical Points by Order and Scaling at Tricritical Points," Physical Review, Volume B8, pp. 346-364. (Authored by T. S. Chang, A. Hankey, and H. E. Stanley.)
The goal of this work is to provide an analysis of spaces of critical points for multicomponent systems. First, we propose the geometric concept of order $\mathcal{O}$ for critical points; we distinguish it from a previous definition of a "multicritical" point. Specifically, we may define the intersection of space of critical points of order $\mathcal{O}$ to be a space of critical points of order $(\mathcal{O} + 1)$. Ordinary critical points are defined to be of order $\mathcal{O} = 2$, so that the tricritical points introduced by Griffiths are of order $\mathcal{O} = 3$. We discuss more general examples of critical spaces of order $\mathcal{O} = 3$ which are known for a wide variety of systems; we also propose several examples of models of magnetic systems showing critical points of order $\mathcal{O} = 4$ - i.e., systems having intersecting lines of tricritical points. The analysis of critical and coexistence spaces also provides a new form of the Gibbs phase rule suitable for complex magnetic models. Next we define - for the critical points of order $\mathcal{O}$ of which examples have been given - special directions in terms of which to make a scaling hypothesis. We give the hypothesis for simple systems and then for tricritical points, and then, in a subsequent paper, part II, the special directions are used to make a scaling hypothesis at spaces of critical points of any order. Certain predictions (e.g., scaling laws and "single-power"

scaling functions) follow in a simple and straightforward fashion. We consider the scaling hypothesis at a critical space of order $\mathcal{O}$ in terms of a group of transformations. We can define a set of invariants of the group. It is possible, for $\mathcal{O} > 3$, to make a second scaling hypothesis for the space of order $\mathcal{O} - 1$ using certain of these invariants as independent variables. This is advantageous because certain "double-power" scaling functions then follow directly; these predict that for $\mathcal{O} = 3$, experimental data collapse from a volume onto a line. This prediction is to be contrasted with ordinary scaling function, which predict that data collapse by only a single dimension (e.g., from a volume onto a surface or from a surface onto a line).

III.4. "Double-Power Scaling Functions Near Tricritical Points," Physical Review, Volume B7, pp. 4263-4266, 1973. (Authored by T. S. Chang, A. Hankey, and H. E. Stanley.)
We introduce invariants of the scaling equation about the tricritical point. Using these invariants, a modified version of the scaling hypothesis about the three critical lines meeting at the tricritical point is presented. From it we demonstrate that the thermodynamic equation of state near a tricritical point and near a critical line may be expressed as double-power scaling functions. These imply that experimental data should collapse from a volume onto a line (i.e., by two dimensions). This behavior is in contrast to ordinary "single-power" scaling functions, which predict data collapsing from a volume onto a surface or from a surface onto a line (i.e., by one dimension).

In conclusion, we have obtained much information pertaining to the behavior materials under impact, particularly hypervelocity impact. Two useful numerical des have been developed for calculations of axisymmetric hypervelocity impact for terials with rather general equations of state. Fundamental research in the eas of critical equations of state and non-equilibrium statistical mechanics and at transfer have also been considered.

With best wishes, I am

Very sincerely yours,

Tom

Tien Sun Chang
Professor

C:mlm

closures

: NASA Scientific and Technical
Information Facility (3 copies)

I.1. "Stress Waves Resulting from Hypervelocity Impact"

I.2. "Nonlinear Waves in a Rate-Sensitive, Elastoplastic Material"

I.3. "Curved Characteristics Behind Blast Waves"

I.4. "On Dispersion and Characteristic Motions of Temperature-Rate Dependent Materials"
NASA Report - copies not enclosed

I.5. "Comments on Application of Singular Eigenfunction Expansions to the Propagation of Periodic Disturbances in a Radiating Grey Gas"

PAPERS INTENTIONALLY OMITTED

II.1. Method of Characteristics Calculations and the Computer Code Using Orthogonal Polynomial Least Square Surface Fits

List of Symbols

t = time (μsec)

r = radial coordinate (cm)

Z = axial coordinate (cm)

U = radial velocity (cm/μsec)

V = axial velocity (cm/μsec)

ρ = mass density (gm/cm^3)

e = internal energy per unit mass (megabar cm^3/gm)

a = sound speed (cm/μsec)

P = pressure (megabars)

$\cos \alpha_o$ = direction cosine of normal with respect to r axis

$\sin \alpha_o$ = direction cosine of normal with respect to Z axis

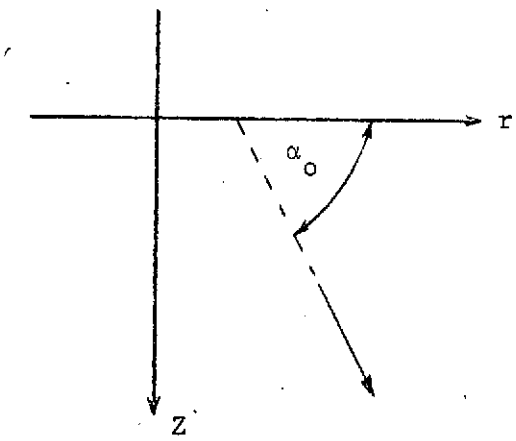

Table 1. Flow properties in Projectile Shock at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Othogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec.

(1)					(2)				
Z ρ	r e	P a	U $\cos \alpha_o$	V $\sin \alpha_o$	Z ρ	r e	P a	U $\cos \alpha_o$	V $\sin \alpha_o$
-0.3532	0.0	1.0869	0.0	0.3800	-0.3532	0.0	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
-0.3532	0.2500	1.0869	0.0	0.3800	-0.3532	0.2500	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
-0.3521	0.5012	1.0412	0.0025	0.3910	-0.3509	0.5009	0.9911	0.0017	0.4033
4.1738	0.0681	0.9934	-0.0068	1.0000	4.1325	0.0636	0.9820	-0.0049	1.0000
-0.3312	0.7611	0.8591	0.0209	0.4372	-0.3312	0.7630	0.7891	0.0106	0.4554
4.0185	0.0521	0.9500	-0.0648	0.9976	3.9533	0.0463	0.9318	-0.0348	0.9991
-0.2120	1.0183	0.4162	0.0124	0.5679	-0.2117	1.0177	0.4090	0.0116	0.5704
3.5399	0.0183	0.8122	-0.0667	0.9968	3.5303	0.0178	0.8094	-0.0613	0.9972

Table 2. Flow properties in Target Shock at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec.

(1)					(2)				
Z ρ	r e	P a	U cos α_o	V sin α_o	Z ρ	r e	P a	U cos α_o	V sin α_o
1.2500	0.0	1.0869	0.0	0.3800	1.2500	0.0	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
1.2500	0.2500	1.0869	0.0	0.3800	1.2500	0.2500	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
1.2500	0.5007	1.0686	0.0029	0.3756	1.2497	0.5007	1.0685	0.0029	0.3756
4.1957	0.0750	0.9997	0.0078	1.0000	4.1957	0.0705	0.9997	0.0078	1.0000
1.2398	0.7544	0.9647	0.0058	0.3501	1.2398	0.7544	0.9647	0.0058	0.3501
4.1106	0.0613	0.9758	0.0165	0.9998	4.1106	0.0613	0.9758	0.0165	0.9998
1.2143	1.0281	0.8382	0.0192	0.3169	1.2143	1.0281	0.8382	0.0192	0.3169
3.9996	0.0503	0.9446	0.0605	0.9979	3.9996	0.0503	0.9446	0.0605	0.9979
1.1235	1.3139	0.5624	0.0302	0.2368	1.1236	1.3139	0.5679	0.0304	0.2384
3.7190	0.0285	0.8649	0.1265	0.9910	3.7252	0.0290	0.8666	0.1265	0.9910
0.7683	1.7372	0.1558	0.0540	0.0691	0.7678	1.7377	0.1546	0.0528	0.0694
3.1170	0.0038	0.6776	0.6152	0.7870	3.1144	0.0037	0.6768	0.6050	0.7948
0.5808	1.8634	0.0670	0.0330	0.0263	0.5807	1.8634	0.0664	0.0327	0.0261
2.9088	0.0008	0.6045	0.7817	0.6227	2.9071	0.0008	0.6039	0.7816	0.6227
0.3716	1.9378	0.0	0.0	0.0	0.3716	1.9377	0.0	0.0	0.0
2.7000	0.0	0.5277	0.9289	0.3690	2.7000	0.0	0.5277	0.9289	0.3690

Table 3. Flow properties in Rarefaction at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec.

(1)				(2)			
Z	r	cos α_o	sin α_o	Z	r	cos α_o	sin α_o
1.2500	0.3781	0.6768	-0.7362	1.2500	0.3781	0.6768	-0.7362
1.1356	0.2852	0.5801	-0.8145	1.1355	0.2852	0.5801	-0.8145
1.0210	0.2132	0.4834	-0.8754	1.0210	0.2132	0.4834	-0.8754
0.9065	0.1577	0.3867	-0.9222	0.9065	0.1577	0.3867	-0.9222
0.7920	0.1165	0.2901	-0.9570	0.7920	0.1165	0.2901	-0.9570
0.6774	0.0879	0.1934	-0.9811	0.6774	0.0879	0.1934	-0.9811
0.5629	0.0711	0.0967	-0.9953	0.5629	0.0711	0.0967	-0.9953
0.4484	0.0656	-0.0000	-1.0000	0.4484	0.0656	-0.0000	-1.0000
0.3339	0.0711	-0.0967	-0.9953	0.3339	0.0711	-0.0967	-0.9953
0.2194	0.0879	-0.1934	-0.9811	0.2194	0.0879	-0.1934	-0.9811
0.1048	0.1165	-0.2901	-0.9570	0.1048	0.1165	-0.2901	-0.9570
-0.0097	0.1577	-0.3867	-0.9222	-0.0097	0.1577	-0.3867	-0.9222
-0.1242	0.2132	-0.4834	-0.8754	-0.1242	0.2132	-0.4834	-0.8754
-0.2387	0.2852	-0.5801	-0.8145	-0.2387	0.2852	-0.5801	-0.8145
-0.3532	0.3781	-0.6768	-0.7362	-0.3532	0.3781	-0.6768	-0.7362

Table 4. Flow properties in Interior Region at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomial Least Square Surfact Fit with Double Interpolation after t = 1.1 μsec at Z = -0.25 cm.

Z = - 0.25 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.9289	0.0167	0.4159	4.050	0.0622	0.9654
	0.7500	0.6891	0.0558	0.3987	3.8200	0.0422	0.9012
	1.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.2500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.6710	-0.1555	0.4333	3.7854	0.0425	0.8946
	0.7500	2.2439	-0.0865	0.9374	5.2602	0.1201	1.2174
	1.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.2500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 5. Flow properties in Interior Region at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomial Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 0.0 cm.

Z = 0.0 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9644	0.0130	0.3829	4.0861	0.0646	0.9743
	0.5000	0.6875	0.0985	0.4466	3.7705	0.0478	0.8972
	0.7500	0.4822	0.2065	0.5931	3.5022	0.0348	0.8269
	1.0000	0.1931	0.2829	0.7128	3.0774	0.0132	0.6916
	1.2500	0.0	0.6160	0.3904	2.7000	0.0	0.5277
	1.5000	0.0	0.1923	-0.0971	2.7000	0.0	0.5277
	1.7500	0.0	0.1103	-0.1452	2.7000	0.0	0.5277
	2.0000	0.0	0.0303	-0.0074	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.4956	-0.1726	0.3333	3.5563	0.0318	0.8347
	0.5000	0.5533	0.0033	0.4539	3.6020	0.0395	0.8537
	0.7500	0.7227	0.2308	0.6779	3.8156	0.0497	0.9081
	1.0000	0.0112	0.3021	0.6287	2.6397	0.0053	0.5362
	1.2500	0.0	0.3460	0.4024	2.7000	0.0	0.5277
	1.5000	0.0	0.2988	-0.1707	2.7000	0.0	0.5277
	1.7500	0.0	0.0076	-0.0333	2.7000	0.0	0.5277
	2.000	0.0	1.0304	0.0920	2.7000	0.0	0.5277

Table 6. Flow properties in Interior Region at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomial Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 0.25 cm.

Z = 0.25 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9018	0.0414	0.3889	4.0190	0.0608	0.9582
	0.5000	0.6611	0.1029	0.3898	3.7383	0.0461	0.8890
	0.7500	0.5468	0.1589	0.4410	3.5875	0.0393	0.8504
	1.0000	0.4078	0.2552	0.5698	3.3982	0.0296	0.7973
	1.2500	0.2713	0.3356	0.2505	3.1741	0.0216	0.7328
	1.5000	0.1800	0.2782	-0.0038	3.0497	0.0126	0.6831
	1.7500	0.1452	0.1345	-0.0307	3.0979	0.0032	0.6704
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9041	0.0405	0.4685	4.0212	0.0610	0.9588
	0.5000	0.6238	0.1083	0.3428	3.6922	0.0436	0.8770
	0.7500	0.4999	0.1591	0.4221	3.5219	0.0365	0.8332
	1.0000	0.4384	0.1553	0.5946	3.4452	0.0314	0.8102
	1.2500	0.3310	0.3414	0.2448	3.2767	0.0250	0.7629
	1.5000	0.1820	0.2935	0.0031	3.0507	0.0130	0.6841
	1.7500	0.1509	0.1379	-0.0592	3.1113	0.0033	0.6746
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 7. Flow properties in Interior Region at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomial Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 0.50 cm.

Z = 0.50 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9285	0.0338	0.3758	4.0475	0.0625	0.9651
	0.5000	0.7314	0.0768	0.3523	3.8244	0.0504	0.9106
	0.7500	0.6101	0.1090	0.3385	3.6714	0.0432	0.8723
	1.0000	0.5674	0.1441	0.3850	3.6154	0.0406	0.8577
	1.2500	0.3240	0.2039	0.1874	3.2650	0.0246	0.7595
	1.5000	0.2336	0.1796	0.0690	3.2048	0.0115	0.7206
	1.7500	0.1461	0.0865	0.0345	3.1018	0.0031	0.6713
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9477	0.0025	0.4235	4.0676	0.0637	0.9700
	0.5000	0.7109	0.0920	0.3266	3.8004	0.0491	0.9045
	0.7500	0.5934	0.0993	0.3379	3.6493	0.0422	0.8666
	1.0000	0.5876	0.1442	0.3938	3.6421	0.0418	0.8647
	1.2500	0.3056	0.2154	0.1785	3.2283	0.0241	0.7501
	1.5000	0.2380	0.1708	0.0771	3.2140	0.0117	0.7232
	1.7500	0.1611	0.1319	0.0292	3.1346	0.0036	0.6820
	2.000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 8. Flow properties in Interior Region at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomial Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 0.75 cm.

Z = 0.75 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0006	0.0200	0.3730	4.1231	0.0669	0.9832
	0.5000	0.8307	0.0490	0.3472	3.9397	0.0565	0.9391
	0.7500	0.7051	0.0710	0.3163	3.7917	0.0489	0.9026
	1.0000	0.6166	0.0937	0.3127	3.6908	0.0423	0.8752
	1.2500	0.4242	0.1292	0.1985	3.4661	0.0263	0.8077
	1.5000	0.3014	0.1187	0.1145	3.3803	0.0108	0.7624
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9148	-0.0201	0.4072	4.0334	0.0615	0.9616
	0.5000	0.8167	0.0542	0.3333	3.9244	0.0556	0.9352
	0.7500	0.6996	0.0658	0.3149	3.7846	0.0486	0.9009
	1.0000	0.5993	0.0982	0.3095	3.6667	0.0414	0.8693
	1.2500	0.4229	0.1272	0.1785	3.4620	0.0265	0.8070
	1.5000	0.3248	0.1134	0.1264	3.4247	0.0115	0.7744
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 9. Flow properties in Interior Region at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomial Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 1.00 cm.

Z = 1.00 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.9551	0.0239	0.3569	4.0754	0.0642	0.9719
	0.7500	0.8458	0.0404	0.3263	3.9658	0.0562	0.9438
	1.0000	0.7492	0.0545	0.3053	3.8760	0.0477	0.9180
	1.2500	0.5566	0.0703	0.2330	3.6866	0.0306	0.8607
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.9137	0.0337	0.3572	4.0315	0.0616	0.9613
	0.7500	0.8233	0.0460	0.3269	3.9397	0.0549	0.9376
	1.0000	0.7430	0.0646	0.3254	3.8604	0.0465	0.9137
	1.2500	0.5142	0.0880	0.2854	3.6369	0.0275	0.8463
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 10. Flow properties in Interior Region at t = 1.18 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomial Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 1.25 cm.

Z = 1.25 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	0.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.2500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	0.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.2500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 11. Flow properties in Projectile Shock at t = 1.25 μsec after impact of a 2.5-cm-diameter projectile 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec.

(1)					(2)				
Z ρ	r e	P a	U cos α_o	V sin α_o	Z ρ	r e	P a	U cos α_o	V sin α_o
-0.3742	0.0	1.0869	0.0	0.3800	-0.3742	0.0	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
-0.3742	0.2500	1.0869	0.0	0.3800	-0.3742	0.2500	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
-0.3713	0.5018	1.0071	0.0029	0.3993	-0.3684	0.5014	0.9280	0.0019	0.4191
4.1460	0.0650	0.9857	-0.0079	0.9999	4.0789	0.0581	0.9670	-0.0057	1.0000
-0.3468	0.7660	0.8343	0.0217	0.4438	-0.3437	0.7655	0.7182	0.0104	0.4750
3.9954	0.0501	0.9436	-0.0685	0.9973	3.8844	0.0405	0.9123	-0.0366	0.9990
-0.2153	1.0232	0.4007	0.0144	0.5731	-0.2140	1.0213	0.3767	0.0113	0.5816
3.5195	0.0173	0.8060	-0.0775	0.9958	3.4869	0.0157	0.7961	-0.0636	0.9970

Table 12. Flow properties in Target Shock at t = 1.25 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec or an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec.

(1)					(2)				
Z ρ	r e	P a	U cos α_o	V sin α_o	Z ρ	r e	P a	U cos α_o	V sin α_o
1.3242	0.0	1.0869	0.0	0.3800	1.3242	0.0	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
1.3242	0.2500	1.0869	0.0	0.3800	1.3242	0.2500	1.0869	0.0	0.3800
4.2103	0.0722	1.0038	0.0	1.0000	4.2103	0.0722	1.0038	0.0	1.0000
1.3233	0.5015	1.0568	0.0039	0.3724	1.3232	0.5014	1.0550	0.0034	0.3723
4.1863	0.0695	0.9970	0.0105	0.9999	4.2848	0.0693	0.9966	0.0092	1.0000
1.3110	0.7558	0.9511	0.0066	0.3467	1.3109	0.7558	0.9506	0.0066	0.3465
4.0991	0.0601	0.9726	0.0190	0.9998	4.0986	0.0600	0.9725	0.0190	0.9998
1.2823	1.0325	0.8208	0.0203	0.3122	1.2823	1.0325	0.8240	0.0204	0.3130
3.9830	0.0490	0.9401	0.0650	0.9976	3.9859	0.0492	0.9409	0.0649	0.9976
1.1836	1.3220	0.5493	0.0312	0.2325	1.1840	1.3224	0.5610	0.0332	0.2359
3.7041	0.0276	0.8654	0.1328	0.9901	3.7174	0.0284	0.8645	0.1390	0.9892
0.8044	1.7655	0.1534	0.0550	0.0669	0.8039	1.7655	0.1475	0.0512	0.0664
3.1120	0.0037	0.6759	0.6341	0.7718	3.0997	0.0035	0.6717	0.6098	0.7910
0.6060	1.8958	0.0637	0.0318	0.0248	0.6060	1.8957	0.0621	0.0310	0.0242
2.9000	0.0007	0.6013	0.7876	0.6152	2.8955	0.0007	0.5997	0.7875	0.6152
0.3853	1.9721	0.0	0.0	0.0	0.3853	1.9722	0.0	0.0	0.0
2.7000	0.0	0.5277	0.9354	0.3522	2.7000	0.0	0.5277	0.9354	0.3524

Table 13. Flow properties in Rarefaction at t = 1.25 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec.

(1)				(2)			
Z	r	$\cos \alpha_o$	$\sin \alpha_o$	Z	r	$\cos \alpha_o$	$\sin \alpha_o$
1.3242	0.3263	0.6768	-0.7362	1.3242	0.3263	0.6768	-0.7362
1.2029	0.2280	0.5801	-0.8145	1.2029	0.2280	0.5801	-0.8145
1.0816	0.1517	0.4834	-0.8754	1.0816	0.1517	0.4834	-0.8754
0.9602	0.0929	0.3867	-0.9222	0.9602	0.0929	0.3867	-0.9222
0.8389	0.0493	0.2901	-0.9570	0.8389	0.0493	0.2901	-0.9570
0.7176	0.0190	0.1934	-0.9811	0.7176	0.0190	0.1934	-0.9811
0.5963	0.0012	0.0967	-0.9953	0.5963	0.0012	0.0967	-0.9953
0.4750	-0.0047	0.0000	-1.0000	0.4750	-0.0047	0.0000	-1.0000
0.3537	0.0012	-0.0967	-0.9953	0.3537	0.0012	-0.0967	-0.9953
0.2324	0.0190	-0.1934	-0.9811	0.2324	0.0190	-0.1934	-0.9811
0.1111	0.0493	-0.2901	-0.9570	0.1111	0.0493	-0.2901	-0.9570
-0.0102	0.0929	-0.3867	-0.9222	-0.0102	0.0929	-0.3867	-0.9222
-0.1316	0.1517	-0.4834	-0.8754	-0.1316	0.1517	-0.4834	-0.8754
-0.2529	0.2280	-0.5801	-0.8145	-0.2529	0.2280	-0.5801	-0.8145
-0.3742	0.3263	-0.6768	-0.7362	-0.3742	0.3263	-0.6768	-0.7362

Table 14. Flow properties in Interior Region at t = 1.11 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation afte t = 1.1 μsec at Z = -0.25 cm.

Z = - 0.25cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	1.0000	0.0011	0.3947	4.1232	0.0668	0.9832
	0.7500	0.9432	0.0686	0.4380	4.1035	0.0579	0.9715
	1.0000	0.0	0.0	0.0	2.70000	0.0	0.5277
	1.2500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.9865	-0.0923	0.4746	4.1090	0.0660	0.9798
	0.7500	1.6829	0.0102	0.7228	4.7963	0.0979	1.1264
	1.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.2500	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 15. Flow properties in Interior Region at t = 1.11 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half-space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 0.0 cm.

Z = 0.0 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.38000	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.7294	0.0887	0.4327	3.8222	0.0503	0.9100
	0.7500	0.5505	0.1836	0.5982	3.5915	0.0396	0.8517
	1.0000	0.1969	0.2836	0.7136	3.0808	0.0137	0.6937
	1.2500	0.0	0.6041	0.3687	2.7000	0.0	0.5277
	1.5000	0.0	0.2022	-0.1010	2.7000	0.0	0.5277
	1.7500	0.0	0.1250	-0.1445	2.7000	0.0	0.5277
	2.0000	0.0	0.0672	0.0310	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	0.6684	0.0649	0.4247	3.7487	0.0464	0.8914
	0.7500	0.5433	0.2089	0.5837	3.5837	0.0390	0.8493
	1.0000	0.1233	0.2851	0.6878	2.9268	0.0100	0.6429
	1.2500	0.0	0.5798	0.3784	2.7000	0.0	0.5277
	1.5000	0.0	0.2384	-0.1266	2.7000	0.0	0.5277
	1.7500	0.0	0.0790	-0.1272	2.7000	0.0	0.5277
	2.0000	0.0	0.7397	0.1453	2.7000	0.0	0.5277

Table 16. Flow properties in Interior Region at t = 1.11 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 0.25 cm.

Z = 0.25cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9839	0.0272	0.3851	4.1059	0.0659	0.9791
	0.5000	0.7084	0.0902	0.3852	3.7971	0.0489	0.9037
	0.7500	0.5403	0.1560	0.4163	3.5790	0.0388	0.8481
	1.0000	0.4323	0.2422	0.5445	3.4320	0.0315	0.8073
	1.2500	0.2618	0.3301	0.2324	3.1521	0.0215	0.7274
	1.5000	0.1760	0.2720	0.0015	3.0472	0.0120	0.6809
	1.7500	0.1315	0.1172	-0.0253	3.0716	0.0025	0.6606
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9982	0.0263	0.4170	4.1207	0.0668	0.9826
	0.5000	0.6946	0.0922	0.3700	3.7806	0.0480	0.8995
	0.7500	0.5285	0.1555	0.4120	3.5626	0.0381	0.8439
	1.0000	0.4507	0.2414	0.5557	3.4600	0.0325	0.8148
	1.2500	0.2818	0.3320	0.2294	3.1875	0.0226	0.7380
	1.5000	0.1784	0.2771	0.0039	3.0516	0.0122	0.6825
	1.7500	0.1331	0.1192	-0.0361	3.0754	0.0025	0.6618
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 17. Flow properties in Interior Region at t = 1.11 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 2.50 cm.

Z = 0.50 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0058	0.0224	0.3776	4.1284	0.0672	0.9845
	0.5000	0.7873	0.0644	0.3560	3.8904	0.0538	0.9270
	0.7500	0.6405	0.1002	0.3370	3.7108	0.0450	0.8823
	1.0000	0.5742	0.1362	0.3663	3.6236	0.0410	0.8600
	1.2500	0.3283	0.1942	0.1842	3.2750	0.0246	0.7618
	1.5000	0.2347	0.1758	0.0773	3.2145	0.0110	0.7219
	1.7500	0.1343	0.0741	0.0354	3.0770	0.0026	0.6626
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0122	0.0136	0.3928	4.1350	0.0676	0.9860
	0.5000	0.7791	0.0687	0.3477	3.8810	0.0533	0.9246
	0.7500	0.6353	0.0971	0.3368	3.7042	0.0447	0.8806
	1.0000	0.5763	0.1374	0.3665	3.6261	0.0412	0.8607
	1.2500	0.3191	0.1977	0.1809	3.2574	0.0243	0.7572
	1.5000	0.2371	0.1742	0.0802	3.2194	0.0111	0.7233
	1.7500	0.1428	0.0846	0.0336	3.0931	0.0028	0.6679
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 18. Flow properties in Interior Region at t = 1.1 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 0.75 cm.

Z = 0.75 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0575	0.0069	0.3782	4.1810	0.0704	0.9969
	0.5000	0.8898	0.0374	0.3551	4.0054	0.0601	0.9550
	0.7500	0.7535	0.0622	0.3208	3.8501	0.0518	0.9171
	1.0000	0.6515	0.0859	0.3099	3.7372	0.0442	0.8867
	1.2500	0.4555	0.1199	0.2073	3.5178	0.0276	0.8208
	1.5000	0.3195	0.1068	0,1168	3.4168	0.0112	0.7720
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	0.9930	-0.0229	0.3930	4.1156	0.0664	0.9814
	0.5000	0.8864	0.0404	0.3514	4.1108	0.0599	0.9541
	0.7500	0.7504	0.0603	0.3195	3.8462	0.0517	0.9162
	1.0000	0.6505	0.0868	0.3100	3.7355	0.0442	0.8864
	1.2500	0.4552	0.1210	0.2011	3.5168	0.0277	0.8263
	1.5000	0.3313	0.1054	0.1197	3.4382	0.0116	0.7778
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

Table 19. Flow properties in Interior Region at t = 1.1 μsec after impact of a 2.5-cm-diameter projectile at 0.76 cm/μsec on an aluminum half space based on (1) Double Interpolation and (2) Orthogonal Polynomials Least Square Surface Fit with Double Interpolation after t = 1.1 μsec at Z = 1.00 cm.

Z = 1.00 cm	r	P	U	V	ρ	e	a
(1)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	1.0119	0.0131	0.3673	4.1346	0.0676	0.9860
	0.7500	0.8990	0.0297	0.3359	4.0258	0.0593	0.9581
	1.0000	0.7910	0.0414	0.3143	3.9271	0.0499	0.9302
	1.2500	0.6043	0.0512	0.2428	3.7526	0.0330	0.8773
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277
(2)	0.0	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.2500	1.0869	0.0	0.3800	4.2103	0.0722	1.0038
	0.5000	1.0110	0.0122	0.3680	4.1335	0.0676	0.9857
	0.7500	0.8941	0.0332	0.3364	4.0203	0.0590	0.9568
	1.0000	0.7734	0.0489	0.3178	3.9067	0.0488	0.9252
	1.2500	0.6046	0.0551	0.2587	3.7552	0.0328	0.8776
	1.5000	0.0	0.0	0.0	2.7000	0.0	0.5277
	1.7500	0.0	0.0	0.0	2.7000	0.0	0.5277
	2.0000	0.0	0.0	0.0	2.7000	0.0	0.5277

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```
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
      DOUBLE PRECISION PHI(20,20,6)
      KR=7
      EPS=.0000001
      KSTOP=0
1     FORMAT (1H1)
      CALL DVCHK(KEY)
      KICK=0
      IF (KEY.EQ.1) GO TO 9980
C
      DO 2 K=1,6
      DO 2 J=1,20
      DO 2 I=1,20
      XMESH(I,J,K)=0.
      XMESH2(I,J,K)=0.
```

```
2     CONTINUE
C     KRW=0
      NUZON=0
C
C
      WRITE (3,4)
C
C         DATA INPUT SECTION
C
4     FORMAT (52H1HYPERVELOCITY IMPACT METHOD OF CHARACTERISTICS CODE///
     1)
C       ID AND FX. PT. CONSTANTS
C
      READ (1,8) CASEID,ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,NDEL
8     FORMAT (13A6,A2/9I3)
      IRARF=ITI2
C
C       FL. PT. CONSTANTS
C
      READ (1,15) EPS1,EPS2,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5
     1,EPI6,EPI7
      READ (1,14) NP,NT,NR
14    FORMAT (3I3)
      READ (1,15) APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,REF
     1L
      READ (1,15) ZMIN,ZMAX,RMIN,RMAX,GR,GZ,DELTA,VP,LENGTH,RADIUS,HSTAR
15    FORMAT (6E12.8)
      READ (1,15) RST
      IF (RST.GT.0.) GO TO 16
      REWIND 5
C     DO 1529 JTP=1,200
      READ (5)TIME
C     IF(ABS(RST+TIME).LT..001) GO TO 1530
C     READ(5)BLOB
C1529 CONTINUE
1530  CONTINUE
```

```
C     KRW=1
      READ (5)(((XMESH(I,J,K),I=1,20),J=1,20),K=1,6),(Z(I),I=1,20),(R(I)
     1,I=1,20),((SURF(I,J),I=1,15),J=1,8),(((TAB(I,J,K),I=1,15),J=1,14),
     1K=1,2),((RARF(I,J),I=1,15),J=1,11),TIME,ZMIN,ZMAX,RMIN,RMAX,GR,GZ,
     1AR
      DO 1500 J=1,20
      DO 1500 I=1,20
      DO 1500 K=1,6
1500  XMESH2(I,J,K)=XMESH(I,J,K)
      DO 1501 I=1,15
      DO 1501 J=1,8
1501  SURF2(I,J)=SURF(I,J)
      WRITE (3,145) TIME
      CALL SOUT
      CALL PRINT(XMESH2,Z,R,1)
      KREFL=0
16    CONTINUE
      WRITE (3,10) CASEID,ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,NDEL
10    FORMAT (1X13A6,A2//17H SHOCK ITERATIONS6X,4I4//20H INTERIOR ITERAT
     1IONS3X,4I4//7H NDEL =,I4///)
      WRITE (3,18) EPS1,EPS2,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI
     15,EPI6,EPI7,ZMIN,ZMAX,RMIN,RMAX,DELTA,VP,LENGTH,RADIUS,APR,BPR,BIG
     1APR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,REFL
18    FORMAT (///38H ERROR CRITERIA FOR SHOCK COMPUTATIONS//5X8HDELTA Z1
     18X8HDELTA R18X9HDELTA RHO7X7HDELTA E9X7HDELTA P9X7HDELTA U/6E16.6/
     1//41H ERROR CRITERIA FOR INTERIOR COMPUTATIONS//5X8HDELTA ZI8X8HDE
     1LTA RI8X7HDELTA P9X7HDELTA U9X7HDELTA V9X9HDELTA RHO7X7HDELTA E/7E
     116.6///5X4HZMIN12X4HZMAX12X4HRMIN12X4HRMAX12X5HDELTA11X2HVP14X6HLE
     1NGTH10X6HRADIUS/8E16.6///5X2HA'14X2HB'14X6HBIG A'10X6HBIG B'10X2HE
     1*14X5HALPHA11X4HBETA12X4HRHO*/8E16.6//5X3HE'S13X4HREFL/2E16.6///)
      IF (RST.LT.0.) GO TO 140
C
C         STORE RHO* IN ALL XMESH
C
      DO 22 J=1,20
      DO 22 I=1,20
```

```
22    XMESH(I,J,4)=RHOSTR
40    FORMAT (5E12.8)
C
C       PROJECTILE SHOCK
C
      CALL EQOS1(PRHO,PPP,PVV,PEE,TEE,TRHO,KICK)
      IF (KICK.EQ.2200) GO TO 9980
      DO 230 N=1,NP
      TAB(N,1,1)=(PRHO*PVV-RHOSTR*VP)*HSTAR/(PRHO-RHOSTR)
      EE=N-1
      FNP=NP
      TAB(N,2,1)=RMIN+EE*(RADIUS-RMIN)/FNP
      TAB(N,3,1)=PPP
      TAB(N,4,1)=0.0
      TAB(N,5,1)=PVV
      TAB(N,6,1)=PRHO
      TAB(N,7,1)=PEE
      TAB(N,9,1)=0.0
      TAB(N,10,1)=1.0
230   CONTINUE
C
C       TARGET SHOCK
C
      M=0
      DO 240 N=1,NT
      EE=N-1
      FNT=NT-4
      TAB(N,2,2)=RMIN+EE*(RADIUS-RMIN)/FNT
      TAB(N,7,2)=TEE
      TAB(N,6,2)=TRHO
      TAB(N,3,2)=PPP
      IF (TAB(N,2,2).GT.RADIUS) GO TO 250
      TAB(N,1,2)=TRHO*PVV*HSTAR/(TRHO-RHOSTR)
      TAB(N,4,2)=0.0
      TAB(N,5,2)=PVV
      TAB(N,9,2)=0.0
```

```
      TAB(N,10,2)=1.0
      GO TO 240
250   EF=M
      TAB(N,9,2)=SIN(.5236+EF*.2618)
      TAB(N,10,2)=COS(.5236+EF*.2618)
      TAB(N,4,2)=PVV*TAB(N,9,2)
      TAB(N,5,2)=PVV*TAB(N,10,2)
      TAB(N,1,2)=TAB(1,1,2)*TAB(N,10,2)
      TAB(N,2,2)=RADIUS+TAB(1,1,2)*TAB(N,9,2)
      M=M+1
240   CONTINUE
C
C       RAREFACTION
C
      CALL EQOS2(PPP,PRHO,PEE)
      EE=NR-1
      ADEL=(TAB(1,1,2)-TAB(1,1,1))/EE
      RARF(1,1)=TAB(1,1,2)
      DO 205 N=2,NR
      RARF(N,1)=RARF(N-1,1)-ADEL
205   CONTINUE
      DO 210 N=1,NR
      RARF(N,10)=(RARF(N,1)/HSTAR-.5*VP)/AR
      RARF(N,9)=-SQRT(1.-RARF(N,10)**2)
      RARF(N,2)=RADIUS+HSTAR*AR*RARF(N,9)
210   CONTINUE
      DO 220 N=1,NR
      RARF(N,3)=TAB(1,3,1)
      RARF(N,4)=0.
      RARF(N,5)=TAB(1,5,1)
      RARF(N,6)=TAB(1,6,1)
      RARF(N,7)=TAB(1,7,1)
220   CONTINUE
C       REGION INTERIOR TO SHOCKS
      I=-ZMIN/GZ+1.2
      J=0
```

```
260   J=J+1
      XMESH(I,J,1)=PPP
      XMESH(I,J,3)=PVV
      XMESH(I,J,4)=PRHO
      XMESH(I,J,5)=PEE
      EE=(J-1)
      IF ((EE*GR-RADIUS).LT.-EPS) GO TO 260
      XMESH(I,J,1)=0.
      XMESH(I,J,4)=RHOSTR
      XMESH(I,J,5)=0.
C
C       FREE SURFACE
C
      DO 50 I=1,NP
      SURF(I,1)=-LENGTH+VP*HSTAR
      SURF(I,2)=TAB(I,2,1)
      SURF(I,3)=0.
      SURF(I,4)=0.
      SURF(I,5)=VP
      SURF(I,6)=RHOSTR
      SURF(I,7)=0.
      SURF(I,8)=SQRT(BIGAPR/RHOSTR)
50    CONTINUE
      DO 51 I=1,NP
      DO 51 J=1,8
51    SURF2(I,J)=SURF(I,J)
      IF (NUZON.EQ.0) GO TO 5001
5000  GR=GR*2.
      GZ=GZ*2.
      ZMAX=ZMAX*2.-ZMIN
      RMAX=RMAX*2.
      NUZON=1
      WRITE (3,5003)
5003  FORMAT (7H REZONE///)
5001  CONTINUE
C
```

```
C
      DO 55 I=1,20
      EE=I-1
      Z(I)=ZMIN+EE*GZ
      R(I)=RMIN+EE*GR
55    CONTINUE
      IF (NUZON.EQ.0) GO TO 5101
      DO 5100 I=1,10
      DO 5100 J=1,10
      DO 5100 K=1,6
      L=2*I-1
      M=2*J-1
      XMESH(I,J,K)=XMESH(L,M,K)
5100  CONTINUE
      GO TO 157
5101  CONTINUE
C
C          COMPUTE A FOR 2 SHOCKS AND MESH
C
      DO 86 K=1,3
      GO TO (57,59,61),K
57    NN=NP
      JJ=1
      GO TO 63
59    NN=NT
      JJ=1
      GO TO 63
61    NN=20
      JJ=20
63    DO 84 N=1,NN
      DO 82 J=1,JJ
      GO TO (65,65,68),K
65    P=TAB(N,3,K)
      RHO=TAB(N,6,K)
      E=TAB(N,7,K)
      GO TO 70
```

```
68    P=XMESH(J,N,1)
      RHO=XMESH(J,N,4)
      E=XMESH(J,N,5)
70    CONTINUE
      CALL EQOS3(RHO,AA,E,P)
      GO TO (76,76,78),K
76    TAB(N,8,K)=AA
      GO TO 82
78    XMESH(J,N,6)=AA
82    CONTINUE
84    CONTINUE
86    CONTINUE
      KICK=86
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
C
C         STORE A FOR RAREFACTION
C
      DO 90 I=1,NR
90    RARF(I,8)=AR
C
C         COMPLETE SHOCK TABLES
C
      DO 99 K=1,2
      GO TO (92,94),K
92    NN=NP
      GO TO 95
94    NN=NT
      US=0.
95    DO 97 N=1,NN
      GO TO (93,96),K
93    CONTINUE
      US=VP*TAB(N,10,1)
96    CONTINUE
      TAB(N,11,K)=TAB(N,9,K)*TAB(N,4,K)+TAB(N,10,K)*TAB(N,5,K)
      TAB(N,12,K)=TAB(N,9,K)*TAB(N,5,K)-TAB(N,10,K)*TAB(N,4,K)
```

```
      TAB(N,13,K)=((TAB(N,6,K)*ABS(TAB(N,11,K)))/(TAB(N,6,K)-RHOSTR)-US)
     1*(-1.)**K
      TAB(N,14,K)=1.
97    CONTINUE
99    CONTINUE
C
C
C         STORE ALL XMESH IN XMESH2
C
130   DO 135 K=1,6
      DO 135 J=1,20
      DO 135 I=1,20
      XMESH2(I,J,K)=XMESH(I,J,K)
135   CONTINUE
      TIME=HSTAR
      WRITE (3,145) TIME
      CALL SOUT
C     CALL PRINT(XMESH2,Z,R,1)
      CALL PRINT(XMESH2,Z,R,1,PHI,NMAX,MMAX)
C
      KREFL=0
139   IF (KREFL.NE.0) GO TO 143
C         ENTRY FOR TIME STEP
C
140   READ (1,142) H
142   FORMAT (E12.8)
143   CONTINUE
      TIME=TIME+H
      WRITE (3,145) TIME
145   FORMAT (1H1///6H TIME=,E15.8///)
      WRITE (3,999) KR
999   FORMAT (5X,4H KR=,I5)
C
C
C         ADVANCE SHOCK POINTS
C
```

```
      DO 159 N=1,NP
      IF (TAB(N,14,1).LT.0.) GO TO 156
      IF ((TAB(N,1,1)-SURF(N,1)).GT.EPS) GO TO 154
156   TAB2(N,1,1)=TAB(N,1,1)
      TAB2(N,2,1)=TAB(N,2,1)
      TAB(N,14,1)=-1.
      GO TO 159
154   TAB2(N,1,1)=TAB(N,1,1)+TAB(N,13,1)*H*TAB(N,10,1)-VP*TAB(N,9,1)*TAB
     1(N,10,1)*H
150   TAB2(N,2,1)=TAB(N,2,1)+TAB(N,13,1)*H*TAB(N,9,1)-VP*TAB(N,9,1)**2*H
159   CONTINUE
      DO 155 N=1,NT
      TAB2(N,1,2)=TAB(N,1,2)+TAB(N,13,2)*H*TAB(N,10,2)
155   TAB2(N,2,2)=TAB(N,2,2)+TAB(N,13,2)*H*TAB(N,9,2)
      DO 158 M=1,NT
      IF (TAB2(M,1,2).GT.ZMAX) GO TO 5000
      IF (TAB2(M,2,2).GT.RMAX) GO TO 5000
158   CONTINUE
157   NUZON=0
C         ADVANCE RAREFACTION
C
      IF (RARF(1,2).LT.0.)IRARF=1
      IF (IRARF.EQ.1) GO TO 516
      ENR=NR-1
      ADEL=(TAB2(1,1,2)-TAB2(1,1,1))/ENR
      RARF2(1,1)=TAB2(1,1,2)
      DO 510 N=2,NR
      RARF2(N,1)=RARF2(N-1,1)-ADEL
510   CONTINUE
      DO 515 N=1,NR
      RARF2(N,3)=(RARF2(N,1)/TIME-.5*VP)/AR
      RARF2(N,4)=-SQRT(1.-RARF2(N,3)**2)
      RARF2(N,2)=RADIUS+TIME*AR*RARF2(N,4)
515   CONTINUE
516   CONTINUE
      CALL SHOCK
```

```
C
C
      IF (ITS3.EQ.1) GO TO 569
C         SHOCK COMPUTATIONS COMPLETED
C         COMPUTE PARTICLE CURVES
C
      TMP=.5*VP*H
      DO 520 N=1,NP
      SPART(N,1,1)=TAB(N,1,1)+TAB(N,5,1)*H
520   SPART(N,2,1)=TAB(N,2,1)+TAB(N,4,1)*H
      DO 525 N=1,NT
      SPART(N,1,2)=TAB(N,1,2)+TAB(N,5,2)*H
525   SPART(N,2,2)=TAB(N,2,2)+TAB(N,4,2)*H
      IF (IRARF.EQ.1) GO TO 531
      DO 530 N=1,NR
      RPART(N,1)=RARF(N,1)+TMP
530   RPART(N,2)=RARF(N,2)
531   CONTINUE
C
C
568   CALL SOUT2
569   CONTINUE
C       ADVANCE PROJECTILE REAR SURFACE
      DO 5300 I=1,NP
      DO 5300 J=1,8
5300  SURF2(I,J)=SURF(I,J)
      KICK=568
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
C
C         START INTERIOR REGION COMPUTATIONS
C
C     CALL INTER
      CALL INTER(PHI,NMAX,MMAX)
C
C         INTERIOR REGION COMPUTATIONS COMPLETED
```

```
C
C     CALL PRINT(XMESH2,Z,R,2)
      CALL PRINT(XMESH2,Z,R,2,PHI,NMAX,MMAX)
570   CONTINUE
C
C         INITIALIZE FOR NEXT TIME STEP
C
      DO 920 K=1,6
      DO 920 J=1,20
      DO 920 I=1,20
      XMESH(I,J,K)=XMESH2(I,J,K)
920   CONTINUE
      DO 930 J=1,13
      DO 930 I=1,NP
      TAB(I,J,1)=TAB2(I,J,1)
930   CONTINUE
      DO 940 J=1,13
      DO 940 I=1,NT
      TAB(I,J,2)=TAB2(I,J,2)
940   CONTINUE
      IF (IRARF.EQ.1) GO TO 951
      DO 950 I=1,NR
      RARF(I,1)=RARF2(I,1)
      RARF(I,2)=RARF2(I,2)
950   CONTINUE
951   CONTINUE
      DO 960 I=1,NP
      DO 959 J=1,5
      SURF(I,J)=SURF2(I,J)
959   CONTINUE
960   CONTINUE
777   IF (KREFL.EQ.0) GO TO 980
      KREFL=0
      H=H1
      GO TO 143
980   CONTINUE
```

```
      CALL DVCHK(KICK)
      IF (KICK.EQ.2) GO TO 140
      WRITE (3,970)
970   FORMAT (28H0DIVIDE CHECK AT END OF CASE/1H1)
      CALL EXIT
C
C         DIVIDE CHECK
C
9980  WRITE (3,9985) KICK
9985  FORMAT (32H0DIVIDE CHECK NEAR STATEMENT NO.,I5/1H1)
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE DBLTRP(ZX,RX,ANS)
C
C         1ST ORDER DOUBLE INTERPOLATION THAT CONSIDERS
C         LINES OF DISCONTINUITY IF IN CONSIDERED REGION
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON Z0,R0,P0,U0,V0,L0,M0,RHO0,E0,A0,UBAR0,VBAR0
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
```

```
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      DIMENSION ANS(6),ANS1(2,8),ANS2(2,8),ZI(4),RI(4),IK(4)
      CALL DVCHK(KEY)
      IF (KEY.EQ.2) GO TO 4
      NO=0
      GO TO 940
C
C         FIND SUBSCRIPTS FOR GRID
C
4     I1=(ZX-ZMIN)/GZ+1.000001
      I2=I1+1
      J1=(RX-RMIN)/GR+1.000001
      J2=J1+1
      NN=NP
      IF (ITS3.EQ.1) GO TO 3
      DO 1 K=1,2
      IF (K.EQ.2)NN=NT
      DO 1 I=1,NN
      ALF=SQRT((TAB(I,1,K)-ZX)**2+(TAB(I,2,K)-RX)**2)
      IF (ALF.GT.EPS1) GO TO 1
      ANS(1)=TAB(I,3,K)
      ANS(2)=TAB(I,4,K)
      ANS(3)=TAB(I,5,K)
      ANS(4)=TAB(I,6,K)
      ANS(5)=TAB(I,7,K)
      ANS(6)=TAB(I,8,K)
      RETURN
1     CONTINUE
      IF (IRARF.EQ.1) GO TO 3
      DO 2 I=1,NR
      ALF=SQRT((RARF(I,1)-ZX)**2+(RARF(I,2)-RX)**2)
      IF (ALF.GT.EPI1) GO TO 2
      ANS(1)=RARF(I,3)
      ANS(2)=RARF(I,4)
```

```
      ANS(3)=RARF(I,5)
      ANS(4)=RARF(I,6)
      ANS(5)=RARF(I,7)
      ANS(6)=RARF(I,8)
      RETURN
2     CONTINUE
3     CONTINUE
C
C
      ZXX=ZX+.01
      RXX=RX+.01
C
C         I LOOP FOR UPPER AND LOWER Z GRID LINES
C
      DO 800 I=1,2
      IF (ITS3.EQ.1) GO TO 14
      IF (I.EQ.2) GO TO 8
      II=I1
      GO TO 12
8     II=I2
12    M=COMP(ZX,RX,Z(II),R(J1))
      IF (M.EQ.1) GO TO 13
      MCOM=1
      GO TO 20
13    M=COMP(ZX,RX,Z(II),R(J2))
      IF (M.EQ.1) GO TO 14
      MCOM=2
      GO TO 20
C
C         GET 6 VALUES ON GRID LINES
C
14    DO 15 K=1,6
      ANS1(I,K+2)=XMESH(II,J1,K)+(XMESH(II,J2,K)-XMESH(II,J1,K))*(RX-R(J
     11))/(R(J2)-R(J1))
15    CONTINUE
      CALL DVCHK(NO)
```

```
      IF (NO.EQ.2) GO TO 17
      NO=15
      GO TO 940
17    ANS1(I,1)=Z(II)
      ANS1(I,2)=RX
      GO TO 800
C
C
20    ZZ=Z(II)
      RR=RX
      M=COMP(ZX,RX,ZZ,RR)
      IF (M.EQ.1) GO TO 300
C
C
      DO 25 K=1,2
      KATCH=0
      GO TO (21,22),K
21    NN=NP
      GO TO 23
22    NN=NT
23    JJJ=NN-1
      DO 24 M=1,JJJ
      IF (M.EQ.JJJ) GO TO 210
      IF (RX.GT.TAB(M+1,2,K).OR.RX.LT.TAB(M,2,K)) GO TO 24
210   ZI(K)=TAB(M+1,1,K)+(TAB(M,1,K)-TAB(M+1,1,K))*(RX-TAB(M+1,2,K))/(TA
     1B(M,2,K)-TAB(M+1,2,K))
      NO=210
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 940
      IF (I.EQ.2) GO TO 211
      IF (KATCH.EQ.1) GO TO 212
      KATCH=1
      GO TO 213
212   IF ((ZX-ZI(K)).GT.(ZX-ZM)) GO TO 24
      IF (ZI(K).GT.ZX) GO TO 24
213   ZM=ZI(K)
```

```
      IF (K.EQ.2) GO TO 215
      NPS=M
      GO TO 24
215   NTS=M
      GO TO 24
211   CONTINUE
      IF (KATCH.EQ.1) GO TO 26
      KATCH=1
      GO TO 213
26    IF ((ZI(K)-ZX).GT.(ZM-ZX)) GO TO 24
      IF (ZI(K).LT.ZX) GO TO 24
      GO TO 213
24    CONTINUE
      ZI(K)=ZM
      IF (KATCH.NE.0) GO TO 25
      ZI(K)=ZMAX+1.
25    CONTINUE
      IF (IRARF.EQ.1)ZI(3)=ZMAX+1.
      IF (IRARF.EQ.1) GO TO 2504
      KATCH=0
      JJJ=NR-1
      DO 27 M=1,JJJ
      ZI(3)=RARF(M+1,1)+(RARF(M,1)-RARF(M+1,1))*(RX-RARF(M+1,2))/(RARF(M
     1,2)-RARF(M+1,2))
      NO=25
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 940
      IF (ABS(ZI(3)-ZX).GT.1.E-5) GO TO 279
      DO 2799 LN=1,6
      LNN=LN+2
      ANS(LN)=RARF(1,LNN)
2799  CONTINUE
      GO TO 820
279   CONTINUE
      IF (I.EQ.2) GO TO 28
      IF (ZI(3).GT.ZX) GO TO 27
```

```
      IF (KATCH.EQ.1) GO TO 280
      KATCH=1
      GO TO 281
280   IF ((ZX-ZI(3)).GT.(ZX-ZM)) GO TO 27
281   ZM=ZI(3)
      MR=M
      GO TO 27
28    IF (ZI(3).LT.ZX) GO TO 27
      IF (KATCH.EQ.1) GO TO 282
      KATCH=1
      GO TO 281
282   IF ((ZI(3)-ZX).GT.(ZM-ZX)) GO TO 27
      GO TO 281
27    CONTINUE
      ZI(3)=ZM
2504  CONTINUE
      KATCH=0
      K=4
      JJJ=NP-1
      DO 2700 M=1,JJJ
      IF (M.EQ.JJJ) GO TO 2710
      IF (RX.GT.SURF(M+1,2).OR.RX.LT.SURF(M,2)) GO TO 2700
2710  ZI(4)=SURF(M+1,1)+(SURF(M,1)-SURF(M+1,1))*(RX-SURF(M+1,2))/(SURF(M
     1,2)-SURF(M+1,2))
      IF (KQ.EQ.1) GO TO 940
      CALL DVCHK(KQ)
      NO=2710
      IF (I.EQ.2) GO TO 2711
      IF (KATCH.EQ.1) GO TO 2712
      KATCH=1
      GO TO 2713
2712  IF ((ZX-ZI(K)).GT.(ZX-ZM)) GO TO 2700
2713  ZM=ZI(4)
      MS=M
      GO TO 2700
2711  CONTINUE
```

```
      IF (KATCH.EQ.1) GO TO 2726
      KATCH=1
      GO TO 2713
2726  IF ((ZI(K)-ZX).GT.(ZM-ZX)) GO TO 2700
      GO TO 2713
2700  CONTINUE
      ZI(4)=ZM
      IF (KATCH.NE.0) GO TO 2701
      ZI(4)=ZMAX+1.
2701  CONTINUE
      RI(1)=RX
      RI(2)=RX
      RI(3)=RX
      RI(4)=RX
C         FIND INTERSECTION TO USE
C
30    KEY=0
      IF (I.EQ.2) GO TO 50
C
C         UPPER GRID LINE
C
      DO 40 KK=1,4
      IF (Z(II).GT.ZI(KK)) GO TO 40
      IF (ABS(ZI(KK)-ZX).LT.1.E-5) GO TO 35
      IF (ZI(KK).GT.ZX) GO TO 40
      IF (KEY.EQ.0) GO TO 35
      IF (ZI(KK).LE.ZI(KEEP)) GO TO 40
      KEEP=KK
      GO TO 40
35    KEEP=KK
      KEY=1
40    CONTINUE
      GO TO 65
C
C         LOWER GRID LINE
C
```

```
50    DO 60 KK=1,4
      IF (Z(II).LT.ZI(KK)) GO TO 60
      IF (ABS(ZI(KK)-ZX).LT.1.E-5) GO TO 55
      IF (ZI(KK).LT.ZX) GO TO 60
      IF (KEY.EQ.0) GO TO 55
      IF (ZI(KK).GE.ZI(KEEP)) GO TO 60
      KEEP=KK
      GO TO 60
55    KEEP=KK
      KEY=1
60    CONTINUE
C
65    IF (KEY.NE.0) GO TO 70
      WRITE (6,67) ZX,RX,I,(ZI(KEY),KEY=1,4),(RI(KEY),KEY=1,4)
67    FORMAT (34H0ERROR NEAR STATEMENT 65 IN DBLTRP/1X3HZX=,E15.8,4X3HRX
     1=,E15.8,4X2HI=,I3/1X3HZI=,4E20.8/1X3HRI=,4E20.8/1H1)
      XYZ=-2.
      ZYX=SQRT(XYZ)
      CALL EXIT
C
C         FIND 6 VALUES ON SELECTED DISCONTINUITY
C
70    IF (KEEP.EQ.3) GO TO 80
      IF (KEEP.EQ.4) GO TO 81
      IF (KEEP.EQ.2) GO TO 71
      N=NPS
      GO TO 72
71    N=NTS
72    CONTINUE
      ZY=ZI(KEEP)
      RY=RX
      DO 75 K=3,8
      ANS1(I,K)=TAB(N,K,KEEP)+(TAB(N+1,K,KEEP)-TAB(N,K,KEEP))*SQRT(((RY-
     1TAB(N,2,KEEP))**2+(ZY-TAB(N,1,KEEP))**2)/((TAB(N+1,2,KEEP)-TAB(N,2
     1,KEEP))**2+(TAB(N+1,1,KEEP)-TAB(N,1,KEEP))**2))
      NO=75
```

```
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 940
75    CONTINUE
      GO TO 90
80    N=MR
      ZY=ZI(3)
      RY=RX
      DO 85 K=3,8
      ANS1(I,K)=RARF(N,K)+(RARF(N+1,K)-RARF(N,K))*SQRT(((RY-RARF(N,2))**
     12+(ZY-RARF(N,1))**2)/((RARF(N+1,2)-RARF(N,2))**2+(RARF(N+1,1)-RARF
     1(N,1))**2))
      NO=85
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 940
85    CONTINUE
      GO TO 90
81    N=MS
      ZY=ZI(4)
      RY=RX
      DO 86 K=3,8
      ANS1(I,K)=SURF(N,K)+(SURF(N+1,K)-SURF(N,K))*SQRT(((RY-SURF(N,2))**
     12+(ZY-SURF(N,1))**2)/((SURF(N+1,2)-SURF(N,2))**2+(SURF(N+1,1)-SURF
     1(N,1))**2))
86    CONTINUE
90    CALL DVCHK(NO)
      IF (NO.EQ.2) GO TO 92
      NO=90
      GO TO 940
92    ANS1(I,1)=ZY
      ANS1(I,2)=RY
      GO TO 800
C
C         FIND INTERSECTIONS OF 3 DISCONTINUITIES AND Z GRID LINE
C
300   CONTINUE
      KATCHP=0
```

```
      KATCHR=0
      KATCHT=0
      KATCHS=0
      DO 310 K=1,2
      KATCH=0
      GO TO (303,301),K
303   NN=NP
      GO TO 302
301   NN=NT
302   JJJ=NN-1
      DO 309 M=1,JJJ
      IF ((TAB(M,1,K)-TAB(M+1,1,K)).GT.1.E-6) GO TO 3030
      GO TO 309
3030  RI(K)=TAB(M+1,2,K)+(TAB(M,2,K)-TAB(M+1,2,K))*(Z(II)-TAB(M+1,1,K))/
     1(TAB(M,1,K)-TAB(M+1,1,K))
      CALL DVCHK(NO)
      IF (NO.EQ.2) GO TO 3031
      NO=3030
      GO TO 940
3031  CONTINUE
      IF (M.EQ.JJJ) GO TO 3022
      IF (RI(K).GT.TAB(M+1,2,K).OR.RI(K).LT.TAB(M,2,K)) GO TO 309
3022  IF (MCOM.EQ.2) GO TO 305
      IF (KATCH.EQ.1) GO TO 304
      KATCH=1
      GO TO 3050
304   IF ((RX-RI(K)).GT.(RX-RM)) GO TO 309
3050  RM=RI(K)
      IF (K.EQ.2) GO TO 3040
      MPS=M
      KATCHP=1
      GO TO 309
3040  MTS=M
      KATCHT=1
      GO TO 309
305   CONTINUE
```

```
      IF (KATCH.EQ.1) GO TO 306
      KATCH=1
      GO TO 3050
306   IF ((RI(K)-RX).GT.(RM-RX)) GO TO 309
      GO TO 3050
309   CONTINUE
      RI(K)=RM
      IF (KATCH.NE.0) GO TO 310
      RI(K)=RMAX+1.
310   CONTINUE
      K=3
      IF (IRARF.EQ.1)RI(3)=RMAX+1.
      IF (IRARF.EQ.1) GO TO 315
      JJJ=NR-1
      KATCH=0
      DO 312 M=1,JJJ
      RI(3)=RARF(M+1,2)+(RARF(M,2)-RARF(M+1,2))*(Z(II)-RARF(M+1,2))/(RAR
     1F(M,1)-RARF(M+1,1))
      NO=3122
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 940
      IF (M.EQ.JJJ.OR.M.EQ.1) GO TO 3122
      IF (RI(K).GT.RARF(M+1,2).OR.RI(K).LT.RARF(M,2)) GO TO 312
3122  IF (MCOM.EQ.2) GO TO 316
      IF (KATCH.EQ.1) GO TO 317
      KATCH=1
      GO TO 3051
317   IF ((RX-RI(K)).GT.(RX-RM)) GO TO 312
3051  RM=RI(K)
      MR=M
      KATCHR=1
      GO TO 312
316   CONTINUE
      IF (KATCH.EQ.1) GO TO 318
      KATCH=1
      GO TO 3051
```

```
318   IF ((RI(K)-RX).GT.(RM-RX)) GO TO 312
      GO TO 3051
312   CONTINUE
      RI(K)=RM
      IF (KATCH.NE.0) GO TO 315
      RI(K)=RMAX+1.
315   CONTINUE
      KATCH=0
      JJJ=NP-1
      DO 3150 M=1,JJJ
      IF ((SURF(M,1)-SURF(M+1,1)).GT.1.E-6) GO TO 3130
      GO TO 3150
3130  RI(4)=SURF(M+1,2)+(SURF(M,2)-SURF(M+1,2))*(Z(II)-SURF(M+1,1))/(SUR
     1F(M,1)-SURF(M+1,1))
      NO=3130
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 940
      IF (M.EQ.JJJ) GO TO 3123
      IF (RI(4).GT.SURF(M+1,2).OR.RI(4).LT.SURF(M,2)) GO TO 3150
3123  IF (MCOM.EQ.2) GO TO 3105
      IF (KATCH.EQ.1) GO TO 3104
      KATCH=1
      GO TO 3109
3104  IF ((RX-RI(4)).GT.(RX-RM)) GO TO 3150
3109  RM=RI(4)
      MS=M
      KATCHS=1
      GO TO 3150
3105  IF (KATCH.EQ.1) GO TO 3106
      KATCH=1
      GO TO 3109
3106  IF ((RI(4)-RX).GT.(RM-RX)) GO TO 3150
      GO TO 3109
3150  CONTINUE
      RI(4)=RM
      IF (KATCH.NE.0) GO TO 3107
```

```
      RI(4)=RMAX+1.
3107  CONTINUE
      IF (KATCHP+KATCHT+KATCHR+KATCHS.EQ.0) GO TO 485
      ZI(1)=Z(II)
      ZI(2)=Z(II)
      ZI(3)=Z(II)
      ZI(4)=Z(II)
C         J LOOP FOR LEFT AND RIGHT R GRID LINES
C
      DO 700 J=1,2
      IF (J.EQ.2) GO TO 350
C
C         LEFT R GRID LINE
C
      JJ=J1
      KEY=0
      DO 340 N=1,4
      IF (R(J1).GT.RI(N)) GO TO 340
      IF (RI(N).GT.RX) GO TO 340
      IF (KEY.EQ.1) GO TO 330
      KEY=1
      KEEP=N
      GO TO 340
C
C         FIND CLOSEST
C
330   DIF1=RX-RI(KEEP)
      DIF2=RX-RI(N)
      IF (DIF1.LE.DIF2) GO TO 340
      KEEP=N
340   CONTINUE
      GO TO 375
C
C         RIGHT R GRID LINE
C
350   JJ=J2
```

```
      KEY=0
      DO 360 N=1,4
      IF (R(J2).LT.RI(N)) GO TO 360
      IF (RI(N).LT.RX) GO TO 360
      IF (KEY.EQ.1) GO TO 355
      KEY=1
      KEEP=N
      GO TO 360
355   DIF1=RI(KEEP)-RX
      DIF2=RI(N)-RX
      IF (DIF1.LE.DIF2) GO TO 360
      KEEP=N
360   CONTINUE
375   IF (KEY.EQ.1) GO TO 400
C
C         NO POINTS BETWEEN RX AND GRID POINTS
C
      ANS2(J,1)=Z(II)
      ANS2(J,2)=R(JJ)
      ANS2(J,3)=XMESH(II,JJ,1)
      ANS2(J,4)=XMESH(II,JJ,2)
      ANS2(J,5)=XMESH(II,JJ,3)
      ANS2(J,6)=XMESH(II,JJ,4)
      ANS2(J,7)=XMESH(II,JJ,5)
      ANS2(J,8)=XMESH(II,JJ,6)
      GO TO 700
C
C         POINT FOUND BETWEEN RX AND GRID POINTS
C
400   GO TO (405,410,470,481),KEEP
C
C         INTERSECTION ON PROJECTILE SHOCK
C
405   N1=MPS
      RY=RI(KEEP)
      ZY=Z(II)
```

```
      GO TO 520
C
C          INTERSECTION ON TARGET SHOCK
C
410   N1=MTS
      RY=RI(KEEP)
      ZY=Z(II)
      GO TO 520
C
C         INTERSECTION ON RAREFACTION
C
470   N1=MR
      RY=RI(KEEP)
      ZY=Z(II)
      GO TO 520
C
C     INTERSECTION ON FREE SURFACE
C
481   N1=MS
      RY=RI(KEEP)
      ZY=Z(II)
      GO TO 520
C
C
485   WRITE (3,488) KEEP,II,JJ,ZX,RX
488   FORMAT (25HOERROR NEAR STATEMENT 485/1X5HKEEP=,I4,4X3HII=,I4,4X3HJ
     1J=,I4/1X3HZX=,E15.8,4X3HRX=,E15.8/1H1)
      CALL EXIT
C
C          FIND TABLE VALUES
C
520   IF (KEEP.EQ.3) GO TO 580
      IF (KEEP.EQ.4) GO TO 591
      DO 550 N=3,8
      ANS2(J,N)=TAB(N1,N,KEEP)+(TAB(N1+1,N,KEEP)-TAB(N1,N,KEEP))*SQRT(((
     1RY-TAB(N1,2,KEEP))**2+(ZY-TAB(N1,1,KEEP))**2)/((TAB(N1+1,2,KEEP)-T
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```
     1AB(N1,2,KEEP))**2+(TAB(N1+1,1,KEEP)-TAB(N1,1,KEEP))**2))
550   CONTINUE
      IF (ZX.LT.0..AND.ABS(RX-RADIUS).LT.1.E-6) GO TO 552
      IF (RX.LT.RADIUS.OR.ABS(Z(II)).GT.1.E-6) GO TO 551
552   CONTINUE
      ANS2(J,3)=0.
      ANS2(J,6)=RHOSTR
      ANS2(J,7)=0.
      ANS2(J,8)=SQRT(BIGAPR/RHOSTR)
551   CONTINUE
      GO TO 600
580   DO 590 N=3,8
      ANS2(J,N)=RARF(N1,N)+(RARF(N1+1,N)-RARF(N1,N))*SQRT(((RY-RARF(N1,2
     1))**2+(ZY-RARF(N1,1))**2)/((RARF(N1+1,2)-RARF(N1,2))**2+(RARF(N1+1
     1,1)-RARF(N1,1))**2))
590   CONTINUE
      GO TO 600
591   DO 592 N=3,8
      ANS2(J,N)=SURF(N1,N)+(SURF(N1+1,N)-SURF(N1,N))*SQRT(((RY-SURF(N1,2
     1))**2+(ZY-SURF(N1,1))**2)/((SURF(N1+1,2)-SURF(N1,2))**2+(SURF(N1+1
     1,1)-SURF(N1,1))**2))
592   CONTINUE
600   CALL DVCHK(NO)
      IF (NO.EQ.2) GO TO 605
      NO=600
      GO TO 940
605   ANS2(J,1)=ZY
      ANS2(J,2)=RY
C
C         END OF LOOP FOR BOTH R GRID LINES
C
700   CONTINUE
C
C         INTERPOLATE FOR UPPER AND LOWER VALUES
C
      DO 720 J=3,8
```

```
      ANS1(I,J)=ANS2(1,J)+(ANS2(2,J)-ANS2(1,J))*(RX-ANS2(1,2))/(ANS2(2,2
     1)-ANS2(1,2))
720   CONTINUE
      CALL DVCHK(NO)
      IF (NO.EQ.2) GO TO 730
      NO=720
      GO TO 940
730   ANS1(I,1)=Z(II)
      ANS1(I,2)=RX
C
C         END OF LOOP FOR BOTH Z GRID LINES
C
800   CONTINUE
C
C         FIND FINAL VALUES
C
      DO 810 J=1,6
      ANS(J)=ANS1(1,J+2)+(ANS1(2,J+2)-ANS1(1,J+2))*(ZX-ANS1(1,1))/(ANS1(
     12,1)-ANS1(1,1))
810   CONTINUE
      CALL DVCHK(NO)
      IF (NO.EQ.2) GO TO 820
      NO=810
      GO TO 940
820   RETURN
C
940   WRITE (3,942)
942   FORMAT (35HODIVIDE CHECK ERROR IN SUBR. DBLTRP)
950   WRITE (3,952) NO,ZX,RX,I1,J1,KEEP,ZI,RI
952   FORMAT (19H NEAR STATEMENT NO.,I4/1X3HZX=,E15.8,4X3HRX=,E15.8/1X3H
     1I1=,I4,4X3HJ1=,I4,4X5HKEEP=,I4/1X3HZI=,4E18.8/1X3HRI=,4E18.8)
      WRITE (3,955) ((ANS1(I,J),J=1,8),I=1,2),((ANS2(I,J),J=1,8),I=1,2)
955   FORMAT (1X5HANS1=/8E16.8/8E16.8/1X5HANS2=/8E16.8/8E16.8/1H1)
      XYZ=-2.
      ZYX=SQRT(XYZ)
      CALL EXIT
```

```
      RETURN                                                            600
      DEBUG SUBCHK
      END                                                               601
      SUBROUTINE SHOCK
C         COMPUTES SHOCK VALUES
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
      REAL LO,MO,LENGTH,MU,KO
C
      DIMENSION ANS(6)
      EXTERNAL FGOF1
      EPS=.0000001
C
C         BEGIN SHOCK POINT COMPUTATIONS
      DO 505 K=1,2
      GO TO (158,160),K
158   NN=NP
      GO TO 162
160   NN=NT
```

```
      VBARS=0.
162   DO 500 I=1,NN
      MPROJ=0
      IF (TAB(I,14,K).LT.0.) GO TO 500
164   CONTINUE
C
C         INITIALIZE TO ITERATE ON 1 SHOCK POINT
C
      NBIC=0
      ZO=TAB2(I,1,K)
      RO=TAB2(I,2,K)
      PO=TAB(I,3,K)
      UO=TAB(I,4,K)
      VO=TAB(I,5,K)
      RHOO=TAB(I,6,K)
      EO=TAB(I,7,K)
      AO=TAB(I,8,K)
      LO=TAB(I,9,K)
      MO=TAB(I,10,K)
      UBARO=TAB(I,11,K)
      VBARO=TAB(I,12,K)
      UTOH=TAB(I,13,K)
      UTO=UTOH
      ITS44=ITS4
      IF (IRARF.EQ.1) GO TO 170
      M=1-(NR-2)*(K-2)
      FF=RO-RARF2(M+1,2)-(RARF2(M,2)-RARF2(M+1,2))*(ZO-RARF2(M+1,1))/(RA
     1RF2(M,1)-RARF2(M+1,1))
169   CONTINUE
      IF (FF.LT..001) GO TO 350
170   IF (I.NE.1) GO TO 180
      MO=TAB(I,10,K)
      LO=0.
      GO TO 190
180   IF (I.LT.NN) GO TO 184
      UP=H*(TAB(I-1,13,K)-TAB(I,13,K))
```

```
      TMP=SQRT((TAB2(I-1,2,K)-RO)**2+(TAB2(I-1,1,K)-ZO)**2)
      DOMEG=UP/TMP
      GO TO 186
184   DR1=TAB2(I+1,2,K)-RO
      DR2=RO-TAB2(I-1,2,K)
      DZ1=TAB2(I+1,1,K)-ZO
      DZ2=ZO-TAB2(I-1,1,K)
      UP=H*(TAB(I-1,13,K)-TAB(I+1,13,K))
      TMP=SQRT(DR1**2+DZ1**2)+SQRT(DR2**2+DZ2**2)
      DOMEG=UP/TMP
      KICK=184
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
C
C         COMPUTE NEW LO,MO
C
186   COMEG=COS(DOMEG)
      SOMEG=SIN(DOMEG)
      XLO=LO*COMEG+MO*SOMEG
      XMO=MO*COMEG-LO*SOMEG
      LO=XLO
      MO=XMO
      IF (PO.GT..0025) GO TO 190
      PO=0.
      UO=0.
      VO=VP*(1.-(-1.)**K)/2.
      RHOO=RHOSTR
      EO=0.
      AO=SQRT(BIGAPR/RHOSTR)
      UBARO=MO*VO
      VBARO=VBARS
      UTO=UBARO+AO*(-1.)**K
      GO TO 350
190   ITS33=ITS3
C
C         FIND GUESS TO START ITERATION
```

```
C
195   CALL GUESS(1,KOD2,ZO,RO,I,K,ZZ,RR,DZ,DR)
      IF (KOD2.EQ.1) GO TO 200
      WRITE (3,198) I,K,ZO,RO
      WRITE (3,7002) ZZ,RR,DZ,DR
198   FORMAT (31HONO GUESS FOUND FOR SHOCK POINT/3HOI=,I4,6X2HK=,I4,10X3
     1HZO=,E15.8,10X3HRO=,E15.8/1H1)
      CALL EXIT
200   CONTINUE
      KY=K
      NTW=0
      IF (K.EQ.2) GO TO 201
      VBARS=VP*LO
      DIRCOS=-MO
      GO TO 203
201   DIRCOS=MO
203   CONTINUE
      CALL NRIT2(Z1,R1,ZZ,DZ,RR,DR,EPS1,EPS2,FGOF1,ITS1,KODE)
      IF (KODE.EQ.0) GO TO 205
C
C    BICHARACTERISTIC SELECTION SCHEME
C
      IF (NBIC.EQ.0) GO TO 204
      IF (NTW.EQ.8)KY=KY+1
      IF (NTW.GT.21) GO TO 7000
      ANG1=ANG1+DTPSI*(-1.)**KY
      DIRCOS=SIN(ANG1)
      LO=COS(ANG1)
      NTW=NTW+1
      GO TO 203
204   CONTINUE
      NBIC=1
      CALL DBLTRP(ZZ,RR,ANS)
      UA=ANS(2)
      VA=ANS(3)
      AA=ANS(6)
```

```
      ZZZ=ZZ+DZ
      CALL DBLTRP(ZZZ,RR,ANS)
      UB=ANS(2)
      VB=ANS(3)
      AB=ANS(6)
      RRR=RR+DR
      CALL DBLTRP(ZZ,RRR,ANS)
      UC=ANS(2)
      VC=ANS(3)
      AC=ANS(6)
      MM=0
      TPSI=1.5708*(-1.)**K
      XB=ZZ
      YB=RR
      NOM=5
      CA=NOM
6201  DTPSI=.01745
      DTPSI=CA*DTPSI
      TPSI=TPSI+DTPSI*(-1.)**K
      A1=1.+H*(VB-VA+(AB-AA)*SIN(TPSI))/DZ
      B1=H*(VC-VA+(AC-AA)*SIN(TPSI))/DR
      C1=-(ZZ-ZO+H*(VA+AA*SIN(TPSI)))
      A2=H*(UB-UA+(AB-AA)*COS(TPSI))/DZ
      B2=1.+H*(UC-UA+(AC-AA)*COS(TPSI))/DR
      C2=-(RR-RO+H*(UA+AA*COS(TPSI)))
      DET=A1*B2-A2*B1
      DELX=(B2*C1-B1*C2)/DET
      DELY=(A1*C2-A2*C1)/DET
C
C         TEST FOR SAME REGION
C
      XB1=XB+DELX
      YB1=YB+DELY
      M=COMP(XB,YB,XB1,YB1)
      IF (M.EQ.1) GO TO 6203
      MM=MM+1
```

```
      IF (MM.LT.360/NOM) GO TO 6201
7000  WRITE (3,7001)
7001  FORMAT (41HOBICHARACTERISTIC SELECTION SCHEME FAILED)
      WRITE (3,614) ZO,RO
614   FORMAT (1X5HZO  =,E15.8,4X5HRO  =,E15.8)
      WRITE (3,7002) UA,VA,AA,UB,VB,AB,UC,VC,AC,ZZ,DZ,RR,DR,ANG1
7002  FORMAT (4E16.8)
      CALL EXIT
6203  CONTINUE
      WRITE (3,6210)
6210  FORMAT (53HOBICHARACTERISTIC SELECTION SCHEME EMPLOYED BY SHOCKX)
6204  ANG1=TPSI
      T1=DIRCOS
      T2=LO
      DIRCOS=SIN(ANG1)
      LO=COS(ANG1)
      GO TO 203
205   CONTINUE
      UBARS1=0.
      IF (K.EQ.1)UBARS1=MO*VP
      CALL DBLTRP(Z1,R1,ANS)
      P1=ANS(1)
      U1=ANS(2)
      V1=ANS(3)
      RHO1=ANS(4)
      E1=ANS(5)
      A1=ANS(6)
206   CONTINUE
      KICK=205
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      IF (NBIC.EQ.0) GO TO 207
7003  SINTH=ABS(DIRCOS)
      COSTH=ABS(LO)
      DIRCOS=T1
      LO=T2
```

```
207   CONTINUE
      UBAR1=LO*U1+MO*V1
      IF (K.EQ.2) GO TO 208
      IF (UBAR1.LT.VP/2.) GO TO 208
      UBAR1=UBARS1-UBAR1
208   CONTINUE
218   CONTINUE
      M1=PART(1,Z1,R1,ZZ,RR,DELTA,NDEL)
      IF (M1.EQ.1) GO TO 210
      PUR=0.
      PVR=0.
      GO TO 215
210   CALL DBLTRP(ZZ,RR,ANS)
      DP=RR-R1
      PUR=(ANS(2)-U1)/DP
219   CONTINUE
      PVR=(ANS(3)-V1)/DP
215   M1=PART(2,Z1,R1,ZZ,RR,DELTA,NDEL)
      IF (M1.EQ.1) GO TO 220
      PUZ=0.
      PVZ=0.
      PAZ=0.
      GO TO 225
220   CALL DBLTRP(ZZ,RR,ANS)
      DP=ZZ-Z1
      PUZ=(ANS(2)-U1)/DP
      PVZ=(ANS(3)-V1)/DP
225   CONTINUE
      IF (NBIC.EQ.1) GO TO 7004
      PURB1=LO*PUR+MO*PVR
      PVRB1=LO*PVR-MO*PUR
      PVZB1=LO*PVZ-MO*PUZ
      PVEB1=-MO*PVRB1+LO*PVZB1
      SBAR1=PVEB1
226   CONTINUE
      IF (ABS(R1).LE.EPS) GO TO 235
```

```
      SBAR1=SBAR1+U1/R1
      GO TO 240
7004  CONTINUE
      IF (V1.GT.VP/2..AND.K.EQ.1)V1=VP-V1
      SBAR1=SINTH**2*PUR-SINTH*COSTH*(PUZ+PVR)+COSTH**2*PVZ
      GO TO 226
235   SBAR1=SBAR1+PUR
C
C
240   ITS22=ITS2
      MMM=0
250   CONTINUE
      CALL EQOSS(PFR,PFE)
      BIGA1=RHO1*A1
      KICK=250
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      TEMP=1.-RHOSTR/RHOO
      TMP=SQRT(PO*TEMP/RHOSTR)
      IF (K.EQ.2) GO TO 251
      IF (TMP.LT.VP/2.) GO TO 251
      MPROJ=1
      TMP=UBARS1-TMP
251   CONTINUE
      TMP6=TMP
256   CONTINUE
      FNBIC=NBIC
      TMP1=P1+BIGA1*UBAR1-RHO1*H*SBAR1*A1**2+BIGA1*(-UBAR1+COSTH*U1+SINT
     1H*V1-SINTH*LO*VBARS+COSTH*MO*VBARS)*(FNBIC)
      TMP2=PFR*TEMP+PO*RHOSTR/RHOO**2
      TMP5=PFE*TEMP
      GTMP=-RHO1*A1
      IF (NBIC.EQ.0) GO TO 259
      GTMP=GTMP*(COSTH*LO+SINTH*MO)
259   CONTINUE
      BIGG=PO-(GTMP*TMP+TMP1)
```

```
      PGR=PFR-((GTMP*TMP2)/(2.*RHOSTR*TMP6))
      PGE=PFE-((GTMP*TMP5)/(2.*RHOSTR*TMP6))
265   TMP=.5*(1./RHOSTR-1./RHOO)
      BIGH=EO-TMP*PO
      PHR=-TMP*PFR-.5*PO/RHOO**2
      PHE=1.-TMP*PFE
      IF (ABS(BIGH).GT..0001) GO TO 267
      BIGH=0.
267   IF (ABS(BIGG).GT..0001) GO TO 269
      BIGG=0.
269   CONTINUE
C
C         COMPUTE DELTA EO,DELTA RHOO
C
      DOWN=PGE*PHR-PGR*PHE
      DEO=(-BIGG*PHR+BIGH*PGR)/DOWN
      DRHOO=(-BIGH*PGE+BIGG*PHE)/DOWN
C
      EO2=EO+DEO
      IF (EO2.LT.0.)EO2=0.
      RHOO2=RHOO+DRHOO
      IF (RHOO2.LT.RHOSTR)RHOO2=RHOO
      KICK=265
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      CALL EQOSP(RHOO2,EO2,PO2)
      UBARO2=(1.-RHOSTR/RHOO2)*(PO2/RHOSTR)
      IF (UBARO2.GT.0.) GO TO 2669
      WRITE (3,2700) PO2,RHOO2,EO2,RO,ZO
      WRITE (3,7002) P1,U1,V1,RHO1,E1,Z1TR1,SBAR1
2700  FORMAT (4E16.8)
2669  CONTINUE
      UBARO2=SQRT(UBARO2)
      IF (EO2.LT.1.E-5) GO TO 273
      IF (ABS((EO2-EO)/EO2).LT.EPS4) GO TO 273
      IF (ABS(DEO).GT..01*EPS4) GO TO 275
```

```
273   IF (ABS((RHOO2-RHOO)/RHOO2).LE.EPS3) GO TO 285
      IF (ABS(DRHOO).LT.EPS3) GO TO 285
275   ITS22=ITS22-1
      IF (ITS22.GT.0) GO TO 280
      WRITE (3,278) ITS2
278   FORMAT (35HOE AND RHO FAILED TO CONVERGE AFTER,I4,6H TRIES)
      WRITE (3,279) I,K,ZO,RO,EO,RHOO,PO,EO2,RHOO2,PO2
279   FORMAT (1X2HI=,I4,4X2HK=,I4/1X4HZO =,E15.8,4X4HRO =,E15.8,4X4HEO =
     1,E15.8,4X6HRHOO =,E15.8,4X4HPO =,E15.8/1X4HEO2=,E15.8,4X6HRHOO2=,E
     115.8,4X4HPO2=,E15.8/1H1)
      STOP
280   EO=EO2
      RHOO=RHOO2
      PO=PO2
      UBARO=UBARO2
      GO TO 250
285   EO=EO2
      RHOO=RHOO2
      UBARO=UBARO2
      AO=SQRT(PFR+PO2*PFE/RHOO**2)
C
C
      CALL DVCHK(KQ)
      KICK=285
      IF (KQ.EQ.1) GO TO 9980
      IF (K.EQ.2) GO TO 286
      VBARO=VP*LO
      GO TO 287
286   VBARO=0.
287   CONTINUE
295   PO=PO2
      IF (K.EQ.2) GO TO 296
      UBARO=UBARS1-UBARO
296   CONTINUE
      UTO=(RHOO*UBARO-RHOSTR*UBARS1)/(RHOO-RHOSTR)
      VO=MO*UBARO+LO*VBARO
```

```
      UO=LO*UBARO-MO*VBARO
      UBAR=.5*(UTOH+UTO)
      IF (ABS((UBAR-UTOH)/UBAR).LE.EPS6) GO TO 350
      IF (ABS(UBAR-UTOH).LT.EPS6) GO TO 350
      ITS44=ITS44-1
      IF (ITS44.GT.0) GO TO 325
      WRITE (3,297) ITS4,UTOH,UTO
297   FORMAT (30HOUBAR FAILED TO CONVERGE AFTER,I4,6H TRIES/1X5HUTOH=,E1
     15.8,4X4HUTO=,E15.8)
      CALL EXIT
      WRITE (3,279) I,K,ZO,RO,EO,RHOO,PO,EO2,RHOO2,PO2
C
C         INIT. FOR MORE U BAR ITERATIONS
C
325   UTOH=UBAR
      AVMO=(TAB(I,10,K)+MO)*.5
      AVLO=(TAB(I,9,K)+LO)*.5
      ZO=TAB(I,1,K)+UBAR*H*AVMO-VBARS*AVLO*H
      RO=TAB(I,2,K)+UBAR*H*AVLO-VBARS*AVMO*H
      LO=AVLO
      MO=AVMO
      GO TO 195
C
C         ONE SHOCK POINT HAS CONVERGED
C
350   TAB2(I,1,K)=ZO
      TAB2(I,2,K)=RO
      TAB2(I,3,K)=PO
      TAB2(I,4,K)=UO
      TAB2(I,5,K)=VO
      TAB2(I,6,K)=RHOO
      TAB2(I,7,K)=EO
      TAB2(I,8,K)=AO
      TAB2(I,9,K)=LO
      TAB2(I,10,K)=MO
      TAB2(I,11,K)=UBARO
```

```
      TAB2(I,12,K)=VBARO
      TAB2(I,13,K)=UTO
      KICK=500
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
C
C
500   CONTINUE
505   CONTINUE
      RETURN
9980  WRITE (3,9985) KICK
9985  FORMAT (32HODIVIDE CHECK NEAR STATEMENT NO.,I5,15H IN SUBR. SHOCK/
     11H1)
      CALL EXIT
      RETURN
      END
      SUBROUTINE FGOF1(ZX,RX,SS,QQ)
C
C         COMPUTES S1,Q1 FOR SHOCK LINE
C         ITERATION FOR Z1,R1
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
```

```
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      DIMENSION ANS(6)
C
      REAL LO,MO
      CALL DBLTRP(ZX,RX,ANS)
      U1=ANS(2)
      V1=ANS(3)
      A1=ANS(6)
      SS=ZX-ZO+H*(V1+A1*DIRCOS)
      QQ=RX-RO+H*(U1+A1*LO)
      RETURN
      END
      SUBROUTINE INTER(PHI,NMAX,MMAX)
C     SUBROUTINE INTER
C         COMPUTES INTERIOR REGION POINTS
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
```

```
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
      DOUBLE PRECISION PHI(20,20,6)
      DIMENSION ANS(6),LL(3),ZI(11),RI(11),PI(11),UI(11),VI(11),RHOI(11)
     1,EI(11),AI(11),PUR(11),PVR(11),PAR(11),PUZ(11),PVZ(11),PAZ(11),PSI
     1(7),SPSI(11),CPSI(11),S(11)
C
      EXTERNAL FGOFI,FGOF5
      INTEGER CHECK,CHECK2
C
1     FORMAT (1H1)
      TSSS=1.1
      EPS=.0000001
      DO 905 J=1,20
      DO 900 I=1,20
      M=TEST(Z(I),R(J))
      ZO=Z(1)
      RO=R(J)
      KICK=1
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      IF (M.EQ.3.AND.ZO.LT.EPS.AND.ABS(RO-RADIUS).LT.EPS)M=1
      IF (M.NE.1) GO TO 900
      DO 2 L=1,NP
      IF (TAB(L,14,1).LT.0.) GO TO 20
2     CONTINUE
      IF (IRARF.EQ.1) GO TO 20
      DO 3 N=1,NR
      IF (R(J).GT.RARF(N,2)) GO TO 5
3     CONTINUE
      GO TO 6
5     CONTINUE
```

```
      M=PICK(Z(I),R(J),3)
      FF=R(J)-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(Z(I)-RARF(M+1,1))/(RA
     1RF(M,1)-RARF(M+1,1))
      IF (FF.GT.0.) GO TO 20
6     CONTINUE
      PO2=RARF(1,3)
      UO2=RARF(1,4)
      VO2=RARF(1,5)
      RHOO2=RARF(1,6)
      EO2=RARF(1,7)
      AO2=RARF(1,8)
      GO TO 870
20    CONTINUE
      CALL GUESS(2,KOD,ZO,RO,I,J,ZZ,RR,DZ,DR)
      IF (KOD.EQ.1) GO TO 580
      WRITE (3,575) I,J,ZO,RO
575   FORMAT (41HONO GUESS FOUND FOR INTERIOR REGION POINT/3HOI=I4,6X2HK
     1=,I4,10X3HZO=,E15.8,10X3HRO=,E15.8/1H1)
      CALL EXIT
  580 IF(TIME.GT.TSSS) GO TO 150
      CALL DBLTRP(ZZ,RR,ANS)
      GO TO 151
  150 CALL  DSURFT(ZZ,RR,ANS,PHI,NMAX,MMAX)
C
C         INITIALIZE FOR 1 POINT
C
C     PSI(1)=0.
  151 PSI(1)=0.
      PSI(3)=1.0472
      PSI(4)=2.0944
      PSI(6)=4.18879
      PSI(7)=5.23599
      NBIC=0
      ITI22=ITI2
      PO=ANS(1)
      UO=ANS(2)
```

```
      VO=ANS(3)
      RHOO=ANS(4)
      EO=ANS(5)
      AO=ANS(6)
      KICK=580
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
590   IF (ABS(RO).GT.EPS) GO TO 594
      L1=1
      LL(1)=4
      LL(2)=6
      LLL=2
      GO TO 620
C
C
594   IF (ABS(RO-RADIUS).GT.EPS) GO TO 600
      IF (ZO.GT.EPS) GO TO 610
      L1=2
      LL(1)=3
      LL(2)=7
      LLL=2
      GO TO 620
600   IF (RO.LE.RADIUS.OR.ABS(ZO).GT.EPS) GO TO 610
      L1=3
      LL(1)=6
      LL(2)=7
      LLL=2
      GO TO 620
C
C
610   L1=4
      LL(1)=1
      LL(2)=4
      LL(3)=6
      LLL=3
C
```

```
C          ITERATE FOR I VALUES
C
619   CONTINUE
620   DO 630 KK=1,LLL
      LUMP=L1
      ISUB=LL(KK)
621   CONTINUE
      TPSI=PSI(ISUB)
      SPSI(ISUB)=SIN(TPSI)
      CPSI(ISUB)=COS(TPSI)
C     CALL NRIT2(ZI(ISUB),RI(ISUB),ZZ,DZ,RR,DR,EPI1,EPI2,FGOFI,ITI1,KODE
C    1)
      CALL NRIT2(ZI(ISUB),RI(ISUB),ZZ,DZ,RR,DR,EPI1,EPI2,FGOFI,ITI1,KODE
     1,PHI,NMAX,MMAX)
      IF (KODE.NE.0) GO TO 6200
  625 IF(TIME.GT.TSSS) GO TO 125
      CALL DBLTRP(ZI(ISUB),RI(ISUB),ANS)
      GO TO 122
  125 CALL DSURFT(ZI(ISUB),RI(ISUB),ANS,PHI,NMAX,MMAX)
  122 PI(ISUB)=ANS(1)
C     PI(ISUB)=ANS(1)
      UI(ISUB)=ANS(2)
      VI(ISUB)=ANS(3)
      RHOI(ISUB)=ANS(4)
      EI(ISUB)=ANS(5)
      AI(ISUB)=ANS(6)
630   CONTINUE
C
C
      KICK=630
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      GO TO 6400
C
C    BICHARACTERISTIC SELECTION SCHEME
C
```

```
7000  WRITE (3,7001)
7001  FORMAT (41HOBICHARACTERISTIC SELECTION SCHEME FAILED)
      WRITE (3,614) ZO,RO
      WRITE (3,7002) (PSI(MNMN),MNMN=1,7),UA,VA,AA,UB,VB,AB,UC,VC,AC,ZZ,
     1DZ,RR,DR,ANG1,ANG2
      SUB=ISUB
      WRITE (3,7002) SUB,ZI(ISUB),RI(ISUB)
7002  FORMAT (4E16.8)
      CALL EXIT
6200  CONTINUE
      IF (NBIC.NE.0) GO TO 7000
      IF (L1.NE.2.OR.LL(1).EQ.1) GO TO 7300
      LL(1)=1
      GO TO 619
7300  CONTINUE
      IF (L1.NE.3) GO TO 7310
      IF (PSI(6).GT.4.2) GO TO 7310
      PSI(6)=5.75959
      GO TO 619
7310  CONTINUE
      IF(TIME.GT.TSSS) GO TO 222
      CALL DBLTRP(ZZ,RR,ANS)
      GO TO 223
  222 CALL DSURFT(ZZ,RR,ANS,PHI,NMAX,MMAX)
  223 UA=ANS(2)
C     UA=ANS(2)
      VA=ANS(3)
      AA=ANS(6)
      ZZZ=ZZ+DZ
      IF(TIME.GT.TSSS) GO TO 128
      CALL DBLTRP(ZZZ,RR,ANS)
      GO TO 129
  128 CALL DSURFT(ZZZ,RR, ANS,PHI,NMAX,MMAX)
  129 UB=ANS(2)
C     UB=ANS(2)
      VB=ANS(3)
```

```
      AB=ANS(6)
      RRR=RR+DR
      IF(TIME.GT.TSSS) GO TO 130
      CALL DBLTRP(ZZ,RRR,ANS)
      GO TO 131
  130 CALL DSURFT(ZZ,RRR,ANS,PHI,NMAX,MMAX)
  131 UC=ANS(2)
C     UC=ANS(2)
      VC=ANS(3)
      AC=ANS(6)
      MM=0
      TPSI=PSI(ISUB)
      XB=ZZ
      YB=RR
      NOM=5
      CA=NOM
      DO 6210 LM=1,2
6201  DTPSI=.01745
      DTPSI=CA*DTPSI
      TPSI=TPSI+DTPSI
      A1=1.+H*(VB-VA+(AB-AA)*SIN(TPSI))/DZ
      B1=H*(VC-VA+(AC-AA)*SIN(TPSI))/DR
      C1=-(ZZ-ZO+H*(VA+AA*SIN(TPSI)))
      A2=H*(UB-UA+(AB-AA)*COS(TPSI))/DZ
      B2=1.+H*(UC-UA+(AC-AA)*COS(TPSI))/DR
      C2=-(RR-RO+H*(UA+AA*COS(TPSI)))
      DET=A1*B2-A2*B1
      DELX=(B2*C1-B1*C2)/DET
      DELY=(A1*C2-A2*C1)/DET
C
C         TEST FOR SAME REGION
C
      XB1=XB+DELX
      YB1=YB+DELY
      M=COMP(XB,YB,XB1,YB1)
      IF (LM.EQ.2) GO TO 6700
```

```
      IF (M.EQ.1) GO TO 6203
      GO TO 6800
6700  CONTINUE
      IF (M.NE.1) GO TO 6203
6800  CONTINUE
      MM=MM+1
      IF (MM.LE.360/NOM) GO TO 6201
612   WRITE (3,613) ITI1
613   FORMAT (44H0FAILED TO FIND 2 POINTS IN THE SAME REGION 21H IN SUBR
     1. NRIT2 AFTER,I4,6H TRIES)
      WRITE (3,614) Z0,R0
614   FORMAT (1X5HZ0  =,E15.8,4X5HR0  =,E15.8)
      WRITE (3,6144) LM
      WRITE (3,6145) M
      WRITE (3,6146) KODE
      WRITE (3,7002) XB,YB,XB1,YB1
6144  FORMAT (4H LM=,I4)
6145  FORMAT (3H M=,I4)
6146  FORMAT (6H KODE=,I4)
      CALL EXIT
6203  GO TO (6204,6205),LM
6204  ANG1=TPSI
      MM=0
      GO TO 6210
6205  ANG2=TPSI-DTPSI
6210  CONTINUE
      AL=LLL+1
      DO 6300 KK=1,LLL
      ISUB=LL(KK)
      AK=KK
      PSI(ISUB)=ANG1+(ANG2-ANG1)*AK/AL
6300  CONTINUE
      NBIC=1
      GO TO 619
C
C
```

```
6400  CONTINUE
      IF (L1.EQ.2.OR.L1.EQ.3) GO TO 642
C     CALL NRIT2(ZI(8),RI(8),ZZ,DZ,RR,DR,EPI1,EPI2,FGOF5,ITI1,KODE)
      CALL NRIT2(ZI(8),RI(8),ZZ,DZ,RR,DR,EPI1,EPI2,FGOF5,ITI1,KODE,
     1 PHI,NMAX,MMAX)
      IF (KODE.EQ.0) GO TO 635
      ISUB=8
      WRITE (3,622) ITI1,I,J,ISUB,ZO,RO,ZZ,RR,ZI(8),RI(8)
622   FORMAT (27HOFAILED TO FIND ZI,RI AFTER,I4,6H TRIES,3X2HI=,I4,3X2HJ
     1=,I4,3X5HISUB=,I4/1X3HZO=,E15.8,6X3HRO=,E15.8/1X3HZZ=,E15.8,6X3HRR
     1=,E15.8/1X3HZI=,E15.8,6X3HRI=,E15.8/1H1)
      CALL EXIT
C
C
  635 IF(TIME.GT.TSSS) GO TO 132
      CALL DBLTRP(ZI(8),RI(8),ANS)
       GO TO 133
  132 CALL DSURFT(ZI(8),RI(8),ANS,PHI,NMAX,MMAX)
  133 PI(8)=ANS(1)
C     PI(8)=ANS(1)
      UI(8)=ANS(2)
      VI(8)=ANS(3)
      RHOI(8)=ANS(4)
      EI(8)=ANS(5)
      AI(8)=ANS(6)
C
642   DO 670 IL=1,LLL
      NN=LL(IL)
      M=PART(1,ZI(NN),RI(NN),ZX,RX,DELTA,NDEL)
      IF (M.EQ.1) GO TO 645
      PUR(NN)=0.
      PVR(NN)=0.
      GO TO 648
  645 IF(TIME.GT.TSSS) GO TO 134
      CALL DBLTRP(ZX,RX,ANS)
      GO TO 135
```

```
  134 CALL DSURFT(ZX,RX,ANS,PHI,NMAX,MMAX)
  135 DEN=RX-RI(NN)
C     DEN=RX-RI(NN)
      PUR(NN)=(ANS(2)-UI(NN))/DEN
      PVR(NN)=(ANS(3)-VI(NN))/DEN
648   M=PART(2,ZI(NN),RI(NN),ZX,RX,DELTA,NDEL)
      IF (M.EQ.1) GO TO 650
      PUZ(NN)=0.
      PVZ(NN)=0.
      GO TO 655
  650 IF(TIME.GT.TSSS) GO TO 136
      CALL DBLTRP(ZX,RX,ANS)
      GO TO 137
  136 CALL DSURFT(ZX,RX,ANS,PHI,NMAX,MMAX)
  137 DEN=ZX-ZI(NN)
      PUZ(NN)=(ANS(2)-UI(NN))/DEN
      PVZ(NN)=(ANS(3)-VI(NN))/DEN
655   S(NN)=SPSI(NN)**2*PUR(NN)-CPSI(NN)*SPSI(NN)*(PVR(NN)+PUZ(NN))+CPSI
     1(NN)**2*PVZ(NN)
C
      IF (ABS(RI(NN)).GT.EPS) GO TO 660
      CON=PUR(NN)
      GO TO 662
660   CON=UI(NN)/RI(NN)
662   S(NN)=-RHOI(NN)*H*AI(NN)**2*(S(NN)+CON)+PI(NN)+RHOI(NN)*AI(NN)*CPS
     1I(NN)*UI(NN)+RHOI(NN)*AI(NN)*SPSI(NN)*VI(NN)
670   CONTINUE
1005  CONTINUE
1002  FORMAT (4E16.8)
      KICK=670
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
C
C         COMPUTE NEW P,U,V
C
      GO TO (690,692,695,698),L1
```

```
690   DUO=0.
      UO2=0.
      VO2=(S(4)-S(6))/(RHOI(4)*AI(4)*SPSI(4)-RHOI(6)*AI(6)*SPSI(6))
      PO2=S(4)-RHOI(4)*AI(4)*SPSI(4)*VO2
      GO TO 700
C
C
692   DPO=0.
      PO2=0.
      L=LL(1)
      TMP1=RHOI(7)*RHOI(L)*AI(7)*AI(L)*(CPSI(7)*SPSI(L)-CPSI(L)*SPSI(7))
      VO2=(S(L)*RHOI(7)*AI(7)*CPSI(7)-S(7)*RHOI(L)*AI(L)*CPSI(L))/TMP1
      UO2=(S(L)-RHOI(L)*AI(L)*SPSI(L)*VO2)/(RHOI(L)*AI(L)*CPSI(L))
      GO TO 700
C
C
695   DPO=0.
      PO2=0.
      TMP1=RHOI(7)*RHOI(6)*AI(7)*AI(6)*(CPSI(7)*SPSI(6)-SPSI(7)*CPSI(6))
      VO2=(S(6)*RHOI(7)*AI(7)*CPSI(7)-S(7)*RHOI(6)*AI(6)*CPSI(6))/TMP1
      UO2=(S(6)-RHOI(6)*AI(6)*SPSI(6)*VO2)/(RHOI(6)*AI(6)*CPSI(6))
      GO TO 700
698   CONTINUE
      L=LL(1)
      TMP1=RHOI(4)*AI(4)*CPSI(4)-RHOI(L)*AI(L)*CPSI(L)
      TMP2=RHOI(4)*AI(4)*SPSI(4)-RHOI(L)*AI(L)*SPSI(L)
      TMP3=RHOI(6)*AI(6)*CPSI(6)-RHOI(L)*AI(L)*CPSI(L)
      TMP4=RHOI(6)*AI(6)*SPSI(6)-RHOI(L)*AI(L)*SPSI(L)
      VO2=((S(4)-S(L))*TMP3-(S(6)-S(L))*TMP1)/(TMP3*TMP2-TMP1*TMP4)
      UO2=(S(4)-S(L)-TMP2*VO2)/TMP1
      PO2=S(6)-RHOI(6)*AI(6)*CPSI(6)*UO2-RHOI(6)*AI(6)*SPSI(6)*VO2
700   KICK=700
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
C
C
```

```
C          ITERATE FOR RHOO,EO
C
705    ITI33=ITI3
       ITI44=ITI4
       KM=1
708    CONTINUE
       CALL EQOSI(PO2,PGRHO,PGE,BIGG,CHECK,KRTT,AO2,EO2,RHOO2,KM,EPS)
       IF (KRTT.EQ.1) GO TO 871
725    T1=RHOO-RHOI(8)
       T2=PI(8)/RHOI(8)**2
       BIGH=EI(8)+T2*T1-EO
       PHE=-1.
       PHRHO=T2
       KICK=725
       CALL DVCHK(KQ)
       IF (KQ.EQ.1) GO TO 9980
C
C          COMPUTE NEW EO,RHOO
C
       DOWN=PGE*PHRHO-PGRHO*PHE
       DEO=(-BIGG*PHRHO+BIGH*PGRHO)/DOWN
       DRHOO=(-BIGH*PGE+BIGG*PHE)/DOWN
       EO2=EO+DEO
       RHOO2=RHOO+DRHOO
C
C          CHECK EO2,RHOO2 FOR CONVERGENCE
       KICK=726
       CALL DVCHK(KQ)
       IF (KQ.EQ.1) GO TO 9980
C
       IF (ABS(DEO/EO).LT.EPI7) GO TO 726
       IF (ABS(DEO).GT..01*EPI7) GO TO 730
726    IF (ABS(DRHOO/RHOO).LE.EPI6) GO TO 740
       IF (ABS(DRHOO).LT.EPI6) GO TO 740
730    ITI33=ITI33-1
       IF (ITI33.NE.0) GO TO 735
```

```
      WRITE (6,732) ITI3,I,J,Z0,R0,P0,U0,V0,RHO0,E0,P02,U02,V02,RHO02,E0
     12
732   FORMAT (33H0E0,RHO0 FAILED TO CONVERGE AFTER,I4,6H TRIES/1X2HI=,I4
     1,4X2HJ=,I4,4X2HZ=,E15.8,4X2HR=,E15.8/5X2HP018X2HU018X2HV018X4HRHO0
     116X2HE0/5X3HP0217X3HU0217X3HV0217X5HRHO0215X3HE02//(5E20.8))
      WRITE (3,1)
      CALL EXIT
735   E0=E02
      RHO0=RHO02
      KM=0
      GO TO 708
C
C         CHECK FOR PROPER EQUATIONS
C
740   CONTINUE
      PGE=-PGE
      PGRHO=-PGRHO
      IF (RHO02.GE.RHOSTR) GO TO 750
      IF (E02.LT.EPRS) GO TO 750
742   CHECK2=0
      GO TO 752
750   CHECK2=1
752   A02=SQRT(+PGRHO+P02*PGE/RHO02**2)
      IF (CHECK.EQ.CHECK2) GO TO 870
      ITI44=ITI44-1
      IF (ITI44.NE.0) GO TO 770
      WRITE (3,755) ITI4,I,J,Z0,R0,P0,U0,V0,RHO0,E0,A0,P02,U02,V02,RHO02
     1,E02,A02
755   FORMAT (38H0FAILED TO USE CORRECT EQUATIONS AFTER,I4,6H TRIES/1X2H
     1I=,I4,4X2HJ=,I4,4X2HZ=,E15.8,4X2HR=,E15.8/5X2HP018X2HU018X2HV018X4
     1HRHO016X2HE018X2HA0/5X3HP0217X3HU0217X3HV0217X5HRHO0215X3HE0217X3H
     1A02//(6E20.8))
      WRITE (3,1)
      CALL EXIT
770   KICK=770
      CALL DVCHK(KQ)
```

```
      IF (KQ.EQ.1) GO TO 9980
      ITI33=ITI3
      GO TO 735
C
C         ALL VALUES HAVE CONVERGED FOR 1 INTERIOR POINT
C
871   KRTT=0
870   XMESH2(I,J,1)=PO2
      XMESH2(I,J,2)=UO2
      XMESH2(I,J,3)=VO2
      XMESH2(I,J,4)=RHOO2
      XMESH2(I,J,5)=EO2
      XMESH2(I,J,6)=AO2
      KICK=900
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
900   CONTINUE
905   CONTINUE
      IF (ITS3.EQ.1) GO TO 950
      CALL ITRP
      RETURN
950   CONTINUE
9980  WRITE (3,9985) KICK
      WRITE (3,614) ZO,RO
9985  FORMAT (32HODIVIDE CHECK NEAR STATEMENT NO.,I5,15H IN SUBR. INTER/
     11H1)
      CALL EXIT
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE EQOS1(PRHO,PPP,PVV,PEE,TEE,TRHO,KICK)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
```

```
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
      RHO=RHOSTR
      E=VP**2/8.
      DO 100 M=1,100
      ETA=RHO/RHOSTR
      MU=ETA-1.
      G=-RHOSTR*(VP/2.)**2+((APR+BPR/(E/(ESTAR*ETA**2)+1.))*E*RHO+BIGAPR
     1*MU+BIGBPR*MU**2)*(1.-RHOSTR/RHO)
      DERIVG=((APR+BPR/(E/(ESTAR*ETA**2)+1.))*E+BIGAPR/RHOSTR+2.*BIGBPR*
     1MU/RHOSTR+2.*E**2*BPR/(ESTAR*ETA**2*(E/(ESTAR*ETA**2)+1.)**2))*(1.
     1-RHOSTR/RHO)+((APR+BPR/(E/(ESTAR*ETA**2)+1.))*E*RHO+BIGAPR*MU+BIGB
     1PR*MU**2)*RHOSTR/RHO**2
      DLTRHO=-G/DERIVG
      RHO=RHO+DLTRHO
C     IF(ABS(DLTRHO).LT.1.E-07) GO TO 101
      IF (ABS(DLTRHO).LT.1.E-06) GO TO 101
100   CONTINUE
      KICK=2200
      GO TO 9980
101   CONTINUE
```

```
      PRHO=RHO
      TRHO=RHO
      PEE=E
      TEE=E
      PVV=VP/2.
      PPP=(APR+BPR/(E/(ESTAR*ETA**2)+1.))*E*RHO+BIGAPR*MU+BIGBPR*MU**2
9980  RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE EQOS2(PPP,PRHO,PEE)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
C
      COMMON TPSI
      COMMON KKK
C
      REAL LO,MO,LENGTH,MU,KO
      P=PPP
      RHO=PRHO
      E=PEE
      ETA=RHO/RHOSTR
```

```
      MU=ETA-1.
      EE=E/(ESTAR*ETA**2)+1.
      PGRHO=E*(APR+BPR/EE)+BIGAPR/RHOSTR+(2.*BIGBPR*MU)/RHOSTR+(2.*E**2*
     1BPR)/(ESTAR*ETA**2*EE**2)
      PGE=(APR+BPR/EE)*RHO-(E*BPR*RHO)/(ESTAR*ETA**2*EE**2)
      AR=SQRT(PGRHO+PGE*P/RHO**2)
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE EQOS3(RHO,AA,E,P)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
70    ETA=RHO/RHOSTR
      MU=ETA-1.
      EE=E/(ESTAR*ETA**2)+1.
      IF (RHO.GT.RHOSTR) GO TO 72
```

```
      IF (E.GE.EPRS) GO TO 74
72    PGRHO=E*(APR+BPR/EE)+BIGAPR/RHOSTR+(2.*BIGBPR*MU)/RHOSTR+(2.*E**2*
     1BPR)/(ESTAR*ETA**2*EE**2)
      PGE=(APR+BPR/EE)*RHO-(E*BPR*RHO)/(ESTAR*ETA**2*EE**2)
      GO TO 75
74    C1=RHOSTR/RHO-1.
      C2=EXP(-BETA*C1)
      C3=EXP(-ALPHA*C1**2)
      T1=(BPR*E*RHO)/EE+BIGAPR*MU*C2
      T2=2.*ALPHA*C1*(RHOSTR/(RHO**2))
      T3=BPR*E/EE
      T4=(2.*E)/(ESTAR*ETA**2*EE)
      T4=T3*T4
      T5=(BIGAPR*C2)/RHOSTR
      T6=(BIGAPR*MU*BETA*RHOSTR*C2)/(RHO**2)
      PGRHO=APR*E+C3*(T1*T2+T3+T4+T5+T6)
      T7=(BPR*RHO)/EE
      PGE=APR*RHO+C3*(T7-T7*(E/(ESTAR*ETA**2*EE)))
75    AA=SQRT(PGRHO+PGE*P/RHO**2)
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE EQOSS(PFR,PFE)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
```

```
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
250   ETA=RHOO/RHOSTR
      MU=ETA-1.
C
C
      EPP=EO/(ESTAR*ETA**2)+1.
      TMP=APR+BPR/EPP
      TMP1=BPR/(ESTAR*ETA**2*EPP**2)
      PFR=TMP*EO+(BIGAPR+2.*BIGBPR*MU)/RHOSTR+2.*EO**2*TMP1
      PFE=TMP*RHOO-EO*RHOO*TMP1
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE EQOSP(RHOO2,EO2,PO2)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
```

```
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
      ETA=RHOO2/RHOSTR
      MU=ETA-1.
      PO2=EO2*RHOO2*(APR+(BPR*ESTAR*ETA**2)/(EO2+ESTAR*ETA**2))+BIGAPR*M
     1U+BIGBPR*MU**2
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE EQOSI(PO2,PGRHO,PGE,BIGG,CHECK,KRTT,AO2,EO2,RHOO2,KM,EP
     1S)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
```

```
C
C
      REAL LO,MO,LENGTH,MU,KO
      INTEGER CHECK,CHECK2
      IF (KM.EQ.0) GO TO 708
      RHOO=RHOSTR
      TMP1=(APR+BPR)*RHOSTR-PO2/ESTAR
      TMP2=SQRT(TMP1**2+4.*PO2*APR*RHOSTR/ESTAR)
      EO=(-TMP1+TMP2)/(2.*APR*RHOSTR/ESTAR)
      IF (PO2.GT.EPS) GO TO 708
      PO2=0.
      EO2=0.
      RHOO2=RHOSTR
      AO2=SQRT(BIGAPR/RHOSTR)
      KRTT=1
      GO TO 870
708   KRTT=0
      ETA=RHOO/RHOSTR
      MU=ETA-1.
      EE=EO/(ESTAR*ETA**2)+1.
      IF (RHOO.GT.RHOSTR) GO TO 720
      IF (EO.LT.EPRS) GO TO 720
715   C1=RHOSTR/RHOO-1.
      BEC1=BETA*C1
      IF (BEC1.LT.10.E10) GO TO 716
      C2=0.0
      GO TO 717
716   C2=EXP(-BEC1)
717   C3AL=ALPHA*C1**2
      IF (C3AL.LT.10.E12) GO TO 718
      C3=0.0
      GO TO 719
718   C3=EXP(-C3AL)
719   CONTINUE
      T1=(BPR*EO*RHOO)/EE+BIGAPR*MU*C2
      T2=2.*ALPHA*C1*(RHOSTR/(RHOO**2))
```

```
      T3=BPR*EO/EE
      T4=(2.*EO)/(ESTAR*ETA**2*EE)
      T4=T3*T4
      T5=(BIGAPR*C2)/RHOSTR
      T6=(BIGAPR*MU*BETA*RHOSTR*C2)/(RHOO**2)
      T7=(BPR*RHOO)/EE
      PGRHO=APR*EO+C3*(T1*T2+T3+T4+T5+T6)
      PGE=APR*RHOO+C3*(T7-T7*(EO/(ESTAR*ETA**2*EE)))
      BIGG=PO2-APR*EO*RHOO-T1*C3
      CHECK=0
      GO TO 725
720   T1=APR+BPR/EE
      T2=(BPR*EO)/(ESTAR*ETA**2*EE**2)
      BIGG=PO2-T1*EO*RHOO-BIGAPR*MU-BIGBPR*MU**2
      PGRHO=T1*EO+BIGAPR/RHOSTR+2.*BIGBPR*MU/RHOSTR+T2*2.*EO
      PGRHO=-PGRHO
      PGE=T1*RHOO-RHOO*T2
      PGE=-PGE
      CHECK=1
725   CONTINUE
870   CONTINUE
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE SOUT2
C
C         PRINTS 6 LINES OF DISCONTINUITY AT TO
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
```

```
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
4     FORMAT (///30H CURVES OF DISCONTINUITY AT TO//40X20H--PROJECTILE S
     1HOCK--//)
6     FORMAT (//35X29H--PROJECTILE PARTICLE CURVE--//)
8     FORMAT (//42X16H--TARGET SHOCK--//)
10    FORMAT (//38X25H--TARGET PARTICLE CURVE--//)
12    FORMAT (//42X15H--RAREFACTION--//)
14    FORMAT (//35X30H--RAREFACTION PARTICLE CURVE--//)
16    FORMAT (7X1HZ19X1HR19X1HP19X1HU19X1HV/7X3HRHO17X1HE19X1HA19X1HL19X
     11HM//)
18    FORMAT (7X1HZ19X1HR//)
20    FORMAT (7X1HZ19X1HR19X1HL19X1HM//)
30    FORMAT (5E20.8/5E20.8//)
35    FORMAT (2E20.8)
38    FORMAT (4E20.8)
39    FORMAT (//35X16H--FREE SURFACE--//)
40    FORMAT (1H1)
      WRITE (3,4)
      WRITE (3,16)
      WRITE (3,30) ((TAB2(I,J,1),J=1,10),I=1,NP)
      WRITE (3,6)
      WRITE (3,18)
      WRITE (3,35) ((SPART(I,J,1),J=1,2),I=1,NP)
      WRITE (3,8)
```

```
      WRITE (3,16)
      WRITE (3,30) ((TAB2(I,J,2),J=1,10),I=1,NT)
      WRITE (3,10)
      WRITE (3,18)
      WRITE (3,35) ((SPART(I,J,2),J=1,2),I=1,NT)
      WRITE (3,12)
      WRITE (3,20)
      WRITE (3,38) ((RARF2(I,J),J=1,4),I=1,NR)
      WRITE (3,14)
      WRITE (3,39)
      WRITE (3,35) ((SURF2(I,J),J=1,2),I=1,NP)
      WRITE (3,40)
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE SOUT
C
C       PRINTS 4 LINES OF DISCONTINUITY AT TO-H
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
```

```
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
4     FORMAT (///32H CURVES OF DISCONTINUITY AT TO-H//40X20H--PROJECTILE
     1 SHOCK--//)
6     FORMAT (//42X16H--TARGET SHOCK--//)
8     FORMAT (//42X15H--RAREFACTION--//)
10    FORMAT (7X1HZ19X1HR19X1HP19X1HU19X1HV/7X3HRHO17X1HE19X1HA19X1HL19X
     11HM//)
15    FORMAT (5E20.8/5E20.8//)
18    FORMAT (1H1)
21    FORMAT (//35X16H--FREE SURFACE--//)
25    FORMAT (2E20.8)
      WRITE (3,4)
      WRITE (3,10)
      WRITE (3,15) ((TAB(I,J,1),J=1,10),I=1,NP)
      WRITE (3,6)
      WRITE (3,10)
      WRITE (3,15) ((TAB(I,J,2),J=1,10),I=1,NT)
      WRITE (3,8)
      WRITE (3,10)
      WRITE (3,15) ((RARF(I,J),J=1,10),I=1,NR)
      WRITE (3,21)
      WRITE (3,25) ((SURF(I,J),J=1,2),I=1,NP)
      WRITE (3,18)
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE PRINT(BL,ZTAB,RTAB,KK,PHI,NMAX,MMAX)
C     SUBROUTINE PRINT(BL,ZTAB,RTAB,KK)
      DOUBLE PRECISION XS(20),RU(20),ZU(20,20,6),UU(20),WW(20),
     1ZCOMP(20,20,6),PHI(20,20,6),CETA(20,20),DENC,POLY
C         PRINTS INTERIOR REGION
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
```

```
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      DIMENSION BL(20,20,6),ZTAB(20),RTAB(20)
C
      TSSS=1.1
      M=0
      N=0
      DO 15 I=1,20
      DO 15 J=1,20
      IF (ABS(BL(I,J,1))+ABS(BL(I,J,2))+ABS(BL(I,J,3)))  20,15,20
15    CONTINUE
      WRITE (3,18)
18    FORMAT (15H1TABLES ALL = 0/1H1)
      CALL EXIT
20    I1=I
      DO 30 I=I1,20
      IF (ABS(BL(I,1,1))+ABS(BL(I,1,2))+ABS(BL(I,1,3)))  30,22,30
22    DO 25 J=1,20
```

```
      IF (ABS(BL(I,J,1))+ABS(BL(I,J,2))+ABS(BL(I,J,3)))  30,25,30
25    CONTINUE
      I2=I-1
      GO TO 35
30    CONTINUE
      I2=20
35    DO 45 J=1,20
      IF (ABS(BL(I1,J,1))+ABS(BL(I1,J,2))+ABS(BL(I1,J,3)))  45,37,45
37    DO 40 I=I1,I2
      IF (ABS(BL(I,J,1))+ABS(BL(I,J,2))+ABS(BL(I,J,3)))  45,40,45
40    CONTINUE
      J2=J-1
      GO TO 50
45    CONTINUE
      J2=20
50    J1=1
C
C         PRINT TABLE
C
      GO TO (52,56),KK
52    WRITE (3,53)
53    FORMAT (//24HOINTERIOR REGION AT TO-H///)
      GO TO 62
56    WRITE (3,57)
57    FORMAT (//22HOINTERIOR REGION AT TO///)
62    DO 70 I=I1,I2
      WRITE (3,64) ZTAB(I)
64    FORMAT (///7HOZTAB =,F10.4//7X1HR9X1HP17X1HU17X1HV17X3HRHO15X1HE17
     1X1HA//)
      M=M+1
      XS(M)=ZTAB(I)
      UU(M)=1.0
      DO 69 J=J1,J2
      WRITE (3,68) RTAB(J),(BL(I,J,K),K=1,6)
      N=N+1
      RU(N)=RTAB(J)
```

```
      WW(N)=1.0
      DO 156 IK=1,6
C     ZU(M,N)=BL(I,J,4)
C     ZZ(M,N)=BL(I,J,1)
  156 ZU(M,N,IK)=BL(I,J,IK)
68    FORMAT (F12.4,6E18.8)                                          69
69    CONTINUE                                                       70
      MMAX=N
      N=0
70    CONTINUE                                                       71
      NMAX=M
C     IF(TIME.LT.TSSS) GO TO 80
  333 IMAX=I2+1-I1
      JMAX=J2+1-J1
      CALL SURFIT(XS,UU,RU,WW,ZU,NMAX,MMAX,IMAX,JMAX,CETA,PHI,ZCOMP,
     1SQD,SQDC,SDC,DFC)
      WRITE(3,100)
  100 FORMAT('  *** ')
      DO 88 IK=1,6
      DO 48 I=1,IMAX
      DO 48 J=1,JMAX
      DENC=0.D0
      DO 43 IS=1,NMAX
      K=NMAX-IS+1
      POLY=PHI(K,MMAX,IK)
      IF(MMAX-1)43,43,46
   46 DO 42 IT=2,MMAX
      L=MMAX-IT+1
   42 POLY=POLY*RU(J)+PHI(K,L,IK)
   43 DENC=DENC*XS(I)+POLY
      ZCOMP(I,J,IK)=DENC
   48 CONTINUE
   88 CONTINUE
80    WRITE (3,82)                                                   72
82    FORMAT (1H1)                                                   73
      RETURN                                                         74
```

```
      DEBUG SUBCHK
      END
      SUBROUTINE NRIT2(X,Y,XO,DX,YO,DY,EX,EY,FGOF,IT,KODE,
     1PHI,NMAX,MMAX)
C     SUBROUTINE NRIT2(X,Y,XO,DX,YO,DY,EX,EY,FGOF,IT,KODE)
C
C         NEWTON-RAPHSON METHOD FOR SOLUTION OF
C         TWO NON LINEAR EQUATIONS IN TWO UNKNOWNS
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
      DOUBLE PRECISION PHI(20,20,6)
C
      TSSS=1.1
      XB=XO
      YB=YO
      DXX=DX
      DYY=DY
```

```
      DELX1=0
      DELY1=0
      KODE=0
1     CONTINUE
      DO 50 I=1,IT
      KK=0
      XX=XB+DXX
      YY=YB+DYY
C
C
      IF(TIME.LT.TSSS) GO TO 266
      CALL FGOF(XB,YY,F2,G2,PHI,NMAX,MMAX)
      CALL FGOF(XX,YB,F1,G1,PHI,NMAX,MMAX)
      CALL FGOF(XB,YB,F0,G0,PHI,NMAX,MMAX)
      GO TO 267
  266 CALL FGOF(XB,YY,F2,G2)
      CALL FGOF(XX,YB,F1,G1)
      CALL FGOF(XB,YB,F0,G0)
  267 A1=(F1-F0)/DXX
      B1=(F2-F0)/DYY
      C1=-F0
      A2=(G1-G0)/DXX
      B2=(G2-G0)/DYY
      C2=-G0
      DET=A1*B2-A2*B1
      IF (DET.EQ.0.) GO TO 920
      DELX=(B2*C1-B1*C2)/DET
      DELY=(A1*C2-A2*C1)/DET
      IF (ABS(DELX).GT..001) GO TO 8
      DELX=0.
8     IF (ABS(DELY).GT..001) GO TO 9
      DELY=0.
9     CONTINUE
      SDEL=ABS(DELX+DELX1)+ABS(DELY+DELY1)
      DELX1=DELX
      DELY1=DELY
```

```
C
C          TEST FOR SAME REGION
C
      DO 10 J=1,IT
      XB1=XB+DELX
      YB1=YB+DELY
      IF (YB1.LE.0.)YB1=0.
      M=COMP(XB,YB,XB1,YB1)
      IF (M.EQ.1) GO TO 15
11    CONTINUE
      KK=1
      DELX=.5*DELX
      DELY=.5*DELY
10    CONTINUE
      GO TO 930
15    IF (ABS(XB-XB1).GT.EX) GO TO 45
      IF (ABS(YB-YB1).GT.EY) GO TO 45
      IF (KK.NE.0) GO TO 45
      X=XB1
      Y=YB1
      KODE=0
      RETURN
45    CONTINUE
      IF (KODE.NE.1) GO TO 46
      IF (SDEL.GT.EPI1) GO TO 46
      DELX=.5*DELX
      DELY=.5*DELY
      GO TO 9
46    XB=XB1
      YB=YB1
      DEL=DELTA
      DO 70 N=1,NDEL
      XB2=XB+DEL
      M=COMP(XB,YB,XB2,YB)
      IF (M.NE.1) GO TO 55
      DXX=DEL
```

```
      GO TO 80
55    XB2=XB-DEL
      M=COMP(XB,YB,XB2,YB)
      IF (M.NE.1) GO TO 60
      DXX=-DEL
      GO TO 80
60    DEL=.5*DEL
70    CONTINUE
      GO TO 980
80    DEL=DELTA
      DO 100 N=1,NDEL
      YB2=YB+DEL
      M=COMP(XB,YB,XB,YB2)
      IF (M.NE.1) GO TO 85
      DYY=DEL
      GO TO 50
85    YB2=YB-DEL
      M=COMP(XB,YB,XB,YB2)
      IF (M.NE.1) GO TO 90
      DYY=-DEL
      GO TO 50
90    DEL=.5*DEL
100   CONTINUE
      GO TO 990
50    CONTINUE
      X=XB1
      Y=YB1
      IF (KODE.EQ.1) RETURN
      KODE=1
      GO TO 1
920   WRITE (3,922) I
922   FORMAT (46HODETERMINANT IS 0 IN SUBR. NRIT2 FOR ITERATION,I4)
      GO TO 950
930   KODE=2
      RETURN
950   WRITE (3,952) XO,YO,XB,YB,XB1,YB1,DELX,DELY
```

```
952   FORMAT (1X5HZO  =,E15.8,4X5HRO  =,E15.8/1X5HZB  =,E15.8,4X5HRB  =,
     1E15.8/1X5HZB1 =,E15.8,4X5HRB1 =,E15.8/1X5HDELZ=,E15.8,4X5HDELR=,E1
     15.8/1H1)
      CALL EXIT
      RETURN
980   KODE=3
      RETURN
990   KODE=4
      RETURN
      DEBUG SUBCHK
      END
      FUNCTION COMP(ZP,RP,ZP1,RP1)
C
C         DETERMINES IF 2 POINTS ARE IN THE SAME REGION
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
      EPS=.0000001
      IF (RP1.LT.0.) GO TO 80
      IF (ZP1.GE.0.) GO TO 4
```

```
      IF (RP1.GT.RADIUS) GO TO 80
C
C         FIND CONTROL CONSTANTS FOR ZP,RP
C
4     CONTINUE
      IF (ITS3.EQ.1) GO TO 33
      IF (IRARF.EQ.1) GO TO 13
      M=PICK(ZP,RP,3)
      IF (ZP.GT.RARF(M,1).AND.M.NE.1)M=M-1
      FF=RP-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(ZP-RARF(M+1,1))/(RARF(M
     1,1)-RARF(M+1,1))
      IF (FF.LT.0.) GO TO 11
10    NN=1
      GO TO 13
11    NN=0
13    CONTINUE
      DO 22 K=1,2
      M=PICK(ZP1,RP1,K)
      IF (RP1.LT.TAB(M,2,K).AND.M.NE.1)M=M-1
5     CONTINUE
      FF=ZP1-TAB(M+1,1,K)-(TAB(M,1,K)-TAB(M+1,1,K))*(RP1-TAB(M+1,2,K))/(
     1TAB(M,2,K)-TAB(M+1,2,K))
      IF (K.EQ.2) GO TO 17
      IF (RP1.GT.RADIUS) GO TO 21
      IF (FF.LT.-EPS) GO TO 90
      GO TO 21
17    IF (FF.GT.EPS) GO TO 100
21    IF (RP.GT.RADIUS) GO TO 22
      M=PICK(ZP1,RP1,4)
      FF=ZP1-SURF(M+1,1)-(SURF(M,1)-SURF(M+1,1))*(RP1-SURF(M+1,2))/(SURF
     1(M,2)-SURF(M+1,2))
      IF (FF)  80,22,22
22    CONTINUE
      IF (IRARF.EQ.1) GO TO 33
      M=PICK(ZP1,RP1,3)
      IF (ZP1.GT.RARF(M,1).AND.M.NE.1)M=M-1
```

```
      FF=RP1-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(ZP1-RARF(M+1,1))/(RARF
     1(M,1)-RARF(M+1,1))
      IF (FF.LT.0.) GO TO 31
30    NN1=1
      GO TO 32
31    NN1=0
32    IF (NN1.NE.NN) GO TO 110
33    CONTINUE
      COMP=1
      COMP=COMP+.2
      RETURN
80    COMP=2
      COMP=COMP+.2
      RETURN
90    COMP=3.
      COMP=COMP+.2
      RETURN
100   COMP=4.
      COMP=COMP+.2
      RETURN
110   COMP=5.
      COMP=COMP+.2
      RETURN
      DEBUG SUBCHK
      END
      FUNCTION PICK(ZP,RP,KODE)
C
C         DETERMINES 2 CLOSEST CONSECUTIVE POINTS ON SPECIFIED
C         LINE OF DISCONTINUITY TO A GIVEN POINT
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
```

```
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      GO TO (5,10,100,300),KODE
5     NN=NP
      K=1
      GO TO 15
10    NN=NT
      K=2
15    AA=(TAB(1,1,K)-ZP)**2+(TAB(1,2,K)-RP)**2
C
C         SEARCH SHOCK TABLES
C
      DO 60 N=2,NN
      A=(TAB(N,1,K)-ZP)**2+(TAB(N,2,K)-RP)**2
      IF (A.GE.AA) GO TO 23
      AA=A
60    CONTINUE
      PICK=NN-1
      PICK=PICK+.2
      RETURN
23    PICK=N-1
      PICK=PICK+.2
      RETURN
```

```
100   AA=(RARF(1,1)-ZP)**2+(RARF(1,2)-RP)**2
C
C         SEARCH RAREFACTION TABLE
C
      DO 200 N=2,NR
      A=(RARF(N,1)-ZP)**2+(RARF(N,2)-RP)**2
      IF (A.GE.AA) GO TO 203
      AA=A
200   CONTINUE
      PICK=NR-1
      PICK=PICK+.2
      RETURN
203   PICK=N-1
      PICK=PICK+.2
      RETURN
300   AA=(SURF(1,1)-ZP)**2+(SURF(1,2)-RP)**2
C
C     SEARCH FREE SURFACE TABLE
C
      DO 400 N=2,NP
      A=(SURF(N,1)-ZP)**2+(SURF(N,2)-RP)**2
      IF (A.GE.AA) GO TO 303
      AA=A
400   CONTINUE
      PICK=NP-1
      PICK=PICK+.2
      RETURN
303   PICK=N-1
      PICK=PICK+.2
304   CONTINUE
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE GUESS(KOD1,KOD2,ZP,RP,I2,K2,ZG,RG,DZ,DR)
C
C         DETERMINES STARTING POINT AND DELTAS
```

```
C          FOR NEWTON-RAPHSON ITERATION
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      KS=0
      IF (KOD1.EQ.2) GO TO 10
      ZG=TAB(I2,1,K2)
      RG=TAB(I2,2,K2)
      IF (IRARF.EQ.1) GO TO 9
2     M=1-(NR-2)*(K2-2)
      FF=RG-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(ZG-RARF(M+1,1))/(RARF(M
     1,1)-RARF(M+1,1))
      IF (FF.GT.0.) GO TO 9
      ZG=(1.-.02/(RADIUS-RG))*ZG
      RG=RG+.02
      IF (RG.GT.(RADIUS-.01)) GO TO 110
      GO TO 2
```

```
9     CONTINUE
      GO TO 50
10    JJJ=NT-1
      IF (ITS3.EQ.1) GO TO 26
      DO 24 M=1,JJJ
      IF (RP.GT.TAB(M+1,2,2).OR.RP.LT.TAB(M,2,2)) GO TO 24
      GO TO 25
24    CONTINUE
25    CONTINUE
      FF=ZP-TAB(M+1,1,2)-(TAB(M,1,2)-TAB(M+1,1,2))*(RP-TAB(M+1,2,2))/(TA
     1B(M,2,2)-TAB(M+1,2,2))
      IF (FF.GT.0.) GO TO 20
26    CONTINUE
      ZG=ZP
      RG=RP
      GO TO 50
20    IK=M
      M=CROSS(TAB(IK,1,2),TAB(IK,2,2),TAB(IK+1,1,2),TAB(IK+1,2,2),0.,0.,
     1ZP,RP,ZG,RG)
      GO TO (50,920,930),M
C
C         COMPUTE DELTAS
C
50    DEL=DELTA
C
C         Z DELTA
C
      LL=0
52    DO 70 N=1,NDEL
      ZZ=ZG+DEL
      M=COMP(ZG,RG,ZZ,RG)
      IF (M.NE.1) GO TO 55
      DZ=DEL
      GO TO 80
55    ZZ=ZG-DEL
      M=COMP(ZG,RG,ZZ,RG)
```

```
      IF (M.NE.1) GO TO 60
      DZ=-DEL
      GO TO 80
60    DEL=.5*DEL
70    CONTINUE
      LL=LL+1
      IF (LL.EQ.3) GO TO 75
      RG=RG-DELTA/5.
      DEL=DELTA
      GO TO 52
75    KOD2=2
      RETURN
80    DEL=DELTA
      IF (KS.EQ.1) GO TO 120
C
C         R DELTA
C
      LL=0
82    DO 100 N=1,NDEL
      RR=RG+DEL
      M=COMP(ZG,RG,ZG,RR)
      IF (M.NE.1) GO TO 85
      DR=DEL
      IF (KS.EQ.1) GO TO 50
      GO TO 120
85    RR=RG-DEL
      M=COMP(ZG,RG,ZG,RR)
      IF (M.NE.1) GO TO 90
      DR=-DEL
      IF (KS.EQ.1) GO TO 50
      GO TO 120
90    DEL=.5*DEL
100   CONTINUE
108   CONTINUE
      LL=LL+1
      FLL=LL
```

```
      IF (LL.EQ.5) GO TO 110
C
104   ZG1=ZG+DELTA/5.*FLL*(-1.)**LL
      M=COMP(ZG,RG,ZG1,RG)
      ZG=ZG1
      IF (M.NE.1) GO TO 108
      KS=1
      GO TO 82
110   KOD2=2
      RETURN
120   KOD2=1
      RETURN
920   WRITE (3,922)
922   FORMAT (42HOERROR FOR COINCIDENT LINES IN SUBR. GUESS)
      GO TO 950
C
930   WRITE (3,932)
932   FORMAT (40HOERROR FOR PARALLEL LINES IN SUBR. GUESS)
C
950   WRITE (3,952) KOD1,I2,K2,ZP,RP
952   FORMAT (1X5HKOD1=,I4,4X3HI2=,I4,4X3HK2=,I4/1X3HZP=,E15.8,4X3HRP=,E
     115.8/1H1)
      XYZ=-2.
      ZYX=SQRT(XYZ)
      CALL EXIT
      RETURN
      END
      FUNCTION CROSS(X1,Y1,X2,Y2,X3,Y3,X4,Y4,X,Y)
C
C         FINDS INTERSECTION OF TWO STRAIGHT LINES
C
      EPS=.0000001
      A1=Y2-Y1
      B1=X1-X2
      C1=X1*A1+Y1*B1
      A2=Y4-Y3
```

```
      B2=X3-X4
      C2=X3*A2+Y3*B2
      DET=A1*B2-A2*B1
      D1=C1*B2-C2*B1
      D2=A1*C2-A2*C1
      IF (ABS(DET).LE.EPS) GO TO 10
      X=D1/DET
      Y=D2/DET
      CROSS=1
      CROSS=CROSS+.2
      RETURN
10    IF (ABS(D1).GT.EPS) GO TO 20
      IF (ABS(D2).LE.EPS) GO TO 30
20    CROSS=3
      CROSS=CROSS+.2
      RETURN
30    X=X1
      Y=Y1
      CROSS=2
      CROSS=CROSS+.2
316   CONTINUE
      RETURN
      DEBUG SUBCHK
      END
      FUNCTION PART(MODE,ZP,RP,ZX,RX,DELTA,NDEL)
C
C         LOCATES A POINT IN THE SAME REGION AS A GIVEN POINT
C         TO BE USED IN COMPUTING A PARTIAL
C     MODE=1,WITH RESPECT TO R
C     MODE=2,WITH RESPECT TO Z
C
      GO TO (2,4),MODE
2     DR=DELTA
      DZ=0.
      GO TO 8
4     DR=0.
```

```
      DZ=DELTA
8     DO 50 NN=1,NDEL
      RR=RP+DR
      ZZ=ZP+DZ
      M=COMP(ZP,RP,ZZ,RR)
      IF (M.EQ.1) GO TO 60
      RR=RP-DR
      ZZ=ZP-DZ
      M=COMP(ZP,RP,ZZ,RR)
      IF (M.EQ.1) GO TO 60
      DZ=DZ*.5
      DR=DR*.5
50    CONTINUE
      PART=2
      PART=PART+.2
      RETURN
60    ZX=ZZ
      RX=RR
      PART=1
      PART=PART+.2
      RETURN
      DEBUG SUBCHK
      END
      FUNCTION PICK2(ZP,RP,KODE)
C
C         DETERMINES 2 CLOSEST CONSECUTIVE POINTS ON SPECIFIED
C         LINE OF DISCONTINUITY TO A GIVEN POINT
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
      COMMON NP,NT,NR,NI,NDEL,ISUB
```

///

```
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      GO TO (5,10,100,205,210,300,500),KODE
5     NN=NP
      K=1
      GO TO 15
10    NN=NT
      K=2
15    AA=(TAB2(1,1,K)-ZP)**2+(TAB2(1,2,K)-RP)**2
C
C               SEARCH SHOCK TABLES
C
      DO 60 N=2,NN
      A=(TAB2(N,1,K)-ZP)**2+(TAB2(N,2,K)-RP)**2
      IF (A.GE.AA) GO TO 23
      AA=A
60    CONTINUE
      PICK2=NN-1
      PICK2=PICK2+.2
      RETURN
23    PICK2=N-1
      PICK2=PICK2+.2
      RETURN
100   AA=(RARF2(1,1)-ZP)**2+(RARF2(1,2)-RP)**2
C
C               SEARCH RAREFACTION TABLE
C
      DO 200 N=2,NR
```

```
      A=(RARF2(N,1)-ZP)**2+(RARF2(N,2)-RP)**2
      IF (A.GE.AA) GO TO 203
      AA=A
200   CONTINUE
      PICK2=NR-1
      PICK2=PICK2+.2
      RETURN
203   PICK2=N-1
      PICK2=PICK2+.2
      RETURN
205   NN=NP
      K=1
      GO TO 215
210   NN=NT
      K=2
215   AA=(SPART(1,1,K)-ZP)**2+(SPART(1,2,K)-RP)**2
C
C               SEARCH SHOCK PARTICLE TABLES
C
      DO 260 N=2,NN
      A=(SPART(N,1,K)-ZP)**2+(SPART(N,2,K)-RP)**2
      IF (A.GE.AA) GO TO 223
      AA=A
260   CONTINUE
      PICK2=NN-1
      PICK2=PICK2+.2
      RETURN
223   PICK2=N-1
      PICK2=PICK2+.2
      RETURN
300   AA=(RPART(1,1)-ZP)**2+(RPART(1,2)-RP)**2
C
C               SEARCH RAREFACTION PARTICLE TABLE
C
      DO 400 N=2,NR
      A=(RPART(N,1)-ZP)**2+(RPART(N,2)-RP)**2
```

```
      IF (A.GE.AA) GO TO 403
      AA=A
400   CONTINUE
      PICK2=NR-1
      PICK2=PICK2+.2
      RETURN
403   PICK2=N-1
      PICK2=PICK2+.2
      RETURN
500   AA=(SURF2(1,1)-ZP)**2+(SURF2(1,2)-RP)**2
C
C     SEARCH FREE SURFACE TABLE
C
      DO 520 N=2,NP
      A=(SURF2(N,1)-ZP)**2+(SURF2(N,2)-RP)**2
      IF (A.GE.AA) GO TO 523
      AA=A
520   CONTINUE
      PICK2=NP-1
      PICK2=PICK2+.2
      RETURN
523   PICK2=N-1
      PICK2=PICK2+.2
      RETURN
      DEBUG SUBCHK
      END
      FUNCTION TEST(ZP,RP)
C
C
C         DETERMINES IF A GIVEN INTERIOR POINT IS IN
C         THE REGION TO BE CONSIDERED
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
```

```
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      EPS=.0001
      IF (ITS3.EQ.1) GO TO 5
      IF (RP.GT.(RADIUS+EPS)) GO TO 5
      M=PICK2(ZP,RP,7)
      FF=ZP-SURF2(M+1,1)-(SURF2(M,1)-SURF2(M+1,1))*(RP-SURF2(M,2))/(SURF
     12(M,2)-SURF2(M+1,2))
      KICK=5
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      IF (FF)  200,5,5
5     CONTINUE
      IF (ZP.GT.-EPS) GO TO 1
      IF (RP.GT.(RADIUS+EPS)) GO TO 200
1     DO 10 K=1,2
      IF (ITS3.EQ.1) GO TO 100
      M=PICK2(ZP,RP,K)
      IF (TAB2(M,2,K).GT.RP.AND.M.NE.1)M=M-1
      FF=ZP-TAB2(M+1,1,K)-(TAB2(M,1,K)-TAB2(M+1,1,K))*(RP-TAB2(M+1,2,K))
     1/(TAB2(M,2,K)-TAB2(M+1,2,K))
```

```
      KICK=50
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      IF (K.EQ.2) GO TO 50
      IF (RP.GT.RADIUS) GO TO 10
      IF (FF)  200,10,10
50    IF (FF)  10,10,200
10    CONTINUE
      DO 20 K=1,2
      J=K+3
      M=PICK2(ZP,RP,J)
      IF (SPART(M,2,K).GT.RP.AND.M.NE.1)M=M-1
      FF=ZP-SPART(M+1,1,K)-(SPART(M,1,K)-SPART(M+1,1,K))*(RP-SPART(M+1,2
     1,K))/(SPART(M,2,K)-SPART(M+1,2,K))
      KICK=15
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      IF (K.EQ.2) GO TO 15
      IF (RP.GT.RADIUS) GO TO 20
      IF (FF.LT..001) GO TO 300
      GO TO 20
15    IF (FF.GT.-.001) GO TO 400
20    CONTINUE
      IF (IRARF.EQ.1) GO TO 100
      M=PICK2(ZP,RP,3)
      FF=RP-RARF2(M+1,2)-(RARF2(M,2)-RARF2(M+1,2))*(ZP-RARF2(M+1,1))/(RA
     1RF2(M,1)-RARF2(M+1,1))
      KICK=20
      CALL DVCHK(KQ)
      IF (KQ.EQ.1) GO TO 9980
      IF (FF.LT.0.) GO TO 100
      M=PICK2(ZP,RP,6)
      FF=RP-RPART(M+1,2)-(RPART(M,2)-RPART(M+1,2))*(ZP-RPART(M+1,1))/(RP
     1ART(M,1)-RPART(M+1,1))
      KICK=100
      CALL DVCHK(KQ)
```

```
      IF (KQ.EQ.1) GO TO 9980
      IF (FF.LT.0.) GO TO 500
100   TEST=1
      TEST=TEST+.2
      RETURN
200   TEST=2
      TEST=TEST+.2
      RETURN
300   TEST=3
      TEST=TEST+.2
      RETURN
400   TEST=4
      TEST=TEST+.2
      RETURN
500   TEST=5
      TEST=TEST+.2
      RETURN
9980  WRITE (3,9985) KICK
9985  FORMAT (32HODIVIDE CHECK NEAR STATEMENT NO.,I5,14H IN SUBR. TEST/1
     1H1)
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE FGOF5(Z5,R5,SS,QQ,PHI,NMAX,MMAX)
C     SUBROUTINE FGOF5(Z5,R5,SS,QQ)
C
C         COMPUTES S5,Q5 FOR INTERIOR REGION
C         ITERATION FOR Z5,R5
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
```

```
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
      DOUBLE PRECISION PHI(20,20,6)
C
      DIMENSION ANS(6)
C
      TSSS=1.1
      IF(TIME.GT.TSSS) GO TO 100
      CALL DBLTRP(Z5,R5,ANS)
      GO TO 101
  100 CALL DSURFT(Z5,R5,ANS,PHI,NMAX,MMAX)
  101 U5=ANS(2)
C     U5=ANS(2)
      V5=ANS(3)
      SS=Z5-ZO+H*V5
      QQ=R5-RO+H*U5
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE ITRP
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
```

```
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
C
C INTERPOLATION SCHEME FOR POINTS BETWEEN PARTICLE CURVES
C AND DISCONTINUITIES
C
      EPS=.0000001
      KOD1=0
      KOD2=0
      DO 1000 J=1,20
      DO 1000 I=1,20
      M=TEST(Z(I),R(J))
      IF (M.NE.5) GO TO 906
      IF (IRARF.EQ.1) GO TO 906
      NR1=NR-1
      DO 907 JJ=1,NR1
      IF (RARF2(JJ,1).LT.Z(I).AND.RARF2(JJ+1,1).GT.Z(I)) GO TO 908
907   CONTINUE
908   CONTINUE
      FF=R(J)-RARF2(JJ+1,2)+(RARF2(JJ,2)-RARF2(JJ+1,2))*(Z(I)-RARF2(JJ+1
     1,1))/(RARF2(JJ,1)-RARF2(JJ+1,1))
```

```
      IF (FF.LT.0.) GO TO 1000
906   CONTINUE
      IF (M.EQ.3.AND.Z(I).LT.EPS.AND.ABS(R(J)-RADIUS).LT.EPS) GO TO 1000
      IF (M.LT.3) GO TO 8051
      WRITE (3,8050)
8050  FORMAT (30H0INTERPOLATION SCHEME EMPLOYED)
614   FORMAT (1X5HZ0  =,E15.8,4X5HR0  =,E15.8)
      Z0=Z(I)
      R0=R(J)
      WRITE (3,614) Z0,R0
      WRITE (3,8888) M
8888  FORMAT (1X4HM  =,I4)
8051  CONTINUE
      GO TO (1000,1000,1001,1010,1100),M
1001  IF (IRARF.EQ.1) GO TO 1003
      M=PICK2(Z(I),R(J),3)
      FF=R(J)-RARF2(M+1,2)+(RARF2(M,2)-RARF2(M+1,2))*(Z(I)-RARF2(M+1,1))
     1/(RARF2(M,1)-RARF2(M+1,1))
      IF (FF.GT.0.) GO TO 1003
      DO 8002 K=1,6
      L=K+2
8002  XMESH2(I,J,K)=RARF(1,L)
      GO TO 1000
1003  L=I+1
      N=TEST(Z(L),R(J))
      GO TO (1004,1007,1030,1030,1050),N
1004  M=PICK2(Z(I),R(J),1)
      DO 1006 K=1,8
      ANS=TAB2(M,K,1)+(TAB2(M+1,K,1)-TAB2(M,K,1))*(R(J)-TAB2(M,2,1))/(TA
     1B2(M+1,2,1)-TAB2(M,2,1))
      IF (K.NE.1) GO TO 8005
      ANS1=ANS
      GO TO 1006
8005  CONTINUE
      IF (K.EQ.2) GO TO 1006
      KX=K-2
```

```
      IF (ABS(R(J)-RADIUS).GT.EPS) GO TO 9024
      IF (K.GT.5.OR.K.LT.4) GO TO 9024
      ANS=TAB2(M+1,K,1)
9024  CONTINUE
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)
      IF (ABS(R(J)-RADIUS).GT.EPS) GO TO 1006
      XMESH2(I,J,1)=0.
      XMESH2(I,J,4)=RHOSTR
      XMESH2(I,J,5)=0.
      XMESH2(I,J,6)=SQRT(BIGAPR/RHOSTR)
1006  CONTINUE
      GO TO 1000
1007  MM=PICK2(Z(I),R(J),2)
      M=PICK2(Z(I),R(J),1)
      DO 1009 K=1,8
      ANS=TAB2(M,K,1)+(TAB2(M+1,K,1)-TAB2(M,K,1))*(R(J)-TAB2(M,2,1))/(TA
     1B2(M+1,2,1)-TAB2(M,2,1))
      ANSW=TAB2(MM,K,2)+(TAB2(MM+1,K,2)-TAB2(MM,K,2))*(R(J)-TAB2(MM,2,2)
     1)/(TAB2(MM+1,2,2)-TAB2(MM,2,1))
      IF (K.NE.1) GO TO 1008
      ANS1=ANS
      ANS2=ANSW
      GO TO 1009
1008  CONTINUE
      IF (K.EQ.2) GO TO 1009
      KX=K-2
      XMESH2(I,J,KX)=ANS+(ANSW-ANS)*(Z(I)-ANS1)/(ANS2-ANS1)
1009  CONTINUE
      GO TO 1000
1010  IF (IRARF.EQ.1) GO TO 1013
      M=PICK2(Z(I),R(J),3)
      FF=R(J)-RARF2(M+1,2)+(RARF2(M,2)-RARF2(M+1,2))*(Z(I)-RARF2(M+1,1))
     1/(RARF2(M,1)-RARF2(M+1,1))
      IF (FF.GT.0.) GO TO 1013
      DO 1012 K=1,6
      L=K+2
```

```
1012  XMESH2(I,J,K)=RARF(1,L)
      GO TO 1000
1013  L=I-1
      IF (ABS(Z(I)).LT.EPS) GO TO 1017
      N=TEST(Z(L),R(J))
      GO TO (1014,1017,1030,1017,1051),N
1014  M=PICK2(Z(I),R(J),2)
      DO 1016 K=1,8
      ANS=TAB2(M,K,2)+(TAB2(M+1,K,2)-TAB2(M,K,2))*(R(J)-TAB2(M,2,2))/(TA
     1B2(M+1,2,2)-TAB2(M,2,2))
      IF (K.NE.1) GO TO 1015
      ANS1=ANS
      GO TO 1016
1015  CONTINUE
      IF (K.EQ.2) GO TO 1016
      KX=K-2
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)
1016  CONTINUE
      GO TO 1000
1017  L=J-1
      N=TEST(Z(I),R(L))
      GO TO (1024,1030,1030,1030,1051),N
1024  M=PICK2(Z(I),R(J),2)
      DO 1026 K=2,8
      ANS=TAB2(M,K,2)+(TAB2(M+1,K,2)-TAB2(M,K,2))*(Z(I)-TAB2(M,1,2))/(TA
     1B2(M+1,1,2)-TAB2(M,1,2))
      IF (K.NE.2) GO TO 1025
      ANS1=ANS
      GO TO 1026
1025  CONTINUE
      KX=K-2
      IF (ABS(Z(I)).GT.EPS) GO TO 9125
      IF (K.GT.5.OR.K.LT.4) GO TO 9125
      ANS=TAB2(M+1,K,2)
9125  CONTINUE
      XMESH2(I,J,KX)=ANS+(XMESH2(I,L,KX)-ANS)*(R(J)-ANS1)/(R(L)-ANS1)
```

```
      IF (ABS(Z(I)).GT.EPS) GO TO 1026
      XMESH2(I,J,1)=0.
      XMESH2(I,J,4)=RHOSTR
      XMESH2(I,J,5)=0.
      XMESH2(I,J,6)=SQRT(BIGAPR/RHOSTR)
1026  CONTINUE
      GO TO 1000
1100  M=PICK2(Z(I),R(J),3)
      ANS1=RARF2(M+1,2)+(RARF2(M,2)-RARF2(M+1,2))*(Z(I)-RARF2(M+1,1))/(R
     1ARF2(M,1)-RARF2(M+1,1))
      L=J+1
      M=TEST(Z(I),R(L))
      GO TO (1101,1030,1051,1030),M
1101  CONTINUE
      DO 1106 K=1,6
      LL=K+2
      XMESH2(I,J,K)=RARF(1,LL)+(XMESH2(I,L,K)-RARF(1,LL))*(R(J)-ANS1)/(R
     1(L)-ANS1)
1106  CONTINUE
      GO TO 1000
1050  JJ1=J
      II1=I
      KOD1=1
      GO TO 1000
1051  JJ2=J
      II2=I
      KOD2=1
1000  CONTINUE
      IF (KOD1.EQ.0) GO TO 2000
      M=PICK2(Z(II1),R(JJ1),1)
      DO 2016 K=1,8
      ANS=TAB2(M,K,1)+(TAB2(M+1,K,1)-TAB2(M,K,1))*(R(JJ1)-TAB2(M,2,1))/(
     1TAB2(M+1,2,1)-TAB2(M,2,1))
      IF (K.NE.1) GO TO 2005
      ANS1=ANS
      GO TO 2016
```

```
2005  CONTINUE
      I=II1
      J=JJ1
      L=II1+1
      IF (K.EQ.2) GO TO 2016
      KX=K-2
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)
2016  CONTINUE
2000  IF (KOD2.EQ.0) GO TO 3000
      M=PICK2(Z(II2),R(JJ2),2)
      DO 3016 K=1,8
      ANS=TAB2(M,K,2)+(TAB2(M+1,K,2)-TAB2(M,K,2))*(R(JJ2)-TAB2(M,2,2))/(
     1TAB2(M+1,2,2)-TAB2(M,2,2))
      IF (K.NE.1) GO TO 3015
      ANS1=ANS
      GO TO 3016
3015  CONTINUE
      I=II2
      J=JJ2
      L=II2-1
      IF (K.EQ.2) GO TO 3016
      KX=K-2
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)
3016  CONTINUE
3000  CONTINUE
      GO TO 3017
1030  WRITE (3,1040) I,J
1040  FORMAT (27H0 TIME STEP TOO LARGE AT I=,I4,2HJ=,I4,///)
      CALL EXIT
3017  CONTINUE
C
C
      RETURN
      DEBUG SUBCHK
      END
      SUBROUTINE EXIT
```

```
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
      KSTOP=1
      STOP
      END
      SUBROUTINE FGOFI(ZX,RX,SS,QQ,PHI,NMAX,MMAX)
C     SUBROUTINE FGOFI(ZX,RX,SS,QQ)
C
C         COMPUTES SI,QI FOR INTERIOR REGION
C         ITERATION FOR ZI,RI
C
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
```

```
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
      REAL LO,MO,LENGTH,MU,KO
C
      DIMENSION ANS(6),PSI(4),SPSI(11),CPSI(11)
      DOUBLE PRECISION PHI(20,20,6)
C
C
C
C
C
      TSSS=1.1
      IF(TIME.GT.TSSS) GO TO 100
      CALL DBLTRP(ZX,RX,ANS)
      GO TO 101
  100 CALL DSURFT(ZX,RX,ANS,PHI,NMAX,MMAX)
  101 UI=ANS(2)
C     UI=ANS(2)
      VI=ANS(3)
      AI=ANS(6)
      SS=ZX-ZO+H*(VI+AI*SIN(TPSI))
      QQ=RX-RO+H*(UI+AI*COS(TPSI))
      RETURN
```

II.2. Method of Characteristics Calculations and the Computer Code for Materials with Arbitrary Equations of State.

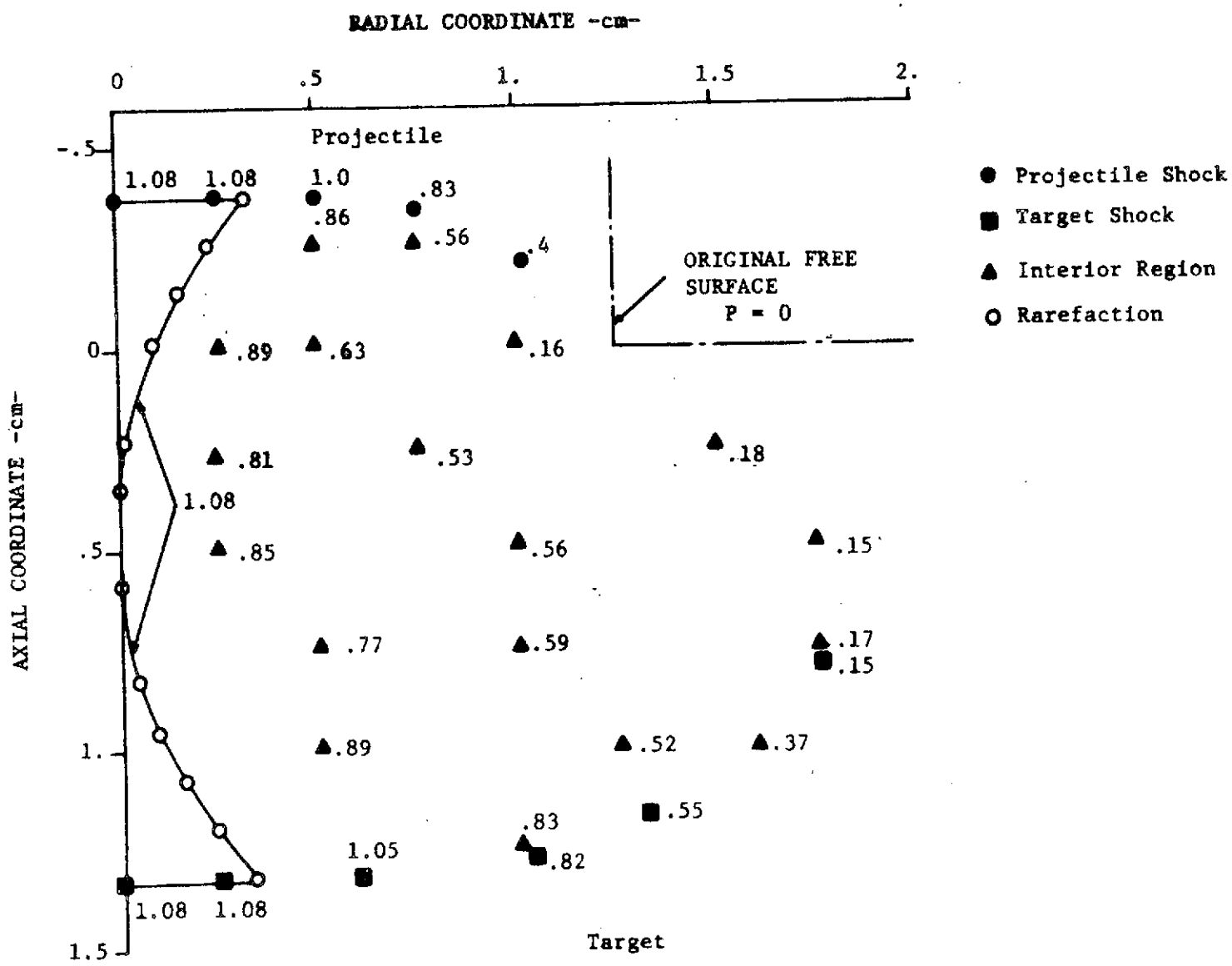

Fig. 1. Pressure distribution from the characteristic solution at t = 1.25 μsec after impact of a 2.5 -cm- diameter projectile at 0.76 cm/μsec on an aluminum half-space.

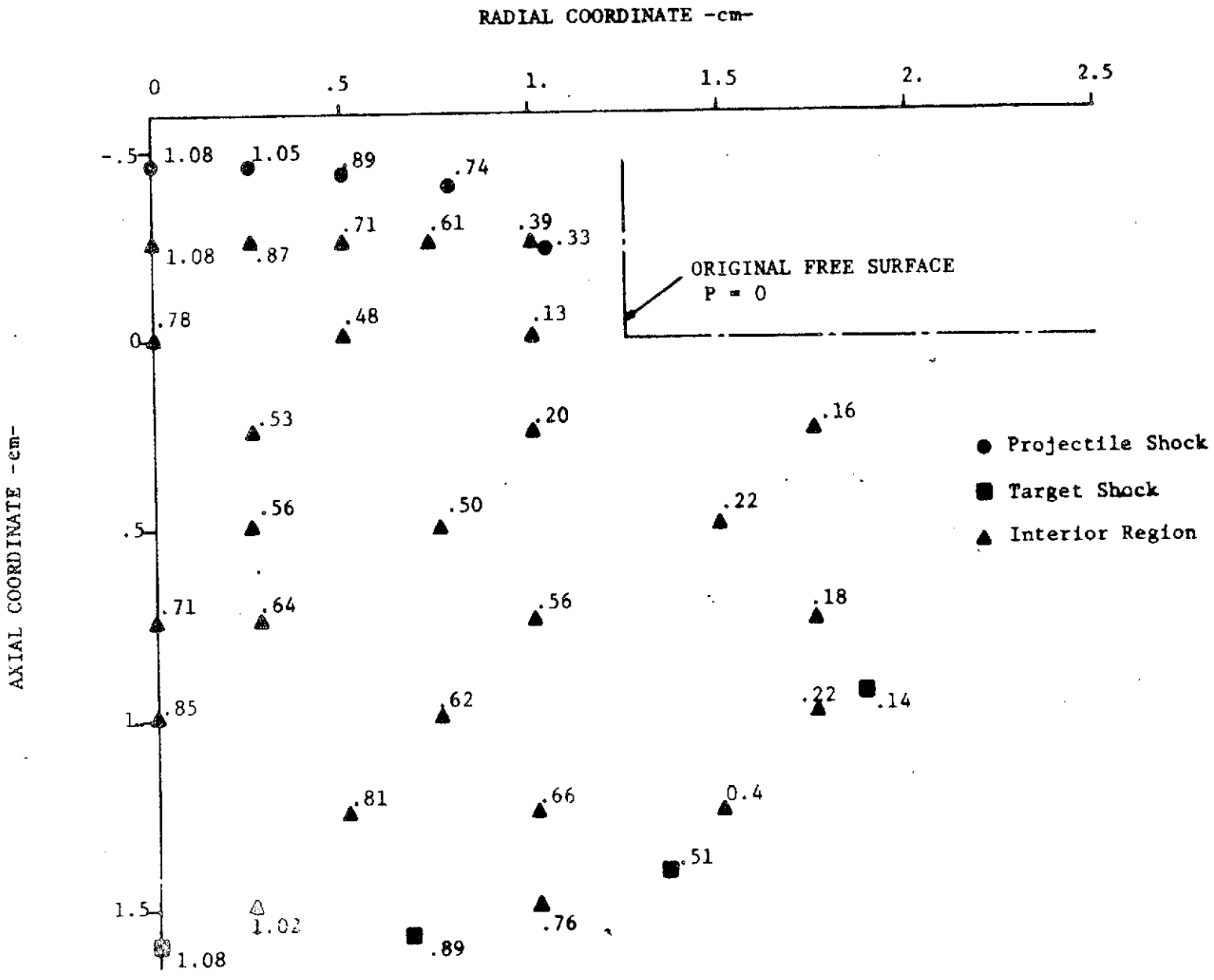

Fig. 2. Pressure distribtuion from the characteristic solution at t = 1.52 μsec after impact of a 2.5 -cm- diameter projectile at 0.76 cm/μsec on an aluminum half-space.

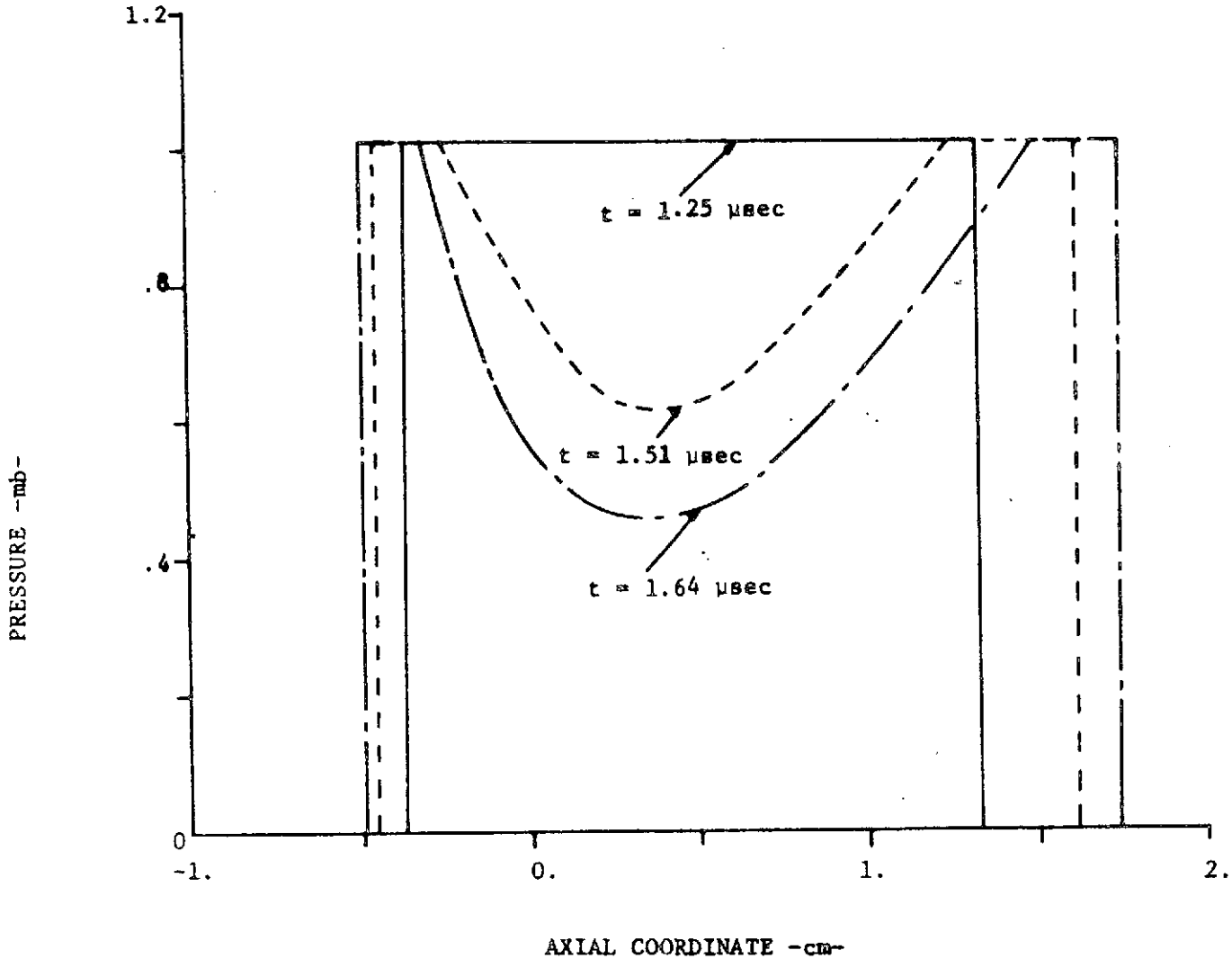

Fig 3. Axial pressure profiles at various times as predicted by the characteraitc method for a 2.5 -cm- diameter aluminum projectile impacting on aluminum half-space at 0.76 cm/μsec.

```
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSMAIN   1
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENMAIN   2
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS        MAIN   3
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2MAIN   4
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(MAIN   5
     115,4),RPART(15,2)                                                  MAIN   6
C                                                                        MAIN   7
C                                                                        MAIN   8
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                 MAIN   9
C                                                                        MAIN  10
      COMMON NP,NT,NR,NI,NDEL,ISUB                                       MAIN  11
C                                                                        MAIN  12
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                    MAIN  13
      COMMON DIRCOS                                                      MAIN  14
      COMMON TIME                                                        MAIN  15
      COMMON IRARF                                                       MAIN  16
      COMMON KSTOP                                                       MAIN  17
      COMMON TPSI                                                        MAIN  18
      COMMON KKK                                                         MAIN  19
C                                                                        MAIN  20
C                                                                        MAIN  21
      REAL LO,MO,LENGTH,MU,KO                                            MAIN  22
      KR=10                                                              MAIN  23
      EPS=.0000001                                                       MAIN  24
      KSTOP=0                                                            MAIN  25
1     FORMAT (1H1)                                                       MAIN  26
      CALL DVCHK(KEY)                                                    MAIN  27
      KICK=0                                                             MAIN  28
      IF (KEY.EQ.1) GO TO 9980                                           MAIN  29
C                                                                        MAIN  30
      DO 2 K=1,6                                                         MAIN  31
      DO 2 J=1,20                                                        MAIN  32
      DO 2 I=1,20                                                        MAIN  33
      XMESH(I,J,K)=0.                                                    MAIN  34
      XMESH2(I,J,K)=0.                                                   MAIN  35
2     CONTINUE                                                           MAIN  36
```

```
C     KRW=0                                                             MAIN  37
      NUZON=0                                                           MAIN  38
C                                                                       MAIN  39
C                                                                       MAIN  40
      WRITE (3,4)                                                       MAIN  41
C                                                                       MAIN  42
C         DATA INPUT SECTION                                            MAIN  43
C                                                                       MAIN  44
4     FORMAT (52H1HYPERVELOCITY IMPACT METHOD OF CHARACTERISTICS CODE///MAIN  45
     1)                                                                 MAIN  46
C       ID AND FX. PT. CONSTANTS                                        MAIN  47
C                                                                       MAIN  48
      READ (1,8) CASEID,ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,NDEL    MAIN  49
8     FORMAT (13A6,A2/9I3)                                              MAIN  50
      IRARF=ITI2                                                        MAIN  51
C                                                                       MAIN  52
C       FL. PT. CONSTANTS                                               MAIN  53
C                                                                       MAIN  54
      READ (1,15) EPS1,EPS2,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5MAIN  55
     1,EPI6,EPI7                                                        MAIN  56
      READ (1,14) NP,NT,NR                                              MAIN  57
14    FORMAT (3I3)                                                      MAIN  58
      READ (1,15) APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,REFMAIN  59
     1L                                                                 MAIN  60
      READ (1,15) ZMIN,ZMAX,RMIN,RMAX,GR,GZ,DELTA,VP,LENGTH,RADIUS,HSTARMAIN  61
15    FORMAT (6E12.8)                                                   MAIN  62
      READ (1,15) RST                                                   MAIN  63
      IF (RST.GT.0.) GO TO 16                                           MAIN  64
      REWIND 9                                                          MAIN  65
C     DO 1529 JTP=1,200                                                 MAIN  66
      READ (9)TIME                                                      MAIN  67
C     IF(ABS(RST+TIME).LT..001) GO TO 1530                              MAIN  68
C     READ(9)BLOB                                                       MAIN  69
C1529 CONTINUE                                                          MAIN  70
1530  CONTINUE                                                          MAIN  71
C     KRW=1                                                             MAIN  72
```

```
      READ (9)(((XMESH(I,J,K),I=1,20),J=1,20),K=1,6),(Z(I),I=1,20),(R(I)MAIN  73
     1,I=1,20),((SURF(I,J),I=1,15),J=1,8),(((TAB(I,J,K),I=1,15),J=1,14),MAIN  74
     1K=1,2),((RARF(I,J),I=1,15),J=1,11),TIME,ZMIN,ZMAX,RMIN,RMAX,GR,GZ,MAIN  75
     1AR                                                                MAIN  76
      DO 1500 J=1,20                                                    MAIN  77
      DO 1500 I=1,20                                                    MAIN  78
      DO 1500 K=1,6                                                     MAIN  79
1500  XMESH2(I,J,K)=XMESH(I,J,K)                                        MAIN  80
      DO 1501 I=1,15                                                    MAIN  81
      DO 1501 J=1,8                                                     MAIN  82
1501  SURF2(I,J)=SURF(I,J)                                              MAIN  83
      WRITE (3,145) TIME                                                MAIN  84
      CALL SOUT                                                         MAIN  85
      CALL PRINT(XMESH2,Z,R,1)                                          MAIN  86
      KREFL=0                                                           MAIN  87
16    CONTINUE                                                          MAIN  88
      WRITE (3,10) CASEID,ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,NDEL  MAIN  89
10    FORMAT (1X13A6,A2//17H SHOCK ITERATIONS6X,4I4//20H INTERIOR ITERATMAIN  90
     1IONS3X,4I4//7H NDEL =,I4///)                                      MAIN  91
      WRITE (3,18) EPS1,EPS2,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPIMAIN  92
     15,EPI6,EPI7,ZMIN,ZMAX,RMIN,RMAX,DELTA,VP,LENGTH,RADIUS,APR,BPR,BIGMAIN  93
     1APR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,REFL                      MAIN  94
18    FORMAT (///38H ERROR CRITERIA FOR SHOCK COMPUTATIONS//5X8HDELTA Z1MAIN  95
     18X8HDELTA R18X9HDELTA RHO7X7HDELTA E9X7HDELTA P9X7HDELTA U/6E16.6/MAIN  96
     1//41H ERROR CRITERIA FOR INTERIOR COMPUTATIONS//5X8HDELTA Z18X8HDEMAIN  97
     1LTA R18X7HDELTA P9X7HDELTA U9X7HDELTA V9X9HDELTA RHO7X7HDELTA E/7EMAIN  98
     116.6///5X4HZMIN12X4HZMAX12X4HRMIN12X4HRMAX12X5HDELTA11X2HVP14X6HLEMAIN  99
     1NGTH10X6HRADIUS/8E16.6///5X2HA'14X2HB'14X6HBIG A'10X6HBIG B'10X2HEMAIN 100
     1*14X5HALPHA11X4HBETA12X4HRHO*/8E16.6//5X3HE'S13X4HREFL/2E16.6///) MAIN 101
      IF (RST.LT.0.) GO TO 140                                          MAIN 102
C                                                                       MAIN 103
C         STORE RHO* IN ALL XMESH                                       MAIN 104
C                                                                       MAIN 105
      DO 22 J=1,20                                                      MAIN 106
      DO 22 I=1,20                                                      MAIN 107
22    XMESH(I,J,4)=RHOSTR                                               MAIN 108
```

```
40    FORMAT (5E12.8)                                                   MAIN 109
C                                                                       MAIN 110
C       PROJECTILE SHOCK                                                MAIN 111
C                                                                       MAIN 112
      CALL EQOS1(PRHO,PPP,PVV,PEE,TEE,TRHO,KICK)                        MAIN 113
      IF (KICK.EQ.2200) GO TO 9980                                      MAIN 114
      DO 230 N=1,NP                                                     MAIN 115
      TAB(N,1,1)=(PRHO*PVV-RHOSTR*VP)*HSTAR/(PRHO-RHOSTR)               MAIN 116
      EE=N-1                                                            MAIN 117
      FNP=NP                                                            MAIN 118
      TAB(N,2,1)=RMIN+EE*(RADIUS-RMIN)/FNP                              MAIN 119
      TAB(N,3,1)=PPP                                                    MAIN 120
      TAB(N,4,1)=0.0                                                    MAIN 121
      TAB(N,5,1)=PVV                                                    MAIN 122
      TAB(N,6,1)=PRHO                                                   MAIN 123
      TAB(N,7,1)=PEE                                                    MAIN 124
      TAB(N,9,1)=0.0                                                    MAIN 125
      TAB(N,10,1)=1.0                                                   MAIN 126
230   CONTINUE                                                          MAIN 127
C                                                                       MAIN 128
C       TARGET SHOCK                                                    MAIN 129
C                                                                       MAIN 130
      M=0                                                               MAIN 131
      DO 240 N=1,NT                                                     MAIN 132
      EE=N-1                                                            MAIN 133
      FNT=NT-4                                                          MAIN 134
      TAB(N,2,2)=RMIN+EE*(RADIUS-RMIN)/FNT                              MAIN 135
      TAB(N,7,2)=TEE                                                    MAIN 136
      TAB(N,6,2)=TRHO                                                   MAIN 137
      TAB(N,3,2)=PPP                                                    MAIN 138
      IF (TAB(N,2,2).GT.RADIUS) GO TO 250                               MAIN 139
      TAB(N,1,2)=TRHO*PVV*HSTAR/(TRHO-RHOSTR)                           MAIN 140
      TAB(N,4,2)=0.0                                                    MAIN 141
      TAB(N,5,2)=PVV                                                    MAIN 142
      TAB(N,9,2)=0.0                                                    MAIN 143
      TAB(N,10,2)=1.0                                                   MAIN 144
```

```
      GO TO 240                                                         MAIN 145
250   EF=M                                                              MAIN 146
      TAB(N,9,2)=SIN(.5236+EF*.2618)                                    MAIN 147
      TAB(N,10,2)=COS(.5236+EF*.2618)                                   MAIN 148
      TAB(N,4,2)=PVV*TAB(N,9,2)                                         MAIN 149
      TAB(N,5,2)=PVV*TAB(N,10,2)                                        MAIN 150
      TAB(N,1,2)=TAB(1,1,2)*TAB(N,10,2)                                 MAIN 151
      TAB(N,2,2)=RADIUS+TAB(1,1,2)*TAB(N,9,2)                           MAIN 152
      M=M+1                                                             MAIN 153
240   CONTINUE                                                          MAIN 154
C                                                                       MAIN 155
C       RAREFACTION                                                     MAIN 156
C                                                                       MAIN 157
      CALL EQOS2(PPP,PRHO,PEE)                                          MAIN 158
      EE=NR-1                                                           MAIN 159
      ADEL=(TAB(1,1,2)-TAB(1,1,1))/EE                                   MAIN 160
      RARF(1,1)=TAB(1,1,2)                                              MAIN 161
      DO 205 N=2,NR                                                     MAIN 162
      RARF(N,1)=RARF(N-1,1)-ADEL                                        MAIN 163
205   CONTINUE                                                          MAIN 164
      DO 210 N=1,NR                                                     MAIN 165
      RARF(N,10)=(RARF(N,1)/HSTAR-.5*VPI/AR                             MAIN 166
      RARF(N,9)=-SQRT(1.-RARF(N,10)**2)                                 MAIN 167
      RARF(N,2)=RADIUS+HSTAR*AR*RARF(N,9)                               MAIN 168
210   CONTINUE                                                          MAIN 169
      DO 220 N=1,NR                                                     MAIN 170
      RARF(N,3)=TAB(1,3,1)                                              MAIN 171
      RARF(N,4)=0.                                                      MAIN 172
      RARF(N,5)=TAB(1,5,1)                                              MAIN 173
      RARF(N,6)=TAB(1,6,1)                                              MAIN 174
      RARF(N,7)=TAB(1,7,1)                                              MAIN 175
220   CONTINUE                                                          MAIN 176
C       REGION INTERIOR TO SHOCKS                                       MAIN 177
      I=-ZMIN/GZ+1.2                                                    MAIN 178
      J=0                                                               MAIN 179
260   J=J+I                                                             MAIN 180
```

```
      XMESH(I,J,1)=PPP                                                  MAIN 181
      XMESH(I,J,3)=PVV                                                  MAIN 182
      XMESH(I,J,4)=PRHO                                                 MAIN 183
      XMESH(I,J,5)=PEE                                                  MAIN 184
      EE=(J-1)                                                          MAIN 185
      IF ((EE*GR-RADIUS).LT.-EPS) GO TO 260                             MAIN 186
      XMESH(I,J,1)=0.                                                   MAIN 187
      XMESH(I,J,4)=RHOSTR                                               MAIN 188
      XMESH(I,J,5)=0.                                                   MAIN 189
C                                                                       MAIN 190
C       FREE SURFACE                                                    MAIN 191
C                                                                       MAIN 192
      DO 50 I=1,NP                                                      MAIN 193
      SURF(I,1)=-LENGTH+VP*HSTAR                                        MAIN 194
      SURF(I,2)=TAB(I,2,1)                                              MAIN 195
      SURF(I,3)=0.                                                      MAIN 196
      SURF(I,4)=0.                                                      MAIN 197
      SURF(I,5)=VP                                                      MAIN 198
      SURF(I,6)=RHOSTR                                                  MAIN 199
      SURF(I,7)=0.                                                      MAIN 200
      SURF(I,8)=SQRT(BIGAPR/RHOSTR)                                     MAIN 201
50    CONTINUE                                                          MAIN 202
      DO 51 I=1,NP                                                      MAIN 203
      DO 51 J=1,8                                                       MAIN 204
51    SURF2(I,J)=SURF(I,J)                                              MAIN 205
      IF (NUZON.EQ.0) GO TO 5001                                        MAIN 206
5000  GR=GR*2.                                                          MAIN 207
      GZ=GZ*2.                                                          MAIN 208
      ZMAX=ZMAX*2.-ZMIN                                                 MAIN 209
      RMAX=RMAX*2.                                                      MAIN 210
      NUZON=1                                                           MAIN 211
      WRITE (3,5003)                                                    MAIN 212
5003  FORMAT (7H REZONE///)                                             MAIN 213
5001  CONTINUE                                                          MAIN 214
C                                                                       MAIN 215
C                                                                       MAIN 216
```

```
      DO 55 I=1,20                                                      MAIN 217
      EE=I-1                                                            MAIN 218
      Z(I)=ZMIN+EE*GZ                                                   MAIN 219
      R(I)=RMIN+EE*GR                                                   MAIN 220
55    CONTINUE                                                          MAIN 221
      IF (NUZON.EQ.0) GO TO 5101                                        MAIN 222
      DO 5100 I=1,10                                                    MAIN 223
      DO 5100 J=1,10                                                    MAIN 224
      DO 5100 K=1,6                                                     MAIN 225
      L=2*I-1                                                           MAIN 226
      M=2*J-1                                                           MAIN 227
      XMESH(I,J,K)=XMESH(L,M,K)                                         MAIN 228
5100  CONTINUE                                                          MAIN 229
      GO TO 157                                                         MAIN 230
5101  CONTINUE                                                          MAIN 231
C                                                                       MAIN 232
C         COMPUTE A FOR 2 SHOCKS AND MESH                               MAIN 233
C                                                                       MAIN 234
      DO 86 K=1,3                                                       MAIN 235
      GO TO (57,59,61),K                                                MAIN 236
57    NN=NP                                                             MAIN 237
      JJ=1                                                              MAIN 238
      GO TO 63                                                          MAIN 239
59    NN=NT                                                             MAIN 240
      JJ=1                                                              MAIN 241
      GO TO 63                                                          MAIN 242
61    NN=20                                                             MAIN 243
      JJ=20                                                             MAIN 244
63    DO 84 N=1,NN                                                      MAIN 245
      DO 82 J=1,JJ                                                      MAIN 246
      GO TO (65,65,68),K                                                MAIN 247
65    P=TAB(N,3,K)                                                      MAIN 248
      RHO=TAB(N,6,K)                                                    MAIN 249
      E=TAB(N,7,K)                                                      MAIN 250
      GO TO 70                                                          MAIN 251
68    P=XMESH(J,N,1)                                                    MAIN 252
```

```
      RHO=XMESH(J,N,4)                                                  MAIN 253
      E=XMESH(J,N,5)                                                    MAIN 254
70    CONTINUE                                                          MAIN 255
      CALL EQOS3(RHO,AA,E,P)                                            MAIN 256
      GO TO (76,76,78),K                                                MAIN 257
76    TAB(N,8,K)=AA                                                     MAIN 258
      GO TO 82                                                          MAIN 259
78    XMESH(J,N,6)=AA                                                   MAIN 260
82    CONTINUE                                                          MAIN 261
84    CONTINUE                                                          MAIN 262
86    CONTINUE                                                          MAIN 263
      KICK=86                                                           MAIN 264
      CALL DVCHK(KQ)                                                    MAIN 265
      IF (KQ.EQ.1) GO TO 9980                                           MAIN 266
C                                                                       MAIN 267
C         STORE A FOR RAREFACTION                                       MAIN 268
C                                                                       MAIN 269
      DO 90 I=1,NR                                                      MAIN 270
90    RARF(I,8)=AR                                                      MAIN 271
C                                                                       MAIN 272
C         COMPLETE SHOCK TABLES                                         MAIN 273
C                                                                       MAIN 274
      DO 99 K=1,2                                                       MAIN 275
      GO TO (92,94),K                                                   MAIN 276
92    NN=NP                                                             MAIN 277
      GO TO 95                                                          MAIN 278
94    NN=NT                                                             MAIN 279
      US=0.                                                             MAIN 280
95    DO 97 N=1,NN                                                      MAIN 281
      GO TO (93,96),K                                                   MAIN 282
93    CONTINUE                                                          MAIN 283
      US=VP*TAB(N,10,1)                                                 MAIN 284
96    CONTINUE                                                          MAIN 285
      TAB(N,11,K)=TAB(N,9,K)*TAB(N,4,K)+TAB(N,10,K)*TAB(N,5,K)          MAIN 286
      TAB(N,12,K)=TAB(N,9,K)*TAB(N,5,K)-TAB(N,10,K)*TAB(N,4,K)          MAIN 287
      TAB(N,13,K)=((TAB(N,6,K)*ABS(TAB(N,11,K)))/(TAB(N,6,K)-RHOSTR)-US)MAIN 288
```

```
     1*(-1.)**K                                                         MAIN 289
      TAB(N,14,K)=1.                                                    MAIN 290
97    CONTINUE                                                          MAIN 291
99    CONTINUE                                                          MAIN 292
C                                                                       MAIN 293
C                                                                       MAIN 294
C          STORE ALL XMESH IN XMESH2                                    MAIN 295
C                                                                       MAIN 296
130   DO 135 K=1,6                                                      MAIN 297
      DO 135 J=1,20                                                     MAIN 298
      DO 135 I=1,20                                                     MAIN 299
      XMESH2(I,J,K)=XMESH(I,J,K)                                        MAIN 300
135   CONTINUE                                                          MAIN 301
      TIME=HSTAR                                                        MAIN 302
      WRITE (3,145) TIME                                                MAIN 303
      CALL SOUT                                                         MAIN 304
      CALL PRINT(XMESH2,Z,R,1)                                          MAIN 305
C                                                                       MAIN 306
      KREFL=0                                                           MAIN 307
139   IF (KREFL.NE.0) GO TO 143                                         MAIN 308
C          ENTRY FOR TIME STEP                                          MAIN 309
C                                                                       MAIN 310
140   READ (1,142) H                                                    MAIN 311
142   FORMAT (E12.8)                                                    MAIN 312
143   CONTINUE                                                          MAIN 313
      TIME=TIME+H                                                       MAIN 314
      WRITE (3,145) TIME                                                MAIN 315
145   FORMAT (1H1///6H TIME=,E15.8///)                                  MAIN 316
      WRITE (3,999) KR                                                  MAIN 317
999   FORMAT (5X,4H KR=,I5)                                             MAIN 318
C                                                                       MAIN 319
C                                                                       MAIN 320
C          ADVANCE SHOCK POINTS                                         MAIN 321
C                                                                       MAIN 322
      DO 159 N=1,NP                                                     MAIN 323
      IF (TAB(N,14,1).LT.0.) GO TO 156                                  MAIN 324
```

```
      IF ((TAB(N,1,1)-SURF(N,1)).GT.EPS) GO TO 154                      MAIN 325
156   TAB2(N,1,1)=TAB(N,1,1)                                            MAIN 326
      TAB2(N,2,1)=TAB(N,2,1)                                            MAIN 327
      TAB(N,14,1)=-1.                                                   MAIN 328
      GO TO 159                                                         MAIN 329
154   TAB2(N,1,1)=TAB(N,1,1)+TAB(N,13,1)*H*TAB(N,10,1)-VP*TAB(N,9,1)*TABMAIN 330
     1(N,10,1)*H                                                        MAIN 331
150   TAB2(N,2,1)=TAB(N,2,1)+TAB(N,13,1)*H*TAB(N,9,1)-VP*TAB(N,9,1)**2*HMAIN 332
159   CONTINUE                                                          MAIN 333
      DO 155 N=1,NT                                                     MAIN 334
      TAB2(N,1,2)=TAB(N,1,2)+TAB(N,13,2)*H*TAB(N,10,2)                  MAIN 335
155   TAB2(N,2,2)=TAB(N,2,2)+TAB(N,13,2)*H*TAB(N,9,2)                   MAIN 336
      DO 158 M=1,NT                                                     MAIN 337
      IF (TAB2(M,1,2).GT.ZMAX) GO TO 5000                               MAIN 338
      IF (TAB2(M,2,2).GT.RMAX) GO TO 5000                               MAIN 339
158   CONTINUE                                                          MAIN 340
157   NUZON=0                                                           MAIN 341
C         ADVANCE RAREFACTION                                           MAIN 342
C                                                                       MAIN 343
      IF (RARF(1,2).LT.0.)IRARF=1                                       MAIN 344
      IF (IRARF.EQ.1) GO TO 516                                         MAIN 345
      ENR=NR-1                                                          MAIN 346
      ADEL=(TAB2(1,1,2)-TAB2(1,1,1))/ENR                                MAIN 347
      RARF2(1,1)=TAB2(1,1,2)                                            MAIN 348
      DO 510 N=2,NR                                                     MAIN 349
      RARF2(N,1)=RARF2(N-1,1)-ADEL                                      MAIN 350
510   CONTINUE                                                          MAIN 351
      DO 515 N=1,NR                                                     MAIN 352
      RARF2(N,3)=(RARF2(N,1)/TIME-.5*VP)/AR                             MAIN 353
      RARF2(N,4)=-SQRT(1.-RARF2(N,3)**2)                                MAIN 354
      RARF2(N,2)=RADIUS+TIME*AR*RARF2(N,4)                              MAIN 355
515   CONTINUE                                                          MAIN 356
516   CONTINUE                                                          MAIN 357
      CALL SHOCK                                                        MAIN 358
C                                                                       MAIN 359
C                                                                       MAIN 360
```

```
      IF (ITS3.EQ.1) GO TO 569                                          MAIN 361
C         SHOCK COMPUTATIONS COMPLETED                                  MAIN 362
C         COMPUTE PARTICLE CURVES                                       MAIN 363
C                                                                       MAIN 364
      TMP=.5*VP*H                                                       MAIN 365
      DO 520 N=1,NP                                                     MAIN 366
      SPART(N,1,1)=TAB(N,1,1)+TAB(N,5,1)*H                              MAIN 367
520   SPART(N,2,1)=TAB(N,2,1)+TAB(N,4,1)*H                              MAIN 368
      DO 525 N=1,NT                                                     MAIN 369
      SPART(N,1,2)=TAB(N,1,2)+TAB(N,5,2)*H                              MAIN 370
525   SPART(N,2,2)=TAB(N,2,2)+TAB(N,4,2)*H                              MAIN 371
      IF (IRARF.EQ.1) GO TO 531                                         MAIN 372
      DO 530 N=1,NR                                                     MAIN 373
      RPART(N,1)=RARF(N,1)+TMP                                          MAIN 374
530   RPART(N,2)=RARF(N,2)                                              MAIN 375
531   CONTINUE                                                          MAIN 376
C                                                                       MAIN 377
C                                                                       MAIN 378
568   CALL SOUT2                                                        MAIN 379
569   CONTINUE                                                          MAIN 380
C       ADVANCE PROJECTILE REAR SURFACE                                 MAIN 381
      DO 5300 I=1,NP                                                    MAIN 382
      DO 5300 J=1,8                                                     MAIN 383
5300  SURF2(I,J)=SURF(I,J)                                              MAIN 384
      KICK=568                                                          MAIN 385
      CALL DVCHK(KQ)                                                    MAIN 386
      IF (KQ.EQ.1) GO TO 9980                                           MAIN 387
C                                                                       MAIN 388
C         START INTERIOR REGION COMPUTATIONS                            MAIN 389
C                                                                       MAIN 390
      CALL INTER                                                        MAIN 391
C                                                                       MAIN 392
C         INTERIOR REGION COMPUTATIONS COMPLETED                        MAIN 393
C                                                                       MAIN 394
      CALL PRINT(XMESH2,Z,R,2)                                          MAIN 395
570   CONTINUE                                                          MAIN 396
```

```
C                                                                       MAIN 397
C          INITIALIZE FOR NEXT TIME STEP                                MAIN 398
C                                                                       MAIN 399
      DO 920 K=1,6                                                      MAIN 400
      DO 920 J=1,20                                                     MAIN 401
      DO 920 I=1,20                                                     MAIN 402
      XMESH(I,J,K)=XMESH2(I,J,K)                                        MAIN 403
920   CONTINUE                                                          MAIN 404
      DO 930 J=1,13                                                     MAIN 405
      DO 930 I=1,NP                                                     MAIN 406
      TAB(I,J,1)=TAB2(I,J,1)                                            MAIN 407
930   CONTINUE                                                          MAIN 408
      DO 940 J=1,13                                                     MAIN 409
      DO 940 I=1,NT                                                     MAIN 410
      TAB(I,J,2)=TAB2(I,J,2)                                            MAIN 411
940   CONTINUE                                                          MAIN 412
      IF (IRARF.EQ.1) GO TO 951                                         MAIN 413
      DO 950 I=1,NR                                                     MAIN 414
      RARF(I,1)=RARF2(I,1)                                              MAIN 415
      RARF(I,2)=RARF2(I,2)                                              MAIN 416
950   CONTINUE                                                          MAIN 417
951   CONTINUE                                                          MAIN 418
      DO 960 I=1,NP                                                     MAIN 419
      DO 959 J=1,5                                                      MAIN 420
      SURF(I,J)=SURF2(I,J)                                              MAIN 421
959   CONTINUE                                                          MAIN 422
960   CONTINUE                                                          MAIN 423
      IF (KR.EQ.10) GO TO 888                                           MAIN 424
      REWIND 4                                                          MAIN 425
      WRITE (4)TIME                                                     MAIN 426
      WRITE (4)(((XMESH(I,J,K),I=1,20),J=1,20),K=1,6),(Z(I),I=1,20),(R(IMAIN 427
     1),I=1,20),((SURF(I,J),I=1,15),J=1,8),(((TAB(I,J,K),I=1,15),J=1,14)MAIN 428
     1,K=1,2),((RARF(I,J),I=1,15),J=1,11),TIME,ZMIN,ZMAX,RMIN,RMAX,GR,GZMAIN 429
     1,AR                                                               MAIN 430
      KR=10                                                             MAIN 431
      GO TO 777                                                         MAIN 432
```

```
888   REWIND 10                                                         MAIN 433
C     IF(KRW.EQ.1)REWIND10                                              MAIN 434
C     KRW=0                                                             MAIN 435
      WRITE (10)TIME                                                    MAIN 436
      WRITE (10)(((XMESH(I,J,K),I=1,20),J=1,20),K=1,6),(Z(I),I=1,20),(R(MAIN 437
     1I),I=1,20),((SURF(I,J),I=1,15),J=1,8),(((TAB(I,J,K),I=1,15),J=1,14MAIN 438
     1),K=1,2),((RARF(I,J),I=1,15),J=1,11),TIME,ZMIN,ZMAX,RMIN,RMAX,GR,GMAIN 439
     1Z,AR                                                              MAIN 440
      KR=4                                                              MAIN 441
777   IF (KREFL.EQ.0) GO TO 980                                         MAIN 442
      KREFL=0                                                           MAIN 443
      H=H1                                                              MAIN 444
      GO TO 143                                                         MAIN 445
980   CONTINUE                                                          MAIN 446
      CALL DVCHK(KICK)                                                  MAIN 447
      IF (KICK.EQ.2) GO TO 140                                          MAIN 448
      WRITE (3,970)                                                     MAIN 449
970   FORMAT (28HODIVIDE CHECK AT END OF CASE/1H1)                      MAIN 450
      CALL EXIT                                                         MAIN 451
C                                                                       MAIN 452
C         DIVIDE CHECK                                                  MAIN 453
C                                                                       MAIN 454
9980  WRITE (3,9985) KICK                                               MAIN 455
9985  FORMAT (32HODIVIDE CHECK NEAR STATEMENT NO.,I5/1H1)               MAIN 456
      RETURN                                                            MAIN 457
      END                                                               MAIN 458
      SUBROUTINE DBLTRP(ZX,RX,ANS)                                      SUB1   1
C                                                                       SUB1   2
C         1ST ORDER DOUBLE INTERPOLATION THAT CONSIDERS                 SUB1   3
C         LINES OF DISCONTINUITY IF IN CONSIDERED REGION                SUB1   4
C                                                                       SUB1   5
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSUB1   6
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSUB1   7
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SUB1   8
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SUB1   9
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SUB1  10
```

```
     115,4),RPART(15,2)                                                 SUB1  11
C                                                                       SUB1  12
C                                                                       SUB1  13
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SUB1  14
C                                                                       SUB1  15
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB1  16
C                                                                       SUB1  17
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB1  18
      COMMON DIRCOS                                                     SUB1  19
      COMMON TIME                                                       SUB1  20
      COMMON IRARF                                                      SUB1  21
      COMMON KSTOP                                                      SUB1  22
      COMMON TPSI                                                       SUB1  23
      COMMON KKK                                                        SUB1  24
      REAL LO,MO,LENGTH,MU,KO                                           SUB1  25
C                                                                       SUB1  26
      DIMENSION ANS(6),ANS1(2,8),ANS2(2,8),ZI(4),RI(4),IK(4)            SUB1  27
      CALL DVCHK(KEY)                                                   SUB1  28
      IF (KEY.EQ.2) GO TO 4                                             SUB1  29
      NO=0                                                              SUB1  30
      GO TO 940                                                         SUB1  31
C                                                                       SUB1  32
C         FIND SUBSCRIPTS FOR GRID                                      SUB1  33
C                                                                       SUB1  34
4     I1=(ZX-ZMIN)/GZ+1.000001                                          SUB1  35
      I2=I1+1                                                           SUB1  36
      J1=(RX-RMIN)/GR+1.000001                                          SUB1  37
      J2=J1+1                                                           SUB1  38
      NN=NP                                                             SUB1  39
      IF (ITS3.EQ.1) GO TO 3                                            SUB1  40
      DO 1 K=1,2                                                        SUB1  41
      IF (K.EQ.2)NN=NT                                                  SUB1  42
      DO 1 I=1,NN                                                       SUB1  43
      ALF=SQRT((TAB(I,1,K)-ZX)**2+(TAB(I,2,K)-RX)**2)                   SUB1  44
      IF (ALF.GT.EPS1) GO TO 1                                          SUB1  45
      ANS(1)=TAB(I,3,K)                                                 SUB1  46
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```
      ANS(2)=TAB(I,4,K)                                                 SUB1  47
      ANS(3)=TAB(I,5,K)                                                 SUB1  48
      ANS(4)=TAB(I,6,K)                                                 SUB1  49
      ANS(5)=TAB(I,7,K)                                                 SUB1  50
      ANS(6)=TAB(I,8,K)                                                 SUB1  51
      RETURN                                                            SUB1  52
1     CONTINUE                                                          SUB1  53
      IF (IRARF.EQ.1) GO TO 3                                           SUB1  54
      DO 2 I=1,NR                                                       SUB1  55
      ALF=SQRT((RARF(I,1)-ZX)**2+(RARF(I,2)-RX)**2)                     SUB1  56
      IF (ALF.GT.EPI1) GO TO 2                                          SUB1  57
      ANS(1)=RARF(I,3)                                                  SUB1  58
      ANS(2)=RARF(I,4)                                                  SUB1  59
      ANS(3)=RARF(I,5)                                                  SUB1  60
      ANS(4)=RARF(I,6)                                                  SUB1  61
      ANS(5)=RARF(I,7)                                                  SUB1  62
      ANS(6)=RARF(I,8)                                                  SUB1  63
      RETURN                                                            SUB1  64
2     CONTINUE                                                          SUB1  65
3     CONTINUE                                                          SUB1  66
C                                                                       SUB1  67
C                                                                       SUB1  68
      ZXX=ZX+.01                                                        SUB1  69
      RXX=RX+.01                                                        SUB1  70
C                                                                       SUB1  71
C         I LOOP FOR UPPER AND LOWER Z GRID LINES                       SUB1  72
C                                                                       SUB1  73
      DO 800 I=1,2                                                      SUB1  74
      IF (ITS3.EQ.1) GO TO 14                                           SUB1  75
      IF (I.EQ.2) GO TO 8                                               SUB1  76
      II=I1                                                             SUB1  77
      GO TO 12                                                          SUB1  78
8     II=I2                                                             SUB1  79
12    M=COMP(ZX,RX,Z(II),R(J1))                                         SUB1  80
      IF (M.EQ.1) GO TO 13                                              SUB1  81
      MCOM=1                                                            SUB1  82
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```
      GO TO 20                                                          SUB1  83
13    M=COMP(ZX,RX,Z(II),R(J2))                                         SUB1  84
      IF (M.EQ.1) GO TO 14                                              SUB1  85
      MCOM=2                                                            SUB1  86
      GO TO 20                                                          SUB1  87
C                                                                       SUB1  88
C         GET 6 VALUES ON GRID LINES                                    SUB1  89
C                                                                       SUB1  90
14    DO 15 K=1,6                                                       SUB1  91
      ANS1(I,K+2)=XMESH(II,J1,K)+(XMESH(II,J2,K)-XMESH(II,J1,K))*(RX-R(JSUB1  92
     11))/(R(J2)-R(J1))                                                 SUB1  93
15    CONTINUE                                                          SUB1  94
      CALL DVCHK(NO)                                                    SUB1  95
      IF (NO.EQ.2) GO TO 17                                             SUB1  96
      NO=15                                                             SUB1  97
      GO TO 940                                                         SUB1  98
17    ANS1(I,1)=Z(II)                                                   SUB1  99
      ANS1(I,2)=RX                                                      SUB1 100
      GO TO 800                                                         SUB1 101
C                                                                       SUB1 102
C                                                                       SUB1 103
20    ZZ=Z(II)                                                          SUB1 104
      RR=RX                                                             SUB1 105
      M=COMP(ZX,RX,ZZ,RR)                                               SUB1 106
      IF (M.EQ.1) GO TO 300                                             SUB1 107
C                                                                       SUB1 108
C                                                                       SUB1 109
      DO 25 K=1,2                                                       SUB1 110
      KATCH=0                                                           SUB1 111
      GO TO (21,22),K                                                   SUB1 112
21    NN=NP                                                             SUB1 113
      GO TO 23                                                          SUB1 114
22    NN=NT                                                             SUB1 115
23    JJJ=NN-1                                                          SUB1 116
      DO 24 M=1,JJJ                                                     SUB1 117
      IF (M.EQ.JJJ) GO TO 210                                           SUB1 118
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```
      IF (RX.GT.TAB(M+1,2,K).OR.RX.LT.TAB(M,2,K)) GO TO 24                SUB1 119
210   ZI(K)=TAB(M+1,1,K)+(TAB(M,1,K)-TAB(M+1,1,K))*(RX-TAB(M+1,2,K))/(TASUB1 120
     1B(M,2,K)-TAB(M+1,2,K))                                              SUB1 121
      NO=210                                                              SUB1 122
      CALL DVCHK(KQ)                                                      SUB1 123
      IF (KQ.EQ.1) GO TO 940                                              SUB1 124
      IF (I.EQ.2) GO TO 211                                               SUB1 125
      IF (KATCH.EQ.1) GO TO 212                                           SUB1 126
      KATCH=1                                                             SUB1 127
      GO TO 213                                                           SUB1 128
212   IF ((ZX-ZI(K)).GT.(ZX-ZM)) GO TO 24                                 SUB1 129
      IF (ZI(K).GT.ZX) GO TO 24                                           SUB1 130
213   ZM=ZI(K)                                                            SUB1 131
      IF (K.EQ.2) GO TO 215                                               SUB1 132
      NPS=M                                                               SUB1 133
      GO TO 24                                                            SUB1 134
215   NTS=M                                                               SUB1 135
      GO TO 24                                                            SUB1 136
211   CONTINUE                                                            SUB1 137
      IF (KATCH.EQ.1) GO TO 26                                            SUB1 138
      KATCH=1                                                             SUB1 139
      GO TO 213                                                           SUB1 140
26    IF ((ZI(K)-ZX).GT.(ZM-ZX)) GO TO 24                                 SUB1 141
      IF (ZI(K).LT.ZX) GO TO 24                                           SUB1 142
      GO TO 213                                                           SUB1 143
24    CONTINUE                                                            SUB1 144
      ZI(K)=ZM                                                            SUB1 145
      IF (KATCH.NE.0) GO TO 25                                            SUB1 146
      ZI(K)=ZMAX+1.                                                       SUB1 147
25    CONTINUE                                                            SUB1 148
      IF (IRARF.EQ.1)ZI(3)=ZMAX+1.                                        SUB1 149
      IF (IRARF.EQ.1) GO TO 2504                                          SUB1 150
      KATCH=0                                                             SUB1 151
      JJJ=NR-1                                                            SUB1 152
      DO 27 M=1,JJJ                                                       SUB1 153
      ZI(3)=RARF(M+1,1)+(RARF(M,1)-RARF(M+1,1))*(RX-RARF(M+1,2))/(RARF(MSUB1 154
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     1,2)-RARF(M+1,2))                                                  SUB1 155
      NO=25                                                             SUB1 156
      CALL DVCHK(KQ)                                                    SUB1 157
      IF (KQ.EQ.1) GO TO 940                                            SUB1 158
      IF (ABS(ZI(3)-ZX).GT.1.E-5) GO TO 279                             SUB1 159
      DO 2799 LN=1,6                                                    SUB1 160
      LNN=LN+2                                                          SUB1 161
      ANS(LN)=RARF(1,LNN)                                               SUB1 162
2799  CONTINUE                                                          SUB1 163
      GO TO 820                                                         SUB1 164
279   CONTINUE                                                          SUB1 165
      IF (I.EQ.2) GO TO 28                                              SUB1 166
      IF (ZI(3).GT.ZX) GO TO 27                                         SUB1 167
      IF (KATCH.EQ.1) GO TO 280                                         SUB1 168
      KATCH=1                                                           SUB1 169
      GO TO 281                                                         SUB1 170
280   IF ((ZX-ZI(3)).GT.(ZX-ZM)) GO TO 27                               SUB1 171
281   ZM=ZI(3)                                                          SUB1 172
      MR=M                                                              SUB1 173
      GO TO 27                                                          SUB1 174
28    IF (ZI(3).LT.ZX) GO TO 27                                         SUB1 175
      IF (KATCH.EQ.1) GO TO 282                                         SUB1 176
      KATCH=1                                                           SUB1 177
      GO TO 281                                                         SUB1 178
282   IF ((ZI(3)-ZX).GT.(ZM-ZX)) GO TO 27                               SUB1 179
      GO TO 281                                                         SUB1 180
27    CONTINUE                                                          SUB1 181
      ZI(3)=ZM                                                          SUB1 182
2504  CONTINUE                                                          SUB1 183
      KATCH=0                                                           SUB1 184
      K=4                                                               SUB1 185
      JJJ=NP-1                                                          SUB1 186
      DO 2700 M=1,JJJ                                                   SUB1 187
      IF (M.EQ.JJJ) GO TO 2710                                          SUB1 188
      IF (RX.GT.SURF(M+1,2).OR.RX.LT.SURF(M,2)) GO TO 2700              SUB1 189
2710  ZI(4)=SURF(M+1,1)+(SURF(M,1)-SURF(M+1,1))*(RX-SURF(M+1,2))/(SURF(MSUB1 190
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     1,2)-SURF(M+1,2))                                                  SUB1 191
      IF (KQ.EQ.1) GO TO 940                                            SUB1 192
      CALL DVCHK(KQ)                                                    SUB1 193
      NO=2710                                                           SUB1 194
      IF (I.EQ.2) GO TO 2711                                            SUB1 195
      IF (KATCH.EQ.1) GO TO 2712                                        SUB1 196
      KATCH=1                                                           SUB1 197
      GO TO 2713                                                        SUB1 198
2712  IF ((ZX-ZI(K)).GT.(ZX-ZM)) GO TO 2700                             SUB1 199
2713  ZM=ZI(4)                                                          SUB1 200
      MS=M                                                              SUB1 201
      GO TO 2700                                                        SUB1 202
2711  CONTINUE                                                          SUB1 203
      IF (KATCH.EQ.1) GO TO 2726                                        SUB1 204
      KATCH=1                                                           SUB1 205
      GO TO 2713                                                        SUB1 206
2726  IF ((ZI(K)-ZX).GT.(ZM-ZX)) GO TO 2700                             SUB1 207
      GO TO 2713                                                        SUB1 208
2700  CONTINUE                                                          SUB1 209
      ZI(4)=ZM                                                          SUB1 210
      IF (KATCH.NE.0) GO TO 2701                                        SUB1 211
      ZI(4)=ZMAX+1.                                                     SUB1 212
2701  CONTINUE                                                          SUB1 213
      RI(1)=RX                                                          SUB1 214
      RI(2)=RX                                                          SUB1 215
      RI(3)=RX                                                          SUB1 216
      RI(4)=RX                                                          SUB1 217
C         FIND INTERSECTION TO USE                                      SUB1 218
C                                                                       SUB1 219
30    KEY=0                                                             SUB1 220
      IF (I.EQ.2) GO TO 50                                              SUB1 221
C                                                                       SUB1 222
C         UPPER GRID LINE                                               SUB1 223
C                                                                       SUB1 224
      DO 40 KK=1,4                                                      SUB1 225
      IF (Z(II).GT.ZI(KK)) GO TO 40                                     SUB1 226
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      IF (ABS(ZI(KK)-ZX).LT.1.E-5) GO TO 35                             SUB1 227
      IF (ZI(KK).GT.ZX) GO TO 40                                        SUB1 228
      IF (KEY.EQ.0) GO TO 35                                            SUB1 229
      IF (ZI(KK).LE.ZI(KEEP)) GO TO 40                                  SUB1 230
      KEEP=KK                                                           SUB1 231
      GO TO 40                                                          SUB1 232
35    KEEP=KK                                                           SUB1 233
      KEY=1                                                             SUB1 234
40    CONTINUE                                                          SUB1 235
      GO TO 65                                                          SUB1 236
C                                                                       SUB1 237
C         LOWER GRID LINE                                               SUB1 238
C                                                                       SUB1 239
50    DO 60 KK=1,4                                                      SUB1 240
      IF (Z(II).LT.ZI(KK)) GO TO 60                                     SUB1 241
      IF (ABS(ZI(KK)-ZX).LT.1.E-5) GO TO 55                             SUB1 242
      IF (ZI(KK).LT.ZX) GO TO 60                                        SUB1 243
      IF (KEY.EQ.0) GO TO 55                                            SUB1 244
      IF (ZI(KK).GE.ZI(KEEP)) GO TO 60                                  SUB1 245
      KEEP=KK                                                           SUB1 246
      GO TO 60                                                          SUB1 247
55    KEEP=KK                                                           SUB1 248
      KEY=1                                                             SUB1 249
60    CONTINUE                                                          SUB1 250
C                                                                       SUB1 251
65    IF (KEY.NE.0) GO TO 70                                            SUB1 252
      WRITE (6,67) ZX,RX,I,(ZI(KEY),KEY=1,4),(RI(KEY),KEY=1,4)          SUB1 253
67    FORMAT (34HOERROR NEAR STATEMENT 65 IN DBLTRP/1X3HZX=,E15.8,4X3HRXSUB1 254
     1=,F15.8,4X2HI=,I3/1X3HZI=,4E20.8/1X3HRI=,4E20.8/1H1)              SUB1 255
      XYZ=-2.                                                           SUB1 256
      ZYX=SQRT(XYZ)                                                     SUB1 257
      CALL EXIT                                                         SUB1 258
C                                                                       SUB1 259
C         FIND 6 VALUES ON SELECTED DISCONTINUITY                       SUB1 260
C                                                                       SUB1 261
70    IF (KEEP.EQ.3) GO TO 80                                           SUB1 262
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      IF (KEEP.EQ.4) GO TO 81                                           SUB1 263
      IF (KEEP.EQ.2) GO TO 71                                           SUB1 264
      N=NPS                                                             SUB1 265
      GO TO 72                                                          SUB1 266
71    N=NTS                                                             SUB1 267
72    CONTINUE                                                          SUB1 268
      ZY=ZI(KEEP)                                                       SUB1 269
      RY=RX                                                             SUB1 270
      DO 75 K=3,8                                                       SUB1 271
      ANS1(I,K)=TAB(N,K,KEEP)+(TAB(N+1,K,KEEP)-TAB(N,K,KEEP))*SQRT(((RY-SUB1 272
     1TAB(N,2,KEEP))**2+(ZY-TAB(N,1,KEEP))**2)/((TAB(N+1,2,KEEP)-TAB(N,2SUB1 273
     1,KEEP))**2+(TAB(N+1,1,KEEP)-TAB(N,1,KEEP))**2))                   SUB1 274
      NO=75                                                             SUB1 275
      CALL DVCHK(KQ)                                                    SUB1 276
      IF (KQ.EQ.1) GO TO 940                                            SUB1 277
75    CONTINUE                                                          SUB1 278
      GO TO 90                                                          SUB1 279
80    N=MR                                                              SUB1 280
      ZY=ZI(3)                                                          SUB1 281
      RY=RX                                                             SUB1 282
      DO 85 K=3,8                                                       SUB1 283
      ANS1(I,K)=RARF(N,K)+(RARF(N+1,K)-RARF(N,K))*SQRT(((RY-RARF(N,2))**SUB1 284
     12+(ZY-RARF(N,1))**2)/((RARF(N+1,2)-RARF(N,2))**2+(RARF(N+1,1)-RARFSUB1 285
     1(N,1))**2))                                                       SUB1 286
      NO=85                                                             SUB1 287
      CALL DVCHK(KQ)                                                    SUB1 288
      IF (KQ.EQ.1) GO TO 940                                            SUB1 289
85    CONTINUE                                                          SUB1 290
      GO TO 90                                                          SUB1 291
81    N=MS                                                              SUB1 292
      ZY=ZI(4)                                                          SUB1 293
      RY=RX                                                             SUB1 294
      DO 86 K=3,8                                                       SUB1 295
      ANS1(I,K)=SURF(N,K)+(SURF(N+1,K)-SURF(N,K))*SQRT(((RY-SURF(N,2))**SUB1 296
     12+(ZY-SURF(N,1))**2)/((SURF(N+1,2)-SURF(N,2))**2+(SURF(N+1,1)-SURFSUB1 297
     1(N,1))**2))                                                       SUB1 298
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86    CONTINUE                                                          SUB1 299
90    CALL DVCHK(NO)                                                    SUB1 300
      IF (NO.EQ.2) GO TO 92                                             SUB1 301
      NO=90                                                             SUB1 302
      GO TO 940                                                         SUB1 303
92    ANSI(I,1)=ZY                                                      SUB1 304
      ANSI(I,2)=RY                                                      SUB1 305
      GO TO 800                                                         SUB1 306
C                                                                       SUB1 307
C         FIND INTERSECTIONS OF 3 DISCONTINUITIES AND Z GRID LINE       SUB1 308
C                                                                       SUB1 309
300   CONTINUE                                                          SUB1 310
      KATCHP=0                                                          SUB1 311
      KATCHR=0                                                          SUB1 312
      KATCHT=0                                                          SUB1 313
      KATCHS=0                                                          SUB1 314
      DO 310 K=1,2                                                      SUB1 315
      KATCH=0                                                           SUB1 316
      GO TO (303,301),K                                                 SUB1 317
303   NN=NP                                                             SUB1 318
      GO TO 302                                                         SUB1 319
301   NN=NT                                                             SUB1 320
302   JJJ=NN-1                                                          SUB1 321
      DO 309 M=1,JJJ                                                    SUB1 322
      IF ((TAB(M,1,K)-TAB(M+1,1,K)).GT.1.E-6) GO TO 3030                SUB1 323
      GO TO 309                                                         SUB1 324
3030  RI(K)=TAB(M+1,2,K)+(TAB(M,2,K)-TAB(M+1,2,K))*(Z(II)-TAB(M+1,1,K))/SUB1 325
     1(TAB(M,1,K)-TAB(M+1,1,K))                                         SUB1 326
      CALL DVCHK(NO)                                                    SUB1 327
      IF (NO.EQ.2) GO TO 3031                                           SUB1 328
      NO=3030                                                           SUB1 329
      GO TO 940                                                         SUB1 330
3031  CONTINUE                                                          SUB1 331
      IF (M.EQ.JJJ) GO TO 3022                                          SUB1 332
      IF (RI(K).GT.TAB(M+1,2,K).OR.RI(K).LT.TAB(M,2,K)) GO TO 309       SUB1 333
3022  IF (MCOM.EQ.2) GO TO 305                                          SUB1 334
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      IF (KATCH.EQ.1) GO TO 304                                         SUB1 335
      KATCH=1                                                           SUB1 336
      GO TO 3050                                                        SUB1 337
304   IF ((RX-RI(K)).GT.(RX-RM)) GO TO 309                              SUB1 338
3050  RM=RI(K)                                                          SUB1 339
      IF (K.EQ.2) GO TO 3040                                            SUB1 340
      MPS=M                                                             SUB1 341
      KATCHP=1                                                          SUB1 342
      GO TO 309                                                         SUB1 343
3040  MTS=M                                                             SUB1 344
      KATCHT=1                                                          SUB1 345
      GO TO 309                                                         SUB1 346
305   CONTINUE                                                          SUB1 347
      IF (KATCH.EQ.1) GO TO 306                                         SUB1 348
      KATCH=1                                                           SUB1 349
      GO TO 3050                                                        SUB1 350
306   IF ((RI(K)-RX).GT.(RM-RX)) GO TO 309                              SUB1 351
      GO TO 3050                                                        SUB1 352
309   CONTINUE                                                          SUB1 353
      RI(K)=RM                                                          SUB1 354
      IF (KATCH.NE.0) GO TO 310                                         SUB1 355
      RI(K)=RMAX+1.                                                     SUB1 356
310   CONTINUE                                                          SUB1 357
      K=3                                                               SUB1 358
      IF (IRARF.EQ.1)RI(3)=RMAX+1.                                      SUB1 359
      IF (IRARF.EQ.1) GO TO 315                                         SUB1 360
      JJJ=NR-1                                                          SUB1 361
      KATCH=0                                                           SUB1 362
      DO 312 M=1,JJJ                                                    SUB1 363
      RI(3)=RARF(M+1,2)+(RARF(M,2)-RARF(M+1,2))*(Z(II)-RARF(M+1,2))/(RARSUB1 364
     1F(M,1)-RARF(M+1,1))                                               SUB1 365
      NO=3122                                                           SUB1 366
      CALL DVCHK(KQ)                                                    SUB1 367
      IF (KQ.EQ.1) GO TO 940                                            SUB1 368
      IF (M.EQ.JJJ.OR.M.EQ.1) GO TO 3122                                SUB1 369
      IF (RI(K).GT.RARF(M+1,2).OR.RI(K).LT.RARF(M,2)) GO TO 312         SUB1 370
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3122  IF (MCOM.EQ.2) GO TO 316                                          SUB1 371
      IF (KATCH.EQ.1) GO TO 317                                         SUB1 372
      KATCH=1                                                           SUB1 373
      GO TO 3051                                                        SUB1 374
317   IF ((RX-RI(K)).GT.(RX-RM)) GO TO 312                              SUB1 375
3051  RM=RI(K)                                                          SUB1 376
      MR=M                                                              SUB1 377
      KATCHR=1                                                          SUB1 378
      GO TO 312                                                         SUB1 379
316   CONTINUE                                                          SUB1 380
      IF (KATCH.EQ.1) GO TO 318                                         SUB1 381
      KATCH=1                                                           SUB1 382
      GO TO 3051                                                        SUB1 383
318   IF ((RI(K)-RX).GT.(RM-RX)) GO TO 312                              SUB1 384
      GO TO 3051                                                        SUB1 385
312   CONTINUE                                                          SUB1 386
      RI(K)=RM                                                          SUB1 387
      IF (KATCH.NE.0) GO TO 315                                         SUB1 388
      RI(K)=RMAX+1.                                                     SUB1 389
315   CONTINUE                                                          SUB1 390
      KATCH=0                                                           SUB1 391
      JJJ=NP-1                                                          SUB1 392
      DO 3150 M=1,JJJ                                                   SUB1 393
      IF ((SURF(M,1)-SURF(M+1,1)).GT.1.E-6) GO TO 3130                  SUB1 394
      GO TO 3150                                                        SUB1 395
3130  RI(4)=SURF(M+1,2)+(SURF(M,2)-SURF(M+1,2))*(Z(II)-SURF(M+1,1))/(SUR SUB1 396
     1F(M,1)-SURF(M+1,1))                                               SUB1 397
      NO=3130                                                           SUB1 398
      CALL DVCHK(KQ)                                                    SUB1 399
      IF (KQ.EQ.1) GO TO 940                                            SUB1 400
      IF (M.EQ.JJJ) GO TO 3123                                          SUB1 401
      IF (RI(4).GT.SURF(M+1,2).OR.RI(4).LT.SURF(M,2)) GO TO 3150        SUB1 402
3123  IF (MCOM.EQ.2) GO TO 3105                                         SUB1 403
      IF (KATCH.EQ.1) GO TO 3104                                        SUB1 404
      KATCH=1                                                           SUB1 405
      GO TO 3109                                                        SUB1 406
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3104  IF ((RX-RI(4)).GT.(RX-RM)) GO TO 3150                          SUB1 407
3109  RM=RI(4)                                                       SUB1 408
      MS=M                                                           SUB1 409
      KATCHS=1                                                       SUB1 410
      GO TO 3150                                                     SUB1 411
3105  IF (KATCH.EQ.1) GO TO 3106                                     SUB1 412
      KATCH=1                                                        SUB1 413
      GO TO 3109                                                     SUB1 414
3106  IF ((RI(4)-RX).GT.(RM-RX)) GO TO 3150                          SUB1 415
      GO TO 3109                                                     SUB1 416
3150  CONTINUE                                                       SUB1 417
      RI(4)=RM                                                       SUB1 418
      IF (KATCH.NE.0) GO TO 3107                                     SUB1 419
      RI(4)=RMAX+1.                                                  SUB1 420
3107  CONTINUE                                                       SUB1 421
      IF (KATCHP+KATCHT+KATCHR+KATCHS.EQ.0) GO TO 485                SUB1 422
      ZI(1)=Z(II)                                                    SUB1 423
      ZI(2)=Z(II)                                                    SUB1 424
      ZI(3)=Z(II)                                                    SUB1 425
      ZI(4)=Z(II)                                                    SUB1 426
C         J LOOP FOR LEFT AND RIGHT R GRID LINES                     SUB1 427
C                                                                    SUB1 428
      DO 700 J=1,2                                                   SUB1 429
      IF (J.EQ.2) GO TO 350                                          SUB1 430
C                                                                    SUB1 431
C         LEFT R GRID LINE                                           SUB1 432
C                                                                    SUB1 433
      JJ=J1                                                          SUB1 434
      KEY=0                                                          SUB1 435
      DO 340 N=1,4                                                   SUB1 436
      IF (R(J1).GT.RI(N)) GO TO 340                                  SUB1 437
      IF (RI(N).GT.RX) GO TO 340                                     SUB1 438
      IF (KEY.EQ.1) GO TO 330                                        SUB1 439
      KEY=1                                                          SUB1 440
      KEEP=N                                                         SUB1 441
      GO TO 340                                                      SUB1 442
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C                                                                       SUB1 443
C         FIND CLOSEST                                                  SUB1 444
C                                                                       SUB1 445
330   DIF1=RX-RI(KEEP)                                                  SUB1 446
      DIF2=RX-RI(N)                                                     SUB1 447
      IF (DIF1.LE.DIF2) GO TO 340                                       SUB1 448
      KEEP=N                                                            SUB1 449
340   CONTINUE                                                          SUB1 450
      GO TO 375                                                         SUB1 451
C                                                                       SUB1 452
C         RIGHT R GRID LINE                                             SUB1 453
C                                                                       SUB1 454
350   JJ=J2                                                             SUB1 455
      KEY=0                                                             SUB1 456
      DO 360 N=1,4                                                      SUB1 457
      IF (R(J2).LT.RI(N)) GO TO 360                                     SUB1 458
      IF (RI(N).LT.RX) GO TO 360                                        SUB1 459
      IF (KEY.EQ.1) GO TO 355                                           SUB1 460
      KEY=1                                                             SUB1 461
      KEEP=N                                                            SUB1 462
      GO TO 360                                                         SUB1 463
355   DIF1=RI(KEEP)-RX                                                  SUB1 464
      DIF2=RI(N)-RX                                                     SUB1 465
      IF (DIF1.LE.DIF2) GO TO 360                                       SUB1 466
      KEEP=N                                                            SUB1 467
360   CONTINUE                                                          SUB1 468
375   IF (KEY.EQ.1) GO TO 400                                           SUB1 469
C                                                                       SUB1 470
C         NO POINTS BETWEEN RX AND GRID POINTS                          SUB1 471
C                                                                       SUB1 472
      ANS2(J,1)=Z(II)                                                   SUB1 473
      ANS2(J,2)=R(JJ)                                                   SUB1 474
      ANS2(J,3)=XMESH(II,JJ,1)                                          SUB1 475
      ANS2(J,4)=XMESH(II,JJ,2)                                          SUB1 476
      ANS2(J,5)=XMESH(II,JJ,3)                                          SUB1 477
      ANS2(J,6)=XMESH(II,JJ,4)                                          SUB1 478
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      ANS2(J,7)=XMESH(II,JJ,5)                                          SUB1 479
      ANS2(J,8)=XMESH(II,JJ,6)                                          SUB1 480
      GO TO 700                                                         SUB1 481
C                                                                       SUB1 482
C         POINT FOUND BETWEEN RX AND GRID POINTS                        SUB1 483
C                                                                       SUB1 484
400   GO TO (405,410,470,481),KEEP                                      SUB1 485
C                                                                       SUB1 486
C         INTERSECTION ON PROJECTILE SHOCK                              SUB1 487
C                                                                       SUB1 488
405   N1=MPS                                                            SUB1 489
      RY=RI(KEEP)                                                       SUB1 490
      ZY=Z(II)                                                          SUB1 491
      GO TO 520                                                         SUB1 492
C                                                                       SUB1 493
C         INTERSECTION ON TARGET SHOCK                                  SUB1 494
C                                                                       SUB1 495
410   N1=MTS                                                            SUB1 496
      RY=RI(KEEP)                                                       SUB1 497
      ZY=Z(II)                                                          SUB1 498
      GO TO 520                                                         SUB1 499
C                                                                       SUB1 500
C        INTERSECTION ON RAREFACTION                                    SUB1 501
C                                                                       SUB1 502
470   N1=MR                                                             SUB1 503
      RY=RI(KEEP)                                                       SUB1 504
      ZY=Z(II)                                                          SUB1 505
      GO TO 520                                                         SUB1 506
C                                                                       SUB1 507
C     INTERSECTION ON FREE SURFACE                                      SUB1 508
C                                                                       SUB1 509
481   N1=MS                                                             SUB1 510
      RY=RI(KEEP)                                                       SUB1 511
      ZY=Z(II)                                                          SUB1 512
      GO TO 520                                                         SUB1 513
C                                                                       SUB1 514
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C                                                                       SUB1 515
485   WRITE (3,488) KEEP,II,JJ,ZX,RX                                    SUB1 516
488   FORMAT (25HOERROR NEAR STATEMENT 485/1X5HKEEP=,I4,4X3HII=,I4,4X3HJSUB1 517
     1J=,I4/1X3HZX=,E15.8,4X3HRX=,E15.8/1H1)                            SUB1 518
      CALL EXIT                                                         SUB1 519
C                                                                       SUB1 520
C          FIND TABLE VALUES                                            SUB1 521
C                                                                       SUB1 522
520   IF (KEEP.EQ.3) GO TO 580                                          SUB1 523
      IF (KEEP.EQ.4) GO TO 591                                          SUB1 524
      DO 550 N=3,8                                                      SUB1 525
      ANS2(J,N)=TAB(N1,N,KEEP)+(TAB(N1+1,N,KEEP)-TAB(N1,N,KEEP))*SQRT(((SUB1 526
     1RY-TAB(N1,2,KEEP))**2+(ZY-TAB(N1,1,KEEP))**2)/((TAB(N1+1,2,KEEP)-TSUB1 527
     1AB(N1,2,KEEP))**2+(TAB(N1+1,1,KEEP)-TAB(N1,1,KEEP))**2))          SUB1 528
550   CONTINUE                                                          SUB1 529
      IF (ZX.LT.0..AND.ABS(RX-RADIUS).LT.1.E-6) GO TO 552               SUB1 530
      IF (RX.LT.RADIUS.OR.ABS(Z(II)).GT.1.E-6) GO TO 551                SUB1 531
552   CONTINUE                                                          SUB1 532
      ANS2(J,3)=0.                                                      SUB1 533
      ANS2(J,6)=RHOSTR                                                  SUB1 534
      ANS2(J,7)=0.                                                      SUB1 535
      ANS2(J,8)=SQRT(BIGAPR/RHOSTR)                                     SUB1 536
551   CONTINUE                                                          SUB1 537
      GO TO 600                                                         SUB1 538
580   DO 590 N=3,8                                                      SUB1 539
      ANS2(J,N)=RARF(N1,N)+(RARF(N1+1,N)-RARF(N1,N))*SQRT(((RY-RARF(N1,2SUB1 540
     1))**2+(ZY-RARF(N1,1))**2)/((RARF(N1+1,2)-RARF(N1,2))**2+(RARF(N1+1SUB1 541
     1,1)-RARF(N1,1))**2))                                              SUB1 542
590   CONTINUE                                                          SUB1 543
      GO TO 600                                                         SUB1 544
591   DO 592 N=3,8                                                      SUB1 545
      ANS2(J,N)=SURF(N1,N)+(SURF(N1+1,N)-SURF(N1,N))*SQRT(((RY-SURF(N1,2SUB1 546
     1))**2+(ZY-SURF(N1,1))**2)/((SURF(N1+1,2)-SURF(N1,2))**2+(SURF(N1+1SUB1 547
     1,1)-SURF(N1,1))**2))                                              SUB1 548
592   CONTINUE                                                          SUB1 549
600   CALL DVCHK(NO)                                                    SUB1 550
```

```
      IF (NO.EQ.2) GO TO 605                                            SUB1 551
      NO=600                                                            SUB1 552
      GO TO 940                                                         SUB1 553
605   ANS2(J,1)=ZY                                                      SUB1 554
      ANS2(J,2)=RY                                                      SUB1 555
C                                                                       SUB1 556
C         END OF LOOP FOR BOTH R GRID LINES                             SUB1 557
C                                                                       SUB1 558
700   CONTINUE                                                          SUB1 559
C                                                                       SUB1 560
C         INTERPOLATE FOR UPPER AND LOWER VALUES                        SUB1 561
C                                                                       SUB1 562
      DO 720 J=3,8                                                      SUB1 563
      ANS1(I,J)=ANS2(1,J)+(ANS2(2,J)-ANS2(1,J))*(RX-ANS2(1,2))/(ANS2(2,2SUB1 564
     1)-ANS2(1,2))                                                      SUB1 565
720   CONTINUE                                                          SUB1 566
      CALL DVCHK(NO)                                                    SUB1 567
      IF (NO.EQ.2) GO TO 730                                            SUB1 568
      NO=720                                                            SUB1 569
      GO TO 940                                                         SUB1 570
730   ANS1(I,1)=Z(II)                                                   SUB1 571
      ANS1(I,2)=RX                                                      SUB1 572
C                                                                       SUB1 573
C         END OF LOOP FOR BOTH Z GRID LINES                             SUB1 574
C                                                                       SUB1 575
800   CONTINUE                                                          SUB1 576
C                                                                       SUB1 577
C         FIND FINAL VALUES                                             SUB1 578
C                                                                       SUB1 579
      DO 810 J=1,6                                                      SUB1 580
      ANS(J)=ANS1(1,J+2)+(ANS1(2,J+2)-ANS1(1,J+2))*(ZX-ANS1(1,1))/(ANS1(SUB1 581
     12,1)-ANS1(1,1))                                                   SUB1 582
810   CONTINUE                                                          SUB1 583
      CALL DVCHK(NO)                                                    SUB1 584
      IF (NO.EQ.2) GO TO 820                                            SUB1 585
      NO=810                                                            SUB1 586
```

```
      GO TO 940                                                         SUB1 587
820   RETURN                                                            SUB1 588
C                                                                       SUB1 589
940   WRITE (3,942)                                                     SUB1 590
942   FORMAT (35HODIVIDE CHECK ERROR IN SUBR. DBLTRP)                   SUB1 591
950   WRITE (3,952) NO,ZX,RX,I1,J1,KEEP,ZI,RI                           SUB1 592
952   FORMAT (19H NEAR STATEMENT NO.,I4/1X3HZX=,E15.8,4X3HRX=,E15.8/1X3HSUB1 593
     1I1=,I4,4X3HJ1=,I4,4X5HKEEP=,I4/1X3HZI=,4E18.8/1X3HRI=,4E18.8)     SUB1 594
      WRITE (3,955) ((ANS1(I,J),J=1,8),I=1,2),((ANS2(I,J),J=1,8),I=1,2) SUB1 595
955   FORMAT (1X5HANS1=/8E16.8/8E16.8/1X5HANS2=/8E16.8/8E16.8/1H1)      SUB1 596
      XYZ=-2.                                                           SUB1 597
      ZYX=SQRT(XYZ)                                                     SUB1 598
      CALL EXIT                                                         SUB1 599
      RETURN                                                            SUB1 600
      END                                                               SUB1 601
      SUBROUTINE SHOCK                                                  SUB2   1
C         COMPUTES SHOCK VALUES                                         SUB2   2
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSUB2   3
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSUB2   4
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SUB2   5
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SUB2   6
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SUB2   7
     115,4),RPART(15,2)                                                 SUB2   8
C                                                                       SUB2   9
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SUB2  10
C                                                                       SUB2  11
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB2  12
C                                                                       SUB2  13
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB2  14
      COMMON DIRCOS                                                     SUB2  15
      COMMON TIME                                                       SUB2  16
      COMMON IRARF                                                      SUB2  17
      COMMON KSTOP                                                      SUB2  18
      COMMON TPSI                                                       SUB2  19
      COMMON KKK                                                        SUB2  20
C                                                                       SUB2  21
```

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      REAL LO,MO,LENGTH,MU,KO                                           SUB2  22
C                                                                       SUB2  23
      DIMENSION ANS(6)                                                  SUB2  24
      EXTERNAL FGOF1                                                    SUB2  25
      EPS=.0000001                                                      SUB2  26
C                                                                       SUB2  27
C         BEGIN SHOCK POINT COMPUTATIONS                                SUB2  28
      DO 505 K=1,2                                                      SUB2  29
      GO TO (158,160),K                                                 SUB2  30
158   NN=NP                                                             SUB2  31
      GO TO 162                                                         SUB2  32
160   NN=NT                                                             SUB2  33
      VBARS=0.                                                          SUB2  34
162   DO 500 I=1,NN                                                     SUB2  35
      MPROJ=0                                                           SUB2  36
      IF (TAB(I,14,K).LT.0.) GO TO 500                                  SUB2  37
164   CONTINUE                                                          SUB2  38
C                                                                       SUB2  39
C         INITIALIZE TO ITERATE ON 1 SHOCK POINT                        SUB2  40
C                                                                       SUB2  41
      NBIC=0                                                            SUB2  42
      ZO=TAB2(I,1,K)                                                    SUB2  43
      RO=TAB2(I,2,K)                                                    SUB2  44
      PO=TAB(I,3,K)                                                     SUB2  45
      UO=TAB(I,4,K)                                                     SUB2  46
      VO=TAB(I,5,K)                                                     SUB2  47
      RHOO=TAB(I,6,K)                                                   SUB2  48
      EO=TAB(I,7,K)                                                     SUB2  49
      AO=TAB(I,8,K)                                                     SUB2  50
      LO=TAB(I,9,K)                                                     SUB2  51
      MO=TAB(I,10,K)                                                    SUB2  52
      UBARO=TAB(I,11,K)                                                 SUB2  53
      VBARO=TAB(I,12,K)                                                 SUB2  54
      UTOH=TAB(I,13,K)                                                  SUB2  55
      UTO=UTOH                                                          SUB2  56
      ITS44=ITS4                                                        SUB2  57
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```
      IF (IRARF.EQ.1) GO TO 170                                         SUB2  58
      M=1-(NR-2)*(K-2)                                                  SUB2  59
      FF=RO-RARF2(M+1,2)-(RARF2(M,2)-RARF2(M+1,2))*(ZO-RARF2(M+1,1))/(RASUB2  60
     1RF2(M,1)-RARF2(M+1,1))                                            SUB2  61
169   CONTINUE                                                          SUB2  62
      IF (FF.LT..001) GO TO 350                                         SUB2  63
170   IF (I.NE.1) GO TO 180                                             SUB2  64
      MO=TAB(I,10,K)                                                    SUB2  65
      LO=0.                                                             SUB2  66
      GO TO 190                                                         SUB2  67
180   IF (I.LT.NN) GO TO 184                                            SUB2  68
      UP=H*(TAB(I-1,13,K)-TAB(I,13,K))                                  SUB2  69
      TMP=SQRT((TAB2(I-1,2,K)-RO)**2+(TAB2(I-1,1,K)-ZO)**2)             SUB2  70
      DOMEG=UP/TMP                                                      SUB2  71
      GO TO 186                                                         SUB2  72
184   DR1=TAB2(I+1,2,K)-RO                                              SUB2  73
      DR2=RO-TAB2(I-1,2,K)                                              SUB2  74
      DZ1=TAB2(I+1,1,K)-ZO                                              SUB2  75
      DZ2=ZO-TAB2(I-1,1,K)                                              SUB2  76
      UP=H*(TAB(I-1,13,K)-TAB(I+1,13,K))                                SUB2  77
      TMP=SQRT(DR1**2+DZ1**2)+SQRT(DR2**2+DZ2**2)                       SUB2  78
      DOMEG=UP/TMP                                                      SUB2  79
      KICK=184                                                          SUB2  80
      CALL DVCHK(KQ)                                                    SUB2  81
      IF (KQ.EQ.1) GO TO 9980                                           SUB2  82
C                                                                       SUB2  83
C         COMPUTE NEW LO,MO                                             SUB2  84
C                                                                       SUB2  85
186   COMEG=COS(DOMEG)                                                  SUB2  86
      SOMEG=SIN(DOMEG)                                                  SUB2  87
      XLO=LO*COMEG+MO*SOMEG                                             SUB2  88
      XMO=MO*COMEG-LO*SOMEG                                             SUB2  89
      LO=XLO                                                            SUB2  90
      MO=XMO                                                            SUB2  91
      IF (PO.GT..0025) GO TO 190                                        SUB2  92
      PO=0.                                                             SUB2  93
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      U0=0.                                                             SUB2  94
      V0=VP*(1.-(-1.)**K)/2.                                            SUB2  95
      RHO0=RHOSTR                                                       SUB2  96
      E0=0.                                                             SUB2  97
      A0=SQRT(BIGAPR/RHOSTR)                                            SUB2  98
      UBAR0=M0*V0                                                       SUB2  99
      VBAR0=VBARS                                                       SUB2 100
      UT0=UBAR0+A0*(-1.)**K                                             SUB2 101
      GO TO 350                                                         SUB2 102
190   ITS33=ITS3                                                        SUB2 103
C                                                                       SUB2 104
C         FIND GUESS TO START ITERATION                                 SUB2 105
C                                                                       SUB2 106
195   CALL GUESS(1,KOD2,Z0,R0,I,K,ZZ,RR,DZ,DR)                          SUB2 107
      IF (KOD2.EQ.1) GO TO 200                                          SUB2 108
      WRITE (3,198) I,K,Z0,R0                                           SUB2 109
      WRITE (3,7002) ZZ,RR,DZ,DR                                        SUB2 110
198   FORMAT (31H0NO GUESS FOUND FOR SHOCK POINT/3H0I=,I4,6X2HK=,I4,10X3SUB2 111
     1HZ0=,E15.8,10X3HR0=,E15.8/1H1)                                    SUB2 112
      CALL EXIT                                                         SUB2 113
200   CONTINUE                                                          SUB2 114
      KY=K                                                              SUB2 115
      NTW=0                                                             SUB2 116
      IF (K.EQ.2) GO TO 201                                             SUB2 117
      VBARS=VP*L0                                                       SUB2 118
      DIRCOS=-M0                                                        SUB2 119
      GO TO 203                                                         SUB2 120
201   DIRCOS=M0                                                         SUB2 121
203   CONTINUE                                                          SUB2 122
      CALL NRIT2(Z1,R1,ZZ,DZ,RR,DR,EPS1,EPS2,FGOF1,ITS1,KODE)           SUB2 123
      IF (KODE.EQ.0) GO TO 205                                          SUB2 124
C                                                                       SUB2 125
C    BICHARACTERISTIC SELECTION SCHEME                                  SUB2 126
C                                                                       SUB2 127
      IF (NBIC.EQ.0) GO TO 204                                          SUB2 128
      IF (NTW.EQ.8)KY=KY+1                                              SUB2 129
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      IF (NTW.GT.21) GO TO 7000                                         SUB2 130
      ANG1=ANG1+DTPSI*(-1.)**KY                                         SUB2 131
      DIRCOS=SIN(ANG1)                                                  SUB2 132
      LO=COS(ANG1)                                                      SUB2 133
      NTW=NTW+1                                                         SUB2 134
      GO TO 203                                                         SUB2 135
204   CONTINUE                                                          SUB2 136
      NBIC=1                                                            SUB2 137
      CALL DBLTRP(ZZ,RR,ANS)                                            SUB2 138
      UA=ANS(2)                                                         SUB2 139
      VA=ANS(3)                                                         SUB2 140
      AA=ANS(6)                                                         SUB2 141
      ZZZ=ZZ+DZ                                                         SUB2 142
      CALL DBLTRP(ZZZ,RR,ANS)                                           SUB2 143
      UB=ANS(2)                                                         SUB2 144
      VB=ANS(3)                                                         SUB2 145
      AB=ANS(6)                                                         SUB2 146
      RRR=RR+DR                                                         SUB2 147
      CALL DBLTRP(ZZ,RRR,ANS)                                           SUB2 148
      UC=ANS(2)                                                         SUB2 149
      VC=ANS(3)                                                         SUB2 150
      AC=ANS(6)                                                         SUB2 151
      MM=0                                                              SUB2 152
      TPSI=1.5708*(-1.)**K                                              SUB2 153
      XB=ZZ                                                             SUB2 154
      YB=RR                                                             SUB2 155
      NOM=5                                                             SUB2 156
      CA=NOM                                                            SUB2 157
6201  DTPSI=.01745                                                      SUB2 158
      DTPSI=CA*DTPSI                                                    SUB2 159
      TPSI=TPSI+DTPSI*(-1.)**K                                          SUB2 160
      A1=1.+H*(VB-VA+(AB-AA)*SIN(TPSI))/DZ                              SUB2 161
      B1=H*(VC-VA+(AC-AA)*SIN(TPSI))/DR                                 SUB2 162
      C1=-(ZZ-ZO+H*(VA+AA*SIN(TPSI)))                                   SUB2 163
      A2=H*(UB-UA+(AB-AA)*COS(TPSI))/DZ                                 SUB2 164
      B2=1.+H*(UC-UA+(AC-AA)*COS(TPSI))/DR                              SUB2 165
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      C2=-(RR-RO+H*(UA+AA*COS(TPSI)))                                   SUB2 166
      DET=A1*B2-A2*B1                                                   SUB2 167
      DELX=(B2*C1-B1*C2)/DET                                            SUB2 168
      DELY=(A1*C2-A2*C1)/DET                                            SUB2 169
C                                                                       SUB2 170
C         TEST FOR SAME REGION                                          SUB2 171
C                                                                       SUB2 172
      XB1=XB+DELX                                                       SUB2 173
      YB1=YB+DELY                                                       SUB2 174
      M=COMP(XB,YB,XB1,YB1)                                             SUB2 175
      IF (M.EQ.1) GO TO 6203                                            SUB2 176
      MM=MM+1                                                           SUB2 177
      IF (MM.LT.360/NOM) GO TO 6201                                     SUB2 178
7000  WRITE (3,7001)                                                    SUB2 179
7001  FORMAT (41H0BICHARACTERISTIC SELECTION SCHEME FAILED)             SUB2 180
      WRITE (3,614) ZO,RO                                               SUB2 181
614   FORMAT (1X5HZO  =,E15.8,4X5HRO  =,E15.8)                          SUB2 182
      WRITE (3,7002) UA,VA,AA,UB,VB,AB,UC,VC,AC,ZZ,DZ,RR,DR,ANG1        SUB2 183
7002  FORMAT (4E16.8)                                                  SUB2 184
      CALL EXIT                                                         SUB2 185
6203  CONTINUE                                                          SUB2 186
      WRITE (3,6210)                                                    SUB2 187
6210  FORMAT (53H0BICHARACTERISTIC SELECTION SCHEME EMPLOYED BY SHOCKX) SUB2 188
6204  ANG1=TPSI                                                         SUB2 189
      T1=DIRCOS                                                         SUB2 190
      T2=LO                                                             SUB2 191
      DIRCOS=SIN(ANG1)                                                  SUB2 192
      LO=COS(ANG1)                                                      SUB2 193
      GO TO 203                                                         SUB2 194
205   CONTINUE                                                          SUB2 195
      UBARS1=0.                                                         SUB2 196
      IF (K.EQ.1)UBARS1=MO*VP                                           SUB2 197
      CALL DBLTRP(Z1,R1,ANS)                                            SUB2 198
      P1=ANS(1)                                                         SUB2 199
      U1=ANS(2)                                                         SUB2 200
      V1=ANS(3)                                                         SUB2 201
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      RHO1=ANS(4)                                                       SUB2 202
      E1=ANS(5)                                                         SUB2 203
      A1=ANS(6)                                                         SUB2 204
206   CONTINUE                                                          SUB2 205
      KICK=205                                                          SUB2 206
      CALL DVCHK(KQ)                                                    SUB2 207
      IF (KQ.EQ.1) GO TO 9980                                           SUB2 208
      IF (NBIC.EQ.0) GO TO 207                                          SUB2 209
7003  SINTH=ABS(DIRCOS)                                                 SUB2 210
      COSTH=ABS(LO)                                                     SUB2 211
      DIRCOS=T1                                                         SUB2 212
      LO=T2                                                             SUB2 213
207   CONTINUE                                                          SUB2 214
      UBAR1=LO*U1+MO*V1                                                 SUB2 215
      IF (K.EQ.2) GO TO 208                                             SUB2 216
      IF (UBAR1.LT.VP/2.) GO TO 208                                     SUB2 217
      UBAR1=UBARS1-UBAR1                                                SUB2 218
208   CONTINUE                                                          SUB2 219
218   CONTINUE                                                          SUB2 220
      M1=PART(1,Z1,R1,ZZ,RR,DELTA,NDEL)                                 SUB2 221
      IF (M1.EQ.1) GO TO 210                                            SUB2 222
      PUR=0.                                                            SUB2 223
      PVR=0.                                                            SUB2 224
      GO TO 215                                                         SUB2 225
210   CALL DBLTRP(ZZ,RR,ANS)                                            SUB2 226
      DP=RR-R1                                                          SUB2 227
      PUR=(ANS(2)-U1)/DP                                                SUB2 228
219   CONTINUE                                                          SUB2 229
      PVR=(ANS(3)-V1)/DP                                                SUB2 230
215   M1=PART(2,Z1,R1,ZZ,RR,DELTA,NDEL)                                 SUB2 231
      IF (M1.EQ.1) GO TO 220                                            SUB2 232
      PUZ=0.                                                            SUB2 233
      PVZ=0.                                                            SUB2 234
      PAZ=0.                                                            SUB2 235
      GO TO 225                                                         SUB2 236
220   CALL DBLTRP(ZZ,RR,ANS)                                            SUB2 237
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      DP=ZZ-Z1                                                          SUB2 238
      PUZ=(ANS(2)-U1)/DP                                                SUB2 239
      PVZ=(ANS(3)-V1)/DP                                                SUB2 240
225   CONTINUE                                                          SUB2 241
      IF (NBIC.EQ.1) GO TO 7004                                         SUB2 242
      PURB1=LO*PUR+MO*PVR                                               SUB2 243
      PVRB1=LO*PVR-MO*PUR                                               SUB2 244
      PVZB1=LO*PVZ-MO*PUZ                                               SUB2 245
      PVEB1=-MO*PVRB1+LO*PVZB1                                          SUB2 246
      SBAR1=PVEB1                                                       SUB2 247
226   CONTINUE                                                          SUB2 248
      IF (ABS(R1).LE.EPS) GO TO 235                                     SUB2 249
      SBAR1=SBAR1+U1/R1                                                 SUB2 250
      GO TO 240                                                         SUB2 251
7004  CONTINUE                                                          SUB2 252
      IF (V1.GT.VP/2..AND.K.EQ.1)V1=VP-V1                               SUB2 253
      SBAR1=SINTH**2*PUR-SINTH*COSTH*(PUZ+PVR)+COSTH**2*PVZ             SUB2 254
      GO TO 226                                                         SUB2 255
235   SBAR1=SBAR1+PUR                                                   SUB2 256
C                                                                       SUB2 257
C                                                                       SUB2 258
240   ITS22=ITS2                                                        SUB2 259
      MMM=0                                                             SUB2 260
250   CONTINUE                                                          SUB2 261
      CALL EQOSS(PFR,PFE)                                               SUB2 262
      BIGA1=RHO1*A1                                                     SUB2 263
      KICK=250                                                          SUB2 264
      CALL DVCHK(KQ)                                                    SUB2 265
      IF (KQ.EQ.1) GO TO 9980                                           SUB2 266
      TEMP=1.-RHOSTR/RHOO                                               SUB2 267
      TMP=SQRT(PO*TEMP/RHOSTR)                                          SUB2 268
      IF (K.EQ.2) GO TO 251                                             SUB2 269
      IF (TMP.LT.VP/2.) GO TO 251                                       SUB2 270
      MPROJ=1                                                           SUB2 271
      TMP=UBARS1-TMP                                                    SUB2 272
251   CONTINUE                                                          SUB2 273
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      TMP6=TMP                                                          SUB2 274
256   CONTINUE                                                          SUB2 275
      FNBIC=NBIC                                                        SUB2 276
      TMP1=P1+BIGA1*UBAR1-RHO1*H*SBAR1*A1**2+BIGA1*(-UBAR1+COSTH*U1+SINTSUB2 277
     1H*V1-SINTH*LO*VBARS+COSTH*MO*VBARS)*(FNBIC)                       SUB2 278
      TMP2=PFR*TEMP+PO*RHOSTR/RHOO**2                                   SUB2 279
      TMP5=PFE*TEMP                                                     SUB2 280
      GTMP=-RHO1*A1                                                     SUB2 281
      IF (NBIC.EQ.0) GO TO 259                                          SUB2 282
      GTMP=GTMP*(COSTH*LO+SINTH*MO)                                     SUB2 283
259   CONTINUE                                                          SUB2 284
      BIGG=PO-(GTMP*TMP+TMP1)                                           SUB2 285
      PGR=PFR-((GTMP*TMP2)/(2.*RHOSTR*TMP6))                            SUB2 286
      PGE=PFE-((GTMP*TMP5)/(2.*RHOSTR*TMP6))                            SUB2 287
265   TMP=.5*(1./RHOSTR-1./RHOO)                                        SUB2 288
      BIGH=EO-TMP*PO                                                    SUB2 289
      PHR=-TMP*PFR-.5*PO/RHOO**2                                        SUB2 290
      PHE=1.-TMP*PFE                                                    SUB2 291
      IF (ABS(BIGH).GT..0001) GO TO 267                                 SUB2 292
      BIGH=0.                                                           SUB2 293
267   IF (ABS(BIGG).GT..0001) GO TO 269                                 SUB2 294
      BIGG=0.                                                           SUB2 295
269   CONTINUE                                                          SUB2 296
C                                                                       SUB2 297
C         COMPUTE DELTA EO,DELTA RHOO                                   SUB2 298
C                                                                       SUB2 299
      DOWN=PGE*PHR-PGR*PHE                                              SUB2 300
      DEO=(-BIGG*PHR+BIGH*PGR)/DOWN                                     SUB2 301
      DRHOO=(-BIGH*PGE+BIGG*PHE)/DOWN                                   SUB2 302
C                                                                       SUB2 303
      EO2=EO+DEO                                                        SUB2 304
      IF (EO2.LT.0.)EO2=0.                                              SUB2 305
      RHOO2=RHOO+DRHOO                                                  SUB2 306
      IF (RHOO2.LT.RHOSTR)RHOO2=RHOO                                    SUB2 307
      KICK=265                                                          SUB2 308
      CALL DVCHK(KQ)                                                    SUB2 309
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      IF (KQ.EQ.1) GO TO 9980                                           SUB2 310
      CALL EQOSP(RHOO2,EO2,PO2)                                         SUB2 311
      UBARO2=(1.-RHOSTR/RHOO2)*(PO2/RHOSTR)                             SUB2 312
      IF (UBARO2.GT.0.) GO TO 2669                                      SUB2 313
      WRITE (3,2700) PO2,RHOO2,EO2,RO,ZO                                SUB2 314
      WRITE (3,7002) P1,U1,V1,RHO1,E1,Z1TR1,SBAR1                       SUB2 315
2700  FORMAT (4E16.8)                                                   SUB2 316
2669  CONTINUE                                                          SUB2 317
      UBARO2=SQRT(UBARO2)                                               SUB2 318
      IF (EO2.LT.1.E-5) GO TO 273                                       SUB2 319
      IF (ABS((EO2-EO)/EO2).LT.EPS4) GO TO 273                          SUB2 320
      IF (ABS(DEO).GT..01*EPS4) GO TO 275                               SUB2 321
273   IF (ABS((RHOO2-RHOO)/RHOO2).LE.EPS3) GO TO 285                    SUB2 322
      IF (ABS(DRHOO).LT.EPS3) GO TO 285                                 SUB2 323
275   ITS22=ITS22-1                                                     SUB2 324
      IF (ITS22.GT.0) GO TO 280                                         SUB2 325
      WRITE (3,278) ITS2                                                SUB2 326
278   FORMAT (35HOE AND RHO FAILED TO CONVERGE AFTER,I4,6H TRIES)       SUB2 327
      WRITE (3,279) I,K,ZO,RO,EO,RHOO,PO,EO2,RHOO2,PO2                  SUB2 328
279   FORMAT (1X2HI=,I4,4X2HK=,I4/1X4HZO =,E15.8,4X4HRO =,E15.8,4X4HEO =SUB2 329
     1,E15.8,4X6HRHOO =,E15.8,4X4HPO =,E15.8/1X4HEO2=,E15.8,4X6HRHOO2=,ESUB2 330
     115.8,4X4HPO2=,E15.8/1H1)                                          SUB2 331
      STOP                                                              SUB2 332
280   EO=EO2                                                            SUB2 333
      RHOO=RHOO2                                                        SUB2 334
      PO=PO2                                                            SUB2 335
      UBARO=UBARO2                                                      SUB2 336
      GO TO 250                                                         SUB2 337
285   EO=EO2                                                            SUB2 338
      RHOO=RHOO2                                                        SUB2 339
      UBARO=UBARO2                                                      SUB2 340
      AO=SQRT(PFR+PO2*PFE/RHOO**2)                                      SUB2 341
C                                                                       SUB2 342
C                                                                       SUB2 343
      CALL DVCHK(KQ)                                                    SUB2 344
      KICK=285                                                          SUB2 345
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      IF (KQ.EQ.1) GO TO 9980                                           SUB2 346
      IF (K.EQ.2) GO TO 286                                             SUB2 347
      VBARO=VP*LO                                                       SUB2 348
      GO TO 287                                                         SUB2 349
286   VBARO=0.                                                          SUB2 350
287   CONTINUE                                                          SUB2 351
295   PO=PO2                                                            SUB2 352
      IF (K.EQ.2) GO TO 296                                             SUB2 353
      UBARO=UBARS1-UBARO                                                SUB2 354
296   CONTINUE                                                          SUB2 355
      UTO=(RHOO*UBARO-RHOSTR*UBARS1)/(RHOO-RHOSTR)                      SUB2 356
      VO=MO*UBARO+LO*VBARO                                              SUB2 357
      UO=LO*UBARO-MO*VBARO                                              SUB2 358
      UBAR=.5*(UTOH+UTO)                                                SUB2 359
      IF (ABS((UBAR-UTOH)/UBAR).LE.EPS6) GO TO 350                      SUB2 360
      IF (ABS(UBAR-UTOH).LT.EPS6) GO TO 350                             SUB2 361
      ITS44=ITS44-1                                                     SUB2 362
      IF (ITS44.GT.0) GO TO 325                                         SUB2 363
      WRITE (3,297) ITS4,UTOH,UTO                                       SUB2 364
297   FORMAT (30HOUBAR FAILED TO CONVERGE AFTER,I4,6H TRIES/1X5HUTOH=,E1SUB2 365
     15.8,4X4HUTO=,E15.8)                                               SUB2 366
      CALL EXIT                                                         SUB2 367
      WRITE (3,279) I,K,ZO,RO,EO,RHOO,PO,EO2,RHOO2,PO2                  SUB2 368
C                                                                       SUB2 369
C         INIT. FOR MORE U BAR ITERATIONS                               SUB2 370
C                                                                       SUB2 371
325   UTOH=UBAR                                                         SUB2 372
      AVMO=(TAB(I,10,K)+MO)*.5                                          SUB2 373
      AVLO=(TAB(I,9,K)+LO)*.5                                           SUB2 374
      ZO=TAB(I,1,K)+UBAR*H*AVMO-VBARS*AVLO*H                            SUB2 375
      RO=TAB(I,2,K)+UBAR*H*AVLO-VBARS*AVMO*H                            SUB2 376
      LO=AVLO                                                           SUB2 377
      MO=AVMO                                                           SUB2 378
      GO TO 195                                                         SUB2 379
C                                                                       SUB2 380
C         ONE SHOCK POINT HAS CONVERGED                                 SUB2 381
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C                                                                       SUB2 382
350   TAB2(I,1,K)=Z0                                                    SUB2 383
      TAB2(I,2,K)=R0                                                    SUB2 384
      TAB2(I,3,K)=P0                                                    SUB2 385
      TAB2(I,4,K)=U0                                                    SUB2 386
      TAB2(I,5,K)=V0                                                    SUB2 387
      TAB2(I,6,K)=RHO0                                                  SUB2 388
      TAB2(I,7,K)=E0                                                    SUB2 389
      TAB2(I,8,K)=A0                                                    SUB2 390
      TAB2(I,9,K)=L0                                                    SUB2 391
      TAB2(I,10,K)=M0                                                   SUB2 392
      TAB2(I,11,K)=UBAR0                                                SUB2 393
      TAB2(I,12,K)=VBAR0                                                SUB2 394
      TAB2(I,13,K)=UT0                                                  SUB2 395
      KICK=500                                                          SUB2 396
      CALL DVCHK(KQ)                                                    SUB2 397
      IF (KQ.EQ.1) GO TO 9980                                           SUB2 398
C                                                                       SUB2 399
C                                                                       SUB2 400
500   CONTINUE                                                          SUB2 401
505   CONTINUE                                                          SUB2 402
      RETURN                                                            SUB2 403
9980  WRITE (3,9985) KICK                                               SUB2 404
9985  FORMAT (32H0DIVIDE CHECK NEAR STATEMENT NO.,I5,15H IN SUBR. SHOCK/SUB2 405
     11H1)                                                              SUB2 406
      CALL EXIT                                                         SUB2 407
      RETURN                                                            SUB2 408
      END                                                               SUB2 409
      SUBROUTINE FGOF1(ZX,RX,SS,QQ)                                     SUB3   1
C                                                                       SUB3   2
C         COMPUTES S1,Q1 FOR SHOCK LINE                                 SUB3   3
C         ITERATION FOR Z1,R1                                           SUB3   4
C                                                                       SUB3   5
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSUB3   6
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSUB3   7
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SUB3   8
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      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SUB3    9
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SUB3   10
     115,4),RPART(15,2)                                                 SUB3   11
C                                                                       SUB3   12
C                                                                       SUB3   13
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SUB3   14
C                                                                       SUB3   15
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB3   16
C                                                                       SUB3   17
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB3   18
      COMMON DIRCOS                                                     SUB3   19
      COMMON TIME                                                       SUB3   20
      COMMON IRARF                                                      SUB3   21
      COMMON KSTOP                                                      SUB3   22
      COMMON TPSI                                                       SUB3   23
      COMMON KKK                                                        SUB3   24
      REAL LO,MO,LENGTH,MU,KO                                           SUB3   25
C                                                                       SUB3   26
      DIMENSION ANS(6)                                                  SUB3   27
C                                                                       SUB3   28
      REAL LO,MO                                                        SUB3   29
      CALL DBLTRP(ZX,RX,ANS)                                            SUB3   30
      U1=ANS(2)                                                         SUB3   31
      V1=ANS(3)                                                         SUB3   32
      A1=ANS(6)                                                         SUB3   33
      SS=ZX-ZO+H*(V1+A1*DIRCOS)                                         SUB3   34
      QQ=RX-RO+H*(U1+A1*LO)                                             SUB3   35
      RETURN                                                            SUB3   36
      END                                                               SUB3   37
      SUBROUTINE INTER                                                  SUB4    1
C         COMPUTES INTERIOR REGION POINTS                               SUB4    2
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSUB4    3
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSUB4    4
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SUB4    5
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SUB4    6
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SUB4    7
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     115,4),RPART(15,2)                                                 SUB4   8
C                                                                       SUB4   9
C                                                                       SUB4  10
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SUB4  11
C                                                                       SUB4  12
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB4  13
C                                                                       SUB4  14
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB4  15
      COMMON DIRCOS                                                     SUB4  16
      COMMON TIME                                                       SUB4  17
      COMMON IRARF                                                      SUB4  18
      COMMON KSTOP                                                      SUB4  19
      COMMON TPSI                                                       SUB4  20
      COMMON KKK                                                        SUB4  21
C                                                                       SUB4  22
C                                                                       SUB4  23
      REAL LO,MO,LENGTH,MU,KO                                           SUB4  24
      DIMENSION ANS(6),LL(3),ZI(11),RI(11),PI(11),UI(11),VI(11),RHOI(11)SUB4  25
     1,EI(11),AI(11),PUR(11),PVR(11),PAR(11),PUZ(11),PVZ(11),PAZ(11),PSISUB4  26
     1(7),SPSI(11),CPSI(11),S(11)                                       SUB4  27
C                                                                       SUB4  28
      EXTERNAL FGOFI,FGOF5                                              SUB4  29
      INTEGER CHECK,CHECK2                                              SUB4  30
C                                                                       SUB4  31
1     FORMAT (1H1)                                                      SUB4  32
      EPS=.0000001                                                      SUB4  33
      DO 905 J=1,20                                                     SUB4  34
      DO 900 I=1,20                                                     SUB4  35
      M=TEST(Z(I),R(J))                                                 SUB4  36
      ZO=Z(I)                                                           SUB4  37
      RO=R(J)                                                           SUB4  38
      KICK=1                                                            SUB4  39
      CALL DVCHK(KQ)                                                    SUB4  40
      IF (KQ.EQ.1) GO TO 9980                                           SUB4  41
      IF (M.EQ.3.AND.ZO.LT.EPS.AND.ABS(RO-RADIUS).LT.EPS)M=1            SUB4  42
      IF (M.NE.1) GO TO 900                                             SUB4  43
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      DO 2 L=1,NP                                                       SUB4  44
      IF (TAB(L,14,1).LT.0.) GO TO 20                                   SUB4  45
2     CONTINUE                                                          SUB4  46
      IF (IRARF.EQ.1) GO TO 20                                          SUB4  47
      DO 3 N=1,NR                                                       SUB4  48
      IF (R(J).GT.RARF(N,2)) GO TO 5                                    SUB4  49
3     CONTINUE                                                          SUB4  50
      GO TO 6                                                           SUB4  51
5     CONTINUE                                                          SUB4  52
      M=PICK(Z(I),R(J),3)                                               SUB4  53
      FF=R(J)-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(Z(I)-RARF(M+1,1))/(RASUB4  54
     1RF(M,1)-RARF(M+1,1))                                              SUB4  55
      IF (FF.GT.0.) GO TO 20                                            SUB4  56
6     CONTINUE                                                          SUB4  57
      P02=RARF(1,3)                                                     SUB4  58
      U02=RARF(1,4)                                                     SUB4  59
      V02=RARF(1,5)                                                     SUB4  60
      RHO02=RARF(1,6)                                                   SUB4  61
      E02=RARF(1,7)                                                     SUB4  62
      A02=RARF(1,8)                                                     SUB4  63
      GO TO 870                                                         SUB4  64
20    CONTINUE                                                          SUB4  65
      CALL GUESS(2,KOD,Z0,R0,I,J,ZZ,RR,DZ,DR)                           SUB4  66
      IF (KOD.EQ.1) GO TO 580                                           SUB4  67
      WRITE (3,575) I,J,Z0,R0                                           SUB4  68
575   FORMAT (41HONO GUESS FOUND FOR INTERIOR REGION POINT/3HOI=I4,6X2HKSUB4  69
     1=,I4,10X3HZ0=,E15.8,10X3HR0=,E15.8/1H1)                           SUB4  70
      CALL EXIT                                                         SUB4  71
580   CALL DBLTRP(ZZ,RR,ANS)                                            SUB4  72
C                                                                       SUB4  73
C         INITIALIZE FOR 1 POINT                                        SUB4  74
C                                                                       SUB4  75
      PSI(1)=0.                                                         SUB4  76
      PSI(3)=1.0472                                                     SUB4  77
      PSI(4)=2.0944                                                     SUB4  78
      PSI(6)=4.18879                                                    SUB4  79
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      PSI(7)=5.23599                                                    SUB4  80
      NBIC=0                                                            SUB4  81
      ITI22=ITI2                                                        SUB4  82
      PO=ANS(1)                                                         SUB4  83
      UO=ANS(2)                                                         SUB4  84
      VO=ANS(3)                                                         SUB4  85
      RHOO=ANS(4)                                                       SUB4  86
      EO=ANS(5)                                                         SUB4  87
      AO=ANS(6)                                                         SUB4  88
      KICK=580                                                          SUB4  89
      CALL DVCHK(KQ)                                                    SUB4  90
      IF (KQ.EQ.1) GO TO 9980                                           SUB4  91
590   IF (ABS(RO).GT.EPS) GO TO 594                                     SUB4  92
      L1=1                                                              SUB4  93
      LL(1)=4                                                           SUB4  94
      LL(2)=6                                                           SUB4  95
      LLL=2                                                             SUB4  96
      GO TO 620                                                         SUB4  97
C                                                                       SUB4  98
C                                                                       SUB4  99
594   IF (ABS(RO-RADIUS).GT.EPS) GO TO 600                              SUB4 100
      IF (ZO.GT.EPS) GO TO 610                                          SUB4 101
      L1=2                                                              SUB4 102
      LL(1)=3                                                           SUB4 103
      LL(2)=7                                                           SUB4 104
      LLL=2                                                             SUB4 105
      GO TO 620                                                         SUB4 106
600   IF (RO.LE.RADIUS.OR.ABS(ZO).GT.EPS) GO TO 610                     SUB4 107
      L1=3                                                              SUB4 108
      LL(1)=6                                                           SUB4 109
      LL(2)=7                                                           SUB4 110
      LLL=2                                                             SUB4 111
      GO TO 620                                                         SUB4 112
C                                                                       SUB4 113
C                                                                       SUB4 114
610   L1=4                                                              SUB4 115
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      LL(1)=1                                                           SUB4 116
      LL(2)=4                                                           SUB4 117
      LL(3)=6                                                           SUB4 118
      LLL=3                                                             SUB4 119
C                                                                       SUB4 120
C         ITERATE FOR I VALUES                                          SUB4 121
C                                                                       SUB4 122
619   CONTINUE                                                          SUB4 123
620   DO 630 KK=1,LLL                                                   SUB4 124
      LUMP=L1                                                           SUB4 125
      ISUB=LL(KK)                                                       SUB4 126
621   CONTINUE                                                          SUB4 127
      TPSI=PSI(ISUB)                                                    SUB4 128
      SPSI(ISUB)=SIN(TPSI)                                              SUB4 129
      CPSI(ISUB)=COS(TPSI)                                              SUB4 130
      CALL NRIT2(ZI(ISUB),RI(ISUB),ZZ,DZ,RR,DR,EPI1,EPI2,FGOFI,ITI1,KODESUB4 131
     1)                                                                 SUB4 132
      IF (KODE.NE.0) GO TO 6200                                         SUB4 133
625   CALL DBLTRP(ZI(ISUB),RI(ISUB),ANS)                                SUB4 134
      PI(ISUB)=ANS(1)                                                   SUB4 135
      UI(ISUB)=ANS(2)                                                   SUB4 136
      VI(ISUB)=ANS(3)                                                   SUB4 137
      RHOI(ISUB)=ANS(4)                                                 SUB4 138
      EI(ISUB)=ANS(5)                                                   SUB4 139
      AI(ISUB)=ANS(6)                                                   SUB4 140
630   CONTINUE                                                          SUB4 141
C                                                                       SUB4 142
C                                                                       SUB4 143
      KICK=630                                                          SUB4 144
      CALL DVCHK(KQ)                                                    SUB4 145
      IF (KQ.EQ.1) GO TO 9980                                           SUB4 146
      GO TO 6400                                                        SUB4 147
C                                                                       SUB4 148
C    BICHARACTERISTIC SELECTION SCHEME                                  SUB4 149
C                                                                       SUB4 150
7000  WRITE (3,7001)                                                    SUB4 151
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7001  FORMAT (41HOBICHARACTERISTIC SELECTION SCHEME FAILED)
      WRITE (3,614) ZO,RO
      WRITE (3,7002) (PSI(MNMN),MNMN=1,7),UA,VA,AA,UB,VB,AB,UC,VC,AC,ZZ,
     1DZ,RR,DR,ANG1,ANG2
      SUB=ISUB
      WRITE (3,7002) SUB,ZI(ISUB),RI(ISUB)
7002  FORMAT (4E16.8)
      CALL EXIT
6200  CONTINUE
      IF (NBIC.NE.0) GO TO 7000
      IF (L1.NE.2.OR.LL(1).EQ.1) GO TO 7300
      LL(1)=1
      GO TO 619
7300  CONTINUE
      IF (L1.NE.3) GO TO 7310
      IF (PSI(6).GT.4.2) GO TO 7310
      PSI(6)=5.75959
      GO TO 619
7310  CONTINUE
      CALL DBLTRP(ZZ,RR,ANS)
      UA=ANS(2)
      VA=ANS(3)
      AA=ANS(6)
      ZZZ=ZZ+DZ
      CALL DBLTRP(ZZZ,RR,ANS)
      UB=ANS(2)
      VB=ANS(3)
      AB=ANS(6)
      RRR=RR+DR
      CALL DBLTRP(ZZ,RRR,ANS)
      UC=ANS(2)
      VC=ANS(3)
      AC=ANS(6)
      MM=0
      TPSI=PSI(ISUB)
      XB=ZZ
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      YB=RR                                                             SUB4 188
      NOM=5                                                             SUB4 189
      CA=NOM                                                            SUB4 190
      DO 6210 LM=1,2                                                    SUB4 191
6201  DTPSI=.01745                                                      SUB4 192
      DTPSI=CA*DTPSI                                                    SUB4 193
      TPSI=TPSI+DTPSI                                                   SUB4 194
      A1=1.+H*(VB-VA+(AB-AA)*SIN(TPSI))/DZ                              SUB4 195
      B1=H*(VC-VA+(AC-AA)*SIN(TPSI))/DR                                 SUB4 196
      C1=-(ZZ-ZO+H*(VA+AA*SIN(TPSI)))                                   SUB4 197
      A2=H*(UB-UA+(AB-AA)*COS(TPSI))/DZ                                 SUB4 198
      B2=1.+H*(UC-UA+(AC-AA)*COS(TPSI))/DR                              SUB4 199
      C2=-(RR-RO+H*(UA+AA*COS(TPSI)))                                   SUB4 200
      DET=A1*B2-A2*B1                                                   SUB4 201
      DELX=(B2*C1-B1*C2)/DET                                            SUB4 202
      DELY=(A1*C2-A2*C1)/DET                                            SUB4 203
C                                                                       SUB4 204
C         TEST FOR SAME REGION                                          SUB4 205
C                                                                       SUB4 206
      XB1=XB+DELX                                                       SUB4 207
      YB1=YB+DELY                                                       SUB4 208
      M=COMP(XB,YB,XB1,YB1)                                             SUB4 209
      IF (LM.EQ.2) GO TO 6700                                           SUB4 210
      IF (M.EQ.1) GO TO 6203                                            SUB4 211
      GO TO 6800                                                        SUB4 212
6700  CONTINUE                                                          SUB4 213
      IF (M.NE.1) GO TO 6203                                            SUB4 214
6800  CONTINUE                                                          SUB4 215
      MM=MM+1                                                           SUB4 216
      IF (MM.LE.360/NOM) GO TO 6201                                     SUB4 217
612   WRITE (3,613) ITI1                                                SUB4 218
613   FORMAT (44HOFAILED TO FIND 2 POINTS IN THE SAME REGION 21H IN SUBRSUB4 219
     1. NRIT2 AFTER,I4,6H TRIES)                                        SUB4 220
      WRITE (3,614) ZO,RO                                               SUB4 221
614   FORMAT (1X5HZO  =,E15.8,4X5HRO  =,E15.8)                          SUB4 222
      WRITE (3,6144) LM                                                 SUB4 223
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      WRITE (3,6145) M                                                  SUB4 224
      WRITE (3,6146) KODE                                               SUB4 225
      WRITE (3,7002) XB,YB,XB1,YB1                                      SUB4 226
 6144 FORMAT (4H LM=,I4)                                                SUB4 227
 6145 FORMAT (3H M=,I4)                                                 SUB4 228
 6146 FORMAT (6H KODE=,I4)                                              SUB4 229
      CALL EXIT                                                         SUB4 230
 6203 GO TO (6204,6205),LM                                              SUB4 231
 6204 ANG1=TPSI                                                         SUB4 232
      MM=0                                                              SUB4 233
      GO TO 6210                                                        SUB4 234
 6205 ANG2=TPSI-DTPSI                                                   SUB4 235
 6210 CONTINUE                                                          SUB4 236
      AL=LLL+1                                                          SUB4 237
      DO 6300 KK=1,LLL                                                  SUB4 238
      ISUB=LL(KK)                                                       SUB4 239
      AK=KK                                                             SUB4 240
      PSI(ISUB)=ANG1+(ANG2-ANG1)*AK/AL                                  SUB4 241
 6300 CONTINUE                                                          SUB4 242
      NBIC=1                                                            SUB4 243
      GO TO 619                                                         SUB4 244
C                                                                       SUB4 245
C                                                                       SUB4 246
 6400 CONTINUE                                                          SUB4 247
      IF (L1.EQ.2.OR.L1.EQ.3) GO TO 642                                 SUB4 248
      CALL NRIT2(ZI(8),RI(8),ZZ,DZ,RR,DR,EPI1,EPI2,FGOF5,ITI1,KODE)     SUB4 249
      IF (KODE.EQ.0) GO TO 635                                          SUB4 250
      ISUB=8                                                            SUB4 251
      WRITE (3,622) ITI1,I,J,ISUB,ZO,RO,ZZ,RR,ZI(8),RI(8)               SUB4 252
 622  FORMAT (27HOFAILED TO FIND ZI,RI AFTER,I4,6H TRIES,3X2HI=,I4,3X2HJSUB4 253
     1=,I4,3X5HISUB=,I4/1X3HZO=,E15.8,6X3HRO=,E15.8/1X3HZZ=,E15.8,6X3HRRSUB4 254
     1=,E15.8/1X3HZI=,E15.8,6X3HRI=,E15.8/1H1)                          SUB4 255
      CALL EXIT                                                         SUB4 256
C                                                                       SUB4 257
C                                                                       SUB4 258
 635  CALL OBLTRP(ZI(8),RI(8),ANS)                                      SUB4 259
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      PI(8)=ANS(1)                                                      SUB4 260
      UI(8)=ANS(2)                                                      SUB4 261
      VI(8)=ANS(3)                                                      SUB4 262
      RHOI(8)=ANS(4)                                                    SUB4 263
      EI(8)=ANS(5)                                                      SUB4 264
      AI(8)=ANS(6)                                                      SUB4 265
C                                                                       SUB4 266
642   DO 670 IL=1,LLL                                                   SUB4 267
      NN=LL(IL)                                                         SUB4 268
      M=PART(1,ZI(NN),RI(NN),ZX,RX,DELTA,NDEL)                          SUB4 269
      IF (M.EQ.1) GO TO 645                                             SUB4 270
      PUR(NN)=0.                                                        SUB4 271
      PVR(NN)=0.                                                        SUB4 272
      GO TO 648                                                         SUB4 273
645   CALL DBLTRP(ZX,RX,ANS)                                            SUB4 274
      DEN=RX-RI(NN)                                                     SUB4 275
      PUR(NN)=(ANS(2)-UI(NN))/DEN                                       SUB4 276
      PVR(NN)=(ANS(3)-VI(NN))/DEN                                       SUB4 277
648   M=PART(2,ZI(NN),RI(NN),ZX,RX,DELTA,NDEL)                          SUB4 278
      IF (M.EQ.1) GO TO 650                                             SUB4 279
      PUZ(NN)=0.                                                        SUB4 280
      PVZ(NN)=0.                                                        SUB4 281
      GO TO 655                                                         SUB4 282
650   CALL DBLTRP(ZX,RX,ANS)                                            SUB4 283
      DEN=ZX-ZI(NN)                                                     SUB4 284
      PUZ(NN)=(ANS(2)-UI(NN))/DEN                                       SUB4 285
      PVZ(NN)=(ANS(3)-VI(NN))/DEN                                       SUB4 286
655   S(NN)=SPSI(NN)**2*PUR(NN)-CPSI(NN)*SPSI(NN)*(PVR(NN)+PUZ(NN))+CPSISUB4 287
     1(NN)**2*PVZ(NN)                                                   SUB4 288
C                                                                       SUB4 289
      IF (ABS(RI(NN)).GT.EPS) GO TO 660                                 SUB4 290
      CON=PUR(NN)                                                       SUB4 291
      GO TO 662                                                         SUB4 292
660   CON=UI(NN)/RI(NN)                                                 SUB4 293
662   S(NN)=-RHOI(NN)*H*AI(NN)**2*(S(NN)+CON)+PI(NN)+RHOI(NN)*AI(NN)*CPSSUB4 294
     1I(NN)*UI(NN)+RHOI(NN)*AI(NN)*SPSI(NN)*VI(NN)                      SUB4 295
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670   CONTINUE                                                          SUB4 296
1005  CONTINUE                                                          SUB4 297
1002  FORMAT (4E16.8)                                                   SUB4 298
      KICK=670                                                          SUB4 299
      CALL DVCHK(KQ)                                                    SUB4 300
      IF (KQ.EQ.1) GO TO 9980                                           SUB4 301
C                                                                       SUB4 302
C         COMPUTE NEW P,U,V                                             SUB4 303
C                                                                       SUB4 304
      GO TO (690,692,695,698),L1                                        SUB4 305
690   DU0=0.                                                            SUB4 306
      U02=0.                                                            SUB4 307
      V02=(S(4)-S(6))/(RHOI(4)*AI(4)*SPSI(4)-RHOI(6)*AI(6)*SPSI(6))     SUB4 308
      P02=S(4)-RHOI(4)*AI(4)*SPSI(4)*V02                                SUB4 309
      GO TO 700                                                         SUB4 310
C                                                                       SUB4 311
C                                                                       SUB4 312
692   DP0=0.                                                            SUB4 313
      P02=0.                                                            SUB4 314
      L=LL(1)                                                           SUB4 315
      TMP1=RHOI(7)*RHOI(L)*AI(7)*AI(L)*(CPSI(7)*SPSI(L)-CPSI(L)*SPSI(7))SUB4 316
      V02=(S(L)*RHOI(7)*AI(7)*CPSI(7)-S(7)*RHOI(L)*AI(L)*CPSI(L))/TMP1  SUB4 317
      U02=(S(L)-RHOI(L)*AI(L)*SPSI(L)*V02)/(RHOI(L)*AI(L)*CPSI(L))      SUB4 318
      GO TO 700                                                         SUB4 319
C                                                                       SUB4 320
C                                                                       SUB4 321
695   DP0=0.                                                            SUB4 322
      P02=0.                                                            SUB4 323
      TMP1=RHOI(7)*RHOI(6)*AI(7)*AI(6)*(CPSI(7)*SPSI(6)-SPSI(7)*CPSI(6))SUB4 324
      V02=(S(6)*RHOI(7)*AI(7)*CPSI(7)-S(7)*RHOI(6)*AI(6)*CPSI(6))/TMP1  SUB4 325
      U02=(S(6)-RHOI(6)*AI(6)*SPSI(6)*V02)/(RHOI(6)*AI(6)*CPSI(6))      SUB4 326
      GO TO 700                                                         SUB4 327
698   CONTINUE                                                          SUB4 328
      L=LL(1)                                                           SUB4 329
      TMP1=RHOI(4)*AI(4)*CPSI(4)-RHOI(L)*AI(L)*CPSI(L)                  SUB4 330
      TMP2=RHOI(4)*AI(4)*SPSI(4)-RHOI(L)*AI(L)*SPSI(L)                  SUB4 331
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      TMP3=RHOI(6)*AI(6)*CPSI(6)-RHOI(L)*AI(L)*CPSI(L)                  SUB4 332
      TMP4=RHOI(6)*AI(6)*SPSI(6)-RHOI(L)*AI(L)*SPSI(L)                  SUB4 333
      V02=((S(4)-S(L))*TMP3-(S(6)-S(L))*TMP1)/(TMP3*TMP2-TMP1*TMP4)     SUB4 334
      U02=(S(4)-S(L)-TMP2*V02)/TMP1                                     SUB4 335
      P02=S(6)-RHOI(6)*AI(6)*CPSI(6)*U02-RHOI(6)*AI(6)*SPSI(6)*V02      SUB4 336
700   KICK=700                                                          SUB4 337
      CALL DVCHK(KQ)                                                    SUB4 338
      IF (KQ.EQ.1) GO TO 9980                                           SUB4 339
C                                                                       SUB4 340
C                                                                       SUB4 341
C         ITERATE FOR RHOO,EO                                           SUB4 342
C                                                                       SUB4 343
705   ITI33=ITI3                                                        SUB4 344
      ITI44=ITI4                                                        SUB4 345
      KM=1                                                              SUB4 346
708   CONTINUE                                                          SUB4 347
      CALL EQOSI(P02,PGRHO,PGE,BIGG,CHECK,KRTT,A02,E02,RHOO2,KM,EPS)    SUB4 348
      IF (KRTT.EQ.1) GO TO 871                                          SUB4 349
725   T1=RHOO-RHOI(8)                                                   SUB4 350
      T2=PI(8)/RHOI(8)**2                                               SUB4 351
      BIGH=EI(8)+T2*T1-EO                                               SUB4 352
      PHE=-1.                                                           SUB4 353
      PHRHO=T2                                                          SUB4 354
      KICK=725                                                          SUB4 355
      CALL DVCHK(KQ)                                                    SUB4 356
      IF (KQ.EQ.1) GO TO 9980                                           SUB4 357
C                                                                       SUB4 358
C         COMPUTE NEW EO,RHOO                                           SUB4 359
C                                                                       SUB4 360
      DOWN=PGE*PHRHO-PGRHO*PHE                                          SUB4 361
      DEO=(-BIGG*PHRHO+BIGH*PGRHO)/DOWN                                 SUB4 362
      DRHOO=(-BIGH*PGE+BIGG*PHE)/DOWN                                   SUB4 363
      E02=EO+DEO                                                        SUB4 364
      RHOO2=RHOO+DRHOO                                                  SUB4 365
C                                                                       SUB4 366
C         CHECK E02,RHOO2 FOR CONVERGENCE                               SUB4 367
```

```
      KICK=726                                                          SUB4 368
      CALL DVCHK(KQ)                                                    SUB4 369
      IF (KQ.EQ.1) GO TO 9980                                           SUB4 370
C                                                                       SUB4 371
      IF (ABS(DEO/EO).LT.EPI7) GO TO 726                                SUB4 372
      IF (ABS(DEO).GT..01*EPI7) GO TO 730                               SUB4 373
726   IF (ABS(DRHOO/RHOO).LE.EPI6) GO TO 740                            SUB4 374
      IF (ABS(DRHOO).LT.EPI6) GO TO 740                                 SUB4 375
730   ITI33=ITI33-1                                                     SUB4 376
      IF (ITI33.NE.0) GO TO 735                                         SUB4 377
      WRITE (6,732) ITI3,I,J,ZO,RO,PO,UO,VO,RHOO,EO,PO2,UO2,VO2,RHOO2,EOSUB4 378
     12                                                                 SUB4 379
732   FORMAT (33HOEO,RHOO FAILED TO CONVERGE AFTER,I4,6H TRIES/1X2HI=,I4SUB4 380
     1,4X2HJ=,I4,4X2HZ=,E15.8,4X2HR=,E15.8/5X2HPO18X2HUO18X2HVO18X4HRHOOSUB4 381
     116X2HEO/5X3HPO217X3HUO217X3HVO217X5HRHOO215X3HEO2//(5E20.8))      SUB4 382
      WRITE (3,1)                                                       SUB4 383
      CALL EXIT                                                         SUB4 384
735   EO=EO2                                                            SUB4 385
      RHOO=RHOO2                                                        SUB4 386
      KM=0                                                              SUB4 387
      GO TO 708                                                         SUB4 388
C                                                                       SUB4 389
C         CHECK FOR PROPER EQUATIONS                                    SUB4 390
C                                                                       SUB4 391
740   CONTINUE                                                          SUB4 392
      PGE=-PGE                                                          SUB4 393
      PGRHO=-PGRHO                                                      SUB4 394
      IF (RHOO2.GE.RHOSTR) GO TO 750                                    SUB4 395
      IF (EO2.LT.EPRS) GO TO 750                                        SUB4 396
742   CHECK2=0                                                          SUB4 397
      GO TO 752                                                         SUB4 398
750   CHECK2=1                                                          SUB4 399
752   AO2=SQRT(+PGRHO+PO2*PGE/RHOO2**2)                                 SUB4 400
      IF (CHECK.EQ.CHECK2) GO TO 870                                    SUB4 401
      ITI44=ITI44-1                                                     SUB4 402
      IF (ITI44.NE.0) GO TO 770                                         SUB4 403
```

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      WRITE (3,755) ITI4,I,J,ZO,RO,PO,UO,VO,RHOO,EO,AO,PO2,UO2,VO2,RHOO2SUB4 404
     1,EO2,AO2                                                         SUB4 405
755   FORMAT (38HOFAILED TO USE CORRECT EQUATIONS AFTER,I4,6H TRIES/1X2HSUB4 406
     1I=,I4,4X2HJ=,I4,4X2HZ=,E15.8,4X2HR=,E15.8/5X2HPO18X2HUO18X2HVO18X4SUB4 407
     1HRHOO16X2HEO18X2HAO/5X3HPO217X3HUO217X3HVO217X5HRHOO215X3HEO217X3HSUB4 408
     1AO2//(6E20.8))                                                   SUB4 409
      WRITE (3,1)                                                      SUB4 410
      CALL EXIT                                                        SUB4 411
770   KICK=770                                                         SUB4 412
      CALL DVCHK(KQ)                                                   SUB4 413
      IF (KQ.EQ.1) GO TO 9980                                          SUB4 414
      ITI33=ITI3                                                       SUB4 415
      GO TO 735                                                        SUB4 416
C                                                                      SUB4 417
C          ALL VALUES HAVE CONVERGED FOR 1 INTERIOR POINT              SUB4 418
C                                                                      SUB4 419
871   KRTT=0                                                           SUB4 420
870   XMESH2(I,J,1)=PO2                                                SUB4 421
      XMESH2(I,J,2)=UO2                                                SUB4 422
      XMESH2(I,J,3)=VO2                                                SUB4 423
      XMESH2(I,J,4)=RHOO2                                              SUB4 424
      XMESH2(I,J,5)=EO2                                                SUB4 425
      XMESH2(I,J,6)=AO2                                                SUB4 426
      KICK=900                                                         SUB4 427
      CALL DVCHK(KQ)                                                   SUB4 428
      IF (KQ.EQ.1) GO TO 9980                                          SUB4 429
900   CONTINUE                                                         SUB4 430
905   CONTINUE                                                         SUB4 431
      IF (ITS3.EQ.1) GO TO 950                                         SUB4 432
      CALL ITRP                                                        SUB4 433
      RETURN                                                           SUB4 434
950   CONTINUE                                                         SUB4 435
9980  WRITE (3,9985) KICK                                              SUB4 436
      WRITE (3,614) ZO,RO                                              SUB4 437
9985  FORMAT (32HODIVIDE CHECK NEAR STATEMENT NO.,I5,15H IN SUBR. INTER/SUB4 438
     11H1)                                                             SUB4 439
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```
      CALL EXIT                                                         SUB4  440
      RETURN                                                            SUB4  441
      END                                                               SUB4  442
      SUBROUTINE EQOS1(PRHO,PPP,PVV,PEE,TEE,TRHO,KICK)                  SUB5    1
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSUB5    2
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSUB5    3
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SUB5    4
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SUB5    5
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SUB5    6
     115,4),RPART(15,2)                                                 SUB5    7
C                                                                       SUB5    8
C                                                                       SUB5    9
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SUB5   10
C                                                                       SUB5   11
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB5   12
C                                                                       SUB5   13
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB5   14
      COMMON DIRCOS                                                     SUB5   15
      COMMON TIME                                                       SUB5   16
      COMMON IRARF                                                      SUB5   17
      COMMON KSTOP                                                      SUB5   18
      COMMON TPSI                                                       SUB5   19
      COMMON KKK                                                        SUB5   20
C                                                                       SUB5   21
C                                                                       SUB5   22
      REAL LO,MO,LENGTH,MU,KO                                           SUB5   23
      RHO=RHOSTR                                                        SUB5   24
      E=VP**2/8.                                                        SUB5   25
      DO 100 M=1,100                                                    SUB5   26
      ETA=RHO/RHOSTR                                                    SUB5   27
      MU=ETA-1.                                                         SUB5   28
      G=-RHOSTR*(VP/2.)**2+((APR+BPR/(E/(ESTAR*ETA**2)+1.))*E*RHO+BIGAPRSUB5   29
     1*MU+BIGBPR*MU**2)*(1.-RHOSTR/RHO)                                 SUB5   30
      DERIVG=((APR+BPR/(E/(ESTAR*ETA**2)+1.))*E+BIGAPR/RHOSTR+2.*BIGBPR*SUB5   31
     1MU/RHOSTR+2.*E**2*BPR/(ESTAR*ETA**2*(E/(ESTAR*ETA**2)+1.)**2))*(1.SUB5   32
     1-RHOSTR/RHO)+((APR+BPR/(E/(ESTAR*ETA**2)+1.))*E*RHO+BIGAPR*MU+BIGBSUB5   33
```

```
     1PR*MU**2)*RHOSTR/RHO**2                                           SUB5  34
      DLTRHO=-G/DERIVG                                                  SUB5  35
      RHO=RHO+DLTRHO                                                    SUB5  36
      IF(ABS(DLTRHO).LT.1.E-07) GO TO 101                               SUB5  37
C     IF (ABS(DLTRHO).LT.1.E-06) GO TO 101                              SUB5  38
100   CONTINUE                                                          SUB5  39
      KICK=2200                                                         SUB5  40
      GO TO 9980                                                        SUB5  41
101   CONTINUE                                                          SUB5  42
      PRHO=RHO                                                          SUB5  43
      TRHO=RHO                                                          SUB5  44
      PEE=E                                                             SUB5  45
      TEE=E                                                             SUB5  46
      PVV=VP/2.                                                         SUB5  47
      PPP=(APR+BPR/(E/(ESTAR*ETA**2)+1.))*E*RHO+BIGAPR*MU+BIGBPR*MU**2  SUB5  48
9980  RETURN                                                            SUB5  49
      END                                                               SUB5  50
      SUBROUTINE EQOS2(PPP,PRHO,PEE)                                    SUB6   1
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSUB6   2
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSUB6   3
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SUB6   4
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SUB6   5
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SUB6   6
     115,4),RPART(15,2)                                                 SUB6   7
C                                                                       SUB6   8
C                                                                       SUB6   9
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SUB6  10
C                                                                       SUB6  11
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB6  12
C                                                                       SUB6  13
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB6  14
      COMMON DIRCOS                                                     SUB6  15
      COMMON TIME                                                       SUB6  16
      COMMON IRARF                                                      SUB6  17
      COMMON KSTOP                                                      SUB6  18
C                                                                       SUB6  19
```

```
      COMMON TPSI                                                       SUB6  20
      COMMON KKK                                                        SUB6  21
C                                                                       SUB6  22
      REAL LO,MO,LENGTH,MU,KO                                           SUB6  23
      P=PPP                                                             SUB6  24
      RHO=PRHO                                                          SUB6  25
      E=PEE                                                             SUB6  26
      ETA=RHO/RHOSTR                                                    SUB6  27
      MU=ETA-1.                                                         SUB6  28
      EE=E/(ESTAR*ETA**2)+1.                                            SUB6  29
      PGRHO=E*(APR+BPR/EE)+BIGAPR/RHOSTR+(2.*BIGBPR*MU)/RHOSTR+(2.*E**2*SUB6  30
     1BPR)/(ESTAR*ETA**2*EE**2)                                         SUB6  31
      PGE=(APR+BPR/EE)*RHO-(E*BPR*RHO)/(ESTAR*ETA**2*EE**2)             SUB6  32
      AR=SQRT(PGRHO+PGE*P/RHO**2)                                       SUB6  33
      RETURN                                                            SUB6  34
      END                                                               SUB6  35
      SUBROUTINE EQOS3(RHO,AA,E,P)                                      SUB7   1
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSUB7   2
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSUB7   3
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SUB7   4
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SUB7   5
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SUB7   6
     115,4),RPART(15,2)                                                 SUB7   7
C                                                                       SUB7   8
C                                                                       SUB7   9
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SUB7  10
C                                                                       SUB7  11
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB7  12
C                                                                       SUB7  13
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB7  14
      COMMON DIRCOS                                                     SUB7  15
      COMMON TIME                                                       SUB7  16
      COMMON IRARF                                                      SUB7  17
      COMMON KSTOP                                                      SUB7  18
      COMMON TPSI                                                       SUB7  19
      COMMON KKK                                                        SUB7  20
```

```
C
C
      REAL LO,MO,LENGTH,MU,KO
70    ETA=RHO/RHOSTR
      MU=ETA-1.
      EE=E/(ESTAR*ETA**2)+1.
      IF (RHO.GT.RHOSTR) GO TO 72
      IF (E.GE.EPRS) GO TO 74
72    PGRHO=E*(APR+BPR/EE)+BIGAPR/RHOSTR+(2.*BIGBPR*MU)/RHOSTR+(2.*E**2*
     1BPR)/(ESTAR*ETA**2*EE**2)
      PGE=(APR+BPR/EE)*RHO-(E*BPR*RHO)/(ESTAR*ETA**2*EE**2)
      GO TO 75
74    C1=RHOSTR/RHO-1.
      C2=EXP(-BETA*C1)
      C3=EXP(-ALPHA*C1**2)
      T1=(BPR*E*RHO)/EE+BIGAPR*MU*C2
      T2=2.*ALPHA*C1*(RHOSTR/(RHO**2))
      T3=BPR*E/EE
      T4=(2.*E)/(ESTAR*ETA**2*EE)
      T4=T3*T4
      T5=(BIGAPR*C2)/RHOSTR
      T6=(BIGAPR*MU*BETA*RHOSTR*C2)/(RHO**2)
      PGRHO=APR*E+C3*(T1*T2+T3+T4+T5+T6)
      T7=(BPR*RHO)/EE
      PGE=APR*RHO+C3*(T7-T7*(E/(ESTAR*ETA**2*EE)))
75    AA=SQRT(PGRHO+PGE*P/RHO**2)
      RETURN
      END
      SUBROUTINE EQOSS(PFR,PFE)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
```

```
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
C
      COMMON NP,NT,NR,NI,NDEL,ISUB
C
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H
      COMMON DIRCOS
      COMMON TIME
      COMMON IRARF
      COMMON KSTOP
      COMMON TPSI
      COMMON KKK
C
C
      REAL LO,MO,LENGTH,MU,KO
250   ETA=RHOO/RHOSTR
      MU=ETA-1.
C
C
      EPP=EO/(ESTAR*ETA**2)+1.
      TMP=APR+BPR/EPP
      TMP1=BPR/(ESTAR*ETA**2*EPP**2)
      PFR=TMP*EO+(BIGAPR+2.*BIGBPR*MU)/RHOSTR+2.*EO**2*TMP1
      PFE=TMP*RHOO-EO*RHOO*TMP1
      RETURN
      END
      SUBROUTINE EQOSP(RHOO2,EO2,PO2)
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPS
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LEN
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(
     115,4),RPART(15,2)
C
C
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO
```

```
C                                                                       SUB9  11
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SUB9  12
C                                                                       SUB9  13
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SUB9  14
      COMMON DIRCOS                                                     SUB9  15
      COMMON TIME                                                       SUB9  16
      COMMON IRARF                                                      SUB9  17
      COMMON KSTOP                                                      SUB9  18
      COMMON TPSI                                                       SUB9  19
      COMMON KKK                                                        SUB9  20
C                                                                       SUB9  21
C                                                                       SUB9  22
      REAL LO,MO,LENGTH,MU,KO                                           SUB9  23
      ETA=RHOO2/RHOSTR                                                  SUB9  24
      MU=ETA-1.                                                         SUB9  25
      PO2=EO2*RHOO2*(APR+(BPR*ESTAR*ETA**2)/(EO2+ESTAR*ETA**2))+BIGAPR*MSUB9  26
     1U+BIGBPR*MU**2                                                    SUB9  27
      RETURN                                                            SUB9  28
      END                                                               SUB9  29
      SUBROUTINE EQOSI(PO2,PGRHO,PGE,BIGG,CHECK,KRTT,AO2,EO2,RHOO2,KM,EPSU10   1
     1S)                                                                SU10   2
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU10   3
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU10   4
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU10   5
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU10   6
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU10   7
     115,4),RPART(15,2)                                                 SU10   8
C                                                                       SU10   9
C                                                                       SU10  10
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SU10  11
C                                                                       SU10  12
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU10  13
C                                                                       SU10  14
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU10  15
      COMMON DIRCOS                                                     SU10  16
      COMMON TIME                                                       SU10  17
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      COMMON IRARF                                                      SU10  18
      COMMON KSTOP                                                      SU10  19
      COMMON TPSI                                                       SU10  20
      COMMON KKK                                                        SU10  21
C                                                                       SU10  22
C                                                                       SU10  23
      REAL LO,MO,LENGTH,MU,KO                                           SU10  24
      INTEGER CHECK,CHECK2                                              SU10  25
      IF (KM.EQ.0) GO TO 708                                            SU10  26
      RHOO=RHOSTR                                                       SU10  27
      TMP1=(APR+BPR)*RHOSTR-PO2/ESTAR                                   SU10  28
      TMP2=SQRT(TMP1**2+4.*PO2*APR*RHOSTR/ESTAR)                        SU10  29
      EO=(-TMP1+TMP2)/(2.*APR*RHOSTR/ESTAR)                             SU10  30
      IF (PO2.GT.EPS) GO TO 708                                         SU10  31
      PO2=0.                                                            SU10  32
      EO2=0.                                                            SU10  33
      RHOO2=RHOSTR                                                      SU10  34
      AO2=SQRT(BIGAPR/RHOSTR)                                           SU10  35
      KRTT=1                                                            SU10  36
      GO TO 870                                                         SU10  37
708   KRTT=0                                                            SU10  38
      ETA=RHOO/RHOSTR                                                   SU10  39
      MU=ETA-1.                                                         SU10  40
      EE=EO/(ESTAR*ETA**2)+1.                                           SU10  41
      IF (RHOO.GT.RHOSTR) GO TO 720                                     SU10  42
      IF (EO.LT.EPRS) GO TO 720                                         SU10  43
715   C1=RHOSTR/RHOO-1.                                                 SU10  44
      BEC1=BETA*C1                                                      SU10  45
      IF (BEC1.LT.10.E10) GO TO 716                                     SU10  46
      C2=0.0                                                            SU10  47
      GO TO 717                                                         SU10  48
716   C2=EXP(-BEC1)                                                     SU10  49
717   C3AL=ALPHA*C1**2                                                  SU10  50
      IF (C3AL.LT.10.E12) GO TO 718                                     SU10  51
      C3=0.0                                                            SU10  52
      GO TO 719                                                         SU10  53
```

```
718   C3=EXP(-C3AL)                                                    SU10  54
719   CONTINUE                                                         SU10  55
      T1=(BPR*E0*RHO0)/EE+BIGAPR*MU*C2                                 SU10  56
      T2=2.*ALPHA*C1*(RHOSTR/(RHO0**2))                                SU10  57
      T3=BPR*E0/EE                                                     SU10  58
      T4=(2.*E0)/(ESTAR*ETA**2*EE)                                     SU10  59
      T4=T3*T4                                                         SU10  60
      T5=(BIGAPR*C2)/RHOSTR                                            SU10  61
      T6=(BIGAPR*MU*BETA*RHOSTR*C2)/(RHO0**2)                          SU10  62
      T7=(BPR*RHO0)/EE                                                 SU10  63
      PGRHO=APR*E0+C3*(T1*T2+T3+T4+T5+T6)                              SU10  64
      PGE=APR*RHO0+C3*(T7-T7*(E0/(ESTAR*ETA**2*EE)))                   SU10  65
      BIGG=P02-APR*E0*RHO0-T1*C3                                       SU10  66
      CHECK=0                                                          SU10  67
      GO TO 725                                                        SU10  68
720   T1=APR+BPR/EE                                                    SU10  69
      T2=(BPR*E0)/(ESTAR*ETA**2*EE**2)                                 SU10  70
      BIGG=P02-T1*E0*RHO0-BIGAPR*MU-BIGBPR*MU**2                       SU10  71
      PGRHO=T1*E0+BIGAPR/RHOSTR+2.*BIGBPR*MU/RHOSTR+T2*2.*E0           SU10  72
      PGRHO=-PGRHO                                                     SU10  73
      PGE=T1*RHO0-RHO0*T2                                              SU10  74
      PGE=-PGE                                                         SU10  75
      CHECK=1                                                          SU10  76
725   CONTINUE                                                         SU10  77
870   CONTINUE                                                         SU10  78
      RETURN                                                           SU10  79
      END                                                              SU10  80
      SUBROUTINE SOUT2                                                 SU11   1
C                                                                      SU11   2
C         PRINTS 6 LINES OF DISCONTINUITY AT TO                        SU11   3
C                                                                      SU11   4
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU11   5
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU11   6
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS      SU11   7
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU11   8
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU11   9
```

```
     115,4),RPART(15,2)                                                 SU11  10
C                                                                       SU11  11
C                                                                       SU11  12
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SU11  13
C                                                                       SU11  14
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU11  15
C                                                                       SU11  16
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU11  17
      COMMON DIRCOS                                                     SU11  18
      COMMON TIME                                                       SU11  19
      COMMON IRARF                                                      SU11  20
      COMMON KSTOP                                                      SU11  21
      COMMON TPSI                                                       SU11  22
      COMMON KKK                                                        SU11  23
      REAL LO,MO,LENGTH,MU,KO                                           SU11  24
C                                                                       SU11  25
4     FORMAT (///30H CURVES OF DISCONTINUITY AT TO//40X20H--PROJECTILE SSU11  26
     1HOCK--//)                                                         SU11  27
6     FORMAT (//35X29H--PROJECTILE PARTICLE CURVE--//)                  SU11  28
8     FORMAT (//42X16H--TARGET SHOCK--//)                               SU11  29
10    FORMAT (//38X25H--TARGET PARTICLE CURVE--//)                      SU11  30
12    FORMAT (//42X15H--RAREFACTION--//)                                SU11  31
14    FORMAT (//35X30H--RAREFACTION PARTICLE CURVE--//)                 SU11  32
16    FORMAT (7X1HZ19X1HR19X1HP19X1HU19X1HV/7X3HRHO17X1HE19X1HA19X1HL19XSU11  33
     11HM//)                                                            SU11  34
18    FORMAT (7X1HZ19X1HR//)                                            SU11  35
20    FORMAT (7X1HZ19X1HR19X1HL19X1HM//)                                SU11  36
30    FORMAT (5E20.8/5E20.8//)                                          SU11  37
35    FORMAT (2E20.8)                                                   SU11  38
38    FORMAT (4E20.8)                                                   SU11  39
39    FORMAT (//35X16H--FREE SURFACE--//)                               SU11  40
40    FORMAT (1H1)                                                      SU11  41
      WRITE (3,4)                                                       SU11  42
      WRITE (3,16)                                                      SU11  43
      WRITE (3,30) ((TAB2(I,J,1),J=1,10),I=1,NP)                        SU11  44
      WRITE (3,6)                                                       SU11  45
```

```
      WRITE (3,18)                                                      SU11  46
      WRITE (3,35) ((SPART(I,J,1),J=1,2),I=1,NP)                        SU11  47
      WRITE (3,8)                                                       SU11  48
      WRITE (3,16)                                                      SU11  49
      WRITE (3,30) ((TAB2(I,J,2),J=1,10),I=1,NT)                        SU11  50
      WRITE (3,10)                                                      SU11  51
      WRITE (3,18)                                                      SU11  52
      WRITE (3,35) ((SPART(I,J,2),J=1,2),I=1,NT)                        SU11  53
      WRITE (3,12)                                                      SU11  54
      WRITE (3,20)                                                      SU11  55
      WRITE (3,38) ((RARF2(I,J),J=1,4),I=1,NR)                          SU11  56
      WRITE (3,14)                                                      SU11  57
      WRITE (3,39)                                                      SU11  58
      WRITE (3,35) ((SURF2(I,J),J=1,2),I=1,NP)                          SU11  59
      WRITE (3,40)                                                      SU11  60
      RETURN                                                            SU11  61
      END                                                               SU11  62
      SUBROUTINE SOUT                                                   SU12   1
C                                                                       SU12   2
C       PRINTS 4 LINES OF DISCONTINUITY AT TO-H                         SU12   3
C                                                                       SU12   4
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU12   5
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU12   6
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU12   7
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU12   8
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU12   9
     115,4),RPART(15,2)                                                 SU12  10
C                                                                       SU12  11
C                                                                       SU12  12
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SU12  13
C                                                                       SU12  14
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU12  15
C                                                                       SU12  16
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU12  17
      COMMON DIRCOS                                                     SU12  18
      COMMON TIME                                                       SU12  19
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```
      COMMON IRARF                                                      SU12  20
      COMMON KSTOP                                                      SU12  21
      COMMON TPSI                                                       SU12  22
      COMMON KKK                                                        SU12  23
      REAL LO,MO,LENGTH,MU,KO                                           SU12  24
C                                                                       SU12  25
4     FORMAT (///32H CURVES OF DISCONTINUITY AT TO-H//40X20H--PROJECTILESU12  26
     1 SHOCK--//)                                                       SU12  27
6     FORMAT (//42X16H--TARGET SHOCK--//)                               SU12  28
8     FORMAT (//42X15H--RAREFACTION--//)                                SU12  29
10    FORMAT (7X1HZ19X1HR19X1HP19X1HU19X1HV/7X3HRHO17X1HE19X1HA19X1HL19XSU12  30
     11HM//)                                                            SU12  31
15    FORMAT (5E20.8/5E20.8//)                                          SU12  32
18    FORMAT (1H1)                                                      SU12  33
21    FORMAT (//35X16H--FREE SURFACE--//)                               SU12  34
25    FORMAT (2E20.8)                                                   SU12  35
      WRITE (3,4)                                                       SU12  36
      WRITE (3,10)                                                      SU12  37
      WRITE (3,15) ((TAB(I,J,1),J=1,10),I=1,NP)                         SU12  38
      WRITE (3,6)                                                       SU12  39
      WRITE (3,10)                                                      SU12  40
      WRITE (3,15) ((TAB(I,J,2),J=1,10),I=1,NT)                         SU12  41
      WRITE (3,8)                                                       SU12  42
      WRITE (3,10)                                                      SU12  43
      WRITE (3,15) ((RARF(I,J),J=1,10),I=1,NR)                          SU12  44
      WRITE (3,21)                                                      SU12  45
      WRITE (3,25) ((SURF(I,J),J=1,2),I=1,NP)                           SU12  46
      WRITE (3,18)                                                      SU12  47
      RETURN                                                            SU12  48
      END                                                               SU12  49
      SUBROUTINE PRINT(BL,ZTAB,RTAB,KK)                                 SU13   1
C         PRINTS INTERIOR REGION                                        SU13   2
C                                                                       SU13   3
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU13   4
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU13   5
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU13   6
```

```
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU13    7
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU13    8
     115,4),RPART(15,2)                                                 SU13    9
C                                                                       SU13   10
C                                                                       SU13   11
      COMMON Z0,R0,P0,U0,V0,L0,M0,RHO0,E0,A0,UBAR0,VBAR0                SU13   12
C                                                                       SU13   13
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU13   14
C                                                                       SU13   15
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU13   16
      COMMON DIRCOS                                                     SU13   17
      COMMON TIME                                                       SU13   18
      COMMON IRARF                                                      SU13   19
      COMMON KSTOP                                                      SU13   20
      COMMON TPSI                                                       SU13   21
      COMMON KKK                                                        SU13   22
      REAL L0,M0,LENGTH,MU,K0                                           SU13   23
C                                                                       SU13   24
      DIMENSION BL(20,20,6),ZTAB(20),RTAB(20)                           SU13   25
C                                                                       SU13   26
      DO 15 I=1,20                                                      SU13   27
      DO 15 J=1,20                                                      SU13   28
      IF (ABS(BL(I,J,1))+ABS(BL(I,J,2))+ABS(BL(I,J,3)))  20,15,20       SU13   29
15    CONTINUE                                                          SU13   30
      WRITE (3,18)                                                      SU13   31
18    FORMAT (15H1TABLES ALL = 0/1H1)                                   SU13   32
      CALL EXIT                                                         SU13   33
20    I1=I                                                              SU13   34
      DO 30 I=I1,20                                                     SU13   35
      IF (ABS(BL(I,1,1))+ABS(BL(I,1,2))+ABS(BL(I,1,3)))  30,22,30       SU13   36
22    DO 25 J=1,20                                                      SU13   37
      IF (ABS(BL(I,J,1))+ABS(BL(I,J,2))+ABS(BL(I,J,3)))  30,25,30       SU13   38
25    CONTINUE                                                          SU13   39
      I2=I-1                                                            SU13   40
      GO TO 35                                                          SU13   41
30    CONTINUE                                                          SU13   42
```

```
      I2=20                                                             SU13  43
35    DO 45 J=1,20                                                      SU13  44
      IF (ABS(BL(I1,J,1))+ABS(BL(I1,J,2))+ABS(BL(I1,J,3)))  45,37,45    SU13  45
37    DO 40 I=I1,I2                                                     SU13  46
      IF (ABS(BL(I,J,1))+ABS(BL(I,J,2))+ABS(BL(I,J,3)))  45,40,45       SU13  47
40    CONTINUE                                                          SU13  48
      J2=J-1                                                            SU13  49
      GO TO 50                                                          SU13  50
45    CONTINUE                                                          SU13  51
      J2=20                                                             SU13  52
50    J1=1                                                              SU13  53
C                                                                       SU13  54
C         PRINT TABLE                                                   SU13  55
C                                                                       SU13  56
      GO TO (52,56),KK                                                  SU13  57
52    WRITE (3,53)                                                      SU13  58
53    FORMAT (//24H0INTERIOR REGION AT TO-H///)                         SU13  59
      GO TO 62                                                          SU13  60
56    WRITE (3,57)                                                      SU13  61
57    FORMAT (//22H0INTERIOR REGION AT TO///)                           SU13  62
62    DO 70 I=I1,I2                                                     SU13  63
      WRITE (3,64) ZTAB(I)                                              SU13  64
64    FORMAT (///7H0ZTAB =,F10.4//7X1HR9X1HP17X1HU17X1HV17X3HRHO15X1HE17SU13  65
     1X1HA//)                                                           SU13  66
      DO 69 J=J1,J2                                                     SU13  67
      WRITE (3,68) RTAB(J),(BL(I,J,K),K=1,6)                            SU13  68
68    FORMAT (F12.4,6E18.8)                                             SU13  69
69    CONTINUE                                                          SU13  70
70    CONTINUE                                                          SU13  71
80    WRITE (3,82)                                                      SU13  72
82    FORMAT (1H1)                                                      SU13  73
      RETURN                                                            SU13  74
      END                                                               SU13  75
      SUBROUTINE NRIT2(X,Y,XO,DX,YO,DY,EX,EY,FGOF,IT,KODE)              SU14   1
C                                                                       SU14   2
C         NEWTON-RAPHSON METHOD FOR SOLUTION OF                         SU14   3
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C          TWO NON LINEAR EQUATIONS IN TWO UNKNOWNS                      SU14   4
C                                                                        SU14   5
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU14   6
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU14   7
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU14   8
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU14   9
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU14  10
     115,4),RPART(15,2)                                                  SU14  11
C                                                                        SU14  12
C                                                                        SU14  13
      COMMON Z0,R0,P0,U0,V0,L0,M0,RHO0,E0,A0,UBAR0,VBAR0                 SU14  14
C                                                                        SU14  15
      COMMON NP,NT,NR,NI,NDEL,ISUB                                       SU14  16
C                                                                        SU14  17
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                    SU14  18
      COMMON DIRCOS                                                      SU14  19
      COMMON TIME                                                        SU14  20
      COMMON IRARF                                                       SU14  21
      COMMON KSTOP                                                       SU14  22
      COMMON TPSI                                                        SU14  23
      COMMON KKK                                                         SU14  24
      REAL L0,M0,LENGTH,MU,K0                                            SU14  25
C                                                                        SU14  26
      XB=X0                                                              SU14  27
      YB=Y0                                                              SU14  28
      DXX=DX                                                             SU14  29
      DYY=DY                                                             SU14  30
      DELX1=0                                                            SU14  31
      DELY1=0                                                            SU14  32
      KODE=0                                                             SU14  33
1     CONTINUE                                                           SU14  34
      DO 50 I=1,IT                                                       SU14  35
      KK=0                                                               SU14  36
      XX=XB+DXX                                                          SU14  37
      YY=YB+DYY                                                          SU14  38
C                                                                        SU14  39
```

```
C                                                                       SU14  40
      CALL FGOF(XB,YY,F2,G2)                                            SU14  41
      CALL FGOF(XX,YB,F1,G1)                                            SU14  42
      CALL FGOF(XB,YB,F0,G0)                                            SU14  43
      A1=(F1-F0)/DXX                                                    SU14  44
      B1=(F2-F0)/DYY                                                    SU14  45
      C1=-F0                                                            SU14  46
      A2=(G1-G0)/DXX                                                    SU14  47
      B2=(G2-G0)/DYY                                                    SU14  48
      C2=-G0                                                            SU14  49
      DET=A1*B2-A2*B1                                                   SU14  50
      IF (DET.EQ.0.) GO TO 920                                          SU14  51
      DELX=(B2*C1-B1*C2)/DET                                            SU14  52
      DELY=(A1*C2-A2*C1)/DET                                            SU14  53
      IF (ABS(DELX).GT..001) GO TO 8                                    SU14  54
      DELX=0.                                                           SU14  55
8     IF (ABS(DELY).GT..001) GO TO 9                                    SU14  56
      DELY=0.                                                           SU14  57
9     CONTINUE                                                          SU14  58
      SDEL=ABS(DELX+DELX1)+ABS(DELY+DELY1)                              SU14  59
      DELX1=DELX                                                        SU14  60
      DELY1=DELY                                                        SU14  61
C                                                                       SU14  62
C         TEST FOR SAME REGION                                          SU14  63
C                                                                       SU14  64
      DO 10 J=1,IT                                                      SU14  65
      XB1=XB+DELX                                                       SU14  66
      YB1=YB+DELY                                                       SU14  67
      IF (YB1.LE.0.)YB1=0.                                              SU14  68
      M=COMP(XB,YB,XB1,YB1)                                             SU14  69
      IF (M.EQ.1) GO TO 15                                              SU14  70
11    CONTINUE                                                          SU14  71
      KK=1                                                              SU14  72
      DELX=.5*DELX                                                      SU14  73
      DELY=.5*DELY                                                      SU14  74
10    CONTINUE                                                          SU14  75
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```
      GO TO 930                                                         SU14  76
15    IF (ABS(XB-XB1).GT.EX) GO TO 45                                   SU14  77
      IF (ABS(YB-YB1).GT.EY) GO TO 45                                   SU14  78
      IF (KK.NE.0) GO TO 45                                             SU14  79
      X=XB1                                                             SU14  80
      Y=YB1                                                             SU14  81
      KODE=0                                                            SU14  82
      RETURN                                                            SU14  83
45    CONTINUE                                                          SU14  84
      IF (KODE.NE.1) GO TO 46                                           SU14  85
      IF (SDEL.GT.EPI1) GO TO 46                                        SU14  86
      DELX=.5*DELX                                                      SU14  87
      DELY=.5*DELY                                                      SU14  88
      GO TO 9                                                           SU14  89
46    XB=XB1                                                            SU14  90
      YB=YB1                                                            SU14  91
      DEL=DELTA                                                         SU14  92
      DO 70 N=1,NDEL                                                    SU14  93
      XB2=XB+DEL                                                        SU14  94
      M=COMP(XB,YB,XB2,YB)                                              SU14  95
      IF (M.NE.1) GO TO 55                                              SU14  96
      DXX=DEL                                                           SU14  97
      GO TO 80                                                          SU14  98
55    XB2=XB-DEL                                                        SU14  99
      M=COMP(XB,YB,XB2,YB)                                              SU14 100
      IF (M.NE.1) GO TO 60                                              SU14 101
      DXX=-DEL                                                          SU14 102
      GO TO 80                                                          SU14 103
60    DEL=.5*DEL                                                        SU14 104
70    CONTINUE                                                          SU14 105
      GO TO 980                                                         SU14 106
80    DEL=DELTA                                                         SU14 107
      DO 100 N=1,NDEL                                                   SU14 108
      YB2=YB+DEL                                                        SU14 109
      M=COMP(XB,YB,XB,YB2)                                              SU14 110
      IF (M.NE.1) GO TO 85                                              SU14 111
```

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      DYY=DEL                                                           SU14 112
      GO TO 50                                                          SU14 113
85    YB2=YB-DEL                                                        SU14 114
      M=COMP(XB,YB,XB,YB2)                                              SU14 115
      IF (M.NE.1) GO TO 90                                              SU14 116
      DYY=-DEL                                                          SU14 117
      GO TO 50                                                          SU14 118
90    DEL=.5*DEL                                                        SU14 119
100   CONTINUE                                                          SU14 120
      GO TO 990                                                         SU14 121
50    CONTINUE                                                          SU14 122
      X=XB1                                                             SU14 123
      Y=YB1                                                             SU14 124
      IF (KODE.EQ.1) RETURN                                             SU14 125
      KODE=1                                                            SU14 126
      GO TO 1                                                           SU14 127
920   WRITE (3,922) I                                                   SU14 128
922   FORMAT (46HODETERMINANT IS 0 IN SUBR. NRIT2 FOR ITERATION,I4)     SU14 129
      GO TO 950                                                         SU14 130
930   KODE=2                                                            SU14 131
      RETURN                                                            SU14 132
950   WRITE (3,952) XO,YO,XB,YB,XB1,YB1,DELX,DELY                       SU14 133
952   FORMAT (1X5HZO  =,E15.8,4X5HRO  =,E15.8/1X5HZB  =,E15.8,4X5HRB  =,SU14 134
     1E15.8/1X5HZB1 =,E15.8,4X5HRB1 =,E15.8/1X5HDELZ=,E15.8,4X5HDELR=,E1SU14 135
     15.8/1H1)                                                          SU14 136
      CALL EXIT                                                         SU14 137
      RETURN                                                            SU14 138
980   KODE=3                                                            SU14 139
      RETURN                                                            SU14 140
990   KODE=4                                                            SU14 141
      RETURN                                                            SU14 142
      END                                                               SU14 143
      FUNCTION COMP(ZP,RP,ZP1,RP1)                                      SU15   1
C                                                                       SU15   2
C         DETERMINES IF 2 POINTS ARE IN THE SAME REGION                 SU15   3
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU15   4
```

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     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU15    5
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS        SU15    6
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU15    7
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU15    8
     115,4),RPART(15,2)                                                  SU15    9
C                                                                        SU15   10
      COMMON Z0,R0,P0,U0,V0,L0,M0,RHO0,E0,A0,UBAR0,VBAR0                 SU15   11
C                                                                        SU15   12
      COMMON NP,NT,NR,NI,NDEL,ISUB                                       SU15   13
C                                                                        SU15   14
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                    SU15   15
      COMMON DIRCOS                                                      SU15   16
      COMMON TIME                                                        SU15   17
      COMMON IRARF                                                       SU15   18
      COMMON KSTOP                                                       SU15   19
      COMMON TPSI                                                        SU15   20
      COMMON KKK                                                         SU15   21
      REAL L0,M0,LENGTH,MU,K0                                            SU15   22
      EPS=.0000001                                                       SU15   23
      IF (RP1.LT.0.) GO TO 80                                            SU15   24
      IF (ZP1.GE.0.) GO TO 4                                             SU15   25
      IF (RP1.GT.RADIUS) GO TO 80                                        SU15   26
C                                                                        SU15   27
C         FIND CONTROL CONSTANTS FOR ZP,RP                               SU15   28
C                                                                        SU15   29
4     CONTINUE                                                           SU15   30
      IF (ITS3.EQ.1) GO TO 33                                            SU15   31
      IF (IRARF.EQ.1) GO TO 13                                           SU15   32
      M=PICK(ZP,RP,3)                                                    SU15   33
      IF (ZP.GT.RARF(M,1).AND.M.NE.1)M=M-1                               SU15   34
      FF=RP-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(ZP-RARF(M+1,1))/(RARF(MSU15   35
     1,1)-RARF(M+1,1))                                                   SU15   36
      IF (FF.LT.0.) GO TO 11                                             SU15   37
10    NN=1                                                               SU15   38
      GO TO 13                                                           SU15   39
11    NN=0                                                               SU15   40
```

```
13    CONTINUE                                                          SU15  41
      DO 22 K=1,2                                                       SU15  42
      M=PICK(ZP1,RP1,K)                                                 SU15  43
      IF (RP1.LT.TAB(M,2,K).AND.M.NE.1)M=M-1                            SU15  44
5     CONTINUE                                                          SU15  45
      FF=ZP1-TAB(M+1,1,K)-(TAB(M,1,K)-TAB(M+1,1,K))*(RP1-TAB(M+1,2,K))/(SU15  46
     1TAB(M,2,K)-TAB(M+1,2,K))                                          SU15  47
      IF (K.EQ.2) GO TO 17                                              SU15  48
      IF (RP1.GT.RADIUS) GO TO 21                                       SU15  49
      IF (FF.LT.-EPS) GO TO 90                                          SU15  50
      GO TO 21                                                          SU15  51
17    IF (FF.GT.EPS) GO TO 100                                          SU15  52
21    IF (RP.GT.RADIUS) GO TO 22                                        SU15  53
      M=PICK(ZP1,RP1,4)                                                 SU15  54
      FF=ZP1-SURF(M+1,1)-(SURF(M,1)-SURF(M+1,1))*(RP1-SURF(M+1,2))/(SURFSU15  55
     1(M,2)-SURF(M+1,2))                                                SU15  56
      IF (FF)  80,22,22                                                 SU15  57
22    CONTINUE                                                          SU15  58
      IF (IRARF.EQ.1) GO TO 33                                          SU15  59
      M=PICK(ZP1,RP1,3)                                                 SU15  60
      IF (ZP1.GT.RARF(M,1).AND.M.NE.1)M=M-1                             SU15  61
      FF=RP1-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(ZP1-RARF(M+1,1))/(RARFSU15  62
     1(M,1)-RARF(M+1,1))                                                SU15  63
      IF (FF.LT.0.) GO TO 31                                            SU15  64
30    NN1=1                                                             SU15  65
      GO TO 32                                                          SU15  66
31    NN1=0                                                             SU15  67
32    IF (NN1.NE.NN) GO TO 110                                          SU15  68
33    CONTINUE                                                          SU15  69
      COMP=1                                                            SU15  70
      COMP=COMP+.2                                                      SU15  71
      RETURN                                                            SU15  72
80    COMP=2                                                            SU15  73
      COMP=COMP+.2                                                      SU15  74
      RETURN                                                            SU15  75
90    COMP=3.                                                           SU15  76
```

```
      COMP=COMP+.2                                                      SU15  77
      RETURN                                                            SU15  78
100   COMP=4.                                                           SU15  79
      COMP=COMP+.2                                                      SU15  80
      RETURN                                                            SU15  81
110   COMP=5.                                                           SU15  82
      COMP=COMP+.2                                                      SU15  83
      RETURN                                                            SU15  84
      END                                                               SU15  85
      FUNCTION PICK(ZP,RP,KODE)                                         SU16   1
C                                                                       SU16   2
C         DETERMINES 2 CLOSEST CONSECUTIVE POINTS ON SPECIFIED          SU16   3
C         LINE OF DISCONTINUITY TO A GIVEN POINT                        SU16   4
C                                                                       SU16   5
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU16   6
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU16   7
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU16   8
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU16   9
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU16  10
     115,4),RPART(15,2)                                                 SU16  11
C                                                                       SU16  12
C                                                                       SU16  13
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SU16  14
C                                                                       SU16  15
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU16  16
C                                                                       SU16  17
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU16  18
      COMMON DIRCOS                                                     SU16  19
      COMMON TIME                                                       SU16  20
      COMMON IRARF                                                      SU16  21
      COMMON KSTOP                                                      SU16  22
      COMMON TPSI                                                       SU16  23
      COMMON KKK                                                        SU16  24
      REAL LO,MO,LENGTH,MU,KO                                           SU16  25
C                                                                       SU16  26
      GO TO (5,10,100,300),KODE                                         SU16  27
```

```
5     NN=NP                                                    SU16  28
      K=1                                                      SU16  29
      GO TO 15                                                 SU16  30
10    NN=NT                                                    SU16  31
      K=2                                                      SU16  32
15    AA=(TAB(1,1,K)-ZP)**2+(TAB(1,2,K)-RP)**2                 SU16  33
C                                                              SU16  34
C         SEARCH SHOCK TABLES                                  SU16  35
C                                                              SU16  36
      DO 60 N=2,NN                                             SU16  37
      A=(TAB(N,1,K)-ZP)**2+(TAB(N,2,K)-RP)**2                  SU16  38
      IF (A.GE.AA) GO TO 23                                    SU16  39
      AA=A                                                     SU16  40
60    CONTINUE                                                 SU16  41
      PICK=NN-1                                                SU16  42
      PICK=PICK+.2                                             SU16  43
      RETURN                                                   SU16  44
23    PICK=N-1                                                 SU16  45
      PICK=PICK+.2                                             SU16  46
      RETURN                                                   SU16  47
100   AA=(RARF(1,1)-ZP)**2+(RARF(1,2)-RP)**2                   SU16  48
C                                                              SU16  49
C         SEARCH RAREFACTION TABLE                             SU16  50
C                                                              SU16  51
      DO 200 N=2,NR                                            SU16  52
      A=(RARF(N,1)-ZP)**2+(RARF(N,2)-RP)**2                    SU16  53
      IF (A.GE.AA) GO TO 203                                   SU16  54
      AA=A                                                     SU16  55
200   CONTINUE                                                 SU16  56
      PICK=NR-1                                                SU16  57
      PICK=PICK+.2                                             SU16  58
      RETURN                                                   SU16  59
203   PICK=N-1                                                 SU16  60
      PICK=PICK+.2                                             SU16  61
      RETURN                                                   SU16  62
300   AA=(SURF(1,1)-ZP)**2+(SURF(1,2)-RP)**2                   SU16  63
```

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C                                                                       SU16  64
C     SEARCH FREE SURFACE TABLE                                         SU16  65
C                                                                       SU16  66
      DO 400 N=2,NP                                                     SU16  67
      A=(SURF(N,1)-ZP)**2+(SURF(N,2)-RP)**2                             SU16  68
      IF (A.GE.AA) GO TO 303                                            SU16  69
      AA=A                                                              SU16  70
400   CONTINUE                                                          SU16  71
      PICK=NP-1                                                         SU16  72
      PICK=PICK+.2                                                      SU16  73
      RETURN                                                            SU16  74
303   PICK=N-1                                                          SU16  75
      PICK=PICK+.2                                                      SU16  76
304   CONTINUE                                                          SU16  77
      RETURN                                                            SU16  78
      END                                                               SU16  79
      SUBROUTINE GUESS(KOD1,KOD2,ZP,RP,I2,K2,ZG,RG,DZ,DR)               SU17   1
C                                                                       SU17   2
C         DETERMINES STARTING POINT AND DELTAS                          SU17   3
C         FOR NEWTON-RAPHSON ITERATION                                  SU17   4
C                                                                       SU17   5
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU17   6
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU17   7
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU17   8
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU17   9
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU17  10
     115,4),RPART(15,2)                                                 SU17  11
C                                                                       SU17  12
C                                                                       SU17  13
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SU17  14
C                                                                       SU17  15
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU17  16
C                                                                       SU17  17
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU17  18
      COMMON DIRCOS                                                     SU17  19
      COMMON TIME                                                       SU17  20
```

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      COMMON IRARF                                                      SU17  21
      COMMON KSTOP                                                      SU17  22
      COMMON TPSI                                                       SU17  23
      COMMON KKK                                                        SU17  24
      REAL LO,MO,LENGTH,MU,KO                                           SU17  25
C                                                                       SU17  26
      KS=0                                                              SU17  27
      IF (KOD1.EQ.2) GO TO 10                                           SU17  28
      ZG=TAB(I2,1,K2)                                                   SU17  29
      RG=TAB(I2,2,K2)                                                   SU17  30
      IF (IRARF.EQ.1) GO TO 9                                           SU17  31
2     M=1-(NR-2)*(K2-2)                                                 SU17  32
      FF=RG-RARF(M+1,2)-(RARF(M,2)-RARF(M+1,2))*(ZG-RARF(M+1,1))/(RARF(MSU17  33
     1,1)-RARF(M+1,1))                                                  SU17  34
      IF (FF.GT.0.) GO TO 9                                             SU17  35
      ZG=(1.-.02/(RADIUS-RG))*ZG                                        SU17  36
      RG=RG+.02                                                         SU17  37
      IF (RG.GT.(RADIUS-.01)) GO TO 110                                 SU17  38
      GO TO 2                                                           SU17  39
9     CONTINUE                                                          SU17  40
      GO TO 50                                                          SU17  41
10    JJJ=NT-1                                                          SU17  42
      IF (ITS3.EQ.1) GO TO 26                                           SU17  43
      DO 24 M=1,JJJ                                                     SU17  44
      IF (RP.GT.TAB(M+1,2,2).OR.RP.LT.TAB(M,2,2)) GO TO 24              SU17  45
      GO TO 25                                                          SU17  46
24    CONTINUE                                                          SU17  47
25    CONTINUE                                                          SU17  48
      FF=ZP-TAB(M+1,1,2)-(TAB(M,1,2)-TAB(M+1,1,2))*(RP-TAB(M+1,2,2))/(TASU17  49
     1B(M,2,2)-TAB(M+1,2,2))                                            SU17  50
      IF (FF.GT.0.) GO TO 20                                            SU17  51
26    CONTINUE                                                          SU17  52
      ZG=ZP                                                             SU17  53
      RG=RP                                                             SU17  54
      GO TO 50                                                          SU17  55
20    IK=M                                                              SU17  56
```

```
      M=CROSS(TAB(IK,1,2),TAB(IK,2,2),TAB(IK+1,1,2),TAB(IK+1,2,2),0.,0.,SU17  57
     1ZP,RP,ZG,RG)                                                    SU17  58
      GO TO (50,920,930),M                                            SU17  59
C                                                                     SU17  60
C         COMPUTE DELTAS                                              SU17  61
C                                                                     SU17  62
50    DEL=DELTA                                                       SU17  63
C                                                                     SU17  64
C         Z DELTA                                                     SU17  65
C                                                                     SU17  66
      LL=0                                                            SU17  67
52    DO 70 N=1,NDEL                                                  SU17  68
      ZZ=ZG+DEL                                                       SU17  69
      M=COMP(ZG,RG,ZZ,RG)                                             SU17  70
      IF (M.NE.1) GO TO 55                                            SU17  71
      DZ=DEL                                                          SU17  72
      GO TO 80                                                        SU17  73
55    ZZ=ZG-DEL                                                       SU17  74
      M=COMP(ZG,RG,ZZ,RG)                                             SU17  75
      IF (M.NE.1) GO TO 60                                            SU17  76
      DZ=-DEL                                                         SU17  77
      GO TO 80                                                        SU17  78
60    DEL=.5*DEL                                                      SU17  79
70    CONTINUE                                                        SU17  80
      LL=LL+1                                                         SU17  81
      IF (LL.EQ.3) GO TO 75                                           SU17  82
      RG=RG-DELTA/5.                                                  SU17  83
      DEL=DELTA                                                       SU17  84
      GO TO 52                                                        SU17  85
75    KOD2=2                                                          SU17  86
      RETURN                                                          SU17  87
80    DEL=DELTA                                                       SU17  88
      IF (KS.EQ.1) GO TO 120                                          SU17  89
C                                                                     SU17  90
C         R DELTA                                                     SU17  91
C                                                                     SU17  92
```

```
      LL=0                                                              SU17  93
82    DO 100 N=1,NDEL                                                   SU17  94
      RR=RG+DEL                                                         SU17  95
      M=COMP(ZG,RG,ZG,RR)                                               SU17  96
      IF (M.NE.1) GO TO 85                                              SU17  97
      DR=DEL                                                            SU17  98
      IF (KS.EQ.1) GO TO 50                                             SU17  99
      GO TO 120                                                         SU17 100
85    RR=RG-DEL                                                         SU17 101
      M=COMP(ZG,RG,ZG,RR)                                               SU17 102
      IF (M.NE.1) GO TO 90                                              SU17 103
      DR=-DEL                                                           SU17 104
      IF (KS.EQ.1) GO TO 50                                             SU17 105
      GO TO 120                                                         SU17 106
90    DEL=.5*DEL                                                        SU17 107
100   CONTINUE                                                          SU17 108
108   CONTINUE                                                          SU17 109
      LL=LL+1                                                           SU17 110
      FLL=LL                                                            SU17 111
      IF (LL.EQ.5) GO TO 110                                            SU17 112
C                                                                       SU17 113
104   ZG1=ZG+DELTA/5.*FLL*(-1.)**LL                                     SU17 114
      M=COMP(ZG,RG,ZG1,RG)                                              SU17 115
      ZG=ZG1                                                            SU17 116
      IF (M.NE.1) GO TO 108                                             SU17 117
      KS=1                                                              SU17 118
      GO TO 82                                                          SU17 119
110   KOD2=2                                                            SU17 120
      RETURN                                                            SU17 121
120   KOD2=1                                                            SU17 122
      RETURN                                                            SU17 123
920   WRITE (3,922)                                                     SU17 124
922   FORMAT (42HOERROR FOR COINCIDENT LINES IN SUBR. GUESS)            SU17 125
      GO TO 950                                                         SU17 126
C                                                                       SU17 127
930   WRITE (3,932)                                                     SU17 128
```

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932   FORMAT (40HOERROR FOR PARALLEL LINES IN SUBR. GUESS)                SU17 129
C                                                                         SU17 130
950   WRITE (3,952) KOD1,I2,K2,ZP,RP                                      SU17 131
952   FORMAT (1X5HKOD1=,I4,4X3HI2=,I4,4X3HK2=,I4/1X3HZP=,E15.8,4X3HRP=,ESU17 132
     115.8/1H1)                                                           SU17 133
      XYZ=-2.                                                             SU17 134
      ZYX=SQRT(XYZ)                                                       SU17 135
      CALL EXIT                                                           SU17 136
      RETURN                                                              SU17 137
      END                                                                 SU17 138
      FUNCTION CROSS(X1,Y1,X2,Y2,X3,Y3,X4,Y4,X,Y)                         SU18   1
C                                                                         SU18   2
C         FINDS INTERSECTION OF TWO STRAIGHT LINES                        SU18   3
C                                                                         SU18   4
      EPS=.0000001                                                        SU18   5
      A1=Y2-Y1                                                            SU18   6
      B1=X1-X2                                                            SU18   7
      C1=X1*A1+Y1*B1                                                      SU18   8
      A2=Y4-Y3                                                            SU18   9
      B2=X3-X4                                                            SU18  10
      C2=X3*A2+Y3*B2                                                      SU18  11
      DET=A1*B2-A2*B1                                                     SU18  12
      D1=C1*B2-C2*B1                                                      SU18  13
      D2=A1*C2-A2*C1                                                      SU18  14
      IF (ABS(DET).LE.EPS) GO TO 10                                       SU18  15
      X=D1/DET                                                            SU18  16
      Y=D2/DET                                                            SU18  17
      CROSS=1                                                             SU18  18
      CROSS=CROSS+.2                                                      SU18  19
      RETURN                                                              SU18  20
10    IF (ABS(D1).GT.EPS) GO TO 20                                        SU18  21
      IF (ABS(D2).LE.EPS) GO TO 30                                        SU18  22
20    CROSS=3                                                             SU18  23
      CROSS=CROSS+.2                                                      SU18  24
      RETURN                                                              SU18  25
30    X=X1                                                                SU18  26
```

```
      Y=Y1                                                              SU18  27
      CROSS=2                                                           SU18  28
      CROSS=CROSS+.2                                                    SU18  29
316   CONTINUE                                                          SU18  30
      RETURN                                                            SU18  31
      END                                                               SU18  32
      FUNCTION PART(MODE,ZP,RP,ZX,RX,DELTA,NDEL)                        SU19   1
C                                                                       SU19   2
C         LOCATES A POINT IN THE SAME REGION AS A GIVEN POINT           SU19   3
C         TO BE USED IN COMPUTING A PARTIAL                             SU19   4
C     MODE=1,WITH RESPECT TO R                                          SU19   5
C     MODE=2,WITH RESPECT TO Z                                          SU19   6
C                                                                       SU19   7
      GO TO (2,4),MODE                                                  SU19   8
2     DR=DELTA                                                          SU19   9
      DZ=0.                                                             SU19  10
      GO TO 8                                                           SU19  11
4     DR=0.                                                             SU19  12
      DZ=DELTA                                                          SU19  13
8     DO 50 NN=1,NDEL                                                   SU19  14
      RR=RP+DR                                                          SU19  15
      ZZ=ZP+DZ                                                          SU19  16
      M=COMP(ZP,RP,ZZ,RR)                                               SU19  17
      IF (M.EQ.1) GO TO 60                                              SU19  18
      RR=RP-DR                                                          SU19  19
      ZZ=ZP-DZ                                                          SU19  20
      M=COMP(ZP,RP,ZZ,RR)                                               SU19  21
      IF (M.EQ.1) GO TO 60                                              SU19  22
      DZ=DZ*.5                                                          SU19  23
      DR=DR*.5                                                          SU19  24
50    CONTINUE                                                          SU19  25
      PART=2                                                            SU19  26
      PART=PART+.2                                                      SU19  27
      RETURN                                                            SU19  28
60    ZX=ZZ                                                             SU19  29
      RX=RR                                                             SU19  30
```

```
      PART=1                                                            SU19  31
      PART=PART+.2                                                      SU19  32
      RETURN                                                            SU19  33
      END                                                               SU19  34
      FUNCTION PICK2(ZP,RP,KODE)                                        SU20   1
C                                                                       SU20   2
C         DETERMINES 2 CLOSEST CONSECUTIVE POINTS ON SPECIFIED          SU20   3
C         LINE OF DISCONTINUITY TO A GIVEN POINT                        SU20   4
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU20   5
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU20   6
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU20   7
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU20   8
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU20   9
     115,4),RPART(15,2)                                                 SU20  10
C                                                                       SU20  11
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SU20  12
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU20  13
C                                                                       SU20  14
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU20  15
      COMMON DIRCOS                                                     SU20  16
      COMMON TIME                                                       SU20  17
      COMMON IRARF                                                      SU20  18
      COMMON KSTOP                                                      SU20  19
      COMMON TPSI                                                       SU20  20
      COMMON KKK                                                        SU20  21
      REAL LO,MO,LENGTH,MU,KO                                           SU20  22
C                                                                       SU20  23
      GO TO (5,10,100,205,210,300,500),KODE                             SU20  24
5     NN=NP                                                             SU20  25
      K=1                                                               SU20  26
      GO TO 15                                                          SU20  27
10    NN=NT                                                             SU20  28
      K=2                                                               SU20  29
15    AA=(TAB2(1,1,K)-ZP)**2+(TAB2(1,2,K)-RP)**2                        SU20  30
C                                                                       SU20  31
C               SEARCH SHOCK TABLES                                     SU20  32
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C                                                                       SU20  33
      DO 60 N=2,NN                                                      SU20  34
      A=(TAB2(N,1,K)-ZP)**2+(TAB2(N,2,K)-RP)**2                         SU20  35
      IF (A.GE.AA) GO TO 23                                             SU20  36
      AA=A                                                              SU20  37
60    CONTINUE                                                          SU20  38
      PICK2=NN-1                                                        SU20  39
      PICK2=PICK2+.2                                                    SU20  40
      RETURN                                                            SU20  41
23    PICK2=N-1                                                         SU20  42
      PICK2=PICK2+.2                                                    SU20  43
      RETURN                                                            SU20  44
100   AA=(RARF2(1,1)-ZP)**2+(RARF2(1,2)-RP)**2                          SU20  45
C                                                                       SU20  46
C               SEARCH RAREFACTION TABLE                                SU20  47
C                                                                       SU20  48
      DO 200 N=2,NR                                                     SU20  49
      A=(RARF2(N,1)-ZP)**2+(RARF2(N,2)-RP)**2                           SU20  50
      IF (A.GE.AA) GO TO 203                                            SU20  51
      AA=A                                                              SU20  52
200   CONTINUE                                                          SU20  53
      PICK2=NR-1                                                        SU20  54
      PICK2=PICK2+.2                                                    SU20  55
      RETURN                                                            SU20  56
203   PICK2=N-1                                                         SU20  57
      PICK2=PICK2+.2                                                    SU20  58
      RETURN                                                            SU20  59
205   NN=NP                                                             SU20  60
      K=1                                                               SU20  61
      GO TO 215                                                         SU20  62
210   NN=NT                                                             SU20  63
      K=2                                                               SU20  64
215   AA=(SPART(1,1,K)-ZP)**2+(SPART(1,2,K)-RP)**2                      SU20  65
C                                                                       SU20  66
C               SEARCH SHOCK PARTICLE TABLES                            SU20  67
C                                                                       SU20  68
```

```
      DO 260 N=2,NN                                                     SU20  69
      A=(SPART(N,1,K)-ZP)**2+(SPART(N,2,K)-RP)**2                       SU20  70
      IF (A.GE.AA) GO TO 223                                            SU20  71
      AA=A                                                              SU20  72
260   CONTINUE                                                          SU20  73
      PICK2=NN-1                                                        SU20  74
      PICK2=PICK2+.2                                                    SU20  75
      RETURN                                                            SU20  76
223   PICK2=N-1                                                         SU20  77
      PICK2=PICK2+.2                                                    SU20  78
      RETURN                                                            SU20  79
300   AA=(RPART(1,1)-ZP)**2+(RPART(1,2)-RP)**2                          SU20  80
C                                                                       SU20  81
C               SEARCH RAREFACTION PARTICLE TABLE                       SU20  82
C                                                                       SU20  83
      DO 400 N=2,NR                                                     SU20  84
      A=(RPART(N,1)-ZP)**2+(RPART(N,2)-RP)**2                           SU20  85
      IF (A.GE.AA) GO TO 403                                            SU20  86
      AA=A                                                              SU20  87
400   CONTINUE                                                          SU20  88
      PICK2=NR-1                                                        SU20  89
      PICK2=PICK2+.2                                                    SU20  90
      RETURN                                                            SU20  91
403   PICK2=N-1                                                         SU20  92
      PICK2=PICK2+.2                                                    SU20  93
      RETURN                                                            SU20  94
500   AA=(SURF2(1,1)-ZP)**2+(SURF2(1,2)-RP)**2                          SU20  95
C                                                                       SU20  96
C     SEARCH FREE SURFACE TABLE                                         SU20  97
C                                                                       SU20  98
      DO 520 N=2,NP                                                     SU20  99
      A=(SURF2(N,1)-ZP)**2+(SURF2(N,2)-RP)**2                           SU20 100
      IF (A.GE.AA) GO TO 523                                            SU20 101
      AA=A                                                              SU20 102
520   CONTINUE                                                          SU20 103
      PICK2=NP-1                                                        SU20 104
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      PICK2=PICK2+.2                                                    SU20 105
      RETURN                                                            SU20 106
523   PICK2=N-1                                                         SU20 107
      PICK2=PICK2+.2                                                    SU20 108
      RETURN                                                            SU20 109
      END                                                               SU20 110
      FUNCTION TEST(ZP,RP)                                              SU21   1
C                                                                       SU21   2
C                                                                       SU21   3
C         DETERMINES IF A GIVEN INTERIOR POINT IS IN                    SU21   4
C         THE REGION TO BE CONSIDERED                                   SU21   5
C                                                                       SU21   6
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU21   7
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU21   8
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU21   9
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU21  10
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU21  11
     115,4),RPART(15,2)                                                 SU21  12
C                                                                       SU21  13
C                                                                       SU21  14
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                SU21  15
C                                                                       SU21  16
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU21  17
C                                                                       SU21  18
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU21  19
      COMMON DIRCOS                                                     SU21  20
      COMMON TIME                                                       SU21  21
      COMMON IRARF                                                      SU21  22
      COMMON KSTOP                                                      SU21  23
      COMMON TPSI                                                       SU21  24
      COMMON KKK                                                        SU21  25
      REAL LO,MO,LENGTH,MU,KO                                           SU21  26
C                                                                       SU21  27
      EPS=.0001                                                         SU21  28
      IF (ITS3.EQ.1) GO TO 5                                            SU21  29
      IF (RP.GT.(RADIUS+EPS)) GO TO 5                                   SU21  30
```

```
      M=PICK2(ZP,RP,7)                                                  SU21   31
      FF=ZP-SURF2(M+1,1)-(SURF2(M,1)-SURF2(M+1,1))*(RP-SURF2(M,2))/(SURFSU21   32
     12(M,2)-SURF2(M+1,2))                                              SU21   33
      KICK=5                                                            SU21   34
      CALL DVCHK(KQ)                                                    SU21   35
      IF (KQ.EQ.1) GO TO 9980                                           SU21   36
      IF (FF)  200,5,5                                                  SU21   37
5     CONTINUE                                                          SU21   38
      IF (ZP.GT.-EPS) GO TO 1                                           SU21   39
      IF (RP.GT.(RADIUS+EPS)) GO TO 200                                 SU21   40
1     DO 10 K=1,2                                                       SU21   41
      IF (ITS3.EQ.1) GO TO 100                                          SU21   42
      M=PICK2(ZP,RP,K)                                                  SU21   43
      IF (TAB2(M,2,K).GT.RP.AND.M.NE.1)M=M-1                            SU21   44
      FF=ZP-TAB2(M+1,1,K)-(TAB2(M,1,K)-TAB2(M+1,1,K))*(RP-TAB2(M+1,2,K))SU21   45
     1/(TAB2(M,2,K)-TAB2(M+1,2,K))                                      SU21   46
      KICK=50                                                           SU21   47
      CALL DVCHK(KQ)                                                    SU21   48
      IF (KQ.EQ.1) GO TO 9980                                           SU21   49
      IF (K.EQ.2) GO TO 50                                              SU21   50
      IF (RP.GT.RADIUS) GO TO 10                                        SU21   51
      IF (FF)  200,10,10                                                SU21   52
50    IF (FF)  10,10,200                                                SU21   53
10    CONTINUE                                                          SU21   54
      DO 20 K=1,2                                                       SU21   55
      J=K+3                                                             SU21   56
      M=PICK2(ZP,RP,J)                                                  SU21   57
      IF (SPART(M,2,K).GT.RP.AND.M.NE.1)M=M-1                           SU21   58
      FF=ZP-SPART(M+1,1,K)-(SPART(M,1,K)-SPART(M+1,1,K))*(RP-SPART(M+1,2SU21   59
     1,K))/(SPART(M,2,K)-SPART(M+1,2,K))                                SU21   60
      KICK=15                                                           SU21   61
      CALL DVCHK(KQ)                                                    SU21   62
      IF (KQ.EQ.1) GO TO 9980                                           SU21   63
      IF (K.EQ.2) GO TO 15                                              SU21   64
      IF (RP.GT.RADIUS) GO TO 20                                        SU21   65
      IF (FF.LT..001) GO TO 300                                         SU21   66
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      GO TO 20                                                          SU21  67
15    IF (FF.GT.-.001) GO TO 400                                        SU21  68
20    CONTINUE                                                          SU21  69
      IF (IRARF.EQ.1) GO TO 100                                         SU21  70
      M=PICK2(ZP,RP,3)                                                  SU21  71
      FF=RP-RARF2(M+1,2)-(RARF2(M,2)-RARF2(M+1,2))*(ZP-RARF2(M+1,1))/(RASU21  72
     1RF2(M,1)-RARF2(M+1,1))                                            SU21  73
      KICK=20                                                           SU21  74
      CALL DVCHK(KQ)                                                    SU21  75
      IF (KQ.EQ.1) GO TO 9980                                           SU21  76
      IF (FF.LT.0.) GO TO 100                                           SU21  77
      M=PICK2(ZP,RP,6)                                                  SU21  78
      FF=RP-RPART(M+1,2)-(RPART(M,2)-RPART(M+1,2))*(ZP-RPART(M+1,1))/(RPSU21  79
     1ART(M,1)-RPART(M+1,1))                                            SU21  80
      KICK=100                                                          SU21  81
      CALL DVCHK(KQ)                                                    SU21  82
      IF (KQ.EQ.1) GO TO 9980                                           SU21  83
      IF (FF.LT.0.) GO TO 500                                           SU21  84
100   TEST=1                                                            SU21  85
      TEST=TEST+.2                                                      SU21  86
      RETURN                                                            SU21  87
200   TEST=2                                                            SU21  88
      TEST=TEST+.2                                                      SU21  89
      RETURN                                                            SU21  90
300   TEST=3                                                            SU21  91
      TEST=TEST+.2                                                      SU21  92
      RETURN                                                            SU21  93
400   TEST=4                                                            SU21  94
      TEST=TEST+.2                                                      SU21  95
      RETURN                                                            SU21  96
500   TEST=5                                                            SU21  97
      TEST=TEST+.2                                                      SU21  98
      RETURN                                                            SU21  99
9980  WRITE (3,9985) KICK                                               SU21 100
9985  FORMAT (32H0DIVIDE CHECK NEAR STATEMENT NO.,I5,14H IN SUBR. TEST/1SU21 101
     1H1)                                                               SU21 102
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      RETURN                                                            SU21 103
      END                                                               SU21 104
      SUBROUTINE FGOF5(Z5,R5,SS,QQ)                                     SU22   1
C                                                                       SU22   2
C         COMPUTES S5,Q5 FOR INTERIOR REGION                            SU22   3
C         ITERATION FOR Z5,R5                                           SU22   4
C                                                                       SU22   5
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU22   6
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU22   7
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU22   8
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU22   9
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU22  10
     115,4),RPART(15,2)                                                 SU22  11
C                                                                       SU22  12
C                                                                       SU22  13
      COMMON Z0,R0,P0,U0,V0,L0,M0,RHO0,E0,A0,UBAR0,VBAR0                SU22  14
C                                                                       SU22  15
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU22  16
C                                                                       SU22  17
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU22  18
      COMMON DIRCOS                                                     SU22  19
      COMMON TIME                                                       SU22  20
      COMMON IRARF                                                      SU22  21
      COMMON KSTOP                                                      SU22  22
      COMMON TPSI                                                       SU22  23
      COMMON KKK                                                        SU22  24
      REAL L0,M0,LENGTH,MU,K0                                           SU22  25
C                                                                       SU22  26
      DIMENSION ANS(6)                                                  SU22  27
C                                                                       SU22  28
      CALL DBLTRP(Z5,R5,ANS)                                            SU22  29
      U5=ANS(2)                                                         SU22  30
      V5=ANS(3)                                                         SU22  31
      SS=Z5-Z0+H*V5                                                     SU22  32
      QQ=R5-R0+H*U5                                                     SU22  33
      RETURN                                                            SU22  34
```

```
      END                                                               SU22  35
      SUBROUTINE ITRP                                                   SU23   1
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU23   2
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU23   3
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU23   4
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU23   5
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU23   6
     115,4),RPART(15,2)                                                 SU23   7
C                                                                       SU23   8
C                                                                       SU23   9
      COMMON Z0,R0,P0,U0,V0,L0,M0,RHO0,E0,A0,UBAR0,VBAR0                SU23  10
C                                                                       SU23  11
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU23  12
C                                                                       SU23  13
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU23  14
      COMMON DIRCOS                                                     SU23  15
      COMMON TIME                                                       SU23  16
      COMMON IRARF                                                      SU23  17
      COMMON KSTOP                                                      SU23  18
      COMMON TPSI                                                       SU23  19
      COMMON KKK                                                        SU23  20
C                                                                       SU23  21
C                                                                       SU23  22
      REAL L0,M0,LENGTH,MU,K0                                           SU23  23
C                                                                       SU23  24
C INTERPOLATION SCHEME FOR POINTS BETWEEN PARTICLE CURVES               SU23  25
C AND DISCONTINUITIES                                                   SU23  26
C                                                                       SU23  27
      EPS=.0000001                                                      SU23  28
      KOD1=0                                                            SU23  29
      KOD2=0                                                            SU23  30
      DO 1000 J=1,20                                                    SU23  31
      DO 1000 I=1,20                                                    SU23  32
      M=TEST(Z(I),R(J))                                                 SU23  33
      IF (M.NE.5) GO TO 906                                             SU23  34
      IF (IRARF.EQ.1) GO TO 906                                         SU23  35
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      NR1=NR-1                                                          SU23  36
      DO 907 JJ=1,NR1                                                   SU23  37
      IF (RARF2(JJ,1).LT.Z(I).AND.RARF2(JJ+1,1).GT.Z(I)) GO TO 908      SU23  38
907   CONTINUE                                                          SU23  39
908   CONTINUE                                                          SU23  40
      FF=R(J)-RARF2(JJ+1,2)+(RARF2(JJ,2)-RARF2(JJ+1,2))*(Z(I)-RARF2(JJ+1SU23  41
     1,1))/(RARF2(JJ,1)-RARF2(JJ+1,1))                                  SU23  42
      IF (FF.LT.0.) GO TO 1000                                          SU23  43
906   CONTINUE                                                          SU23  44
      IF (M.EQ.3.AND.Z(I).LT.EPS.AND.ABS(R(J)-RADIUS).LT.EPS) GO TO 1000SU23  45
      IF (M.LT.3) GO TO 8051                                            SU23  46
      WRITE (3,8050)                                                    SU23  47
8050  FORMAT (30H0INTERPOLATION SCHEME EMPLOYED)                        SU23  48
614   FORMAT (1X5HZ0  =,E15.8,4X5HR0  =,E15.8)                          SU23  49
      Z0=Z(I)                                                           SU23  50
      R0=R(J)                                                           SU23  51
      WRITE (3,614) Z0,R0                                               SU23  52
      WRITE (3,8888) M                                                  SU23  53
8888  FORMAT (1X4HM  =,I4)                                              SU23  54
8051  CONTINUE                                                          SU23  55
      GO TO (1000,1000,1001,1010,1100),M                                SU23  56
1001  IF (IRARF.EQ.1) GO TO 1003                                        SU23  57
      M=PICK2(Z(I),R(J),3)                                              SU23  58
      FF=R(J)-RARF2(M+1,2)+(RARF2(M,2)-RARF2(M+1,2))*(Z(I)-RARF2(M+1,1))SU23  59
     1/(RARF2(M,1)-RARF2(M+1,1))                                        SU23  60
      IF (FF.GT.0.) GO TO 1003                                          SU23  61
      DO 8002 K=1,6                                                     SU23  62
      L=K+2                                                             SU23  63
8002  XMESH2(I,J,K)=RARF(1,L)                                           SU23  64
      GO TO 1000                                                        SU23  65
1003  L=I+1                                                             SU23  66
      N=TEST(Z(L),R(J))                                                 SU23  67
      GO TO (1004,1007,1030,1030,1050),N                                SU23  68
1004  M=PICK2(Z(I),R(J),1)                                              SU23  69
      DO 1006 K=1,8                                                     SU23  70
      ANS=TAB2(M,K,1)+(TAB2(M+1,K,1)-TAB2(M,K,1))*(R(J)-TAB2(M,2,1))/(TASU23  71
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     1B2(M+1,2,1)-TAB2(M,2,1))                                          SU23  72
      IF (K.NE.1) GO TO 8005                                            SU23  73
      ANS1=ANS                                                          SU23  74
      GO TO 1006                                                        SU23  75
8005  CONTINUE                                                          SU23  76
      IF (K.EQ.2) GO TO 1006                                            SU23  77
      KX=K-2                                                            SU23  78
      IF (ABS(R(J)-RADIUS).GT.EPS) GO TO 9024                           SU23  79
      IF (K.GT.5.OR.K.LT.4) GO TO 9024                                  SU23  80
      ANS=TAB2(M+1,K,1)                                                 SU23  81
9024  CONTINUE                                                          SU23  82
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)   SU23  83
      IF (ABS(R(J)-RADIUS).GT.EPS) GO TO 1006                           SU23  84
      XMESH2(I,J,1)=0.                                                  SU23  85
      XMESH2(I,J,4)=RHOSTR                                              SU23  86
      XMESH2(I,J,5)=0.                                                  SU23  87
      XMESH2(I,J,6)=SQRT(BIGAPR/RHOSTR)                                 SU23  88
1006  CONTINUE                                                          SU23  89
      GO TO 1000                                                        SU23  90
1007  MM=PICK2(Z(I),R(J),2)                                             SU23  91
      M=PICK2(Z(I),R(J),1)                                              SU23  92
      DO 1009 K=1,8                                                     SU23  93
      ANS=TAB2(M,K,1)+(TAB2(M+1,K,1)-TAB2(M,K,1))*(R(J)-TAB2(M,2,1))/(TASU23  94
     1B2(M+1,2,1)-TAB2(M,2,1))                                          SU23  95
      ANSW=TAB2(MM,K,2)+(TAB2(MM+1,K,2)-TAB2(MM,K,2))*(R(J)-TAB2(MM,2,2)SU23  96
     1)/(TAB2(MM+1,2,2)-TAB2(MM,2,1))                                   SU23  97
      IF (K.NE.1) GO TO 1008                                            SU23  98
      ANS1=ANS                                                          SU23  99
      ANS2=ANSW                                                         SU23 100
      GO TO 1009                                                        SU23 101
1008  CONTINUE                                                          SU23 102
      IF (K.EQ.2) GO TO 1009                                            SU23 103
      KX=K-2                                                            SU23 104
      XMESH2(I,J,KX)=ANS+(ANSW-ANS)*(Z(I)-ANS1)/(ANS2-ANS1)             SU23 105
1009  CONTINUE                                                          SU23 106
      GO TO 1000                                                        SU23 107
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1010  IF (IRARF.EQ.1) GO TO 1013                                        SU23 108
      M=PICK2(Z(I),R(J),3)                                              SU23 109
      FF=R(J)-RARF2(M+1,2)+(RARF2(M,2)-RARF2(M+1,2))*(Z(I)-RARF2(M+1,1))SU23 110
     1/(RARF2(M,1)-RARF2(M+1,1))                                        SU23 111
      IF (FF.GT.0.) GO TO 1013                                          SU23 112
      DO 1012 K=1,6                                                     SU23 113
      L=K+2                                                             SU23 114
1012  XMESH2(I,J,K)=RARF(1,L)                                           SU23 115
      GO TO 1000                                                        SU23 116
1013  L=I-1                                                             SU23 117
      IF (ABS(Z(I)).LT.EPS) GO TO 1017                                  SU23 118
      N=TEST(Z(L),R(J))                                                 SU23 119
      GO TO (1014,1017,1030,1017,1051),N                                SU23 120
1014  M=PICK2(Z(I),R(J),2)                                              SU23 121
      DO 1016 K=1,8                                                     SU23 122
      ANS=TAB2(M,K,2)+(TAB2(M+1,K,2)-TAB2(M,K,2))*(R(J)-TAB2(M,2,2))/(TASU23 123
     1B2(M+1,2,2)-TAB2(M,2,2))                                          SU23 124
      IF (K.NE.1) GO TO 1015                                            SU23 125
      ANS1=ANS                                                          SU23 126
      GO TO 1016                                                        SU23 127
1015  CONTINUE                                                          SU23 128
      IF (K.EQ.2) GO TO 1016                                            SU23 129
      KX=K-2                                                            SU23 130
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)   SU23 131
1016  CONTINUE                                                          SU23 132
      GO TO 1000                                                        SU23 133
1017  L=J-1                                                             SU23 134
      N=TEST(Z(I),R(L))                                                 SU23 135
      GO TO (1024,1030,1030,1030,1051),N                                SU23 136
1024  M=PICK2(Z(I),R(J),2)                                              SU23 137
      DO 1026 K=2,8                                                     SU23 138
      ANS=TAB2(M,K,2)+(TAB2(M+1,K,2)-TAB2(M,K,2))*(Z(I)-TAB2(M,1,2))/(TASU23 139
     1B2(M+1,1,2)-TAB2(M,1,2))                                          SU23 140
      IF (K.NE.2) GO TO 1025                                            SU23 141
      ANS1=ANS                                                          SU23 142
      GO TO 1026                                                        SU23 143
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1025  CONTINUE                                                          SU23 144
      KX=K-2                                                            SU23 145
      IF (ABS(Z(I)).GT.EPS) GO TO 9125                                  SU23 146
      IF (K.GT.5.OR.K.LT.4) GO TO 9125                                  SU23 147
      ANS=TAB2(M+1,K,2)                                                 SU23 148
9125  CONTINUE                                                          SU23 149
      XMESH2(I,J,KX)=ANS+(XMESH2(I,L,KX)-ANS)*(R(J)-ANS1)/(R(L)-ANS1)   SU23 150
      IF (ABS(Z(I)).GT.EPS) GO TO 1026                                  SU23 151
      XMESH2(I,J,1)=0.                                                  SU23 152
      XMESH2(I,J,4)=RHOSTR                                              SU23 153
      XMESH2(I,J,5)=0.                                                  SU23 154
      XMESH2(I,J,6)=SQRT(BIGAPR/RHOSTR)                                 SU23 155
1026  CONTINUE                                                          SU23 156
      GO TO 1000                                                        SU23 157
1100  M=PICK2(Z(I),R(J),3)                                              SU23 158
      ANS1=RARF2(M+1,2)+(RARF2(M,2)-RARF2(M+1,2))*(Z(I)-RARF2(M+1,1))/(RSU23 159
     1ARF2(M,1)-RARF2(M+1,1))                                           SU23 160
      L=J+1                                                             SU23 161
      M=TEST(Z(I),R(L))                                                 SU23 162
      GO TO (1101,1030,1051,1030),M                                     SU23 163
1101  CONTINUE                                                          SU23 164
      DO 1106 K=1,6                                                     SU23 165
      LL=K+2                                                            SU23 166
      XMESH2(I,J,K)=RARF(1,LL)+(XMESH2(I,L,K)-RARF(1,LL))*(R(J)-ANS1)/(RSU23 167
     1(L)-ANS1)                                                         SU23 168
1106  CONTINUE                                                          SU23 169
      GO TO 1000                                                        SU23 170
1050  JJ1=J                                                             SU23 171
      II1=I                                                             SU23 172
      KOD1=1                                                            SU23 173
      GO TO 1000                                                        SU23 174
1051  JJ2=J                                                             SU23 175
      II2=I                                                             SU23 176
      KOD2=1                                                            SU23 177
1000  CONTINUE                                                          SU23 178
      IF (KOD1.EQ.0) GO TO 2000                                         SU23 179
```

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      M=PICK2(Z(II1),R(JJ1),1)                                          SU23 180
      DO 2016 K=1,8                                                     SU23 181
      ANS=TAB2(M,K,1)+(TAB2(M+1,K,1)-TAB2(M,K,1))*(R(JJ1)-TAB2(M,2,1))/(SU23 182
     1TAB2(M+1,2,1)-TAB2(M,2,1))                                        SU23 183
      IF (K.NE.1) GO TO 2005                                            SU23 184
      ANS1=ANS                                                          SU23 185
      GO TO 2016                                                        SU23 186
2005  CONTINUE                                                          SU23 187
      I=II1                                                             SU23 188
      J=JJ1                                                             SU23 189
      L=II1+1                                                           SU23 190
      IF (K.EQ.2) GO TO 2016                                            SU23 191
      KX=K-2                                                            SU23 192
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)   SU23 193
2016  CONTINUE                                                          SU23 194
2000  IF (KOD2.EQ.0) GO TO 3000                                         SU23 195
      M=PICK2(Z(II2),R(JJ2),2)                                          SU23 196
      DO 3016 K=1,8                                                     SU23 197
      ANS=TAB2(M,K,2)+(TAB2(M+1,K,2)-TAB2(M,K,2))*(R(JJ2)-TAB2(M,2,2))/(SU23 198
     1TAB2(M+1,2,2)-TAB2(M,2,2))                                        SU23 199
      IF (K.NE.1) GO TO 3015                                            SU23 200
      ANS1=ANS                                                          SU23 201
      GO TO 3016                                                        SU23 202
3015  CONTINUE                                                          SU23 203
      I=II2                                                             SU23 204
      J=JJ2                                                             SU23 205
      L=II2-1                                                           SU23 206
      IF (K.EQ.2) GO TO 3016                                            SU23 207
      KX=K-2                                                            SU23 208
      XMESH2(I,J,KX)=ANS+(XMESH2(L,J,KX)-ANS)*(Z(I)-ANS1)/(Z(L)-ANS1)   SU23 209
3016  CONTINUE                                                          SU23 210
3000  CONTINUE                                                          SU23 211
      GO TO 3017                                                        SU23 212
1030  WRITE (3,1040) I,J                                                SU23 213
1040  FORMAT (27H0 TIME STEP TOO LARGE AT I=,I4,2HJ=,I4,///)            SU23 214
      CALL EXIT                                                         SU23 215
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3017  CONTINUE                                                          SU23 216
C                                                                       SU23 217
C                                                                       SU23 218
      RETURN                                                            SU23 219
      END                                                               SU23 220
      SUBROUTINE EXIT                                                   SU24   1
C                                                                       SU24   2
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU24   3
     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU24   4
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS       SU24   5
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU24   6
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU24   7
     115,4),RPART(15,2)                                                 SU24   8
C                                                                       SU24   9
C                                                                       SU24  10
      COMMON Z0,R0,P0,U0,V0,L0,M0,RHO0,E0,A0,UBAR0,VBAR0                SU24  11
C                                                                       SU24  12
      COMMON NP,NT,NR,NI,NDEL,ISUB                                      SU24  13
C                                                                       SU24  14
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                   SU24  15
      COMMON DIRCOS                                                     SU24  16
      COMMON TIME                                                       SU24  17
      COMMON IRARF                                                      SU24  18
      COMMON KSTOP                                                      SU24  19
      COMMON TPSI                                                       SU24  20
      COMMON KKK                                                        SU24  21
      REAL L0,M0,LENGTH,MU,K0                                           SU24  22
      KSTOP=1                                                           SU24  23
      STOP                                                              SU24  24
      END                                                               SU24  25
      SUBROUTINE FGOFI(ZX,RX,SS,QQ)                                     SU25   1
C                                                                       SU25   2
C         COMPUTES SI,QI FOR INTERIOR REGION                            SU25   3
C         ITERATION FOR ZI,RI                                           SU25   4
C                                                                       SU25   5
      COMMON CASEID(14),ITS1,ITS2,ITS3,ITS4,ITI1,ITI2,ITI3,ITI4,EPS1,EPSSU25   6
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     12,EPS3,EPS4,EPS5,EPS6,EPI1,EPI2,EPI3,EPI4,EPI5,EPI6,EPI7,VP,AR,LENSU25    7
     1GTH,APR,BPR,BIGAPR,BIGBPR,ESTAR,ALPHA,BETA,RHOSTR,EPRS,RHOS        SU25    8
      COMMON XMESH(20,20,6),XMESH2(20,20,6),Z(20),R(20),SURF(15,8),SURF2SU25    9
     1(15,8),TAB(15,14,2),TAB2(15,14,2),SPART(15,2,2),RARF(15,11),RARF2(SU25   10
     115,4),RPART(15,2)                                                  SU25   11
C                                                                        SU25   12
C                                                                        SU25   13
      COMMON ZO,RO,PO,UO,VO,LO,MO,RHOO,EO,AO,UBARO,VBARO                 SU25   14
C                                                                        SU25   15
      COMMON NP,NT,NR,NI,NDEL,ISUB                                       SU25   16
C                                                                        SU25   17
      COMMON ZMIN,ZMAX,RMIN,RMAX,RADIUS,GZ,GR,DELTA,H                    SU25   18
      COMMON DIRCOS                                                      SU25   19
      COMMON TIME                                                        SU25   20
      COMMON IRARF                                                       SU25   21
      COMMON KSTOP                                                       SU25   22
      COMMON TPSI                                                        SU25   23
      COMMON KKK                                                         SU25   24
      REAL LO,MO,LENGTH,MU,KO                                            SU25   25
C                                                                        SU25   26
      DIMENSION ANS(6),PSI(4),SPSI(11),CPSI(11)                          SU25   27
C                                                                        SU25   28
C                                                                        SU25   29
C                                                                        SU25   30
C                                                                        SU25   31
C                                                                        SU25   32
      CALL DBLTRP(ZX,RX,ANS)                                             SU25   33
      UI=ANS(2)                                                          SU25   34
      VI=ANS(3)                                                          SU25   35
      AI=ANS(6)                                                          SU25   36
      SS=ZX-ZO+H*(VI+AI*SIN(TPSI))                                       SU25   37
      QQ=RX-RO+H*(UI+AI*COS(TPSI))                                       SU25   38
      RETURN                                                             SU25   39
      END                                                                SU25   40
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III.1. "Elementary Solutions of Coupled Model Equations in the Kinetic Tehory of Gases"

III.2. "Tricritical Points in Multicomponent Fluid Mixtures"

III.3. "Generalized Scaling Hypothesis in Multicomponent Systems. I. Classification of Critical Points by Order and Scaling at Tricritical Points"

III.4. "Double-Power Scaling Functions Near Tricritical Points"

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