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THE BRL 7600 VERSION OF THE HELP CODE

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January 1980

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
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The HELP computer code (BRLHELP) which is maintained on the CDC 7600 computers at the Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland and the Ballistic Missile Defense Advanced Technology Center in Huntsville, Alabama is described. Three shaped charge design applications, a 43 mm conical shaped charge, a hemispherical shaped charge, and an impacting copper wedge, are discussed. Input decks and selected output for each problem are listed, and results are compared with experiments. The energy formulation in the HELP code is analyzed and the cause of the unphysical internal energy values is identified.

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FOREWORD

One aspect of the weapons effects research at the Ballistic Research Laboratory (BRL) is the study of penetration mechanics for shaped charges impacting military targets. In the Continuum Mechanics Center (CMC) of the BRL this research involves theoretical and numerical modeling studies pertaining to the fundamental characteristics and behavior of materials subjected to dynamic loads. The product of this research is the development and maintenance of large-scale hydrocodes for application to problems of military interest. The subject of this report is the BRL version of the HELP code.

I. INTRODUCTION

One of the objectives of the Continuum Mechanics Center (CMC) of the Ballistic Research Laboratory is the development and maintenance of large-scale continuum mechanics codes at the state-of-the-art for application to problems of military interest in both basic research and experimental studies. This objective is approached at the CMC by analyzing, evaluating and documenting existing calculational techniques and numerical models in terms of validity, accuracy and efficiency, and where necessary, refining and upgrading them, or suggesting new methods and models. Since such considerations cannot always be the concern of the user looking for the solution to a specific problem or seeking information to fit into some overall scheme, the CMC maintains a library of working continuum mechanics codes available for use at the BRL, along with relevant documentation.

The HELP (Hydrodynamics ELastic-Plastic) code[1] or one of its evolutionary antecedents has been used for some time as a calculational predictive tool in research involving intermediate ballistics (e.g. muzzle blast), warhead mechanisms (e.g. shaped charge jet formation) and terminal ballistics (e.g. impact and penetration) with varying degrees of success. Effective use of the code has been hampered at times by the memory size and speed of the computers available for running HELP calculations, and more seriously, by questions concerning the accuracy of some of its predictive models.

Furthermore, many problems with understanding and using a large complex code arise from a lack of complete documentation. When a code evolves, such as HELP has, over a period of twenty years, much information about changes and corrections vanishes and becomes part of the "folklore" of the code. A special effort will therefore be made at the CMC to document any modifications made to such codes.

This report describes the current effort at the CMC to test and evaluate the capabilities and potential of the HELP code as a predictive tool in shaped charge studies. In Section II we briefly describe the HELP model, the implementation of the code on a CDC 7600 computer and its application to shaped charge design. For readers unfamiliar with shaped charge theory we recommend the work of Birkhoff et al. in reference 2. Section III describes calculations made with the code and their comparison with experiments and other numerical results. Section IV contains a discussion of experimental temperature measurements for shaped

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1. L. J. Hageman, et al., "HELP, A Multi-material Eulerian Program for Compressible Fluid and Elastic-Plastic Flows in Two-Dimensions and Time," Systems, Science and Software Report SSS-R-75-2654, July 1975.

2. G. Birkhoff, et al., "Explosion with Lined Cavities," J. Appl. Phys. 19, 563, 1948.

charges and the difficulties encountered with HELP's internal energy calculation. Conclusions and recommendations for upgrading the code are presented in Section V.

II. THE HELP CODE

A. Brief Description of the Model

The HELP code is a two-dimensional Eulerian code capable of describing unsteady multi-material interactions and treating material strength as an elastic-plastic phenomenon. An important feature of the code is its utilization of massless tracer particles to define material interfaces and free surfaces. These particles are initially placed along the surface boundaries and moved thereafter with a local material velocity. This Lagrangian style description of moving surfaces provides an accurate definition of the material interfaces and free surfaces without sacrificing the ease of treating extreme distortion by an Eulerian model.

The HELP algorithm numerically models the solution of the conservation equations governing the motion and interaction of continuous media. In integral form over a control volume V, the equations are:

$$\frac{\partial}{\partial t}\int_V \rho dV = -\int_S \rho u_i n_i dS, \qquad \text{(conservation of mass)} \qquad (1)$$

$$\frac{\partial}{\partial t}\int_V \rho u_j dV = \int_S \sigma_{ij} n_i dS - \int_S \rho u_i u_j n_i dS,\ j = 1,2, \qquad \text{(conservation of momentum)} \qquad (2)$$

$$\frac{\partial}{\partial t}\int_V \rho E_T dV = \int_S \sigma_{ij} u_j n_i dS - \int_S \rho u_i E_T n_i dS, \qquad \text{(conservation of total energy)} \qquad (3)$$

where the summation convention is used. Here ρ, u_i, σ_{ij}, E_T, t denote the density, ith component of the velocity, (i,j) component of the stress tensor, specific total energy, and time, respectively. The surface of the control volume is denoted by S and the ith component of the outward normal to it is denoted by n_i. The stress tensor is taken as the sum of the hydrostatic stress $-\delta_{ij}P$ (δ_{ij} denotes the Kronecker delta and P, the pressure) and the stress deviator tensor S_{ij}; that is,

$$\sigma_{ij} = S_{ij} - \delta_{ij}P. \qquad (4)$$

The numerical treatment of pure cells (containing only one material) and of mixed cells (containing more than one material) can differ substantially in the HELP algorithm. For simplicity and clarity, the treatment of pure cells only will be described below. The control volume V is taken to be the computational cell. The time step Δt is determined using a Courant condition. Equations (1) - (3) are finite differenced over the time step Δt and can be rewritten, using equation (4), as:

	SPHASE	HPHASE	TPHASE	
$\Delta(m) =$			$-\Delta t \int_S \rho u_i n_i dS,$	(5)
$\Delta(mu_j) =$	$\Delta t \int_S S_{ij} n_i dS$	$- \Delta t \int_S P n_j dS$	$- \Delta t \int_S (\rho u_j u_i) n_i dS, \; j = 1,2,$	(6)
$\Delta(mE_T) =$	$\Delta t \int_S S_{ij} u_j n_i dS$	$- \Delta t \int_S P u_i n_i dS$	$- \Delta t \int_S (\rho u_i E_T) n_i dS.$	(7)

In solving these equations the values of the cell-centered mass, velocity and specific total energy at a new time level are found from the values at a previous time level. This is accomplished in three stages by determining the time rate of change of the mass, momentum and total energy due to the effects of: (1) the deviator stress (involving those terms with the variable S_{ij}), (2) the pressure (involving those terms with the variable P), and (3) the transport of material (involving the convection terms). These phases are appropriately named SPHASE, HPHASE AND TPHASE, respectively. During each time step, each value of the mass, momentum and total energy is updated sequentially by each phase in the order listed and each phase uses the previously updated values as its initial values. The surface integrals in equations (5) - (7) are evaluated using the value of the integrands at the surfaces of the computational cells.

Besides the dependent variables already listed, the specific internal energy and the pressure need to be determined. The former is evaluated at any phase by subtracting from the specific total energy the specific kinetic energy, that is,

$$E_I = E_T - 0.5\ (u_1^2 + u_2^2). \qquad (8)$$

Equation (8) is evaluated at each cell and at the end of each phase. The pressure is calculated prior to SPHASE via the algebraic equation of state which has the functional form $P = P(\rho,\ E_I)$.

Input to the code consists of an initial geometric configuration, initial values and/or explosive loading parameters, relevant material properties and desired editing features. Output includes pressure, density, material velocity components, specific internal energy and deviatoric stress components as functions of space and time.

The latest documented version[1] of the HELP code contains several features designed to enhance the code's ability to model high explosive-metal interactions for complex geometric configurations such as found in shaped charge designs. The geometry package is capable of describing any configuration decomposable into straight line segments, arcs of circles, or arcs of ellipses. A high explosive detonation model can account for multiple explosives and multiple detonation points as well as for the presence of wave shaping devices. Sliplines may be employed at interfaces. These are especially useful at high explosive-metal interfaces where there is a large difference in material density. The sliplines allow different materials in the interface cells to develop velocities commensurate with their material properties, rather than requiring all material in the interface cells to move with the same velocity.

B. Installation of HELP on the CDC 7600 Computer

Before the acquisition of the BRL CYBER 7600, locally available computers were BRLESC and UNIVAC 1108. The advantages in using the CDC 7600 to perform calculations with a code of HELP's complexity arise essentially from machine speed. A CDC 7600 possessing about 160K octal, 60-bit words of small core and 1.2 million octal bits of large core has potential for running problems with very fine spatial gridding over long real time periods.

A UNIVAC 1108 card-image tape version of the code was obtained from Systems, Science and Software to create the current BRL 7600 version of the HELP code. The entire source tape was initially transferred to an UPDATE[3] Program Library, and then transferred one subroutine at a time via *ADDFILE and *DECK directives to a new program library. Thus each subroutine is a "deck" on the "program library", and may be altered and compiled separately from the entire program.

In addition to the original subroutine decks (Table A-1), three new deck IDENTS (Table A-2), and several "correction" IDENTS (Table A-3) were generated during the installation. A discussion of each IDENT appears in Appendix A.

Since the BRL's CYBER 76 computer system was not initially available, a telephone dial-up connection had to be instituted to a distant host site. In order to obtain the graphics display (both static and dynamic) often necessary to interpreting hydrocode results, a method was devised to send data telephonically to an in-house UNITECH terminal driven tape drive. This data tape was then used with the BRL CALCOMP

3. Control Data Corporation, UPDATE Reference Manual, 7600 Computer System, Arden Hills, Minnesota, 1975.

plotting facilities to produce static results, or with an interactive CRT to look at dynamic description of phenomena such as liner collapse and jet formation and break up. Figure 1 indicates schematically the transmission procedure, and the necessary programs for this procedure are available from CMC on request.

In the process of checking out the CDC 7600 version of HELP, two sample calculations were made to compare running times of the CDC with those of the BRLESC and UNIVAC 1108 computers for this code. In the first problem, the calculation of the liner collapse of a 81.3 mm (called 3.2 inch precision shaped charge) conical liner, the CDC 7600 ran at a rate of two seconds per time cycle, while the comparable BRLESC calculation took one minute per time cycle. Thus, for this problem, the CDC 7600 would require about one minute to perform a HELP calculation requiring a half hour on BRLESC. The second calculation, an iron rod impacting on aluminum, ran seven times faster on the CDC 7600 than on UNIVAC 1108. It should be noted that the 81.3 mm shaped charge calculation was not run on the UNIVAC 1108 because this particular machine's memory was too small to permit a grid structure of the size used in the calculation on the CDC 7600 and BRLESC.

While running the HELP code on the CDC 7600 several alterations were made to correct the coding, improve the code's input format and permit further output options. These modifications are documented in Appendices A (see Table A-3) and B of this report. Of particular note is a modification made to subroutine UVCALC. This subroutine is called after the HPHASE calculations and updates the material velocities in multi-material cells containing sliplines by solving four simultaneous linear equations. (See reference 1, pp. 5.2-5.3). When the angle made by the slipline relative to the positive x-axis is 0° or 180°, the solution[4] of the four equations is wrong. The IDENT CORUVC corrects this error.

In addition to the above mentioned documentation, a set of sample input and corresponding output is provided in Appendix C to aid users of the BRL version of the code (to be known as BRLHELP). Specifically the I/O corresponds to calculations of (1) a 43 mm conical shaped charge, (2) a hemispherical shaped charge, and (3) a copper wedge impacting on a reflective wall.

C. Application to Shaped Charge Design

HELP has the potential to simulate much of shaped charge behavior, and thus provide a needed numerical tool able to perform optimization and prefabrication studies for materials and geometries proposed in warhead design. The code has the capability of modeling the collapse of the liner and the formation and development of the jet and the slug.

4. A. R. Kiwan, Private Communication.

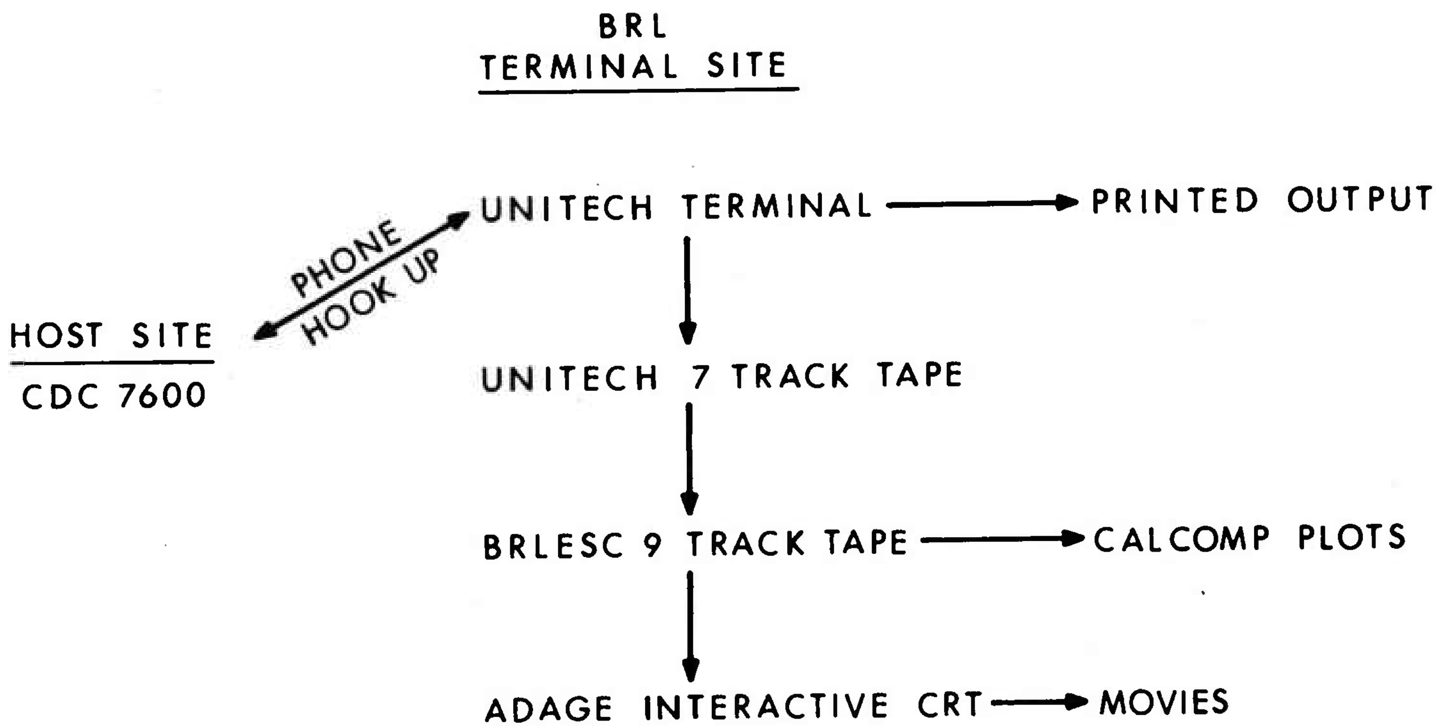

Figure 1. HELP Output Procedure.

The code provides information which can be used to determine (1) jet tip velocity, (2) collapse velocity and collapse angle, (3) liner position as a function of time, (4) stretching rate of the jet, and (5) strength effects.

To date, the code has been used with success in predicting jet tip velocities and liner collapse for a variety of geometric designs.[5,6,7] However, it overestimates the internal energy in the collapsed portion of the conical shaped charge liner materials. In an earlier version of the code (BRLSC - Ballistic Research Laboratory Shaped Charge)[8], this overestimation led to unreasonably low estimates of jet densities.[5] Because of this, an artificial bound on the internal energy in the liner was used in the subroutine for the metal equation of state (Tillotson Equation of State)[9] in an attempt to maintain a more appropriate jet density. Without this bound, the jet tip would exhibit internal energies so high and densities so low for some liners as to imply vaporization.* Until the code is able to predict internal energy accurately, internal energy dependent quantities such as temperature, and strength effects cannot be calculated with much confidence. A cause of this problem will be identified and solutions suggested in Section IV of this report.

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5. J. T. Harrison, "Comparison Between the Eulerian Hydrodynamic Computer Code (BRLSC) and Experimental Collapse of a Shaped Charge Liner," BRL Memorandum Report ARBRL-MR-02841, June 1978. (AD #A059711)

6. Janet Lacetera, "Study of Liner Collapse and Jet Formation for Various Hemispherical Shaped-Charge Systems," BRL Draft Report.

7. A. Kiwan, and A. Arbuckle, "Study of Liner Collapse, Jet Formation and Characteristics from Impulsive Shaped-Charge Systems," BRL Report No. 2028, November 1977. (AD #A051342)

8. M. L. Gittings, "BRLSC: An Advanced Eulerian Code for Predicting Shaped Charges, Volume I," BRL Contract Report 279, December 1975. (AD #A023962).

9. J. H. Tillotson, "Metallic Equation of State for Hypervelocity Impacts," General Atomic Report No. GS-3216, July 1962.

*It should be noted that the artificial energy bound may be applied to any portion of a metal in a shaped charge problem, whether or not that portion of the metal constitutes part of the liner. This is because the equation of state subroutine EQST checks only that the parameter NLINER (see Appendix B) is nonzero before applying the bound to the appropriate material; and NLINER is a parameter correlated with a material as opposed to a material package.

III. HELP CALCULATIONS

Over the years possible causes of the HELP code's shortcomings have been suggested as resulting from incorrect or incomplete physical modeling, incorrect coding or a combination of these factors. An added complication heretofore was that HELP had been run on computers with either limited memory or speed. This necessitated the use of various equivalencing and overlaying techniques and relatively coarse grid structures which might have obscured or compounded the code's actual weaknesses. Using the CDC 7600 computer with its relatively high speed and memory capacity diminished these complications. Therefore to substantiate HELP's capabilities and determine its weaknesses, several lengthy calculations made on the CDC 7600 are reviewed. The input and selected output from these studies are presented in Appendix C.

A. 43 mm Conical Shaped Charge

The first study using BRLHELP modeled the liner collapse and jet formation for a 43 mm hollow, conical copper liner driven by a right circular cylinder of unconfined Composition B explosive (Figure 2). This shaped charge design was chosen since both experimental and numerical[5] results existed for comparison: Boyd Taylor of BRL had produced a series of early-time flash radiographs which permitted a comparison between HELP tracer particle plots and photographs of the early stages of the liner's collapse, as well as estimates of the relative jet tip velocity (the velocity difference between the tip of the jet and the tail of the slug). John Harrison, using the BRLSC code, had also performed an extensive comparison with this experiment.[5] He had found that the code-simulated collapse agreed quite well with experiment and that the code predicted that after approximately 11.5 μs, the jet tip reaches a constant relative velocity of 6.54 mm/μs which matched the experimentally measured value. Figure 3 illustrates these results. He also noted the overly low jet density and extremely high internal energy predicted by BRLSC.

The calculations made with the HELP code also match the kinematic results obtained experimentally as indicated in Figure 4. The relative jet tip velocity calculated was 6.31 mm/μs which differs from Harrison and Taylor's results by about 3.3 percent. This difference results from the bound on the internal energy used in the equation of state which enforces a higher density in the jet material and consequently a lower velocity. It should be noted that both calculations were made without using the strength options available in each of the codes (i.e. the subroutine SPHASE in the HELP code and PH3 in BRLSC were not used).

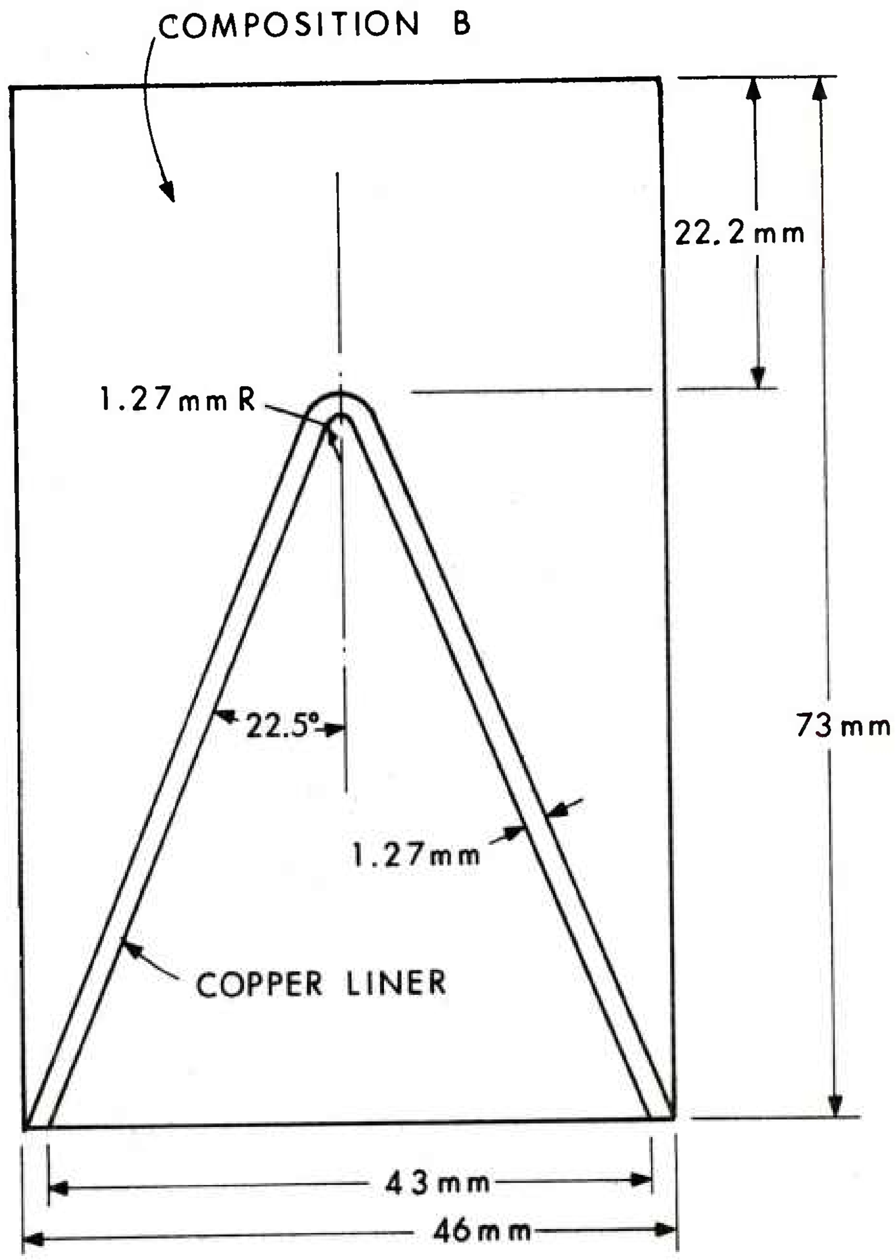

Figure 2. Line Drawing of the 43 mm Conical Shaped Charge.

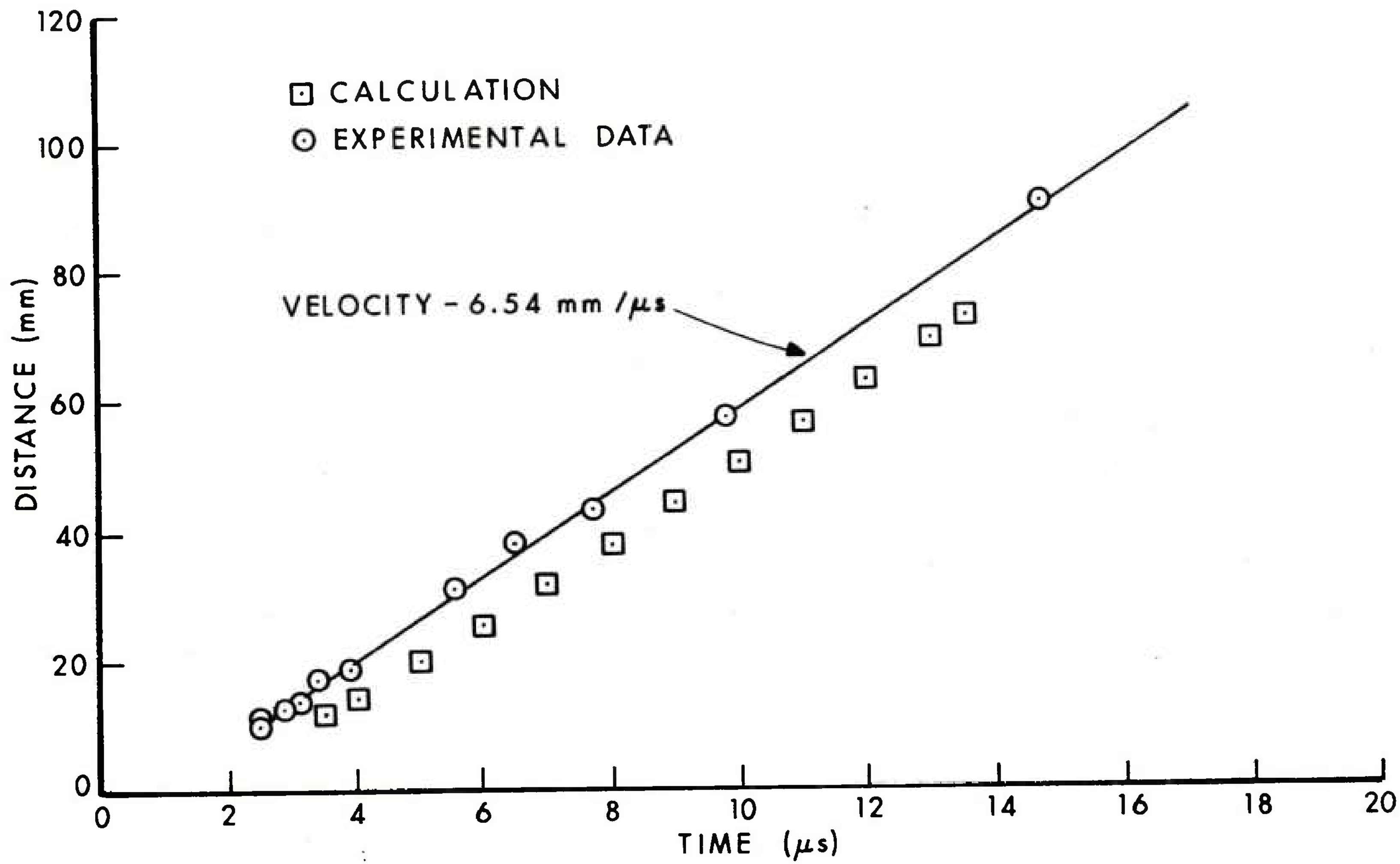

Figure 3. Comparison Between the BRLSC Code Results and Experimentally Measured Velocity Differences (Jet Tip Minus Slug Tail). (Taken from Reference 5.)

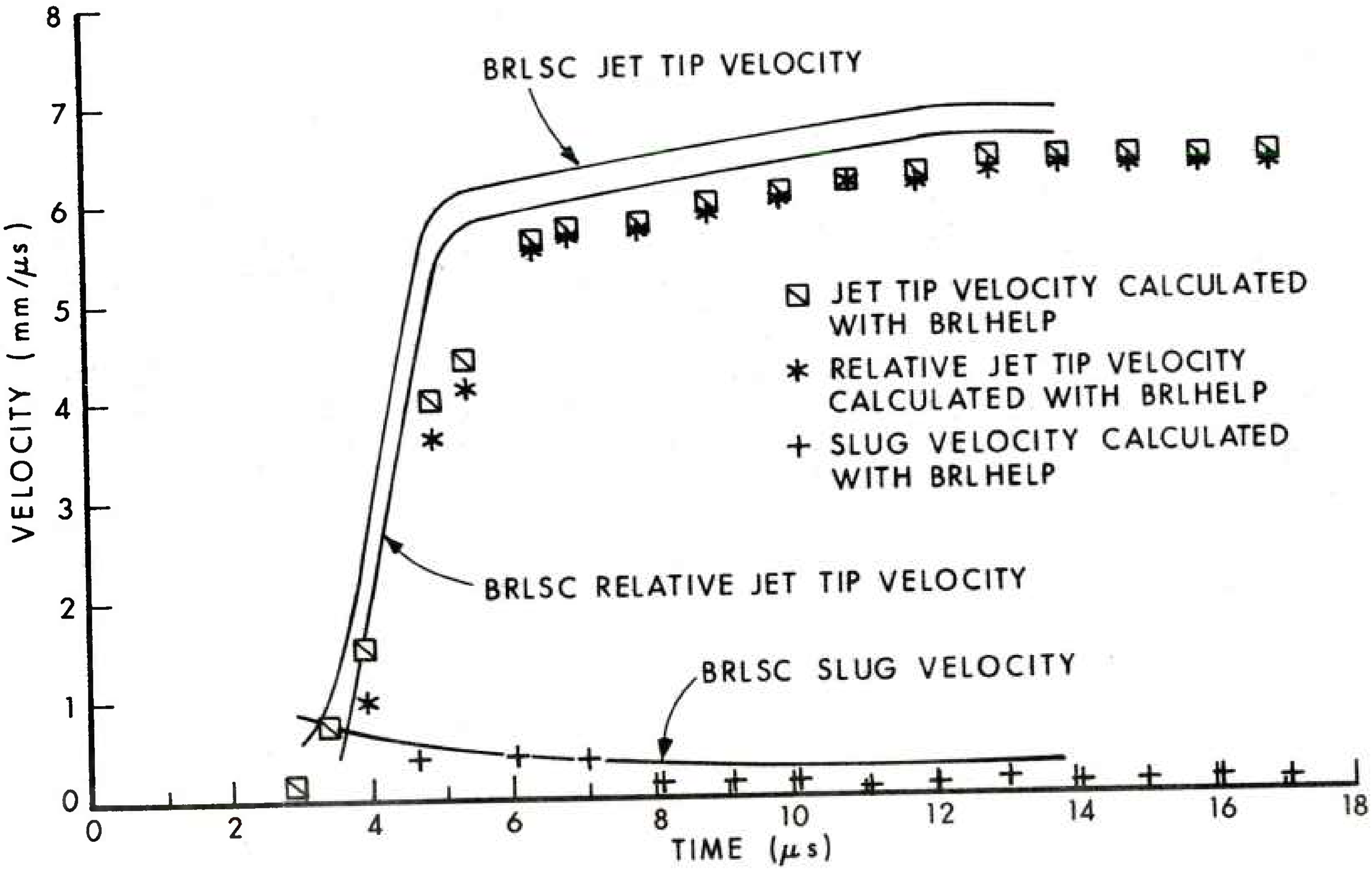

Figure 4. Comparison of BRLSC and BRLHELP Code Results for the 43 mm Conical Shaped Charge.

B. Hemispherical Shaped Charge

Another configuration often used in shaped charge design is the hemisphere. Since one-dimensional codes such as BASC[10] cannot provide accurate liner collapse and jet formation information for designs based on this shape, it is very important to have a two-dimensional code which can serve as a reliable modeling tool.

To determine HELP's ability to model hemispherical shaped charges, a study was made using a scaled version of a five inch copper hemisphere for which series of flash radiographs (made by Seymour Kronman of BRL) existed to provide comparison. In this case the copper liner possessed an inner diameter of 35.814 mm, a thickness of 1.143 mm, and was driven by an unconfined right circular cylinder of Composition B explosive where the head-height was 19.05 mm, and the charge was subcalibered by 2.54 mm. The calculation was carried out without using the strength option in HELP. The liner configuration is pictured in Figure 5.

Comparison of the HELP calculated tracer plots with photographs from the flash radiograph series showed good agreement in size and shape as the jet developed. (See Figures 6 and 7.) A systematic time difference between the flash radiographs and the HELP results was observed. The HELP calculation took three microseconds longer for the jet to reach the same state of development as that exhibited in the radiographs. This difference is due to the fact that the experimental time measurements do not begin until a wire stretched across the open edge of the hemisphere is broken by the oncoming detonation wave, while HELP starts counting time from the onset of detonation in the burn routine.[6]

The relative jet tip velocity calculated by HELP was 3.06 mm/μs while experimentally a value of 3.4 mm/μ sec was measured. Thus HELP's prediction was 10 percent low, but well within experimental error bounds.[6]

C. Copper Wedge

The previous examples of HELP calculations model three areas of shaped charge studies, the detonation of the explosive, the liner collapse, and the jet formation. These two-dimensional unsteady calculations are lengthy and complicated. A solid wedge (conical or planar) impinging on a reflective wall simulates the liner collapse and the jet formation[2], and on occasion, is more suited for primary studies. Furthermore, it does provide a vehicle to examine a somewhat different behavior with respect to the energy calculation. In problems described

10. J. T. Harrison, "BASC: A Simplified Analytical Shaped Charge Code," BRL Draft Report.

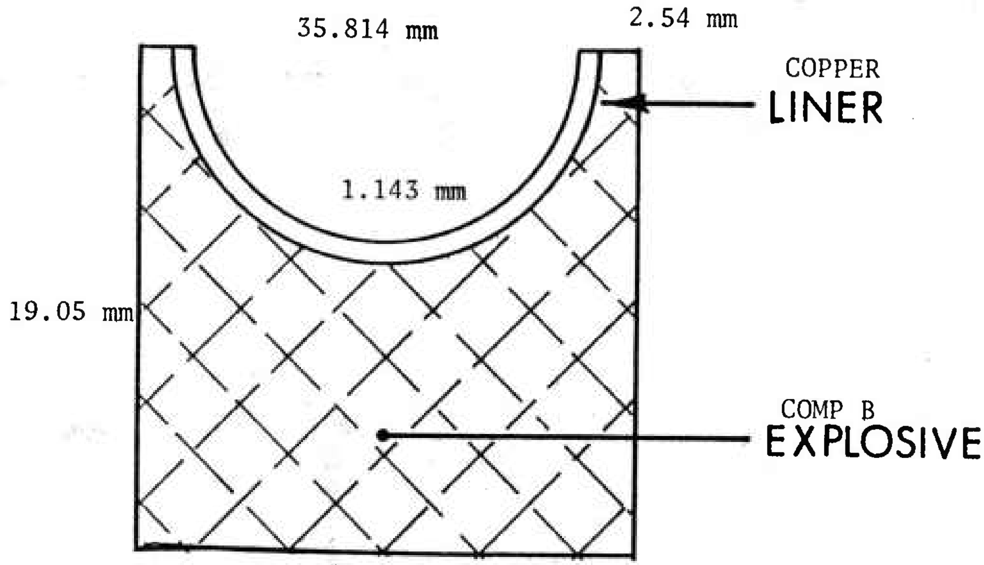

Figure 5. Line drawing of the Hemispherical Shaped Charge.

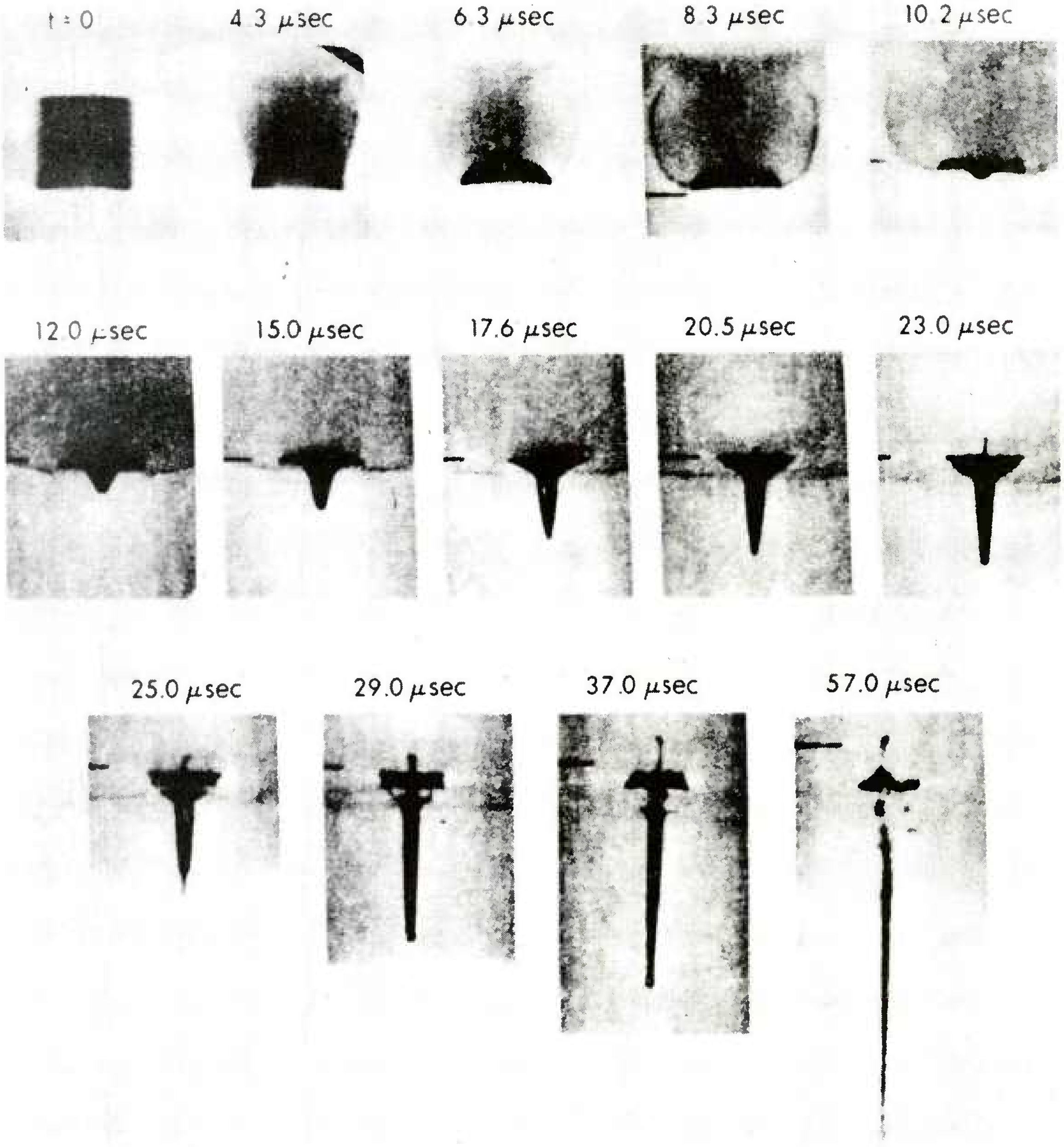

Figure 6. Photographs of the Kronman Flash Radiographs Illustrate the Collapse and Jet Formation for a Hemispherical Liner.

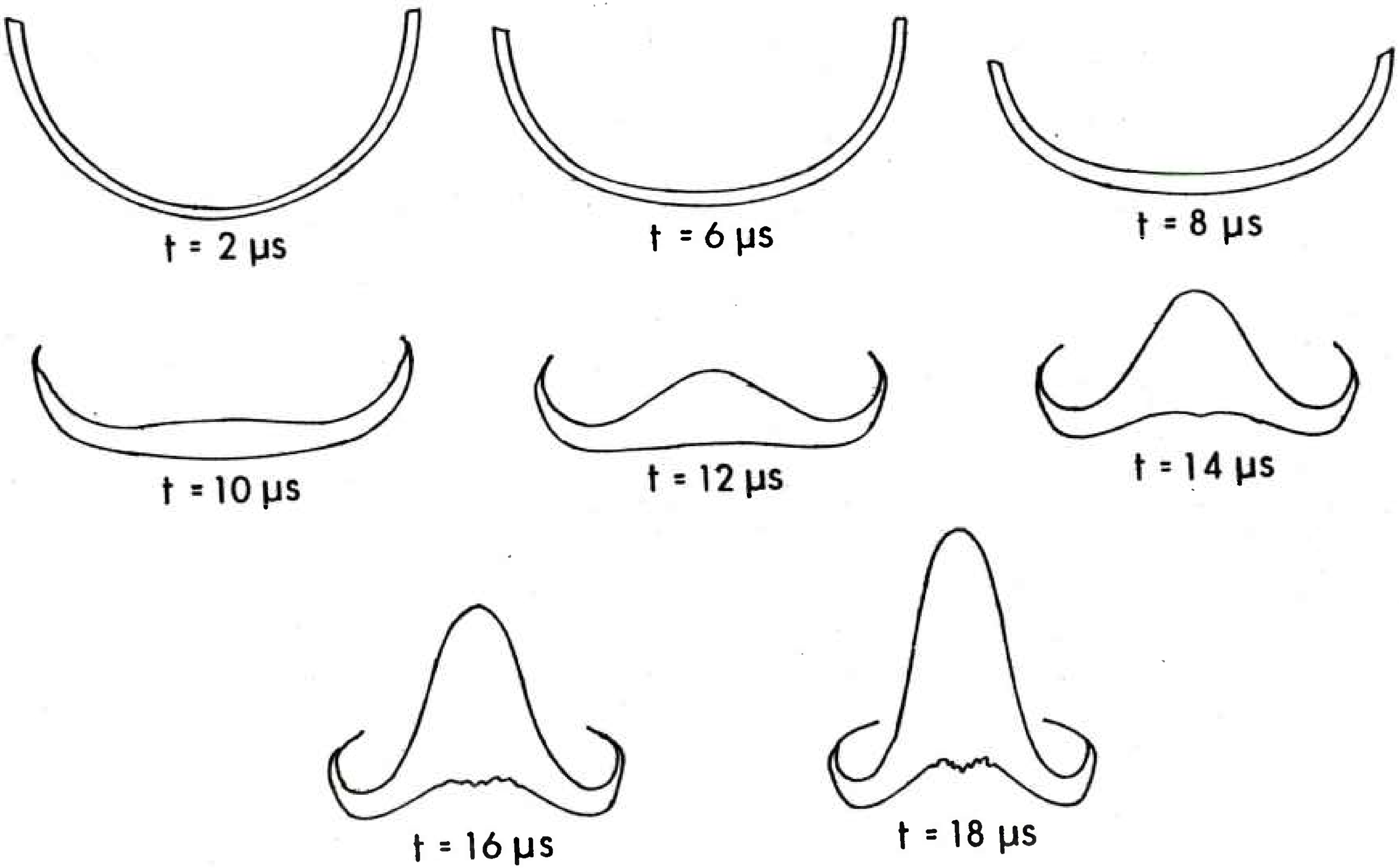

Figure 7. HELP Tracer Particle Plot of the Liner Collapse and Jet Formation for the Hemispherical Shaped Charge Used in the Kronman Experiment.

in Sections III-A and III-B, the detonation of the explosive releases internal energy generating a driving force which accelerates the liner from rest while internal energy is simultaneously evolved. In the wedge impact problem the wedge initially has all kinetic energy and the internal energy is evolved from the impact and deformation of the material. At early times, the physics of the problem becomes similar to the shaped charge calculation; however the initial energy partition lends an independent check on the source of the internal energy problem.

The planar wedge impact problem consists of a pure copper wedge at a 60° angle of obliquity impacting a wall (the ordinate) with a velocity perpendicular to the wedge's length and of magnitude 2.5043 mm/μs (see Figure 8). We note that the direction of the velocity is different from that given in reference 2. However, a Galilean transform at the intersection of the wedge and the wall gives the appropriate direction to the velocity. The impact as depicted in the calculation was performed without strength effects.

IV. INTERNAL ENERGY PROBLEM

The material properties of a shaped charge jet and of a kinetic energy penetrator are important quantities to the designers and engineers working in the field of penetration mechanics. The accurate prediction of these properties depends directly on the accurate calculation of the internal energy of the material. However, at the present time the internal energies predicted by the HELP computer code can be unphysically high and imply vaporization in cases where experimental evidence is to the contrary. In this section we discuss: (1) the results of experimental temperature measurements for copper and tin-lead eutectic conical shaped charge jets[11], and (2) the solution to the HELP internal energy problem.

A. Comparison with Experiments

The temperature measurement of copper conical shaped charge jets has been performed by Von Holle and Trimble at BRL, using two-color infrared radiometry[12]. They made temperature measurements at the jet tip and as a function of distance behind the jet tip which indicated that the copper jets were in the solid state.

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11. W. G. Von Holle and J. J. Trimble, "Temperature Measurement of Copper and Eutectic Metal Shaped Charge Jets," BRL Report 2004, August 1977. (AD #B021338L).

12. W. G. Von Holle and J. J. Trimble, "Residual Temperature of Shocked Solids by Two-Band Infrared Radiometry," BRL Memorandum Report 2624, May 1976. (AD #B011450L)

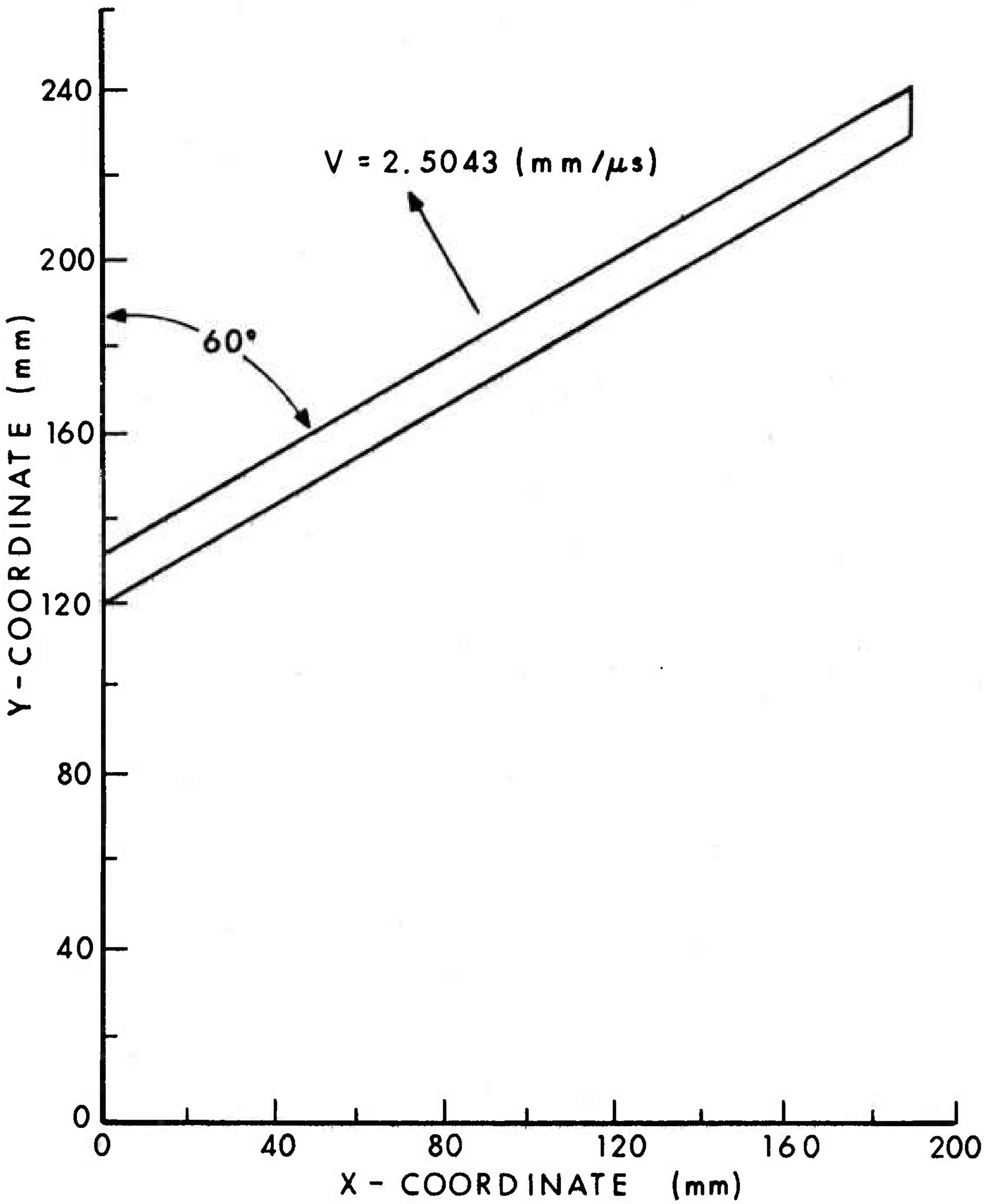

Figure 8. Initial Conditions for Copper Wedge Impact Problem.

Measurements were made for jets formed with both Composition B and octol charges. Jet tip temperatures for the Composition B charges averaged 714.15K with a standard deviation of 80K, and for the octol charges averaged 794.15K with a standard deviation of 40 K. These temperatures are all well below the melting point (1356.6K) of copper[13].

Temperatures behind the jet tip were not as well correlated as those at the jet tip. In the case of standard rounded-apex liners, observations were hampered by large amounts of debris near the jet. Jets from specially machined conical liners were free of debris behind the jet tip; however, the scatter in the data was quite large and, in fact, most of the temperature measurements were outside the calibration range (500-1100K) of the experiments. This fact is illustrated in Figure 9 which was adapted from a similar figure in reference 11. However, all measured jet temperatures were well below the melting point of copper, and we feel that comparisons with hydrodynamic theory and similar experiments with tin-lead eutectic jets give supporting evidence that the copper jets were in the solid state.

The reliability of the shaped-charge temperature measurements is supported by the success of Von Holle's[12] residual temperature measurements on copper plates. Experimentally determined temperatures of copper plates, plotted as a function of estimated pressure, are compared (Figure 10) with a theoretical curve due to McQueen and Marsh[14], based on bulk hydrodynamic theory. The theoretical curve gives consistently lower temperatures, indicating that the experimentally determined copper plate temperatures were probably not underestimates, and may be considered reasonably accurate. Furthermore, we may assume that those temperature measurements for the conical liners are also reasonably accurate, and assert, as did Von Holle, that the jets are solid at least near the tip.

Further evidence that the copper jets were in the solid state comes from comparisons with tin-lead eutectic jets[11] which were considered to be in the liquid state. Framing camera and x-ray pictures of these jets support a model of the jets as a condensed jet preceded by a cloud of much less dense materials. A rather long rise time (4 μsec) of the infrared signal from the jet lead to the assumption that the leading cloud was translucent and behaved as a volume radiator. Under the assumptions of a radiation model, consistent with the framing camera and x-ray observations, the derived temperatures indicate that

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13. D. R. Stull and H. Prophet, Project Directors, JANAF Thermochemical Tables, 2d ed., June 1971.

14. R. G. McQueen and S. P. Marsh, "Equation of State for Nineteen Metallic Elements from Shock-Wave Measurements to Two Megabars," J. Appl. Phys. 31, 1253, 1960.

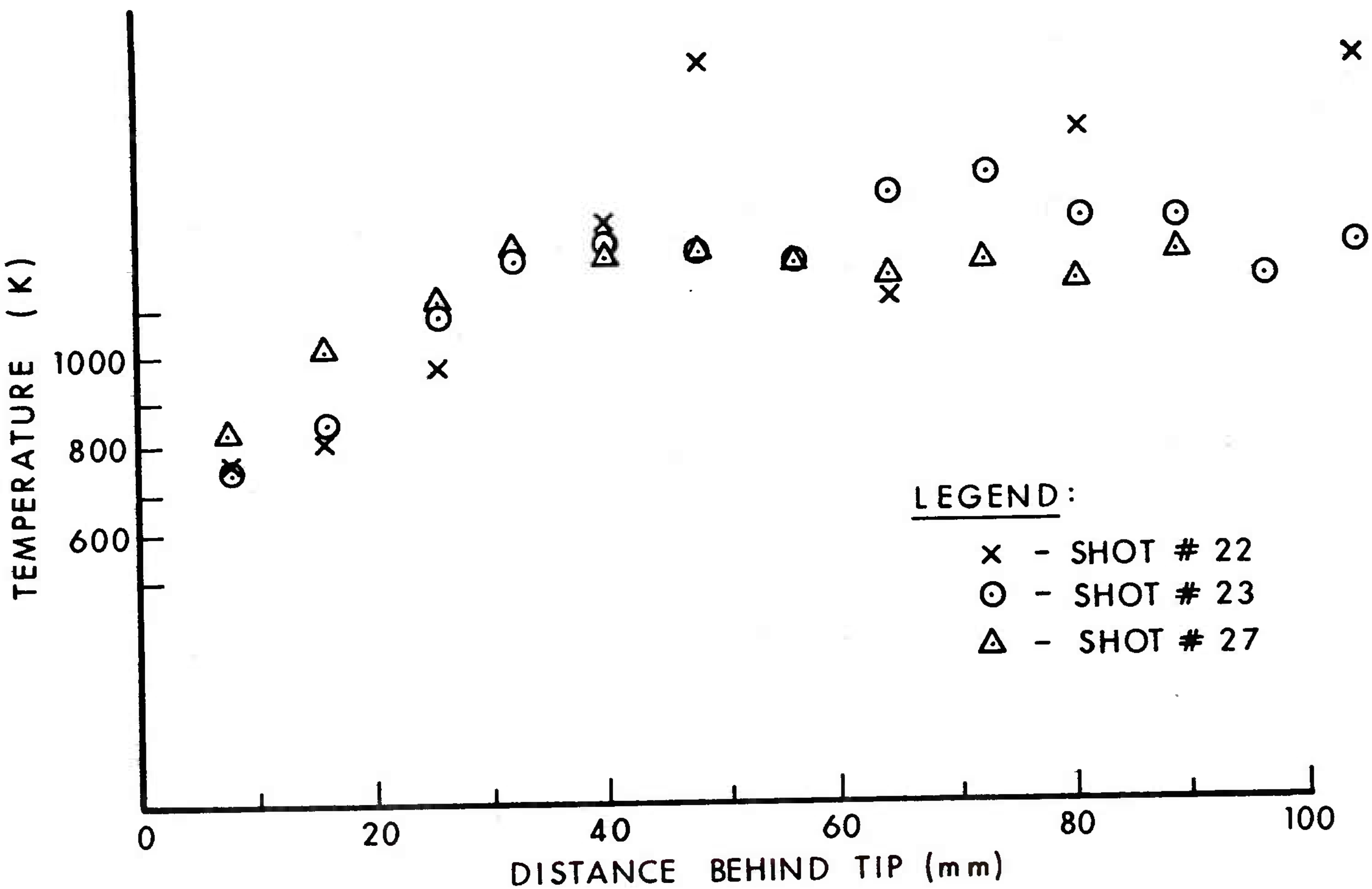

Figure 9. Temperature vs Distance Behind Tip for Octol Charges. (Adapted from Reference 11.)

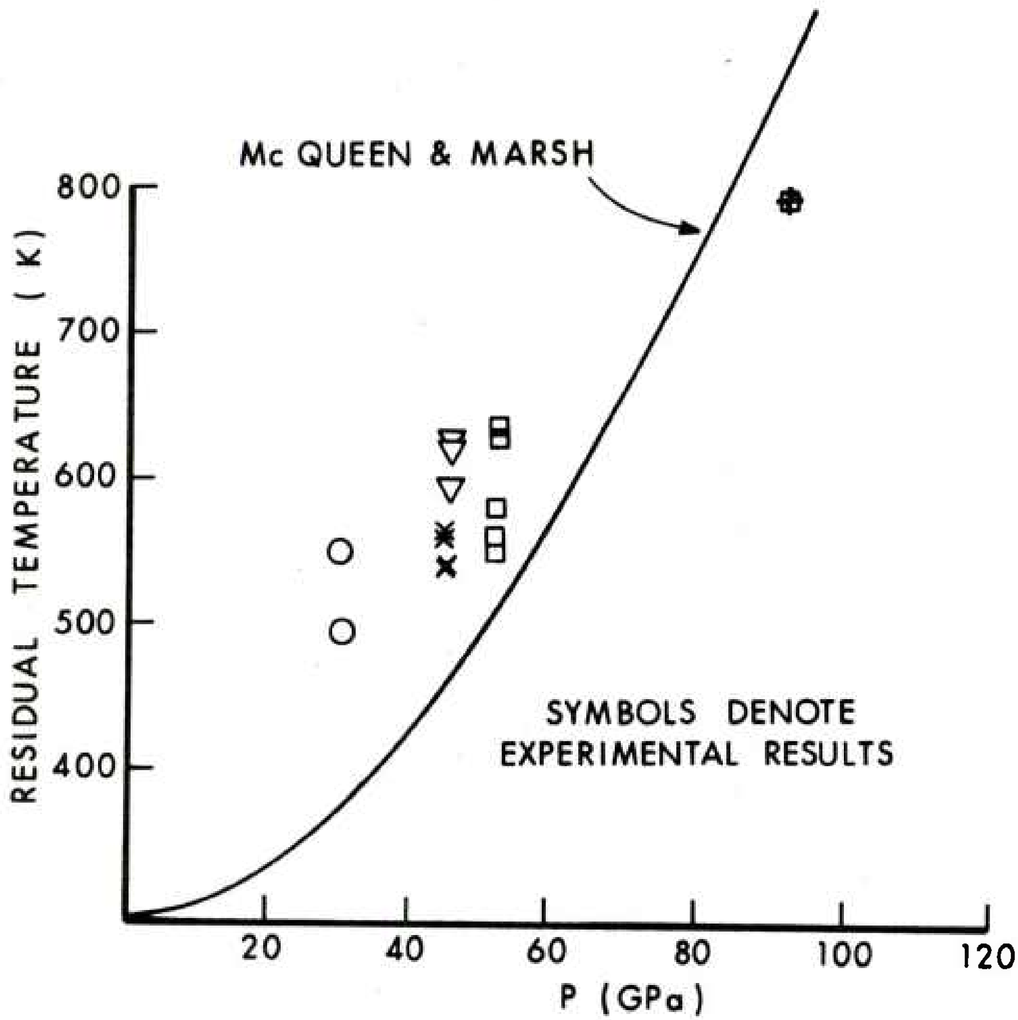

Figure 10. Plot of Copper Residual Temperature Versus Hugoniot Pressure Exhibiting Comparison of Experimental with Theoretical Data. (Adapted from Reference 12.)

the cloud material and the following condensed jet were both in the liquid state. The radiation model applicable to the copper jets was not as complex, a rapid rise time for the infrared signals indicating radiation from an opaque object. Comparisons of this model with that applicable to the eutectic jet observations indicate that the copper was not in the liquid state.

For the interested reader, Von Holle cited further evidence that the copper jets were in the solid state[15] and that the eutectic jets were in the liquid state[16].

In the copper wedge we note that while internal energies above that required for incipient vaporization are evolved, the impact velocity (1.71 km/s) is well below those determined experimentally which would induce this behavior. Experiments by Weihrauch[17], with copper projectiles impacting copper targets, indicate that in the range of impact velocities of 1-3 km/s, fluid-like behavior is manifested, with surface temperatures in excess of melt (1436-1473K for impact velocities on the order of 1.15 km/s). However, phase changes leading to vaporization should not occur until the range of impact velocities of 3-12 km/s is reached.

Internal energies for both the 43 mm conical shaped charge and copper wedge impact problems generated by the HELP code are high enough to imply that portions of the collapsed liner and deformed wedge are in the vapor state (see Figures 11 and 12). On the basis of the experimental evidence such energies are considered unphysical. The artificial bound on the internal energy used in the subroutine for the metal equation of state, for the shaped-charge problem, does maintain greater jet densities than would be obtained without the bound. However, internal energy dependent variables such as temperature and material strength remain unphysical. In the case of the hemispherical shaped charge, the calculated internal energies do not approach incipient vaporization. This does not imply that the calculated internal energy is correct, but only that we have no obvious indication of error (see Figure 13).

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15. R. Karpp and J. Simon, "An Estimate of the Strength of a Copper Shaped Charge Jet and the Effect of Strength on the Breakup of a Stretching Jet," BRL Report 1893, June 1976. (AD #B012141L)

16. G. Hauver, "Residual Temperature Measurements on Shock Compressed Metals," Bull. Am. Phys. Soc. 20, 19, 1975.

17. G. Weihrauch, "The Behavior of Copper Pins Impacting Materials with Velocities Between 50 m/s and 1650 m/s," Dissertation toward the academic degree of Doctor-Engineer in Mechanical Engineering, University of Karlsruhe, February 1971.

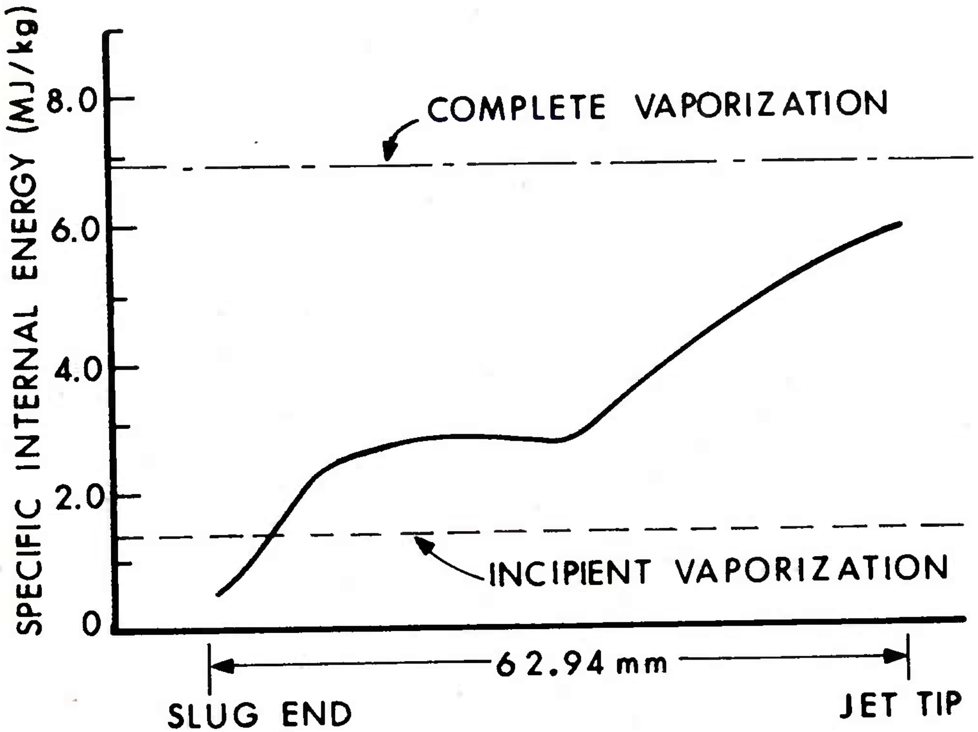

Figure 11. Specific Internal Energy of Copper for 43 mm Conical Shaped Charge Computed Along the Axis of Symmetry at 15μs Using BRLHELP.

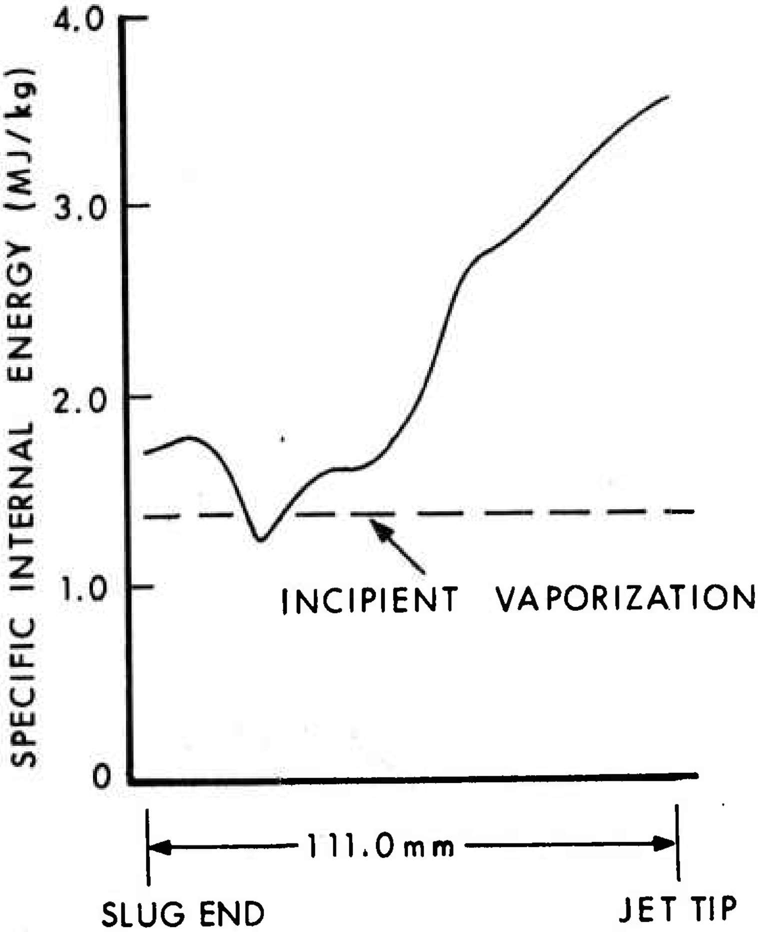

Figure 12. Specific Internal Energy for Copper Wedge Impact Computed Along the Axis at 15μs Using BRLHELP

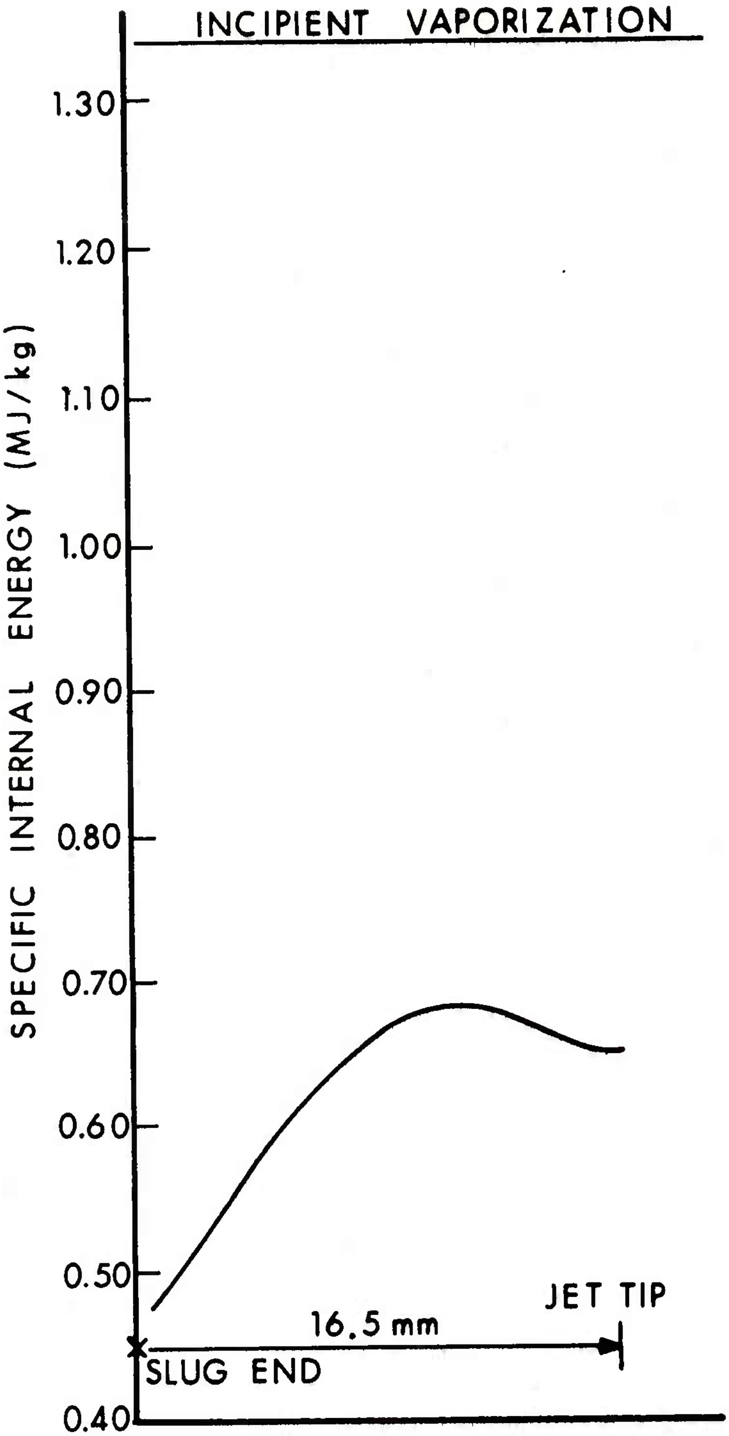

Figure 13. Specific Internal Energy for a Hemispherical Shaped Charge Computed Along the Axis of Symmetry at 16μs Using BRLHELP.

B. Numerical Analysis of HELP's Energy Formulation

It is the purpose of this section to identify the sources of error in the internal energy calculation and examine possible solutions. The algorithm by which the specific internal energy is calculated in pure cells is outlined in Section II-A. We recall that the specific internal energy at a given time level is computed as the difference between the specific total energy and the specific kinetic energy. The former is updated using a finite difference approximation to the conservation of total energy equation (3) and the latter is obtained by an algebraic manipulation of the updated values of the mass and momentum derived from finite difference approximations to the conservation of mass and momentum equations (1) and (2), respectively. All of the above quantities are calculated at the center of the computational cell.

The numerical treatment of mixed cells is far more complicated and in some instances substantially different from the pure cell treatment. As an example, the cell pressure in a multimaterial cell is obtained by an iterative procedure whereby for a constant specific internal energy value of each material the densities are varied until the pressures converge to the same value. Furthermore, in the TPHASE calculation, the properties of each material in a slipline cell are updated using previously determined individual material properties within the cell rather than the cell-centered properties. These specific treatments, although important and indispensable to the correct running of the code, make an accurate and complete analysis of the numerical treatment of mixed cells unwieldy. Consequently, the following discussion will address only the pure cell algorithm.

Two possible sources of error in the internal energy calculation are (1) the functional evaluation via equation (8) of the internal energy, and (2) the subtraction of two large quantities to obtain a small quantity. Since the former error tends to be small in actual calculations, and since the latter error would be restricted to at most a small portion of a calculation (for the class of problems considered), neither error would seem to be a major contributor to a gross error in the internal energy.

Another possible source of error is the numerical algorithm used to compute the total energy or the kinetic energy or both. After a detailed study of the total energy algorithm, no error or discrepancy was found in the manner in which it was updated at each phase. However, this was not the case with the kinetic energy calculation. To demonstrate the problem associated with the kinetic energy algorithm, we will initially limit our discussion to that portion of the HELP calculation that contributes most significantly to the artificial value of the internal energy-TPHASE. The following statements will be proven: (1) the approximations used in TPHASE to update the mass and momentum of a cell are first order accurate approximations* to the TPHASE portion of the partial differential

*A finite difference approximation to a differential equation is said to be first order accurate if the formal truncation error is first order.

equations governing conservation of mass and momentum; (2) the calculation of the corresponding kinetic energy includes terms which are of the order of the truncation error, (3) the inclusion of these first order terms produces smaller kinetic energies than that of a strictly first order approximation and, thus, larger internal energies via equation (8).

Before establishing the order of the mass and momentum approximations, we will outline the mass and momentum approximations in TPHASE. In order to simplify the discussion we consider the one-dimensional Cartesian formulation. Recall that TPHASE considers only the transport of material from cell to cell and does not consider any terms associated with the pressure or deviator stress. Thus, in modeling this phase the conservation of mass and momentum in one dimension is

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x}(\rho u) = 0, \tag{9}$$

$$\frac{\partial(\rho u)}{\partial t} + \frac{\partial}{\partial x}\left[(\rho u)u\right] = 0. \tag{10}$$

Consider three adjacent cells i-1, i and i+1 of equal length Δx. The center of the ith cell is at $x = (i-\frac{1}{2})\Delta x$. Let the velocity be positive; that is, the material is moving to the right. See Figure 14. The interface between cell i-1 and i is denoted by ℓ and that between i and i+1 by r. Integrating equations (9) and (10) over cell i, we obtain

$$\frac{\partial}{\partial t}\int_{\text{cell } i} \rho dx + (\rho u)_r - (\rho u)_\ell = 0, \tag{11}$$

$$\frac{\partial}{\partial t}\int_{\text{cell } i} \rho u dx + \left[(\rho u)u\right]_r - \left[(\rho u)u\right]_\ell = 0, \tag{12}$$

where the subscripts r and ℓ denote the evaluation of the bracketed quantities at the interfaces $r = i\Delta x$ and $\ell = (i-1)\Delta x$. The integrals in equations (11) and (12) represent the mass $m_i = \rho_i \Delta x$ and the momentum $m_i u_i = \rho_i u_i \Delta x$ in cell i, respectively. Equations (11) and (12) are the one-dimensional TPHASE portion of equations (1) and (2), respectively. The HELP code approximates equations (11) and (12) by equations

$$m_i^{n+1} - m_i^n + \delta m_r - \delta m_\ell = 0, \tag{13}$$

$$m_i^{n+1} u_i^{n+1} - m_i^n u_i^n + u_i^n \delta m_r - u_{i-1}^n \delta m_\ell = 0, \tag{14}$$

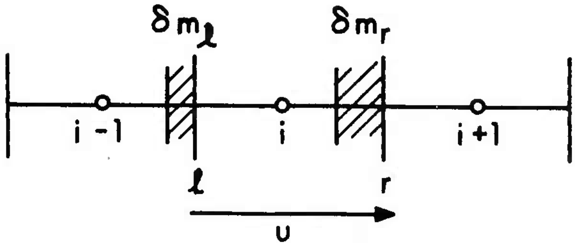

Figure 14. Geometry Associated with the TPHASE Calculation in One Dimension with a Positive Velocity.

where superscript n denotes post-HPHASE time level and n+1 the post-TPHASE time level. During a timestep Δt, an amount of mass δm and momentum $u\delta m$ associated with cells i-1 and i will be transported to cells i and i+1, respectively, since the velocity is positive. Furthermore, the HELP algorithm approximates the convected masses δm_ℓ, δm_r by

$$\delta m_\ell = \rho_{i-1}^n u_\ell \Delta t, \tag{15}$$

$$\delta m_r = \rho_i^n u_r \Delta t, \tag{16}$$

where u_ℓ and u_r are the corresponding transport velocities and a unit cross sectional area is assumed. We note that the specific momentum of each δm is based on its cell-centered velocity.

We shall now prove that the HELP approximations (13) - (16) form a first order accurate approximation to equations (9) - (10) within TPHASE. We take for example the conservation of mass. Using the relationship $m = \rho\Delta x$ and equations (15) and (16), we rewrite (13) as

$$\frac{\rho_i^{n+1} - \rho_i^n}{\Delta t} + \frac{\rho_i^n u_r - \rho_{i-1}^n u_\ell}{\Delta x} = 0. \tag{17}$$

For this simple analysis we shall use the average velocity between cell i-1 and i for u_ℓ and i and i+1 for u_r. Although the HELP code uses a more sophisticated approximation to u_ℓ and u_r, the qualitative results are the same. We expand ρ_i^{n+1}, ρ_{i-1}^n, u_{i-1}^n, u_{i+1}^n in a Taylor series with a remainder about the ith cell center and the nth time level and obtain to second order

$$\rho_i^{n+1} = \rho_i^n + \left(\frac{\partial\rho}{\partial t}\right)_i^n \Delta t + 0.5 \left(\frac{\partial^2\rho}{\partial t^2}\right)_i^{n+\theta} \Delta t^2,$$

$$\rho_{i-1}^n = \rho_i^n - \left(\frac{\partial\rho}{\partial x}\right)_i^n \Delta x + 0.5 \left(\frac{\partial^2\rho}{\partial x^2}\right)_{i-\alpha}^n \Delta x^2,$$

$$u_{i-1}^n = u_i^n - \left(\frac{\partial u}{\partial x}\right)_i^n \Delta x + 0.5 \left(\frac{\partial^2 u}{\partial x^2}\right)_{i-\beta}^n \Delta x^2, \tag{18}$$

$$u_{i+1}^n = u_i^n + \left(\frac{\partial u}{\partial x}\right)_i^n \Delta x + 0.5 \left(\frac{\partial^2 u}{\partial x^2}\right)_{i+\gamma}^n \Delta x^2,$$

where θ, α, β, γ are between zero and one. Substituting the above expansions into equation (17), we have

$$\begin{aligned}
\frac{\rho_i^{n+1} - \rho_i^n}{\Delta t} + \frac{\rho_i^n u_r^n - \rho_{i-1}^n u_\ell}{\Delta x} &= \left[\frac{\partial\rho}{\partial t} + \rho\frac{\partial u}{\partial x} + u\frac{\partial\rho}{\partial x}\right]_i^n \\
&+ \Delta x\left\{-\frac{1}{2}\left(\frac{\partial^2\rho}{\partial x^2}\right)_{i-\alpha}^n u_i^n - \frac{1}{2}\left(\frac{\partial\rho}{\partial x}\right)_i^n\left(\frac{\partial u}{\partial x}\right)_i^n + \frac{1}{4}\rho_i^n\left[\left(\frac{\partial^2 u}{\partial x^2}\right)_{i+\gamma}^n - \left(\frac{\partial^2 u}{\partial x^2}\right)_{i-\beta}^n\right]\right\} \\
&+ \Delta x^2\left\{\frac{1}{4}\left(\frac{\partial^2\rho}{\partial x^2}\right)_{i-\alpha}^n\left(\frac{\partial u}{\partial x}\right)_i^n + \frac{1}{4}\left(\frac{\partial\rho}{\partial x}\right)_i^n\left(\frac{\partial^2 u}{\partial x^2}\right)_{i-\beta}^n\right\} \qquad (19) \\
&+ \Delta x^3\left\{-\frac{1}{8}\left(\frac{\partial^2\rho}{\partial x^2}\right)_{i-\alpha}^n\left(\frac{\partial^2 u}{\partial x^2}\right)_{i-\beta}^n\right\} \\
&+ \Delta t\left\{\frac{1}{2}\left(\frac{\partial^2\rho}{\partial t^2}\right)_i^{n+\theta}\right\}.
\end{aligned}$$

From equation (19), we see that the finite difference approximation (17) differs from the partial differential equation (9) by terms multiplied by Δx or Δt. Therefore, equation (17) is a first order accurate approximation to equation (9). The formal truncation error is $O(\Delta x)$ and $O(\Delta t)$. However, the approximation (17) is equivalent to the HELP approximation (13) and, consequently, the HELP approximation (13) is said to be a first order approximation to the conservation of mass equation (9). When equation (13) is used to approximate equation (9), we observe from equation (19) that all $O(\Delta x)$, $O(\Delta t)$ and higher order terms are excluded. We shall see that this is not true in the kinetic energy calculation. Similar comments and observations to those on the conservation of mass approximation hold true for the conservation of momentum approximation.

The governing equation for the kinetic energy (obtained from an algebraic manipulation of equations (9) and (10)) is

$$\frac{\partial}{\partial t}(\rho e) + \frac{\partial}{\partial x}(\rho u)e = 0, \tag{20}$$

where $e = u^2/2$. To calculate the specific kinetic energy, the HELP algorithm takes the already computed momentum $m_i^{n+1}u_i^{n+1}$, divides it by the value of m_i^{n+1}, squares it and multiplies the result by 0.5. To determine the accuracy of the HELP approximation to equation (20), we calculate the specific kinetic energy in terms of the HELP approximations (13) and (14). From equation (14) we have

$$0.5\left(u_i^{n+1}\right)^2 = 0.5\left(m_i^{n+1}\right)^{-2}\left[m_i^n u_i^n - u_i^n \delta m_r + u_{i-1}^n \delta m_\ell\right]^2. \tag{21}$$

We expand the bracketed term, use equation (13) and obtain

$$\begin{aligned}
0.5\left(u^{n+1}\right)^2 &= 0.5\left(m_i^{n+1}\right)^2\Bigg\{m_i^n\left(u_i^n\right)^2\left[m_i^{n+1}+\delta m_r-\delta m_\ell\right] + \delta m_\ell\left(u_{i-1}^n\right)^2\left[m_i^{n+1}-m_i^n+\delta m_r\right] \\
&\quad + \delta m_r\left(u_i^n\right)^2\left[-m_i^{n+1}+m_i^n+\delta m_\ell\right] - 2m_i^n\delta m_r\left(u_i^n\right)^2 \\
&\quad + 2m_i^n\delta m_\ell u_i^n u_{i-1}^n - 2\delta m_r \delta m_\ell u_i^n u_{i-1}^n\Bigg\} \qquad (22) \\
&= \left(m_i^{n+1}\right)^{-1}\left\{m_i^n\left(u_i^n\right)^2/2 + \delta m_\ell\left(u_{i-1}^n\right)^2/2 - \delta m_r\left(u_i^n\right)^2/2\right\} \\
&\quad - 0.5\left(m_i^{n+1}\right)^{-2}\left\{\delta m_\ell\left(m_i^n-\delta m_r\right)\left(u_i-u_{i-1}\right)^2\right\}.
\end{aligned}$$

The value obtained from equation (22) for the specific kinetic energy is identical to the value the HELP algorithm calculates. We now perform a similar analysis on equation (22) to that performed on equation (13). By using equations (15), (16), $m = \rho\Delta x$ and $e = u^2/2$, we rewrite equation (22) in a more convenient form:

$$\frac{\rho_i^{n+1} e_i^{n+1} - \rho_i^n e_i^n}{\Delta t} + \frac{\rho_i^n e_i^n u_r - \rho_{i-1}^n e_{i-1}^n u_\ell}{\Delta x}$$

$$+ \frac{u_\ell \rho_{i-1}^n \rho_i^n}{2\rho_i^{n+1}} \left[\frac{u_i^n - u_{i-1}^n}{\Delta x}\right]^2 (\Delta x - u_r \Delta t) = 0. \qquad (23)$$

We now expand the quantities ρ_i^{n+1}, ρ_{i-1}^n, u_{i-1}^n, u_{i+1}^n, $(\rho e)_i^{n+1}$ and $(\rho e)_{i-1}^n$ in Taylor series about the cell center i and time level n, substitute them into equation (23) and obtain

$$\frac{\rho_i^{n+1} e_i^{n+1} - \rho_i^n e_i^n}{\Delta t} + \frac{\rho_i^n e_i^n u_r - \rho_{i-1}^n e_{i-1}^n u_\ell}{\Delta x} + \frac{u_\ell \rho_{i-1}^n \rho_i^n}{2\rho_i^{n+1}} \left[\frac{u_i^n - u_{i-1}^n}{\Delta x}\right]^2 (\Delta x - u_r \Delta t)$$

$$= \left[\frac{\partial(\rho e)}{\partial t} + \frac{\partial}{\partial x}(\rho u e)\right]_i^n + \Delta x \left\{ \frac{1}{2}\left[u\rho\left(\frac{\partial u}{\partial x}\right)^2\right]_i^n \right.$$

$$+ \frac{1}{4}(\rho e)_i^n \left[\left(\frac{\partial^2 u}{\partial x^2}\right)_{i+\gamma}^n - \left(\frac{\partial^2 u}{\partial x^2}\right)_{i-\beta}^n\right] - \frac{1}{2}\left[\frac{\partial u}{\partial x}\frac{\partial}{\partial x}(\rho e)\right]_i^n \qquad (24)$$

$$\left. - \frac{1}{2} u_i^n \left[\frac{\partial^2(\rho e)}{\partial x^2}\right]_{i-\alpha}^n \right\} + \Delta t \left\{ -\frac{1}{2}\left[u^2\rho\left(\frac{\partial u}{\partial x}\right)^2\right]_i^n + \frac{1}{2}\left[\frac{\partial^2(\rho e)}{\partial t^2}\right]_i^{n+\sigma} \right\}$$

$$+ O(\Delta x^2) + O(\Delta t^2) + O(\Delta x \Delta t).$$

The constants α, β, γ, and σ are between zero and one and are associated with Taylor expansions of $(\rho e)^n_{i-1}$, u^n_{i-1}, u^n_{i+1}, and $(\rho e)^{n+1}_i$, respectively. In order to retrieve equation (20) from the right-hand side of equation (24), $O(\Delta x)$ and $O(\Delta t)$ terms must be neglected. Thus, equation (23) is a first order approximation to equation (20). We note that the terms $0.5\left[\rho u(\partial u/\partial x)^2\right]^n_i \Delta x$ and $-0.5\left[\rho u^2(\partial u/\partial x)^2\right]^n_i \Delta t$ in equation (24) are the lowest terms derived from

$$\frac{u_\ell \rho^n_{i-1}\rho^n_i}{2\rho^{n+1}_i}\left(\frac{u^n_i - u^n_{i-1}}{\Delta x}\right)^2 (\Delta x - u_r\Delta t) \tag{25}$$

and are of the order of the truncation error. Thus, expression (25) which is included in HELP's kinetic energy approximation is of the order of the truncation error ($O(\Delta x)$, $O(\Delta t)$). If one would neglect expression (25) in equation (23), the results would still be a first order approximation to equation (20).

Although in the theoretical limit as the mesh approaches zero the truncation error term (25) approaches zero, in practice the inclusion of it in equation (23) alters the computed value of the kinetic energy of each cell at each cycle. Some important properties of expression (25) are: (1) The factor $(\Delta x - u_r\Delta t)$ is positive and the sign of the whole term depends on the transport velocity u_ℓ. Consequently, it can be easily shown that it decreases the value of the kinetic energy at the new time level. This decrease is converted to an increase in the internal energy via equation (8). (2) In regions of steep velocity gradients, the magnitude of expression (25) increases significantly because of the squared factor. In a conical shaped charge calculation, this term can decrease a cell's kinetic energy by as much as 15 percent in one time-step. During a calculation which typically consists of hundreds of cycles, the effect on the internal energy by this truncation error expression in the kinetic energy calculation at each time level is cumulative and may be substantial. (3) Expression (25) does not model any term in the partial differential equation (20) governing the kinetic energy. It is solely a result of the finite difference approximation (13) and (14). If we were to finite difference equation (20) directly, it would be

$$m^{n+1}_i e^{n+1}_i = m^n_i e^n_i + \delta m_\ell e^n_{i-1} - \delta m_r e^n_i. \tag{26}$$

Comparing equations (22) and (26), we find that the last term of equation (22), which is equivalent to expression (25), is excluded.

Furthermore, a similar analysis to the one above for the TPHASE portion of the calculation can also be done for the SPHASE and HPHASE portions and a similar result obtained. The terms corresponding to expression (25) in HPHASE and SPHASE depend on the density and the gradient squared of the pressure and normal stress, respectively. However, they are only $O(\Delta t)$ and would increase the kinetic energy (the internal energy would decrease). However, in practice the value of Δt is much less than the value of $\Delta x [O(10^{-8})$ vs $O(10^{-2})]$. Consequently, the effect of these extraneous terms may not be as significant as in TPHASE. For example, in a similar situation which gave 15 percent decrease to the kinetic energy in TPHASE, the corresponding terms in HPHASE gave only a 0.25 percent increase.

We have shown that the terms of the order of the truncation error which are included in the kinetic energy calculation increase the computed values of the internal energy. This algorithm mechanism is the cause of the unphysically high internal energy values seen in conical shaped charge simulations. A detailed analysis of the two-dimensional algorithm and the effects of the truncation error terms on the accuracy of the internal energy calculation is given in reference 18. We note that these truncation error terms are direct consequences of the method in which the kinetic energy is updated via the finite difference equations for mass and momentum in HELP. If one retains the total energy formulation in HELP and neglects these terms in the calculation of the internal energy, the present kinetic energy algorithm must be altered. The other alternative is calculating the internal energy directly from the partial differential equation governing internal energy.

V. CONCLUSIONS AND RECOMMENDATIONS

The preceding sections have sought to briefly describe the BRL CDC version of the HELP code, and to identify some of its strong and weak points in relation to shaped-charge behavior. We showed in Sections III-A and III-B that velocities and shapes of developing jets are accurately computed. However, we know from Section IV-A that the internal energy computed by HELP is unphysically high and from Section IV-B the cause. With these facts in mind, we outline a program to upgrade the code's performance while retaining its best features.

The cause of the unphysical internal energies has been identified as the inclusion of terms in the computation of the kinetic energy, which are of the order of the truncation error, in the HELP algorithm.

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18. J. A. Schmitt, "A New Internal Energy Calculation for the HELP Code, and Its Implications to Conical Shaped Charge Simulations," BRL Report ARBRL-TR-02168, June 1979, and to appear in J. Comp. Phys. (AD #A072785)

Terms of this order are only included directly in the calculation of the kinetic energy and thus, implicity, via equation (8), in the calculation of the internal energy. We recommend that another method which neglects these terms be incorporated into the HELP code[18]. Two possible approaches are: (1) a direct internal energy formulation based on the partial differential equation for internal energy, or (2) retention of the current total energy formulation but deriving computed values of the kinetic energy from the partial differential equation for kinetic energy, and not from the updated values of mass and momentum. In either case we expect a more accurately calculated value of the internal energy, and hence, a more useful HELP code.

Accurate calculation of the internal energy in metallic liners will make viable the employment of a more sophisticated metal equation of state in the HELP code. Such an equation of state is the improved (BRL-GRAY)[19] version of the GRAY[20] equation of the state. It is a multiphase (solid-liquid-vapor) equation of state which treats mixed phases in explicit detail, and is therefore particularly suited to the treatment of jet formation and breakup.

The BRL-GRAY EOS will be installed in the HELP code and comparison of this EOS with the Tillotson EOS will be made for thermodynamic regimes not well described by the Tillotson EOS. Thus, the requirements for an EOS such as BRL-GRAY for such calculations may be established.

We will also be making a modification to the HELP code that will eliminate most of the pressure iteration problems that we have encountered in our running of the code, and that have plagued other users of the code.

Ultimately we hope to provide a numerical capability with HELP that can be used reliably in prefabrication studies for proposed liner materials and gometries and generally provide theoretical support for experimental efforts.

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APPENDIX A. UPDATE Modifications

Table A-I: Subroutine DECK Names

MAIN	ADDTCR	CALFRC	CDT	COMPRSN	COMPRS	DETIME	DMADJ
EDIT	ENCHCK	ENDMV	EOUT	EQST	ERROR	FILGRD	FLGSET
FRACS	HPHASE	INFACE	INPUT	MAP	MOVTCR	NEWFLG	NEWMIX
NEWRHO	PLGADD	PLGALF	PLGGEN	PLGMAS	PLGTCR	PLGVOL	PLUGUV
PTSAV	REZONE	RNDOFF	SETUP	SETUPA	SPHASE	STRNG	THETAS
TPHASE	TSETUP	UVCALC	UVMOD	VDCLOS	XPTOC	YPTOC	ADDENG
CARDS	UC	VC	VOLFND	WN	WT	XCTOP	YCTOP

Table A-II: Additional DECK Names

IDENT	EXPLANATION
HELPCOM	COMMON deck containing blank COMMON, labeled COMMON, and related DIMENSION statements.
HELPEQ	COMMON deck containing EQUIVALENCE statements and an additional DIMENSION statement.
HELP75	DECK name used when originally loading source program from card images.

Table A-III: Correction IDENTs

IDENT	EXPLANATION
BRL76	Simplifies z-variable I/O; adds print suppression options; deletes subroutine CARDS. (See Appendix B)
CHINPUT	Corrects FORMAT error in original coding.
CHKTIM	Enables code to halt calculation before running out of CPU time.
CML77	Suppresses the repetitious CDC-FORTRAN, informative error message 115 by using the CDC utility subroutine SYSTEMC. The diagnostic is caused by the argument of the intrinsic function EXP being smaller than -675.84.
COMMOD	IDENT which was used when installing HELPCOM and HELPEQ decks into program library.
CORUVC	Corrects algebraic error in the subroutine UVCALC. (See Section II-B)
ECARDS	Added EQUIVALENCE statement to subroutine CARDS for operation on CDC 7600.

IDENT	EXPLANATION
ENENCHK	Provides printing, in each cycle, of kinetic and internal energy summs for all the cells in the grid for both material and cell-centered values.
JOHN	Corrects original coding in JWL EOS in subroutine EQST.
LCHANGE	Corrections, made by Laura Hagerman of S^3 and transmitted to TBD, dealing primarily with program errors and corrections to the automatic void closing routine.
MEMEXPND	Modifies HELPCOM to increase the number of cells in a calculation.
MOD76, MOD76A	Used in loading subroutines from HELP75 deck to new program library.
NOEDPRT	Provides options, via NAMELIST input, for suppressing certain printout from subroutine EDIT.
PRT	Added print statements to HPHASE and CMPRSN to overcome error in CDC-FORTRAN 4.3 compiler. This error does not exist in the CDC-FORTRAN 4.6 compiler.
PRTPLT	Copies variables to a deck file for subsequent plotting.
PRTPLTL	Changes PRT prints to WRITE on FILE 9.
RID	Removes improperly labeled sections of coding.

APPENDIX B. Modified Input

Instructions for generating HELP problems, using the UNIVAC 1108 version of the code, are given in Section 7.2 of reference 1. Here we indicate input differences between the BRL7600 and UNIVAC 1108 versions of the code.

In the HELP code input parameters located in the first 150 words of blank common are called Z-block variables. They are so-called because they follow Z(1), the first word of blank common, and therefore can be referenced as Z(I), where I can take any value between 1 and 150. In the UNIVAC 1108 version these parameters are read by a subroutine called CARDS. In the BRL7600 version this subroutine has been eliminated and the Z-block variables are read using the NAMELIST option.

A set of edit control parameters are first read using the NAMELIST OPTNS. The Z-variables are then read using the NAMELISTS START and RUN. These are described below.

NAMELIST OPTNS: (Edit control parameters. It should be noted that the first three of these parameters can be used to suppress diagnostic print and should be used with caution.)

IFLGST: = 0, default;
= 1, suppresses message "SUM OF FRACS NOT EQUAL TO TOTAL AREA I, J, TAU, XDY2PI =".

IPMADJ: = 0, default;
= 1, suppresses message "EVALUATION OF MATERIAL N I, J, N, M, ML, MB, TFLUX, XMASS (N,M), SAMMP (N,M), SAMPY (N,M)".

ITPHASE: = 0, default;
= 1, suppresses message "MASS EVAPORATED DUE TO ROUND-OFF IN TPHASE I, J, MFLAG, AMX, T, E".

NPRTOP: = 0, default;
= 1, suppresses edit on sliplines;
= 2, suppresses long edit on last cycle;
= 3, combines effects of (1) and (2).

TIMMAX: The maximum time in CPU seconds (decimal) that the code will use in the calculations.

For NPRTOP = 2 or 3 TIMMAX should be about 4 seconds less than the JOB CARD time; for NPRTOP = 1 or 0 TIMMAX should be about 10 seconds less than the JOB CARD time.

NAMELIST START

PK(1): Problem number.

PK(2): Restart cycle number.

PK(3): = 0, for initial run;
= -1, for restart without short edit print of restart cycle;
= -2, for restart with short edit print of restart cycle. (see p. 7.21 of reference 1)

NAMELIST RUN (Contains all Z-block variables not contained in NAMELIST START).

Input Z-Block Variables

Variable Name	Default Value	Definition
BBAR	.5	A constant used in the calculation of the local sound speed of materials other than ideal gases and high explosives. $C = C_o + BBAR \cdot \sqrt{\lvert P \rvert}$.
CRATIO	10^4	The compression of the material in adjacent cells is computed. If the ratio of these cells' compressions is greater than CRATIO, their pressures are inverse compression weighted and their velocities are compression weighted to define cell boundary values in HPHASE.
CVIS		A flag that describes the condition of the bottom grid boundary. If CVIS = 0, the bottom boundary will be reflective. If CVIS = -1, the bottom boundary will be transmittive.
CYCMX	2	The number of passes through subroutine INFACE each cycle to minimize transport noise near interfaces.
CYCPH3	1	The number of passes through subroutine SPHASE (strength phase) each cycle. When the calculation is purely hydrodynamic (no strength effects), set CYCPH3 = -1.

Variable Name	Default Value	Definition
DMIN	10^{-3}	The maximum relative error in the energy sum that the user wants to tolerate. The error is computed as follows: $\left(\sum_{k=2}^{KMAX} E_k - ETH\right)/ETH$ where E_k is total energy of cell k and ETH is theoretical energy in the grid -- computed in SETUP and updated in HPHASE, TPHASE, SPHASE, ADDENG, REZONE, and RNDOFF.
DTMIN	10^{-11}	The minimum value for the timestep. The program gives an error exit if CDT calculates a Δt < DTMIN.
EMIN	10^{7}	The minimum value of specific internal energy to be used in the ideal gas equation of state.
EMOB		This variable was read by CARDS as a dummy end card of a setup deck after all other cards were read. This card is not used in BRLHELP input.
FINAL	.4	The <u>final</u> value of the stability fraction used in determining the timestep. See STAB.
GAMMA		γ in $P = (\gamma-1) E$ for material #20, an ideal gas.
IEXTX		A rezone flag. The grid will be rezoned in the x-direction only when IEXTX = 1. Omit this card if the grid is not to be rezoned, or if it is to be rezoned in the y-direction only.
ICSTOP		Gives cycle at which execution will stop if the user wants to specify a cycle, rather than a value of T (time), on which to stop. If stopping on time, omit this card.

Variable Name	Default Value	Definition
IGM		When IGM = 0 code uses cylindrical coordinates. When IGM = 1, code uses plane coordinates.
IMAX		The number of columns in the grid. If planning to rezone the grid in the x-direction, IMAX must be an even number. IMAX also must be at least 3.
INTER		A special editing flag for debugging: = 2, for debug prints in CDT = 3, for debug prints by EDIT after HPHASE and SPHASE = 5, for debug prints in TPHASE = 7, for debug prints in SPHASE = 11, for debug prints in UVMOD = 13, for debug prints in UVCALC.
IPCYCL		The number of cycles between EDIT prints. If printing on time intervals, omit this card.
IPLGBT		The bottom-most row of the plugging region of the target. (Usually the first row of the target.) Omit this card when not using the plugging option.
IPLGRT		The right-most column of the plugging region of the target. (2-3 columns to the right of the expected location of the plug's vertical edge.) Omit this card when not using the plugging option.
IPLGTP		The top-most row of the plugging region of the target. (Usually the top row of the target.) Omit this card when not using the plugging option.
IPR	35	Maximum number of iterations CDT will perform when attempting to equilibrate the pressures of materials in a multi-material cell. If the pressures are not within an epsilon (PRCNT) of the average pressure after iterations, an error exit occurs.

Variable Name	Default Value	Definition
I1		The number of columns in the grid that have nonzero velocities or energy plus 2. I1 and I2 define the "active" grid. (Many quantities are computed only for cells inside the active grid.)
I2		The number of rows in the grid that have nonzero velocities or energy plus 2.
JEXTY		A rezone flag. The grid will be rezoned in the y-direction only when JEXTY = 1. Omit this card if the grid is not to be rezoned, or if it is to be rezoned in the x-direction only.
JMAX		The number of rows in the grid. If planning to rezone in the y-direction, JMAX must be an even number. JMAX also must be at least 3.
KUNITR	7	The name of the file INPUT will read from.
KUNITW	7	The name of the file EDIT and SETUP will write on.
LVISC		A linear artificial viscosity term is added to cell boundary pressures if LVISC = 1.
MAPS		When MAPS > 0, part of the EDIT print is a set of symbolic maps of the compression (or density), pressure, radial and axial velocities, and specific internal energy of the cells in the active grid. MAPS = 1, gives a compression map. MAPS = 2, gives a density map.
MINX MAXX MINY MAXY		These parameters specify the left and right columns and the bottom and top rows, respectively, of the region in which ADDTCR will add tracer particles. These variables must be defined when NADD $\neq$ 0.
NADD		A flag for automatically adding material tracer particles in the region specified by MINX, MAXX, MINY, MAXY. If NADD = 10 ADDTCR is called every cycle which is a multiple of 10, (e.g., cycle 20, 30, ...

Variable Name	Default Value	Definition
		250, 260, etc.). NOTE: NTRACR (=Z(72)) must also be defined before material tracers can be added by ADDTCR.
NDUMP7		Gives frequency of restart tape dumps relative to EDIT prints. (Program dumps only when EDIT prints.) e.g., if NDUMP7 = 5, a restart dump will be made every 5th time EDIT prints.
NFRELP		Gives frequency of "long" EDIT prints, which give velocities, energy, compression (or density) and stresses for all cells in active grid. A "short" EDIT gives this information only for the first column of cells, e.g., when NFRELP = 2, every second EDIT print is "long," when NFRELP = 5, every fifth EDIT print is "long", etc.
NMXCLS		The maximum number of interface cells to exist in the grid on any one cycle during the calculation. This maximum should correspond to the dimensions of the material arrays (XMASS, SIE, etc.).
NLINER		The package number of the shaped charge liner material that forms the jet. Used only when calculating the collapse of a liner.
NMAT		The number of material packages, excluding the void package.
NODUMP		When NODUMP = 1, EDIT will not write any restart dumps. (This flag overrides the NDUMP7 option, but does not prevent SETUP from writing the cycle 0 dump.)
NOSLIP		If no sliplines are to be generated, set NOSLIP = 1, which causes the instructions and routines that affect only slipline cells to be skipped.
NSLD		The maximum number of cells the user expects will contain the slipline on any one cycle. This maximum should also depend on the dimensions of the slipline arrays (MSLD, etc.).

Variable Name	Default Value	Definition
NTCC		When NTCC > 0, NTCC passive tracer particles are initially placed in the center of every fourth nonempty cell and subsequently moved through the grid with the material. These are used only for producing particle plots and do not affect the material behavior. When this card is omitted (NTCC = 0), cell-centered tracers are not computed unless the plugging option is being used, in which case they are automatically generated in the plugging region of the target.
NTPMX		The maximum number of tracer particles per material package. This maximum should correspond to the dimensions of the TX and TY arrays.
NTRACR		The number of material tracers per cell diagonal. Used by ADDTCR when adding tracers. ADDTCR adds tracers only when the distance between two consecutive tracers in a specified region is greater than a cell diagonal divided by NTRACR. MINX, MAXX, MINY, MAXY specify the region of the grid considered by ADDTCR. NADD specifies the frequency with which ADDTCR is called.
NUMREZ		The total number of times the grid will be automatically rezoned. If not automatically rezoning the grid, omit this card.
NUMSCA		The number of times the cycle or time interval between EDIT prints is increased. (See PRLIM)
NVRTEX		The second index of the void tracer particle that is at the vertex of the void closing region, i.e., (TX(NVOID, NVRTEX), TY(NVOID, NVRTEX)) are the coordinates of the vertex point. Used only when the code's automatic void closing routine is to be activated.
PK(1)		Problem number. Any number from .0001 to 99.9999.

Variable Name	Default Value	Definition
PLGOPT		If the user is generating a plugging calculation, PLGOPT must be set equal to 1. The special plugging mechanisms are activated only if PLGOPT = 1. (See Chapter VI, Ref. 1, before using the plugging option.)
PLWMIN		The required minimum specific plastic work (ergs/gm) which the material near the top of the vertical edge of the plug must have before the plug edge is extended to the next row. Omit this card when not using the plugging option.
PMIN	5×10^6	A pressure cutoff. If $\lvert P(k) \rvert$ < PMIN, then then $P(k) = 0$.
PRCNT	.001	Convergence criterion for the pressure equilibration of material in a multi-material cell. All material pressures, P_i, must satisfy the following: $\lvert (P_{av} - P_i)/P_{av} \rvert <$ PRCNT.
PRDELT		The time (sec) between EDIT prints. If printing on cycle intervals, omit this card.
PRFACT		The factor by which the print interval (PRDELT or IPCYCL) and the print limit (PRLIM) are increased. (See PRLIM)
PRLIM		The time or cycle at which the EDIT print frequency is changed. Example: you wish to print every 10^{-8} sec until $T = 10^{-7}$ sec; and every 10^{-7} sec until $T = 10^{-6}$ sec, and every 10^{-6} sec thereafter. Set: PRDELT = 10^{-8} IPCYCL = 0. PRLIM = 10^{-7} PRFACT = 10. NUMSCA = 2. NOTE: When PRDELT is increased by a factor PRLIM is also increased by the same

Variable Name	Default Value	Definition
		factor for the next rescaling. If you want a constant print interval, omit NUMSCA, PRLIM, PRFACT.
PROB		Problem number. Is set equal to PK(1) by the code.
REZ		The flag which initiates the rezoning of the grid. If NUMREZ > 0, this flag will be set automatically by the code. However, the user can force a rezone on any restart cycle by setting REZ = 1 in the restart deck. (IEXTX and/or JEXTY must also be defined in order for the grid to be rezoned.)
ROEPS	10^{-5}	A round-off epsilon used to define cutoffs in the calculation.
SIEMIN	10^{5}	A cutoff on the total specific internal energy increment of a cell in TPHASE. This cutoff prevents small numerical signals from enlarging the active grid.
STAB	10^{-3}	The <u>initial</u> value of the stability fraction used in determining the time step. If FINAL = 0, STAB is constant. Otherwise, its value is doubled each cycle until it reaches the value of FINAL.
TSTOP		The value of T (time) at which the calculation will stop. When stopping on a specified cycle (ICSTOP > 0), set TSTOP = 0. TSTOP must always be included in both the setup deck and the restart deck.

APPENDIX C. Sample Calculations

This appendix contains listings of input decks and corresponding output for three sample problems:

1. 43mm conical shaped charge;
2. Hemispherical shaped charge;
3. (a) Copper wedge startup; and,
   (b) Copper wedge restart.

The input deck listings are contained in Section C-I along with an explanation of the job control language (JCL) statements necessary for running these problems on a CDC 7600. The remaining sections of Appendix C deal with the code output for each problem.

Appendix C-I: Input Deck Listings

The JCL stream typically contains seven cards if input-output (IO) is performed on disk. These are as follows:

Card 1	"Job card", specifies user name, mainframe station, time limit.
Card 2	Request for permanent file space allocation (for code restart file, TAPE 10).
Card 3	GETPF, which puts a copy of the HELP program library onto a local file (A).
Card 4	Full UPDATE with OLDPL = A, NEWPL = B.
Card 5	FTN card.
Card 6	LGO card.
Card 7	Catalogs "TAPE 10" on permanent file.

The next cards shown in the startup (initial run) decks are: a problem identifier card (Hollerith); the NAMELIST input described in Appendix B; grid specifications; material package information including initial density, velocity, and specific internal energy for each material; strength constants; tracer particle specifications; slipline information if used; and specifications of high explosive detonation points.

To run the copper wedge problem a modification is necessary to the basic geometry. This modification is shown in the UPDATE input stream with the IDENT WEDGEOM. It shortens the YAXIS array and lengthens the XAXIS array to allow as large a copper bar as possible within the constraints of the problem and the total number of cells allowed (12001). It should also be noted that in this problem no sliplines (NOSLIP = 1) are employed.

In the copper wedge restart one JCL card is added to put the restart file onto a local file. The code expects this file to be called TAPE7. It should also be noted that the general specifications following the NAMELIST input on initial runs is not needed here as this information is already available to the code from the restart file. The variable PK(2) = 11 specifies the restart cycle number and PK(3) = -1 indicates that the problem is a restart. ICSTOP = 14 specifies that the calculation should halt after 14 cycles.

```
MBR48,STMFZ,T2000. SAMPLE PROBLEM 2-CU HEMISPHERE LACETERA,JANET
REQUEST(TAPE7, *PF)
GETPF(A,BRLHELP,ID=CMCHYDRO)
UPDATE(F,P=A,N=B)
FTN(I=COMPILE,L=0,PL=55000,LCM=I)
RFL(160000)
LGO.
CATALOG(TAPE7,HEMI,ID=CMCHYDRO)
EXIT.
 SAMPLE PROBLEM 2 - COPPER HEMISPHERE LOADED WITH COMP B HE UNCONFINED
 $OPTNS NPRTOP=2,  TIMMAX=1000,   IFLGST=1,    IPMADJ=1,    ITPHSE=1$
 $START PK(1)=1,   PK(2)=0,       PK(3)=-0$
 $RUN   TSTOP=1.5E-04,           PRDELT= 2.0E-06,
        KUNITW=7,  KUNITR=7,
        NOSLIP=0,  LVISC=1,
        NMAT=2,    NMXCLS=800,    NTRACR=5,    NTPMX=900,   REZ=0.,
        CYCPH3=-1,  NLINER=1,      NSLD=300,
        MAPS=1,    IMAX=60,       JMAX=200,    DMIN=100,
        IPR=100,
        NFRELP=100, NDUMP7=1,     IPCYCL=0,    I1=3,        I2=53,
        CVIS=-1,    IGM=0$
 60                .05
 999
 200               .05
 999
   0
   3      8.94     0.0       0.0       0.0
  21      1.717    0.0       0.0       0.0
  2.35E+09  6.95E+10  5.50E+10  5.30E+09  4.55E+11   .9785
  0.0       0.0       0.0       0.0       0.0        1.0
   4    1   300
   3.14159  1.57080
  0.0       6.35      1.905
   1    1   50
  1.905     6.35      1.7907    6.35
  -4    1   300
   1.57080  3.14159
  0.0       6.35      1.7907
   1    2   100
  0.0       2.54      2.159     2.54
   2    2   200
   2.159    2.54      2.159     6.35
   1    2   50
   2.159    6.35      1.905     6.35
  -4    2   300
   1.57080  3.14159
  0.0       6.35      1.905
   4    3   300
   3.14159  1.57080
```

```
  0.0       6.35      1.7907
    1    3   50
   1.7907   6.35      1.905     6.35
    1    3   50
   1.905    6.35      2.159     6.35
    2    3  200
   2.159    6.35      2.159     2.54
   -1    3  100
   2.159    2.54      0.0       2.54
  100
    1    0    1    0  300       0
    0    2    0  301    0    600
         1         2         0.0       2.54       0.0
         2         2         1.82      5.62
         0
  0.0           2.54      2.159     6.35
  0.0           5.59      2.159     6.35
*EOI
```

```
MBR48,STMFZ,T77.  BRLHELP     TEST WEDGE 1.0      STARTUP
REQUEST(TAPE10,*PF)
GETPF(A,BRLHELP,ID=CMCHYDRO)
UPDATE(F,P=A,N=B)
FTN(I=COMPILE,L=0,PL=55000,LCM=I)
LGO.
CATALOG(TAPE10,60WEGECU,ID=CMCHYDRO)
*EOR
*IDENT 08NOV77
*I EDIT.240

  305 CONTINUE
*D NOEDPRT.8
*IDENT WEDGEOM
*D MEMEXPND.3
       COMMON/MISC/ PQ(5,8),XAXIS(5,85),YAXIS(5,140),VL(4)
*D MEMEXPND.4
      COMMON/XDXYDY/ X00,X(85),Y00,Y(140),DX00,DX(85),DY00,DY(140)
*D MEMEXPND.12
     2 MFLAG(12001),TAU(85),UL(400),PL(400),TX(5,900),
*D MEMEXPND.33
       COMMON/MAP/ PROP(85),PR(85)
*EOR
       COPPER IMPACT STUDY 60 DEGREE WEDGE
 $OPTNS NPRTOP=3,     TIMMAX= 60., IFLGST=1, IPMADJ=1, ITPHSE=1$
 $START PK(1)=29.$
 $RUN KUNITW=10,
 NOSLIP=1,   LVISC=1,
 NMAT=1.,   NMXCLS=800.,   NTRACR=5.,   NTPMX=900,   REZ=0.,
 CYCPH3=-1.,
 MAPS=1.,  I1=85,  I2=140, IMAX=85,  JMAX=140,
 TSTOP=5.0E-06,    NFRELP=100,    NDUMP7=1,      IPCYCL=50,
 CVIS=-1.,   IGM=1$
  60   6   5  14    .1        .25        .5        1.0
 999
  10  10 100  10    .5        .25        .1        .25
  10                .5
 999
   0
   2       8.94     0.0      -2.170E+05 1.250E+05
 2.350E+09 6.950E+10 5.500E+10 5.300E+09 4.550E+11  .9785
   3    1  200
 0.0       12.0     19.00     22.972
   2    1   50
  19.0     22.972   19.0      24.129
  -3    1  200
 19.0      24.129   0.        13.159
   3    2  200
 0.0       13.159   19.0      24.129
   2    2   50
 19.0      24.129   19.0      22.972
  -3    2  200
 19.0      22.972   0.        12.0
  100
```

```
MBR48,STMFZ,T77.  BRLHELP     TEST WEDGE 2.0      RESTART
REQUEST(TAPE10,*PF)
GETPF(TAPE7,60WEGECU,CY=1,ID=CMCHYDRO)
GETPF(A,BRLHELP,ID=CMCHYDRO)
UPDATE(F,P=A,N=B)
FTN(I=COMPILE,L=0,PL=55000,LCM=I)
LGO.
CATALOG(TAPE10,60WEGECU,ID=CMCHYDRO)
*EOR
*IDENT 08NOV77
*I EDIT.240

  305 CONTINUE
*D NOEDPRT.8
*IDENT WEDGEOM
*D MEMEXPND.3
       COMMON/MISC/ PQ(5,8),XAXIS(5,85),YAXIS(5,140),VL(4)
*D MEMEXPND.4
      COMMON/XDXYDY/ X00,X(85),Y00,Y(140),DX00,DX(85),DY00,DY(140)
*D MEMEXPND.12
     2 MFLAG(12001),TAU(85),UL(400),PL(400),TX(5,900),
*D MEMEXPND.33
       COMMON/MAP/ PROP(85),PR(85)
*EOR
       COPPER IMPACT STUDY 60 DEGREE WEDGE
 $OPTNS NPRTOP=3,     TIMMAX= 60., IFLGST=1, IPMADJ=1, ITPHSE=1$
 $START PK(1)=29.$
 $START PK(1)=29.,   PK(2)=11.,   PK(3)=-1.$
 $RUN KUNITW=10,   KUNITR=7,
 NOSLIP=1,   LVISC=1,
 NMAT=1.,   NMXCLS=800.,   NTRACR=5.,   NTPMX=900,   REZ=0.,
 CYCPH3=-1.,
 MAPS=1.,  I1=85,  I2=140, IMAX=85,  JMAX=140,
 TSTOP=0.0E-06,   NFRELP=100,   NDUMP7=1,     IPCYCL=50,  ICSTOP=14,
 CVIS=-1.,   IGM=1$
*EOI
```

```
MBR48,STMFZ,T77.                    43-MM SHAPED CHARGE
REQUEST(TAPE10,*PF)
GETPF(A,BRLHELP,ID=CMCHYDRO)
UPDATE(F,P=A,N=B,L=A1234)
FTN(I=COMPILE,L=0,PL=55000,LCM=I)
LGO.
CATALOG(TAPE10,43MMCALC,ID=CMCHYDRO)
             43-MM SHAPED CHARGE CALCULATION
 $OPTNS NPRTOP=2,     TIMMAX=60.,  IFLGST=0, IPMADJ=1, ITPHSE=0$
 $START PK(1)=43.$
 $RUN      NOSLIP=0,   LVISC=0,   DMIN=1.0E03,
 NMAT=2.,   NMXCLS=800.,   NTRACR=5.,   NTPMX=900,   REZ=0.,
 MAPS=0,   I1= 60, I2=187, IMAX=60,  JMAX=187,
 ICSTOP=849,       PRDELT=5.0E-07,   NLINER=1,  NSLD=300,
 TSTOP=0.0,        NFRELP=1000,   NDUMP7=1,      IPCYCL=0,
 CYCPH3=+1.,      KUNITW=10,
 CVIS=-1.,   IGM=0$
  46   1   1   1    .052      .0572     .0629     .0692
   1   1   1   1    .0761     .0837     .0921     .1013
   1   1   1   1    .1114     .1225     .1348     .1483
   1   1   1        .15       .1992     .1993
 999
 187                .052
 999
    0
    2       8.9       0.0       0.0       0.0
   21       1.717    0.0       0.0       0.0
 2.350E+09 6.950E+10 5.500E+10 5.300E+09 4.550E+11  .9785
 0.0       0.0       0.        0.        0.         1.0
    4    1  100
     3.142     1.950
     0.000     3.696     0.254
    3    1  300
     0.236     3.600     2.296     8.573
    1    1   50
     2.296     8.573     2.159     8.573
    3    1  300
     2.159     8.573     0.118     3.649
   -4    1  100
     1.950     3.142
     0.000     3.696     0.127
    1    2  100
     0.000     1.270     2.296     1.270
    2    2  200
     2.296     1.270     2.296     8.573
    3    2  300
     2.296     8.573     0.236     3.600
   -4    2  100
     1.950     3.142
     0.000     3.696     0.254
```

```
    4    3   100
     3.142      1.950
     0.000      3.696      0.127
    3    3   300
     0.118      3.649      2.159      8.573
    1    3    50
     2.159      8.573      2.296      8.573
    2    3   200
     2.296      8.573      2.296      1.270
   -1    3   100
     2.296      1.270      0.000      1.270
  100
    1    0    1    0  400    0
    0    2    0  301    0  700
         1         2         0.0        1.27        0.0
         0
0.         1.27        2.29646    8.57
```

Appendix C-II: 43 mm Shaped Charge Output

The complete code output is shown for the 43 mm shaped charge calculation, along with one page of UPDATE output and three pages of system output. The first two pages of UPDATE output were calls to COMDECKS and are not shown. The third UPDATE page shows the correction IDENT and DECK lists. The system output consists of the SCOPE 2 load map.

The first page of code output is the OPTNS namelist followed by: material package geometry and slidepoint information; a short edit on the explosive detonation*; Z-variable values; initial conditions for each material; material properties needed for strength calculations (note that specific internal energy as well as pressure are given relative to reference values at ambient conditions); mesh specifications; a message that cell (1, 25) has been detonated and that $t_o = 3.2964778 \times 10^{-8}$ sec; a cycle zero summary; eight pages of cell coordinates for tracer particles; and a summary of the total energy in the grid in terms of both cell-centered and material values for SPHASE and HPHASE.

These are followed by part of a map of the mixed and pure cells. If the Z-variable MAPS had not been set to zero these would also have been a complete set of maps for the other output variables (compression, pressure, radial velocity, axial velocity, and specific internal energy).

The remaining output is typical for terminal output with NPRTOP = 2 and MAPS = 0. Following the tracer particle edit is an edit of output parameters along the y-axis of the problem with the y-axis of the problem with the y-axis index varying from 185 to 1.

It should be noted that while IFLGST and ITPHSE are zero in this problem the corresponding output does not appear here because the conditions for these outputs have not yet occurred.

To obtain the full print out, the following coding must be inserted in DETIME in place of statement 436 CONTINUE:

```
436 WRITE(6,530) J,(DETIM(K+I), I=1,IMAX).
```

*The full detonation edit, including detonation times for each detonation point, is automatically suppressed in this version of BRLHELP but will appear as optional output in subsequent versions.

```
          CORRECTION IOENTS ARE LISTED IN CHRONOLOGICAL ORDER OF INSERTION

     HELPCOM  MAIN     AOOTCR   CALFRC   COT      CMPRSN   COMPRS   OETIME
     OMAOJ    OMCALC   EOIT     ENCHCK   ENOMV    EOUT     EQST     ERROR
     FILGRO   FLGSET   FRACS    HPHASE   INFACE   INPUT    MAP      MOVTCR
     NEWFLG   NEWMIX   NEWRHO   PLGADO   PLGALF   PLGGEN   PLGMAS   PLGTCR
     PLGVOL   PLUGUV   PTSAV    REZONE   RNDOFF   SETUP    SETUPA   SPHASE
     STRNG    THETAS   TPHASE   TSETUP   UVCALC   UVMOO    VOCLOS   XPTOC
     YPTOC    HELP75   HELPEQ   ADOENG   CAROS    UC       VC       VOLFNO
     WN       WT       XCTOP    YCTOP    COMMOO   MOD76    MOO76A   RID
     JOHN     ECAROS   MEMEXPNO PRF      PRTPLT   LCHANGE  PRTPLT1  CHKTIM
     NOEOPRT  ENENCHCK CHINPUT  BRL76    CMC77    CMCFEB77 CORUVC   CMCOCT77


OECKS ARE LISTED IN THE ORDER OF THEIR OCCURRENCE ON A NEW PROGRAM LIBRARY IF ONE IS CREATEO BY THIS UPOATE

     YANK$$$  HELPCOM  MAIN     AOOTCR   CALFRC   COT      CMPRSN   COMPRS
     OETIME   OMAOJ    EOIT     ENCHCK   ENOMV    EOUT     EQST     ERROR
     FILGRO   FLGSET   FRACS    HPHASE   INFACE   INPUT    MAP      MOVTCR
     NEWFLG   NEWMIX   NEWRHO   PLGAOO   PLGALF   PLGGEN   PLGMAS   PLGTCR
     PLGVOL   PLUGUV   PTSAV    REZONE   RNOOFF   SETUP    SETUPA   SPHASE
     STRNG    THETAS   TPHASE   TSETUP   UVCALC   UVMOO    VOCLOS   XPTOC
     YPTOC    HELPEQ   ADOENG   CAROS    UC       VC       VOLFNO   WN
     WT       XCTOP    YCTOP

      COMMON OECKS ENCOUNTEREO

     HELPCOM  HELPEQ


     OECKS WRITTEN TO COMPILE FILE

     MAIN     AUOTCR   CALFRC   COT      CMPRSN   COMPRS   DETIME   OMAOJ
     EOIT     ENCHCK   ENOMV    EOUT     EQST     ERROR    FILGRO   FLGSET
     FRACS    HPHASE   INFACE   INPUT    MAP      MOVTCR   NEWFLG   NEWMIX
     NEWRHO   PLGAOO   PLGALF   PLGGEN   PLGMAS   PLGTCR   PLGVOL   PLUGUV
     PTSAV    REZONE   RNOOFF   SETUP    SETUPA   SPHASE   STRNG    THETAS
     TPHASE   TSETUP   UVCALC   UVMOO    VOCLOS   XPTOC    YPTOC    AOUENG
     CAROS    UC       VC       VOLFNO   WN       WT       XCTOP    YCTOP

 THIS UPOATE REQUIREU  25400B WOROS OF CORE.
```

S C O P E   2   L O A D   M A P   LOADER VERSION 1.0   06/29/78 13.54.50   PAGE 1

PROGRAM WILL BE ENTERED AT MAIN (56200)   SCM LENGTH   153257   LCM LENGTH   535160

BLOCK	ADDRESS	LENGTH
/TRACRS/	100	3410
/MXCELL/	3510	31132
/SL/	34642	40
/SLIDE/	34702	2734
/SLIDPK/	37636	30
/MISC/	37666	2500
/PLSTC/	42366	12432
/XDXYDY/	55020	1014
/OPTNS/	56034	5
/ERRDEC/	56041	6
MAIN	56047	346
ADDTCH	56415	664
CALFRC	57301	741
CDT	60242	2070
CMPRSN	62332	201
COMPRS	62533	754
DETIME	63507	2040
/INF/	65547	2
DMADJ	65551	733
DMCALC	66504	1123
EDIT	67627	2572
ENCHCK	72421	307
ENDMV	72730	271
EOUT	73221	162
EQST	73403	1053
ERROR	74456	561
FILGRD	75237	615
FLGSET	76054	1121
FRACS	77175	2673
HPHASE	102070	1164
INFACE	103254	177
INPUT	103453	2462
MAP	106135	1520
/MOV/	107655	27
MOVTCR	107704	1034
NEWFLG	110740	221
NEWMIX	111161	237
NEWRHO	111420	317
PLGADD	111737	211
/MKPLUG/	112150	3
PLGALF	112153	206
PLGGEN	112361	331
PLGMAS	112712	432
PLGTCR	113344	1020
PLGVOL	114364	405
PLUGUV	114771	327
PTSAV	115320	346
REZONE	115666	1316
RNDOFF	117204	214
SETUP	117420	1533
SETUPA	121153	577
SPHASE	121752	6265

```
STRNG        130237        301
THETAS       130540        636
TPHASE       131376       3524
TSETUP       135122       1125
UVCALC       136247        540
UVMOO        137007        515
VOCLOS       137524        532
XPTOC        140256        213
YPTOC        140471        207
AODENG       140700        350
UC           141250         20
VC           141270         20
VOLFNO       141310        755
WN           142265         20
WT           142305         20
XCTOP        142325        155
YCTOP        142502        152
 /STP.ENO/   142654          1
 /FCL.C./    142655         23
 /Q8.IO./    142700        135
Q8NTRY=      143035          1
BACKSP=      143036         50
COMIO=       143106         60
ENOFIL=      143166         45
FECMSK=      143233         41
FLTIN=       143274        154
FLTOUT=      143450        315
FMTAP=       143765        372
FORSYS=      144357        557
FORUTL=      145136         16
GETFIT=      145154         43
INCOM=       145217        262
 /IO.BUF./   145501        227
INPB=        145730        316
INPC=        146246        173
KODER=       146441        467
KRAKER=      147130        435
NAMIN=       147565        534
NAMOUT=      150321        267
OUTB=        150610        207
OUTC=        151017        174
OUTCOM=      151213        204
REWIND=      151417         35
SYSTEMC      151454        411
CLOCK=       152065         34
GOTOER=      152121         14
ACOSIN=      152135         77
ATAN2        152234        100
EXP          152334        100
SINCOS=      152434         74
SQRT         152530         46
SYSAIO=      152576          1
SYS=1ST      152577         62
SYS=AIO      152661          7
TAN=         152670         74
 //          152764        273
 /ELPL/           0 L   106250
```

```
/MXCEL1/    106250 L     42310
/GRID/      150560 L    267340
/ADDENG/    440120 L     45410
/CUT/       505530 L        50
/MAP/       505600 L       170
/INFACE/    505770 L      7640
/PH2/       515630 L     11360
/REZONE/    527210 L      5750
```

```
$OPTNS
IFLGST  = 0,
IPMADJ  = 1,
ITPHSE  = 0,
NPRTOP  = 2,
TIMMAX  = .6E+02,
$END
```

43-MM SHAPED CHARGE CALCULATION

```
   TYPE=   4      PACKAGE=  1      NUMBER OF POINTS=  100
 TH1=   .3142000E+01  TH2=   .1950000E+01  A=  0.           B=   .3696000E+01  R=   .2540000E+00
   TYPE=   3      PACKAGE=  1      NUMBER OF POINTS=  300
   X1=   .2360000E+00     Y1=   .3600000E+01     X2=   .2296000E+01     Y2=   .8573000E+01
   TYPE=   1      PACKAGE=  1      NUMBER OF POINTS=   50
   X1=   .2296000E+01     Y1=   .8573000E+01     X2=   .2159000E+01     Y2=   .8573000E+01
   TYPE=   3      PACKAGE=  1      NUMBER OF POINTS=  300
   X1=   .2159000E+01     Y1=   .8573000E+01     X2=   .1180000E+00     Y2=   .3649000E+01
   TYPE=  -4      PACKAGE=  1      NUMBER OF POINTS=  100
 TH1=   .1950000E+01  TH2=   .3142000E+01  A=  0.           B=   .3696000E+01  R=   .1270000E+00
   TYPE=   1      PACKAGE=  2      NUMBER OF POINTS=  100
   X1=  0.                Y1=   .1270000E+01     X2=   .2296000E+01     Y2=   .1270000E+01
   TYPE=   2      PACKAGE=  2      NUMBER OF POINTS=  200
   X1=   .2296000E+01     Y1=   .1270000E+01     X2=   .2296000E+01     Y2=   .8573000E+01
   TYPE=   3      PACKAGE=  2      NUMBER OF POINTS=  300
   X1=   .2296000E+01     Y1=   .8573000E+01     X2=   .2360000E+00     Y2=   .3600000E+01
   TYPE=  -4      PACKAGE=  2      NUMBER OF POINTS=  100
 TH1=   .1950000E+01  TH2=   .3142000E+01  A=  0.           B=   .3696000E+01  R=   .2540000E+00
   TYPE=   4      PACKAGE=  3      NUMBER OF POINTS=  100
 TH1=   .3142000E+01  TH2=   .1950000E+01  A=  0.           B=   .3696000E+01  R=   .1270000E+00
   TYPE=   3      PACKAGE=  3      NUMBER OF POINTS=  300
   X1=   .1180000E+00     Y1=   .3649000E+01     X2=   .2159000E+01     Y2=   .8573000E+01
   TYPE=   1      PACKAGE=  3      NUMBER OF POINTS=   50
   X1=   .2159000E+01     Y1=   .8573000E+01     X2=   .2296000E+01     Y2=   .8573000E+01
   TYPE=   2      PACKAGE=  3      NUMBER OF POINTS=  200
   X1=   .2296000E+01     Y1=   .8573000E+01     X2=   .2296000E+01     Y2=   .1270000E+01
   TYPE=  -1      PACKAGE=  3      NUMBER OF POINTS=  100
   X1=   .2296000E+01     Y1=   .1270000E+01     X2=  0.                Y2=   .1270000E+01
   TYPE= 100      PACKAGE=  0      NUMBER OF POINTS=    0
```

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	1	0	1	0	400	0
2	0	2	0	301	0	700

DETONATION TIME CALCULATION FOR EXPLOSIVE PACKAGES

TYPE OF INITIATION POINT 1 EXPLOSIVE PACKAGE 2 INITIATION POINTS 0. 1.27000E+00 DELAY TIME 0.

```
SEARCH AREA XMIN  0.            YMIN  1.2700000E+00  XMAX  2.2964600E+00  YMAX  8.5700000E+00
INITIATION POINT X    0.           Y      1.2700000E+00  DELAY TIME  0.

               DETONATION TIME FOR EACH ROW(J)

      J


Z-VARIABLES
 BBAR   = 5.000E-01   CRATID= 1.000E+04   CVIS   =-1.000E+00   CYCMX  = 2.000E+00   CYCPH3= 1.000E+00   DMIN   = 1.000E+03
 DTMIN  = 1.000E-11   EMIN   = 1.000E+07   EMOB   = 0.          FINAL  = 4.000E-01   GAMMA  = 0.          IEXTX  =          0
 ICSTOP=        849   IGM    =          0   IMAX   =         60   INTER  =          0   IPCYCL=          0   IPLGBT=          0
 IPLGRT=          0   IPR    =         35   I1     =         60   I2     =        187   JEXTY  =          0   JMAX   =        187
 KUNITR=         10   KUNITW=         10   LVISC  =          0   MAPS   =          0   MINX   =          0   MAXX   =          0
 MINY   =         0   MAXY   =          0   NADD   =          0   NDUMP7=          1   NFRELP=       1000   NMXCLS=        800
 NLINER=          1   NMAT   =          2   NODUMP=          0   NOSLIP=          0   NSLD   =        300   NTCC   =          0
 NTPMX  =       900   NTRACR=          5   NUMREZ= 0.          NUMSCA=          0   NVRTEX=          0
 PK(1)  = 4.300E+01   PK(2)  = 0.          PK(3)  = 0.          PK(4)  = 0.          PK(5)  = 0.
 PLGOPT= 0.           PLWMIN= 0.           PMIN   = 5.000E+06   PRCNT  = 1.000E-03   PRDELT= 5.000E-07   PRFACT= 0.
 PRLIM  = 0.          PROB   = 4.300E+01   REZ    = 0.          ROEPS  = 1.000E-05   SIEMIN= 1.000E+05   STAB   = 1.000E-03
 TSTOP  = 0.
```

PACKAGE NUMBER	NORMAL DENSITY (RHOZ)	INITIAL DENSITY (RHOIN)	S.I.E.	U	V	MATERIAL
1	8.900	8.900	0.	0.	0.	COPPER
2	1.717	1.717	0.	0.	0.	COMP B

S T R E N G T H   C O N S T A N T S

PACKAGE NUMBER	CZERO	STK1	STK2	STEZ	RMU	AMOM
1	2.350E+09	6.950E+10	5.500E+10	5.300E+09	4.550E+11	9.785E-01
2	0.	0.	0.	0.	0.	1.000E+00

I	DR	I	DR	I	DR	I	DR	I	DR	I	DR	I	DR
1	5.200E-02	2	5.200E-02	3	5.200E-02	4	5.200E-02	5	5.200E-02	6	5.200E-02	7	5.200E-02
8	5.200E-02	9	5.200E-02	10	5.200E-02	11	5.200E-02	12	5.200E-02	13	5.200E-02	14	5.200E-02
15	5.200E-02	16	5.200E-02	17	5.200E-02	18	5.200E-02	19	5.200E-02	20	5.200E-02	21	5.200E-02
22	5.200E-02	23	5.200E-02	24	5.200E-02	25	5.200E-02	26	5.200E-02	27	5.200E-02	28	5.200E-02
29	5.200E-02	30	5.200E-02	31	5.200E-02	32	5.200E-02	33	5.200E-02	34	5.200E-02	35	5.200E-02
36	5.200E-02	37	5.200E-02	38	5.200E-02	39	5.200E-02	40	5.200E-02	41	5.200E-02	42	5.200E-02
43	5.200E-02	44	5.200E-02	45	5.200E-02	46	5.200E-02	47	5.720E-02	48	6.290E-02	49	6.920E-02
50	7.610E-02	51	8.370E-02	52	9.210E-02	53	1.013E-01	54	1.114E-01	55	1.225E-01	56	1.348E-01
57	1.483E-01	58	1.500E-01	59	1.992E-01	60	1.993E-01						

I	R	I	R	I	R	I	R	I	R	I	R	I	R
1	5.200E-02	2	1.040E-01	3	1.560E-01	4	2.080E-01	5	2.600E-01	6	3.120E-01	7	3.640E-01
8	4.160E-01	9	4.680E-01	10	5.200E-01	11	5.720E-01	12	6.240E-01	13	6.760E-01	14	7.280E-01
15	7.800E-01	16	8.320E-01	17	8.840E-01	18	9.360E-01	19	9.880E-01	20	1.040E+00	21	1.092E+00
22	1.144E+00	23	1.196E+00	24	1.248E+00	25	1.300E+00	26	1.352E+00	27	1.404E+00	28	1.456E+00
29	1.508E+00	30	1.560E+00	31	1.612E+00	32	1.664E+00	33	1.716E+00	34	1.768E+00	35	1.820E+00
36	1.872E+00	37	1.924E+00	38	1.976E+00	39	2.028E+00	40	2.080E+00	41	2.132E+00	42	2.184E+00
43	2.236E+00	44	2.288E+00	45	2.340E+00	46	2.392E+00	47	2.449E+00	48	2.512E+00	49	2.581E+00
50	2.657E+00	51	2.741E+00	52	2.833E+00	53	2.935E+00	54	3.046E+00	55	3.168E+00	56	3.303E+00
57	3.451E+00	58	3.601E+00	59	3.801E+00	60	4.000E+00						

J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ
1	5.200E-02	2	5.200E-02	3	5.200E-02	4	5.200E-02	5	5.200E-02	6	5.200E-02	7	5.200E-02
8	5.200E-02	9	5.200E-02	10	5.200E-02	11	5.200E-02	12	5.200E-02	13	5.200E-02	14	5.200E-02
15	5.200E-02	16	5.200E-02	17	5.200E-02	18	5.200E-02	19	5.200E-02	20	5.200E-02	21	5.200E-02
22	5.200E-02	23	5.200E-02	24	5.200E-02	25	5.200E-02	26	5.200E-02	27	5.200E-02	28	5.200E-02
29	5.200E-02	30	5.200E-02	31	5.200E-02	32	5.200E-02	33	5.200E-02	34	5.200E-02	35	5.200E-02
36	5.200E-02	37	5.200E-02	38	5.200E-02	39	5.200E-02	40	5.200E-02	41	5.200E-02	42	5.200E-02
43	5.200E-02	44	5.200E-02	45	5.200E-02	46	5.200E-02	47	5.200E-02	48	5.200E-02	49	5.200E-02
50	5.200E-02	51	5.200E-02	52	5.200E-02	53	5.200E-02	54	5.200E-02	55	5.200E-02	56	5.200E-02
57	5.200E-02	58	5.200E-02	59	5.200E-02	60	5.200E-02	61	5.200E-02	62	5.200E-02	63	5.200E-02
64	5.200E-02	65	5.200E-02	66	5.200E-02	67	5.200E-02	68	5.200E-02	69	5.200E-02	70	5.200E-02
71	5.200E-02	72	5.200E-02	73	5.200E-02	74	5.200E-02	75	5.200E-02	76	5.200E-02	77	5.200E-02
78	5.200E-02	79	5.200E-02	80	5.200E-02	81	5.200E-02	82	5.200E-02	83	5.200E-02	84	5.200E-02
85	5.200E-02	86	5.200E-02	87	5.200E-02	88	5.200E-02	89	5.200E-02	90	5.200E-02	91	5.200E-02
92	5.200E-02	93	5.200E-02	94	5.200E-02	95	5.200E-02	96	5.200E-02	97	5.200E-02	98	5.200E-02
99	5.200E-02	100	5.200E-02	101	5.200E-02	102	5.200E-02	103	5.200E-02	104	5.200E-02	105	5.200E-02
106	5.200E-02	107	5.200E-02	108	5.200E-02	109	5.200E-02	110	5.200E-02	111	5.200E-02	112	5.200E-02
113	5.200E-02	114	5.200E-02	115	5.200E-02	116	5.200E-02	117	5.200E-02	118	5.200E-02	119	5.200E-02
120	5.200E-02	121	5.200E-02	122	5.200E-02	123	5.200E-02	124	5.200E-02	125	5.200E-02	126	5.200E-02
127	5.200E-02	128	5.200E-02	129	5.200E-02	130	5.200E-02	131	5.200E-02	132	5.200E-02	133	5.200E-02
134	5.200E-02	135	5.200E-02	136	5.200E-02	137	5.200E-02	138	5.200E-02	139	5.200E-02	140	5.200E-02
141	5.200E-02	142	5.200E-02	143	5.200E-02	144	5.200E-02	145	5.200E-02	146	5.200E-02	147	5.200E-02
148	5.200E-02	149	5.200E-02	150	5.200E-02	151	5.200E-02	152	5.200E-02	153	5.200E-02	154	5.200E-02
155	5.200E-02	156	5.200E-02	157	5.200E-02	158	5.200E-02	159	5.200E-02	160	5.200E-02	161	5.200E-02
162	5.200E-02	163	5.200E-02	164	5.200E-02	165	5.200E-02	166	5.200E-02	167	5.200E-02	168	5.200E-02
169	5.200E-02	170	5.200E-02	171	5.200E-02	172	5.200E-02	173	5.200E-02	174	5.200E-02	175	5.200E-02
176	5.200E-02	177	5.200E-02	178	5.200E-02	179	5.200E-02	180	5.200E-02	181	5.200E-02	182	5.200E-02

183 5.200E-02 184 5.200E-02 185 5.200E-02 186 5.200E-02 187 5.200E-02

J	Z	J	Z	J	Z	J	Z	J	Z	J	Z	J	Z
1	5.200E-02	2	1.040E-01	3	1.560E-01	4	2.080E-01	5	2.600E-01	6	3.120E-01	7	3.640E-01
8	4.160E-01	9	4.680E-01	10	5.200E-01	11	5.720E-01	12	6.240E-01	13	6.760E-01	14	7.280E-01
15	7.800E-01	16	8.320E-01	17	8.840E-01	18	9.360E-01	19	9.880E-01	20	1.040E+00	21	1.092E+00
22	1.144E+00	23	1.196E+00	24	1.248E+00	25	1.300E+00	26	1.352E+00	27	1.404E+00	28	1.456E+00
29	1.508E+00	30	1.560E+00	31	1.612E+00	32	1.664E+00	33	1.716E+00	34	1.768E+00	35	1.820E+00
36	1.872E+00	37	1.924E+00	38	1.976E+00	39	2.028E+00	40	2.080E+00	41	2.132E+00	42	2.184E+00
43	2.236E+00	44	2.288E+00	45	2.340E+00	46	2.392E+00	47	2.444E+00	48	2.496E+00	49	2.548E+00
50	2.600E+00	51	2.652E+00	52	2.704E+00	53	2.756E+00	54	2.808E+00	55	2.860E+00	56	2.912E+00
57	2.964E+00	58	3.016E+00	59	3.060E+00	60	3.120E+00	61	3.172E+00	62	3.224E+00	63	3.276E+00
64	3.328E+00	65	3.380E+00	66	3.432E+00	67	3.484E+00	68	3.536E+00	69	3.588E+00	70	3.640E+00
71	3.692E+00	72	3.744E+00	73	3.796E+00	74	3.848E+00	75	3.900E+00	76	3.952E+00	77	4.004E+00
78	4.056E+00	79	4.108E+00	80	4.160E+00	81	4.212E+00	82	4.264E+00	83	4.316E+00	84	4.368E+00
85	4.420E+00	86	4.472E+00	87	4.524E+00	88	4.576E+00	89	4.628E+00	90	4.680E+00	91	4.732E+00
92	4.784E+00	93	4.836E+00	94	4.888E+00	95	4.940E+00	96	4.992E+00	97	5.044E+00	98	5.096E+00
99	5.148E+00	100	5.200E+00	101	5.252E+00	102	5.304E+00	103	5.356E+00	104	5.408E+00	105	5.460E+00
106	5.512E+00	107	5.564E+00	108	5.616E+00	109	5.668E+00	110	5.720E+00	111	5.772E+00	112	5.824E+00
113	5.876E+00	114	5.928E+00	115	5.980E+00	116	6.032E+00	117	6.004E+00	110	6.136E+00	119	6.188E+00
120	6.240E+00	121	6.292E+00	122	6.344E+00	123	6.396E+00	124	6.448E+00	125	6.500E+00	126	6.552E+00
127	6.604E+00	128	6.656E+00	129	6.708E+00	130	6.760E+00	131	6.812E+00	132	6.864E+00	133	6.916E+00
134	6.968E+00	135	7.020E+00	136	7.072E+00	137	7.124E+00	138	7.176E+00	139	7.228E+00	140	7.280E+00
141	7.332E+00	142	7.384E+00	143	7.436E+00	144	7.488E+00	145	7.540E+00	146	7.592E+00	147	7.644E+00
148	7.696E+00	149	7.748E+00	150	7.800E+00	151	7.852E+00	152	7.904E+00	153	7.956E+00	154	8.008E+00
155	8.060E+00	156	8.112E+00	157	8.164E+00	158	8.216E+00	159	8.268E+00	160	8.320E+00	161	8.372E+00
162	8.424E+00	163	8.476E+00	164	8.528E+00	165	8.580E+00	166	8.632E+00	167	8.684E+00	168	8.736E+00
169	8.788E+00	170	8.840E+00	171	8.892E+00	172	8.944E+00	173	8.996E+00	174	9.048E+00	175	9.100E+00
176	9.152E+00	177	9.204E+00	178	9.256E+00	179	9.308E+00	180	9.360E+00	181	9.412E+00	182	9.464E+00
183	9.516E+00	184	9.568E+00	185	9.620E+00	186	9.672E+00	187	9.724E+00				

CYCLE 0

.2165974E+06ERGS HAS BEEN ADDED DUE TO DETONATION OF THESE CELLS'

1 25

CDT 43 164 T=3.2964778E-08 DT=2.6329114E-10 MAXCUV=3.9500000E+05 MAXUV=0. UMIN=3.9500000E+00 PMIN=5.0000000E+06

PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE		IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
43.0000	3.2964778E-08	0	2.1659744E+07	0.	0	0.	0.

PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WORK
1	0.	0.	0.	4.5904689E+01	0.	0.	0.	0.
2	2.1659744E+07	0.	2.1659744E+07	1.5515881E+02	0.	0.	0.	0.
TOTALS	2.1659744E+07	0.	2.1659744E+07	2.0106350E+02	0.	0.	0.	0.

	IE OUT	KE OUT
1	0.	0.
2	0.	0.

BOUNDARY	BOTTOM	RIGHT	TOP	$EVAPORATED$
MASS OUT	0.	0.	0.	0.
ENERGY OUT	0.	0.	0.	0.
MU OUT	0.	0.	0.	0.
MV OUT	0.	0.	0.	0.
WORK DONE	0.	0.	0.	

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	1	0	1	0	400	0
2	0	2	0	301	0	700

CELL-COORDINATES OF TRACERS FOR EACH MATERIAL PACKAGE

PACKAGE 1

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	0.00	66.19	2	.06	66.19	3	.12	66.19	4	.17	66.20	5	.23	66.20
6	.29	66.20	7	.35	66.20	8	.41	66.21	9	.47	66.21	10	.53	66.22
11	.58	66.23	12	.64	66.23	13	.70	66.24	14	.76	66.25	15	.82	66.26
16	.88	66.27	17	.93	66.28	18	.99	66.29	19	1.05	66.31	20	1.11	66.32
21	1.16	66.33	22	1.22	66.35	23	1.28	66.36	24	1.33	66.38	25	1.39	66.39
26	1.45	66.41	27	1.50	66.43	28	1.56	66.45	29	1.61	66.47	30	1.67	66.49
31	1.72	66.51	32	1.78	66.53	33	1.83	66.55	34	1.89	66.57	35	1.94	66.60
36	2.00	66.62	37	2.05	66.64	38	2.10	66.67	39	2.16	66.69	40	2.21	66.72
41	2.26	66.75	42	2.31	66.77	43	2.36	66.80	44	2.42	66.83	45	2.47	66.86
46	2.52	66.89	47	2.57	66.92	48	2.62	66.95	49	2.67	66.98	50	2.72	67.02
51	2.76	67.05	52	2.81	67.08	53	2.86	67.12	54	2.91	67.15	55	2.96	67.19
56	3.00	67.22	57	3.05	67.26	58	3.09	67.30	59	3.14	67.33	60	3.18	67.37
61	3.23	67.41	62	3.27	67.45	63	3.32	67.49	64	3.36	67.53	65	3.40	67.57
66	3.44	67.61	67	3.48	67.65	68	3.53	67.70	69	3.57	67.74	70	3.61	67.78
71	3.65	67.83	72	3.68	67.87	73	3.72	67.91	74	3.76	67.96	75	3.80	68.00
76	3.83	68.05	77	3.87	68.10	78	3.91	68.14	79	3.94	68.19	80	3.98	68.24
81	4.01	68.29	82	4.04	68.34	83	4.08	68.38	84	4.11	68.43	85	4.14	68.48
86	4.17	68.53	87	4.20	68.58	88	4.23	60.63	89	4.26	68.69	90	4.29	68.74
91	4.32	68.79	92	4.34	68.84	93	4.37	68.89	94	4.40	68.95	95	4.42	69.00
96	4.45	69.05	97	4.47	69.11	98	4.49	69.16	99	4.52	69.21	100	4.54	69.27
101	4.54	69.23	102	4.67	69.55	103	4.80	69.87	104	4.94	70.19	105	5.07	70.51
106	5.20	70.83	107	5.33	71.15	108	5.47	71.47	109	5.60	71.79	110	5.73	72.11
111	5.86	72.43	112	6.00	72.75	113	6.13	73.07	114	6.26	73.39	115	6.39	73.71
116	6.53	74.03	117	6.66	74.35	118	6.79	74.67	119	6.92	74.99	120	7.06	75.31
121	7.19	75.63	122	7.32	75.95	123	7.45	76.27	124	7.59	76.59	125	7.72	76.91

126	7.85	77.23	127	7.98	77.55	128	8.12	77.87	129	8.25	78.19	130	8.38	78.51
131	8.51	78.83	132	8.65	79.15	133	8.78	79.47	134	8.91	79.79	135	9.04	80.11
136	9.18	80.43	137	9.31	80.75	138	9.44	81.07	139	9.57	81.39	140	9.71	81.70
141	9.84	82.02	142	9.97	82.34	143	10.10	82.66	144	10.24	82.98	145	10.37	83.30
146	10.50	83.62	147	10.63	83.94	148	10.77	84.26	149	10.90	84.58	150	11.03	84.90
151	11.16	85.22	152	11.30	85.54	153	11.43	85.86	154	11.56	86.18	155	11.69	86.50
156	11.83	86.82	157	11.96	87.14	158	12.09	87.46	159	12.22	87.78	160	12.36	88.10
161	12.49	88.42	162	12.62	88.74	163	12.75	89.06	164	12.89	89.38	165	13.02	89.70
166	13.15	90.02	167	13.28	90.34	168	13.42	90.66	169	13.55	90.98	170	13.68	91.30
171	13.81	91.62	172	13.95	91.94	173	14.08	92.26	174	14.21	92.58	175	14.34	92.90
176	14.48	93.22	177	14.61	93.54	178	14.74	93.86	179	14.87	94.18	180	15.01	94.50
181	15.14	94.82	182	15.27	95.14	183	15.40	95.46	184	15.54	95.78	185	15.67	96.10
186	15.80	96.42	187	15.93	96.74	188	16.07	97.06	189	16.20	97.38	190	16.33	97.70
191	16.46	98.02	192	16.60	98.34	193	16.73	98.66	194	16.86	98.98	195	16.99	99.30
196	17.13	99.62	197	17.26	99.94	198	17.39	100.26	199	17.52	100.58	200	17.66	100.90
201	17.79	101.22	202	17.92	101.54	203	18.05	101.86	204	18.19	102.18	205	18.32	102.49
206	18.45	102.81	207	18.58	103.13	208	18.72	103.45	209	18.85	103.77	210	18.98	104.09
211	19.11	104.41	212	19.25	104.73	213	19.38	105.05	214	19.51	105.37	215	19.64	105.69
216	19.78	106.01	217	19.91	106.33	218	20.04	106.65	219	20.17	106.97	220	20.31	107.29
221	20.44	107.61	222	20.57	107.93	223	20.70	108.25	224	20.84	108.57	225	20.97	108.89
226	21.10	109.21	227	21.23	109.53	228	21.37	109.85	229	21.50	110.17	230	21.63	110.49
231	21.76	110.81	232	21.90	111.13	233	22.03	111.45	234	22.16	111.77	235	22.29	112.09
236	22.43	112.41	237	22.56	112.73	238	22.69	113.05	239	22.82	113.37	240	22.95	113.69
241	23.09	114.01	242	23.22	114.33	243	23.35	114.65	244	23.48	114.97	245	23.62	115.29
246	23.75	115.61	247	23.88	115.93	248	24.01	116.25	249	24.15	116.57	250	24.28	116.89
251	24.41	117.21	252	24.54	117.53	253	24.68	117.85	254	24.81	118.17	255	24.94	118.49
256	25.07	118.81	257	25.21	119.13	258	25.34	119.45	259	25.47	119.77	260	25.60	120.09
261	25.74	120.41	262	25.87	120.73	263	26.00	121.05	264	26.13	121.37	265	26.27	121.69
266	26.40	122.01	267	26.53	122.33	268	26.66	122.65	269	26.80	122.97	270	26.93	123.29
271	27.06	123.60	272	27.19	123.92	273	27.33	124.24	274	27.46	124.56	275	27.59	124.88
276	27.72	125.20	277	27.86	125.52	278	27.99	125.84	279	28.12	126.16	280	28.25	126.48
281	28.39	126.80	282	28.52	127.12	283	28.65	127.44	284	28.78	127.76	285	28.92	128.08
286	29.05	128.40	287	29.18	128.72	288	29.31	129.04	289	29.45	129.36	290	29.58	129.68
291	29.71	130.00	292	29.84	130.32	293	29.98	130.64	294	30.11	130.96	295	30.24	131.28
296	30.37	131.60	297	30.51	131.92	298	30.64	132.24	299	30.77	132.56	300	30.90	132.88
301	31.04	133.20	302	31.17	133.52	303	31.30	133.84	304	31.43	134.16	305	31.57	134.48
306	31.70	134.80	307	31.83	135.12	308	31.96	135.44	309	32.10	135.76	310	32.23	136.08
311	32.36	136.40	312	32.49	136.72	313	32.63	137.04	314	32.76	137.36	315	32.89	137.68
316	33.02	138.00	317	33.16	138.32	318	33.29	138.64	319	33.42	138.96	320	33.55	139.28
321	33.69	139.60	322	33.82	139.92	323	33.95	140.24	324	34.08	140.56	325	34.22	140.88
326	34.35	141.20	327	34.48	141.52	328	34.61	141.84	329	34.75	142.16	330	34.88	142.48
331	35.01	142.80	332	35.14	143.12	333	35.28	143.44	334	35.41	143.76	335	35.54	144.08
336	35.67	144.40	337	35.81	144.71	338	35.94	145.03	339	36.07	145.35	340	36.20	145.67
341	36.34	145.99	342	36.47	146.31	343	36.60	146.63	344	36.73	146.95	345	36.87	147.27
346	37.00	147.59	347	37.13	147.91	348	37.26	148.23	349	37.40	148.55	350	37.53	148.87
351	37.66	149.19	352	37.79	149.51	353	37.93	149.83	354	38.06	150.15	355	38.19	150.47
356	38.32	150.79	357	38.46	151.11	358	38.59	151.43	359	38.72	151.75	360	38.85	152.07
361	38.99	152.39	362	39.12	152.71	363	39.25	153.03	364	39.38	153.35	365	39.52	153.67
366	39.65	153.99	367	39.78	154.31	368	39.91	154.63	369	40.05	154.95	370	40.18	155.27
371	40.31	155.59	372	40.44	155.91	373	40.58	156.23	374	40.71	156.55	375	40.84	156.87
376	40.97	157.19	377	41.11	157.51	378	41.24	157.83	379	41.37	158.15	380	41.50	158.47
381	41.64	158.79	382	41.77	159.11	383	41.90	159.43	384	42.03	159.75	385	42.17	160.07
386	42.30	160.39	387	42.43	160.71	388	42.56	161.03	389	42.70	161.35	390	42.83	161.67
391	42.96	161.99	392	43.09	162.31	393	43.23	162.63	394	43.36	162.95	395	43.49	163.27
396	43.62	163.59	397	43.76	163.91	398	43.89	164.23	399	44.02	164.55	400	44.15	164.87
401	44.15	164.87	402	44.10	164.87	403	44.05	164.87	404	43.99	164.87	405	43.94	164.87
406	43.89	164.87	407	43.83	164.87	408	43.78	164.87	409	43.72	164.87	410	43.67	164.87
411	43.62	164.87	412	43.56	164.87	413	43.51	164.87	414	43.45	164.87	415	43.40	164.87
416	43.35	164.87	417	43.29	164.87	418	43.24	164.87	419	43.19	164.87	420	43.13	164.87
421	43.08	164.87	422	43.02	164.87	423	42.97	164.87	424	42.92	164.87	425	42.86	164.87
426	42.81	164.87	427	42.76	164.87	428	42.70	164.87	429	42.65	164.87	430	42.59	164.87
431	42.54	164.87	432	42.49	164.87	433	42.43	164.87	434	42.38	164.87	435	42.33	164.87
436	42.27	164.87	437	42.22	164.87	438	42.16	164.87	439	42.11	164.87	440	42.06	164.87
441	42.00	164.87	442	41.95	164.87	443	41.90	164.87	444	41.84	164.87	445	41.79	164.87
446	41.73	164.87	447	41.68	164.87	448	41.63	164.87	449	41.57	164.87	450	41.52	164.87
451	41.52	164.87	452	41.39	164.55	453	41.26	164.23	454	41.13	163.92	455	40.99	163.60

456	40.86	163.28	457	40.73	162.97	458	40.60	162.65	459	40.47	162.33	460	40.34	162.02
461	40.21	161.70	462	40.08	161.38	463	39.94	161.07	464	39.81	160.75	465	39.68	160.43
466	39.55	160.11	467	39.42	159.80	468	39.29	159.48	469	39.16	159.16	470	39.03	158.85
471	38.89	158.53	472	38.76	158.21	473	38.63	157.90	474	38.50	157.58	475	38.37	157.26
476	38.24	156.95	477	38.11	156.63	478	37.97	156.31	479	37.84	156.00	480	37.71	155.68
481	37.58	155.36	482	37.45	155.05	483	37.32	154.73	484	37.19	154.41	485	37.06	154.10
486	36.92	153.78	487	36.79	153.46	488	36.66	153.15	489	36.53	152.83	490	36.40	152.51
491	36.27	152.20	492	36.14	151.88	493	36.01	151.56	494	35.87	151.25	495	35.74	150.93
496	35.61	150.61	497	35.48	150.30	498	35.35	149.98	499	35.22	149.66	500	35.09	149.35
501	34.96	149.03	502	34.82	148.71	503	34.69	148.40	504	34.56	148.08	505	34.43	147.76
506	34.30	147.45	507	34.17	147.13	508	34.04	146.81	509	33.91	146.50	510	33.77	146.18
511	33.64	145.86	512	33.51	145.55	513	33.38	145.23	514	33.25	144.91	515	33.12	144.60
516	32.99	144.28	517	32.86	143.96	518	32.72	143.65	519	32.59	143.33	520	32.46	143.01
521	32.33	142.70	522	32.20	142.38	523	32.07	142.06	524	31.94	141.75	525	31.81	141.43
526	31.67	141.11	527	31.54	140.80	528	31.41	140.48	529	31.28	140.16	530	31.15	139.85
531	31.02	139.53	532	30.89	139.21	533	30.76	138.90	534	30.62	138.58	535	30.49	138.26
536	30.36	137.95	537	30.23	137.63	538	30.10	137.31	539	29.97	137.00	540	29.84	136.68
541	29.70	136.36	542	29.57	136.05	543	29.44	135.73	544	29.31	135.41	545	29.18	135.10
546	29.05	134.78	547	28.92	134.46	548	28.79	134.15	549	28.65	133.83	550	28.52	133.51
551	28.39	133.20	552	28.26	132.88	553	28.13	132.56	554	28.00	132.25	555	27.87	131.93
556	27.74	131.61	557	27.60	131.30	558	27.47	130.98	559	27.34	130.66	560	27.21	130.35
561	27.08	130.03	562	26.95	129.71	563	26.82	129.40	564	26.69	129.08	565	26.55	128.76
566	26.42	128.45	567	26.29	128.13	568	26.16	127.81	569	26.03	127.50	570	25.90	127.18
571	25.77	126.86	572	25.64	126.55	573	25.50	126.23	574	25.37	125.91	575	25.24	125.59
576	25.11	125.28	577	24.98	124.96	578	24.85	124.64	579	24.72	124.33	580	24.59	124.01
581	24.45	123.69	582	24.32	123.38	583	24.19	123.06	584	24.06	122.74	585	23.93	122.43
586	23.80	122.11	587	23.67	121.79	588	23.54	121.48	589	23.40	121.16	590	23.27	120.84
591	23.14	120.53	592	23.01	120.21	593	22.88	119.89	594	22.75	119.58	595	22.62	119.26
596	22.48	118.94	597	22.35	118.63	598	22.22	118.31	599	22.09	117.99	600	21.96	117.68
601	21.83	117.36	602	21.70	117.04	603	21.57	116.73	604	21.43	116.41	605	21.30	116.09
606	21.17	115.78	607	21.04	115.46	608	20.91	115.14	609	20.78	114.83	610	20.65	114.51
611	20.52	114.19	612	20.38	113.88	613	20.25	113.56	614	20.12	113.24	615	19.99	112.93
616	19.86	112.61	617	19.73	112.29	618	19.60	111.98	619	19.47	111.66	620	19.33	111.34
621	19.20	111.03	622	19.07	110.71	623	18.94	110.39	624	18.81	110.08	625	18.68	109.76
626	18.55	109.44	627	18.42	109.13	628	18.28	108.81	629	18.15	108.49	630	18.02	108.18
631	17.89	107.86	632	17.76	107.54	633	17.63	107.23	634	17.50	106.91	635	17.37	106.59
636	17.23	106.28	637	17.10	105.96	638	16.97	105.64	639	16.84	105.33	640	16.71	105.01
641	16.58	104.69	642	16.45	104.38	643	16.32	104.06	644	16.18	103.74	645	16.05	103.43
646	15.92	103.11	647	15.79	102.79	648	15.66	102.48	649	15.53	102.16	650	15.40	101.84
651	15.27	101.53	652	15.13	101.21	653	15.00	100.89	654	14.87	100.58	655	14.74	100.26
656	14.61	99.94	657	14.48	99.63	658	14.35	99.31	659	14.21	98.99	660	14.08	98.68
661	13.95	98.36	662	13.82	98.04	663	13.69	97.73	664	13.56	97.41	665	13.43	97.09
666	13.30	96.78	667	13.16	96.46	668	13.03	96.14	669	12.90	95.83	670	12.77	95.51
671	12.64	95.19	672	12.51	94.88	673	12.38	94.56	674	12.25	94.24	675	12.11	93.93
676	11.98	93.61	677	11.85	93.29	678	11.72	92.98	679	11.59	92.66	680	11.46	92.34
681	11.33	92.03	682	11.20	91.71	683	11.06	91.39	684	10.93	91.08	685	10.80	90.76
686	10.67	90.44	687	10.54	90.12	688	10.41	89.81	689	10.28	89.49	690	10.15	89.17
691	10.01	88.86	692	9.88	88.54	693	9.75	88.22	694	9.62	87.91	695	9.49	87.59
696	9.36	87.27	697	9.23	86.96	698	9.10	86.64	699	8.96	86.32	700	8.83	86.01
701	8.70	85.69	702	8.57	85.37	703	8.44	85.06	704	8.31	84.74	705	8.18	84.42
706	8.05	84.11	707	7.91	83.79	708	7.78	83.47	709	7.65	83.16	710	7.52	82.84
711	7.39	82.52	712	7.26	82.21	713	7.13	81.89	714	6.99	81.57	715	6.86	81.26
716	6.73	80.94	717	6.60	80.62	718	6.47	80.31	719	6.34	79.99	720	6.21	79.67
721	6.08	79.36	722	5.94	79.04	723	5.81	78.72	724	5.68	78.41	725	5.55	78.09
726	5.42	77.77	727	5.29	77.46	728	5.16	77.14	729	5.03	76.82	730	4.89	76.51
731	4.76	76.19	732	4.63	75.87	733	4.50	75.56	734	4.37	75.24	735	4.24	74.92
736	4.11	74.61	737	3.98	74.29	738	3.84	73.97	739	3.71	73.66	740	3.58	73.34
741	3.45	73.02	742	3.32	72.71	743	3.19	72.39	744	3.06	72.07	745	2.93	71.76
746	2.79	71.44	747	2.66	71.12	748	2.53	70.81	749	2.40	70.49	750	2.27	70.17
751	2.27	70.17	752	2.26	70.15	753	2.25	70.12	754	2.23	70.09	755	2.22	70.06
756	2.21	70.04	757	2.20	70.01	758	2.18	69.99	759	2.17	69.96	760	2.16	69.93
761	2.14	69.91	762	2.13	69.88	763	2.11	69.86	764	2.10	69.83	765	2.08	69.81
766	2.07	69.78	767	2.05	69.76	768	2.04	69.73	769	2.02	69.71	770	2.00	69.68
771	1.99	69.66	772	1.97	69.63	773	1.95	69.61	774	1.94	69.59	775	1.92	69.56
776	1.90	69.54	777	1.88	69.52	778	1.86	69.50	779	1.84	69.47	780	1.82	69.45
781	1.80	69.43	782	1.78	69.41	783	1.76	69.39	784	1.74	69.37	785	1.72	69.34

786	1.70	69.32	787	1.68	69.30	788	1.66	69.28	789	1.64	69.26	790	1.61	69.24
791	1.59	69.22	792	1.57	69.21	793	1.55	69.19	794	1.52	69.17	795	1.50	69.15
796	1.48	69.13	797	1.45	69.11	798	1.43	69.10	799	1.41	69.08	800	1.38	69.06
801	1.36	69.05	802	1.33	69.03	803	1.31	69.01	804	1.28	69.00	805	1.26	68.98
806	1.23	68.97	807	1.21	68.95	808	1.18	68.94	809	1.16	68.93	810	1.13	68.91
811	1.10	68.90	812	1.08	68.89	813	1.05	68.87	814	1.02	68.86	815	1.00	68.85
816	.97	68.84	817	.94	68.82	818	.92	68.81	819	.89	68.80	820	.86	68.79
821	.83	68.78	822	.81	68.77	823	.78	68.76	824	.75	68.75	825	.72	68.74
826	.70	68.74	827	.67	68.73	828	.64	68.72	829	.61	68.71	830	.58	68.70
831	.55	68.70	832	.52	68.69	833	.50	68.69	834	.47	68.68	835	.44	68.67
836	.41	68.67	837	.38	68.66	838	.35	68.66	839	.32	68.66	840	.29	68.65
841	.26	68.65	842	.23	68.65	843	.20	68.64	844	.18	68.64	845	.15	68.64
846	.12	68.64	847	.09	68.64	848	.06	68.64	849	.03	68.63	850	0.00	68.63
851-1000	.00	0.00												

PACKAGE 2

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	0.00	24.42	2	.45	24.42	3	.89	24.42	4	1.34	24.42	5	1.78	24.42
6	2.23	24.42	7	2.68	24.42	8	3.12	24.42	9	3.57	24.42	10	4.01	24.42
11	4.46	24.42	12	4.91	24.42	13	5.35	24.42	14	5.80	24.42	15	6.24	24.42
16	6.69	24.42	17	7.14	24.42	18	7.58	24.42	19	8.03	24.42	20	8.47	24.42
21	8.92	24.42	22	9.37	24.42	23	9.81	24.42	24	10.26	24.42	25	10.70	24.42
26	11.15	24.42	27	11.60	24.42	28	12.04	24.42	29	12.49	24.42	30	12.93	24.42
31	13.38	24.42	32	13.83	24.42	33	14.27	24.42	34	14.72	24.42	35	15.16	24.42
36	15.61	24.42	37	16.06	24.42	38	16.50	24.42	39	16.95	24.42	40	17.39	24.42
41	17.84	24.42	42	18.29	24.42	43	18.73	24.42	44	19.18	24.42	45	19.62	24.42
46	20.07	24.42	47	20.52	24.42	48	20.96	24.42	49	21.41	24.42	50	21.85	24.42
51	22.30	24.42	52	22.75	24.42	53	23.19	24.42	54	23.64	24.42	55	24.08	24.42
56	24.53	24.42	57	24.98	24.42	58	25.42	24.42	59	25.87	24.42	60	26.31	24.42
61	26.76	24.42	62	27.21	24.42	63	27.65	24.42	64	28.10	24.42	65	28.54	24.42
66	28.99	24.42	67	29.44	24.42	68	29.88	24.42	69	30.33	24.42	70	30.77	24.42
71	31.22	24.42	72	31.67	24.42	73	32.11	24.42	74	32.56	24.42	75	33.00	24.42
76	33.45	24.42	77	33.90	24.42	78	34.34	24.42	79	34.79	24.42	80	35.23	24.42
81	35.68	24.42	82	36.13	24.42	83	36.57	24.42	84	37.02	24.42	85	37.46	24.42
86	37.91	24.42	87	38.36	24.42	88	38.80	24.42	89	39.25	24.42	90	39.69	24.42
91	40.14	24.42	92	40.59	24.42	93	41.03	24.42	94	41.48	24.42	95	41.92	24.42
96	42.37	24.42	97	42.82	24.42	98	43.26	24.42	99	43.71	24.42	100	44.15	24.42
101	44.15	24.42	102	44.15	25.13	103	44.15	25.83	104	44.15	26.54	105	44.15	27.25
106	44.15	27.95	107	44.15	28.66	108	44.15	29.36	109	44.15	30.07	110	44.15	30.77
111	44.15	31.48	112	44.15	32.19	113	44.15	32.89	114	44.15	33.60	115	44.15	34.30
116	44.15	35.01	117	44.15	35.71	118	44.15	36.42	119	44.15	37.13	120	44.15	37.83
121	44.15	38.54	122	44.15	39.24	123	44.15	39.95	124	44.15	40.66	125	44.15	41.36
126	44.15	42.07	127	44.15	42.77	128	44.15	43.48	129	44.15	44.18	130	44.15	44.89
131	44.15	45.60	132	44.15	46.30	133	44.15	47.01	134	44.15	47.71	135	44.15	48.42
136	44.15	49.12	137	44.15	49.83	138	44.15	50.54	139	44.15	51.24	140	44.15	51.95
141	44.15	52.65	142	44.15	53.36	143	44.15	54.06	144	44.15	54.77	145	44.15	55.48
146	44.15	56.18	147	44.15	56.89	148	44.15	57.59	149	44.15	58.30	150	44.15	59.00
151	44.15	59.71	152	44.15	60.42	153	44.15	61.12	154	44.15	61.83	155	44.15	62.53
156	44.15	63.24	157	44.15	63.94	158	44.15	64.65	159	44.15	65.36	160	44.15	66.06
161	44.15	66.77	162	44.15	67.47	163	44.15	68.18	164	44.15	68.88	165	44.15	69.59
166	44.15	70.30	167	44.15	71.00	168	44.15	71.71	169	44.15	72.41	170	44.15	73.12
171	44.15	73.82	172	44.15	74.53	173	44.15	75.24	174	44.15	75.94	175	44.15	76.65
176	44.15	77.35	177	44.15	78.06	178	44.15	78.77	179	44.15	79.47	180	44.15	80.18
181	44.15	80.88	182	44.15	81.59	183	44.15	82.29	184	44.15	83.00	185	44.15	83.71
186	44.15	84.41	187	44.15	85.12	188	44.15	85.82	189	44.15	86.53	190	44.15	87.23
191	44.15	87.94	192	44.15	88.65	193	44.15	89.35	194	44.15	90.06	195	44.15	90.76
196	44.15	91.47	197	44.15	92.17	198	44.15	92.88	199	44.15	93.59	200	44.15	94.29
201	44.15	95.00	202	44.15	95.70	203	44.15	96.41	204	44.15	97.11	205	44.15	97.82
206	44.15	98.53	207	44.15	99.23	208	44.15	99.94	209	44.15	100.64	210	44.15	101.35
211	44.15	102.05	212	44.15	102.76	213	44.15	103.47	214	44.15	104.17	215	44.15	104.88
216	44.15	105.58	217	44.15	106.29	218	44.15	106.99	219	44.15	107.70	220	44.15	108.41
221	44.15	109.11	222	44.15	109.82	223	44.15	110.52	224	44.15	111.23	225	44.15	111.93
226	44.15	112.64	227	44.15	113.35	228	44.15	114.05	229	44.15	114.76	230	44.15	115.46
231	44.15	116.17	232	44.15	116.88	233	44.15	117.58	234	44.15	118.29	235	44.15	118.99
236	44.15	119.70	237	44.15	120.40	238	44.15	121.11	239	44.15	121.82	240	44.15	122.52

241	44.15	123.23	242	44.15	123.93	243	44.15	124.64	244	44.15	125.34	245	44.15	126.05
246	44.15	126.76	247	44.15	127.46	248	44.15	128.17	249	44.15	128.87	250	44.15	129.58
251	44.15	130.28	252	44.15	130.99	253	44.15	131.70	254	44.15	132.40	255	44.15	133.11
256	44.15	133.81	257	44.15	134.52	258	44.15	135.22	259	44.15	135.93	260	44.15	136.64
261	44.15	137.34	262	44.15	138.05	263	44.15	138.75	264	44.15	139.46	265	44.15	140.16
266	44.15	140.87	267	44.15	141.58	268	44.15	142.28	269	44.15	142.99	270	44.15	143.69
271	44.15	144.40	272	44.15	145.10	273	44.15	145.81	274	44.15	146.52	275	44.15	147.22
276	44.15	147.93	277	44.15	148.63	278	44.15	149.34	279	44.15	150.04	280	44.15	150.75
281	44.15	151.46	282	44.15	152.16	283	44.15	152.87	284	44.15	153.57	285	44.15	154.28
286	44.15	154.99	287	44.15	155.69	288	44.15	156.40	289	44.15	157.10	290	44.15	157.81
291	44.15	158.51	292	44.15	159.22	293	44.15	159.93	294	44.15	160.63	295	44.15	161.34
296	44.15	162.04	297	44.15	162.75	298	44.15	163.45	299	44.15	164.16	300	44.15	164.87
301	44.15	164.87	302	44.02	164.55	303	43.89	164.23	304	43.76	163.91	305	43.62	163.59
306	43.49	163.27	307	43.36	162.95	308	43.23	162.63	309	43.09	162.31	310	42.96	161.99
311	42.83	161.67	312	42.70	161.35	313	42.56	161.03	314	42.43	160.71	315	42.30	160.39
316	42.17	160.07	317	42.03	159.75	318	41.90	159.43	319	41.77	159.11	320	41.64	158.79
321	41.50	158.47	322	41.37	158.15	323	41.24	157.83	324	41.11	157.51	325	40.97	157.19
326	40.84	156.87	327	40.71	156.55	328	40.58	156.23	329	40.44	155.91	330	40.31	155.59
331	40.18	155.27	332	40.05	154.95	333	39.91	154.63	334	39.78	154.31	335	39.65	153.99
336	39.52	153.67	337	39.38	153.35	338	39.25	153.03	339	39.12	152.71	340	38.99	152.39
341	38.85	152.07	342	38.72	151.75	343	38.59	151.43	344	38.46	151.11	345	38.32	150.79
346	38.19	150.47	347	38.06	150.15	348	37.93	149.83	349	37.79	149.51	350	37.66	149.19
351	37.53	148.87	352	37.40	148.55	353	37.26	148.23	354	37.13	147.91	355	37.00	147.59
356	36.87	147.27	357	36.73	146.95	358	36.60	146.63	359	36.47	146.31	360	36.34	145.99
361	36.20	145.67	362	36.07	145.35	363	35.94	145.03	364	35.81	144.71	365	35.67	144.40
366	35.54	144.08	367	35.41	143.76	368	35.28	143.44	369	35.14	143.12	370	35.01	142.80
371	34.88	142.48	372	34.75	142.16	373	34.61	141.84	374	34.48	141.52	375	34.35	141.20
376	34.22	140.88	377	34.08	140.56	378	33.95	140.24	379	33.82	139.92	380	33.69	139.60
381	33.55	139.28	382	33.42	138.96	383	33.29	138.64	384	33.16	138.32	385	33.02	138.00
386	32.89	137.68	387	32.76	137.36	388	32.63	137.04	389	32.49	136.72	390	32.36	136.40
391	32.23	136.08	392	32.10	135.76	393	31.96	135.44	394	31.83	135.12	395	31.70	134.80
396	31.57	134.48	397	31.43	134.16	398	31.30	133.84	399	31.17	133.52	400	31.04	133.20
401	30.90	132.88	402	30.77	132.56	403	30.64	132.24	404	30.51	131.92	405	30.37	131.60
406	30.24	131.28	407	30.11	130.96	408	29.98	130.64	409	29.84	130.32	410	29.71	130.00
411	29.58	129.68	412	29.45	129.36	413	29.31	129.04	414	29.18	128.72	415	29.05	128.40
416	28.92	128.08	417	28.78	127.76	418	28.65	127.44	419	28.52	127.12	420	28.39	126.80
421	28.25	126.48	422	28.12	126.16	423	27.99	125.84	424	27.86	125.52	425	27.72	125.20
426	27.59	124.88	427	27.46	124.56	428	27.33	124.24	429	27.19	123.92	430	27.06	123.60
431	26.93	123.29	432	26.80	122.97	433	26.66	122.65	434	26.53	122.33	435	26.40	122.01
436	26.27	121.69	437	26.13	121.37	438	26.00	121.05	439	25.87	120.73	440	25.74	120.41
441	25.60	120.09	442	25.47	119.77	443	25.34	119.45	444	25.21	119.13	445	25.07	118.81
446	24.94	118.49	447	24.81	118.17	448	24.68	117.85	449	24.54	117.53	450	24.41	117.21
451	24.28	116.89	452	24.15	116.57	453	24.01	116.25	454	23.88	115.93	455	23.75	115.61
456	23.62	115.29	457	23.48	114.97	458	23.35	114.65	459	23.22	114.33	460	23.09	114.01
461	22.95	113.69	462	22.82	113.37	463	22.69	113.05	464	22.56	112.73	465	22.43	112.41
466	22.29	112.09	467	22.16	111.77	468	22.03	111.45	469	21.90	111.13	470	21.76	110.81
471	21.63	110.49	472	21.50	110.17	473	21.37	109.85	474	21.23	109.53	475	21.10	109.21
476	20.97	108.89	477	20.84	108.57	478	20.70	108.25	479	20.57	107.93	480	20.44	107.61
481	20.31	107.29	482	20.17	106.97	483	20.04	106.65	484	19.91	106.33	485	19.78	106.01
486	19.64	105.69	487	19.51	105.37	488	19.38	105.05	489	19.25	104.73	490	19.11	104.41
491	18.98	104.09	492	18.85	103.77	493	18.72	103.45	494	18.58	103.13	495	18.45	102.81
496	18.32	102.49	497	18.19	102.18	498	18.05	101.86	499	17.92	101.54	500	17.79	101.22
501	17.66	100.90	502	17.52	100.58	503	17.39	100.26	504	17.26	99.94	505	17.13	99.62
506	16.99	99.30	507	16.86	98.98	508	16.73	98.66	509	16.60	98.34	510	16.46	98.02
511	16.33	97.70	512	16.20	97.38	513	16.07	97.06	514	15.93	96.74	515	15.80	96.42
516	15.67	96.10	517	15.54	95.78	518	15.40	95.46	519	15.27	95.14	520	15.14	94.82
521	15.01	94.50	522	14.87	94.18	523	14.74	93.86	524	14.61	93.54	525	14.48	93.22
526	14.34	92.90	527	14.21	92.58	528	14.08	92.26	529	13.95	91.94	530	13.81	91.62
531	13.68	91.30	532	13.55	90.98	533	13.42	90.66	534	13.28	90.34	535	13.15	90.02
536	13.02	89.70	537	12.89	89.38	538	12.75	89.06	539	12.62	88.74	540	12.49	88.42
541	12.36	88.10	542	12.22	87.78	543	12.09	87.46	544	11.96	87.14	545	11.83	86.82
546	11.69	86.50	547	11.56	86.18	548	11.43	85.86	549	11.30	85.54	550	11.16	85.22
551	11.03	84.90	552	10.90	84.58	553	10.77	84.26	554	10.63	83.94	555	10.50	83.62
556	10.37	83.30	557	10.24	82.98	558	10.10	82.66	559	9.97	82.34	560	9.84	82.02
561	9.71	81.70	562	9.57	81.39	563	9.44	81.07	564	9.31	80.75	565	9.18	80.43
566	9.04	80.11	567	8.91	79.79	568	8.78	79.47	569	8.65	79.15	570	8.51	78.83

571	8.38	78.51	572	8.25	78.19	573	8.12	77.87	574	7.98	77.55	575	7.85	77.23
576	7.72	76.91	577	7.59	76.59	578	7.45	76.27	579	7.32	75.95	580	7.19	75.63
581	7.06	75.31	582	6.92	74.99	58	6.79	74.67	584	6.66	74.35	585	6.53	74.03
586	6.39	73.71	587	6.26	73.39	588	6.13	73.07	589	6.00	72.75	590	5.86	72.43
591	5.73	72.11	592	5.60	71.79	593	5.47	71.47	594	5.33	71.15	595	5.20	70.83
596	5.07	70.51	597	4.94	70.19	598	4.00	69.87	599	4.67	69.55	600	4.54	69.23
601	4.54	69.27	602	4.52	69.21	603	4.49	69.16	604	4.47	69.11	605	4.45	69.05
606	4.42	69.00	607	4.40	68.95	608	4.37	68.89	609	4.34	68.84	610	4.32	68.79
611	4.29	68.74	612	4.26	68.69	613	4.23	68.63	614	4.20	68.58	615	4.17	68.53
616	4.14	68.48	617	4.11	68.43	618	4.08	68.38	619	4.04	68.34	620	4.01	68.29
621	3.98	68.24	622	3.94	68.19	623	3.91	68.14	624	3.87	68.10	625	3.83	68.05
626	3.00	68.00	627	3.76	67.96	628	3.72	67.91	629	3.68	67.87	630	3.65	67.63
631	3.61	67.78	632	3.57	67.74	633	3.53	67.70	634	3.48	67.65	635	3.44	67.61
636	3.40	67.57	637	3.36	67.53	638	3.32	67.49	639	3.27	67.45	640	3.23	67.41
641	3.18	67.37	642	3.14	67.33	643	3.09	67.30	644	3.05	67.26	645	3.00	67.22
646	2.96	67.19	647	2.91	67.15	648	2.86	67.12	649	2.81	67.08	650	2.76	67.05
651	2.72	67.02	652	2.67	66.98	653	2.62	66.95	654	2.57	66.92	655	2.52	66.89
656	2.47	66.86	657	2.42	66.83	658	2.36	66.80	659	2.31	66.77	660	2.26	66.75
661	2.21	66.72	662	2.16	66.69	663	2.10	66.67	664	2.05	66.64	665	2.00	66.62
666	1.94	66.60	667	1.89	66.57	668	1.83	66.55	669	1.78	66.53	670	1.72	66.51
671	1.67	66.49	672	1.61	66.47	673	1.56	66.45	674	1.50	66.43	675	1.45	66.41
676	1.39	66.39	677	1.33	66.38	678	1.28	66.36	679	1.22	66.35	680	1.16	66.33
681	1.11	66.32	682	1.05	66.31	683	.99	66.29	684	.93	66.28	685	.88	66.27
686	.82	66.26	687	.76	66.25	688	.70	66.24	689	.64	66.23	690	.58	66.23
691	.53	66.22	692	.47	66.21	693	.41	66.21	694	.35	66.20	695	.29	66.20
696	.23	66.20	697	.17	66.20	698	.12	66.19	699	.06	66.19	700	0.00	66.19
701-1000	.00	0.00												

FREE SURFACE TRACERS NVRTEX= 0

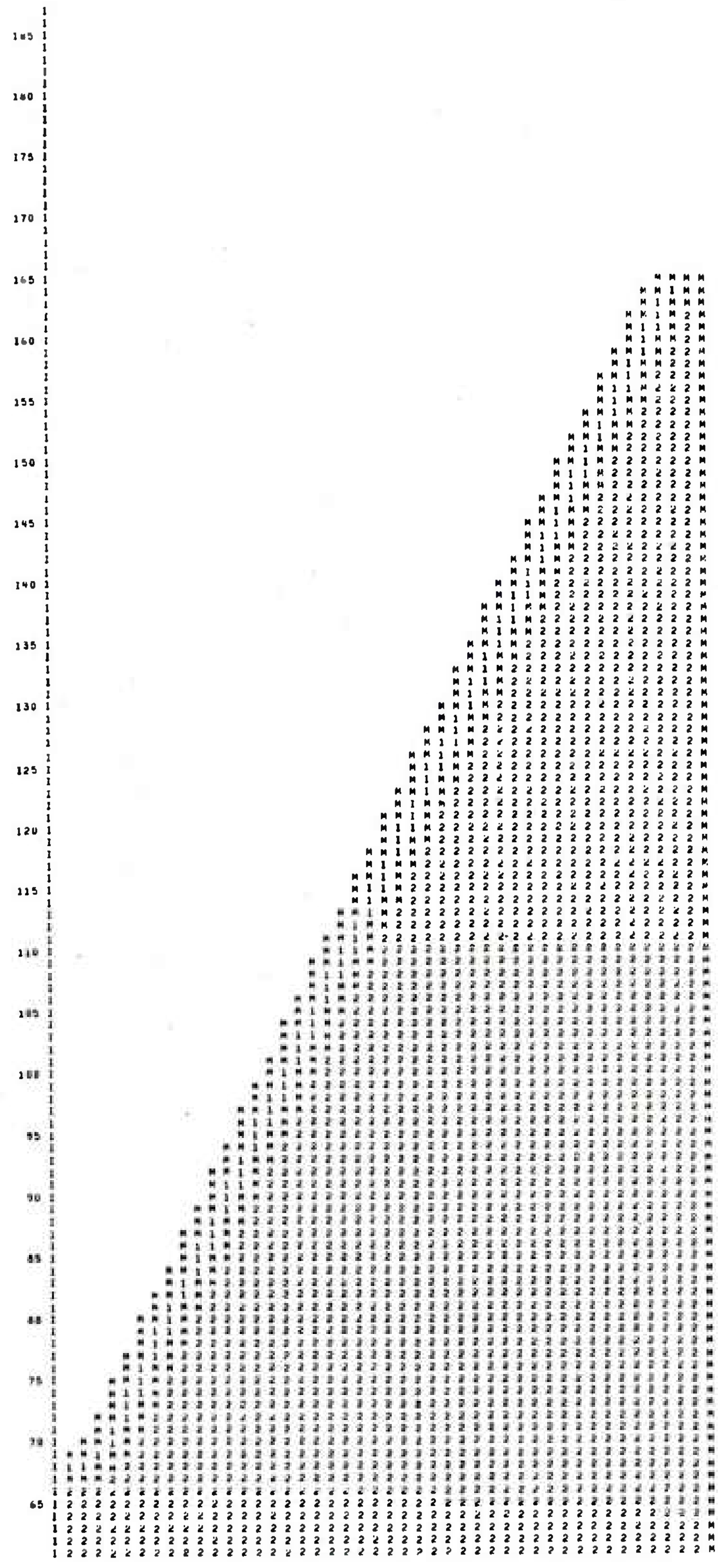
N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	0.00	68.63	2	.03	68.63	3	.06	68.64	4	.09	68.64	5	.12	68.64
6	.15	68.64	7	.18	68.64	8	.20	68.64	9	.23	68.65	10	.26	68.65
11	.29	68.65	12	.32	68.66	13	.35	68.66	14	.38	68.66	15	.41	68.67
16	.44	68.67	17	.47	68.68	18	.50	68.69	19	.52	68.69	20	.55	68.70
21	.58	68.70	22	.61	68.71	23	.64	68.72	24	.67	68.73	25	.70	68.74
26	.72	68.74	27	.75	68.75	28	.78	68.76	29	.81	68.77	30	.83	68.78
31	.86	68.79	32	.89	68.80	33	.92	68.81	34	.94	68.82	35	.97	68.84
36	1.00	68.85	37	1.02	68.86	38	1.05	68.87	39	1.08	68.89	40	1.10	68.90
41	1.13	68.91	42	1.16	68.93	43	1.18	68.94	44	1.21	68.95	45	1.23	68.97
46	1.26	68.98	47	1.28	69.00	48	1.31	69.01	49	1.33	69.03	50	1.36	69.05
51	1.38	69.06	52	1.41	69.08	53	1.43	69.10	54	1.45	69.11	55	1.48	69.13
56	1.50	69.15	57	1.52	69.17	58	1.55	69.19	59	1.57	69.21	60	1.59	69.22
61	1.61	69.24	62	1.64	69.26	63	1.66	69.28	64	1.68	69.30	65	1.70	69.32
66	1.72	69.34	67	1.74	69.37	68	1.76	69.39	69	1.78	69.41	70	1.80	69.43
71	1.82	69.45	72	1.84	69.47	73	1.86	69.50	74	1.88	69.52	75	1.90	69.54
76	1.92	69.56	77	1.94	69.59	78	1.95	69.61	79	1.97	69.63	80	1.99	69.66
81	2.00	69.68	82	2.02	69.71	83	2.04	69.73	84	2.05	69.76	85	2.07	69.78
86	2.08	69.81	87	2.10	69.83	88	2.11	69.86	89	2.13	69.88	90	2.14	69.91
91	2.16	69.93	92	2.17	69.96	93	2.18	69.99	94	2.20	70.01	95	2.21	70.04
96	2.22	70.06	97	2.23	70.09	98	2.25	70.12	99	2.26	70.15	100	2.27	70.17
101	2.27	70.17	102	2.40	70.49	103	2.53	70.81	104	2.66	71.12	105	2.79	71.44
106	2.93	71.76	107	3.06	72.07	108	3.19	72.39	109	3.32	72.71	110	3.45	73.02
111	3.58	73.34	112	3.71	73.66	113	3.84	73.97	114	3.98	74.29	115	4.11	74.61
116	4.24	74.92	117	4.37	75.24	118	4.50	75.56	119	4.63	75.87	120	4.76	76.19
121	4.89	76.51	122	5.03	76.82	123	5.16	77.14	124	5.29	77.46	125	5.42	77.77
126	5.55	78.09	127	5.68	78.41	128	5.81	78.72	129	5.94	79.04	130	6.08	79.36
131	6.21	79.67	132	6.34	79.99	133	6.47	80.31	134	6.60	80.62	135	6.73	80.94
136	6.86	81.26	137	6.99	81.57	138	7.13	81.89	139	7.26	82.21	140	7.39	82.52
141	7.52	82.84	142	7.65	83.16	143	7.78	83.47	144	7.91	83.79	145	8.05	84.11
146	8.18	84.42	147	8.31	84.74	148	8.44	85.06	149	8.57	85.37	150	8.70	85.69
151	8.83	86.01	152	8.96	86.32	153	9.10	86.64	154	9.23	86.96	155	9.36	87.27
156	9.49	87.59	157	9.62	87.91	158	9.75	88.22	159	9.88	88.54	160	10.01	88.86
161	10.15	89.17	162	10.28	89.49	163	10.41	89.81	164	10.54	90.12	165	10.67	90.44
166	10.80	90.76	167	10.93	91.08	168	11.06	91.39	169	11.20	91.71	170	11.33	92.03
171	11.46	92.34	172	11.59	92.66	173	11.72	92.98	174	11.85	93.29	175	11.98	93.61

176	12.11	93.93	177	12.25	94.24	178	12.30	94.56	179	12.51	94.88	180	12.64	95.19
181	12.77	95.51	182	12.90	95.83	183	13.03	96.14	184	13.16	96.46	185	13.30	96.78
186	13.43	97.09	187	13.56	97.41	188	13.69	97.73	189	13.82	98.04	190	13.95	98.36
191	14.08	98.68	192	14.21	98.99	193	14.35	99.31	194	14.48	99.63	195	14.61	99.94
196	14.74	100.26	197	14.87	100.58	198	15.00	100.89	199	15.13	101.21	200	15.27	101.53
201	15.40	101.84	202	15.53	102.16	203	15.66	102.48	204	15.79	102.79	205	15.92	103.11
206	16.05	103.43	207	16.18	103.74	208	16.32	104.06	209	16.45	104.38	210	16.58	104.69
211	16.71	105.01	212	16.84	105.33	213	16.97	105.64	214	17.10	105.96	215	17.23	106.28
216	17.37	106.59	217	17.50	106.91	218	17.63	107.23	219	17.76	107.54	220	17.89	107.86
221	18.02	108.18	222	18.15	108.49	223	18.28	108.81	224	18.42	109.13	225	18.55	109.44
226	18.68	109.76	227	18.81	110.08	228	18.94	110.39	229	19.07	110.71	230	19.20	111.03
231	19.33	111.34	232	19.47	111.66	233	19.60	111.98	234	19.73	112.29	235	19.86	112.61
236	19.99	112.93	237	20.12	113.24	238	20.25	113.56	239	20.38	113.88	240	20.52	114.19
241	20.65	114.51	242	20.78	114.83	243	20.91	115.14	244	21.04	115.46	245	21.17	115.78
246	21.30	116.09	247	21.43	116.41	248	21.57	116.73	249	21.70	117.04	250	21.83	117.36
251	21.96	117.68	252	22.09	117.99	253	22.22	118.31	254	22.35	118.63	255	22.48	118.94
256	22.62	119.26	257	22.75	119.58	258	22.88	119.89	259	23.01	120.21	260	23.14	120.53
261	23.27	120.84	262	23.40	121.16	263	23.54	121.48	264	23.67	121.79	265	23.80	122.11
266	23.93	122.43	267	24.06	122.74	268	24.19	123.06	269	24.32	123.38	270	24.45	123.69
271	24.59	124.01	272	24.72	124.33	273	24.85	124.64	274	24.98	124.96	275	25.11	125.28
276	25.24	125.59	277	25.37	125.91	278	25.50	126.23	279	25.64	126.55	280	25.77	126.86
281	25.90	127.18	282	26.03	127.50	283	26.16	127.81	284	26.29	128.13	285	26.42	128.45
286	26.55	128.76	287	26.69	129.08	288	26.82	129.40	289	26.95	129.71	290	27.08	130.03
291	27.21	130.35	292	27.34	130.66	293	27.47	130.98	294	27.60	131.30	295	27.74	131.61
296	27.87	131.93	297	28.00	132.25	298	28.13	132.56	299	28.26	132.88	300	28.39	133.20
301	28.52	133.51	302	28.65	133.83	303	28.79	134.15	304	28.92	134.46	305	29.05	134.78
306	29.18	135.10	307	29.31	135.41	308	29.44	135.73	309	29.57	136.05	310	29.70	136.36
311	29.84	136.68	312	29.97	137.00	313	30.10	137.31	314	30.23	137.63	315	30.36	137.95
316	30.49	138.26	317	30.62	138.58	318	30.76	138.90	319	30.89	139.21	320	31.02	139.53
321	31.15	139.85	322	31.28	140.16	323	31.41	140.48	324	31.54	140.80	325	31.67	141.11
326	31.81	141.43	327	31.94	141.75	328	32.07	142.06	329	32.20	142.38	330	32.33	142.70
331	32.46	143.01	332	32.59	143.33	333	32.72	143.65	334	32.86	143.96	335	32.99	144.28
336	33.12	144.60	337	33.25	144.91	338	33.38	145.23	339	33.51	145.55	340	33.64	145.86
341	33.77	146.18	342	33.91	146.50	343	34.04	146.81	344	34.17	147.13	345	34.30	147.45
346	34.43	147.76	347	34.56	148.08	348	34.69	148.40	349	34.82	148.71	350	34.96	149.03
351	35.09	149.35	352	35.22	149.66	353	35.35	149.98	354	35.48	150.30	355	35.61	150.61
356	35.74	150.93	357	35.87	151.25	358	36.01	151.56	359	36.14	151.88	360	36.27	152.20
361	36.40	152.51	362	36.53	152.83	363	36.66	153.15	364	36.79	153.46	365	36.92	153.78
366	37.06	154.10	367	37.19	154.41	368	37.32	154.73	369	37.45	155.05	370	37.58	155.36
371	37.71	155.68	372	37.84	156.00	373	37.97	156.31	374	38.11	156.63	375	38.24	156.95
376	38.37	157.26	377	38.50	157.58	378	38.63	157.90	379	38.76	158.21	380	38.89	158.53
381	39.03	158.85	382	39.16	159.16	383	39.29	159.48	384	39.42	159.80	385	39.55	160.11
386	39.68	160.43	387	39.81	160.75	388	39.94	161.07	389	40.08	161.38	390	40.21	161.70
391	40.34	162.02	392	40.47	162.33	393	40.60	162.65	394	40.73	162.97	395	40.86	163.28
396	40.99	163.60	397	41.13	163.92	398	41.26	164.23	399	41.39	164.55	400	41.52	164.87
401	41.52	164.87	402	41.57	164.87	403	41.63	164.87	404	41.68	164.87	405	41.73	164.87
406	41.79	164.87	407	41.84	164.87	408	41.90	164.87	409	41.95	164.87	410	42.00	164.87
411	42.06	164.87	412	42.11	164.87	413	42.16	164.87	414	42.22	164.87	415	42.27	164.87
416	42.33	164.87	417	42.38	164.87	418	42.43	164.87	419	42.49	164.87	420	42.54	164.87
421	42.59	164.87	422	42.65	164.87	423	42.70	164.87	424	42.76	164.87	425	42.81	164.87
426	42.86	164.87	427	42.92	164.87	428	42.97	164.87	429	43.02	164.87	430	43.08	164.87
431	43.13	164.87	432	43.19	164.87	433	43.24	164.87	434	43.29	164.87	435	43.35	164.87
436	43.40	164.87	437	43.45	164.87	438	43.51	164.87	439	43.56	164.87	440	43.62	164.87
441	43.67	164.87	442	43.72	164.87	443	43.78	164.87	444	43.83	164.87	445	43.89	164.87
446	43.94	164.87	447	43.99	164.87	448	44.05	164.87	449	44.10	164.87	450	44.15	164.87
451	44.15	164.87	452	44.15	164.16	453	44.15	163.45	454	44.15	162.75	455	44.15	162.04
456	44.15	161.34	457	44.15	160.63	458	44.15	159.93	459	44.15	159.22	460	44.15	158.51
461	44.15	157.81	462	44.15	157.10	463	44.15	156.40	464	44.15	155.69	465	44.15	154.99
466	44.15	154.28	467	44.15	153.57	468	44.15	152.87	469	44.15	152.16	470	44.15	151.46
471	44.15	150.75	472	44.15	150.04	473	44.15	149.34	474	44.15	148.63	475	44.15	147.93
476	44.15	147.22	477	44.15	146.52	478	44.15	145.81	479	44.15	145.10	480	44.15	144.40
481	44.15	143.69	482	44.15	142.99	483	44.15	142.28	484	44.15	141.58	485	44.15	140.87
486	44.15	140.16	487	44.15	139.46	488	44.15	138.75	489	44.15	138.05	490	44.15	137.34
491	44.15	136.64	492	44.15	135.93	493	44.15	135.22	494	44.15	134.52	495	44.15	133.81
496	44.15	133.11	497	44.15	132.40	498	44.15	131.70	499	44.15	130.99	500	44.15	130.28
501	44.15	129.58	502	44.15	128.87	503	44.15	128.17	504	44.15	127.46	505	44.15	126.76

506	44.15	126.05	507	44.15	125.34	508	44.15	124.64	509	44.15	123.93	510	44.15	123.23
511	44.15	122.52	512	44.15	121.82	513	44.15	121.11	514	44.15	120.40	515	44.15	119.70
516	44.15	118.99	517	44.15	118.29	518	44.15	117.58	519	44.15	116.88	520	44.15	116.17
521	44.15	115.46	522	44.15	114.76	523	44.15	114.05	524	44.15	113.35	525	44.15	112.64
526	44.15	111.93	527	44.15	111.23	528	44.15	110.52	529	44.15	109.82	530	44.15	109.11
531	44.15	108.41	532	44.15	107.70	533	44.15	106.99	534	44.15	106.29	535	44.15	105.58
536	44.15	104.88	537	44.15	104.17	538	44.15	103.47	539	44.15	102.76	540	44.15	102.05
541	44.15	101.35	542	44.15	100.64	543	44.15	99.94	544	44.15	99.23	545	44.15	98.53
546	44.15	97.82	547	44.15	97.11	548	44.15	96.41	549	44.15	95.70	550	44.15	95.00
551	44.15	94.29	552	44.15	93.59	553	44.15	92.88	554	44.15	92.17	555	44.15	91.47
556	44.15	90.76	557	44.15	90.06	558	44.15	89.35	559	44.15	88.65	560	44.15	87.94
561	44.15	87.23	562	44.15	86.53	563	44.15	85.82	564	44.15	85.12	565	44.15	84.41
566	44.15	83.71	567	44.15	83.00	568	44.15	82.29	569	44.15	81.59	570	44.15	80.88
571	44.15	80.18	572	44.15	79.47	573	44.15	78.77	574	44.15	78.06	575	44.15	77.35
576	44.15	76.65	577	44.15	75.94	578	44.15	75.24	579	44.15	74.53	580	44.15	73.82
581	44.15	73.12	582	44.15	72.41	583	44.15	71.71	584	44.15	71.00	585	44.15	70.30
586	44.15	69.59	587	44.15	68.88	588	44.15	68.18	589	44.15	67.47	590	44.15	66.77
591	44.15	66.06	592	44.15	65.36	593	44.15	64.65	594	44.15	63.94	595	44.15	63.24
596	44.15	62.53	597	44.15	61.83	598	44.15	61.12	599	44.15	60.42	600	44.15	59.71
601	44.15	59.00	602	44.15	58.30	603	44.15	57.59	604	44.15	56.89	605	44.15	56.18
606	44.15	55.48	607	44.15	54.77	608	44.15	54.06	609	44.15	53.36	610	44.15	52.65
611	44.15	51.95	612	44.15	51.24	613	44.15	50.54	614	44.15	49.83	615	44.15	49.12
616	44.15	48.42	617	44.15	47.71	618	44.15	47.01	619	44.15	46.30	620	44.15	45.60
621	44.15	44.89	622	44.15	44.18	623	44.15	43.48	624	44.15	42.77	625	44.15	42.07
626	44.15	41.36	627	44.15	40.66	628	44.15	39.95	629	44.15	39.24	630	44.15	38.54
631	44.15	37.83	632	44.15	37.13	633	44.15	36.42	634	44.15	35.71	635	44.15	35.01
636	44.15	34.30	637	44.15	33.60	638	44.15	32.89	639	44.15	32.19	640	44.15	31.48
641	44.15	30.77	642	44.15	30.07	643	44.15	29.36	644	44.15	28.66	645	44.15	27.95
646	44.15	27.25	647	44.15	26.54	648	44.15	25.83	649	44.15	25.13	650	44.15	24.42
651	44.15	24.42	652	43.71	24.42	653	43.26	24.42	654	42.82	24.42	655	42.37	24.42
656	41.92	24.42	657	41.48	24.42	658	41.03	24.42	659	40.59	24.42	660	40.14	24.42
661	39.69	24.42	662	39.25	24.42	663	38.80	24.42	664	38.36	24.42	665	37.91	24.42
666	37.46	24.42	667	37.02	24.42	668	36.57	24.42	669	36.13	24.42	670	35.68	24.42
671	35.23	24.42	672	34.79	24.42	673	34.34	24.42	674	33.90	24.42	675	33.45	24.42
676	33.00	24.42	677	32.56	24.42	678	32.11	24.42	679	31.67	24.42	680	31.22	24.42
681	30.77	24.42	682	30.33	24.42	683	29.88	24.42	684	29.44	24.42	685	28.99	24.42
686	28.54	24.42	687	28.10	24.42	688	27.65	24.42	689	27.21	24.42	690	26.76	24.42
691	26.31	24.42	692	25.87	24.42	693	25.42	24.42	694	24.98	24.42	695	24.53	24.42
696	24.08	24.42	697	23.64	24.42	698	23.19	24.42	699	22.75	24.42	700	22.30	24.42
701	21.85	24.42	702	21.41	24.42	703	20.96	24.42	704	20.52	24.42	705	20.07	24.42
706	19.62	24.42	707	19.18	24.42	708	18.73	24.42	709	18.29	24.42	710	17.84	24.42
711	17.39	24.42	712	16.95	24.42	713	16.50	24.42	714	16.06	24.42	715	15.61	24.42
716	15.16	24.42	717	14.72	24.42	718	14.27	24.42	719	13.83	24.42	720	13.38	24.42
721	12.93	24.42	722	12.49	24.42	723	12.04	24.42	724	11.60	24.42	725	11.15	24.42
726	10.70	24.42	727	10.26	24.42	728	9.81	24.42	729	9.37	24.42	730	8.92	24.42
731	8.47	24.42	732	8.03	24.42	733	7.58	24.42	734	7.14	24.42	735	6.69	24.42
736	6.24	24.42	737	5.80	24.42	738	5.35	24.42	739	4.91	24.42	740	4.46	24.42
741	4.01	24.42	742	3.57	24.42	743	3.12	24.42	744	2.68	24.42	745	2.23	24.42
746	1.78	24.42	747	1.34	24.42	748	.89	24.42	749	.45	24.42	750	0.00	24.42
751-1000.00		0.00												

SPHASE ETH= 2.16597438E+07 ESUM= 2.16597438E+07 EMIX= 2.16597438E+07 RELERR= 0.
EINTC= 2.16597438E+07 EINTM= 2.16597438E+07
EKINC= 0. EKINM= 0.
HPHASE ETH= 2.16597438E+07 ESUM= 2.16597438E+07 EMIX= 2.16597438E+07 RELERR= -5.50372575E-15
EINTC= 2.16597388E+07 EINTM= 2.16597388E+07
EKINC= 4.97079753E+00 EKINM= 4.97079753E+00

DISPLAY OF MIXED AND PURE CELLS   M = MIXED CELL   NUMERAL N = PURE CELL OF PACKAGE N MATERIAL



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                                        EKINC=   4.97079753E+00    EKINM=   4.97079753E+00
CYCLE    1
COT 43 164  T=3.3228069E-08  DT=5.2658228E-10  MAXCUV=3.9500000E+05  MAXUV=1.5073148E+02  UMIN=3.9500000E+00  PMIN=5.0000000E+06


APPROACHING CUT OFF TIME  2.551 SECONDS LEFT
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PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE		IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
43.0000	3.3228069E-08	1	2.1659744E+07	-5.5037257E-15	1	2.1365751E-07	0.

PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WORK
1	0.	0.	0.	4.5904689E+01	0.	0.	0.	0.
2	2.1659739E+07	4.9707975E+00	2.1659744E+07	1.5515881E+02	0.	0.	6.5955663E-02	0.
TOTALS	2.1659739E+07	4.9707975E+00	2.1659744E+07	2.0106350E+02	0.	0.	6.5955663E-02	0.

	IE OUT	KE OUT
1	0.	0.
2	-2.1365751E-07	0.

BOUNDARY	BOTTOM	RIGHT	TOP	$EVAPORATED$
MASS OUT	0.	0.	0.	0.
ENERGY OUT	0.	0.	0.	0.
MU OUT	0.	0.	0.	0.
MV OUT	0.	0.	0.	0.
WORK DONE	0.	0.	0.	

TAPE 10 DUMP ON CYCLE 1

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	1	0	1	0	400	0
2	0	2	0	301	0	700

CELL-COORDINATES OF TRACERS FOR EACH MATERIAL PACKAGE

PACKAGE 1

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	0.00	66.19	2	.06	66.19	3	.12	66.19	4	.17	66.20	5	.23	66.20
6	.29	66.20	7	.35	66.20	8	.41	66.21	9	.47	66.21	10	.53	66.22
11	.58	66.23	12	.64	66.23	13	.70	66.24	14	.76	66.25	15	.82	66.26
16	.88	66.27	17	.93	66.28	18	.99	66.29	19	1.05	66.31	20	1.11	66.32
21	1.16	66.33	22	1.22	66.35	23	1.28	66.36	24	1.33	66.38	25	1.39	66.39
26	1.45	66.41	27	1.50	66.43	28	1.56	66.45	29	1.61	66.47	30	1.67	66.49
31	1.72	66.51	32	1.78	66.53	33	1.83	66.55	34	1.89	66.57	35	1.94	66.60
36	2.00	66.62	37	2.05	66.64	38	2.10	66.67	39	2.16	66.69	40	2.21	66.72
41	2.26	66.75	42	2.31	66.77	43	2.36	66.80	44	2.42	66.83	45	2.47	66.86
46	2.52	66.89	47	2.57	66.92	48	2.62	66.95	49	2.67	66.98	50	2.72	67.02
51	2.76	67.05	52	2.81	67.08	53	2.86	67.12	54	2.91	67.15	55	2.96	67.19
56	3.00	67.22	57	3.05	67.26	58	3.09	67.30	59	3.14	67.33	60	3.18	67.37
61	3.23	67.41	62	3.27	67.45	63	3.32	67.49	64	3.36	67.53	65	3.40	67.57
66	3.44	67.61	67	3.48	67.65	68	3.53	67.70	69	3.57	67.74	70	3.61	67.78
71	3.65	67.83	72	3.68	67.87	73	3.72	67.91	74	3.76	67.96	75	3.80	68.00
76	3.83	68.05	77	3.87	68.10	78	3.91	68.14	79	3.94	68.19	80	3.98	68.24
81	4.01	68.29	82	4.04	68.34	83	4.08	68.38	84	4.11	68.43	85	4.14	68.48

86	4.17	68.53	87	4.20	68.58	88	4.23	68.63	89	4.26	68.69	90	4.29	68.74
91	4.32	68.79	92	4.34	68.84	93	4.37	68.89	94	4.40	68.95	95	4.42	69.00
96	4.45	69.05	97	4.47	69.11	98	4.49	69.16	99	4.52	69.21	100	4.54	69.27
101	4.54	69.23	102	4.67	69.55	103	4.80	69.87	104	4.94	70.19	105	5.07	70.51
106	5.20	70.83	107	5.33	71.15	108	5.47	71.47	109	5.60	71.79	110	5.73	72.11
111	5.86	72.43	112	6.00	72.75	113	6.13	73.07	114	6.26	73.39	115	6.39	73.71
116	6.53	74.03	117	6.66	74.35	118	6.79	74.67	119	6.92	74.99	120	7.06	75.31
121	7.19	75.63	122	7.32	75.95	123	7.45	76.27	124	7.59	76.59	125	7.72	76.91
126	7.85	77.23	127	7.98	77.55	128	8.12	77.87	129	8.25	78.19	130	8.38	78.51
131	8.51	78.83	132	8.65	79.15	133	8.78	79.47	134	8.91	79.79	135	9.04	80.11
136	9.18	80.43	137	9.31	80.75	138	9.44	81.07	139	9.57	81.39	140	9.71	81.70
141	9.84	82.02	142	9.97	82.34	143	10.10	82.66	144	10.24	82.98	145	10.37	83.30
146	10.50	83.62	147	10.63	83.94	148	10.77	84.26	149	10.90	84.58	150	11.03	84.90
151	11.16	85.22	152	11.30	85.54	153	11.43	85.86	154	11.56	86.18	155	11.69	86.50
156	11.83	86.82	157	11.96	87.14	158	12.09	87.46	159	12.22	87.78	160	12.36	88.10
161	12.49	88.42	162	12.62	88.74	163	12.75	89.06	164	12.89	89.38	165	13.02	89.70
166	13.15	90.02	167	13.28	90.34	168	13.42	90.66	169	13.55	90.98	170	13.68	91.30
171	13.81	91.62	172	13.95	91.94	173	14.08	92.26	174	14.21	92.58	175	14.34	92.90
176	14.48	93.22	177	14.61	93.54	178	14.74	93.86	179	14.87	94.18	180	15.01	94.50
181	15.14	94.82	182	15.27	95.14	183	15.40	95.46	184	15.54	95.78	185	15.67	96.10
186	15.80	96.42	187	15.93	96.74	188	16.07	97.06	189	16.20	97.38	190	16.33	97.70
191	16.46	98.02	192	16.60	98.34	193	16.73	98.66	194	16.86	98.98	195	16.99	99.30
196	17.13	99.62	197	17.26	99.94	198	17.39	100.26	199	17.52	100.58	200	17.66	100.90
201	17.79	101.22	202	17.92	101.54	203	18.05	101.86	204	18.19	102.18	205	18.32	102.49
206	18.45	102.81	207	18.58	103.13	208	18.72	103.45	209	18.85	103.77	210	18.98	104.09
211	19.11	104.41	212	19.25	104.73	213	19.38	105.05	214	19.51	105.37	215	19.64	105.69
216	19.78	106.01	217	19.91	106.33	218	20.04	106.65	219	20.17	106.97	220	20.31	107.29
221	20.44	107.61	222	20.57	107.93	223	20.70	108.25	224	20.84	108.57	225	20.97	108.89
226	21.10	109.21	227	21.23	109.53	228	21.37	109.85	229	21.50	110.17	230	21.63	110.49
231	21.76	110.81	232	21.90	111.13	233	22.03	111.45	234	22.16	111.77	235	22.29	112.09
236	22.43	112.41	237	22.56	112.73	238	22.69	113.05	239	22.82	113.37	240	22.95	113.69
241	23.09	114.01	242	23.22	114.33	243	23.35	114.65	244	23.48	114.97	245	23.62	115.29
246	23.75	115.61	247	23.88	115.93	248	24.01	116.25	249	24.15	116.57	250	24.28	116.89
251	24.41	117.21	252	24.54	117.53	253	24.68	117.85	254	24.81	118.17	255	24.94	118.49
256	25.07	118.81	257	25.21	119.13	258	25.34	119.45	259	25.47	119.77	260	25.60	120.09
261	25.74	120.41	262	25.87	120.73	263	26.00	121.05	264	26.13	121.37	265	26.27	121.69
266	26.40	122.01	267	26.53	122.33	268	26.66	122.65	269	26.80	122.97	270	26.93	123.29
271	27.06	123.60	272	27.19	123.92	273	27.33	124.24	274	27.46	124.56	275	27.59	124.88
276	27.72	125.20	277	27.86	125.52	278	27.99	125.84	279	28.12	126.16	280	28.25	126.48
281	28.39	126.80	282	28.52	127.12	283	28.65	127.44	284	28.78	127.76	285	28.92	128.08
286	29.05	128.40	287	29.18	128.72	288	29.31	129.04	289	29.45	129.36	290	29.58	129.68
291	29.71	130.00	292	29.84	130.32	293	29.98	130.64	294	30.11	130.96	295	30.24	131.28
296	30.37	131.60	297	30.51	131.92	298	30.64	132.24	299	30.77	132.56	300	30.90	132.88
301	31.04	133.20	302	31.17	133.52	303	31.30	133.84	304	31.43	134.16	305	31.57	134.48
306	31.70	134.80	307	31.83	135.12	308	31.96	135.44	309	32.10	135.76	310	32.23	136.08
311	32.36	136.40	312	32.49	136.72	313	32.63	137.04	314	32.76	137.36	315	32.89	137.68
316	33.02	138.00	317	33.16	138.32	318	33.29	138.64	319	33.42	138.96	320	33.55	139.28
321	33.69	139.60	322	33.82	139.92	323	33.95	140.24	324	34.08	140.56	325	34.22	140.88
326	34.35	141.20	327	34.48	141.52	328	34.61	141.84	329	34.75	142.16	330	34.88	142.48
331	35.01	142.80	332	35.14	143.12	333	35.28	143.44	334	35.41	143.76	335	35.54	144.08
336	35.67	144.40	337	35.81	144.71	338	35.94	145.03	339	36.07	145.35	340	36.20	145.67
341	36.34	145.99	342	36.47	146.31	343	36.60	146.63	344	36.73	146.95	345	36.87	147.27
346	37.00	147.59	347	37.13	147.91	348	37.26	148.23	349	37.40	148.55	350	37.53	148.87
351	37.66	149.19	352	37.79	149.51	353	37.93	149.83	354	38.06	150.15	355	38.19	150.47
356	38.32	150.79	357	38.46	151.11	358	38.59	151.43	359	38.72	151.75	360	38.85	152.07
361	38.99	152.39	362	39.12	152.71	363	39.25	153.03	364	39.38	153.35	365	39.52	153.67
366	39.65	153.99	367	39.78	154.31	368	39.91	154.63	369	40.05	154.95	370	40.18	155.27
371	40.31	155.59	372	40.44	155.91	373	40.58	156.23	374	40.71	156.55	375	40.84	156.87
376	40.97	157.19	377	41.11	157.51	378	41.24	157.83	379	41.37	158.15	380	41.50	158.47
381	41.64	158.79	382	41.77	159.11	383	41.90	159.43	384	42.03	159.75	385	42.17	160.07
386	42.30	160.39	387	42.43	160.71	388	42.56	161.03	389	42.70	161.35	390	42.83	161.67
391	42.96	161.99	392	43.09	162.31	393	43.23	162.63	394	43.36	162.95	395	43.49	163.27
396	43.62	163.59	397	43.76	163.91	398	43.89	164.23	399	44.02	164.55	400	44.15	164.87
401	44.15	164.87	402	44.10	164.87	403	44.05	164.87	404	43.99	164.87	405	43.94	164.87
406	43.89	164.87	407	43.83	164.87	408	43.78	164.87	409	43.72	164.87	410	43.67	164.87
411	43.62	164.87	412	43.56	164.87	413	43.51	164.87	414	43.45	164.87	415	43.40	164.87

416	43.35	164.87	417	43.29	164.87	418	43.24	164.87	419	43.19	164.87	420	43.13	164.87
421	43.08	164.87	422	43.02	164.87	423	42.97	164.87	424	42.92	164.87	425	42.86	164.87
426	42.81	164.87	427	42.76	164.87	428	42.70	164.87	429	42.65	164.87	430	42.59	164.87
431	42.54	164.87	432	42.49	164.87	433	42.43	164.87	434	42.38	164.87	435	42.33	164.87
436	42.27	164.87	437	42.22	164.87	438	42.16	164.87	439	42.11	164.87	440	42.06	164.87
441	42.00	164.87	442	41.95	164.87	443	41.90	164.87	444	41.84	164.87	445	41.79	164.07
446	41.73	164.87	447	41.68	164.87	448	41.63	164.87	449	41.57	164.87	450	41.52	164.87
451	41.52	164.87	452	41.39	164.55	453	41.26	164.23	454	41.13	163.92	455	40.99	163.60
456	40.86	163.28	457	40.73	162.97	458	40.60	162.65	459	40.47	162.33	460	40.34	162.02
461	40.21	161.70	462	40.08	161.38	463	39.94	161.07	464	39.81	160.75	465	39.68	160.43
466	39.55	160.11	467	39.42	159.80	468	39.29	159.48	469	39.16	159.16	470	39.03	158.85
471	38.89	158.53	472	38.76	158.21	473	38.63	157.90	474	38.50	157.58	475	38.37	157.26
476	38.24	156.95	477	38.11	156.63	478	37.97	156.31	479	37.84	156.00	480	37.71	155.68
481	37.58	155.36	482	37.45	155.05	483	37.32	154.73	484	37.19	154.41	485	37.06	154.10
486	36.92	153.78	487	36.79	153.46	488	36.66	153.15	489	36.53	152.83	490	36.40	152.51
491	36.27	152.20	492	36.14	151.88	493	36.01	151.56	494	35.87	151.25	495	35.74	150.93
496	35.61	150.61	497	35.48	150.30	498	35.35	149.98	499	35.22	149.66	500	35.09	149.35
501	34.96	149.03	502	34.82	148.71	503	34.69	148.40	504	34.56	148.08	505	34.43	147.76
506	34.30	147.45	507	34.17	147.13	508	34.04	146.81	509	33.91	146.50	510	33.77	146.18
511	33.64	145.86	512	33.51	145.55	513	33.38	145.23	514	33.25	144.91	515	33.12	144.60
516	32.99	144.28	517	32.86	143.96	518	32.72	143.65	519	32.59	143.33	520	32.46	143.01
521	32.33	142.70	522	32.20	142.38	523	32.07	142.06	524	31.94	141.75	525	31.81	141.43
526	31.67	141.11	527	31.54	140.80	528	31.41	140.48	529	31.28	140.16	530	31.15	139.85
531	31.02	139.53	532	30.89	139.21	533	30.76	138.90	534	30.62	138.58	535	30.49	138.26
536	30.36	137.95	537	30.23	137.63	538	30.10	137.31	539	29.97	137.00	540	29.84	136.68
541	29.70	136.36	542	29.57	136.05	543	29.44	135.73	544	29.31	135.41	545	29.18	135.10
546	29.05	134.78	547	28.92	134.46	548	28.79	134.15	549	28.65	133.83	550	28.52	133.51
551	28.39	133.20	552	28.26	132.88	553	28.13	132.56	554	28.00	132.25	555	27.87	131.93
556	27.74	131.61	557	27.60	131.30	558	27.47	130.98	559	27.34	130.66	560	27.21	130.35
561	27.08	130.03	562	26.95	129.71	563	26.82	129.40	564	26.69	129.08	565	26.55	128.76
566	26.42	128.45	567	26.29	128.13	568	26.16	127.81	569	26.03	127.50	570	25.90	127.18
571	25.77	126.86	572	25.64	126.55	573	25.50	126.23	574	25.37	125.91	575	25.24	125.59
576	25.11	125.28	577	24.98	124.96	578	24.85	124.64	579	24.72	124.33	580	24.59	124.01
581	24.45	123.69	582	24.32	123.38	583	24.19	123.06	584	24.06	122.74	585	23.93	122.43
586	23.80	122.11	587	23.67	121.79	588	23.54	121.48	589	23.40	121.16	590	23.27	120.84
591	23.14	120.53	592	23.01	120.21	593	22.88	119.89	594	22.75	119.58	595	22.62	119.26
596	22.48	118.94	597	22.35	118.63	598	22.22	118.31	599	22.09	117.99	600	21.96	117.68
601	21.83	117.36	602	21.70	117.04	603	21.57	116.73	604	21.43	116.41	605	21.30	116.09
606	21.17	115.78	607	21.04	115.46	608	20.91	115.14	609	20.78	114.83	610	20.65	114.51
611	20.52	114.19	612	20.38	113.88	613	20.25	113.56	614	20.12	113.24	615	19.99	112.93
616	19.86	112.61	617	19.73	112.29	618	19.60	111.98	619	19.47	111.66	620	19.33	111.34
621	19.20	111.03	622	19.07	110.71	623	18.94	110.39	624	18.81	110.08	625	18.68	109.76
626	18.55	109.44	627	18.42	109.13	628	18.28	108.81	629	18.15	108.49	630	18.02	108.18
631	17.89	107.86	632	17.76	107.54	633	17.63	107.23	634	17.50	106.91	635	17.37	106.59
636	17.23	106.28	637	17.10	105.96	638	16.97	105.64	639	16.84	105.33	640	16.71	105.01
641	16.58	104.69	642	16.45	104.38	643	16.32	104.06	644	16.18	103.74	645	16.05	103.43
646	15.92	103.11	647	15.79	102.79	648	15.66	102.48	649	15.53	102.16	650	15.40	101.84
651	15.27	101.53	652	15.13	101.21	653	15.00	100.89	654	14.87	100.58	655	14.74	100.26
656	14.61	99.94	657	14.48	99.63	658	14.35	99.31	659	14.21	98.99	660	14.08	98.68
661	13.95	98.36	662	13.82	98.04	663	13.69	97.73	664	13.56	97.41	665	13.43	97.09
666	13.30	96.78	667	13.16	96.46	668	13.03	96.14	669	12.90	95.83	670	12.77	95.51
671	12.64	95.19	672	12.51	94.88	673	12.38	94.56	674	12.25	94.24	675	12.11	93.93
676	11.98	93.61	677	11.85	93.29	678	11.72	92.98	679	11.59	92.66	680	11.46	92.34
681	11.33	92.03	682	11.20	91.71	683	11.06	91.39	684	10.93	91.08	685	10.80	90.76
686	10.67	90.44	687	10.54	90.12	688	10.41	89.81	689	10.28	89.49	690	10.15	89.17
691	10.01	88.86	692	9.88	88.54	693	9.75	88.22	694	9.62	87.91	695	9.49	87.59
696	9.36	87.27	697	9.23	86.96	698	9.10	86.64	699	8.96	86.32	700	8.83	86.01
701	8.70	85.69	702	8.57	85.37	703	8.44	85.06	704	8.31	84.74	705	8.18	84.42
706	8.05	84.11	707	7.91	83.79	708	7.78	83.47	709	7.65	83.16	710	7.52	82.84
711	7.39	82.52	712	7.26	82.21	713	7.13	81.89	714	6.99	81.57	715	6.86	61.26
716	6.73	80.94	717	6.60	80.62	718	6.47	80.31	719	6.34	79.99	720	6.21	79.67
721	6.08	79.36	722	5.94	79.04	723	5.81	78.72	724	5.68	78.41	725	5.55	78.09
726	5.42	77.77	727	5.29	77.46	728	5.16	77.14	729	5.03	76.82	730	4.89	76.51
731	4.76	76.19	732	4.63	75.87	733	4.50	75.56	734	4.37	75.24	735	4.24	74.92
736	4.11	74.61	737	3.98	74.29	738	3.84	73.97	739	3.71	73.66	740	3.58	73.34
741	3.45	73.02	742	3.32	72.71	743	3.19	72.39	744	3.06	72.07	745	2.93	71.76

746	2.79	71.44	747	2.66	71.12	748	2.53	70.81	749	2.40	70.49	750	2.27	70.17
751	2.27	70.17	752	2.26	70.15	753	2.25	70.12	754	2.23	70.09	755	2.22	70.06
756	2.21	70.04	757	2.20	70.01	758	2.18	69.99	759	2.17	69.96	760	2.16	69.93
761	2.14	69.91	762	2.13	69.88	763	2.11	69.86	764	2.10	69.83	765	2.08	69.81
766	2.07	69.78	767	2.05	69.76	768	2.04	69.73	769	2.02	69.71	770	2.00	69.68
771	1.99	69.66	772	1.97	69.63	773	1.95	69.61	774	1.94	69.59	775	1.92	69.56
776	1.90	69.54	777	1.88	69.52	778	1.86	69.50	779	1.04	69.47	780	1.82	69.45
781	1.80	69.43	782	1.78	69.41	783	1.76	69.39	784	1.74	69.37	785	1.72	69.34
786	1.70	69.32	787	1.68	69.30	788	1.66	69.28	789	1.64	69.26	790	1.61	69.24
791	1.59	69.22	792	1.57	69.21	793	1.55	69.19	794	1.52	69.17	795	1.50	69.15
796	1.48	69.13	797	1.45	69.11	798	1.43	69.10	799	1.41	69.08	800	1.38	69.06
801	1.36	69.05	802	1.33	69.03	803	1.31	69.01	804	1.28	69.00	805	1.26	68.98
806	1.23	68.97	807	1.21	68.95	808	1.18	68.94	809	1.16	68.93	810	1.13	68.91
811	1.10	68.90	812	1.08	68.89	813	1.05	68.87	814	1.02	68.86	815	1.00	68.85
816	.97	68.84	817	.94	68.82	818	.92	68.81	819	.89	68.80	820	.86	68.79
821	.83	68.78	822	.81	68.77	823	.78	68.76	824	.75	68.75	825	.72	68.74
826	.70	68.74	827	.67	68.73	828	.64	68.72	829	.61	68.71	830	.58	68.70
831	.55	68.70	832	.52	68.69	833	.50	68.69	834	.47	68.68	835	.44	68.67
836	.41	68.67	837	.38	68.66	838	.35	68.66	839	.32	68.66	840	.29	68.65
841	.26	68.65	842	.23	68.65	843	.20	68.64	844	.18	68.64	845	.15	68.64
846	.12	68.64	847	.09	68.64	848	.06	68.64	849	.03	68.63	850	0.00	68.63
851-1000.00		0.00												

PACKAGE 2

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	0.00	24.42	2	.45	24.42	3	.89	24.42	4	1.34	24.42	5	1.78	24.42
6	2.23	24.42	7	2.68	24.42	8	3.12	24.42	9	3.57	24.42	10	4.01	24.42
11	4.46	24.42	12	4.91	24.42	13	5.35	24.42	14	5.80	24.42	15	6.24	24.42
16	6.69	24.42	17	7.14	24.42	18	7.58	24.42	19	8.03	24.42	20	8.47	24.42
21	8.92	24.42	22	9.37	24.42	23	9.81	24.42	24	10.26	24.42	25	10.70	24.42
26	11.15	24.42	27	11.60	24.42	28	12.04	24.42	29	12.49	24.42	30	12.93	24.42
31	13.38	24.42	32	13.83	24.42	33	14.27	24.42	34	14.72	24.42	35	15.16	24.42
36	15.61	24.42	37	16.06	24.42	38	16.50	24.42	39	16.95	24.42	40	17.39	24.42
41	17.84	24.42	42	18.29	24.42	43	18.73	24.42	44	19.18	24.42	45	19.62	24.42
46	20.07	24.42	47	20.52	24.42	48	20.96	24.42	49	21.41	24.42	50	21.85	24.42
51	22.30	24.42	52	22.75	24.42	53	23.19	24.42	54	23.64	24.42	55	24.08	24.42
56	24.53	24.42	57	24.98	24.42	58	25.42	24.42	59	25.87	24.42	60	26.31	24.42
61	26.76	24.42	62	27.21	24.42	63	27.65	24.42	64	28.10	24.42	65	28.54	24.42
66	28.99	24.42	67	29.44	24.42	68	29.88	24.42	69	30.33	24.42	70	30.77	24.42
71	31.22	24.42	72	31.67	24.42	73	32.11	24.42	74	32.56	24.42	75	33.00	24.42
76	33.45	24.42	77	33.90	24.42	78	34.34	24.42	79	34.79	24.42	80	35.23	24.42
81	35.68	24.42	82	36.13	24.42	83	36.57	24.42	84	37.02	24.42	85	37.46	24.42
86	37.91	24.42	87	38.36	24.42	88	38.80	24.42	89	39.25	24.42	90	39.69	24.42
91	40.14	24.42	92	40.59	24.42	93	41.03	24.42	94	41.48	24.42	95	41.92	24.42
96	42.37	24.42	97	42.82	24.42	98	43.26	24.42	99	43.71	24.42	100	44.15	24.42
101	44.15	24.42	102	44.15	25.13	103	44.15	25.83	104	44.15	26.54	105	44.15	27.25
106	44.15	27.95	107	44.15	28.66	108	44.15	29.36	109	44.15	30.07	110	44.15	30.77
111	44.15	31.48	112	44.15	32.19	113	44.15	32.89	114	44.15	33.60	115	44.15	34.30
116	44.15	35.01	117	44.15	35.71	118	44.15	36.42	119	44.15	37.13	120	44.15	37.83
121	44.15	38.54	122	44.15	39.24	123	44.15	39.95	124	44.15	40.66	125	44.15	41.36
126	44.15	42.07	127	44.15	42.77	128	44.15	43.48	129	44.15	44.18	130	44.15	44.89
131	44.15	45.60	132	44.15	46.30	133	44.15	47.01	134	44.15	47.71	135	44.15	48.42
136	44.15	49.12	137	44.15	49.83	138	44.15	50.54	139	44.15	51.24	140	44.15	51.95
141	44.15	52.65	142	44.15	53.36	143	44.15	54.06	144	44.15	54.77	145	44.15	55.48
146	44.15	56.18	147	44.15	56.89	148	44.15	57.59	149	44.15	58.30	150	44.15	59.00
151	44.15	59.71	152	44.15	60.42	153	44.15	61.12	154	44.15	61.83	155	44.15	62.53
156	44.15	63.24	157	44.15	63.94	158	44.15	64.65	159	44.15	65.36	160	44.15	66.06
161	44.15	66.77	162	44.15	67.47	163	44.15	68.18	164	44.15	68.88	165	44.15	69.59
166	44.15	70.30	167	44.15	71.00	168	44.15	71.71	169	44.15	72.41	170	44.15	73.12
171	44.15	73.82	172	44.15	74.53	173	44.15	75.24	174	44.15	75.94	175	44.15	76.65
176	44.15	77.35	177	44.15	78.06	178	44.15	78.77	179	44.15	79.47	180	44.15	80.18
181	44.15	80.88	182	44.15	81.59	183	44.15	82.29	184	44.15	83.00	185	44.15	83.71
186	44.15	84.41	187	44.15	85.12	188	44.15	85.82	189	44.15	86.53	190	44.15	87.23
191	44.15	87.94	192	44.15	88.65	193	44.15	89.35	194	44.15	90.06	195	44.15	90.76
196	44.15	91.47	197	44.15	92.17	198	44.15	92.88	199	44.15	93.59	200	44.15	94.29

201	44.15	95.00	202	44.15	95.70	203	44.15	96.41	204	44.15	97.11	205	44.15	97.82
206	44.15	98.53	207	44.15	99.23	208	44.15	99.94	209	44.15	100.64	210	44.15	101.35
211	44.15	102.05	212	44.15	102.76	213	44.15	103.47	214	44.15	104.17	215	44.15	104.88
216	44.15	105.58	217	44.15	106.29	218	44.15	106.99	219	44.15	107.70	220	44.15	108.41
221	44.15	109.11	222	44.15	109.82	223	44.15	110.52	224	44.15	111.23	225	44.15	111.93
226	44.15	112.64	227	44.15	113.35	228	44.15	114.05	229	44.15	114.76	230	44.15	115.46
231	44.15	116.17	232	44.15	116.88	233	44.15	117.58	234	44.15	118.29	235	44.15	118.99
236	44.15	119.70	237	44.15	120.40	238	44.15	121.11	239	44.15	121.82	240	44.15	122.52
241	44.15	123.23	242	44.15	123.93	243	44.15	124.64	244	44.15	125.34	245	44.15	126.05
246	44.15	126.76	247	44.15	127.46	248	44.15	128.17	249	44.15	128.87	250	44.15	129.58
251	44.15	130.28	252	44.15	130.99	253	44.15	131.70	254	44.15	132.40	255	44.15	133.11
256	44.15	133.81	257	44.15	134.52	258	44.15	135.22	259	44.15	135.93	260	44.15	136.64
261	44.15	137.34	262	44.15	138.05	263	44.15	138.75	264	44.15	139.46	265	44.15	140.16
266	44.15	140.87	267	44.15	141.58	268	44.15	142.28	269	44.15	142.99	270	44.15	143.69
271	44.15	144.40	272	44.15	145.10	273	44.15	145.81	274	44.15	146.52	275	44.15	147.22
276	44.15	147.93	277	44.15	148.63	278	44.15	149.34	279	44.15	150.04	280	44.15	150.75
281	44.15	151.46	282	44.15	152.16	283	44.15	152.87	284	44.15	153.57	285	44.15	154.28
286	44.15	154.99	287	44.15	155.69	288	44.15	156.40	289	44.15	157.10	290	44.15	157.81
291	44.15	158.51	292	44.15	159.22	293	44.15	159.93	294	44.15	160.63	295	44.15	161.34
296	44.15	162.04	297	44.15	162.75	298	44.15	163.45	299	44.15	164.16	300	44.15	164.87
301	44.15	164.87	302	44.02	164.55	303	43.89	164.23	304	43.76	163.91	305	43.62	163.59
306	43.49	163.27	307	43.36	162.95	308	43.23	162.63	309	43.09	162.31	310	42.96	161.99
311	42.83	161.67	312	42.70	161.35	313	42.56	161.03	314	42.43	160.71	315	42.30	160.39
316	42.17	160.07	317	42.03	159.75	318	41.90	159.43	319	41.77	159.11	320	41.64	158.79
321	41.50	158.47	322	41.37	158.15	323	41.24	157.83	324	41.11	157.51	325	40.97	157.19
326	40.84	156.87	327	40.71	156.55	328	40.58	156.23	329	40.44	155.91	330	40.31	155.59
331	40.18	155.27	332	40.05	154.95	333	39.91	154.63	334	39.78	154.31	335	39.65	153.99
336	39.52	153.67	337	39.38	153.35	338	39.25	153.03	339	39.12	152.71	340	38.99	152.39
341	38.85	152.07	342	38.72	151.75	343	38.59	151.43	344	38.46	151.11	345	38.32	150.79
346	38.19	150.47	347	38.06	150.15	348	37.93	149.83	349	37.79	149.51	350	37.66	149.19
351	37.53	148.87	352	37.40	148.55	353	37.26	148.23	354	37.13	147.91	355	37.00	147.59
356	36.87	147.27	357	36.73	146.95	358	36.60	146.63	359	36.47	146.31	360	36.34	145.99
361	36.20	145.67	362	36.07	145.35	363	35.94	145.03	364	35.81	144.71	365	35.67	144.40
366	35.54	144.08	367	35.41	143.76	368	35.28	143.44	369	35.14	143.12	370	35.01	142.80
371	34.88	142.48	372	34.75	142.16	373	34.61	141.84	374	34.48	141.52	375	34.35	141.20
376	34.22	140.88	377	34.08	140.56	378	33.95	140.24	379	33.82	139.92	380	33.69	139.60
381	33.55	139.28	382	33.42	138.96	383	33.29	138.64	384	33.16	138.32	385	33.02	138.00
386	32.89	137.68	387	32.76	137.36	388	32.63	137.04	389	32.49	136.72	390	32.36	136.40
391	32.23	136.08	392	32.10	135.76	393	31.96	135.44	394	31.83	135.12	395	31.70	134.80
396	31.57	134.48	397	31.43	134.16	398	31.30	133.84	399	31.17	133.52	400	31.04	133.20
401	30.90	132.88	402	30.77	132.56	403	30.64	132.24	404	30.51	131.92	405	30.37	131.60
406	30.24	131.28	407	30.11	130.96	408	29.98	130.64	409	29.84	130.32	410	29.71	130.00
411	29.58	129.68	412	29.45	129.36	413	29.31	129.04	414	29.18	128.72	415	29.05	128.40
416	28.92	128.08	417	28.78	127.76	418	28.65	127.44	419	28.52	127.12	420	28.39	126.80
421	28.25	126.48	422	28.12	126.16	423	27.99	125.84	424	27.86	125.52	425	27.72	125.20
426	27.59	124.88	427	27.46	124.56	428	27.33	124.24	429	27.19	123.92	430	27.06	123.60
431	26.93	123.29	432	26.80	122.97	433	26.66	122.65	434	26.53	122.33	435	26.40	122.01
436	26.27	121.69	437	26.13	121.37	438	26.00	121.05	439	25.87	120.73	440	25.74	120.41
441	25.60	120.09	442	25.47	119.77	443	25.34	119.45	444	25.21	119.13	445	25.07	118.81
446	24.94	118.49	447	24.81	118.17	448	24.68	117.85	449	24.54	117.53	450	24.41	117.21
451	24.28	116.89	452	24.15	116.57	453	24.01	116.25	454	23.88	115.93	455	23.75	115.61
456	23.62	115.29	457	23.48	114.97	458	23.35	114.65	459	23.22	114.33	460	23.09	114.01
461	22.95	113.69	462	22.82	113.37	463	22.69	113.05	464	22.56	112.73	465	22.43	112.41
466	22.29	112.09	467	22.16	111.77	468	22.03	111.45	469	21.90	111.13	470	21.76	110.81
471	21.63	110.49	472	21.50	110.17	473	21.37	109.85	474	21.23	109.53	475	21.10	109.21
476	20.97	108.89	477	20.84	108.57	478	20.70	108.25	479	20.57	107.93	480	20.44	107.61
481	20.31	107.29	482	20.17	106.97	483	20.04	106.65	484	19.91	106.33	485	19.78	106.01
486	19.64	105.69	487	19.51	105.37	488	19.38	105.05	489	19.25	104.73	490	19.11	104.41
491	18.98	104.09	492	18.85	103.77	493	18.72	103.45	494	18.58	103.13	495	18.45	102.81
496	18.32	102.49	497	18.19	102.18	498	18.05	101.86	499	17.92	101.54	500	17.79	101.22
501	17.66	100.90	502	17.52	100.58	503	17.39	100.26	504	17.26	99.94	505	17.13	99.62
506	16.99	99.30	507	16.86	98.98	508	16.73	98.66	509	16.60	98.34	510	16.46	98.02
511	16.33	97.70	512	16.20	97.38	513	16.07	97.06	514	15.93	96.74	515	15.80	96.42
516	15.67	96.10	517	15.54	95.78	518	15.40	95.46	519	15.27	95.14	520	15.14	94.82
521	15.01	94.50	522	14.87	94.18	523	14.74	93.86	524	14.61	93.54	525	14.48	93.22
526	14.34	92.90	527	14.21	92.58	528	14.08	92.26	529	13.95	91.94	530	13.81	91.62

531	13.68	91.30	532	13.55	90.98	533	13.42	90.66	534	13.28	90.34	535	13.15	90.02
536	13.02	89.70	537	12.89	89.38	538	12.75	89.06	539	12.62	88.74	540	12.49	88.42
541	12.36	88.10	542	12.22	87.78	543	12.09	87.46	544	11.96	87.14	545	11.83	06.82
546	11.69	86.50	547	11.56	86.18	548	11.43	85.86	549	11.30	85.54	550	11.16	85.22
551	11.03	84.90	552	10.90	04.58	553	10.77	84.26	554	10.63	83.94	555	10.50	03.62
556	10.37	83.30	557	10.24	82.98	558	10.10	82.66	559	9.97	82.34	560	9.84	82.02
561	9.71	81.70	562	9.57	81.39	563	9.44	81.07	564	9.31	80.75	565	9.18	80.43
566	9.04	80.11	567	8.91	79.79	568	8.78	79.47	569	8.65	79.15	570	8.51	78.83
571	8.38	78.51	572	8.25	78.19	573	8.12	77.87	574	7.98	77.55	575	7.85	77.23
576	7.72	76.91	577	7.59	76.59	578	7.45	76.27	579	7.32	75.95	580	7.19	75.63
581	7.06	75.31	582	6.92	74.99	583	6.79	74.67	584	6.66	74.35	585	6.53	74.03
586	6.39	73.71	587	6.26	73.39	588	6.13	73.07	589	6.00	72.75	590	5.86	72.43
591	5.73	72.11	592	5.60	71.79	593	5.47	71.47	594	5.33	71.15	595	5.20	70.83
596	5.07	70.51	597	4.94	70.19	598	4.80	69.87	599	4.67	69.55	600	4.54	69.23
601	4.54	69.27	602	4.52	69.21	603	4.49	69.16	604	4.47	69.11	605	4.45	69.05
606	4.42	69.00	607	4.40	68.95	608	4.37	68.89	609	4.34	68.84	610	4.32	60.79
611	4.29	68.74	612	4.26	68.69	613	4.23	68.63	614	4.20	68.58	615	4.17	68.53
616	4.14	68.48	617	4.11	68.43	618	4.08	68.38	619	4.04	68.34	620	4.01	68.29
621	3.98	68.24	622	3.94	68.19	623	3.91	68.14	624	3.87	68.10	625	3.83	68.05
626	3.80	68.00	627	3.76	67.96	628	3.72	67.91	629	3.68	67.87	630	3.65	67.83
631	3.61	67.78	632	3.57	67.74	633	3.53	67.70	634	3.48	67.65	635	3.44	67.61
636	3.40	67.57	637	3.36	67.53	638	3.32	67.49	639	3.27	67.45	640	3.23	67.41
641	3.18	67.37	642	3.14	67.33	643	3.09	67.30	644	3.05	67.26	645	3.00	67.22
646	2.96	67.19	647	2.91	67.15	648	2.86	67.12	649	2.81	67.08	650	2.76	67.05
651	2.72	67.02	652	2.67	66.98	653	2.62	66.95	654	2.57	66.92	655	2.52	66.89
656	2.47	66.86	657	2.42	66.83	658	2.36	66.80	659	2.31	66.77	660	2.26	66.75
661	2.21	66.72	662	2.16	66.69	663	2.10	66.67	664	2.05	66.64	665	2.00	66.62
666	1.94	66.60	667	1.89	66.57	668	1.83	66.55	669	1.78	66.53	670	1.72	66.51
671	1.67	66.49	672	1.61	66.47	673	1.56	66.45	674	1.50	66.43	675	1.45	66.41
676	1.39	66.39	677	1.33	66.38	678	1.28	66.36	679	1.22	66.35	680	1.16	66.33
681	1.11	66.32	682	1.05	66.31	683	.99	66.29	684	.93	66.28	685	.88	66.27
686	.82	66.26	687	.76	66.25	688	.70	66.24	689	.64	66.23	690	.58	66.23
691	.53	66.22	692	.47	66.21	693	.41	66.21	694	.35	66.20	695	.29	66.20
696	.23	66.20	697	.17	66.20	698	.12	66.19	699	.06	66.19	700	0.00	66.19
701-1000.00		0.00												

FREE SURFACE TRACERS NVRTEX= 0

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	0.00	68.63	2	.03	68.63	3	.06	68.64	4	.09	68.64	5	.12	68.64
6	.15	68.64	7	.18	68.64	8	.20	68.64	9	.23	68.65	10	.26	68.65
11	.29	68.65	12	.32	68.66	13	.35	68.66	14	.38	68.66	15	.41	68.67
16	.44	68.67	17	.47	68.68	18	.50	68.69	19	.52	68.69	20	.55	68.70
21	.58	68.70	22	.61	68.71	23	.64	68.72	24	.67	68.73	25	.70	68.74
26	.72	68.74	27	.75	68.75	28	.78	68.76	29	.81	68.77	30	.83	68.78
31	.86	68.79	32	.89	68.80	33	.92	68.81	34	.94	68.82	35	.97	68.84
36	1.00	68.85	37	1.02	68.86	38	1.05	68.87	39	1.08	68.89	40	1.10	68.90
41	1.13	68.91	42	1.16	68.93	43	1.18	68.94	44	1.21	68.95	45	1.23	68.97
46	1.26	68.98	47	1.28	69.00	48	1.31	69.01	49	1.33	69.03	50	1.36	69.05
51	1.38	69.06	52	1.41	69.08	53	1.43	69.10	54	1.45	69.11	55	1.48	69.13
56	1.50	69.15	57	1.52	69.17	58	1.55	69.19	59	1.57	69.21	60	1.59	69.22
61	1.61	69.24	62	1.64	69.26	63	1.66	69.28	64	1.68	69.30	65	1.70	69.32
66	1.72	69.34	67	1.74	69.37	68	1.76	69.39	69	1.78	69.41	70	1.80	69.43
71	1.82	69.45	72	1.84	69.47	73	1.86	69.50	74	1.88	69.52	75	1.90	69.54
76	1.92	69.56	77	1.94	69.59	78	1.95	69.61	79	1.97	69.63	80	1.99	69.66
81	2.00	69.68	82	2.02	69.71	83	2.04	69.73	84	2.05	69.76	85	2.07	69.78
86	2.08	69.81	87	2.10	69.83	88	2.11	69.86	89	2.13	69.88	90	2.14	69.91
91	2.16	69.93	92	2.17	69.96	93	2.18	69.99	94	2.20	70.01	95	2.21	70.04
96	2.22	70.06	97	2.23	70.09	98	2.25	70.12	99	2.26	70.15	100	2.27	70.17
101	2.27	70.17	102	2.40	70.49	103	2.53	70.81	104	2.66	71.12	105	2.79	71.44
106	2.93	71.76	107	3.06	72.07	108	3.19	72.39	109	3.32	72.71	110	3.45	73.02
111	3.58	73.34	112	3.71	73.66	113	3.84	73.97	114	3.98	74.29	115	4.11	74.61
116	4.24	74.92	117	4.37	75.24	118	4.50	75.56	119	4.63	75.87	120	4.76	76.19
121	4.89	76.51	122	5.03	76.82	123	5.16	77.14	124	5.29	77.46	125	5.42	77.77
126	5.55	78.09	127	5.68	78.41	128	5.81	78.72	129	5.94	79.04	130	6.08	79.36
131	6.21	79.67	132	6.34	79.99	133	6.47	80.31	134	6.60	80.62	135	6.73	81.94

136	6.86	81.26	137	6.99	81.57	138	7.13	81.89	139	7.26	82.21	140	7.39	82.52
141	7.52	82.84	142	7.65	83.16	143	7.78	83.47	144	7.91	83.79	145	8.05	84.11
146	8.18	84.42	147	8.31	84.74	148	8.44	85.06	149	8.57	85.37	150	8.70	85.69
151	8.83	86.01	152	8.96	86.32	153	9.10	86.64	154	9.23	86.96	155	9.36	87.27
156	9.49	87.59	157	9.62	87.91	158	9.75	88.22	159	9.88	88.54	160	10.01	88.86
161	10.15	89.17	162	10.28	89.49	163	10.41	89.81	164	10.54	90.12	165	10.67	90.44
166	10.80	90.76	167	10.93	91.08	168	11.06	91.39	169	11.20	91.71	170	11.33	92.03
171	11.46	92.34	172	11.59	92.66	173	11.72	92.98	174	11.85	93.29	175	11.98	93.61
176	12.11	93.93	177	12.25	94.24	178	12.38	94.56	179	12.51	94.88	180	12.64	95.19
181	12.77	95.51	182	12.90	95.83	183	13.03	96.14	184	13.16	96.46	185	13.30	96.78
186	13.43	97.09	187	13.56	97.41	188	13.69	97.73	189	13.82	98.04	190	13.95	98.36
191	14.08	98.68	192	14.21	98.99	193	14.35	99.31	194	14.48	99.63	195	14.61	99.94
196	14.74	100.26	197	14.87	100.58	198	15.00	100.89	199	15.13	101.21	200	15.27	101.53
201	15.40	101.84	202	15.53	102.16	203	15.66	102.48	204	15.79	102.79	205	15.92	103.11
206	16.05	103.43	207	16.18	103.74	208	16.32	104.06	209	16.45	104.38	210	16.58	104.69
211	16.71	105.01	212	16.84	105.33	213	16.97	105.64	214	17.10	105.96	215	17.23	106.28
216	17.37	106.59	217	17.50	106.91	218	17.63	107.23	219	17.76	107.54	220	17.89	107.86
221	18.02	108.18	222	18.15	108.49	223	18.28	108.81	224	18.42	109.13	225	18.55	109.44
226	18.68	109.76	227	18.81	110.08	228	18.94	110.39	229	19.07	110.71	230	19.20	111.03
231	19.33	111.34	232	19.47	111.66	233	19.60	111.98	234	19.73	112.29	235	19.86	112.61
236	19.99	112.93	237	20.12	113.24	238	20.25	113.56	239	20.38	113.88	240	20.52	114.19
241	20.65	114.51	242	20.78	114.83	243	20.91	115.14	244	21.04	115.46	245	21.17	115.78
246	21.30	116.09	247	21.43	116.41	248	21.57	116.73	249	21.70	117.04	250	21.83	117.36
251	21.96	117.68	252	22.09	117.99	253	22.22	118.31	254	22.35	118.63	255	22.48	118.94
256	22.62	119.26	257	22.75	119.58	258	22.88	119.89	259	23.01	120.21	260	23.14	120.53
261	23.27	120.84	262	23.40	121.16	263	23.54	121.48	264	23.67	121.79	265	23.80	122.11
266	23.93	122.43	267	24.06	122.74	268	24.19	123.06	269	24.32	123.38	270	24.45	123.69
271	24.59	124.01	272	24.72	124.33	273	24.85	124.64	274	24.98	124.96	275	25.11	125.28
276	25.24	125.59	277	25.37	125.91	278	25.50	126.23	279	25.64	126.55	280	25.77	126.86
281	25.90	127.18	282	26.03	127.50	283	26.16	127.81	284	26.29	128.13	285	26.42	128.45
286	26.55	128.76	287	26.69	129.08	288	26.82	129.40	289	26.95	129.71	290	27.08	130.03
291	27.21	130.35	292	27.34	130.66	293	27.47	130.98	294	27.60	131.30	295	27.74	131.61
296	27.87	131.93	297	28.00	132.25	298	28.13	132.56	299	28.26	132.88	300	28.39	133.20
301	28.52	133.51	302	28.65	133.83	303	28.79	134.15	304	28.92	134.46	305	29.05	134.78
306	29.18	135.10	307	29.31	135.41	308	29.44	135.73	309	29.57	136.05	310	29.70	136.36
311	29.84	136.68	312	29.97	137.00	313	30.10	137.31	314	30.23	137.63	315	30.36	137.95
316	30.49	138.26	317	30.62	138.58	318	30.76	138.90	319	30.89	139.21	320	31.02	139.53
321	31.15	139.85	322	31.28	140.16	323	31.41	140.48	324	31.54	140.80	325	31.67	141.11
326	31.81	141.43	327	31.94	141.75	328	32.07	142.06	329	32.20	142.38	330	32.33	142.70
331	32.46	143.01	332	32.59	143.33	333	32.72	143.65	334	32.86	143.96	335	32.99	144.28
336	33.12	144.60	337	33.25	144.91	338	33.38	145.23	339	33.51	145.55	340	33.64	145.86
341	33.77	146.18	342	33.91	146.50	343	34.04	146.81	344	34.17	147.13	345	34.30	147.45
346	34.43	147.76	347	34.56	148.08	348	34.69	148.40	349	34.82	148.71	350	34.96	149.03
351	35.09	149.35	352	35.22	149.66	353	35.35	149.98	354	35.48	150.30	355	35.61	150.61
356	35.74	150.93	357	35.87	151.25	358	36.01	151.56	359	36.14	151.88	360	36.27	152.20
361	36.40	152.51	362	36.53	152.83	363	36.66	153.15	364	36.79	153.46	365	36.92	153.78
366	37.06	154.10	367	37.19	154.41	368	37.32	154.73	369	37.45	155.05	370	37.58	155.36
371	37.71	155.68	372	37.84	156.00	373	37.97	156.31	374	38.11	156.63	375	38.24	156.95
376	38.37	157.26	377	38.50	157.58	378	38.63	157.90	379	38.76	158.21	380	38.89	158.53
381	39.03	158.85	382	39.16	159.16	383	39.29	159.48	384	39.42	159.80	385	39.55	160.11
386	39.68	160.43	387	39.81	160.75	388	39.94	161.07	389	40.08	161.38	390	40.21	161.70
391	40.34	162.02	392	40.47	162.33	393	40.60	162.65	394	40.73	162.97	395	40.86	163.28
396	40.99	163.60	397	41.13	163.92	398	41.26	164.23	399	41.39	164.55	400	41.52	164.87
401	41.52	164.87	402	41.57	164.87	403	41.63	164.87	404	41.68	164.87	405	41.73	164.87
406	41.79	164.87	407	41.84	164.87	408	41.90	164.87	409	41.95	164.87	410	42.00	164.87
411	42.06	164.87	412	42.11	164.87	413	42.16	164.87	414	42.22	164.87	415	42.27	164.87
416	42.33	164.87	417	42.38	164.87	418	42.43	164.87	419	42.49	164.87	420	42.54	164.87
421	42.59	164.87	422	42.65	164.87	423	42.70	164.87	424	42.76	164.87	425	42.81	164.87
426	42.86	164.87	427	42.92	164.87	428	42.97	164.87	429	43.02	164.87	430	43.08	164.87
431	43.13	164.87	432	43.19	164.87	433	43.24	164.87	434	43.29	164.87	435	43.35	164.87
436	43.40	164.87	437	43.45	164.87	438	43.51	164.87	439	43.56	164.87	440	43.62	164.87
441	43.67	164.87	442	43.72	164.87	443	43.78	164.87	444	43.83	164.87	445	43.89	164.87
446	43.94	164.87	447	43.99	164.87	448	44.05	164.87	449	44.10	164.87	450	44.15	164.87
451	44.15	164.87	452	44.15	164.16	453	44.15	163.45	454	44.15	162.75	455	44.15	162.04
456	44.15	161.34	457	44.15	160.63	458	44.15	159.93	459	44.15	159.22	460	44.15	158.51
461	44.15	157.81	462	44.15	157.10	463	44.15	156.40	464	44.15	155.69	465	44.15	154.99

466	44.15	154.28	467	44.15	153.57	468	44.15	152.87	469	44.15	152.16	470	44.15	151.46
471	44.15	150.75	472	44.15	150.04	473	44.15	149.34	474	44.15	148.63	475	44.15	147.93
476	44.15	147.22	477	44.15	146.52	478	44.15	145.81	479	44.15	145.10	480	44.15	144.40
481	44.15	143.69	482	44.15	142.99	483	44.15	142.28	484	44.15	141.58	485	44.15	140.87
486	44.15	140.16	487	44.15	139.46	488	44.15	138.75	489	44.15	138.05	490	44.15	137.34
491	44.15	136.64	492	44.15	135.93	493	44.15	135.22	494	44.15	134.52	495	44.15	133.81
496	44.15	133.11	497	44.15	132.40	498	44.15	131.70	499	44.15	130.99	500	44.15	130.28
501	44.15	129.58	502	44.15	128.87	503	44.15	128.17	504	44.15	127.46	505	44.15	126.76
506	44.15	126.05	507	44.15	125.34	508	44.15	124.64	509	44.15	123.93	510	44.15	123.23
511	44.15	122.52	512	44.15	121.82	513	44.15	121.11	514	44.15	120.40	515	44.15	119.70
516	44.15	118.99	517	44.15	118.29	518	44.15	117.58	519	44.15	116.88	520	44.15	116.17
521	44.15	115.46	522	44.15	114.76	523	44.15	114.05	524	44.15	113.35	525	44.15	112.64
526	44.15	111.93	527	44.15	111.23	528	44.15	110.52	529	44.15	109.82	530	44.15	109.11
531	44.15	108.41	532	44.15	107.70	533	44.15	106.99	534	44.15	106.29	535	44.15	105.58
536	44.15	104.88	537	44.15	104.17	538	44.15	103.47	539	44.15	102.76	540	44.15	102.05
541	44.15	101.35	542	44.15	100.64	543	44.15	99.94	544	44.15	99.23	545	44.15	98.53
546	44.15	97.82	547	44.15	97.11	548	44.15	96.41	549	44.15	95.70	550	44.15	95.00
551	44.15	94.29	552	44.15	93.59	553	44.15	92.88	554	44.15	92.17	555	44.15	91.47
556	44.15	90.76	557	44.15	90.06	558	44.15	89.35	559	44.15	88.65	560	44.15	87.94
561	44.15	87.23	562	44.15	86.53	563	44.15	85.82	564	44.15	85.12	565	44.15	84.41
566	44.15	83.71	567	44.15	83.00	568	44.15	82.29	569	44.15	81.59	570	44.15	80.88
571	44.15	80.18	572	44.15	79.47	573	44.15	78.77	574	44.15	78.06	575	44.15	77.35
576	44.15	76.65	577	44.15	75.94	578	44.15	75.24	579	44.15	74.53	580	44.15	73.82
581	44.15	73.12	582	44.15	72.41	583	44.15	71.71	584	44.15	71.00	585	44.15	70.30
586	44.15	69.59	587	44.15	68.88	588	44.15	68.18	589	44.15	67.47	590	44.15	66.77
591	44.15	66.06	592	44.15	65.36	593	44.15	64.65	594	44.15	63.94	595	44.15	63.24
596	44.15	62.53	597	44.15	61.83	598	44.15	61.12	599	44.15	60.42	600	44.15	59.71
601	44.15	59.00	602	44.15	58.30	603	44.15	57.59	604	44.15	56.89	605	44.15	56.18
606	44.15	55.48	607	44.15	54.77	608	44.15	54.06	609	44.15	53.36	610	44.15	52.65
611	44.15	51.95	612	44.15	51.24	613	44.15	50.54	614	44.15	49.83	615	44.15	49.12
616	44.15	48.42	617	44.15	47.71	618	44.15	47.01	619	44.15	46.30	620	44.15	45.60
621	44.15	44.89	622	44.15	44.18	623	44.15	43.48	624	44.15	42.77	625	44.15	42.07
626	44.15	41.36	627	44.15	40.66	628	44.15	39.95	629	44.15	39.24	630	44.15	38.54
631	44.15	37.83	632	44.15	37.13	633	44.15	36.42	634	44.15	35.71	635	44.15	35.01
636	44.15	34.30	637	44.15	33.60	638	44.15	32.89	639	44.15	32.19	640	44.15	31.48
641	44.15	30.77	642	44.15	30.07	643	44.15	29.36	644	44.15	28.66	645	44.15	27.95
646	44.15	27.25	647	44.15	26.54	648	44.15	25.83	649	44.15	25.13	650	44.15	24.42
651	44.15	24.42	652	43.71	24.42	653	43.26	24.42	654	42.82	24.42	655	42.37	24.42
656	41.92	24.42	657	41.48	24.42	658	41.03	24.42	659	40.59	24.42	660	40.14	24.42
661	39.69	24.42	662	39.25	24.42	663	38.80	24.42	664	38.36	24.42	665	37.91	24.42
666	37.46	24.42	667	37.02	24.42	668	36.57	24.42	669	36.13	24.42	670	35.68	24.42
671	35.23	24.42	672	34.79	24.42	673	34.34	24.42	674	33.90	24.42	675	33.45	24.42
676	33.00	24.42	677	32.56	24.42	678	32.11	24.42	679	31.67	24.42	680	31.22	24.42
681	30.77	24.42	682	30.33	24.42	683	29.88	24.42	684	29.44	24.42	685	28.99	24.42
686	28.54	24.42	687	28.10	24.42	688	27.65	24.42	689	27.21	24.42	690	26.76	24.42
691	26.31	24.42	692	25.87	24.42	693	25.42	24.42	694	24.98	24.42	695	24.53	24.42
696	24.08	24.42	697	23.64	24.42	698	23.19	24.42	699	22.75	24.42	700	22.30	24.42
701	21.85	24.42	702	21.41	24.42	703	20.96	24.42	704	20.52	24.42	705	20.07	24.42
706	19.62	24.42	707	19.18	24.42	708	18.73	24.42	709	18.29	24.42	710	17.84	24.42
711	17.39	24.42	712	16.95	24.42	713	16.50	24.42	714	16.06	24.42	715	15.61	24.42
716	15.16	24.42	717	14.72	24.42	718	14.27	24.42	719	13.83	24.42	720	13.38	24.42
721	12.93	24.42	722	12.49	24.42	723	12.04	24.42	724	11.60	24.42	725	11.15	24.42
726	10.70	24.42	727	10.26	24.42	728	9.81	24.42	729	9.37	24.42	730	8.92	24.42
731	8.47	24.42	732	8.03	24.42	733	7.58	24.42	734	7.14	24.42	735	6.69	24.42
736	6.24	24.42	737	5.80	24.42	738	5.35	24.42	739	4.91	24.42	740	4.46	24.42
741	4.01	24.42	742	3.57	24.42	743	3.12	24.42	744	2.68	24.42	745	2.23	24.42
746	1.78	24.42	747	1.34	24.42	748	.89	24.42	749	.45	24.42	750	0.00	24.42
751-1000.00		0.00												

I = 1   R(I) =5.2000E-02   DR(I) =5.2000000E-02   TAU(I) =8.4948667E-03   T =3.3228069E-08   CYCLE = 1

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
187	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.724E+00
186	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.672E+00

185	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.620E+00
184	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.568E+00
183	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.516E+00
182	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.464E+00
181	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.412E+00
180	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.360E+00
179	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.308E+00
178	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.256E+00
177	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.204E+00
176	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.152E+00
175	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.100E+00
174	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.046E+00
173	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.996E+00
172	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.944E+00
171	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.892E+00
170	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.840E+00
169	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.788E+00
168	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.736E+00
167	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.684E+00
166	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.632E+00
165	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.580E+00
164	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.528E+00
163	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.476E+00
162	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.424E+00
161	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.372E+00
160	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.320E+00
159	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.268E+00
158	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.216E+00
157	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.164E+00
156	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.112E+00
155	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.060E+00
154	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.008E+00
153	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.956E+00
152	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.904E+00
151	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.852E+00
150	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.800E+00
149	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.748E+00
148	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.696E+00
147	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.644E+00
146	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.592E+00
145	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.540E+00
144	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.488E+00
143	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.436E+00
142	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.384E+00
141	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.332E+00
140	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.280E+00
139	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.228E+00
138	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.176E+00
137	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.124E+00
136	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.072E+00
135	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.020E+00
134	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.968E+00
133	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.916E+00
132	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.864E+00
131	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.812E+00
130	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.760E+00
129	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.708E+00
128	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.656E+00
127	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.604E+00
126	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.552E+00
125	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.500E+00
124	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.448E+00
123	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.396E+00
122	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.344E+00
121	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.292E+00
120	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.240E+00

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119    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          6.188E+00
118    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          6.136E+00
117    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          6.084E+00
116    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          6.032E+00
115    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.980E+00
114    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.928E+00
113    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.876E+00
112    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.824E+00
111    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.772E+00
110    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.720E+00
109    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.668E+00
108    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.616E+00
107    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.564E+00
106    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.512E+00
105    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.460E+00
104    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.408E+00
103    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.356E+00
102    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.304E+00
101    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.252E+00
100    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.200E+00
 99    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.148E+00
 98    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.096E+00
 97    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          5.044E+00
 96    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.992E+00
 95    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.940E+00
 94    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.888E+00
 93    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.836E+00
 92    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.784E+00
 91    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.732E+00
 90    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.680E+00
 89    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.628E+00
 88    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.576E+00
 87    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.524E+00
 86    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.472E+00
 85    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.420E+00
 84    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.368E+00
 83    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.316E+00
 82    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.264E+00
 81    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.212E+00
 80    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.160E+00
 79    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.108E+00
 78    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.056E+00
 77    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          4.004E+00
 76    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          3.952E+00
 75    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          3.900E+00
 74    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          3.848E+00
 73    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          3.796E+00
 72    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          3.744E+00
 71    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          3.692E+00
 70    0  0.        0.        0.        0.        0.          0.          0.          0.          0.          3.640E+00
 69  382  0.        0.        0.        0.        0.          2.9095E-03  0.          0.          0.          3.588E+00
     MAT      US        VS        RHO         SIE       COMP          MASS        FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       2  0.        0.        8.9000E+00  0.        1.00000E+00  2.9095E-03   7.40065E-01
      21  0.        0.        0.          0.        0.           0.           0.

  J  MFLAG    U         V         P           SIE       COMP        TMASS       SZZ         SRR         SRZ         Z

 68    1  0.        0.        0.        0.        1.00000E+00 3.9314E-03  0.          0.          0.          3.536E+00
 67  101  0.        0.        0.        0.        0.          3.1575E-03  0.          0.          0.          3.484E+00
     MAT      US        VS        RHO         SIE       COMP          MASS        FRAC. VOL.   RHO(NVOID)=0.0  THETA=   .10
       2  0.        0.        8.9000E+00  0.        1.00000E+00  2.9725E-03   7.56089E-01
      21  0.        0.        1.7170E+00  0.        1.00000E+00  1.8500E-04   2.43911E-01

  J  MFLAG    U         V         P           SIE       COMP        TMASS       SZZ         SRR         SRZ         Z

 66    2  0.        0.        0.        0.        1.00000E+00 7.5846E-04  0.          0.          0.          3.432E+00
```

65	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.380E+00
64	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.328E+00
63	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.276E+00
62	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.224E+00
61	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.172E+00
60	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.120E+00
59	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.068E+00
58	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	3.016E+00
57	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.964E+00
56	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.912E+00
55	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.860E+00
54	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.808E+00
53	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.756E+00
52	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.704E+00
51	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.652E+00
50	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.680E+00
49	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.548E+00
48	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.496E+00
47	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.444E+00
46	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.392E+00
45	2	0.	0.	0.	0.	1.00080E+00	7.5846E-04	0.	0.	0.	2.340E+00
44	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.288E+00
43	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.236E+00
42	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.184E+00
41	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.132E+00
40	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.080E+00
39	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	2.028E+00
38	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.976E+00
37	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.924E+00
36	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.872E+00
35	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.820E+00
34	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.768E+00
33	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.716E+00
32	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.664E+00
31	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.612E+00
30	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.560E+00
29	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.508E+00
28	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.456E+00
27	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.404E+00
26	2	0.	0.	0.	0.	1.00000E+00	7.5846E-04	0.	0.	0.	1.352E+00
25	383	1.5073E+02	0.	2.9489E+10	4.9500E+10	0.	4.3757E-04	0.	0.	0.	1.300E+00
	MAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	2	0.	0.	0.	0.	0.	0.	0.			
	21	1.5073E+02	0.	1.7170E+00	4.9500E+10	1.00000E+00	4.3757E-04	5.76923E-01			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
24	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.248E+00
23	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.196E+00
22	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.144E+00
21	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.092E+00
20	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.040E+00
19	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.880E-01
18	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	9.360E-01
17	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.840E-01
16	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	8.320E-01
15	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.800E-01
14	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.280E-01
13	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.760E-01
12	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	6.240E-01
11	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.720E-01
10	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.200E-01
9	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.680E-01
8	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.160E-01
7	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.640E-01
6	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	3.120E-01

5	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.600E-01
4	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	2.080E-01
3	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.560E-01
2	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.040E-01
1	0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	5.200E-02

Appendix C-III: Hemispherical Shaped Charge Output

This section includes only selected output; however, a large number of maps are shown to indicate the detail one can expect from this type of output. Inspection of the compression map for each cycle informs the reader of the location of each material, as they are separated by mixed cells denoted by asterisks (*).

For this reason it was not considered essential to reproduce the pure and mixed cell maps, which are a part of the normal output. All other maps give the output value in the mixed cell as well as the pure cells.

```
$OPTNS
IFLGST  = 1,
IPMADJ  = 1,
ITPHSE  = 1,
NPRTOP  = 2,
TIMMAX  = .1E+04,
$END
```

SAMPLE PROBLEM 2 - COPPER HEMISPHERE LOADED WITH COMP B H.E., UNCONFIN

```
   TYPE=   4      PACKAGE=  1      NUMBER OF POINTS=  300
TH1=   .3141590E+01  TH2=    .1570800E+01  A=  0.                B=   .6350000E+01  R=   .1905000E+01
   TYPE=   1      PACKAGE=  1      NUMBER OF POINTS=   50
   X1=   .1905000E+01      Y1=   .6350000E+01     X2=   .1790700E+01     Y2=   .6350000E+01
   TYPE=  -4      PACKAGE=  1      NUMBER OF POINTS=  300
TH1=   .1570800E+01  TH2=    .3141590E+01  A=  0.                B=   .6350000E+01  R=   .1790700E+01
   TYPE=   1      PACKAGE=  2      NUMBER OF POINTS=  100
   X1=  0.                 Y1=   .2540000E+01     X2=   .2159000E+01     Y2=   .2540000E+01
   TYPE=   2      PACKAGE=  2      NUMBER OF POINTS=  200
   X1=   .2159000E+01      Y1=   .2540000E+01     X2=   .2159000E+01     Y2=   .6350000E+01
   TYPE=   1      PACKAGE=  2      NUMBER OF POINTS=   50
   X1=   .2159000E+01      Y1=   .6350000E+01     X2=   .1905000E+01     Y2=   .6350000E+01
   TYPE=  -4      PACKAGE=  2      NUMBER OF POINTS=  300
TH1=   .1570800E+01  TH2=    .3141590E+01  A=  0.                B=   .6350000E+01  R=   .1905000E+01
   TYPE=   4      PACKAGE=  3      NUMBER OF POINTS=  300
TH1=   .3141590E+01  TH2=    .1570800E+01  A=  0.                B=   .6350000E+01  R=   .1790700E+01
   TYPE=   1      PACKAGE=  3      NUMBER OF POINTS=   50
   X1=   .1790700E+01      Y1=   .6350000E+01     X2=   .1905000E+01     Y2=   .6350000E+01
   TYPE=   1      PACKAGE=  3      NUMBER OF POINTS=   50
   X1=   .1905000E+01      Y1=   .6350000E+01     X2=   .2159000E+01     Y2=   .6350000E+01
   TYPE=   2      PACKAGE=  3      NUMBER OF POINTS=  200
   X1=   .2159000E+01      Y1=   .6350000E+01     X2=   .2159000E+01     Y2=   .2540000E+01
   TYPE=  -1      PACKAGE=  3      NUMBER OF POINTS=  100
   X1=   .2159000E+01      Y1=   .2540000E+01     X2=  0.                  Y2=   .2540000E+01
   TYPE= 100      PACKAGE=  0      NUMBER OF POINTS=    0
```

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	1	0	1	0	300	0
2	0	2	0	301	0	600

DETONATION TIME CALCULATION FOR EXPLOSIVE PACKAGES

```
TYPE OF INITIATION POINT    1   EXPLOSIVE PACKAGE    2   INITIATION POINTS 0.          2.54000E+00  DELAY TIME 0.
TYPE OF INITIATION POINT    2   EXPLOSIVE PACKAGE    2   INITIATION POINTS 1.82000E+00 5.62000E+00  DELAY TIME 0.
```

```
SEARCH AREA XMIN  0.            YMIN  2.5400000E+00  XMAX  2.1590000E+00  YMAX  6.3500000E+00
INITIATION POINT X    0.              Y     2.5400000E+00  DELAY TIME  0.

              DETONATION TIME FOR EACH ROW(J)

   J
```

```
SEARCH AREA XMIN  0.            YMIN  5.5900000E+00  XMAX  2.1590000E+00  YMAX  6.3500000E+00
INITIATION POINT X    1.8200000E+00  Y     5.6200000E+00  DELAY TIME  4.4831342E-06

               DETONATION TIME FOR EACH ROW(J)

     J


Z-VARIABLES
 BBAR   = 5.000E-01   CRATIO= 1.000E+04   CVIS   =-1.000E+00   CYCMX  = 2.000E+00   CYCPH3=-1.000E+00   DMIN   = 1.000E+02
 DTMIN  = 1.000E-11   EMIN   = 1.000E+07   EMOB   = 0.          FINAL  = 4.000E-01   GAMMA  = 0.          IEXTX  =          0
 ICSTOP=           0   IGM    =          0   IMAX   =         60   INTER  =          0   IPCYCL=           0   IPLGBT=           0
 IPLGRT=           0   IPR    =        100   I1     =          3   I2     =         53   JEXTY  =          0   JMAX   =        200
 KUNITR=           7   KUNITW=           7   LVISC  =          1   MAPS   =          1   MINX   =          0   MAXX   =          0
 MINY   =          0   MAXY   =          0   NADD   =          0   NDUMP7=           1   NFRELP=         100   NMXCLS=         800
 NLINER=           1   NMAT   =          2   NODUMP=           0   NOSLIP=           0   NSLD   =        300   NTCC   =          0
 NTPMX  =        900   NTRACR=           5   NUMREZ= 0.           NUMSCA=           0   NVRTEX=           0
 PK(1)  = 1.000E+00   PK(2)  = 0.          PK(3)  = 0.          PK(4)  = 0.          PK(5)  = 0.
 PLGOPT= 0.            PLWMIN= 0.            PMIN   = 5.000E+06   PRCNT  = 1.000E-03   PRDELT= 2.000E-06   PRFACT= 0.
 PRLIM  = 0.           PROB   = 1.000E+00   REZ    = 0.          ROEPS  = 1.000E-05   SIEMIN= 1.000E+05   STAB   = 1.000E-03
 TSTOP  = 1.500E-04
```

PACKAGE NUMBER	NORMAL DENSITY (RHOZ)	INITIAL DENSITY (RHOIN)	CONDITIONS S.I.E.	U	V	MATERIAL
1	8.900	8.900	0.	0.	0.	COPPER
2	1.717	1.717	0.	0.	0.	COMP B

STRENGTH CONSTANTS

PACKAGE NUMBER	CZERO	STK1	STK2	STEZ	RMU	AMOM
1	2.350E+09	6.950E+10	5.500E+10	5.300E+09	4.550E+11	9.785E-01
2	0.	0.	0.	0.	0.	1.000E+00

I	DR	I	DR	I	DR	I	DR	I	DR	I	DR	I	DR
1	5.000E-02	2	5.000E-02	3	5.000E-02	4	5.000E-02	5	5.000E-02	6	5.000E-02	7	5.000E-02
8	5.000E-02	9	5.000E-02	10	5.000E-02	11	5.000E-02	12	5.000E-02	13	5.000E-02	14	5.000E-02
15	5.000E-02	16	5.000E-02	17	5.000E-02	18	5.000E-02	19	5.000E-02	20	5.000E-02	21	5.000E-02
22	5.000E-02	23	5.000E-02	24	5.000E-02	25	5.000E-02	26	5.000E-02	27	5.000E-02	28	5.000E-02
29	5.000E-02	30	5.000E-02	31	5.000E-02	32	5.000E-02	33	5.000E-02	34	5.000E-02	35	5.000E-02
36	5.000E-02	37	5.000E-02	38	5.000E-02	39	5.000E-02	40	5.000E-02	41	5.000E-02	42	5.000E-02
43	5.000E-02	44	5.000E-02	45	5.000E-02	46	5.000E-02	47	5.000E-02	48	5.000E-02	49	5.000E-02
50	5.000E-02	51	5.000E-02	52	5.000E-02	53	5.000E-02	54	5.000E-02	55	5.000E-02	56	5.000E-02
57	5.000E-02	58	5.000E-02	59	5.000E-02	60	5.000E-02						

I	R	I	R	I	R	I	R	I	R	I	R	I	R
1	5.000E-02	2	1.000E-01	3	1.500E-01	4	2.000E-01	5	2.500E-01	6	3.000E-01	7	3.500E-01
8	4.000E-01	9	4.500E-01	10	5.000E-01	11	5.500E-01	12	6.000E-01	13	6.500E-01	14	7.000E-01
15	7.500E-01	16	8.000E-01	17	8.500E-01	18	9.000E-01	19	9.500E-01	20	1.000E+00	21	1.050E+00
22	1.100E+00	23	1.150E+00	24	1.200E+00	25	1.250E+00	26	1.300E+00	27	1.350E+00	28	1.400E+00
29	1.450E+00	30	1.500E+00	31	1.550E+00	32	1.600E+00	33	1.650E+00	34	1.700E+00	35	1.750E+00
36	1.800E+00	37	1.850E+00	38	1.900E+00	39	1.950E+00	40	2.000E+00	41	2.050E+00	42	2.100E+00
43	2.150E+00	44	2.200E+00	45	2.250E+00	46	2.300E+00	47	2.350E+00	48	2.400E+00	49	2.450E+00
50	2.500E+00	51	2.550E+00	52	2.600E+00	53	2.650E+00	54	2.700E+00	55	2.750E+00	56	2.800E+00
57	2.850E+00	58	2.900E+00	59	2.950E+00	60	3.000E+00						

J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ
1	5.000E-02	2	5.000E-02	3	5.000E-02	4	5.000E-02	5	5.000E-02	6	5.000E-02	7	5.000E-02
8	5.000E-02	9	5.000E-02	10	5.000E-02	11	5.000E-02	12	5.000E-02	13	5.000E-02	14	5.000E-02
15	5.000E-02	16	5.000E-02	17	5.000E-02	18	5.000E-02	19	5.000E-02	20	5.000E-02	21	5.000E-02
22	5.000E-02	23	5.000E-02	24	5.000E-02	25	5.000E-02	26	5.000E-02	27	5.000E-02	28	5.000E-02
29	5.000E-02	30	5.000E-02	31	5.000E-02	32	5.000E-02	33	5.000E-02	34	5.000E-02	35	5.000E-02
36	5.000E-02	37	5.000E-02	38	5.000E-02	39	5.000E-02	40	5.000E-02	41	5.000E-02	42	5.000E-02
43	5.000E-02	44	5.000E-02	45	5.000E-02	46	5.000E-02	47	5.000E-02	48	5.000E-02	49	5.000E-02
50	5.000E-02	51	5.000E-02	52	5.000E-02	53	5.000E-02	54	5.000E-02	55	5.000E-02	56	5.000E-02
57	5.000E-02	58	5.000E-02	59	5.000E-02	60	5.000E-02	61	5.000E-02	62	5.000E-02	63	5.000E-02
64	5.000E-02	65	5.000E-02	66	5.000E-02	67	5.000E-02	68	5.000E-02	69	5.000E-02	70	5.000E-02
71	5.000E-02	72	5.000E-02	73	5.000E-02	74	5.000E-02	75	5.000E-02	76	5.000E-02	77	5.000E-02
78	5.000E-02	79	5.000E-02	80	5.000E-02	81	5.000E-02	82	5.000E-02	83	5.000E-02	84	5.000E-02
85	5.000E-02	86	5.000E-02	87	5.000E-02	88	5.000E-02	89	5.000E-02	90	5.000E-02	91	5.000E-02
92	5.000E-02	93	5.000E-02	94	5.000E-02	95	5.000E-02	96	5.000E-02	97	5.000E-02	98	5.000E-02
99	5.000E-02	100	5.000E-02	101	5.000E-02	102	5.000E-02	103	5.000E-02	104	5.000E-02	105	5.000E-02
106	5.000E-02	107	5.000E-02	108	5.000E-02	109	5.000E-02	110	5.000E-02	111	5.000E-02	112	5.000E-02
113	5.000E-02	114	5.000E-02	115	5.000E-02	116	5.000E-02	117	5.000E-02	118	5.000E-02	119	5.000E-02
120	5.000E-02	121	5.000E-02	122	5.000E-02	123	5.000E-02	124	5.000E-02	125	5.000E-02	126	5.000E-02
127	5.000E-02	128	5.000E-02	129	5.000E-02	130	5.000E-02	131	5.000E-02	132	5.000E-02	133	5.000E-02
134	5.000E-02	135	5.000E-02	136	5.000E-02	137	5.000E-02	138	5.000E-02	139	5.000E-02	140	5.000E-02
141	5.000E-02	142	5.000E-02	143	5.000E-02	144	5.000E-02	145	5.000E-02	146	5.000E-02	147	5.000E-02
148	5.000E-02	149	5.000E-02	150	5.000E-02	151	5.000E-02	152	5.000E-02	153	5.000E-02	154	5.000E-02
155	5.000E-02	156	5.000E-02	157	5.000E-02	158	5.000E-02	159	5.000E-02	160	5.000E-02	161	5.000E-02
162	5.000E-02	163	5.000E-02	164	5.000E-02	165	5.000E-02	166	5.000E-02	167	5.000E-02	168	5.000E-02
169	5.000E-02	170	5.000E-02	171	5.000E-02	172	5.000E-02	173	5.000E-02	174	5.000E-02	175	5.000E-02

176	5.000E-02	177	5.000E-02	178	5.000E-02	179	5.000E-02	180	5.000E-02	181	5.000E-02	182	5.000E-02
183	5.000E-02	184	5.000E-02	185	5.000E-02	186	5.000E-02	187	5.000E-02	188	5.000E-02	189	5.000E-02
190	5.000E-02	191	5.000E-02	192	5.000E-02	193	5.000E-02	194	5.000E-02	195	5.000E-02	196	5.000E-02
197	5.000E-02	198	5.000E-02	199	5.000E-02	200	5.000E-02						

J	Z	J	Z	J	Z	J	Z	J	Z	J	Z	J	Z
1	5.000E-02	2	1.000E-01	3	1.500E-01	4	2.000E-01	5	2.500E-01	6	3.000E-01	7	3.500E-01
8	4.000E-01	9	4.500E-01	10	5.000E-01	11	5.500E-01	12	6.000E-01	13	6.500E-01	14	7.000E-01
15	7.500E-01	16	8.000E-01	17	8.500E-01	18	9.000E-01	19	9.500E-01	20	1.000E+00	21	1.050E+00
22	1.100E+00	23	1.150E+00	24	1.200E+00	25	1.250E+00	26	1.300E+00	27	1.350E+00	28	1.400E+00
29	1.450E+00	30	1.500E+00	31	1.550E+00	32	1.600E+00	33	1.650E+00	34	1.700E+00	35	1.750E+00
36	1.800E+00	37	1.850E+00	38	1.900E+00	39	1.950E+00	40	2.000E+00	41	2.050E+00	42	2.100E+00
43	2.150E+00	44	2.200E+00	45	2.250E+00	46	2.300E+00	47	2.350E+00	48	2.400E+00	49	2.450E+00
50	2.500E+00	51	2.550E+00	52	2.600E+00	53	2.650E+00	54	2.700E+00	55	2.750E+00	56	2.800E+00
57	2.850E+00	58	2.900E+00	59	2.950E+00	60	3.000E+00	61	3.050E+00	62	3.100E+00	63	3.150E+00
64	3.200E+00	65	3.250E+00	66	3.300E+00	67	3.350E+00	68	3.400E+00	69	3.450E+00	70	3.500E+00
71	3.550E+00	72	3.600E+00	73	3.650E+00	74	3.700E+00	75	3.750E+00	76	3.800E+00	77	3.850E+00
78	3.900E+00	79	3.950E+00	80	4.000E+00	81	4.050E+00	82	4.100E+00	83	4.150E+00	84	4.200E+00
85	4.250E+00	86	4.300E+00	87	4.350E+00	88	4.400E+00	89	4.450E+00	90	4.500E+00	91	4.550E+00
92	4.600E+00	93	4.650E+00	94	4.700E+00	95	4.750E+00	96	4.800E+00	97	4.850E+00	98	4.900E+00
99	4.950E+00	100	5.000E+00	101	5.050E+00	102	5.100E+00	103	5.150E+00	104	5.200E+00	105	5.250E+00
106	5.300E+00	107	5.350E+00	108	5.400E+00	109	5.450E+00	110	5.500E+00	111	5.550E+00	112	5.600E+00
113	5.650E+00	114	5.700E+00	115	5.750E+00	116	5.800E+00	117	5.850E+00	118	5.900E+00	119	5.950E+00
120	6.000E+00	121	6.050E+00	122	6.100E+00	123	6.150E+00	124	6.200E+00	125	6.250E+00	126	6.300E+00
127	6.350E+00	128	6.400E+00	129	6.450E+00	130	6.500E+00	131	6.550E+00	132	6.600E+00	133	6.650E+00
134	6.700E+00	135	6.750E+00	136	6.800E+00	137	6.850E+00	138	6.900E+00	139	6.950E+00	140	7.000E+00
141	7.050E+00	142	7.100E+00	143	7.150E+00	144	7.200E+00	145	7.250E+00	146	7.300E+00	147	7.350E+00
148	7.400E+00	149	7.450E+00	150	7.500E+00	151	7.550E+00	152	7.600E+00	153	7.650E+00	154	7.700E+00
155	7.750E+00	156	7.800E+00	157	7.850E+00	158	7.900E+00	159	7.950E+00	160	8.000E+00	161	8.050E+00
162	8.100E+00	163	8.150E+00	164	8.200E+00	165	8.250E+00	166	8.300E+00	167	8.350E+00	168	8.400E+00
169	8.450E+00	170	8.500E+00	171	8.550E+00	172	8.600E+00	173	8.650E+00	174	8.700E+00	175	8.750E+00
176	8.800E+00	177	8.850E+00	178	8.900E+00	179	8.950E+00	180	9.000E+00	181	9.050E+00	182	9.100E+00
183	9.150E+00	184	9.200E+00	185	9.250E+00	186	9.300E+00	187	9.350E+00	188	9.400E+00	189	9.450E+00
190	9.500E+00	191	9.550E+00	192	9.600E+00	193	9.650E+00	194	9.700E+00	195	9.750E+00	196	9.800E+00
197	9.850E+00	198	9.900E+00	199	9.950E+00	200	1.000E+01						

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CYCLE     0
       .6675217E+07ERGS HAS BEEN ADDED DUE TO DETONATION OF THESE CELLS'
                               1         51

COT  1  51  T=3.6554786E-08  DT=1.0220935E-09  MAXCUV=9.7838408E+04  MAXUV=0.          UMIN=9.7838408E-01  PMIN=5.0000000E+06
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PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE	IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
1.0000	3.6534786E-08	0	6.6752169E+06	0. 0	0.	0.

PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WORK
1	0.	0.	0.	2.1831570E+01	0.	0.	0.	0.
2	6.6752169E+06	0.	6.6752169E+06	7.0936117E+01	0.	0.	0.	0.
TOTALS	6.6752169E+06	0.	6.6752169E+06	9.2767688E+01	0.	0.	0.	0.

	IE OUT	KE OUT
1	0.	0.
2	0.	0.

BOUNDARY	BOTTOM	RIGHT	TOP	$EVAPORATED$
MASS OUT	0.	0.	0.	0.
ENERGY OUT	0.	0.	0.	0.
MU OUT	0.	0.	0.	0.
MV OUT	0.	0.	0.	0.
WORK DONE	0.	0.	0.	

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	1	0	1	0	300	0
2	0	2	0	301	0	600

CELL-COORDINATES OF TRACERS FOR EACH MATERIAL PACKAGE

PACKAGE 1

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	0.00	88.90	2	.20	88.90	3	.40	88.90	4	.60	88.90	5	.80	88.91
6	1.00	88.91	7	1.20	88.92	8	1.40	88.93	9	1.60	88.93	10	1.80	88.94
11	2.00	88.95	12	2.20	88.96	13	2.40	88.98	14	2.60	88.99	15	2.80	89.00
16	3.00	89.02	17	3.20	89.03	18	3.40	89.05	19	3.60	89.07	20	3.80	89.09
21	4.00	89.11	22	4.19	89.13	23	4.39	89.15	24	4.59	89.18	25	4.79	89.20
26	4.99	89.23	27	5.19	89.25	28	5.39	89.28	29	5.58	89.31	30	5.78	89.34
31	5.98	89.37	32	6.18	89.40	33	6.38	89.44	34	6.57	89.47	35	6.77	89.51
36	6.97	89.54	37	7.16	89.58	38	7.36	89.62	39	7.56	89.66	40	7.75	89.70
41	7.95	89.74	42	8.14	89.78	43	8.34	89.82	44	8.53	89.87	45	8.73	89.91
46	8.92	89.96	47	9.12	90.01	48	9.31	90.06	49	9.51	90.10	50	9.70	90.16
51	9.89	90.21	52	10.09	90.26	53	10.28	90.31	54	10.47	90.37	55	10.66	90.42
56	10.86	90.48	57	11.05	90.54	58	11.24	90.60	59	11.43	90.66	60	11.62	90.72
61	11.81	90.78	62	12.00	90.84	63	12.19	90.90	64	12.38	90.97	65	12.57	91.03
66	12.76	91.10	67	12.95	91.17	68	13.14	91.24	69	13.32	91.31	70	13.51	91.38
71	13.70	91.45	72	13.88	91.52	73	14.07	91.59	74	14.26	91.67	75	14.44	91.74
76	14.63	91.82	77	14.81	91.90	78	15.00	91.98	79	15.18	92.05	80	15.36	92.13
81	15.55	92.22	82	15.73	92.30	83	15.91	92.38	84	16.09	92.46	85	16.27	92.55
86	16.45	92.64	87	16.63	92.72	88	16.81	92.81	89	16.99	92.90	90	17.17	92.99
91	17.35	93.08	92	17.53	93.17	93	17.71	93.26	94	17.88	93.36	95	18.06	93.45
96	18.24	93.55	97	18.41	93.64	98	18.59	93.74	99	18.76	93.84	100	18.93	93.94
101	19.11	94.04	102	19.28	94.14	103	19.45	94.24	104	19.62	94.34	105	19.80	94.45
106	19.97	94.55	107	20.14	94.66	108	20.31	94.76	109	20.48	94.87	110	20.64	94.98
111	20.81	95.09	112	20.98	95.20	113	21.15	95.31	114	21.31	95.42	115	21.48	95.53
116	21.64	95.64	117	21.81	95.76	118	21.97	95.87	119	22.13	95.99	120	22.30	96.11

COMPRESSION   CYCLE=   0.0   TIME=3.65348E-08 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.000	.038	.076	.114	.152	.190	.228	.266	.304	.342
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	.380	.418	.456	.494	.532	.570	.608	.646	.684	.722
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	.760	.798	.836	.874	.912	.950	.988	1.026		

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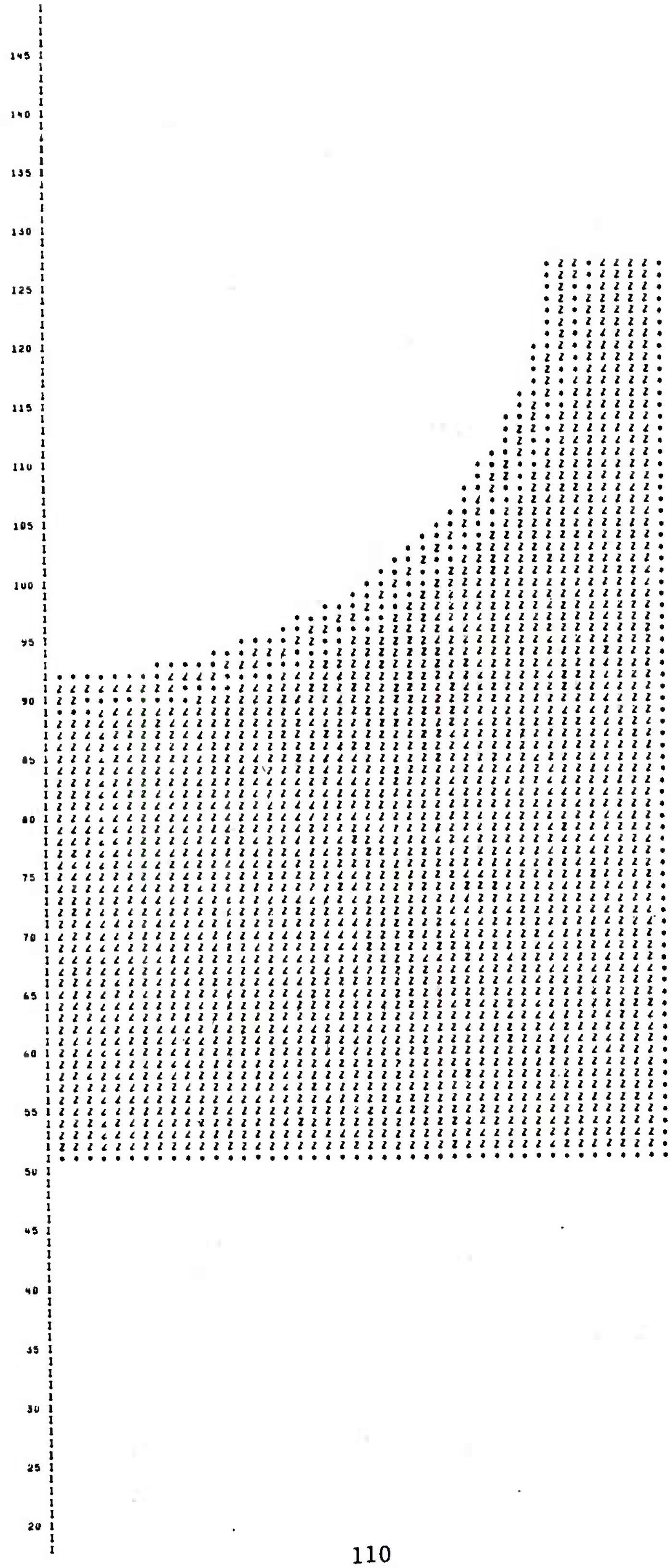
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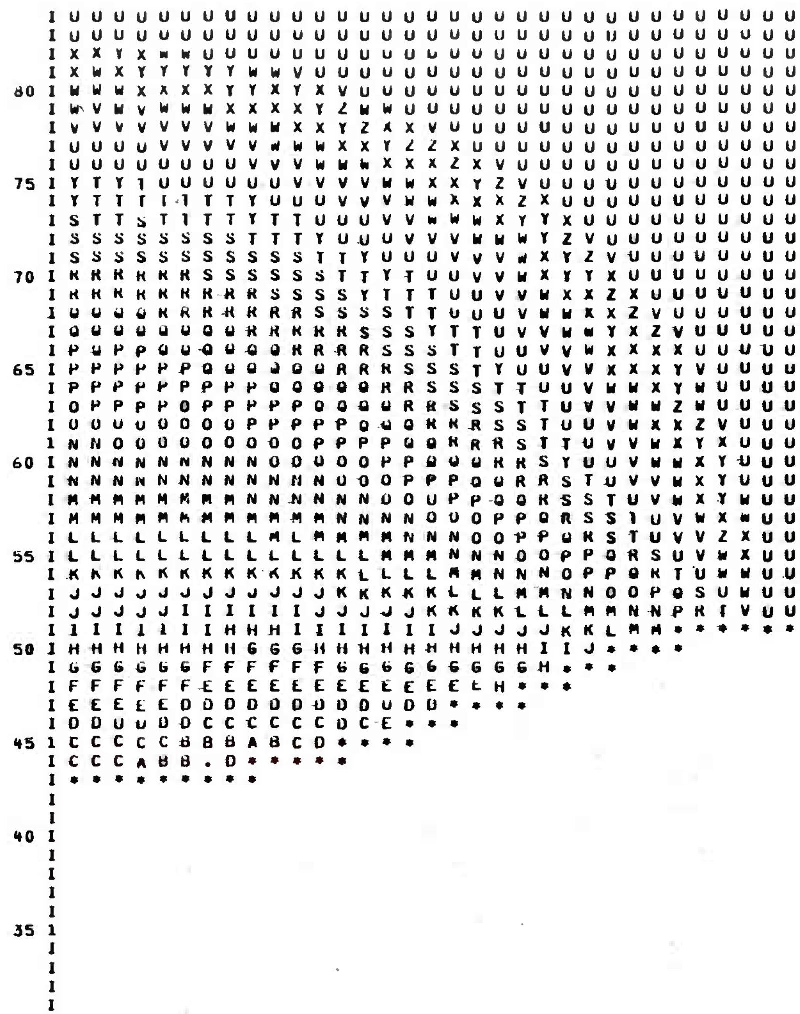
COMPRESSION CYCLE= 68.0 TIME=2.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	.036	.081	.126	.171	.216	.261	.306	.351	.396	.441
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	.486	.531	.576	.621	.666	.711	.756	.801	.846	.891
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	.936	.981	1.026	1.071	1.116	1.161	1.206	1.251		



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PRESSURE         CYCLE=    68.0    TIME=2.00000E-06 SECONDS

  SYMBOL              .          -          A          B          C          D          E          F          G          H
MAXIMUM VALUE      0.         8.52E+08   8.52E+09   1.70E+10   2.56E+10   3.41E+10   4.26E+10   5.11E+10   5.96E+10   6.81E+10
  SYMBOL              I          J          K          L          M          N          O          P          Q          R
MAXIMUM VALUE      7.67E+10   8.52E+10   9.37E+10   1.02E+11   1.11E+11   1.19E+11   1.28E+11   1.36E+11   1.45E+11   1.53E+11
  SYMBOL              S          T          U          V          W          X          Y          Z
MAXIMUM VALUE      1.62E+11   1.70E+11   1.79E+11   1.87E+11   1.96E+11   2.04E+11   2.13E+11   2.21E+11


    I . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
    I D D N N . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
    I V T W T R S P P N . . . . . . . . . . . . . . . . . . . . . . . .
    I U T T X V V W X S S P N . . . . . . . . . . . . . . . . . . . . .
 80 I T T S T U U V W W V W U P D . . . . . . . . . . . . . . . . . . .
    I R R R Q S R S T U T V X Z S R O . . . . . . . . . . . . . . . . .
    I P P Q P Q Q Q R S S T U W Y V U P . . . . . . . . . . . . . . . .
    I D O O O O P P Q Q R R S T V X Y Y U P . . . . . . . . . . . . . .
    I M M N N N O O O O P Q Q R S T U U Y V P . . . . . . . . . . . . .
 75 I M M M M M N N N N O O P P Q R R T V X Z P . . . . . . . . . . . .
    I L L L L L M M M M N N O O P P R S U V V Y T . . . . . . . . . . .
    I L L K L L L L L L M M N N O P Q R S T V W W T . . . . . . . . . .
    I K K K K K K K K L L L M N N N O P Q R S T W Y P . . . . . . . . .
    I J J J J J J J K K K K L L M N O O P Q Q S V W Z P . . . . . . . .
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    I E E F E F F F F F F F F G G H H I I J K K L N O Q R T V Z P . . .
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    I D D D D D D D E E E E E E E F F F G G H I J K L N O Q T U V P . .
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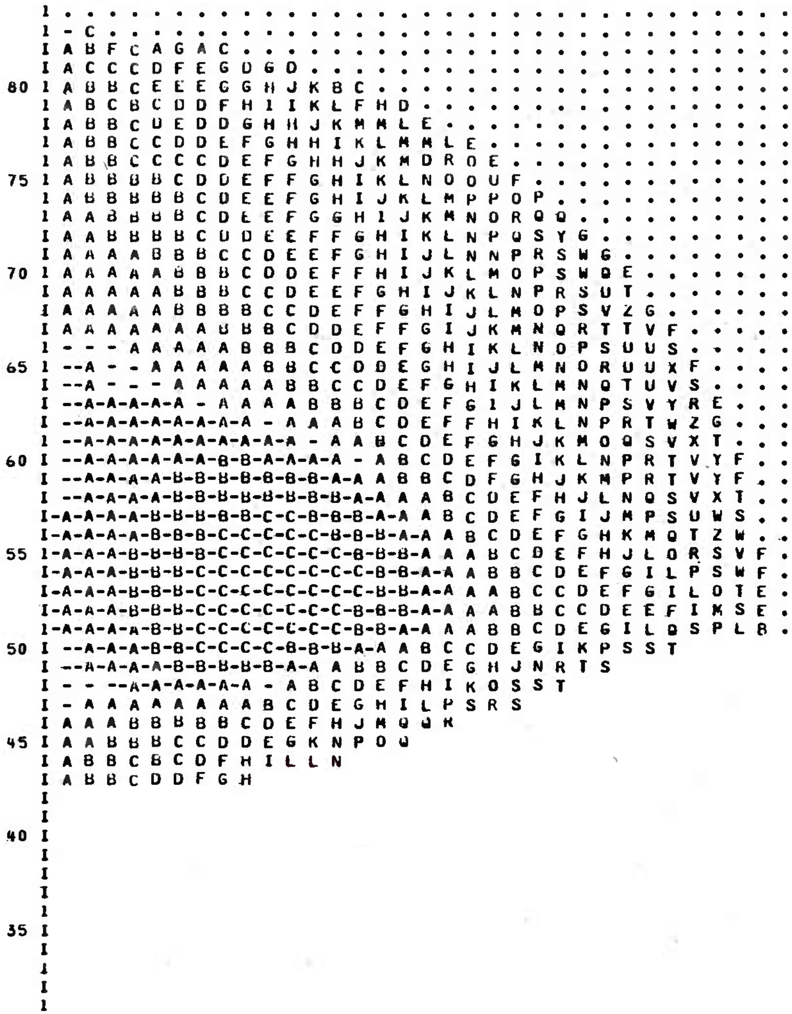
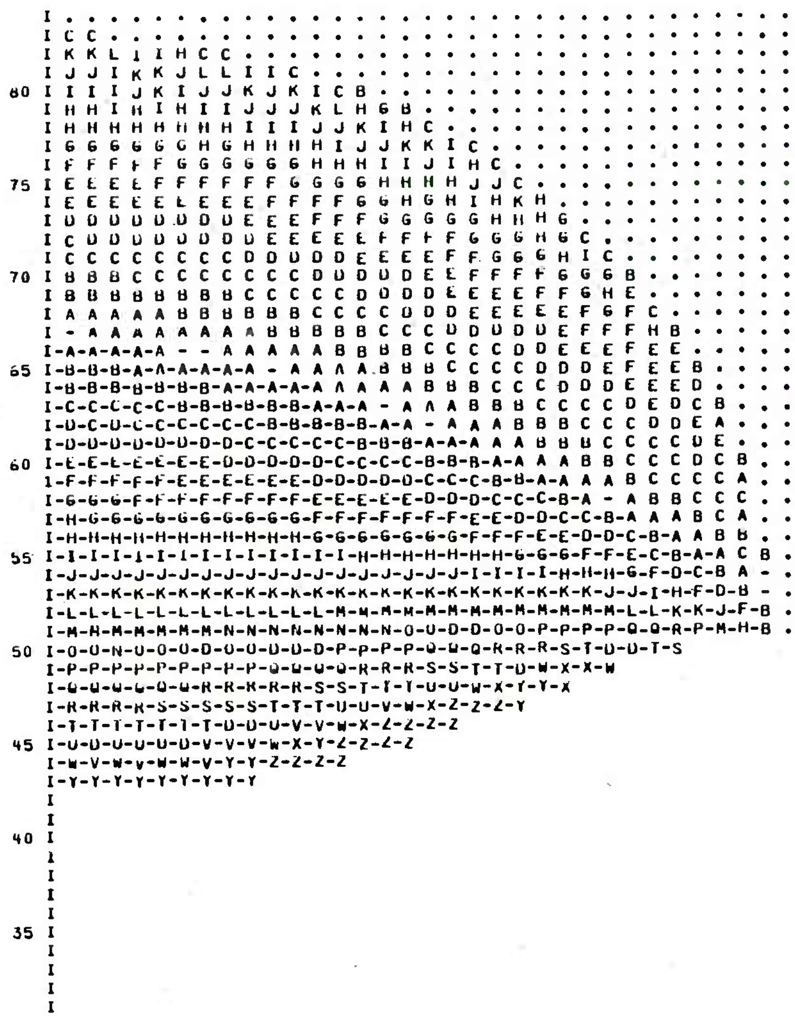
RADIAL VELOCITY CYCLE= 68.0 TIME=2.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	5.39E+02	5.39E+03	1.08E+04	1.62E+04	2.16E+04	2.69E+04	3.23E+04	3.77E+04	4.31E+04
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	4.85E+04	5.39E+04	5.93E+04	6.47E+04	7.01E+04	7.54E+04	8.08E+04	8.62E+04	9.16E+04	9.70E+04
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.02E+05	1.08E+05	1.13E+05	1.19E+05	1.24E+05	1.29E+05	1.35E+05	1.40E+05		



AXIAL VELOCITY CYCLE= 68.0 TIME=2.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	1.25E+03	1.25E+04	2.50E+04	3.74E+04	4.99E+04	6.24E+04	7.49E+04	8.74E+04	9.98E+04
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.12E+05	1.25E+05	1.37E+05	1.50E+05	1.62E+05	1.75E+05	1.87E+05	2.00E+05	2.12E+05	2.25E+05
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	2.37E+05	2.50E+05	2.62E+05	2.75E+05	2.87E+05	3.00E+05	3.12E+05	3.24E+05		



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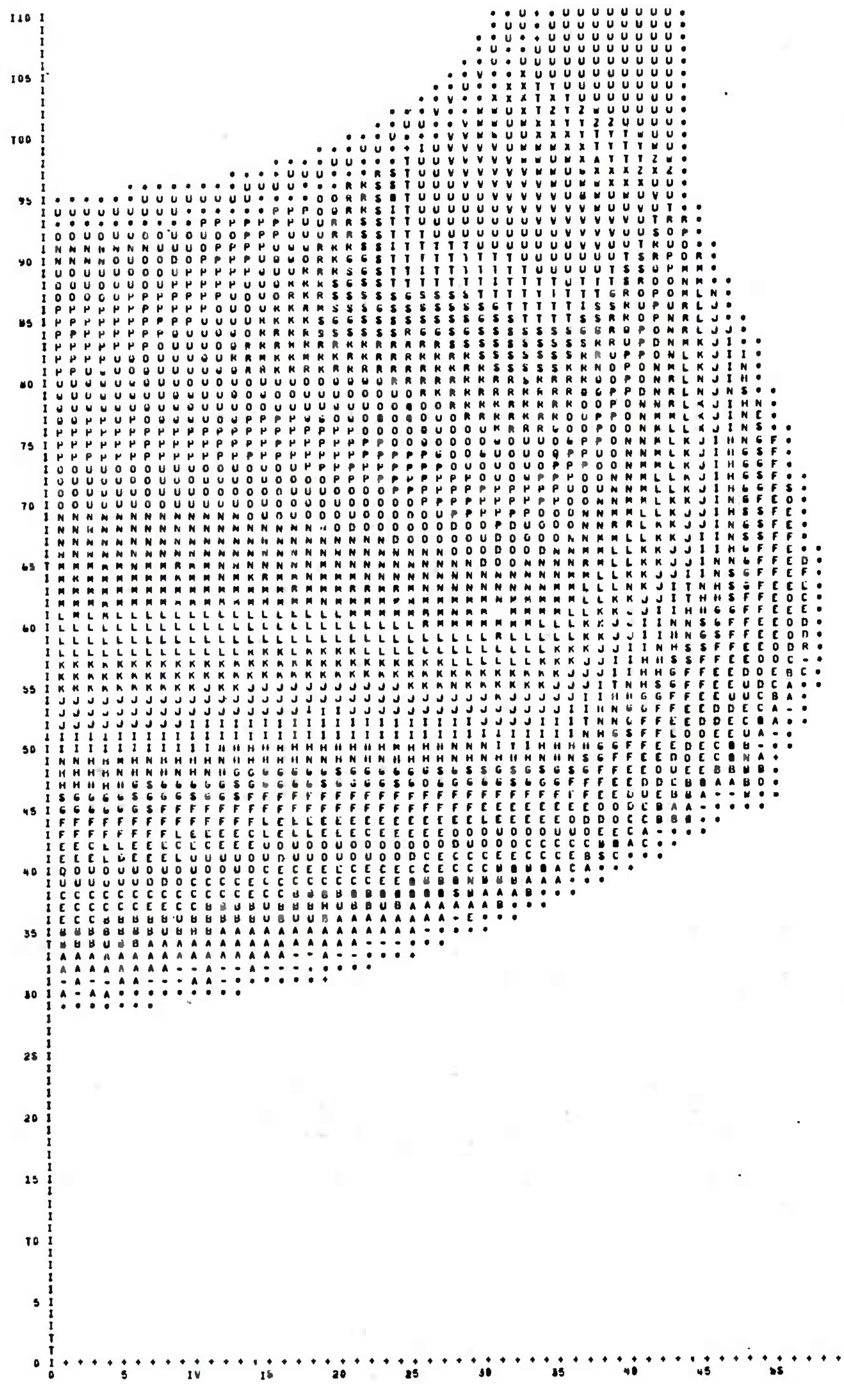
SPECIFIC INTERNAL ENERGY        CYCLE=    68.0    TIME=2.00000E-06 SECONDS

 SYMBOL           .          -          A          B          C          D          E          F          G          H
MAXIMUM VALUE    0.       2.31E+08   2.31E+09   4.63E+09   6.94E+09   9.25E+09   1.16E+10   1.39E+10   1.62E+10   1.85E+10
 SYMBOL           I          J          K          L          M          N          O          P          Q          R
MAXIMUM VALUE  2.08E+10   2.31E+10   2.54E+10   2.78E+10   3.01E+10   3.24E+10   3.47E+10   3.70E+10   3.93E+10   4.16E+10
 SYMBOL           S          T          U          V          W          X          Y          Z
MAXIMUM VALUE  4.39E+10   4.63E+10   4.86E+10   5.09E+10   5.32E+10   5.55E+10   5.78E+10   6.01E+10

   I . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
   I W W V V . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
   I X W V X W W W W V . . . . . . . . . . . . . . . . . . . . . . . .
   I X X X Y Y X X X X W W V . . . . . . . . . . . . . . . . . . . . .
80 I X X W V Y X Y Y Y X X X W V . . . . . . . . . . . . . . . . . . .
   I W V W U X W U W Y X X Y Y Y V V . . . . . . . . . . . . . . . . .
   I V V V U U V U V W W W X Y Z Z X W . . . . . . . . . . . . . . . .
   I U U U U S U U U V V V W W X Y Z X W V . . . . . . . . . . . . . .
   I S S T T T U T T U U U V V W W X X Y Y W . . . . . . . . . . . . .
75 I R R S S S T S S T T T U U U V V W Z Y W W . . . . . . . . . . . .
   I S Q R S R S S S S T T T T T U V X X X Z Y W . . . . . . . . . . .
   I R R Q R R S R R S S S T S T U V V V X X X Z W . . . . . . . . . .
   I R R P R Q R R Q R S S T S T T T U W V V X X Y W . . . . . . . . .
   I Q Q Q Q Q Q Q Q Q Q R S S S S S U U U V V X Z W W . . . . . . . .
70 I Q Q P Q P Q Q Q Q Q Q Q R R R S T T U U V X X Z Y V . . . . . . .
   I P P P P P P Q P P P P Q Q R R R T T T U V V X Z Y W V . . . . . .
   I P P O P U O Q P P P P P Q R R R S S S U U V X W X X W . . . . . .
   I P O O P O O P P P P P Q P P Q Q R S T S T V U V Y Z W W . . . . .
   I O O O O O O O O P P P P P P P Q Q R R S T T T V X Z X W . . . . .
65 I O N P O O O N N O O O O P P P Q Q Q R S S S T U X Z X X W . . . .
   I N N O N U O N N N N O O O O P Q P Q R S S S T U W Y X X W . . . .
   I N M N M N O N N N O N N O O O P P P R R R S S T V W Y X Y V . . .
   I N M N M M M N N M M N N O O P O O P Q R R R S T U V X Y Y W . . .
   I M M M M M M M M M M M N M N O O O O Q Q R R S T T V V X Y W . . .
60 I M N M N M M L M M M M M M N N N N O O Q R R R S T U V W X W W . .
   I L M L M M M M L M L N M M N N N N N O O P Q R S T U W X Y X W . .
   I M M L L L L M L L L M M L M N N N N N O O P Q Q S T U W X Y W . .
   I M L L L L L L L K L M L L L M M N O O N O U P P R T U W X Y W . .
   I L L L L L L K L K K L L L L L M M N N N O O P Q R R T U V W X V .
55 I L K L K K K K L K K L L L L L M M M M M N N O P Q R S T V W W V .
   I K K K K K K K L K K K L L L L M L L M M M M N O O Q R T U W W W .
   I K K K K K K K K K K K K K K L L L L M M M M N N N O P R S U V V .
   I K K K K K K K K K K K K K K L L L L M M M N N N N O O Q S U V V .
   I K K K K K K K K K K K K K K L L L M M M N N N O P Q Q S T U V V .
50 I K K J K K K K K K K K K K L L L M M M N N O P Q Q R R S
   I K K K K K K K K K K K L L L L M M N N O O P Q Q Q
   I K K K K K K K K K L L L L M M M N N O P P P Q
   I K K K K K L L K L L L L M M M N O O P P P
   I K K K L K L L L L L M M M N N O O O
45 I K K K L L L L L L L M N N N O O
   I K K L L L L L M M M M N N
   I K L L L L L M M M
   I
   I
40 I
   I
   I
   I
   I
35 I
   I
   I
   I
   I
```

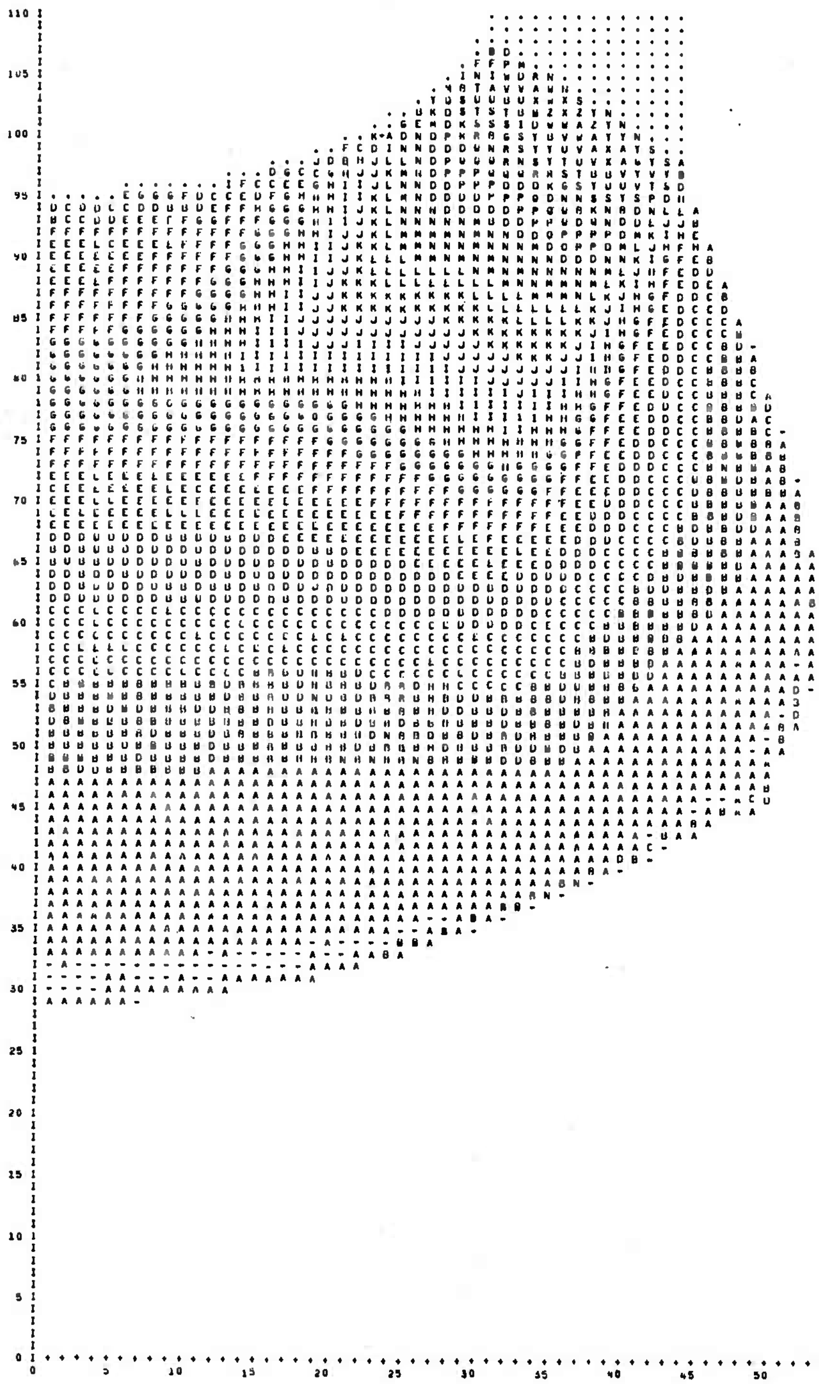
COMPRESSION CYCLE= 141.0 TIME=4.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	.007	.054	.101	.148	.195	.242	.289	.336	.383	.430
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	.477	.524	.571	.618	.665	.712	.759	.806	.853	.900
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	.947	.994	1.041	1.088	1.135	1.182	1.229	1.276		



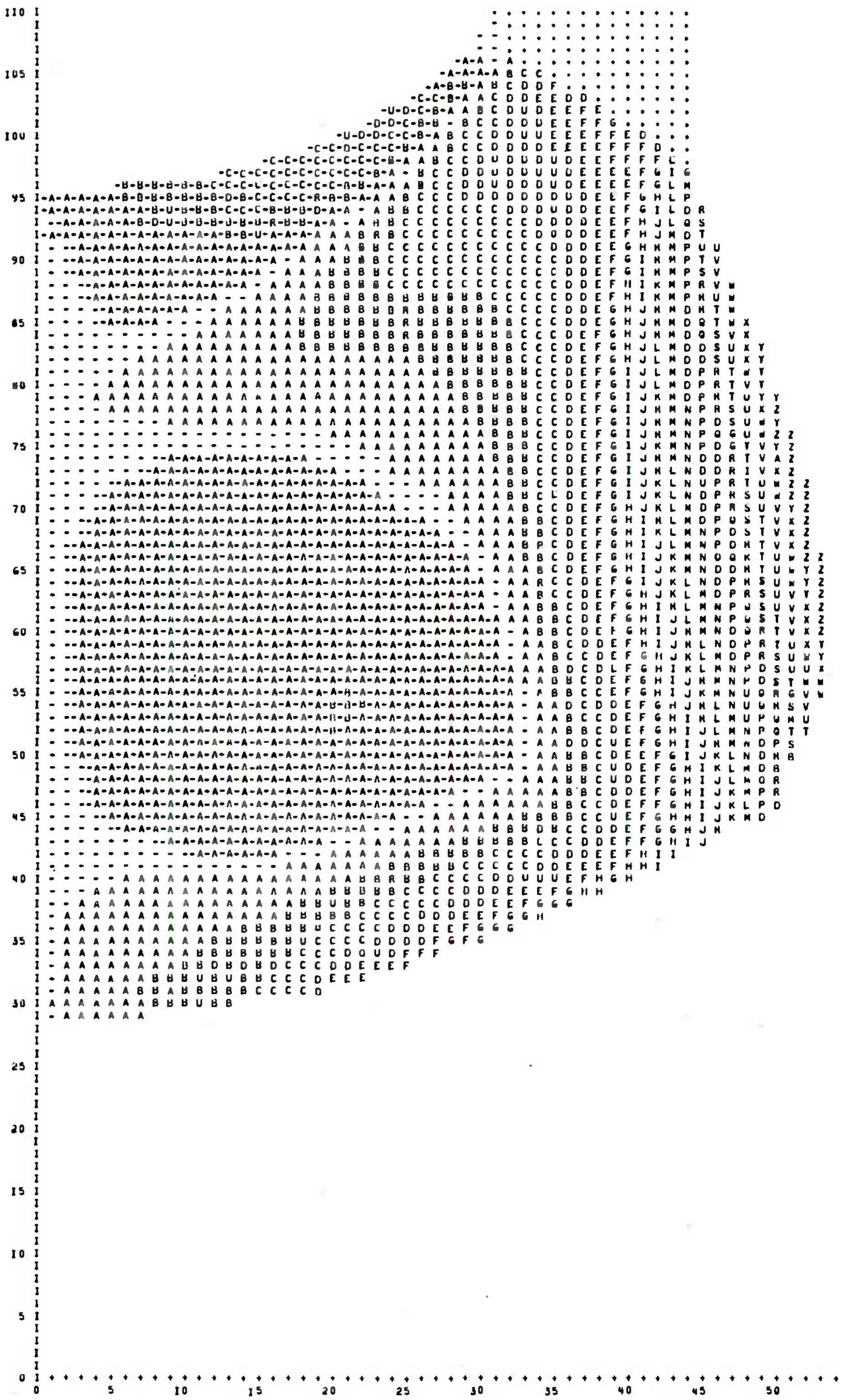
PRESSURE CYCLE= 141.0 TIME=4.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	8.75E+08	8.75E+09	1.75E+10	2.62E+10	3.50E+10	4.37E+10	5.25E+10	6.12E+10	7.00E+10
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	7.87E+10	8.75E+10	9.62E+10	1.05E+11	1.14E+11	1.22E+11	1.31E+11	1.40E+11	1.49E+11	1.57E+11
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.66E+11	1.75E+11	1.84E+11	1.92E+11	2.01E+11	2.10E+11	2.19E+11	2.27E+11		



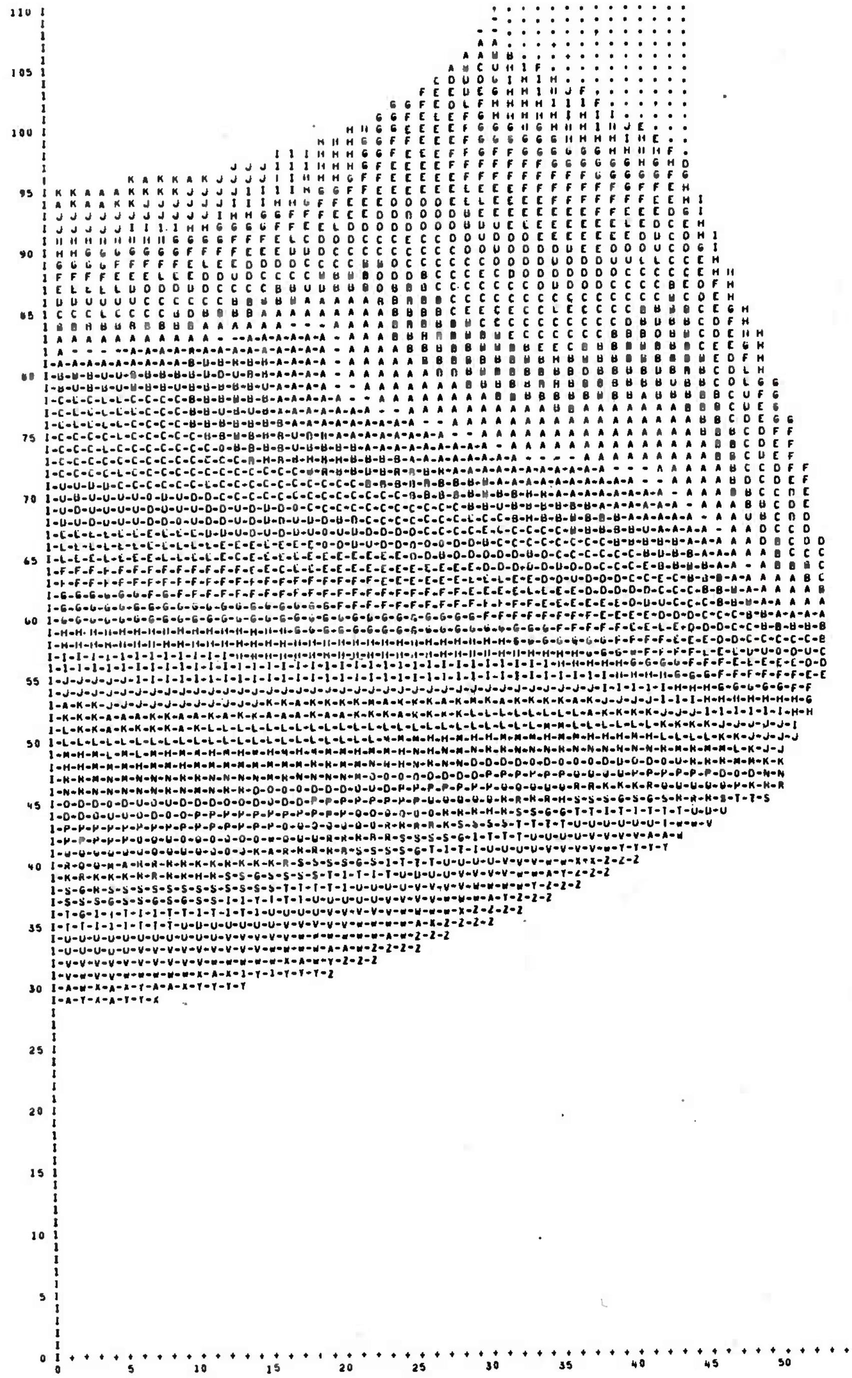
RADIAL VELOCITY CYCLE= 141.0 TIME=4.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	1.77E+03	1.77E+04	3.53E+04	5.30E+04	7.07E+04	8.83E+04	1.06E+05	1.24E+05	1.41E+05
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.59E+05	1.77E+05	1.94E+05	2.12E+05	2.30E+05	2.47E+05	2.65E+05	2.83E+05	3.00E+05	3.18E+05
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	3.36E+05	3.53E+05	3.71E+05	3.89E+05	4.06E+05	4.24E+05	4.42E+05	4.59E+05		



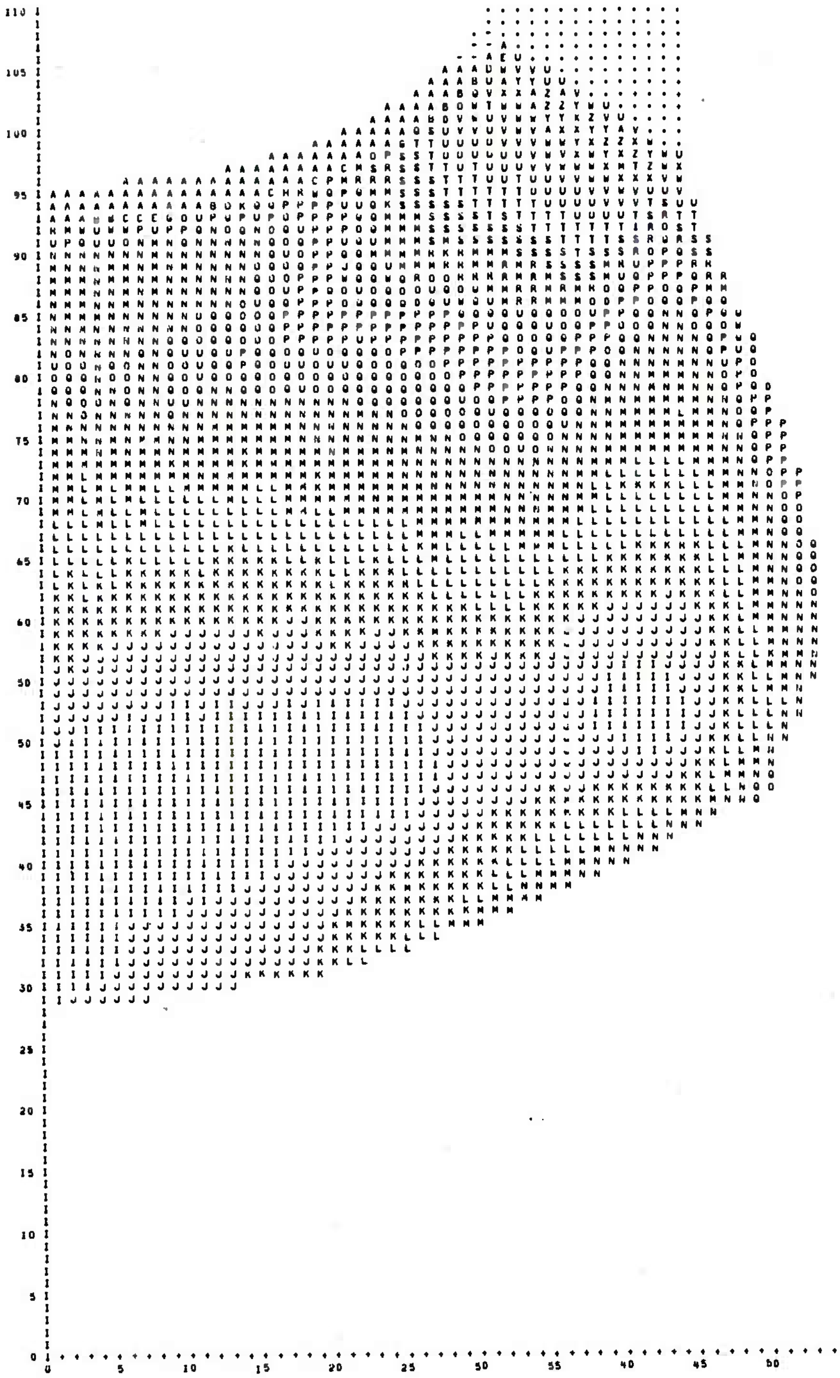
AXIAL VELOCITY CYCLE= 141.0 TIME=4.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	1.49E+03	1.49E+04	2.99E+04	4.48E+04	5.98E+04	7.47E+04	8.97E+04	1.05E+05	1.20E+05
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.34E+05	1.49E+05	1.64E+05	1.79E+05	1.94E+05	2.09E+05	2.24E+05	2.39E+05	2.54E+05	2.69E+05
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	2.84E+05	2.99E+05	3.14E+05	3.29E+05	3.44E+05	3.59E+05	3.74E+05	3.89E+05		



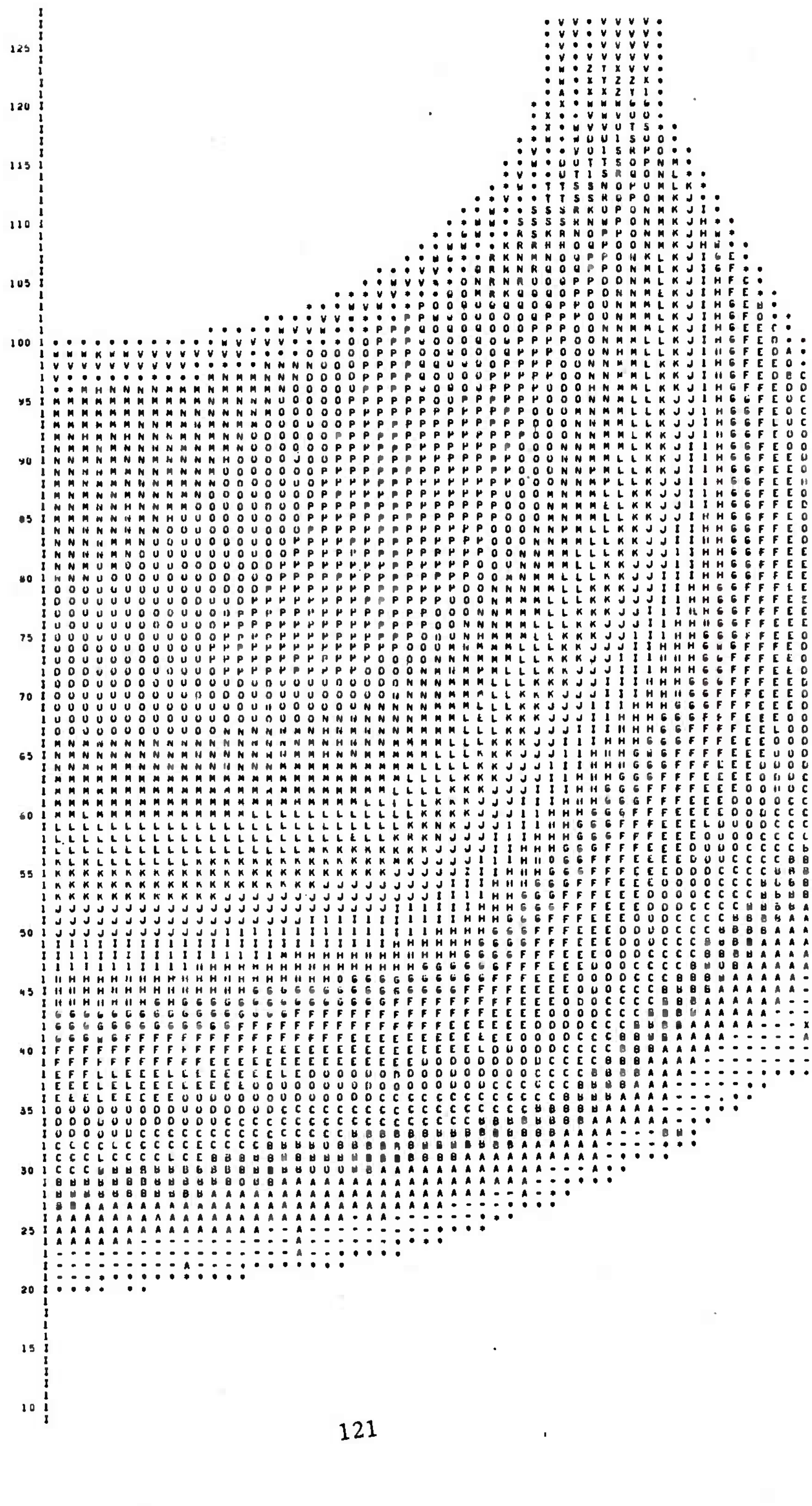
SPECIFIC INTERNAL ENERGY CYCLE= 141.0 TIME=4.00000E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	2.40E+08	2.40E+09	4.80E+09	7.20E+09	9.61E+09	1.20E+10	1.44E+10	1.68E+10	1.92E+10
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	2.16E+10	2.40E+10	2.64E+10	2.88E+10	3.12E+10	3.36E+10	3.60E+10	3.84E+10	4.08E+10	4.32E+10
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	4.56E+10	4.80E+10	5.04E+10	5.28E+10	5.52E+10	5.76E+10	6.00E+10	6.24E+10		



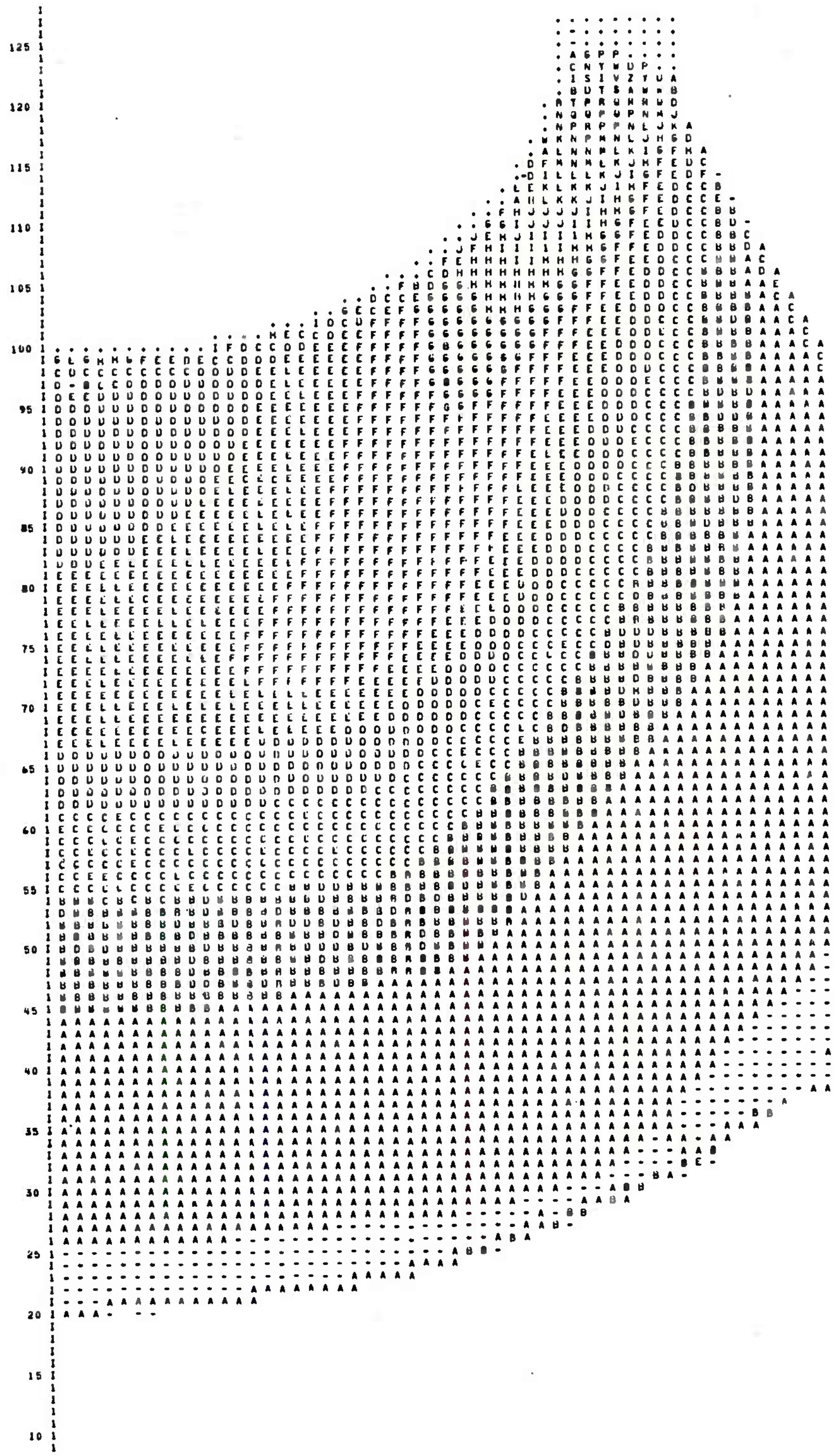
COMPRESSION   CYCLE= 187.0   TIME=5.21171E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	.003	.047	.091	.135	.179	.223	.267	.311	.355	.399
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	.443	.487	.531	.575	.619	.663	.707	.751	.795	.839
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	.883	.927	.971	1.015	1.059	1.103	1.147	1.191		



PRESSURE CYCLE= 187.0 TIME=5.21171E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	7.53E+08	7.53E+09	1.51E+10	2.26E+10	3.01E+10	3.76E+10	4.52E+10	5.27E+10	6.02E+10
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	6.78E+10	7.53E+10	8.28E+10	9.04E+10	9.79E+10	1.05E+11	1.13E+11	1.20E+11	1.20E+11	1.36E+11
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.43E+11	1.51E+11	1.58E+11	1.66E+11	1.73E+11	1.81E+11	1.88E+11	1.96E+11		

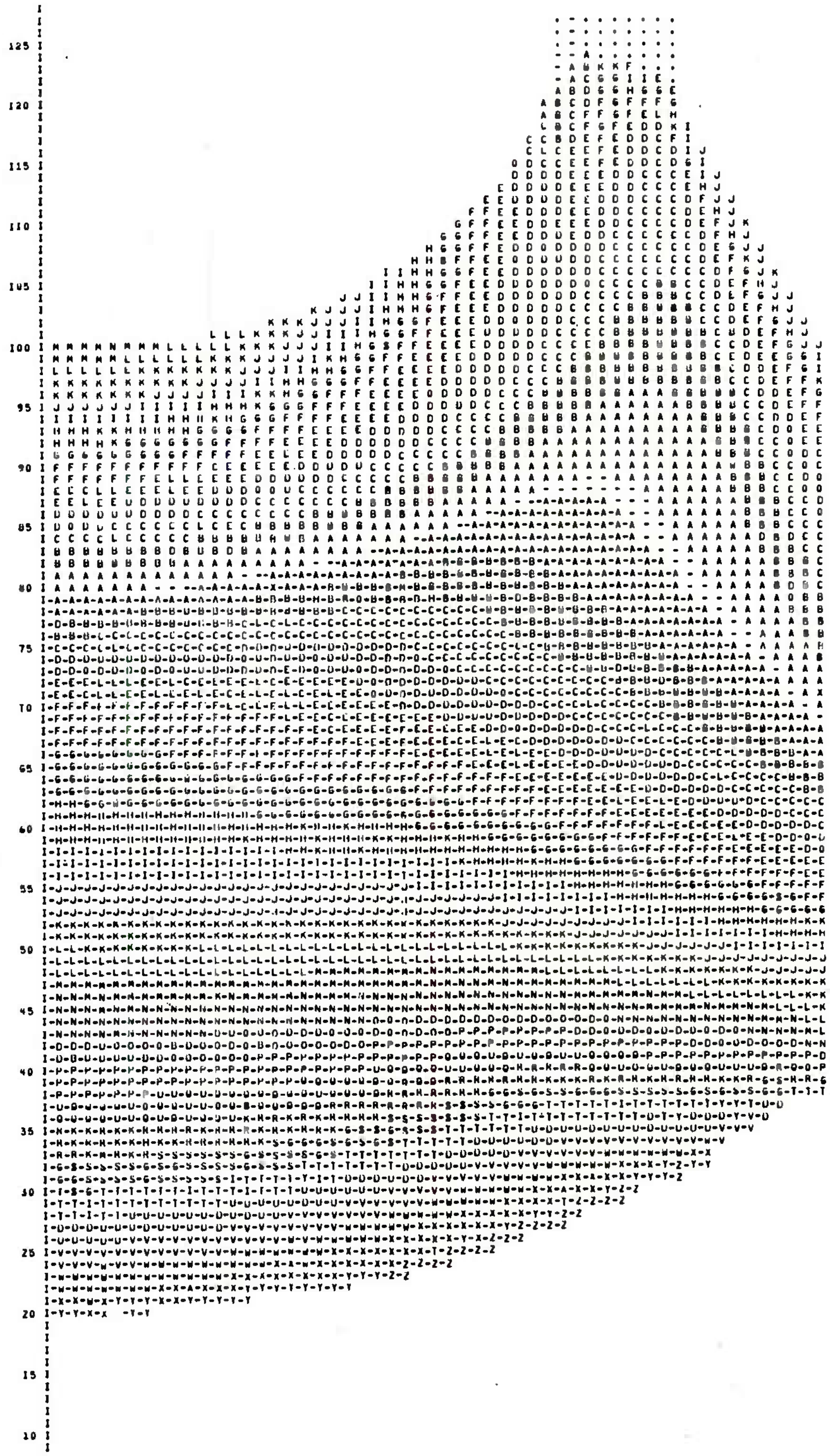


RADIAL VELOCITY CYCLE= 187.0 TIME=5.21171E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	1.77E+03	1.77E+04	3.53E+04	5.30E+04	7.06E+04	8.83E+04	1.06E+05	1.24E+05	1.41E+05
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.59E+05	1.77E+05	1.94E+05	2.12E+05	2.30E+05	2.47E+05	2.65E+05	2.83E+05	3.00E+05	3.18E+05
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	3.36E+05	3.53E+05	3.71E+05	3.89E+05	4.06E+05	4.24E+05	4.42E+05	4.59E+05		

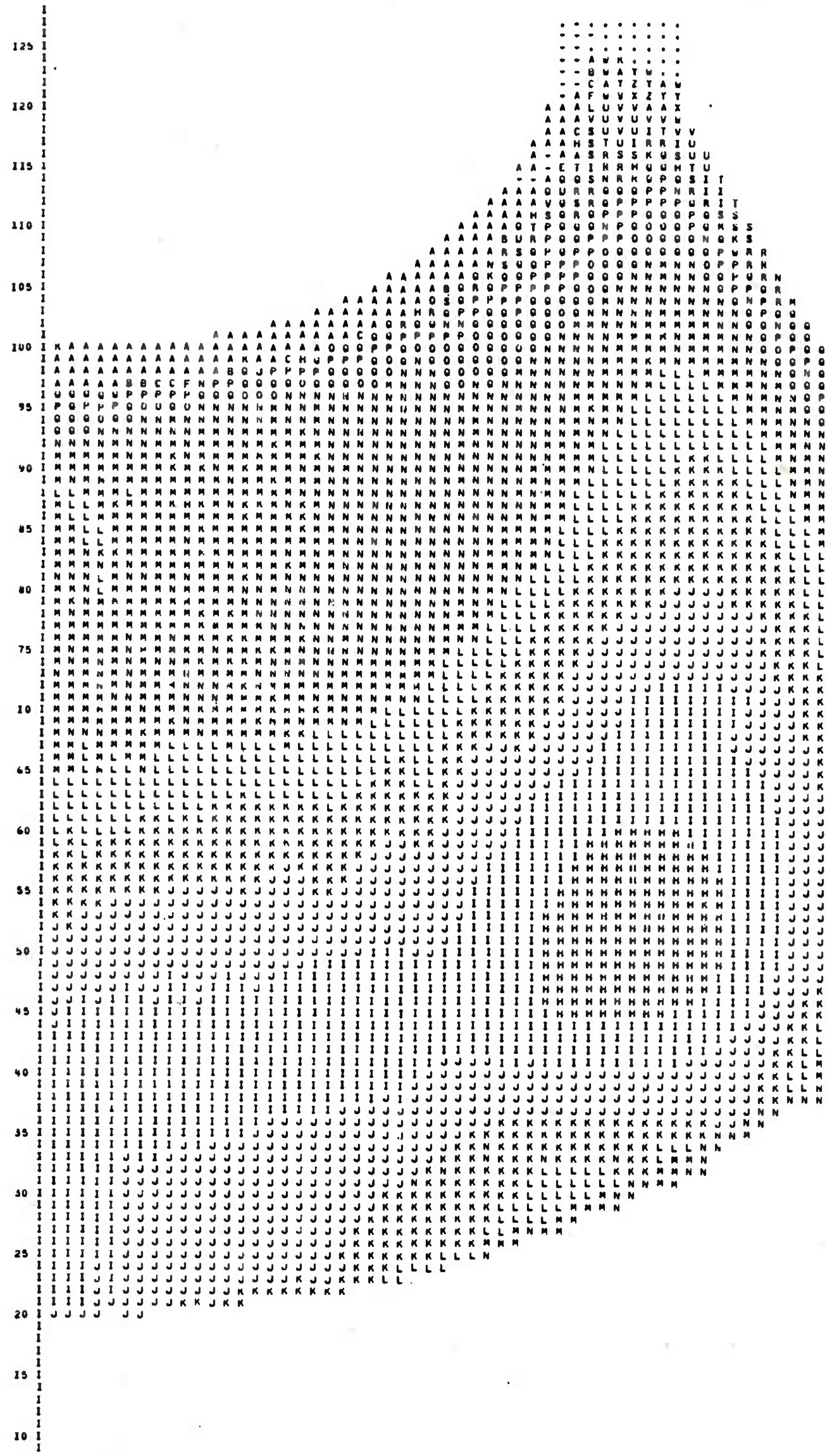
AXIAL VELOCITY CYCLE= 187.0 TIME=5.21171E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	1.56E+03	1.56E+04	3.12E+04	4.67E+04	6.23E+04	7.79E+04	9.35E+04	1.09E+05	1.25E+05
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.40E+05	1.56E+05	1.71E+05	1.87E+05	2.03E+05	2.18E+05	2.34E+05	2.49E+05	2.65E+05	2.80E+05
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	2.96E+05	3.12E+05	3.27E+05	3.43E+05	3.58E+05	3.74E+05	3.90E+05	4.05E+05		



SPECIFIC INTERNAL ENERGY CYCLE= 187.0 TIME=5.21171E-06 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	2.18E+08	2.18E+09	4.35E+09	6.53E+09	8.71E+09	1.09E+10	1.31E+10	1.52E+10	1.74E+10
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.96E+10	2.18E+10	2.39E+10	2.61E+10	2.83E+10	3.05E+10	3.26E+10	3.48E+10	3.70E+10	3.92E+10
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	4.14E+10	4.35E+10	4.57E+10	4.79E+10	5.01E+10	5.22E+10	5.44E+10	5.66E+10		



Appendix C-IVa Copper Wedge Startup Output

Here, the compression map is shown at cycle zero to show the initial configuration of the copper wedge at impact time. At the time $\rho/\rho_o = 1$ for all cells. A compression map is also shown at 1.9 μsec (cycle 11). Here some compression can be seen at the reflecting wall boundary.

```
*****    *IDENT WEDGEOM
/////    *DELETE MEMEXPND.3
               COMMON/MISC/ PQ(5,8),XAXIS(5,85),YAXIS(5,140),VL(4)
/////    *DELETE MEMEXPND.4
              COMMON/XDXYDY/ X00,X(85),Y00,Y(140),DX00,DX(85),DY00,DY(140)
/////    *DELETE MEMEXPND.12
             2 MFLAG(12001),TAU(85),UL(400),PL(400),TX(5,900),
/////    *DELETE MEMEXPND.33
              ,COMMON/MAP/ PROP(85),PR(85)


         MODIFICATIONS / CONTROL CARDS


HELPCOM        COMMON/MISC/ PQ(5,8),XAXIS(5,60),YAXIS(5,200),VL(4)          MEMEXPND    3     D
HELPCOM         COMMON/MISC/ PQ(5,8),XAXIS(5,85),YAXIS(5,140),VL(4)         WEDGEOM     1   I
HELPCOM        COMMON/XDXYDY/ X00,X(60),Y00,Y(200),DX00,DX(60),DY00,DY(200) MEMEXPND    4     D
HELPCOM        COMMON/XDXYDY/ X00,X(85),Y00,Y(140),DX00,DX(85),DY00,DY(140) WEDGEOM     2   I
HELPCOM       1             MFLAG(12001),TAU(60),UL(400),PL(400),TX(5,900), MEMEXPND   12     D
HELPCOM       2 MFLAG(12001),TAU(85),UL(400),PL(400),TX(5,900),             WEDGEOM     3   I
HELPCOM        COMMON/MAP/    PROP(60), PR(60)                              MEMEXPND   33     D
HELPCOM         COMMON/MAP/ PROP(85),PR(85)                                 WEDGEOM     4   I


MAIN     *CALL HELPCOM                                                      MAIN        4


EDIT                                                                        08NOV77     1   I
EDIT        305 CONTINUE                                                    08NOV77     2   I
EDIT        305 CONTINUE                                                    NOEDPRT     8     D


MAIN     *CALL HELPEQ                                                       MAIN        5
ADDTCR   *CALL HELPCOM                                                      ADDTCR      4
ADDTCR   *CALL HELPEQ                                                       ADDTCR      5
CALFRC   *CALL HELPCOM                                                      CALFRC     22
CALFRC   *CALL HELPEQ                                                       CALFRC     26
CDT      *CALL HELPCOM                                                      CDT        10
CDT      *CALL HELPEQ                                                       CDT        14
CMPRSN   *CALL HELPCOM                                                      CMPRSN      3
CMPRSN   *CALL HELPEQ                                                       CMPRSN      4
COMPRS   *CALL HELPCOM                                                      COMPRS      7
COMPRS   *CALL HELPEQ                                                       COMPRS      8
DETIME   *CALL HELPCOM                                                      DETIME      3
DETIME   *CALL HELPEQ                                                       DETIME      6
DMADJ    *CALL HELPCOM                                                      DMADJ       4
DMADJ    *CALL HELPEQ                                                       DMADJ       6
DMADJ    *CALL HELPCOM                                                      DMCALC      5
DMADJ    *CALL HELPEQ                                                       DMCALC      6
```

```
$OPTNS
IFLGST  = 1,
IPMADJ  = 1,
ITPHSE  = 1,
NPRTOP  = 3,
TIMMAX  = .6E+02,
$END
```

COPPER IMPACT STUDY 60 DEGREE WEDGE

```
TYPE=   3     PACKAGE=  1     NUMBER OF POINTS=  200
X1=  0.                Y1=   .1200000E+02     X2=   .1900000E+02     Y2=    .2297200E+02
TYPE=   2     PACKAGE=  1     NUMBER OF POINTS=   50
X1=   .1900000E+02     Y1=   .2297200E+02     X2=   .1900000E+02     Y2=    .2412900E+02
TYPE=  -3     PACKAGE=  1     NUMBER OF POINTS=  200
X1=   .1900000E+02     Y1=   .2412900E+02     X2=  0.                Y2=    .1315900E+02
TYPE=   3     PACKAGE=  2     NUMBER OF POINTS=  200
X1=  0.                Y1=   .1315900E+02     X2=   .1900000E+02     Y2=    .2412900E+02
TYPE=   2     PACKAGE=  2     NUMBER OF POINTS=   50
X1=   .1900000E+02     Y1=   .2412900E+02     X2=   .1900000E+02     Y2=    .2297200E+02
TYPE=  -3     PACKAGE=  2     NUMBER OF POINTS=  200
X1=   .1900000E+02     Y1=   .2297200E+02     X2=  0.                Y2=    .1200000E+02
TYPE= 100     PACKAGE=  0     NUMBER OF POINTS=    0
```

Z-VARIABLES

```
BBAR   = 5.000E-01   CRATIO= 1.000E+04   CVIS   =-1.000E+00   CYCMX  = 2.000E+00   CYCPH3=-1.000E+00   DMIN   = 1.000E-03

DTMIN  = 1.000E-11   EMIN   = 1.000E+07   EMDB   = 0.         FINAL  = 4.000E-01   GAMMA  = 0.         IEXTX  =         0

ICSTOP=          0   IGM    =         1   IMAX   =        85   INTER  =         0   IPCYCL=         50   IPLGBT=          0

IPLGRT=          0   IPR    =        35   I1     =        85   I2     =       140   JEXTY  =         0   JMAX   =       140

KUNITR=         10   KUNITW=         10   LVISC  =         1   MAPS   =         1   MINX   =         0   MAXX   =         0

MINY   =         0   MAXY   =         0   NADD   =         0   NDUMP7=          1   NFRELP=        100   NMXCLS=        800

NLINER=          0   NMAT   =         1   NODUMP=          0   NOSLIP=          1   NSLD   =         0   NTCC   =         0

NTPMX  =       900   NTRACR=          5   NUMREZ= 0.          NUMSCA=          0   NVRTEX=          0

PK(1)  = 2.900E+01   PK(2)  = 0.         PK(3)  = 0.         PK(4)  = 0.         PK(5)  = 0.

PLGOPT= 0.           PLWMIN= 0.          PMIN   = 5.000E+06   PRCNT  = 1.000E-03   PRDELT= 0.          PRFACT= 0.

PRLIM  = 0.          PROB   = 2.900E+01   REZ    = 0.         ROEPS  = 1.000E-05   SIEMIN= 1.000E+05   STAB   = 1.000E-03

TSTOP  = 5.000E-06
```

KAGE NUMBER	NORMAL DENSITY (RHOZ)	INITIAL DENSITY (RHOIN)	CONDITIONS S.I.E.	U	V	MATERIAL
1	8.900	8.900	0.	-2.1700E+05	1.2500E+05	COPPER

STRENGTH CONSTANTS

PACKAGE NUMBER	CZERO	STK1	STK2	STEZ	RMU	AMDM
1	2.350E+09	6.950E+10	5.500E+10	5.300E+09	4.550E+11	9.785E-01

I	DR	I	DR	I	DR	I	DR	I	DR	I	DR	I	DR
1	1.000E-01	2	1.000E-01	3	1.000E-01	4	1.000E-01	5	1.000E-01	6	1.000E-01	7	1.000E-01
8	1.000E-01	9	1.000E-01	10	1.000E-01	11	1.000E-01	12	1.000E-01	13	1.000E-01	14	1.000E-01
15	1.000E-01	16	1.000E-01	17	1.000E-01	18	1.000E-01	19	1.000E-01	20	1.000E-01	21	1.000E-01
22	1.000E-01	23	1.000E-01	24	1.000E-01	25	1.000E-01	26	1.000E-01	27	1.000E-01	28	1.000E-01
29	1.000E-01	30	1.000E-01	31	1.000E-01	32	1.000E-01	33	1.000E-01	34	1.000E-01	35	1.000E-01
36	1.000E-01	37	1.000E-01	38	1.000E-01	39	1.000E-01	40	1.000E-01	41	1.000E-01	42	1.000E-01
43	1.000E-01	44	1.000E-01	45	1.000E-01	46	1.000E-01	47	1.000E-01	48	1.000E-01	49	1.000E-01
50	1.000E-01	51	1.000E-01	52	1.000E-01	53	1.000E-01	54	1.000E-01	55	1.000E-01	56	1.000E-01
57	1.000E-01	58	1.000E-01	59	1.000E-01	60	1.000E-01	61	2.500E-01	62	2.500E-01	63	2.500E-01
64	2.500E-01	65	2.500E-01	66	2.500E-01	67	5.000E-01	68	5.000E-01	69	5.000E-01	70	5.000E-01
71	5.000E-01	72	1.000E+00	73	1.000E+00	74	1.000E+00	75	1.000E+00	76	1.000E+00	77	1.000E+00
78	1.000E+00	79	1.000E+00	80	1.000E+00	81	1.000E+00	82	1.000E+00	83	1.000E+00	84	1.000E+00
85	1.000E+00												

I	R	I	R	I	R	I	R	I	R	I	R	I	R
1	1.000E-01	2	2.000E-01	3	3.000E-01	4	4.000E-01	5	5.000E-01	6	6.000E-01	7	7.000E-01
8	8.000E-01	9	9.000E-01	10	1.000E+00	11	1.100E+00	12	1.200E+00	13	1.300E+00	14	1.400E+00
15	1.500E+00	16	1.600E+00	17	1.700E+00	18	1.800E+00	19	1.900E+00	20	2.000E+00	21	2.100E+00
22	2.200E+00	23	2.300E+00	24	2.400E+00	25	2.500E+00	26	2.600E+00	27	2.700E+00	28	2.800E+00
29	2.900E+00	30	3.000E+00	31	3.100E+00	32	3.200E+00	33	3.300E+00	34	3.400E+00	35	3.500E+00
36	3.600E+00	37	3.700E+00	38	3.800E+00	39	3.900E+00	40	4.000E+00	41	4.100E+00	42	4.200E+00
43	4.300E+00	44	4.400E+00	45	4.500E+00	46	4.600E+00	47	4.700E+00	48	4.800E+00	49	4.900E+00
50	5.000E+00	51	5.100E+00	52	5.200E+00	53	5.300E+00	54	5.400E+00	55	5.500E+00	56	5.600E+00
57	5.700E+00	58	5.800E+00	59	5.900E+00	60	6.000E+00	61	6.250E+00	62	6.500E+00	63	6.750E+00
64	7.000E+00	65	7.250E+00	66	7.500E+00	67	8.000E+00	68	8.500E+00	69	9.000E+00	70	9.500E+00
71	1.000E+01	72	1.100E+01	73	1.200E+01	74	1.300E+01	75	1.400E+01	76	1.500E+01	77	1.600E+01
78	1.700E+01	79	1.800E+01	80	1.900E+01	81	2.000E+01	82	2.100E+01	83	2.200E+01	84	2.300E+01
85	2.400E+01												

J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ
1	5.000E-01	2	5.000E-01	3	5.000E-01	4	5.000E-01	5	5.000E-01	6	5.000E-01	7	5.000E-01
8	5.000E-01	9	5.000E-01	10	5.000E-01	11	2.500E-01	12	2.500E-01	13	2.500E-01	14	2.500E-01
15	2.500E-01	16	2.500E-01	17	2.500E-01	18	2.500E-01	19	2.500E-01	20	2.500E-01	21	1.000E-01
22	1.000E-01	23	1.000E-01	24	1.000E-01	25	1.000E-01	26	1.000E-01	27	1.000E-01	28	1.000E-01
29	1.000E-01	30	1.000E-01	31	1.000E-01	32	1.000E-01	33	1.000E-01	34	1.000E-01	35	1.000E-01
36	1.000E-01	37	1.000E-01	38	1.000E-01	39	1.000E-01	40	1.000E-01	41	1.000E-01	42	1.000E-01
43	1.000E-01	44	1.000E-01	45	1.000E-01	46	1.000E-01	47	1.000E-01	48	1.000E-01	49	1.000E-01
50	1.000E-01	51	1.000E-01	52	1.000E-01	53	1.000E-01	54	1.000E-01	55	1.000E-01	56	1.000E-01
57	1.000E-01	58	1.000E-01	59	1.000E-01	60	1.000E-01	61	1.000E-01	62	1.000E-01	63	1.000E-01
64	1.000E-01	65	1.000E-01	66	1.000E-01	67	1.000E-01	68	1.000E-01	69	1.000E-01	70	1.000E-01
71	1.000E-01	72	1.000E-01	73	1.000E-01	74	1.000E-01	75	1.000E-01	76	1.000E-01	77	1.000E-01
78	1.000E-01	79	1.000E-01	80	1.000E-01	81	1.000E-01	82	1.000E-01	83	1.000E-01	84	1.000E-01
85	1.000E-01	86	1.000E-01	87	1.000E-01	88	1.000E-01	89	1.000E-01	90	1.000E-01	91	1.000E-01
92	1.000E-01	93	1.000E-01	94	1.000E-01	95	1.000E-01	96	1.000E-01	97	1.000E-01	98	1.000E-01
99	1.000E-01	100	1.000E-01	101	1.000E-01	102	1.000E-01	103	1.000E-01	104	1.000E-01	105	1.000E-01
106	1.000E-01	107	1.000E-01	108	1.000E-01	109	1.000E-01	110	1.000E-01	111	1.000E-01	112	1.000E-01
113	1.000E-01	114	1.000E-01	115	1.000E-01	116	1.000E-01	117	1.000E-01	118	1.000E-01	119	1.000E-01
120	1.000E-01	121	2.500E-01	122	2.500E-01	123	2.500E-01	124	2.500E-01	125	2.500E-01	126	2.500E-01
127	2.500E-01	128	2.500E-01	129	2.500E-01	130	2.500E-01	131	5.000E-01	132	5.000E-01	133	5.000E-01
134	5.000E-01	135	5.000E-01	136	5.000E-01	137	5.000E-01	138	5.000E-01	139	5.000E-01	140	5.000E-01

J	Z	J	Z	J	Z	J	Z	J	Z	J	Z	J	Z
1	5.000E-01	2	1.000E+00	3	1.500E+00	4	2.000E+00	5	2.500E+00	6	3.000E+00	7	3.500E+00
8	4.000E+00	9	4.500E+00	10	5.000E+00	11	5.250E+00	12	5.500E+00	13	5.750E+00	14	6.000E+00
15	6.250E+00	16	6.500E+00	17	6.750E+00	18	7.000E+00	19	7.250E+00	20	7.500E+00	21	7.600E+00
22	7.700E+00	23	7.800E+00	24	7.900E+00	25	8.000E+00	26	8.100E+00	27	8.200E+00	28	8.300E+00
29	8.400E+00	30	8.500E+00	31	8.600E+00	32	8.700E+00	33	8.800E+00	34	8.900E+00	35	9.000E+00
36	9.100E+00	37	9.200E+00	38	9.300E+00	39	9.400E+00	40	9.500E+00	41	9.600E+00	42	9.700E+00
43	9.800E+00	44	9.900E+00	45	1.000E+01	46	1.010E+01	47	1.020E+01	48	1.030E+01	49	1.040E+01
50	1.050E+01	51	1.060E+01	52	1.070E+01	53	1.080E+01	54	1.090E+01	55	1.100E+01	56	1.110E+01
57	1.120E+01	58	1.130E+01	59	1.140E+01	60	1.150E+01	61	1.160E+01	62	1.170E+01	63	1.180E+01
64	1.190E+01	65	1.200E+01	66	1.210E+01	67	1.220E+01	68	1.230E+01	69	1.240E+01	70	1.250E+01
71	1.260E+01	72	1.270E+01	73	1.280E+01	74	1.290E+01	75	1.300E+01	76	1.310E+01	77	1.320E+01
78	1.330E+01	79	1.340E+01	80	1.350E+01	81	1.360E+01	82	1.370E+01	83	1.380E+01	84	1.390E+01
85	1.400E+01	86	1.410E+01	87	1.420E+01	88	1.430E+01	89	1.440E+01	90	1.450E+01	91	1.460E+01
92	1.470E+01	93	1.480E+01	94	1.490E+01	95	1.500E+01	96	1.510E+01	97	1.520E+01	98	1.530E+01
99	1.540E+01	100	1.550E+01	101	1.560E+01	102	1.570E+01	103	1.580E+01	104	1.590E+01	105	1.600E+01
106	1.610E+01	107	1.620E+01	108	1.630E+01	109	1.640E+01	110	1.650E+01	111	1.660E+01	112	1.670E+01
113	1.680E+01	114	1.690E+01	115	1.700E+01	116	1.710E+01	117	1.720E+01	118	1.730E+01	119	1.740E+01
120	1.750E+01	121	1.775E+01	122	1.800E+01	123	1.825E+01	124	1.850E+01	125	1.875E+01	126	1.900E+01
127	1.925E+01	128	1.950E+01	129	1.975E+01	130	2.000E+01	131	2.050E+01	132	2.100E+01	133	2.150E+01
134	2.200E+01	135	2.250E+01	136	2.300E+01	137	2.350E+01	138	2.400E+01	139	2.450E+01	140	2.500E+01

CYCLE 0

CDT 69 120 T=0. DT=3.2679739E-10 MAXCUV=6.1200000E+05 MAXUV=2.1700000E+05 UMIN=6.1200000E+00 PMIN=5.0000000E+06

PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE		IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
29.0000	0.	0	6.1405707E+12	5.089103 E-15	0	0.	0.

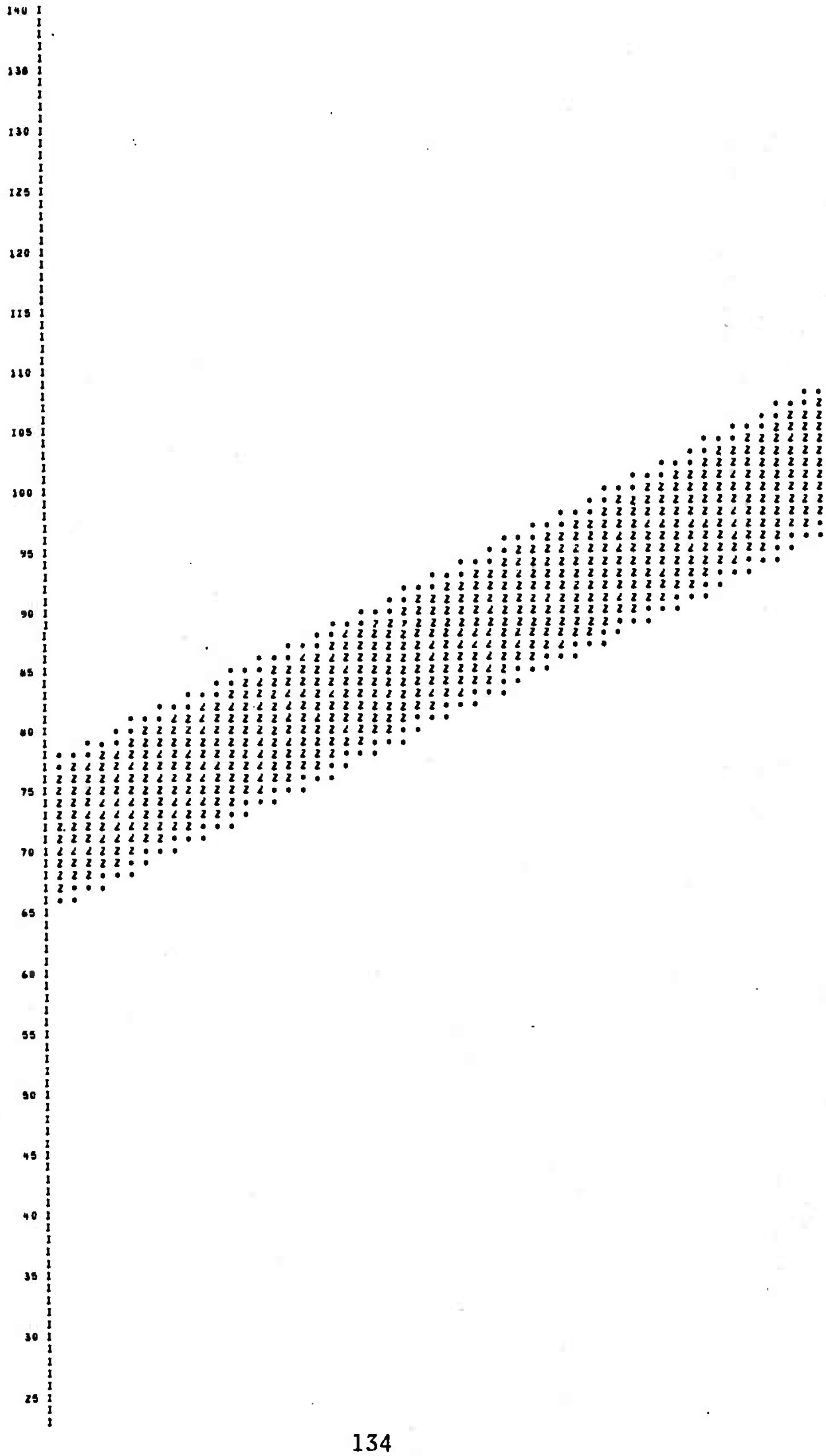
PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WORK
1	0.	6.1405707E+12	6.1405707E+12	1.9582775E+02	2.4478468E+07	2.4478468E+07	-4.2494621E+07	0.
TOTALS	0.	6.1405707E+12	6.1405707E+12	1.9582775E+02	2.4478468E+07	2.4478468E+07	-4.2494621E+07	0.

	IE OUT	KE OUT
1	0.	0.

BOUNDARY	BOTTOM	RIGHT	TOP	$EVAPORATED$
MASS OUT	0.	0.	0.	0.
ENERGY OUT	0.	0.	0.	0.
MU OUT	0.	0.	0.	0.
MV OUT	0.	0.	0.	0.
WORK DONE	0.	0.	0.	

COMPRESSION CYCLE= 0.0 TIME=0. SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.000	.038	.076	.114	.152	.190	.228	.266	.304	.342
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	.380	.418	.456	.494	.532	.570	.608	.646	.684	.722
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	.760	.798	.836	.874	.912	.950	.988	1.026		



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CDT  1  67  T=1.7909227E-08  DT=1.6530077E-08  MAXCUV=7.7434605E+05  MAXUV=2.1700039E+05  UMIN=7.7434605E+00  PMIN=5.0000000E+06
HPHASE   ETH=   6.14056970E+12       ESUM=   6.14056970E+12     EMIX=   6.14056970E+12     RELERR=   3.56237305E-14
                                     E1NTC=  6.30562957E+09     E1NTM=  6.30562957E+09
                                     EK1NC=  6.13426407E+12     EKINM=  6.13426407E+12
TPHASE   ETH=   6.14056970E+12       ESUM=   6.14056970E+12     EMIX=   6.14056970E+12     RELERR=   5.59801479E-14
                                     E1NTC=  8.67774216E+09     EINTM=  8.67774216E+09
                                     EK1NC=  6.13189196E+12     EK1NM=  6.13189196E+12
CYCLE    7

CDT  1  72  T=3.4439304E-08  DT=3.0965372E-08  MAXCUV=8.2672993E+05  MAXUV=2.1700394E+05  UMIN=8.2672993E+00  PMIN=5.0000000E+06
HPHASE   ETH=   6.14056970E+12       ESUM=   6.14056970E+12     EMIX=   6.14056970E+12     RELERR=   4.07128349E-14
                                     EINTC=  1.32706484E+10     EINTM=  1.32706404E+10
                                     EK1NC=  6.12729105E+12     EK1NM=  6.12729105E+12
TPHASE   ETH=   6.14056970E+12       ESUM=   6.14056970E+12     EMIX=   6.14056970E+12     RELERR=   1.06871191E-13
                                     E1NTC=  1.61203138E+10     EINTM=  1.61203138E+10
                                     EK1NC=  6.12444939E+12     EKINM=  6.12444939E+12
CYCLE    8

CDT  1  72  T=6.5404676E-00  DT=4.5134446E-08  MAXCUV=8.8624108E+05  MAXUV=2.1702535E+05  UM1N=8.0624100E+00  PMIN=5.0000000E+06
HPHASE   ETH=   6.14056970E+12       ESUM=   6.14056970E+12     EMIX=   6.14056970E+12     RELERR=   1.06071191E-13
                                     E1NTC=  2.42012533E+10     EINTM=  2.42012533E+10
                                     EK1NC=  6.11636045E+12     EKINM=  6.11636845E+12
TPHASE   ETH=   6.14056970E+12       ESUM=   6.14056970E+12     EM1X=   6.14056970E+12     RELERR=   1.32316713E-13
                                     E1NTC=  2.61654220E+10     EINTM=  2.61654220E+10
                                     EK1NC=  6.11440427E+12     EK1NM=  6.11440427E+12
CYCLE    9

CDT  1  76  T=1.1053912E-07  DT=4.1540848E-08  MAXCUV=9.6290764E+05  MAXUV=2.1712341E+05  UM1N=9.6290764E+00  PM1N=5.0000000E+06
HPHASE   ETH=   6.14056970E+12       ESUM=   6.14056970E+12     EM1X=   6.14056970E+12     RELERR=   1.27227609E-13
                                     E1NTC=  3.40989204E+10     EINTM=  3.40989204E+10
                                     EK1NC=  6.10647078E+12     EK1NM=  6.10647078E+12
TPHASE   ETH=   6.14056965E+12       ESUM=   6.14056965E+12     EM1X=   6.14056965E+12     RELERR=   1.90475071E-13
                                     E1NTC=  3.50738105E+10     EINTM=  3.50730105E+10
                                     EK1NC=  6.10549584E+12     EK1NM=  6.10549504E+12
CYCLE   10

CDT  1  77  T=1.5207997E-07  DT=3.0662671E-08  MAXCUV=1.0345897E+06  MAXUV=2.1729130E+05  UM1N=1.0345897E+01  PMIN=5.0000000E+06
HPHASE   ETH=   6.14056965E+12       ESUM=   6.14056965E+12     EMIX=   6.14056965E+12     RELERR=   1.80296863E-13
                                     E1NTC=  4.20976877E+10     E1NTM=  4.20976877E+10
                                     EKINC=  6.09047196E+12     EK1NM=  6.09847196E+12
TPHASE   ETH=   6.14056949E+12       ESUM=   6.14056949E+12     EMIX=   6.14056949E+12     RELERR=   2.44277017E-13
                                     E1NTC=  4.27434953E+10     E1NTM=  4.27434953E+10
                                     EK1NC=  6.09782599E+12     EK1NM=  6.09782599E+12
CYCLE   11

CDT  1  77  T=1.9074264E-07  DT=3.6069946E-08  MAXCUV=1.1009565E+06  MAXUV=2.1749526E+05  UM1N=1.1089565E+01  PMIN=5.0000000E+06


APPROACHING CUT OFF TIME  3.069 SECONDS LEFT
```

PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE		IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
29.0000	1.9074264E-07	11	6.1405695E+12	3.0025717E-13	11	-1.7643355E+05	0.

PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WORK
1	4.2743495E+10	6.0978260E+12	6.1405695E+12	1.9582772E+02	2.4478464E+07	2.4478464E+07	-4.2203575E+07	0.
TOTALS	4.2743495E+10	6.0978260E+12	6.1405695E+12	1.9582772E+02	2.4478464E+07	2.4478464E+07	-4.2203575E+07	0.

	IE OUT	KE OUT
1	1.7643355E+05	9.9576219E+05

BOUNDARY	BOTTOM	RIGHT	TOP	$EVAPORATED$
MASS OUT	0.	0.	0.	3.1755659E-05
ENERGY OUT	0.	0.	0.	9.9576219E+05
MU OUT	0.	0.	0.	-6.8909780E+00
MV OUT	0.	0.	0.	3.9694574E+00
WORK DONE	0.	0.	0.	

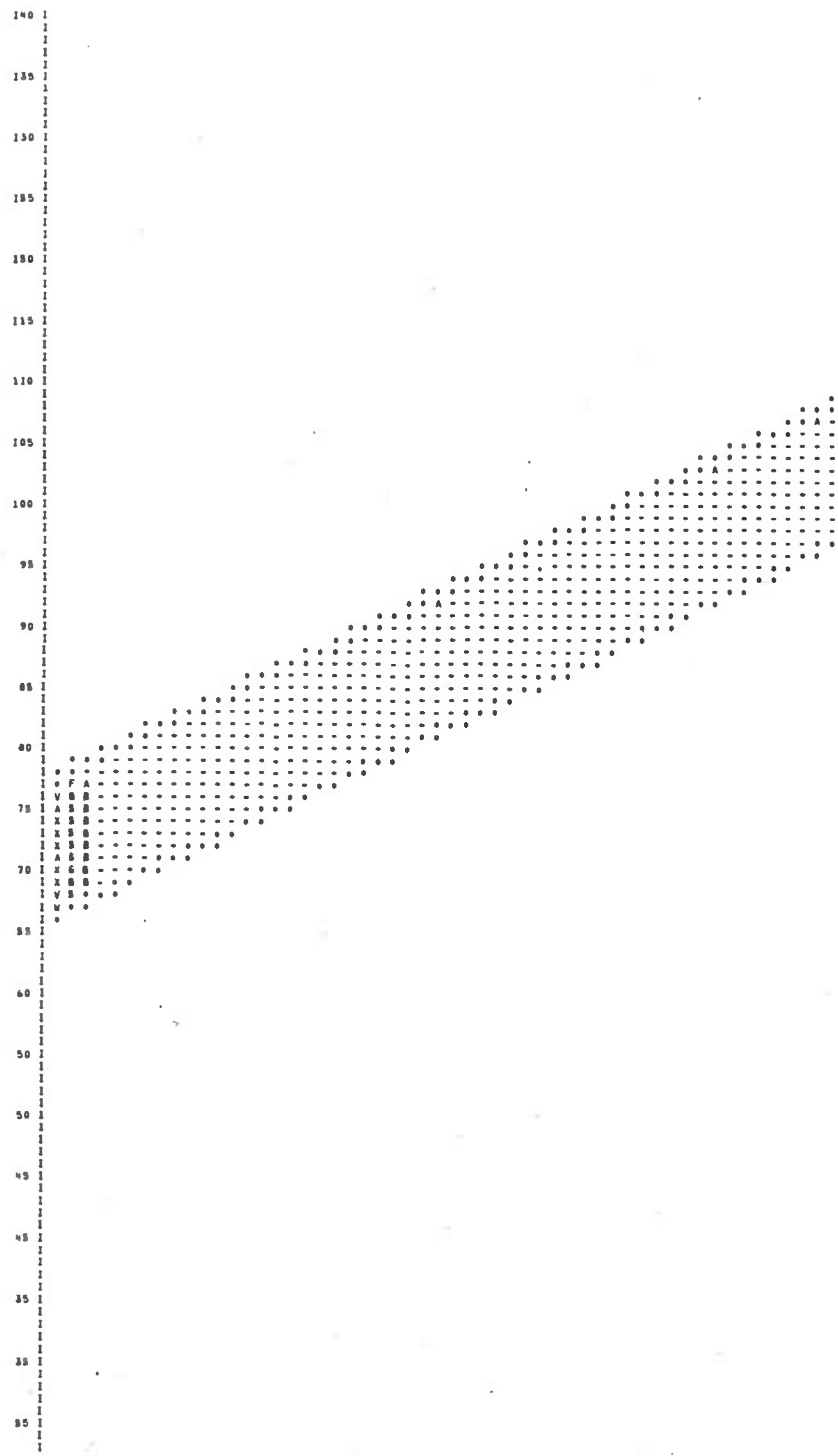
TAPE 10 DUMP ON CYCLE 11

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	0	0	0	0	0	0

COMPRESSION   CYCLE=   11.0   TIME=1.9078E-07 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	1.000	1.012	1.024	1.036	1.048	1.060	1.072	1.084	1.096	1.108
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.120	1.132	1.144	1.156	1.168	1.180	1.192	1.204	1.216	1.228
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.240	1.252	1.264	1.276	1.288	1.300	1.312	1.324		



Appendix C-IVb. Copper Wedge Restart Output

At .295 μsec (cycle 14) compressions can be seen to be increasing at the reflective wall, and the specific energy map, also shown here, indicates specific internal energies in excess of 3.73 E+10 ergs/g.

```
$OPTNS
IFLGST  = 1,
IPMADJ  = 1,
ITPHSE  = 1,
NPRTOP  = 3,
TIMMAX  = .48E+03,
$END
```

```
COPPER IMPACT STUOY 60 DEGREE WEOGE

TAPE OUMP ON CYCLE    0.

Z-VARIABLES
  BBAR   = 5.000E-01   CRATIO= 1.000E+04   CVIS   =-1.000E+00   CYCMX  = 2.000E+00   CYCPH3=-1.000E+00   OMIN   = 1.000E-03
  DTMIN  = 1.000E-11   EMIN   = 1.000E+07   EMOB   = 0.          FINAL  = 4.000E-01   GAMMA  = 0.          IEXTX  =          0
  ICSTOP=          14   IGM    =          1   IMAX   =         85   INTER  =          0   IPCYCL=          50   IPLGBT=          0
  IPLGRT=           0   IPR    =         35   I1     =         85   I2     =        140   JEXTY  =          0   JMAX   =        140
  KUNITR=           7   KUNITW=         10   LVISC  =          1   MAPS   =          1   MINX   =          0   MAXX   =          0
  MINY   =          0   MAXY   =          0   NADO   =          0   NDUMP7=           1   NFRELP=         100   NMXCLS=        800
  NLINER=           0   NMAT   =          1   NODUMP=           0   NOSLIP=           1   NSLD   =          0   NTCC   =          0
  NTPMX  =        900   NTRACR=           5   NUMREZ= 0.          NUMSCA=           0   NVRTEX=           0
  PK(1)  = 2.900E+01   PK(2)  = 1.100E+01   PK(3)  =-1.000E+00   PK(4)  = 0.          PK(5)  = 0.
  PLGOPT= 0.          PLWMIN= 0.          PMIN   = 5.000E+06   PRCNT  = 1.000E-03   PRDELT= 0.          PRFACT= 0.
  PRLIM  = 0.          PROB   = 2.900E+01   REZ    = 0.          ROEPS  = 1.000E-05   SIEMIN= 1.000E+05   STAB   = 4.000E-01
  TSTOP  = 0.
```

```
PROBLEM       TIME         CYCLE   TOT.EN.THEOR.   MAX.REL.ERROR-CYCLE    IE SET TO ZERO-PH2    ELASTIC PLASTIC WORK
29.0000  1.9074264E-07      11     6.1405695E+12   3.0025717E-13   11      -1.7643355E+05         0.

PACKAGE NO.        IE            KE          TOT.EN. (SUM)      MASS            MV          MV(POSITIVE)        MU          PLASTIC-WORK
    1       4.2743495E+10  6.0978260E+12  6.1405695E+12  1.9582772E+02  2.4478464E+07  2.4478464E+07 -4.2203575E+07  0.
            -------------  -------------  -------------  -------------  -------------  -------------  -------------  -------------
TOTALS      4.2743495E+10  6.0978260E+12  6.1405695E+12  1.9582772E+02  2.4478464E+07  2.4478464E+07 -4.2203575E+07  0.

                IE OUT         KE OUT
    1       1.7643355E+05  9.9576219E+05


BOUNDARY          BOTTOM          RIGHT           TOP         $EVAPORATED$

MASS OUT    0.            0.            0.            3.1755659E-05
ENERGY OUT  0.            0.            0.            9.9576219E+05
MU OUT      0.            0.            0.           -6.8909780E+00
MV OUT      0.            0.            0.            3.9694574E+00

WORK DONE   0.            0.            0.

HPHASE   ETH=   6.14056949E+12     ESUM=   6.14056949E+12     EMIX=   6.14056949E+12     RELERR=   2.29009704E-13
                                  EINTC=   4.86475752E+10    EINTM=   4.86475752E+10
                                  EKINC=   6.09192191E+12    EKINM=   6.09192191E+12
TPHASE   ETH=   6.14056912E+12     ESUM=   6.14056912E+12     EMIX=   6.14056912E+12     RELERR=   2.64633452E-13
                                  EINTC=   4.91932515E+10    EINTM=   4.91932515E+10
                                  EKINC=   6.09137587E+12    EKINM=   6.09137587E+12
CYCLE    12

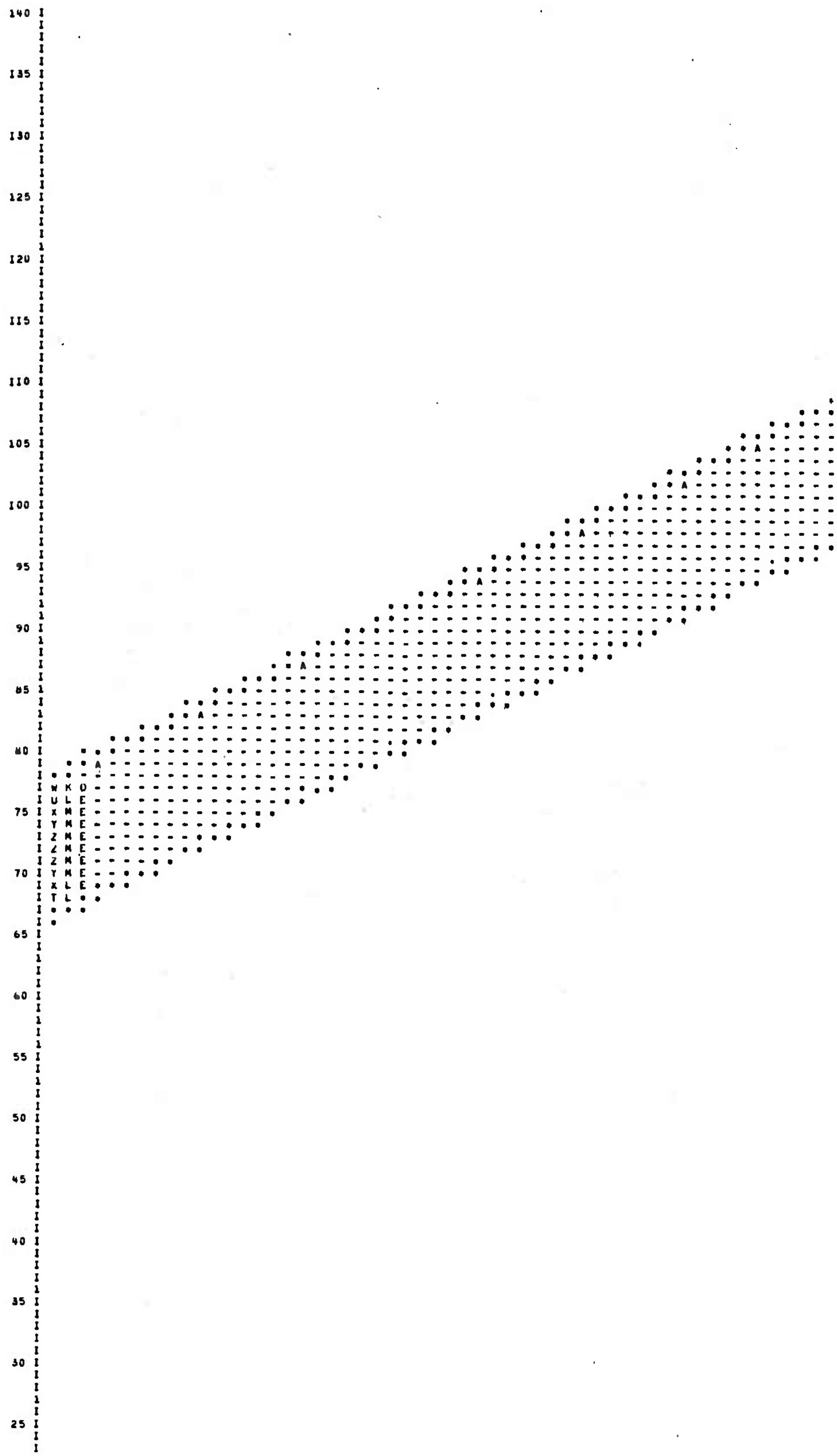
CDT  1  77  T=2.2681259E-07  DT=3.4576213E-08  MAXCUV=1.1568647E+06  MAXUV=2.1769166E+05  UMIN=1.1568647E+01  PMIN=5.0000000E+06
HPHASE   ETH=   6.14056912E+12     ESUM=   6.14056912E+12     EMIX=   6.14056912E+12     RELERR=   2.69722556E-13
                                  EINTC=   5.41674446E+10    EINTM=   5.41674446E+10
                                  EKINC=   6.08640167E+12    EKINM=   6.08640167E+12
TPHASE   ETH=   6.14056854E+12     ESUM=   6.14056854E+12     EMIX=   6.14056854E+12     RELERR=   2.95168108E-13
                                  EINTC=   5.46968653E+10    EINTM=   5.46968653E+10
                                  EKINC=   6.08587168E+12    EKINM=   6.08587168E+12
CYCLE    13

CDT  1  77  T=2.6138880E-07  DT=3.3780114E-08  MAXCUV=1.1841286E+06  MAXUV=2.2002593E+05  UMIN=1.1841286E+01  PMIN=5.0000000E+06
HPHASE   ETH=   6.14056854E+12     ESUM=   6.14056854E+12     EMIX=   6.14056854E+12     RELERR=   2.69722582E-13
                                  EINTC=   5.89894390E+10    EINTM=   5.89894390E+10
                                  EKINC=   6.08157911E+12    EKINM=   6.08157911E+12
TPHASE   ETH=   6.14056822E+12     ESUM=   6.14056822E+12     EMIX=   6.14056822E+12     RELERR=   2.84989913E-13
                                  EINTC=   5.95355756E+10    EINTM=   5.95355756E+10
                                  EKINC=   6.08103264E+12    EKINM=   6.08103264E+12
CYCLE    14

CDT  1  77  T=2.9516891E-07  DT=3.3377336E-08  MAXCUV=1.1984180E+06  MAXUV=2.3677194E+05  UMIN=1.1984180E+01  PMIN=5.0000000E+06
```

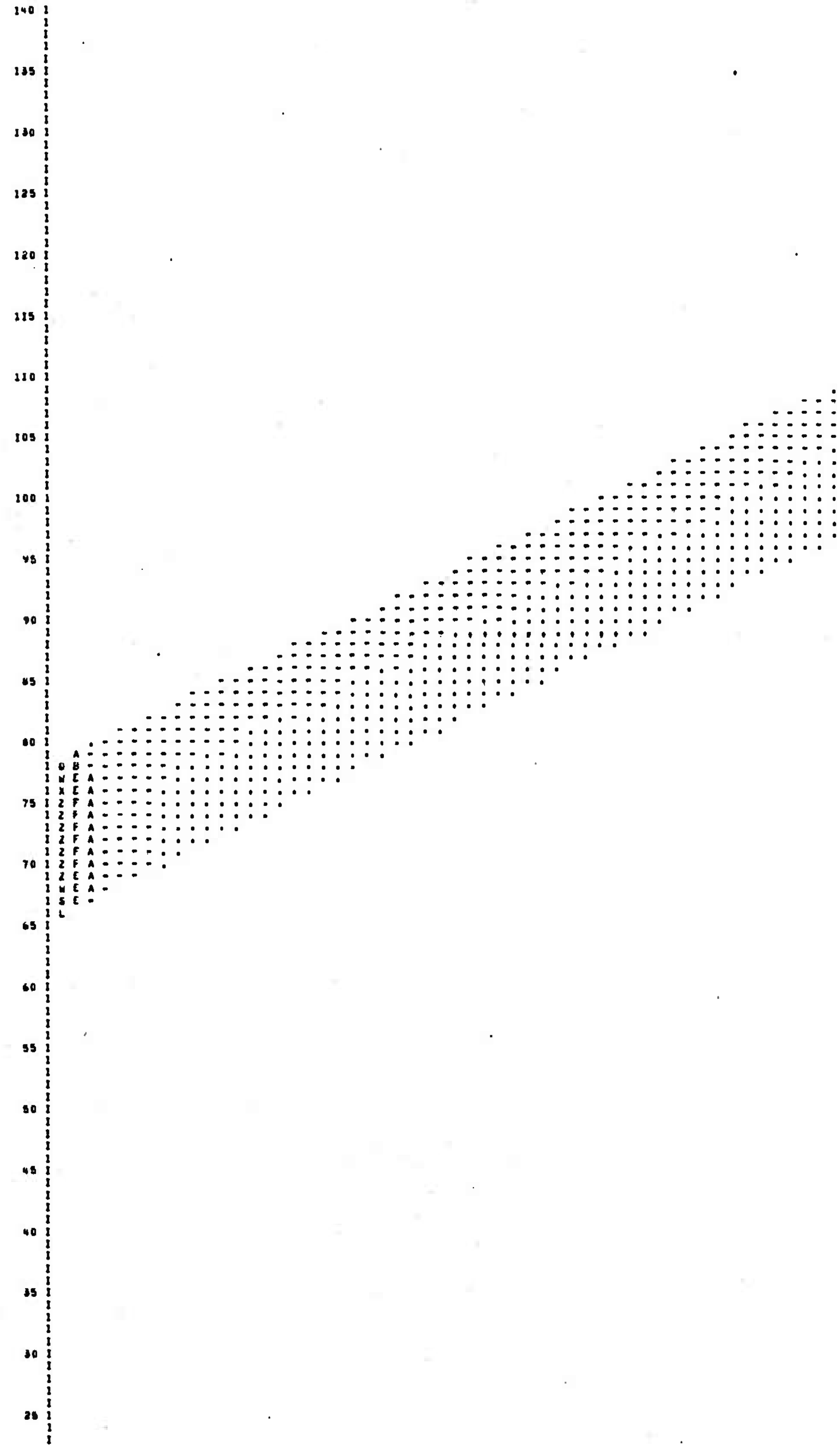
COMPRESSION CYCLE= 14.0 TIME=2.95169E-07 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	1.000	1.014	1.028	1.042	1.056	1.070	1.084	1.098	1.112	1.126
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.140	1.154	1.168	1.182	1.196	1.210	1.224	1.238	1.252	1.266
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.280	1.294	1.308	1.322	1.336	1.350	1.364	1.378		



SPECIFIC INTERNAL ENERGY CYCLE= 14.0 TIME=2.95169E-07 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.	1.48E+08	1.49E+08	2.99E+09	4.48E+09	5.97E+09	7.47E+09	8.96E+09	1.05E+10	1.19E+10
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.34E+10	1.49E+10	1.64E+10	1.79E+10	1.94E+10	2.09E+10	2.24E+10	2.39E+10	2.54E+10	2.69E+10
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	2.84E+10	2.99E+10	3.14E+10	3.29E+10	3.44E+10	3.58E+10	3.73E+10	3.88E+10		



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