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PEBBLE: A Two-Dimensional Steady-State Pebble-Bed-Reactor Thermal-Hydraulics Code

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PEBBLE: A TWO-DIMENSIONAL STEADY-STATE PEBBLE-BED-REACTOR THERMAL-HYDRAULICS CODE

D. R. Vondy

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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
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COMPUTER CODE ABSTRACT

1. Code. PEBBLE, ORNL Version 1 (1980).[1]

2. Problem. The two-dimensional (RZ) steady-state pebble bed reactor thermal hydraulics problem.

3. Method. A relatively straight forward accelerated iterative procedure is used to solve the coolant thermal hydraulics problem[2] cast in the stream function form as a mesh-edgepoint finite-difference representation.

4. Related Material. This code is used in the local modular code system[3] for reactor analysis providing interfacing with the VENTURE diffusion theory neutronics code and associated capability for calculating reactor histories.[4]

5. Restrictions. With variably dimensioned data arrays, problem size is only limited to available computer memory without provision for data transfer during iteration; typically the thermal hydraulics problem requires less computer time than the neutronics problem but requires as much if not more computer memory. This code is a member of a modular code system and cannot operate in a stand alone mode.

6. Computers. IBM 360, 370, 303X series.

7. Running Time. A 37 x 54 mesh point problem required 32K program and 105K data (double precision), 137K short word total, and required 0.81 minutes processor time, 2.6 minutes clock time on an IBM 3033 two-processor multi-tasking machine.

8. Programming Language. Fortran (some service tasks done in assembly language).

9. Operating System. IBM OS 303X under HASP II multitasking, compiler OS 370 Fortran H Extended (Enhanced), Version 1.3.0, Optimization Level 3.

10. Machine Requirements. Typically 7 disc files are used and 150K short words memory, but the memory requirement depends directly on the problem size (mesh points); the code system operates under a resident driver and managing control module. Codes do not read input data from the stream but only process interface data files admitting free ordering and loop structures.

11. Author. D. R. Vondy

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12. References.

1. D. R. Vondy, "PEBBLE: A Two-Dimensional Steady-State Pebble Bed Reactor Thermal Hydraulics Code," ORNL-5698 (this report).

2. K. R. Stroh, "Thermal-Hydraulic Analysis Techniques for Axisymmetric Pebble Bed Nuclear Reactor Cores," Dissertation, Mech. Eng. CSU (LANSL report in progress, 1978).

3. D. R. Vondy, et al., "A Computation System for Nuclear Reactor Core Analysis," DOE Report, ORNL-5158 (April 1977).

4. D. R. Vondy, T. B. Fowler, and G. W. Cunningham, "VENTURE: A Code Block for Solving Multigroup Neutronics Problems Applying the Finite-Difference Diffusion-Theory Approximation to Neutron Transport, Version 1," ORNL-5062,R1 (November 1977).

13. Material Available. The source program and this documenting report are to be placed in the DOE National Energy Software center with the other codes in this system for distribution. The code consists of about 6,000 source cards.

INTRODUCTION

A reactor core thermal hydraulics calculation is a key component of basic reactor analysis. It extends the assessment of power density peaking to assessment of temperature peaking, an essential enhancement for reliable analysis, for both comparative and absolute evaluation. Temperature feedback is a further increase in the level of sophistication that should increase the reliability of usual analysis and enhance the capability to examine reactivity effects important in stability and sensitivity effort.

The two-dimensional thermal hydraulic code PEBBLE was written originally as a Dissertation at Colorado State University by K. R. Stroh[1] of LANL. The effort came after that in Germany done to support development of the pebble bed reactor concept. The German effort at KFA by K. Petersen[2] has yet to be formally documented and the code in use there is not available. Additional effort under T. E. Mott by J. Jones and others at TEC[3] under ORNL contract was done to incorporate the PEBBLE code into our local computation system for reactor core analysis,[4] and to incorporate the capability to calculate pebble temperature distributions with account of the effect of the temperature and the neutron exposure history on the thermal conductivity.

The purpose of the effort reported here was to convert this program from an experimental one to a production tool that can be used routinely by the nuclear engineer having only casual interest in the details, and to document the contents and the use requirements. This report is the code documentation. The local version of the code is quite different from the version received and will not operate in a stand alone mode. It is now a module of the local computation system for reactor core analysis, obtaining data selectively from the interface files including instructions without acquiring data directly from the user input data file, and generating a file of temperature data for temperature feedback, and also saving results that can be recovered. Complete revision of the calculational procedures causes past experience with the code not to be applicable.

The primary sources of the programmed equations are referenced.[5-13] The basic formulation involves finite-difference representations of the stream function form of the fluid flow differential equation, the bulk fluid temperature equation, the pebble surface temperature equation, and the pressure equation. These coupled equations are solved by an iterative procecure.

From available information, namely results of calculations done at KFA, there appeared to be serious doubt that accurate results could be produced with a coarse grid of mesh points. There are two possible sources of major discrepancies: the fluid flow modeling and the power density information. The commitment was made in this effort to use the same geometric discription used by the neutronics code. Whereas one may typically use 5 radial zones and 12 axial zones in the core for exposure (60 locations of different nuclide concentrations, although many more would be possible), a typical mesh may be 30 radial by 40 axial within the core (1200 locations of different power densities). Since the top and bottom and radial reflector can be eliminated for the hydraulics calculation, it always involves fewer mesh points than the neutronics code and is not expected to cost any more to solve (being neither multi-group nor eigenvalue type, although the equations are somewhat more complicated.)

Thus the code obtains the geometric description from the same file used by the neutronics code. Fully compatible with this file is the file of point power densities when made available, and this file is used when available. For treating the general case of multiple pebble passes, a different power density file is required for calculating pebble temperatures. The table below summarizes the use of power density data:

			Priority for Use	
File Name	Where Written	Power Density Contents	Hydraulics	Pebble Temperatures
PWDINT	Neutronics	By Mesh point	1	2
ZNPOWD	Exposure[a] (Neutronics)	By Zone/Subzone (By Zone Only)	2	1

[a] The neutronics code does not have power density data available on the subzone subscale (a zone contains one or more subzones) and the exposure code knows nothing of the mesh but does place volume fraction data in the power density file.

The code uses the high energy neutron flux exposure data generated by the exposure code for determining the effect on thermal conductivity (and temperature dependence).

Instructions to the code are fully contained in a single record of 100 numbers and 100 integers in accordance with the computation system requirements, these instructions being easily supplied and subject to revision along the course of a calculation. The code can be accessed one or more times along a calculational path.

The code generates a pebble temperature file (by zone and the subzone subscale) for feedback.

The following basic enhancements were made in this effort:

1. The code was reprogrammed.

2. The difference equations were changed to enhance reliability.

3. The iterative solution process was thoroughly revised and acceleration procedures added.

4. Flexibility was added regarding the use of power density data - instead of requiring both the point power density data and the zone and optionally the subzone average power densities (granted to be desirable), both may be used, or either. (Basically the hydraulics is done using the point power density data and the pebble temperature calculations using averaged data on a different scale that admits treating multiple pebble passes.)

5. A separate one-dimensional calculation was made compatible.

6. Flexibility was added regarding the treatment of the dependence of thermal conductivity on the exposure, temperature history to either follow the pebble flow or to consider fixed fuel elements.

7. Considerable effort went into additions to make this a production code rather than a stand-alone research tool — for example, if at all possible a calculation is done (if not, a reason is given, and normal system termination should occur - not overflow, underflow, or blind exit),

and major user difficulties were eliminated. As an example, the code determines the core boundaries from the power density data without being told.

8. Certain technical enhancements were added such as extending the solution to the problem boundaries, improving the inner wall boundary condition for the annular core problem, providing improved problem initialization, and reporting supplemental results such as the power weighted pebble average temperature.

9. Some effort has been expended in making this code a true member of the modular computation system - it does not read input data but does properly interface with other modules, and carries out tasks in accordance with instructions.

10. Saving of results and subsequent recovery has enhanced the capability.

11. Override capability was implemented to allow much of the built-in data to be changed by a user if so desired.

12. Optional equations are incorporated to support application to the prismatic core with coolant flow through holes.

As received, the solution procedure closely followed the suggestions given in Ref. 5 from finite difference thermal hydraulic application experience of the early 1960s. It is noted that during much of this effort the "forward-difference" equation option (for only the bulk temperature, not the other primary variables) was retained. Eventually it was decided despite warnings regarding experience with non-convergence (programmed message and also in the above reference and in references in the latter), to drop this rather inferior form since it is not as accurate as the "central difference" method. Actually a somewhat modified form of central difference formulation is used. It does appear that recommendations from limited experience in the rather distant past have likely been followed in application efforts. Such blind trust of course may well expedite effort, and this is good. Every methods developer should not have to reinvent the wheel. The propagation of techniques that are based on assumptions and limited test results is, however, very unfortunate. Documentation of methods testing is poor.

IMPLEMENTATION NOTES

Where does the time go in such effort? Much of it goes into searching for a discrepancy or inconsistency on one of the 6,000 Fortran source cards, especially those caused by revisions. But then, given that remote access to the computer has been available only about 50 percent of the time (new computers and operating systems and poor operation), that system messages leave much to be desired for error tracing (OCO stop means information access was attempted outside of the available memory, or any of several other things), and that another's programming is alien (why did he decide to take this action at this point rather than other action elsewhere), the speed of the game is naturally slow.

The objective of this effort was to make available a reliable two-dimensional thermal hydraulics capability in the local reactor core analysis computation system. Of primary interest was the treatment of the graphite moderated core containing spherical fuel pebbles in some degree of random packing and cooled by helium gas having vertical flow. User input requirements were to be minimized to reduce errors; for example, the neutronics geometric description was to be used providing a mesh point layout avoiding the redundacy of a second description, and the code was to determine the boundaries of the active core to establish the extent of the gas flow. In this way a simple set of input data instructions would serve a wide variety of applications; survey calculations could be done at minimum user burden with a high reliability of problem description.

A significant impact on this effort came from the wide class of problems to be treated. Not only could there be more than one pebble type at any location (six for a simple model of the German THTR reactor with a reference fuel management scheme of pebble recycle, six passes without reprocessing), but the data available could take any of several forms. The intent was to use the neutronics point power density distribution and geometric description that goes with it for the heat source, but also allow zone-averaged data to be used if that is all that is made available.

The code is used in load module form unavailable to the user in source deck form thereby effecting high quality assurance in application. However, for routine use of such a code it is necessary to invest considerable effort to overcome minor difficulties that can cause an abort or ridiculous results (although this is of course always possible), to proof the coding, and to produce adequate information to support application including input error debugging. Perhaps even more effort may be required, however, for the code sponsor, guardian or cognizant and responsible engineer to gain confidence in the contents of an alien code to consider any reported results to have a high level of quality assurance, especially results produced by the casual code system user. Since originators of thermal hydraulics codes often build in data that can not be changed in serious application, revisions are necessary to allow extensive data substitution for effective use on a production basis without the involvement of the originator or coding changes.

This code presented a number of headaches. Storage requirements for containing realistic problems in memory are severe, especially in double precision, requiring compaction of the data storage and multiple use (double allocation). The use of many subroutines to perform trivial functions is not efficient; the original 49 routines were reduced to 21. The thermal hydraulics iterative calculation was a morass of redundant operations that invited thorough revision, yet this had to be done in pieces to avoid total disruption. Common practice in such engineering fields as thermal hydraulics is the incorporation of data in a program wherever needed. Throwing two programs together resulted in two sets of thermal hydraulics data that was worse than merely redundant, they were in disagreement. There were many trivial matters. For example, the edit routines could not handle more than 30 radial mesh points.

What can one say about modification effort on a computer code that leaves a product that requires the inlet pressure to be given in atmospheres and reports the calculated pressure drop in mpa? Incomplete at best.

One always wonders if it pays to revise an alien code or start over from scratch. It is difficult to say and depends somewhat on the situation. The author could not have produced the final product with the amount of effort expended starting from scratch. The likelihood of a discrepancy in the coding would have been higher starting from scratch, although there is some possibility of a defect in this product, hopefully a lower probability the more important the aspect.

The possibilities for a multiplicity of pebble type had a severe impact on this code even without allowing variation in the pebble diameter (which may eventually be needed). One hopes that a procedure can be implemented that calculates a local void fraction consistent with the value used in the neutronics. However, since in the neutronics only the smeared nuclide density need be conserved, the specified volume fractions may range over several possibilities, some of which admit direct interpretation, while others can not be used at all. Therefore, selection must be made from among the possibilities. Selection must be made of a procedure to determine an effective value of the high energy flux exposure (fluence) for estimating the local pebble thermal conductivity when more than one pebble type is involved.

As received, the two-dimensional PEBBLE code and an original TEC[a] one-dimensional code had been paralleled and partially interfaced for service in the local computation system for reactor analysis. It was found by TEC that all of the terms containing the stream function to be calculated in the finite-difference form were not on the left-hand side of the equation. Recasting the equation reportedly cured the poor convergence characteristics (also reportly done by GA in their implementation of the original code), but the behavior of a sample non-trivial problem indicated further improvements were necessary.

As received, the code was a mixture of single precision (IBM half-precision) and double precision. This was due to an incomplete reprogramming of the code. Rather than return the code to single precision, the one-dimensional routines and the pebble temperature and edit routines were placed in single precision while the thermal hydraulics calculation was retained in double precision in the hope that additional acceleration procedures to be incorporated would indeed prove most effective with regular rather than IBM half precision. Of course, the penalty is double the data storage requirements. It was assumed that the problems of interest could be core contained and data transfer during iteration thereby avoided and indeed such capability was not programmed (although program and data overlay were done where practical) because local computer operation is now in the virtual memory mode.

The code as received employed an "equation solver" routine that was used four times to calculate the stream function, the bulk fluid temperature, the pebble surface temperature, and the fluid pressure

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[a] Technology for Energy Corporation, Knoxville, Tennessee.

iteratively in finite-difference form at each mesh point. This procedure appeared to be very inefficient causing low computer utilization. The reprogramming eliminates wasted effort and facilitates the use of a more effective iteration scheme with enhanced acceleration to reduce the number of iterations required to effect an acceptable level of convergence. The adoption of a documented procedure for solving equations in difference form can be very ineffective. In this case the form of the equations disguised their nature and inhibited the recasting of them into a more effective form — indeed inhibited the recognization that there was a better form.

One of the difficulties with modeling RZ geometry in finite-difference form is the large cross sectional area associated with the outer annulus. With 20 radial intervals evenly spaced, a mesh point at the maximum radius has associated with it $100\ [1-(19.5/20)^2] = 5$ percent of the coolant flow that is ignored by setting the axial flow rate to zero at the point. The original coding forced reflective boundary temperature conditions by equating the outer temperatures to the values along the first inner row at both zero radius and maximum radius. This was a rather coarse approximation effectively reducing the number of active points and compromising the results. It also prevented taking into account the flow of heat to the reflector, of considerable interest at low coolant flow rates, and low heat source conditions associated with an after-shutdown state, although such capability remains to be added.

We talk about "foot-dragger's disease" when an equation of the form

$$(a + b)x = cy + ez,$$

where x, y, and z are dependent variables, the others constants, is solved by the procedure

$$x^{n+1} = \frac{1}{a}\left[cy^{n}+ez^{n}-bx^{n}\right],$$

where n is iteration count, rather than by the scheme

$$x^{n+1} = \left(\frac{1}{a+b}\right)\left[cy^{n}+ez^{n}\right].$$

Stability and acceleration characteristics are quite different for the various forms. Generally, the latter is the best provided (a+b) is significant, either a or b might be negative. The dependence of x on y and z is now direct, that is, all of the variable to be calculated has been taken to left hand or solution side of the equation.

The number of arithmetic operations done each iterative sweep was reduced by perhaps a factor of four. The accessing of subroutines in the inner-most loop was eliminated by including the full expressions for each equation solved. This permitted extensive revisions to be made to the equations solved. Also, more of the expression for the steam function was moved from the right-hand side of the equation to the left, in addition to what had already been so moved at TEC. Further the bulk fluid and pebble surface temperatures were then obtained simultaneously rather than iterated separately. All of this leads to more effective iteration. Such improvement is essential for routine application for parameter studies of large (many mesh point) problems.

The original coding of this program seems to have been quite sound. Not effective, but sound. That is, no major discrepancies were found, only minor. The coupling into local interface data files and extended calculation of pebble temperatures was superficial at best; it may have satisfied requirements in a specific application, but often it would not. A code should not be placed into routine production use if it either lacks adequate flexibility in application or would not routinely return converged solutions from an iteration process.

Late in this effort it was decided to change the bulk fluid and related surface temperature difference equations from a basic central difference formulation to an upstream difference form for the flow component of the bulk fluid heat balance and consistent heat source. The other terms were left unchanged, which is a bit inconsistent. The result is better convergence characteristics (less underrelaxation required) but lower accuracy (higher finite-difference error). Quite noticeably different results were observed for a coarse mesh point arrangement with the two formulations, but the error has been noted to decrease as more mesh points are added. Most results displayed in this report were obtained prior to the change. (The original code contained an option on central difference/upstream difference, but this involved only the stream function differences, not the heat balance equations.) The central difference form is available on option.

USE INFORMATION

A large amount of data and many options on the calculational flow path are set at default values. Hopefully most of these values are suitable.

Still, the user must carefully check over the requirements and determine what is appropriate for his specific case.

Primary input data requirements are shown in Table 1. Information about the code including interface data file requirements is shown in Table 2. Special interface data files are documented by the coding where they are generated; see the writing of the data for recovery, file TDATAS, for example.

REMARKS ABOUT APPLICATION

The partial differential equation of flow through a bed of fueled pebbles is cast in the stream function form. A set of derived equations relate the dependent variables at neighboring discrete mesh points with finite difference approximations to the partial differential terms. Similarly, the fluid temperatures are approximated from a heat balance, the pebble surface temperatures from another heat balance, and another set of equations relates pressures. The solution is obtained by an iterative scheme.

A number of approximations to a real situation are inherent in the formulation. The reactor core is assumed to have isotropic properties and be packed uniformly with spherical pebbles in each discrete zone. There is no consideration of wall effects on fluid flow nor entrance or exit losses. The outer radial surface is assumed to be insulated in that there is no heat transmitted across this surface.

Table 1. Input Data Requirements

```
C
CR        PEBBLE THERMAL HYDRAULICS MODULE INSTRUCTIONS, FILE 'CONTRL'
C
CN     (THERMAL PEBBLE BED IN RZ OR Z GEOMETRY)
C
CN     DATE OF THESE USE INSTRUCTIONS, OCTOBER, 1980   --D VONDY, ORNL
C
CL     PBLINS, (XX(I[illegible],100), (IX(I),I=1,100)
C
CW        101*MULT + 100
C
CD     PBLINS   PEBBLE THERMAL HYDRAULICS DATA IDENTIFIER (6HPBLINS)
C
CN*       A * IS PLACED IN COLUMN 3 TO INDICATE THAT THAT DATA MUST
CN*       NORMALLY BE SUPPLIED -- NEED NOTES AND CHECK OLD DECKS
CNX       FLAG TO INDICATE THAT DATA IS USUALLY REQUIRED FOR FLOW THRU
CNX       HOLES IN A SOLID MATRIX
CD
CD     XX(1)     VOID FRACTION IF TO BE CONSTANT
CD               (DEFAULT VALUE 0.39 LACKING OTHER DATA - THE ZONE
CD               FRACTIONS MAY BE USED AS SOLID FRACTIONS IF .02 <X< .98)
CDX             SPECIAL CONSIDERATIONS WITH FLOW THROUGH HOLES
CD*    XX(2)     INLET TEMPERATURE OF COOLANT, DEG C (DEFAULT 350.35)
CD*    XX(3)     INLET PRESSURE OF COOLANT, ATM (DEFAULT 40)
CD     XX(4)     COOLANT MASS FLOW RATE FOR REACTOR, KG/SEC,
CD               NORMALLY CALCULATED GIVEN INLET AND OUTLET TEMPS
CD*    XX(5)     PEBBLE DIAMETER OR COOLANT HOLE DIAMETER, CM
CDN              THIS IS THE COOLANT FLOW CHARACTERISTIC DIAMETER
CD     XX(6)     REFERENCE HIGH ENERGY NEUTRON FLUX FLUENCE, N/CM**2
CD               APPLIED ONLY IF IX(3) < 0
CD     XX(7)     RECOVERABLE ENERGY FRACTION (DEFAULT 1.0)
CD     XX(8)     REACTOR POWER LEVEL DESIRED, W-TH, USUALLY NOT SET
CDX    XX(9)     EFFECTIVE DIAMETER OF UNIT CELL ABOUT FUEL (INSIDE
CDX              A SHELL OF MATERIAL OUTSIDE, LOCATION OF COOLANT FLOW),CM
CDX              SET EQUAL TO XX(5) IF 0
CD*    XX(10)    RADIUS OF THE ZONE PEBBLE HEAT OR HEAVY METAL CORE
CD               (DEFAULT HALF OF PEBBLE DIAMETER - NO SHELL)
CD*    XX(11)    RADIUS OF THE SUBZONE PEBBLE HEAT OR HEAVY METAL CORE
CD               (DEFAULT HALF OF PEBBLE DIAMETER - NO SHELL)
CD     XX(12)    OUTLET TEMPERATURE OF COOLANT, DEG C (DEFAULT 850.35 IF
CD                  XX(4)=0)
CD               (NOT USED IF XX(4) IS NON-ZERO)
CD     XX(13)    FLUENCE MULTIPLIER ON DATA AVAILABLE (DEFAULT 1.0)
CD     XX(14)    RELATIVE PEBBLE GRAPHITE THERMAL CONDUCTIVITY, A
CD               MULTIPLIER ON BUILT IN DATA (DEFAULT 1.0)
CD     XX(15)    ITERATION CONVERGENCE CRITERIA, MAXIMUM RELATIVE ITERATE
CD               CHANGE FOR TERMINATION (DEFAULT 0.00005)
CN           THE OPTION ON BLOCKED FLOW AREA FOLLOWS, USE WITH CAUTION
CD     XX(16)    INSIDE RADIUS (MUST BE ZERO TO BE REALISTIC)
CD     XX(17)    OUTSIDE RADIUS OF BLOCKAGE, CM
CD     XX(18)    DISTANCE BLOCKAGE STARTS FROM COOLANT INLET, CM
CD     XX(19)    HEIGHT OF BLOCKAGE, CM
CD     XX(20)    SOLID BLOCKAGE FRACTION (DEFAULT 0.85 -- USE LARGE VALUES
CD                  WITH DISCRETION)
```

Table 1. (Continued)

```
CN        THE OPTION ON DEFINING CORE BOUNDARIES FOLLOWS
CN        WITHOUT DATA, THE NON-ZERO POWER DENSITY EXTREEMS DEFINE CORE
CD     XX(21)    INSIDE RADIUS (IF NON-ZERO WILL REQUIRE ADDING THE
CD               ANNULAR INTERNAL SOLID BOUNDARY PLANNED)
CD     XX(22)    OUTSIDE RADIUS OF CORE, CM
CD     XX(23)    DISTANCE FROM START OF GEOMETRY, TYPICALLY FROM TOP, CM
CD     XX(24)    HEIGHT OF CORE, CM
C
CN        ADDITIONAL OPTIONS AND OVERRIDE DATA VALUES FOLLOW
CD     XX(25)    LIMITING PROCESSOR TIME, SECONDS (DEFAULT 120)
C
CN     INITIAL ACCELERATION COEFFICIENTS ARE MADE PROBLEM DEPENDENT
CN     AND MAY BE ALTERED DURING THE PROBLEM SOLUTION IF DEEMED TO BE
CN     DESIRABLE BY THE AUTOMATED MONITORING PROCEDURES
C
CN     IT IS QUITE POSSIBLE THAT THE ROUGH ITERATIVE BEHAVIOR EARLY IN
CN     THE HISTORY WILL CAUSE INITIAL COEFFICIENTS TO BE DECREASED
CN     WHICH WOULD REQUIRE INPUT OF SOMEWHAT LARGER VALUES THAN THOSE
CN     EXPECTED TO BE OPTIMUM ASYMPTOTICALLY
C
CD     XX(26)    STREAM FUNCTION OVERRELAXATION COEFFICIENT
CD     XX(27)    BULK TEMPERATURE, DITTO, SEE FOLLOWING NOTE
CN       THIS COEFFICIENT MAY BE OF UTMOST IMPORTANCE, AND AN EFFECTIVE
CN       VALUE SHOULD BE SUPPLIED IF KNOWN (TEST PROVEN FOR AT LEAST A
CN       SIMILIAR PROBLEM).  TYPICALLY THE VALUE IS MUCH LESS THAN 1.
CD     XX(28)    SURFACE TEMPERATURE, DITTO
CN       IT IS DIFFICULT TO SEE HOW A VALUE OTHER THAN UNITY WOULD BE
CN       EFFECTIVE HERE
CD     XX(29)    PRESSURE, DITTO
CD     XX(30)    SPECIFIC HEAT VALUE (5193.)
C
CN        DATA FOR A SECOND AND THIRD CALCULATION FOLLOW (3 DATUM EACH)
CD     XX(31)    NEW INLET COOLANT TEMPERATURE, DEG C  (DEFAULT XX(2))
CD     XX(32)    NEW OUTLET COOLANT TEMPERATURE, DEG C  (DEFAULT XX(12))
CD     XX(33)    RELATIVE POWER LEVEL FOR SUBSEQUENT CALCULATION
CD     XX(34)    NEW INLET COOLANT TEMPERATURE, DEG C  (DEFAULT XX(31))
CD     XX(35)    NEW OUTLET COOLANT TEMPERATURE, DEG C  (DEFAULT XX(32))
CD     XX(36)    RELATIVE POWER LEVEL FOR THIRD CASE (DEFAULT (XX(33))
C                                  (RELATIVE TO THAT FOR THE SECOND CASE)
C
CD     XX(37)    MOLECULAR WEIGHT (4.0026)
CD     XX(38)    AZERO (0.0216)
CD     XX(39)    AGAS (0.49849)
CD     XX(40)    B  (0.)
CD     XX(41)    C (40.)
CD     XX(42)    RGAS (0.08206)
CD     XX(43)    BZERO (0.014)
CD     XX(44)    PCONA  (17.)
CD     XX(45)    PCONB  (20.5)
CD     XX(46)    PCONC  (-15.37)
CD     XX(47)    BETAK (0.95)
CD     XX(48)    GAMMAK (2./3. SPHERE, PI/4. CYLINDER)
```

Table 1. (Continued)

```
CD     XX(49)     FC (3.674E-07)
CD     XX(50)     FD (0.7)
CD     XX(51)     FE (0.71)
CD     XX(52)     FF (2.682E-03)
CD     XX(53)     FG (0.0011379)
CD     XX(54)     FH (1.4389E-4)
CD     XX(55)     AFRIC (4.1666)  HYDRAULIC EQUATION, FIRST COEFFICIENT
CDX                  NOT USED IF IX(13) > 0
CD     XX(56)     BFRIC (.1754)
CDX                                    (1.0  IF IX(13) > 0)
CD     XX(57)     P1 (2.2679E-07)
CD     XX(58)     P2 (3.)
CD     XX(59)     P3 (.1293)
CD     XX(60)     P4 (.3292)
CD     XX(61)     P5 (.277)
CD     XX(62)     P6 (.2426)
CD     XX(63)     P7  (.26)
CD     XX(64)     P8 (.476)
CD     XX(65)     P9 (.41)
CD     XX(66)     P10 (1.176E-04)
CD     XX(67)     P11  (311.)
CD     XX(68)     FOR ONE-DIMENSIONAL CALCULATIONS, RADIAL PEAKING FACTOR
CD                FOR AUXILIARY CALCULATION (DEFAULT 1.2)
CD     XX(69)     P13 (.005)
CD     XX(70)     P14 (2.)
C      XX(71) - XX(83)       REFERENCE THERMAL CONDUCTIVITY DATA
C                            USED IF XX(71) .NE. 0
CN     AT NO EXPOSURE, CORRESPONDING TO TEMPERATURES (K) --
CN 300. 350. 400. 500. 600. 700. 800. 900. 1000. 1100. 1200. 1300. 1600.
CN     REFERENCE POINT C(2) AT T = 350. IS 1.05 WATTS/CM-DEG DELTA T
CN        TO CONVERT GM-CAL TO WATT-SEC, MULTIPLY BY 4.186
CD     XX(84)     P15 (0.1905)
CD     XX(85)     P16  (2./3.)
CD     XX(86)     EOVR  (0.1*DP)
CD     XX(87)     EOVA  (0.5*DP)
CD     XX(88)-XX(100)  RESERVED
C
CD     IX(1)      OPTION ON COOLANT FLOW
CD               -1  NO GRAVITY TERM
CD                0- DOWNWARD FLOW
CD                1- UPWARD FLOW
C
CN     IT MAY BE USEFUL TO CONSIDER THAT AS THE PROBLEMS ARE DESCRIBED
CN     FOR THE NEUTRONICS, FLOW IS FROM THE TOP TO THE BOTTOM
CN     (LEFT TO RIGHT IF ONE DIMENSIONAL)
CN     AND THE COOLANT FLOW MUST BE IN THIS DIRECTION, REASONABLE IT
CN     SEEMS FOR DOWN FLOW OF COOLANT AND PEBBLES, BUT IF THE COOLANT IS
CN     TO FLOW UP AND THE PEBBLES DOWN, THEN THE PROBLEM MUST BE SET UP
CN     QUITE DIFFERENTLY (ZONE NUMBERS RUN UP INSTEAD OF DOWN)
C
CD     IX(2)      OPTION ON PRESSURE DROP AND FILM COEFFICIENT
CD                0- GERMAN
CD                1- US CORRELATIONS (OLD)
CD     IX(3)      OPTION ON FLUENCE, <0- DONT READ DATA (SEE XX(6))
CD                                   0,1- CPHIST FILE, CONTINUOUS FUELING
CN               NOTE THAT THIS FLAG MUST BE SET FOR FIXED FUEL EXPOSURE
CD                                   2- EXPOHT FILE. FIXED FUEL EXPOSURE
```

Table 1. (Continued)

```
CD    IX(4)    FLUENCE SELECTION, 0,1- USE FIRST RANGE IF AVAILABLE
CD                                  2- USE SECOND RANGE IF AVAILABLE
CD                                  3- USE TOTAL IF IT IS AVAILABLE
CN      IF DESIRED DATA IS NOT AVAILABLE, NO DATA IS USED
CD    IX(5)    MEMORY AVAILABLE FOR DATA IN 1000 WORDS
CD                 (DEFAULT  20000 ADDED TO RECORD 'DRVINS' CONTENT
CD                  WHICH IS THE NUMBER SUPPLIED TO THE CONTROL MODULE)
CD                  UNDER VIRTUAL MEMORY, ASSUME FULL CORE CONTAINED
CD                  AND ALLOCATE SPACE ACCORDINGLY
CD    IX(6)    THERMAL CONDUCTIVITY TREATMENT (FOR GROSS HEAT TRANSFER
CD             ACROSS CORE) , OPTIONS
CD            <0- NO SOLID PHASE HEAT TRANSFER
CD             0- USE ZONE EXPOSURE DATA AND SURFACE TEMPERATURE
CD             1- USE SUBZONE EXPOSURE DATA AND SURFACE TEMPERATURE
CD             2-  DITTO, BUT VOLUME FRACTION WEIGHT INSTEAD OF AVERAGE
CD             3- USE BUILT IN AXIAL FUNCTION
CD    IX(7)    DEBUG EDIT LEVEL (0,1,2,3)
CD    IX(8)    EDIT LEVEL OF RESULTS (-1,0,1,2)
CD                  EDIT LEVEL IS INDEXED UP IF RESULTS SEEM UNUSUAL
CD    IX(9)    HEAT REMOVAL OPTIONS
CD                 0- NORMAL
CD                 1- EXCLUDE SOLID CONDUCTION
CD    IX(10)   FUEL ELEMENT GEOMETRY (GRAPHITE, NOW USED ONLY FOR THE
CD               TEMPERATURE CALCULATION IN THE ELEMENT AND AT THE
CD               SURFACE, NOT FOR FLOW)
CD               0-   SPHERICAL
CDX              1- CYLINDRICAL (INFINITE LENGTH)
CD*   IX(11)   ITERATION COUNT TERMINATION (DEFAULT ESTIMATED BY CODE)
CD                 -NO ITERATION IF <0
CDX   IX(12)   OPTION TO ELIMINATE RADIAL (CROSS) FLOW
CD                 0- NORMAL (INCLUDE)
CD                 1- EXCLUDE
CD                 2- EXCLUDE, AND FIX THE AXIAL FLOW RATE PROPORTIONAL
CD                    TO THE AXIAL HEAT LOAD (IDEAL ORIFICING)
CD                 3- SAME AS 2 BUT ORIFICE AT INLET INSTEAD OF OUTLET
CN    NOTE THAT THE ABOVE NON-ZERO OPTIONS APPLY TO FIXED TRAVERSE
CN    COOLANT FLOW REQUIRING ADJUSTMENT IN THE DEFAULT COEFFICIENTS
CDX   IX(13)   OPTION FOR FLOW THROUGH HOLES IN SOLID IF > 0
CD             IF 0, THE UPWIND DIFFERENCE IS USED FOR THE BULK
CD             TEMPERATURE FLOW COMPONENT, CENTRAL DIFFERENCE IF <0.
CD    IX(14)   ITERATION PROCEDURE OPTION,
CD           -1- DO NOT INCREASE OVERRELAXATION COEFFICIENTS
CD            0- ADJUST OVERRELAXATION COEFFIBIENTS DURING ITERATION
CD            1- DO NOT INCREASE NOR DECREASE COEFFICIENTS
CD    IX(15)   EQUATION SWEEP ORDER,
CD            0- SIGMA-1 (ODD POINTS, THEN EVEN POINTS)
CD            1- NORMAL ORDERED (ONE POINT AFTER THE OTHER, Z THEN R)
CD    IX(16)   ASYMPTOTIC EXTRAPOLATION PROCEDURE OPTION,
CD                            0- NORMAL (ALLOW)
CD                            1- DO NOT ALLOW
CD                          >1- MINIMUM CYCLE DELAY
```

Table 1. (Continued)

```
CD     IX(17)   OPTION ON ASYMPTOTIC EXTRAPOLATION, DATA LEVEL
CD             0- STREAM FUNCTION, TEMPERATURES, PRESSURE
CD             1- STREAM FUNCTION, PRESSURE
CD             2- PRESSURE
CD     IX(18)  OPTION ON THE CALCULATION OF THE LOCAL VOID FRACTION
CD        (OVERRIDDEN BY XX(1), APPLICABLE ONLY WHEN THERE ARE SUBZONES)
CD             0- SUMS ZONE AND SUBZONE VOLUME FRACTIONS
CD             1- USES ONLY ZONE VOLUME FRACTION
CD             2- SUMS ONLY SUBZONE VOLUME FRACTIONS
CD     IX(19)   INITIALIZATION OPTIONS
CD            -1  ONLY FOR SUBSEQUENT CASE THE SOLUTION IS KEPT
CD             0- AUTOMATED PROCEDURE (AXIAL FLUID HEATING)
CD             1- SOMETHING DIFFERENT FOR HE WHO HAS TRIED EVERYTHING
CD     IX(20)   WRITE ZONE TEMPERATURE FILE 'ZNTEMP' OPTIONS
CD                   -1- NO
CD                  0,1- WRITE OVER EXISTING ONE IF ONE EXISTS
CD                       OTHERWISE WRITE NEW ONE
CD                    2- WRITE OVER NEXT TO LATEST VERSION IF IT EXISTS,
CD                       OTHERWISE WRITE NEW ONE
CD                    3- GENERATE NEW FILE
CD     IX(21)   SAVE DATA ON AN INTERFACE FILE FOR RECOVERY
CD                -1 SAVE DATA IF CONVERGENCE CRITERIA IS NOT SATISFIED
CD                 0 DO NOT SAVE DATA
CD                 1 SAVE THE THERMAL HYDRAULICS DATA FOR RECOVERY
CD                 2 ALSO SAVE THE PEBBLE THERMAL CONDUCTIVITY DATA
CN    DATA IS SAVED FOR ONLY THE FIRST PROBLEM SOLVED IN A CODE ACCESS
CD     IX(22)   RECOVER DATA FROM AN INTERFACE FILE TO CONTINUE ITERATION
CD                OR TO INITIALIZE WITH (PROBLEM MUST BE SIMILIAR)
CD                   1- RECOVER ALL DATA (NO REPLACEMENT)
CD                   2- DO NOT USE VOID FRACTION, POWER DENSITY, NOR
CD                      EXPOSURE DATA FROM FILE (USE NEW DATA)
CD     IX(23)   OPTION TO RECOVER THE PEBBLE THERMAL CONDUCTIVITY DATA
CD                 0- DO NOT
CD                 1- RECOVER AND USE THE IRRADIATION TEMPERATURE AND
CD                    NEUTRON FLUX EXPOSURE FUNCTION DATA
CD                    (THIS OPTION REQUIRED TO OBTAIN ONLY EFFECTS OF
CD                     SHORT TIME TEMPERATURE CHANGES)
CD                 2- RECOVER AND USE DIRECTLY THE THERMAL CONDUCTIVITY
CN      PEBBLE THERMAL DATA MAY BE SAVED OR RECOVERED, BUT NOT BOTH.
CN      DEFAULT PROCEDURES GIVE PREFERENCE TO DATA RECOVERY OVER SAVING
CN        (USED FIRST PROBLEM ONLY)
CD     IX(24)-IX(100)   RESERVED
C
```

Table 2. Information About the ORNL Version of the Pebble Program

```
C        INTERFACE DATA FILE USAGE
C
C         FILE              DATA USE
C         ----              ---- ---
C
C        GEODST   GEOMETRY DESCRIPTION, MESHPOINT AND ZONE LOCATIONS
C        PWDINT   POWER DENSITY DATA BY MESHPOINT
C        ZNPOWD   POWER DENSITY (FOR PEBBLE TEMPS), VOLUME FRACTIONS
C                      DEFAULT USE IF FILE PWDINT IS NOT AVAILABLE
C        CFHIST   NEUTRON FLUX EXPOSURE, CONTINUOUS FUELING, OR
C        EXPOMT   NEUTRON FLUX EXPOSURE, FIXED FUEL
C        TDATAS   SAVE THERMAL HYDRAULICS RESULTS FOR RECOVERY
CN           --ONLY A SINGLE VERSION IS PERMITTED TO EXIST
C        ZNTEMP   TEMPERATURE RESULTS FOR SUBSEQUENT USE IN OTHER CODES
C
CN         ONLY ONE VERSION OF THE FILE TDATAS IS ADMITTED, SO DATA CAN
CN         NOT BE SAVED AND USED SIMULTANEOUSLY FOR ONE PROBLEM.
CN         NOTE THE ORDER ABOVE OF THE WRITING OF THE LAST TWO FILES,
CN         AND THEREFORE NORMAL INCREASING UNIT NUMBERS
C
C     ROUTINE NAME       PRIMARY ROLE
C     ------- ----       ------- ----
C
C        MAIN     MAIN ROUTINE DOES SOME INITIAL CHECKING
C        INIL     FILE HEADER READING, CHECK INSTRUCTIONS, DATA
C        TIMER    LOCAL ACCESS OF COMPUTER TIME, ETC.
C        SEEK     DATA FIEL MANAGEMENT SERVICE ROUTINE
C        RITE     DATA TRANSFER SERVICE ROUTINE
C        REED     DATA READING PROCEDURE, ENTRY POINT IN RITE
C        GETCOR   MEMORY SPACE ACCESS FOR DATA ARRAYS
C        FRECOR   MEMORY SPACE RELEASE
C        STRT     LINE ROUTINE THAT CONVEYS DATA ARRAY SPACE
C        GTDA     ALLOCATION OF SPACE FOR DATA ARRAYS
C        GEOD     ACCESS DATA FROM GEOMETRY INTERFACE DATA FILE
C        PDRD     ACCESS OF DATA FROM INTERFACE FILES
C        PBST     SELECTS CALCULATION PATH, 1 OR 2 DIMENSIONAL
C                 USER OVERRIDE OF PRIMARY DEFAULT DATA VALUES
C        MPBL     DIRECTS THE 2 DIMENSIONAL CALCULATION
C        BLOC     DATA PROCESSING, HEAT SOURCE, VOID FRACTIONS, DELTAS
C        INIT     INITIALIZES THE 2 DIMENSIONAL PROBLEM
C        TRAC     SPECIAL EDIT FOR CHECKING DETAILS
C        PDEX     ITERATION DRIVER WITH ACCELERATION PROCEDURES
C        IDER     CALCULATIONS OVER THE MESHPOINTS, ITERATION
C        MPLU     PRODUCES AUXILIARY INFORMATION DURING ITERATION
C        POUT     THERMAL HYDRAULICS PRINTOUT, 2 DIMENSIONS
C        CLTE     PEBBLE TEMPERATURE CALCULATION, 2 DIMENSIONAL
C        TBAR     MANAGER ROUTINE TO CALCULATE PEBBLE TEMPERATURES
C        GRAC     ESTIMATION OF THE THERMAL CONDUCTIVITY
C        XOUT     WRITES THE TEMPERATURE INTERFACE DATA FILE
C        PBL1     FLUID FLOW FOR 1 DIMENSION
C        CALT     PEBBLE TEMPERATURE CALCULATION, 1 DIMENSION
C
```

Table 2. (Continued)

```
C      OVERLAY LEVEL       ROUTINES
C      ------- -----        --------
C
C            A              INIL
C            A              PBST
C            B              GTDA,GEOD,PDRD
C            B              MPDT,MPLU
C            C              BLOC,INIT,TRAC
C            C              PDEX
C            C              POUT,CLTE
C            B              PBL1,CALT
C
C            PROGRAM STORAGE REQUIREMENTS
C
C            USE                 SHORT WORDS
C            ---                 ----- -----
C
C        PROGRAM                  17,000  (33,000 WITHOUT OVERLAY)
C        SYSTEM ROUTINES           6,000
C        MINIMUM DATA ARRAYS      20,000
C                                 ------
C        TOTAL                    43,000
C
```

Normally the heat source is the power density data file generated by the VENTURE neutronics code in this computation system. Power density data for the calculation of pebble temperature distribution is produced by the exposure code BURNER. This code also generates the neutron flux exposure (Fluence) data required for the prediction of pebble thermal conductivities. Temperature data generated by the PEBBLE thermal hydraulics code may be used by the other codes to account for the dependence of nuclear microscopic cross sections (temperature feedback). A single geometry description and mesh point arrangement is used by the codes.

In a typical calculation, the steady state continuous fueling reactor core problem is solved by an iterative process that establishes the neutron flux distribution, the nuclide atom density distributions, and the required fuel feed rate to the reactor. This calculation is done in (RZ) geometry assuming azimuthal symmetry of the cylindrical core. The results are used by the thermal hydraulics code PEBBLE to establish the gas coolant flow distribution. The calculated temperatures are then available for assessment and feedback if desired. Subsequent calculations may then be done for such auxiliary results as predicting the effect on the neutron multiplication rate of a power level change (the power coefficient of reactivity).

With this system of codes, the neutron flux level in the reactor core is normalized such that the desired power level is obtained given the energy per fission and capture reactions. This desired power level may be given for a whole reactor while the problem treated is not for the whole core, so a fraction is specified. In one-dimensional axial traverse problems, the appropriate fraction is the reciprocal of the reactor cross sectional area. With (RZ) geometry the full reactor is represented, the integrals done for the ($2\pi r dr$) volume element (full θ). Often the energy data supplied to the neutronics problem represents ideal recovery, so a fractional recovery number is specified, usually smaller the smaller the core. The thermal power is increased above the desired value to allow for losses. When power densities are calculated, this loss is not included, so an integral of the power density data yields the reactor (actually problem) power before unrecoverable losses. Such a degree of freedom likely causes more confusion than it is worth, but then the recoverable fraction is usually quite large unless plant requirements are taken out for a small plant.

Given the file of point power density data, this data is used. If this data is not available, available zone, subzone average power density data will be distributed uniformly. Data availability is determined by the presence of the associated data file name in the interface data file tables. Note also that zone, subzone average power density data is used for the calculation of pebble temperatures. Lacking this data file, zone averages are calculated from the point power density file, but subzone data can not be produced nor void fractions extracted. Pebble temperatures are calculated for reference conditions, then for a ten percent reduction in thermal conductivity, and then for apparent near worst case conditions. In the latter, the peak power density data (if available) and the local peak surface temperature are used as calculated for the average power density.

Note that this is not the same thing as taking all worst conditions. Combining conditions that individually are the worst is probably more reasonable for heat removal assessment (although not grossly conservative as might be desired for safety analysis).

In calculating the pebble temperature distribution, a correlation is applied that approximates the effect of exposure to the neutron flux (fluence) at a reference temperature on the thermal conductivity. With pebbles moving through the reactor, there is a drastic change in the exposure temperature and an accumulation of fluence that reduces the conductivity. Further the conductivity at any time depends on the current temperature. This calculation accounts for variation across the pebble at the average zone conditions.

Perturbations present an analysis challenge. Let us assume that an effect of flow rate change is to be determined. If this change is to apply over the history, then a full recalculation must be done. If the perturbation to apply currently, then proper account must be taken of the effect on thermal conductivity and indeed data must be saved after the reference calculation for use in a subsequent calculation.

Consider that the effect on the core multiplication (reactivity) is to be determined for a power level change to support core control, stability analysis. A calculation would be done for reference conditions with temperature feedback accounted for in the core neutronics problem. Then the power level would be changed (at least enough to be significant), and likely the coolant flow rate also altered (as by retaining average core inlet and outlet coolant temperatures). The calculations would then be redone for the perturbed conditions with account for temperature feedback (but fixed pebble management and compositions). This calculation would be correct only if account were taken of the effect of the current temperature on the pebble thermal conductivity but not a change in the temperature, exposure history effect, requiring data storage and recovery.

Some perturbations are simple to make, but often the thermal hydraulics problem must be solved over again. It is quite generally cost effective in solving such problems and also those involving global iteration loops to save results and recover them for problem initialization.

The flow of gas coolant is in a fixed direction relative to the coordinate system, from top to bottom in the sense that the inlet is at I_1 and the outlet at I_2, $I_2 > I_1$. Since the neutonic/exposure model of pebble flow is by increasing zone number, the pebble and gas move in the same direction, down, if the mesh indexing increases for the increasing zone numbers along each path. To model upflow of the gas and downflow of the pebbles would require that the mesh indexing of the zones decrease, and, of course, special considerations about the inlet (bottom instead of top) and outlet (top instead of bottom) be accounted for in the neutronics problem description that includes the geometric arrangement and material assignments.

At any location there may be only one "zone" material representing a specific pebble type and composition and having an associated power density. A second type of pebble may be considered at the same location (in the sense of homogenization of randomly arranged pebbles) with the "subzone" material. Indeed a zone may contain one or none "zone" material pebbles and any number of "subzone" material pebbles. A typical model of the THTR reactor involves six subzone pebble materials at each location representing different exposure stages (six passes) but no zone material pebbles. Two types of pebbles may be involved, as when one is to be loaded with more fertile material and perhaps less fuel than the other, or when recycle and fresh fuel are to be kept separate for recycle and discard considerations. Typically one pebble would be modeled as zone material and the other as subzone material. It is quite unlikely that consistent calculations will be done for complicated situations unless much care is taken to study the requirements and to eliminate discrepancies. Volume fractions are involved and void fractions may be calculated from zone/subzone data (must be if they vary in space), so what may well be adequate for the neutronics calculation may not be adequate for the thermal hydraulics. Check the requirements. Proof the input data. Check the results.

Remarks are offered about major changes within the problem. It is the author's view that considering the equations applied in difference form, the effects of large variations will be but approximated and perhaps not very well. Small local mesh spacings are deemed undesirable at best. Large changes in the void fraction are apt to produce unrealistic results. The user should be aware of the nature of the formulation: first and second order derivatives are approximated directly. Accuracy depends to some extent on these derivatives changing slowly. A case inviting special concern is that of the programmed blockage calculation. Seldom will a ring of blockage about the reactor be of interest. This leaves only blockage at the centerline as being of significant interest. Full blockage would mean no fluid flow, no heat removal except by secondary mechanisms, and extreme temperaturs likely better calculated by more direct means. Do not expect accurate results by assigning blockage to a single mesh interval.

Given converged results, the only reliability checks available to the user regarding the representation of a specific situation with the programmed equations are reducing the mesh spacings and performing calculations for perturbed conditions. The informed user will have gained experience and confidence by solving a series of simple problems admitting interpretation of the results as being realistic or not.

Shown below are results for a reference case illustrating the effects on solution and on solving a few-zone problem of varying the number of mesh points:

Core Meshpoints (RxZ)	Pressure Drop (Atm)	Error in the Overall Heat Balance (Percent)	Temperatures (°C)					
			Peak Exit Coolant (850 mean)	Peak Pebble Surface		Fuel (Heavy Metal)		
				Local	Zone Average	Average	Zone Peak	Local Extreme
8 x 4	0.6895	-0.049	957.9	987.4	923.2	672.2	977.0	982.6
16 x 8	0.6918	-0.030	905.8	927.3	881.6	672.2	931.2	957.8
32 x 16	0.6939	0.002	932.9	951.1	858.4	672.2	906.3	970.7
64 x 32	0.6943	0.002	959.8	977.5	851.6	672.2	898.9	1008.2
128 x 64	0.6940	-0.054	970.5	978.8	848.0	672.1	896.2	1016.7
Extrapolate (∞)	0.694		974.	979.	847.	672.	894.	1020.

A better resolution of pebble temperatures would be obtained, of course, if the problem were subdivided into more zones. It should be noted that the power density data produced by the neutronics code depend on the mesh. The calculation is for a period of exposure at a uniform loading possibly representative of a start up state for a situation where there is considerable void fraction variation. The increasing peaking indicated with reduced meshspacing is a local effect near the reflector. With higher resolution comes a more accurate distribution of the power density. However, a large void fraction is associated with the edge of a bed of pebbles in the containment vessel. Likely higher flow occurs here and some mitigation of the peaking. Note the attempt to extrapolate the results to estimate the result free of finite-difference error. Additional information about the computer use is shown below:

			Neutronics Problem		Thermal Hydraulics Problem	
Core Mesh Points (RxZ)	IBM-3033 Memory (Short Words)	k_{eff}	Iterations (Inner times outer)	Computer Processor Time (min)	Iterations	Computer Processor Time (min)
8 x 4	4,000	1.0143	33	0.04	79	0.05
16 x 8	6,500	1.0157	88	0.11	44	0.08
32 x 16	22,900	1.0167	149	0.47	59	0.37
64 x 32	86,100	1.0170	302	2.92	122	2.79
128 x 64	334,000	1.0171	483	15.48	284	25.28

It is noted that the thermal hydraulics problem has roughly the same computation burden as the neutronics problem. The latter had a four group energy structure and the problems were solved in the space-stored mode (inner iteration done at each energy with data transferred once).

Information about the radial flow component is shown below:

Mesh Points (RZ)	Maximum Relative Coolant Flow Rate, Radial Component[a]	Axial/Radial Location (fraction of overall dimension)
8 x 4	+ 0.00747	0.500/0.625
16 x 8	+ 0.00425	0.500/0.500
32 x 16	- 0.00274	0.312/0.938
64 x 32	- 0.00325	0.281/0.938
128 x 64	+ 0.00461	0.500/0.562

[a] Relative to the coolant inlet mass flow rate.

A local peak of the radial component of the flow rate occurs at location (0.219/0.938) and has a value of -0.00329 from the finer mesh case. Thus the resolution of the radial flow component is poor with a coarse mesh. Further data presented below for clarification shows the values of the radial component of the flow rate at specific locations as dependent on the mesh:

Mesh Points (RZ)	Location, Axial/Radial 0.25/0.25	0.75/0.25	0.5/0.5	0.25/0.75	0.75/0.75
8 x 4	0.00227	0.00363	0.00741	0.00300	0.00488
16 x 8	0.00218	0.00199	0.00425	0.00209	0.00201
32 x 16	0.00131	0.00109	0.00200	0.00023	0.00043
64 x 32	0.00115	0.00095	0.00204	-0.00017	0.00020
128 x 64	0.00149	0.00202	0.00446	-0.00003	0.00088

These results leave one with serious doubt about the accuracy of any result when the radial flow rate makes a significant contribution. Apparently a very fine mesh point spacing is necessary to effect high resolution of the radial flow rate. There may be no serious difficulty when there is but modest variation in the properties such as void fraction and in the heat source, and especially when such changes occur only gradually. It is not clear that the stream function approach is adequate to properly account for radical changes and discontinuties.

Results obtained for a situation of flat radial power density distribution are shown below (coarse zone allocation, only two along each axial traverse):

	Peak Temperature (^{o}K)			Temperatures (^{o}K) at 5/6 from top		
Axial Intervals	Bulk Coolant	Pebble Surface	Fuel Center	Coolant	Surface	Pressure Drop (Atm)
6	1123.9	1137.8	1189.2	1090.6	1115.6	0.6635
12	1123.2	1130.7	1191.6	1089.6	1115.7	0.6551
24	1123.3	1128.6	1190.9	1089.8	1116.1	0.6573
36	1122.9	1128.9	1191.1	1089.9	1116.2	0.6554
48	1122.8	1128.9	1191.1	1089.9	1116.2	0.6551

Note that even the 12 interval results are relatively good, generally adequate for most any purpose. Integral results are quite simillar. For example an effective fuel temperature of 948.6 ^{o}K was obtained by weighting with the power density in each case (four significant figures). The calculated pressure drop shown for the 24 axial intervals just happens to be poorly converged due to less effective asymptotic extrapolation of the iterate pressure results in this case.

The dependence of the pressure drop on the equation coefficients is shown below over a range of Reynolds number:

R_e	Barthels (1972) $\frac{300}{R_e} + \frac{5.7i}{R_e 0.095}$	Achenbach (1980) $\frac{320}{R_e} + \frac{6}{R_e 0.1}$	Ergun (1952) $\frac{300}{R_e} + 1.75$
10	30+4.588=34.59	32+4.766=36.77	31.75
100	3+3.687=6.687	3.2+3.786=6.986	4.75
1,000	0.3+2.962=3.262	0.32+3.007=3.327	2.05
10,000	0.03+2.380=2.410	0.032+2.389=2.421	1.78
100,000	0.003+1.913=1.916	0.003+1.897=1.901	1.753

Thus the German data indicates a significantly higher pressure drop than the old Ergun correlation, the more recent Achenback correlation yielding slightly higher values than the Bartnel correlation, but not significantly different at the high R_e values of primary interest.

ON STORAGE, WORD LENGTH, AND DATA TRANSFER

As received, the code was written mostly in IBM double precision. The primary iteration calculation was left in double precision to enhance acceleration procedures, significantly better solutions not expected. Mixed precision is rather difficult to work with, especially when storage for data arrays is allocated as needed and overlapped as possible to reduce the total requirement, and usually compiled programs execute less efficiently than if all in double precision and of course slower than if all single precision. For a problem of size IxJ, storage involves

8(IxJ)	primary data arrays
3(IxJ)	arrays for extrapolation
12(IxJ)	secondary data arrays

The original code had 11 primary arrays and none for extrapolation; with all in double precision, the storage requirement was 46(IxJ) short words. Using IBM single precision for the secondary data arrays reduces this to 34(IxJ), a reduction of 26 percent.

A problem from routine core analysis effort had I*J = 38*55 = 2,090 mesh points requiring primary storage of 71,060 short words (actual total data storage 79,013 compared with the original requirement of over 100,000).

No data transfer from auxiliary storage is programmed within the iteration procedure, all required data and results are stored. With the recent change in operation of the local computers to virtual memory, such transfer is handled by the operating system when the data exceeds the memory size. Likely a representative problem can be contained, so data transfer is necessary only for the larger problems, and the amount of data to be transferred would usually be modest so that the virtual memory type of operation should be fairly efficient.

It became evident early in this effort that saving the iterative results in one computer run and recovering them later would be a needed capability. In the event that an adequate level of convergence is not achieved, saving and recovering the data later would avoid the complete loss of the initial investment in computer time. The programmed procedure with default values of the coefficients and choices between the alternatives could prove quite ineffective in a specific application. Of course such restart capability is likely of little utility if the attempt is being made to use the results in additional calculations, as for temperature feedback into the nuclear properties. On the other hand, if a series of similar problems are being solved such as in an iteration loop to completely resolve the temperature feedback problem, then starting with the results of a previous calculation may well be the most efficient procedure and significantly reduce computation costs.

Adding restart capability required about three days work plus one day validation and one day documentation, along with other effort over a two week period. Considerable thought went into the requirements over recent months, how it should be done and where. This time of implementation was minimized by a thorough understanding of what was needed and how this capability could be made available, intimate familiarity with the code and with the requirements for making data files satisfy the modular code system requirements. Only by a concentrated effort was an effective procedure implemented with relatively straight forward logic. Quite different procedures were required for the one- and two-dimensional routines, and recovery of the pebble thermal data presented quite a challenge. Saving data on a disc is of course trivial; the recovery within a data management system in a flexible and very useful way takes time and so does careful documentation.

About two months went into modifications for treating the prismatic core, flow through holes.

ACCELERATION OF THE ITERATIVE PROCESS

The attempt to accelerate the iterative process was quite frustrating and time consuming. Lacking an applicable theoretical treatment in any detail, error vector analysis, it is not possible to outline an effective procedure. Thus a straight forward formulation could not be given to a programmer for implementation nor even be implemented by this originator. It was not known how much of the original programming would have to be redone until well into the effort. Experimentation was necessary and the success of such was rather hampered by the attempt to rush the process causing extensive testing of procedures that should obviously have been identified as inferior or contained flaws.

No doubt a superior acceleration procedure can be found for a specific problem with account of its behavior under a preferred scheme of iteration.

The attempt, however, was to implement a procedure that showed good performance for a variety of problem types. Extensive and primary testing was done of course with small problems. Only limited experience could be gained with the larger problems to be expected in application due to the high computer cost. The test problem available from the originator contained 22 radial and 25 axial mesh points while the reference case, chosen as representative of application, contained 38 radial and 55 axial points, nearly four times as large. Special cases for testing included one with a uniform distribution of the power density radially, for which the core diameter was varied (to change the height to diameter ratio), the bare reactor core which has an extreme radial power density distribution, and an annular core with nearly a flat radial power distribution.

It is beyond the coverage of this document to present the full details of the iteration procedure available in a Fortran source program listing. At the time this report is being written, the procedures are yet being modified in detail and are subject to major changes should significant improvement be found possible. Involved are constraining the calculated changes in the variables, under/over relaxation to dampen or drive the iterate estimates, and adjustment of the coefficients in a attempt to move toward the optimum, and asymptotic extrapolation.

Each iteration new values of the four primary dependent variables are calculated from difference equations for the discrete mesh approximating the differential equations. These variables are the stream function, the fluid bulk temperature, the pebble surface temperature, and the coolant pressure: ψ, (T_b, T_s), P, where the temperatures are grouped to indicate a very close dependence. The equations are quite modified from the original form, for example the two equations for T_b and T_s take the form of two equations for two unknowns and hence are solved simultaneously if the coefficients have numerical significance. So we can consider T_s calculated from the latest estimate of T_b, and there being three primary variables ψ, T_b and P. It was found that given a reasonable approximation for the spacial variation in P, that ψ and T_b have little dependence on changes in P but do depend on each other. Specific aspects of the procedures for acceleration are now discussed. It should be noted that new values of the four primary variables are all obtained at each mesh point in a single sweep loop rather than as done separately over the mesh in the original code.

CONSTRAINTS

Since the axial and radial coolant flow rates are first derivatives of the stream function ψ, a large local change in ψ causes a severe perturbation in the flow rate locally. Various schemes were tried to dampen out such perturbations of most concern in the early iterative history. Good initialization, restraining changes in ψ, dampening calculations of the derivative, σ_1 sweep order discussed below, and restraining asymptotic extrapolation have all been used. Generally a limit of 10 percent increase or decrease in any new iterate estimate was imposed, and a limit of a 50 percent change in the coolant density (after the initial estimate is made) was imposed. A relatively accurate initial estimate is made of the coolant pressure and a reasonable approximation of the axial coolant flow rate with neglect of axial variation in the radial component.

EQUATION SOLVING AND SWEEP ORDER

Generally we expect the use of newly calculated values of the primary variables to accelerate the rate of convergence over use of old values. With a normal ordered sweep, one starts calculating at the first point and proceeds along the first row in order or aternatively along the first column, etc. The result of such a procedure is skewing of the error content into a corner. Also it is not clear whether the required derivatives should be estimated from the past iterate values or using the latest values. With acceleration, one finds that a front of discontinuity moves back across the problem that would appear to cause havoc with estimates of the derivatives. So we expect that flow rate estimates from derivatives of the stream function should be based on the previous iterate set of ψ values and that σ_1 ordering will generally be superior for rapid elimination of the error vectors that dominate in the early history.

. X
. X . X
X . X . X
. X . X
.X

Consider the sketch of a group of mesh points in a regular two-dimensional array. Alternate points are shown as X. With only nearest neighbor coupling a point marked • is surrounded by points marked X. With σ_1 sweep ordering, new iterate estimates of the primary variables are obtained at all points marked • in one sweep and then the same is done for all points marked X in a second sweep. Roughly half as many iterations are required by this procedure for full propogation of all boundary conditions as are necessary with normal sweeps (each mesh point senses even the most remote boundary). This leaves some question regarding the optimum estimation of derivatives. Flow rates are estimated using only the previous iterate set of ψ values, but otherwise latest values are used.

Given J radial and I axial points, propogation of the remote boundary occurs after I+J iterations with normal ordered sweeps and roughly half that with σ_1 ordering.[a] An acceptable level of convergence can be expected only after a few such propogating sweeps. Note the data below:

I+J	3(I+J)
4 (minimum)	12
40	120
400	1200

Thus we expect the number of iterations required to effect an acceptable level of convergence to increase as the number of mesh points increase.

UNDER/OVER RELAXATION

Given iterate estimates of a variable x at location i and iteration n, the equation applied is

$$x_i^n = x_i^{n-1} + \beta_n(x)\left[x_i^{n*} - x_i^{n-1}\right]$$

Where x_i^{n*} is the newly calculated value and $\beta_n(x)$ is the coefficient for this variable and this iteration. Note that $x_i^{n*} - x_i^{n-1}$ is the change in the value of the variable at a location for iteration n, and if $\beta > 1$, the change is increased as an acceleration while if $\beta < 1$, the change is decreased as a dampening technique.

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[a] Limited testing however did not indicate a general gain from σ_1 ordering over normal ordered sweeps along the flow direction.

Initial values of the coefficients are selected that reflect the expectation that the larger the problem the more difficult it will be to solve. Typical values are:

Variable		Value of β	
	$\sqrt{IJ}$	12	50
ψ		1.125	1.3489
T	Upwind difference	0.0932	0.4666
	Central difference	0.233	1.167
T		1.0	1.0
P		1.275	1.4989

Thus the largest coefficient is used for the pressure, next for the stream function, the surface temperature estimate is used as calculated, and dampening is done to the bulk temperature. Much stronger underrelaxation is done with central difference than with the upwind difference formulation. Modest changes are made in these coefficients (5 percent) if deemed desirable from the iterative behavior.

The primary measure of behavior is the maximum relative iterate change in a variable,

$$\varepsilon_n(x) = |\max| \left(\frac{x_n - x_{n-1}}{x_{n-1}} \right)$$

For a convergent process we expect

$$|\varepsilon_n(x)| < |\varepsilon_{n-1}(x)|,$$

but relax this and require

$$|\varepsilon_n(x)| < |\varepsilon_{n-m}(x)|,$$

where currently $m=3$ is used, but 2 and even 1 are often used, the situation depending on the stability or lack there of, and on the effectiveness of the initialization procedure. The coefficient is decreased if the above criterion is not satisfied indicating instability on a cycle of iteration count limiting changes to β. A special indication of overacceleration is judged to be continuing change in sign,

$$\epsilon_n(x)\ \epsilon_{n-1}(x) < 0 \quad .$$

One might expect that the core pressure drop would converge to a value. Use of the relative iterate change in the core pressure drop has not proven useful in judging the behavior; it may increase during a convergent process. (An overall heat balance has proven even less useful. With an axial flow rate balance forced it is not available as a variable locally across the core nor at the exit.)

The coefficients are increased if a dominant single error vector appears to establish as discussed below. If one is reduced, a maximum value is set (at half the sum of the old and new values) as an upper limit for subsequent increases replacing extreme upper limits set initially.

An attempt is made using maximum relative changes to identify which of the variables (and its coefficient) is driving non-convergent behavior. An automatic iteration count delay is used between iterations when the coefficients are changed. Also the coefficients are set smaller for the first few iterations in an attempt to stabilize the initial behavior.

ASYMPTOTIC EXTRAPOLATION

It is assumed that with continuing iteration a dominant error vector will become evident and can be removed, for iteration n, mesh point i and error vector contribution j,

$$x_i^n = x_i^\infty + \sum_j \lambda_j^n(x)\, A_{i,j}(x)$$

$$\simeq x_i^\infty + \lambda^n(x)\, A_i(x)$$

as n increases because $\lambda^n \to 0$ for $\lambda < 1$. Thus at each point we expect asymptotically from the recursion relationship

$$\lambda(x) \simeq \frac{x_i^n - x_i^{n-1}}{x_i^{n-1} - x_i^{n-2}} \quad ,$$

and

$$x_i^\infty = x_i^n + \left(\frac{\lambda(x)}{1-\lambda(x)}\right)\left(x_i^n - x_i^{n-1}\right) \quad .$$

If contamination (error in the iterate estimate) is from a single error vector, this can be extracted leaving a clean solution. Judgement must be made regarding whether or not such a state exists and an accurate estimate of the error vector eigenvalue λ is necessary. It may be noted that often the values of $A_{i,j}$ associated with the largest eigenvalue max λ_j are quite small so that it may surface only late in the iterative history, another surfacing early. Thus estimates of max λ_j tend to change from small to large. If max λ_j is 0.9, the iterative process is rapidly convergent, the error contribution decreasing by 0.9 each iteration. If it is 0.99, the process is slow. The number of iterations required to reduce the error contribution by a factor of Y is given by

$$\lambda^N = Y,$$

$$N = \frac{\ell n Y}{\ell n \lambda} \, .$$

Thus for Y of only 0.01, if $\lambda = 0.9$, $N = 44$, while if $\lambda = 0.99$, $N = 458$. Thus it is important to suppress error vectors having large eigenvalues. With effective single error mode extrapolation the error decay goes essentially as the next to largest error vector eigenvalue.

Note that for extrapolation as formulated the latest iterate change is multiplied by $\lambda/(1-\lambda)$, sensitive to $1-\lambda$ as λ approaches unity. Thus a reasonable test of convergence of iterate estimates of λ (and indication that a single error vector dominates) is

$$\left| \frac{\lambda^n(1-\lambda^{n-1})}{\lambda^{n-1}(1-\lambda^n)} \right| < \varepsilon_\lambda$$

where n refers to iteration (not an exponent).

The L_1 norm estimate is used,

$$\lambda^n(x) = \frac{\sum_i |x_i^n - x_i^{n-1}|}{\sum_i |x_i^{n-1} - x_i^{n-2}|} \quad .$$

Typically some dampening is applied,

$$\lambda_e^n(x) = \left[\lambda^n(x)\ \lambda^{n-1}(x)\right]^{1/2} \quad .$$

Expecting ψ and T_b to have a common behavior,

$$\lambda_e^n(\psi, T_b) = \left[\lambda^n(\psi)\ \lambda(T_b)\right]^{1/2} \quad ,$$

And this effective value is given preference (not for pressure).

Note that previous iterate values are required for the variables to be extrapolated. A number of simplifications and approximations may be made to avoid using extra storage. However, the final scheme in use requires storage for the previous iterate values of ψ, T_b and P. Initially T_s was not extrapolated, but finally the scheme used was

$$\Delta T = \left(\frac{\lambda}{1-\lambda}\right) \left(T_b^n - T_b^{n-1}\right) ,$$

$$T_b^\infty = T_b^n + \Delta T ,$$

$$T_s^\infty = T_s^n + \Delta T ,$$

apparently effective.

It should be noted that it is possible for a simple error vector to establish only if the same thing is done each iteration. The procedure must not be changed nor the coefficients. A delay time in iteration count is used after any change is made before allowing another extrapolation or adjusting the under/over relaxation coefficients. When the criteria for the presence of a single error vector are satisfied, the under/over relaxation coefficients for ψ, T_b, and P are increased individually if extrapolation is done for that variable. Thus the assumption has been made that if the problem is driven hard enough, a simple error vector will not exist, although this is not necessary for the procedure to be effective.

The extrapolation process is constrained. Knowing the maximum relative flux change, negative values of the variables can be avoided, and a simple upper bound is also used,

for $x = x^n + F_n (x^n - x^{n-1})$,

$$F_n = \min\left[\frac{\lambda_n}{1-\lambda_n}\ ,\ \frac{0.1}{\varepsilon_n}\ ,\ 500\right] .$$

The routine that contains the primary iteration in this code ranged around 10 pages of Fortran listing, over 500 statements plus comments. The local compiler handles this using the default memory size of 270K bytes (69,000 short words). Note that shorter routines could be more efficient with tight loop structures, but could not be viewed as desirable (might or might not make the logic easier to follow). It became a continuous chore as changes were made to tighten this routine to avoid exceeding the compiler capacity (limit in table storage). Actually such tightening was probably good, a desirable exercise that is often not done. It took only about six times for the rather obscure system error message to be printed out indicating capacity exceeded before the author learned to recognize it. Finally the routine was split into two.

CONVERGENCE LEVEL

The iterative process is assumed to be adequately converged if

$$\varepsilon_c = \max \mid \varepsilon_n(\psi),\ \varepsilon_n(T_b),\ \varepsilon_n(T_s),\ \varepsilon_n(P),\ 0.1\ \varepsilon_n(\Delta P) \mid$$

is less than the specified or default convergence criteria, where ΔP refers to the pressure drop across the core.

It may be noted that if there were a single error vector present, an absolute error estimate of any point variable would be available,

$$\varepsilon_{ab} = \varepsilon_n\left(\frac{\lambda_n}{1-\lambda_n}\right) ,$$

and such is reported as a convergence estimate. Unfortunately the nearer λ_n is to unity, the smaller ε_n needs to be to effect the same absolute error convergence level.

EQUATIONS

A loss of energy is associated with coolant flow through a packed bed causing a pressure drop. The variable cross sectional area is a dominating feature. The selected[1] differential equation for the steady state condition is

$$\nabla P = -G\theta + \rho g \quad , \qquad (1)$$

where the last term is due to gravity (vertical flow),

P is the pressure

G is the mass flow rate

ρ is the density,

g is the gravitational constant, and

$$\theta = \frac{2B}{\varepsilon^2 \rho D_h} \left[\frac{2A\mu\varepsilon}{BD_h} + \left(\frac{3.65\text{x}10^4}{R_e} \right)^{0.095} |G| \right] , \qquad (2)$$

where A and B are constants,

μ is the fluid dynamic viscosity,

ε is the void fraction,

D_h is the effective hydaulic diameter,

$$D_h = \frac{D_p}{3} \left(\frac{\varepsilon}{1-\varepsilon} \right) , \qquad (3)$$

where D_p is the pebble diameter.

It may be noted that the Reynolds number

$$R_n = \frac{DG}{\mu} , \quad (4)$$

or an effective value

$$R_e = \frac{DG}{\mu(1-\varepsilon)} , \quad (5)$$

is not simply involved (in the first term). The above formulation is used to correlate recent German pressure drop measurements. For the older US data, the term in Eq. (2) involving the R_e to a small power is dropped and a larger value of B is used causing the pressure drop to be estimated to be about 50 percent more than with the German correlation. Typically the value of θ depends primarily on the second term in the brackets of Eq. (2), the inertial term.

A test was made to see the effect of varying the value of the hydraulics equation coefficient A while coefficient B was assigned a fixed value of 0.1754 and the term involving the relative Reynold's Number raised to the 0.095 was included (revision from original code):

Value of A	Pressure Drop (Atm)	Peak Temperature (^{o}C) Outlet Coolant	Peak Temperature (^{o}C) Heavy Metal
4.1666	0.6597	1150.1	1121.1
24.5	0.6768	1153.9	1120.6

Thus the linear term (and the associated coefficient A) plays but a small role, although the effect of its variation on the coolant outlet temperature is larger than was expected and indicates the magnitude of one source of uncertainty.

The continuity of mass equation in (RZ) coordinates is

$$\frac{\partial}{\partial r}(r\ G_r) + \frac{r\partial}{\partial z}(S_z) = 0 \quad ,$$

where G_r is the radial component of the mass flow rate, and

G_z is the axial component;

$$|G| = [G_r^2 + G_z^2]^{1/2} \quad . \tag{6}$$

Consideration of the continuity equation leads to the stream function ψ, formulated as

$$G_r = -\frac{a}{r}\frac{\partial\psi}{\partial z} \, , \tag{7}$$

$$G_z = \frac{1}{r}\frac{\partial\psi}{\partial r} \, , \tag{8}$$

where a is the ratio of bed radius to height making the coordinate references relative.

In this application, the equations are to be applied to an upright cylinder with flow from the top or tho bottom. Operating on Eq. (1) with the divergence operator leads to the following pressure balance equation:

$$\frac{\partial^2 p}{\partial r^2} + \frac{1}{r}\frac{\partial p}{\partial r} + \frac{a^2\partial^2 p}{\partial z^2} + C_1\left\{aG_z\frac{\partial\theta}{\partial z} - G_r\frac{\partial\theta}{\partial r}\right\} - ag\frac{\partial\rho}{\partial z} = 0 \, , \tag{9}$$

where the sign of the last term depends on the flow direction.

The $\nabla\wedge$ operation on Eq. (1) eliminates the pressure term and yields a differential equation for the stream function,

$$a^2\left(\frac{\partial\theta}{\partial z}\frac{\partial\psi}{\partial z} + \theta\frac{\partial^2\psi}{\partial z^2}\right) + \left(\frac{\partial\theta}{\partial r} - \frac{\theta}{r}\right)\frac{\partial\psi}{\partial r} + \theta\frac{\partial^2\psi}{\partial r^2} = 0 \quad . \tag{10}$$

A heat balance on the fluid yields a equation involving the bulk fluid temperature,

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\ K_{br}\frac{\partial T_b}{\partial r}\right)+a^2\frac{\partial}{\partial z}\left(K_{bz}\frac{\partial T_b}{\partial z}\right)$$

$$+\ C_2\left[G_z\frac{\partial T_b}{\partial z}+G_r\frac{\partial T_b}{\partial r}\right]+C_3H\ (T_s-T_b)=0\ , \qquad (11)$$

where K_{br} is the effective radial bulk thermal conductivity coefficient,

K_{bz} is the same axially,

H is the bulk film coefficient,

T_b is the bulk fluid temperature, and

T_s is the pebble surface temperature,

and the film coefficient on the basis of volume rather than surface area is correlated through a Nusselt/Reynolds number correlation.

A heat balance on the solid phase (in a gross sense neglecting local temperatures that would affect the gross transport of heat in the solid phase) yields

$$a^2\frac{\partial}{\partial z}\left(K_e\frac{\partial T_s}{\partial z}\right)+\frac{\partial}{\partial r}\left(rK_e\frac{\partial T_s}{\partial r}\right)+C_3H(T_b-T_s)+C_4q=0, \qquad (12)$$

where K_e is the effective solid phase thermal conductivity and q is the heat source per unit volume.

These equations are cast in a somewhat different form than as programmed in the code as received. For example, use was made of the relationship

$$\frac{\partial}{\partial z}\left(A\,\frac{\partial B}{\partial z}\right) = \frac{\partial A}{\partial z}\frac{\partial B}{\partial z} + A\,\frac{\partial^2 B}{\partial z^2}$$

to recast the equations into what would appear to be a more accurate and effective form.

Equations (9-12) are four second order, non-linear equations coupled through the dependent variables. The primary dependent variables are the pressure P, the stream function ψ, the bulk fluid temperature T_b, and the pebble surface temperature T_s. The mass flow rate and its radial and axial components are given by the auxiliary Eqs. (6-8). Note that the stream function ψ appears explicitly only in Eq. (10), the equation used for its solution. Derivatives of the stream function divided by the radius are used directly for the axial and radial components of the mass flow rate.

Each of these four equations is recast in a finite-difference form which in turn is recast to yield an iterate estimate of the value of the variable at a mesh location based on current estimates of the values of the other variables and their derivates.

Somewhat involved difference equation forms are involved. It is assumed that usually adjacent mesh spacings will be similar. Otherwise reliable forms to estimate derivatives are not assured. Generally these equations reduce to simple forms with a grid of mesh points that tends to assign equal elemental areas to mesh points (equal $\Delta(r^2)$ intervals instead of Δr, equal axial intervals). For mesh location i axial and j radial,

$$\left.\frac{\partial x}{\partial z}\right|_{i,j} \simeq \frac{x_{i+1,j} - x_{i-1,j}}{z_{i+1} - z_{i-1}} \quad ,$$

$$\left.\frac{\partial^2 x}{\partial z^2}\right|_{i,j} \simeq \frac{\left(\frac{x_{i+1,j} - x_{i-j}}{z_{i+1} - z_i}\right) - \left(\frac{x_{i,j} - x_{i-1,j}}{z_i - z_{i-1}}\right)}{\frac{1}{2}(z_{i+1}+z_i) + \frac{1}{2}(z_i+z_{i-1})} .$$

And so on. Thus the iterate form for the iteration n estimate of variable x for a solution of the one-dimensional equation

$$\frac{\partial^2 x}{\partial z^2} + C\frac{\partial x}{\partial z} + S = 0$$

with uniform mesh spacing Δ would be

$$x_i^n = \frac{\Delta^2}{2}\left\{\left(x_{i+1}^n + x_{i-1}^{n-1}\right)\left(\frac{1}{\Delta^2} + \frac{C}{2\Delta}\right) + S^h\right\}$$

where superscripts refer to iterate estimates (not exponentials), and use of the latest iterate estimate is considered with a sweep along increasing index.

Certain global requirements are known. Thus incorporated into the procedures was the accounting to renormalize the axial mass flow rate at each row of points each iteration such that the radial integral equaled the total inlet. Similarly the values of the outlet pressure are set equal to the integral (rdr integral) average each iteration. Attempts to force a global heat balance proved unsuccessful (redundant constraints prevent convergence) so that the results contain an error due to the finite-difference representation.

It should be noted that the formulation ignores the effect on the flow distribution of the containing surface. Clearly the value of the radial component of the mass flow is zero at the values of r=0 and r=R,

$$\left.\frac{1}{r}\frac{\partial\psi}{\partial r}\right|_{r=R} = 0 ,$$

and also

$$\frac{1}{r}\frac{\partial\psi}{\partial r}\bigg|_{r=0} = 0 \text{ ,}$$

although the latter is a bit difficult to enforce directly. Evidently $\partial\psi/\partial r$ approaches zero more rapidly than r approaches zero. It is informative to examine the case of uniform conditions, G_z = constant, $G_r = 0$.

$$G_z = \frac{1}{r}\frac{\partial\psi}{\partial r}$$

$$\psi(r_2) = \int_{r_1}^{r_2} r'G_z\, dr' = \psi(r_1) + \frac{1}{2}\,(r_2^2-r_1^2)\;\bar{G}_z \tag{13}$$

Thus we expect $\psi(0)=0$ and where $r=R$, $\psi(1)=1/2$.

It is noted that the void fraction at the edge of the bed tends to be large due to the edge effect on packing. Thus the amount of flow near the outside of the bed may indeed be high and heat removal efficiency low (rather than the flow be low due to the effect of the surface of the containment). The effect may be appreciable due to the large area involved (the cross sectional area goes as rdr). Experimental measurements are of considerable importance, and indeed special surface conditioning may be desirable, for coolant and pebble flow. It could be found to be practical to pass smaller pebbles near the containment to prevent a high coolant flow rate here. These pebbles could be loaded heavily with fertile material to effect blanketing and also provide shielding of the radial reflector from high energy neutrons to reduce damage.

The point to be made here is that only limited information can be produced about flow conditions near the containment vessel with this code without further development.

Blockage calculations can be made, but only partial blockage and only about the location r=0 makes any sense within the model (an annular block about the core over a range of $r_1<r<r_2$ is not interesting, and the model is inadequate for treating the local flow condition of zero). For an accurate representation, central blocking must extend to at least the second radial mesh point because of the way derivatives are calculated.

The code was modified to admit solutions for the annular core. Unfortunately the stream function formulation may simply be inadequate. Setting the values of $\psi=0$ at r=0 and $\psi=0.5$ at r=1 is nice for the cylindrical problem, while enforcing derivative conditions was not found to be simple. For the annular problem, $\psi|_{r_1}$ is set equal to $(1/2)r_1^2$. Although this makes sense considering the limits as $r_1 \to 0$ and as $r_1 \to 1$, it is not clear that the results will generally be realistic, so more effort would be required to study the situation and to reformulate the problem if necessary to produce accurate solutions.

Key auxiliary equations are shown here. For the effective fluid conductivity,

$$K_{br} = K_g + C_r G C_p D_p, \text{ and}$$

$$K_{bz} = K_g + C_z G C_p D_p,$$

where the radial and axial coefficients are quite different (typically 0.1 radial, 0.5 axial).

The effective fluid heat transfer coefficient is approximated by

$$K_e = \varepsilon\left[K_g + \varepsilon h_{r\nu} D_p\right] + \frac{\varepsilon(1-\varepsilon)}{\frac{1}{K_s} + \frac{1}{\frac{K_g}{\phi} + D_p(h_p + h_{rs})}} \quad . \tag{16}$$

where K_s is the solid thermal conductivity with account taken of the temperature and exposure to the neutron flux,

$$\phi = \phi_2 + (\phi_1 - \phi_2)\left[\frac{\varepsilon - P_7}{P_8 - P_7}\right] \tag{17}$$

where

$$\phi_1 = P_5\left(\frac{K_s}{K_g}\right)^{P_6} \text{, and}$$

$$\phi_2 = P_3\left(\frac{K_s}{K_g}\right)^{P_4} \text{, but}$$

$$\text{if } \varepsilon < P_7,\ \phi = \phi_2 \quad ,$$

$$\text{if } \varepsilon > P_8,\ \phi = \phi_1$$

The equations used to account for radiation effects

$$h_{rs} = P_1\left(\frac{e_m}{2-e_m}\right) T_s^{\ P_2} \quad , \tag{18}$$

and

$$h_{r\nu} = \frac{P_1\ T_s^{\ P_2}}{\left[1 + \frac{\varepsilon(1-e_m)}{2e_m(1-\varepsilon)}\right]} \quad , \tag{19}$$

where naturally P_2 is defaulted to a value of 3, but these coefficients may be altered with input data;

$$\varepsilon_m = P_9 + P_{10}\,(T_s - P_{11}) \quad . \qquad (20)$$

The heat transfer coefficient for the film is approximated by

$$H = \frac{K_g}{D_p}\left\{P_{14} + \left(R_e^{\,0.5} + P_{13}\,R_e\right)\left(\frac{1-\varepsilon}{\varepsilon}\right)\right\} \quad , \qquad (21)$$

where

$$R_e = \frac{GD_p}{1-\varepsilon} \quad ;$$

for the German data, or for the US data

$$H = \frac{P_{15}\,K_f\,R_e^{\,P_{16}}}{\left[\dfrac{2D_p\varepsilon}{3(1-\varepsilon)}\right]} \qquad (22)$$

where

$$R_e = \left(\frac{2\sqrt{2}}{3}\right)\frac{GD_p}{(1-\varepsilon)} \quad .$$

The German correlation for the fluid thermal conductivity of the film

$$K_g = f_f(1. + f_g\,P)\;T_f^{\,(f_e - f_h P)}$$

where coefficients f are shown that may be altered with input data, and for the viscosity of the film,

$$\mu = f_c\,T_f^{\,f_d} \quad ,$$

where locally

$$T_f = \frac{1}{2}\,(T_b + T_s) \quad .$$

The fluid density is calculated from the equations

$$\rho = \frac{W_m}{V} \quad , \tag{23}$$

where

$$V_o = \frac{R_g\ T_b}{P} \quad ,$$

$$V_n = V_{n-1} + \Delta V_n \quad ;$$

$$\Delta V_n = \frac{\left(\{[(-PV_n + R_g T_b)\ V_n + \beta]\ V_n + \gamma\}\ V_n + \delta\right) V_n}{\{[(R_g T_b V_n + 2\beta)\ V_n + 3\gamma]\ V_n + 4\ \delta\}} \quad , \tag{24}$$

done recursively with termination at $\Delta V_n / V_n < 10^{-6}$, or $n = 20$ max, where

$$\beta = B_1 - A_0 - B_2 / T_b^2$$

$$\gamma = B_3\ T_b + B_4 - B_5 / T_b^2$$

$$\delta = B_6 / T_b^2$$

For the pebble temperature distribution,[3]

$$\alpha(T_r) = 1.055 - 0.00057 * T_r,\ \alpha \geq 0,$$

$$H(T) = [1. - 8.45 \times 10^{-8} T(420. + 1.65T)],$$

$$\beta(T_r) = 1.116 - 0.000269 T_r,\ \beta \geq 0,$$

$$F = 8.8\alpha(T_r)H(T)[1 - \exp\{\beta(T_r) \times 10^{-21} S\}],$$

$$R = \frac{1}{1. + F\ K(T)[C(T_r)\delta(T) + \{1. - C(T_r)\}A(T)]} \tag{25}$$

$$K_p(e,T) = R\ K(1);$$

$$K_p \geqslant 0.105 \text{ (0.1 times the second value in the string).}$$

$$z = K(T)/K_p(e,T),$$

$$G = \frac{(R-1.)}{8.8\alpha(T_r)H(T)K(T)[C(T_r)\delta(T) + \{1. - C(T_r)\}A(T)]},$$

$$S = \frac{-10^{21}\log_{10}(1.-G)}{\beta(T_r)} + \Delta s \qquad (26)$$

where additional exposure to the neutron flux is shown as being added directly to S (flux-time, n/cm^2), and K(T), A(T), δ(T) and C(T_r) are obtained by linear interpolation in data strings, T being the estimate for the local temperature and T_r being the irradiation temperature estimate.

The steady state heat transport (by conduction) is solved assuming a uniform source within the meat part of the pebble,

$$\frac{d}{dr}\left(r^2\ K\ \frac{dt}{dr}\right) = -Qr^2\ , \qquad (27)$$

where K is the thermal conductivity and Q the heat source per unit volume. The solutions are cast in a difference form of the differential equations and integrals are then done numerically, as to calculate the meat temperature.

Selecting data in use at the time this is written, for $T=T_r=1000$ K, S=0.7746, C=0.7, A=0.4354, and K=0.5905;

$$\alpha = 0.485$$

$$H = 0.400$$

$$\beta = 0.847$$

$$F = 3.521\ (1 - \exp\{-0.847\ S \times 10^{-21}\}),$$

$$R = \frac{1}{1. + 0.3973F} \text{ ,}$$

$$K_p = 0.62R$$

$$Q = \left(\frac{0.62}{K_p}\right)$$

$$G = 0.715\ (Q-1.)$$

$$S = -1.18 \times 10^{21} \log_{10} (1.-G) + \Delta S$$

and so the dependence on exposure in this case is as follows for a initial condition with initial exposure but no further accumulation (with annealing):

S_o	F_o	$K_{p,o}$	S_1	F_1	$K_{p,1}$
0	0	0.62	0	0	0.62
10^{20}	0.286	0.557	4.32×10^{19}	0.126	0.590
10^{21}	2.012	0.345	4.32×10^{20}	1.080	0.433
10^{22}	3.520	0.258	(fails*)		0.258
	3.521	0.258	(fails)		0.258

*Code action is to leave S unaltered so usually S increases and R takes on the value associated with $s \to \infty$.

Transport of energy within the pebble is of concern because of the associated temperatures and the dependence of these on the power density and the thermal conductivity that degrades with exposure to the neutron flux. Consider the rate of heat transport at the surface of the fueled portion of the pebble,

$$Q = q_f V_f = -KA_f \left.\frac{\partial T}{\partial r}\right|_{fs}$$

where the heat balace equates the total generation rate, source density times volume to the tansport rate which is proportional to the area and the temperature gradient at the surface, the coefficient being the thermal conductivity. Considering that the heat source within the fuel may be related to the average in space of the power density (more apt to be known),

$$q_f r_f^3 = \bar{q}\left(\frac{r_s^3}{f_v}\right)$$

where r_s is the pebble outside radius and f_v is the fill fraction of pebbles (one minus the void fraction),

$$\left.\frac{\partial T}{\partial r}\right|_{fs} = -\frac{\bar{q}r_f}{3f_vK}\left(\frac{r_s}{r_f}\right)^3 \text{ , sphere}$$

$$= -\frac{\bar{q}r_f}{2f_vK}\left(\frac{r_s}{r_f}\right)^2 \text{ , long cylinder.}$$

Thus for a power density of 5.5 watts/cm^3, spherical pebble r_s=3 cm, r_f=2.5 cm, f_v=0.61, and a thermal conductivity of 0.072 cal/cm-°C-sec, 0.301 watt/cm-°C, T/ r = -43.1 °C/cm. Since this gradient is inversely proportional to the thermal conductivity, reducing it in this case to 2/3 the value increases $\partial T/\partial r$ in magnitude to -64.7.

NO CROSS FLOW, FLOW THROUGH HOLES

There is provision in the code to solve a problem on option without radial cross flow. Note that this solution generally places an upper bound on the temperatures because the effect of cross flow is to reduce the temperature peaking of the coolant.

Also, special equations have been programmed for flow of coolant through cylindrical holes in a solid matrix. As programmed, the option for eliminating cross flow must also be exercised, usually with the assumption of ideal orificing at the inlet or outlet. For flow through holes, the void fraction is used to determine how may holes there are per unit cross-sectional area, and the hydraulic diameter is that of the typical hole. For a collection of different sized holes, this diameter would be an effective weighted value (the square of the flow rate is proportional to the hole diameter). The equations programed are:

Equation 2 becomes

$$\theta = \frac{Bf\,G}{g\rho\varepsilon^2 d_h} \tag{28}$$

where d_h is the hole diameter and B is set to 1.0 unless specified differently. Given,

$$R_e = \frac{d_h G}{\mu\varepsilon} \quad ,$$

the Fanning friction factor is obtained by iterative solution of the correlating equation

$$f = \max\left[\frac{16}{R_e}\ ,\ \left\{\frac{1}{4\log(R_e\sqrt{f})-0.4}\right\}^2\right] \tag{29}$$

and the film coefficient is obtained from the equation replacing Eq. 21,

$$H = P_{15}\left[R_e\right]^{P_{16}}\left(\frac{c_p\mu}{K}\right)^{P_{14}} \tag{30}$$

(except that the last term is set constant at 0.87 for one-dimensional problems). The surface for heat removal is given per unit volume by

$$\left(\frac{S}{V}\right) = \frac{4\varepsilon}{d_h} \quad . \tag{31}$$

Also the heat removal mechanisms available to the fluid phase are limited to only axial fluid flow.

In solving these equations for flow through holes it was found that the normal central difference equations for the bulk coolant temperature were so unstable that acceptable results could not be obtained. Upwind temperature difference and heat source were found to effect stability and produce adequate results.

REMARKS ABOUT THE PRINTED RESULTS

The input option on edit level determines the primary arrays that are printed. Generally the axial flow and the bulk fluid and surface temperatures are printed (unless surpressed), but not the radial flow nor the pressure. If the maximum radial flow rate seems high, then the array of radial flow is printed. Higher edit levels produce the array of power density, and the stream function and a flow parameter (θ) printouts.

Debug levels of edit produce elaborate printouts. Even during the iteration process, all calculated properties and thermal hydraulic results at two locations may be obtained. The data associated with coolant properties and heat transfer characteristics are edited on termination of the iteration process. The equation coefficients are printed and key information about the calculation of the local cell temperature distribution.

The normal edit includes the primary input control data (options), a line of edit for each iteration on the thermal hydraulic problem, the key results from the thermal hydraulics problem and also those from the local cell temperature distribution calculations including average and peak fuel temperatures. A summary table for the thermal hydraulics problem shows primary results including peak and mean coolant outlet temperatures, pressure drop data, and flow balance and heat balance information. (Incorporating an axial flow balance in the equations solved eliminated any discrepancy in the flow balance as examined.) Special calculations are made to approximate the axial pressure drop at R/3 and 2R/3 locations as a reliability check. In the event that the option to prevent radial "cross" flow is exercised, then the "apparent extreme pressure drop" is of special interest, and indeed the only meaningful pressure drop data when orificing at the inlet or outlet are opted.

Information is printed each iteration. Following the iteration number are the maximum relative changes in the point values of the stream function, the bulk fluid temperature, the surface temperature, and the pressure. Then the value of the overrelaxation coefficient in current use for the stream function is printed followed by the pressure drop at one core traverse in atmospheres, and then the relative fractional error in the overall heat balance (indicating the accuracy of the integral of the outlet coolant flow rate times its temperature). Then five values of dominant iterate error vector eigenvalues are printed, primarily L_1 norm estimates, but the concerned reader is referred to the program source listing for the current procedure.

ON RELIABILITY OF APPARENT SOLUTIONS

It was found that a much tighter convergence level must be satisfied than recent investigators have indicated if the absolute error in local values is to be reduced adequately to admit the claim of reliability. The difficulty lies in uncertainty about the absolute error and possible large error that may be associated with a false mode of flow or temperature distribution. It was found to be essential to start with a reasonable initialization of problem to produce reliable results within a reasonable investment in computation time. The equations that are solved are nonlinear. In some cases they may be nearly linear while in others there are highly nonlinear effects as for strong temperature dependence in heat removal properties. A scheme that works well in one situation may fail in another. The key aspects of reliability are addressed below.

Expect reasonable results. For example, the radial flow distribution should form a reasonable pattern, not one sign change after another along a coordinate.

<u>Uniqueness</u>. Uniqueness of a solution can not be assured, especially with strong nonlinearity contributions. Under the conditions of reasonable power level and coolant flow rate, a unique solution seems to exist. Uniqueness has been tested by both starting a problem from more than one initial condition and effecting tight convergence of the iterative process. Such testing is highly recommended in the event of any doubt about the apparent solution.

Fluid Flow Regime and Stability. At low coolant flow rates, the coolant temperature increases along a path of high heat deposition reducing the flow rate. In three-dimensions there would be local recirculation not realistically in two dimensions. The point where recirculation occurs has not been simple to identify for a particular situation. In some cases instability seems to occur well below 10 percent design power level and coolant flow, while in others well above 10 percent. Evidently the larger the heat source variation over a core and the greater the effect of temperature rise on the flow, the higher the flow rate at which undesirable recirculation could occur. Similarly for reference power generation conditions, the more uniform the flow and the lower its sensitivity to local conditions, the less likelihood of two or more possible flow regimes for a set of conditions.

On Limitations. With the stream function approach, the flow rate, radial or axial, is the derivative of the stream function which is solved as a continuous function. Evidently radical changes in the flow rate are not admitted, certainly not discontinuities. It would make little, if any sense to try to represent a blocked region that did not extend to zero radius (an azimuthal ring). Indeed, only coarse information may be produced about blocking at the center-line.

Definitive information about a low power level and low flow rates may not be produced. Expect eddies to develop as the flow rate decreases that are three-dimensional in nature. So below some low flow rate for a low heat source, a stable two-dimensional solution should not be expected but this may or may not represent requirements for after cooling. Caution is in order.

Convergence. One troubling aspect of converging the iterative process is the nature of the function being solved. The flow rate is the derivative of the stream function. To converge the iterate solution of the flow rate means converging this derivative. It can be argued that a convergence test should be performed on the derivative. Since none is, a tighter convergence of the local values of the function may be necessary than might be expected. We assume that when the iterative process is convergent as indicated by successive values of the function being nearly the same, the derivative of the function as approximated by differences at neighboring points is also converging. This may not be true when large changes occur from iteration. Note that an iterate change of 0.2 percent of 1000° is 2°, and if the error eigenvalue is 0.9, we expect the absolute error to be $2(0.9)/(1.-0.9)=18^{\circ}$, probably significant.

The analyst should become familiar with convergence level requirements for reliable solutions to the class of problems he is solving for the specific solution method applied.

Numerical Instability. At some risk in compromising solution capability, the upstream finite-difference equations were discarded in favor of recast central difference equations, generally more accurate but often less stable. Overrelaxation is used to accelerate the rate of convergence and underrelaxation to effect stability where needed. Decrease the coefficients if necessary.

It is not unusual to find a problem that oscillates. Temperatures at adjacent points may take on values that indicate they have exchanged locations. If the process is convergent, then fine. The more rapid the rate of convergence, the stronger the dampening, the better.

It should be recognized that strong underrelaxation, as found to be necessary in calculating the bulk coolant and the pebble surface temperatures, is done only with some concern. If new iterate values that are obtained as solutions to the flow and heat balance equations before altering are not better than the old values, then the confidence with which one accepts the iterate solution as being adequately converged must be low. Reliable results may or may not be produced. The analyst should take extreme care in terminating the iterative process and accepting results.

Finite-Difference Error. There is a finite-difference error, but given a reasonable arrangement of mesh points (40x40, not 20x20), and no large, sharp discontinuities, as in properties or void fraction or the heat source, the results should be adequate. Use more mesh points in the neighborhood of large changes or derivatives.

A troublesome discrepancy has not gone away: there may be appreciable error in the overall heat balance. Why in some situations the average coolant exit temprature is off by a fraction of a percent or more is not known. This discrepancy is deemed to have but low importance. Recognize it as a distortion that can't be removed. A uniform axial mesh point spacing has produced the smallest discrepancy in testing.[a]

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[a] Fluid and surface temperatures are arbitrarily adjusted on termination to eliminate the overall heat balance error.

If there is concern that the finite-difference error may be serious in a specific situation, a second solution should be obtained, preferably with many more mesh points reducing the spacing.

Modeling Inaccuracy. Every situation will not be modeled accurately with this code. For example, the conditions near a containment surface will not be determined accurately: the flow equations are for a bed of pebbles (not random packed but rather the effective parameters of a bed are used), the edge effects of increased volu and surface effects are not considered nor power density peaking in the neighborhood of a moderator containment. So there should be reservation regarding accurate modeling, while one expects the modeling to be adequate for primary effects.

Coding Error. This code is qualified for routine application to a limited class of problems. Yet errors are possible, either mistakes in solving the equations as intended or in taking action not expected by the user. An unreasonable solution should not be accepted without testing.

SAMPLE PROBLEM

The sample problems are used to guide the user and serve as validation tools for implementation at other sites. Table 3 presents an input data listing for a selected problem and selected edit of the results. Note that information is generated for the thermal hydraulics code by other modules, and extensive testing is then done by multiple accesses of the thermal hydraulics code. Not only is the thermal hydraulic problem solved several ways but the data saving and selected recovery procedures are used.

Table 3. Sample Problem.

```
//[illegible],    JOB [redacted],'[illegible]',
// MSGLEVEL=(2,0)
/*ROUTE  XEQ   STANDBY
//*CLASS C#33=3130,IO=05,R=500
/*ROUTE PRINT LOCAL
// EXEC [illegible],GOSIZE=950K,O1=720C,O1=120,O2=300,O3=12,O4=300,O5=400,
// O6=12,O7=00,O8=90,O9=90,O10=253,O11=94,O12=40,O13=10,O14=10,O15=10,
// OE=24,O3=30,O16=12,O2=7200
//FT[illegible]  DD UNIT=3330-1,VOL=SER=[illegible],DISP=SHR,
//                DSN=E.[illegible]
// DD UNIT=3330-1,VOL=SER=[illegible],DISP=SHR,DSN=E.[illegible].SCALE.[illegible]
//             DD VOL=SER=[illegible],UNIT=3330-1,DISP=SHR,
//                DSN=E.[illegible]
//GO.PRINT     DD SYSOUT=(A,,1101)
//GO.FT06F001 DD SYSOUT=(A,,1101)
//GO.FT99F001 DD SYSOUT=(A,,1101)
//SYSIN DD *
*CONTROL1
  SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS
V40036                                        1                    1
  1  .  .  7 11 20  2 20  2 20  3

END
 INPUT PROCESSOR
0V EXPOSE / EXPOSURE DATA FOR PBI AND HTGR           04 3-5-80
1D    13020  42  3  1  3  4 19 14  3  6  6 0 C 1.9 C 3 0 0 0 0
2D  400 U-235, 238, TH BASIC [illegible] EXPOSURE DATA FOR [illegible]
  12A  00 3-5-03
          43TH-232PA-233 U-233 U-234 U-235 U-236 U-238NP-239PU-239PU-240
          43PU-241PU-242AM-243 I-135XE-135PM-147PM-148PM148MPM-149SM-149
          18ERD-143   FP1   FP2
          43M RU-03 RH-0384-103RH-135AG-109XE-131XE-133CS-133CS-134CS-135
          54ND-145ND-153EU-154EU-155ED-147SM-150SM-151SM-152RP-237
3D  3.  1  3  5  7  9 11 14 15 19 21 22 23 24 25 26 27 28 29 30 34 35
      37 38 40 41  2  8 11 14 15 16 17 18 19 27 30 32 34 37 38 43 /
4D  2.93E-7  3.61-6  1.60-9 /
             2.87E-5  2.05E-5  8.29E-9  1.49E-6  1.98E-7  3.63E-6  /
  5.36E-5  1.52E-6  9.55E-9  1.37E-9  1.16E-8  7.23E-7  2.75E-10 /
5D    .0539    .0484    .0617  .0578  .0693  .0626 /
      .0021    .0134    .0024  .0022  .0027  .0024 /
      .00945   .0077    .0113   .021  .013  .012  /
      .08      .0591    .0603   .048  .046  .056  /
  .301  .309  .298  .273  .324  .324 /
  1.137  1.119  1.24  1.424  1.456  1.456 /
 .01  .0069  .0028  .0005  .0017  .0007 /
  .0159 .0114  .00544  .0009  .0529  .001 /
  .0016  .016  .03  .062  .054  .362 /
  .0005  .005  .009  .037  .055  .058 /
  .00055  .0004  .0003  .303  .0155  .031 /
  .017  .0341  .0293  .023  .038  .034  /
  .037  .0508  .0655  .352  .069  .06 /
  .066  .0338  .0398  .039  .031  .036 /
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  .00009  .0003  .00033  .0013  .0016  .001 /
  .0382  .0193  .0236  .028  .0205  .022 /
  .002  .0035  .0044  .009  .008  .005 /
  .00085  .0022  .30281  .006  .006  .033 /
6D  1  +2  2  +1  3  +2  4  +2  5  +2  6  +2 42 0 /
  1  +2  2  +2  -4  +2  -5  +2  -6  +2  -42  0  /
  7  +2  8  +1  9  +2  10  +2  11  +2  12  +2  13  0   /
  7  +2  8  +2 -10  +2 -11  +2 -12  +2 -13  0  /
 7 +5  -42  0 /
  14  +1  15  +1  33  9 /
  38 +1  16  +530002  17  +2  19  +1  20  +2 39 +2 40 +2 41 0 /
  38 +1  16  +470002  18  +2 -19  +1 -20  +2 -39 +2 -40 +2 -41 0 /
  -41  +2  35  +2  34  +2  37  0 /
  24  +2  25  8 +26 -0  27  0  28  0  29  0 /
  21  8  22  +2  23  0  30 +1  31  +2  32  0  34  0  0 /
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     0    155     47      1
 2D  2.35209E-04 4.68984E-07 4.11660E-07 2.70103E-06 1.77687E-05
 8.32937E-07 9.80103E-10 2.72391E-11 5.55599E-13 1.48124E-06 9.99648E-09
 2.12524E-09 4.09436E-10 8.37960E-02 8.24666E-10 1.12207E-10 3.13179E-08
 3.26646E-10 2.60050E-10 1.43561E-09 8.23312E-10 1.15119E-07 6.03974E-07
 2.56124E-06 1.36200E-04 5.03070E-09 1.18009E-08 5.65700E-08 6.31900E-11
 6.30136E-10 5.67262E-08 1.45018E-08 1.13959E-07 2.18916E-09 1.22621E-08
 7.07086E-08 3.63935E-09 3.90193E-10 1.46111E-10 1.22590E-08 2.19826E-08
 2.95110E-09 1.09263E-08 5.14020E-04 0.0         1.80000E-09 6.20160E-09
 2.33021E-04 1.16252E-06 1.48742E-06 1.30646E-07 1.30624E-05 1.26370E-06
 2.22063E-09 4.53204E-10 2.28044E-11 1.44046E-06 2.32454E-08 7.99040E-09
 2.73640E-09 8.37960E-02 1.69019E-09 2.05609E-10 9.29149E-04 1.13194E-09
 8.13245E-10 3.42530E-09 1.69801E-09 3.32676E-07 1.04584E-06 7.04260E-06
 1.36200E-04 1.03098E-08 3.37210E-08 1.61137E-07 1.29000E-10 1.95800E-09
 1.66301E-07 3.39349E-08 3.56971E-07 1.33920E-08 3.46713E-08 2.35081E-07
 1.27301E-08 2.16756E-09 4.10355E-10 2.54209E-08 7.53932E-08 6.02665E-09
 3.40178E-08 5.14020E-04 0.0         1.00000E-09 3.37150E-08 2.30475E-04
 1.46231E-06 2.70629E-06 3.47496E-07 8.97250E-06 1.94900E-06 2.40033E-09
 2.01030E-09 1.60799E-10 1.39801E-06 2.56579E-08 1.36501E-08 6.70031E-09
 8.37960E-02 1.65577E-09 1.69639E-10 1.39864E-07 1.90200E-09 1.23296E-09
 4.17029E-09 1.69844E-09 5.88040E-07 3.07501E-06 1.30924E-05 1.36200E-04
 3.22146E-08 5.65799E-08 2.39627E-07 1.24573E-10 3.31381E-09 2.61362E-07
 3.35640E-08 5.98999E-07 3.70347E-08 5.24959E-0  3.77623E-07 2.46703E-08
 5.66501E-09 7.47400E-10 2.52609E-08 1.40703E-07 6.25100E-09 5.57540E-08
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 3.62659E-06 6.01783E-07 5.99400E-06 2.41005E-06 2.33066E-09 4.75207E-09
 5.26426E-10 1.35179E-06 2.32950E-04 1.56020E-08 9.62330E-09 8.37960E-02
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Table 3. CONTINUED

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5.36200E-06	8.57987E-09	1.15987E-07	2.93177E-07	3.03039E-11	6.76772E-09
6.56109E-07	1.25127E-06	1.22963E-06	1.74694E-07	1.36961E-07	1.29130E-07
7.05176E-08	2.16319E-08	2.40762E-09	9.32526E-09	3.02967E-07	7.83571E-09
1.00000E-07	5.16320E-08	0.0	1.33333E-09	2.66755E-07	2.15602E-06
7.26700E-07	6.94110E-06	1.03576E-06	[illegible]	2.55610E-06	8.66161E-13
1.50765E-09	3.47068E-09	1.22561E-06	1.53184E-06	1.16757E-06	8.64717E-06
6.37634E-06	6.56665E-13	8.25009E-11	1.55096E-07	1.15395E-09	1.29128E-06
1.30467E-09	5.23461E-13	7.32133E-07	[illegible]	3.37903E-05	1.36233E-06
9.16671E-08	3.31116E-07	2.07615E-07	2.09961E-11	6.59810E-05	6.65399E-07
9.96207E-09	1.20360E-06	1.93324E-07	1.10559E-07	7.32308E-07	7.52939E-08
2.31361E-08	[illegible]	7.15598E-06	3.56360E-07	7.21563E-06	1.83367E-07
5.16020E-06	0.0	1.00000E-09	2.31291E-07	3.16599E-06	5.90155E-07
6.90073E-06	1.06570E-06	1.26730E-06	[illegible]	6.71567E-13	1.59565E-09
[illegible]	1.27325E-06	5.60370E-08	[illegible]	8.33637E-06	8.37663E-02
3.62073E-13	7.95337E-11	1.53462E-07	1.11622E-09	1.02595E-06	1.05761E-06
8.66356E-13	7.30692E-07	7.63375E-09	3.22552E-05	[illegible]	5.63190E-09
1.35000E-07	2.03779E-07	[illegible]	7.16650E-09	6.73372E-07	7.30333E-07
1.31983E-06	2.02170E-07	1.26774E-07	7.66119E-07	7.91306E-08	2.03210E-06
[illegible]	[illegible]	1.60591E-07	7.27118E-07	1.16793E-07	5.76323E-06
0.0	1.33333E-06	1.11671E-07	2.17876E-06	6.86262E-07	5.32072E-06
1.50111E-06	1.10150E-06	2.96326E-06	5.15370E-10	1.60119E-06	4.17526E-09
1.22151E-06	1.00771E-04	1.06969E-08	[illegible]	8.37960E-02	2.09160E-13
7.60956E-11	1.66362E-07	4.13390E-14	9.61090E-13	8.09138E-13	8.13163E-13
7.29636E-07	7.65776E-06	1.30663E-05	1.36200E-06	1.30069E-07	1.39350E-07
2.77205E-07	1.47317E-11	7.25631E-06	[illegible]	6.18662E-09	1.35361E-06
2.07703E-07	1.34567E-07	[illegible]	[illegible]	[illegible]	2.77230E-06
4.50183E-06	[illegible]	7.10961E-06	1.19630E-07	5.16320E-06	0.0
[illegible]	3.19235E-07	2.17300E-06	[illegible]	7.06201E-06	1.56366E-06
1.05336E-06	2.96270E-06	[illegible]	1.62609E-08	[illegible]	1.19576E-06
1.60677E-08	1.36533E-04	7.91113E-09	4.17960E-02	[illegible]	7.11935E-11
1.61037E-07	7.37682E-13	6.01251E-10	6.23363E-13	7.67233E-13	7.60627E-06
7.83667E-06	3.39710E-07	[illegible]	1.31329E-07	1.60307E-07	2.73167E-07
3.69191E-11	7.33332E-09	6.81723E-07	5.71649E-09	1.37401E-06	2.33060E-07
1.60223E-07	7.73610E-07	4.46726E-09	2.59729E-08	2.03775E-09	3.63350E-09
1.75172E-07	7.33666E-08	1.21655E-07	[illegible]	0.0	1.33333E-09
3.20757E-07	2.16030E-06	3.15693E-07	5.35439E-06	1.56388E-06	9.09608E-07
2.96132E-06	3.61435E-13	1.71460E-08	[illegible]	1.18357E-09	1.63637E-09
1.36675E-09	7.63415E-06	6.37603E-03	1.45610E-13	6.78270E-11	1.36927E-07
5.91573E-13	4.31665E-13	6.75676E-10	[illegible]	7.26663E-07	7.97363E-06
[illegible]	[illegible]	1.35613E-07	[illegible]	2.73326E-07	1.19260E-11
[illegible]	6.07119E-07	[illegible]	1.31390E-06	2.13318E-07	1.69433E-07
7.81727E-07	4.66816E-09	2.65311E-08	2.68369E-09	2.51359E-09	3.77915E-07
7.36983E-09	1.23021E-07	5.16022E-08	0.0	1.33333E-09	3.29932E-07
2.16650E-08	2.55391E-07	5.06954E-06	1.58115E-06	9.63217E-07	2.95923E-06
2.70023E-13	1.70115E-06	6.77916E-09	1.16661E-06	1.33175E-08	1.33261E-08
7.50060E-09	8.37960E-02	1.08910E-13	6.60669E-11	[illegible]	6.75178E-13
7.77195E-13	3.65692E-13	6.69646E-13	7.22733E-07	8.05635E-06	3.50650E-05
1.36200E-06	1.37316E-07	[illegible]	2.67495E-07	[illegible]	7.63716E-09
6.09707E-07	3.31206E-09	1.60915E-06	2.38152E-07	1.56273E-07	7.68117E-07
8.02791E-08	2.69573E-08	2.91218E-09	2.36062E-09	3.75765E-07	7.35780E-09
1.26230E-07	5.16320E-08	0.0	1.00000E-09	[illegible]	2.16155E-06
2.06386E-07	5.07779E-06	1.59615E-06	9.36282E-07	2.95733E-06	2.19932E-13
1.76215E-08	8.90560E-09	1.18663E-06	1.36055E-09	1.02166E-08	7.38535E-03
8.37960E-02	1.19707E-10	6.01099E-11	1.28201E-07	3.78533E-13	7.16307E-13
2.81183E-10	6.55666E-13	[illegible]	8.18610E-06	3.56666E-05	1.36200E-06
1.00051E-07	1.07260E-07	2.65660E-07	7.67623E-12	7.47153E-09	4.91798E-07
2.66701E-09	1.02128E-06	2.00060E-07	1.62710E-07	7.91175E-07	8.95620E-08
2.72736E-08	2.92616E-09	1.88263E-09	3.90951E-07	7.36365E-09	1.25190E-07
5.16020E-08	0.0	1.00000E-09	3.36658E-07	2.15912E-06	1.66575E-07
5.00384E-06	1.60400E-06	8.81733E-07	[illegible]	1.76223E-10	1.77690E-09
5.00593E-09	1.17765E-06	[illegible]	[illegible]	7.28778E-09	8.37960E-02
9.63579E-11	5.59173E-11	1.23955E-07	2.99910E-10	6.50621E-10	2.16105E-13
6.23028E-10	7.20092E-07	9.26300E-06	3.58055E-05	1.36200E-06	1.10001E-07
1.08335E-07	2.63823E-07	6.16033E-12	7.09836E-09	4.93418E-07	2.16835E-09
[illegible]	2.10071E-07	[illegible]	7.07200E-07	[illegible]	[illegible]

Table 3. CONTINUED

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0.0	1.00000E-09	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	8.37960E-02	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	1.36200E-04	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	5.10020E-06	0.0
1.00000E-09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	8.37960E-02	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.36200E-04	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	5.10020E-06	0.0	1.00000E-09
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	8.37960E-02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.36200E-04	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	5.10020E-06	0.0	1.00000E-09	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	8.37960E-02	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.36200E-04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.32760E-06	5.10020E-06	0.0	1.00000E-09	[illegible]	2.30509E-06
[illegible]	2.67262E-06	[illegible]	[illegible]	[illegible]	2.44500E-06
1.90450E-09	1.65367E-13	1.39669E-06	2.57650E-06	[illegible]	6.50360E-09
8.37960E-02	1.63494E-09	1.70975E-10	1.30301E-07	1.06230E-09	1.22105E-09
4.00706E-06	1.73302E-09	5.31540E-07	3.32132E-06	1.28613E-05	1.36200E-04
3.15946E-08	5.50154E-08	2.16946E-07	9.22591E-10	[illegible]	2.57570E-07
3.31773E-06	5.69240E-07	1.65312E-08	5.32211E-06	3.71460E-07	2.41666E-08
5.60013E-09	7.29502E-10	2.69742E-08	1.17692E-07	4.24277E-09	5.40721E-08
5.10020E-06	0.0	1.00000E-09	8.23994E-08	2.28380E-06	1.40556E-06
1.59775E-06	5.83372E-07	6.14709E-06	2.10049E-06	2.31650E-09	4.56462E-09
4.96180E-13	4.75400E-06	2.15303E-06	9.54889E-08	9.53277E-09	8.37960E-02
1.03064E-09	1.01287E-13	1.62180E-07	2.24576E-09	1.37596E-09	6.12503E-09
1.57404E-09	[illegible]	4.13165E-06	1.74987E-09	1.36200E-04	4.52660E-08
7.61220E-08	[illegible]	1.05615E-10	[illegible]	3.29607E-07	2.95181E-08
7.93796E-07	6.85929E-08	[illegible]	[illegible]	3.65322E-08	9.69950E-09
1.15827E-09	[illegible]	2.00625E-07	6.45651E-09	[illegible]	5.10020E-06
0.0	1.00000E-09	[illegible]	2.25790E-06	1.40049E-06	6.18906E-06
8.23560E-07	6.19451E-06	2.66520E-06	2.00251E-09	7.59388E-09	1.35506E-09
1.31733E-06	2.07598E-04	1.53673E-08	1.25301E-08	8.37960E-02	1.17276E-09
1.19503E-13	1.70228E-07	2.29048E-09	1.17741E-09	3.63634E-09	1.40309E-09
6.06140E-07	4.95957E-06	2.13580E-05	1.36260E-06	5.70526E-06	9.31165E-08
3.01350E-07	4.17681E-11	5.33998E-09	3.79891E-07	2.65099E-08	9.07490E-07
1.02207E-07	9.08373E-08	5.69643E-07	4.75098E-08	1.36659E-08	1.57252E-09
1.81396E-08	2.52967E-07	6.67667E-09	6.65707E-08	5.10020E-06	0.0
1.00000E-09	1.92833E-07	2.23812E-06	1.24181E-06	8.56104E-06	1.02545E-06
2.90857E-06	2.81579E-06	1.65065E-05	1.32409E-08	1.71248E-09	1.28710E-06
1.64481E-08	1.42921E-08	1.03611E-06	8.37960E-02	9.29776E-10	1.00842E-10
1.70055E-07	2.53225E-09	1.31761E-09	2.96999E-09	1.24611E-09	7.16202E-07
5.71785E-06	2.44707E-05	1.36200E-04	6.86064E-08	1.06477E-07	3.08775E-07
6.45069E-11	5.99230E-09	4.13856E-07	1.97330E-08	1.06550E-06	1.32650E-07
9.17668E-08	6.30349E-07	5.65916E-08	1.69135E-08	1.91423E-09	1.46543E-08
2.92279E-07	6.86244E-09	9.44797E-09	5.10020E-06	0.0	1.00000E-09
2.33489E-07	2.22160E-06	1.05827E-06	4.74666E-06	1.18152E-06	2.25218E-06
2.09400E-06	1.32946E-09	1.22470E-08	2.35272E-09	1.34242E-06	1.71713E-08
1.32450E-08	9.70712E-09	8.37960E-02	7.32065E-10	9.50395E-11	1.66398E-07
1.88309E-09	1.26214E-09	2.33348E-09	1.11785E-09	7.29717E-07	6.28621E-06
2.69550E-05	1.36200E-04	7.75607E-06	1.16721E-07	3.01163E-07	4.96784E-11
6.44285E-09	4.36861E-07	1.57355E-08	1.15407E-06	1.57491E-07	1.01642E-07
6.73440E-07	6.39487E-08	1.94428E-08	2.17993E-09	1.14212E-08	3.20233E-07
7.00734E-09	1.02119E-07	5.10020E-06	0.0	1.00000E-09	2.63037E-07
2.20805E-06	8.81719E-07	4.87002E-06	1.29699E-06	1.79534E-06	2.93320E-06
1.06024E-09	1.37898E-08	2.91709E-09	1.24350E-06	1.61601E-08	1.24178E-08
9.22868E-09	8.37960E-02	5.77141E-10	6.92600E-11	1.61564E-07	1.61032E-09
1.16764E-09	1.80075E-09	1.01739E-09	7.36091E-07	6.73516E-06	2.89336E-05
1.36200E-04	8.48452E-08	1.24522E-07	2.95245E-07	3.88819E-11	6.75249E-09
4.52753E-07	1.25281E-09	1.22112E-06	1.76446E-07	1.10821E-07	7.05091E-07
6.98796E-08	2.13990E-08	2.38389E-09	9.22659E-09	3.39606E-07	7.11601E-09
1.07987E-07	5.10020E-06	0.0	1.00000E-09	2.83986E-07	2.19705E-04
7.20597E-07	4.94705E-06	1.38073E-04	1.50363E-06	2.95197E-06	8.62885E-10
1.08860E-04	3.38901E-09	1.22816E-06	1.54463E-08	1.18013E-08	8.76073E-09
8.37960E-02	4.56584E-10	8.32201E-11	1.56496E-07	1.34836E-09	1.09780E-09
1.37947E-09	9.37805E-10	7.30327E-07	7.09022E-06	3.05102E-05	1.36200E-04
9.06878E-08	1.30475E-07	2.89105E-07	3.00642E-11	6.96781E-09	4.64004E-07
9.98396E-09	1.27282E-06	1.90049E-07	1.19505E-07	7.28576E-07	7.46529E-08
2.29206E-09	2.56032E-09	7.15301E-09	3.52893E-07	7.19533E-09	1.12488E-07
5.10020E-06	0.0	1.00000E-09	2.98828E-07	2.18818E-04	5.90600E-07
4.99718E-06	1.44113E-06	1.31112E-06	4.96019E-06	6.70090E-10	1.56765E-08
3.77330E-09	1.21599E-08	1.49774E-08	1.13483E-08	8.40090E-09	8.37960E-02
3.62478E-10	7.90900E-11	1.51517E-07	1.11250E-09	1.03196E-09	1.05643E-09
6.73390E-10	7.32884E-07	7.37169E-06	3.17685E-05	1.36200E-04	9.53561E-08
1.35047E-07	2.83620E-07	2.36610E-11	7.12032E-09	4.72160E-07	7.96931E-09
1.31209E-06	1.99172E-07	1.27797E-07	7.46294E-07	7.84888E-08	2.41096E-09
2.65973E-09	5.68525E-09	3.61970E-07	7.25161E-09	1.15918E-07	5.10020E-06
0.0	1.00000E-09	3.09455E-07	2.18103E-04	4.79092E-07	5.03098E-06
1.40083E-06	1.17989E-06	2.96302E-06	5.33449E-10	1.62597E-08	4.08226E-09
1.20631E-06	1.46291E-08	1.10161E-08	8.11899E-09	8.37960E-02	2.88670E-10
7.53767E-11	1.46701E-07	9.07946E-10	9.68003E-10	8.06095E-10	8.19408E-10

Table 3. CONTINUED

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.0
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.03409E-07	7.78115E-07	[illegible]	[illegible]	2.01915E-09	3.02067E-09
3.72155E-07	[illegible]	[illegible]	5.16323E-06	0.0	1.00000E-09
3.22076E-07	[illegible]	3.31591E-07	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.73251E-08	[illegible]	[illegible]	1.01027E-09
[illegible]	7.72007E-09	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.02367E-05	1.36200E-06	[illegible]	[illegible]	[illegible]	[illegible]
7.37210E-09	[illegible]	[illegible]	[illegible]	[illegible]	9.52506E-07
7.70516E-07	[illegible]	[illegible]	[illegible]	[illegible]	3.75106E-07
7.33462E-09	1.22109E-07	5.16323E-06	0.0	1.00000E-09	[illegible]
2.16693E-08	2.52006E-07	[illegible]	[illegible]	[illegible]	2.96357E-08
3.72100E-13	1.72701E-06	[illegible]	[illegible]	[illegible]	1.30122E-08
7.58320E-09	8.37960E-02	1.07963E-10	[illegible]	1.33203E-07	6.72197E-13
7.79975E-10	[illegible]	[illegible]	7.25053E-07	[illegible]	3.67053E-05
1.36200E-06	1.96330E-07	1.05263E-07	[illegible]	[illegible]	7.01012E-09
6.88093E-07	3.20950E-09	1.03173E-06	[illegible]	1.27053E-07	7.00952E-07
6.76673E-08	[illegible]	2.00000E-09	[illegible]	3.77360E-07	7.33671E-08
1.23367E-07	5.10020E-06	0.0	1.33362E-09	3.38370E-07	2.14196E-06
2.80867E-07	5.99176E-06	1.57367E-06	[illegible]	2.95093E-06	2.10131E-13
1.76693E-08	4.08937E-05	1.10157E-06	[illegible]	1.03237E-08	7.06623E-09
8.37966E-02	1.10795E-13	[illegible]	1.20715E-07	3.77556E-13	7.16159E-13
2.70366E-10	6.59322E-10	[illegible]	[illegible]	3.53621E-05	1.36234E-06
1.07858E-07	[illegible]	[illegible]	[illegible]	[illegible]	6.93060E-07
2.64466E-09	1.01385E-06	2.01967E-07	1.63911E-07	7.95310E-07	8.00015E-08
2.70560E-08	2.50261E-09	[illegible]	3.70291E-07	7.30106E-09	1.20310E-07
5.10020E-06	0.0	1.00006E-09	3.32039E-07	2.16155E-06	1.66006E-07
5.09027E-06	1.50090E-06	9.90055E-07	[illegible]	1.70530E-13	1.76193E-08
6.90938E-09	1.10062E-06	1.30259E-08	1.72330E-08	7.30691E-09	8.37963E-02
9.50200E-11	5.59731E-11	1.20062E-07	2.97520E-13	6.57706E-13	2.33516E-13
6.26083E-10	7.22962E-07	8.39512E-06	3.50975E-05	1.36203E-06	1.59376E-07
1.07622E-07	2.65959E-07	[illegible]	7.60306E-09	6.92612E-07	2.12676E-08
1.02354E-06	1.97560E-07	1.69929E-07	7.96377E-07	[illegible]	2.72790E-08
2.93270E-09	1.56002E-09	3.79064E-07	7.33077E-09	1.05363E-07	5.16323E-06
0.0	1.00000E-09	1.36726E-07	2.15963E-06	1.31969E-07	5.13199E-06
1.58069E-06	8.06363E-07	2.95402E-08	1.37070E-13	1.77307E-08	6.90696E-09
1.17792E-06	1.17357E-06	[illegible]	7.20399E-09	8.37963E-02	7.69263E-11
5.15166E-11	1.23277E-07	2.32551E-10	5.63127E-10	1.63797E-13	5.36133E-13
7.22005E-07	8.25429E-06	3.57600E-05	1.36203E-06	1.13362E-07	1.68675E-07
2.60052E-07	6.92765E-12	[illegible]	6.91906E-07	[illegible]	1.03130E-06
1.92391E-07	1.75063E-07	7.97332E-07	9.37306E-08	2.76139E-08	2.09370E-09
1.20956E-09	3.79532E-07	7.32105E-09	1.25696E-07	5.16323E-06	0.0
1.00000E-09	3.36376E-07	2.15813E-06	1.35314E-07	[illegible]	1.59512E-06
8.60975E-07	2.95539E-06	1.33361E-13	1.78097E-06	[illegible]	1.17606E-06
1.33994E-08	1.00950E-08	7.30539E-09	8.37963E-02	[illegible]	6.75606E-11
1.76293E-07	1.01280E-13	[illegible]	1.29333E-10	[illegible]	7.21395E-07
8.30011E-06	3.59906E-05	1.36200E-06	1.13097E-07	1.69169E-07	2.63519E-07
6.12238E-12	7.52080E-09	6.95311E-07	1.03691E-09	1.64317E-06	1.66659E-07
1.83019E-07	8.00369E-07	9.12775E-08	2.76299E-08	2.06767E-09	1.31135E-09
3.79825E-07	7.20970E-09	1.26376E-07	5.16323E-06	0.0	1.00000E-09
3.36605E-07	2.35261E-06	[illegible]	3.91062E-07	2.60979E-06	1.70969E-05
6.10605E-07	9.20661E-10	2.60317E-11	6.22601E-11	[illegible]	9.70549E-08
1.95161E-09	3.50660E-13	8.37960E-02	7.70099E-13	1.12111E-13	2.97592E-09
2.98306E-10	2.05527E-10	1.30616E-09	6.19117E-10	1.09126E-07	5.73069E-07
2.41862E-06	1.36206E-06	5.50017E-05	1.33956E-08	5.36681E-08	5.97697E-11
5.95064E-10	5.37159E-08	1.55931E-08	1.37769E-07	1.88479E-09	1.22066E-08
7.45163E-08	3.43337E-09	3.50560E-13	1.62776E-10	1.15700E-08	2.06375E-08
2.92095E-09	1.02323E-04	5.10020E-06	0.0	1.00000E-09	5.56138E-09
2.33182E-06	1.10693E-06	1.42430E-06	1.25652E-07	1.33812E-05	1.21322E-06
2.12162E-09	3.85296E-13	1.86006E-11	1.06327E-06	2.30215E-08	7.50233E-09
2.08936E-09	8.37960E-02	1.61636E-09	2.36932E-13	6.93330E-08	1.05526E-09
7.81120E-10	3.22150E-09	1.60900E-09	3.18636E-07	1.75647E-06	7.46075E-06
1.36200E-06	1.70566E-08	3.21396E-08	1.56567E-07	1.23617E-13	1.80432E-09
1.59022E-07	3.20209E-08	3.03354E-07	1.21507E-08	3.08206E-08	2.20206E-07
1.23610E-08	1.97871E-09	3.96600E-10	2.62750E-08	7.11352E-08	5.98905E-09
3.23333E-08	5.10020E-06	0.0	1.00000E-09	3.38136E-08	2.33737E-06
1.00560E-06	2.62850E-06	3.18655E-07	9.35719E-06	1.00440E-06	2.39056E-09
1.77369E-09	1.35163E-10	1.39916E-06	2.59051E-06	1.33391E-06	6.31266E-09
8.37960E-02	1.60997E-09	1.72660E-10	1.36466E-07	1.00073E-09	1.20609E-09
3.97803E-09	1.70273E-09	6.92929E-07	2.35070E-06	1.25588E-05	1.36200E-06
3.07000E-08	5.43607E-08	2.33125E-07	1.21037E-10	3.18020E-09	2.52565E-07
3.26200E-08	5.76000E-07	3.47925E-08	5.35005E-08	3.63056E-07	2.35011E-08
5.25954E-09	7.06579E-10	2.05500E-08	1.33726E-07	6.23102E-09	5.37076E-08
5.10020E-06	0.0	1.00000E-09	7.90263E-08	2.28277E-06	1.66760E-06
3.55930E-06	5.50311E-07	6.35654E-06	2.35070E-06	2.28393E-09	6.31095E-09
6.57092E-10	1.35717E-06	2.37861E-08	1.56092E-08	9.40063E-09	8.37960E-02
1.62202E-09	1.03250E-10	1.60968E-07	2.20040E-09	1.37010E-09	9.03987E-09
1.50001E-09	6.11610E-07	4.02231E-06	1.71660E-05	1.36200E-06	4.02342E-08
7.06701E-08	2.79976E-07	1.00842E-10	4.30711E-09	3.20760E-07	2.92306E-08
7.76020E-07	6.50061E-08	6.87755E-08	4.77338E-07	3.56960E-08	9.37901E-09
1.12601E-09	2.10541E-08	1.95625E-07	6.43757E-09	7.00766E-08	5.10020E-06
0.0	1.00000E-09	1.35992E-07	2.26023E-08	1.30269E-06	6.16601E-06
7.92703E-07	6.37153E-06	2.60231E-06	1.90250E-09	7.27269E-09	9.06715E-10
1.32070E-06	2.10722E-08	1.55063E-08	1.05301E-08	8.37960E-02	1.16689E-09
1.21006E-10	1.69811E-07	2.25801E-09	1.37963E-09	3.50323E-09	1.01772E-09
6.79090E-07	4.91355E-06	2.09799E-05	1.36200E-06	5.66102E-08	9.16290E-08
3.00003E-07	8.36155E-11	5.26077E-09	3.75660E-07	2.03606E-08	9.33636E-07
9.06553E-08	8.15614E-08	5.61969E-07	4.66106E-08	1.33123E-08	1.53509E-09
1.80601E-08	2.07570E-07	6.65310E-09	8.33200E-08	5.10020E-06	0.0
1.00000E-08	1.87790E-07	2.20073E-08	1.22511E-06	8.52852E-06	8.01180E-07

Table 3. CONTINUED

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[illegible]	[illegible]	[illegible]	8.37960E-02	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.0	1.00000E-09
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	8.37960E-02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	0.0	1.00000E-09	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.05491E-08	1.36703E-08	2.79372E-09	1.20761E-06	1.60133E-08	1.20206E-08
9.37513E-09	8.37960E-02	5.75906E-10	8.90760E-11	1.62290E-07	1.60097E-09
1.17719E-09	1.76053E-09	1.03600E-09	7.35303E-07	6.60093E-06	2.05255E-05
1.36200E-06	8.30629E-08	1.23293E-07	2.97306E-07	3.05525E-11	6.69010E-09
6.50256E-07	1.26006E-06	1.30093E-06	1.71000E-07	1.12033E-07	6.99154E-07
6.09647E-08	2.15761E-08	2.30965E-09	9.03060E-09	3.36090E-07	7.00061E-08
1.06600E-07	5.10220E-06	0.0	1.00000E-09	2.79956E-07	2.20015E-06
7.16530E-07	6.95773E-06	1.36663E-06	1.58200E-06	2.00760E-06	8.30507E-10
1.45002E-08	3.25076E-09	1.22310E-06	1.56099E-06	1.26031E-08	8.01320E-09
8.37960E-02	6.55251E-13	6.62077E-11	1.57322E-07	1.14105E-09	1.10705E-09
1.37010E-09	9.69623E-13	7.36532E-07	6.09924E-06	3.00954E-05	1.36200E-06
8.92005E-08	1.29225E-07	2.91529E-07	3.00060E-11	6.92115E-09	6.61053E-07
9.90457E-09	1.26060E-06	1.65360E-07	1.26030E-07	7.22909E-07	7.37210E-08
2.26052E-08	2.50660E-09	7.12971E-09	3.08209E-07	7.16052E-09	1.11176E-07
5.10020E-06	0.0	1.00000E-09	2.95196E-07	2.19130E-06	5.02775E-07
5.01112E-06	1.00510E-06	1.37900E-06	2.95771E-06	6.66169E-10	1.53907E-08
3.63060E-09	1.22306E-06	1.51976E-08	1.15669E-08	8.54605E-09	8.37960E-02
3.63971E-10	7.99696E-11	1.52306E-07	1.10612E-09	1.06363E-08	1.06656E-09
8.63091E-10	7.35726E-07	7.37993E-06	3.13061E-05	1.36200E-06	9.39295E-08
1.33067E-07	3.06305E-07	2.36030E-11	7.07001E-09	6.70265E-07	7.92071E-09
1.30051E-06	1.90033E-07	1.29226E-07	7.06979E-07	7.75066E-08	2.37076E-08
2.62136E-09	5.05993E-09	3.57671E-07	7.22660E-09	1.16612E-07	5.10020E-06
0.0	1.00000E-09	3.06151E-07	2.10033E-06	6.73167E-07	5.06752E-06
1.60915E-06	1.24039E-06	2.96191E-06	5.29759E-10	1.59967E-08	3.90671E-09
1.21045E-06	1.60179E-08	1.11900E-08	8.26096E-09	8.37960E-02	2.07050E-10
7.61092E-11	1.67575E-07	9.01970E-16	9.75097E-10	7.99131E-16	8.20760E-10
7.36193E-07	7.50276E-06	3.23456E-05	1.36260E-06	9.76376E-08	1.37621E-07
2.01063E-07	1.06006E-11	7.19292E-09	6.76092E-07	6.33106E-09	1.33160E-06
1.99010E-07	1.37250E-07	7.56710E-07	6.06100E-08	2.07269E-08	2.71609E-09
6.50062E-09	3.03063E-07	7.26310E-09	1.17266E-07	5.10020E-06	0.0
1.00000E-09	3.14135E-07	2.17067E-06	3.02002E-07	5.07201E-06	1.60130E-06
1.16250E-06	2.96309E-06	6.21990E-10	1.66012E-08	6.10963E-09	1.20200E-06
1.45762E-08	1.09627E-08	8.03602E-09	8.37960E-02	2.20061E-10	7.22025E-11
1.42962E-07	7.29067E-10	9.12125E-10	6.10660E-10	7.01100E-10	7.32505E-07
7.60009E-06	3.31036E-05	1.36200E-06	1.00595E-07	1.60204E-07	2.70151E-07
1.60319E-11	7.27697E-09	6.01170E-07	5.06331E-09	1.35598E-06	2.02206E-07
1.60919E-07	7.65336E-07	8.30651E-08	2.56002E-08	2.70136E-09	3.59350E-09
3.60117E-07	7.20035E-09	1.19273E-07	5.10020E-06	0.0	1.00000E-09
3.20036E-07	2.17012E-06	3.00572E-07	5.09076E-06	1.50510E-06	1.07190E-06
2.96270E-06	3.30766E-10	1.67001E-06	4.30516E-09	1.19670E-06	1.03767E-08
1.07491E-08	7.05059E-09	8.37960E-02	1.02077E-10	6.05969E-11	1.30366E-07
5.05203E-10	8.40231E-10	6.67155E-10	7.30033E-10	7.30900E-07	7.02157E-06
3.37831E-05	1.36200E-06	1.02056E-07	1.62305E-07	2.75102E-07	1.10109E-11
7.33906E-09	6.06755E-07	4.05540E-09	1.37521E-06	2.02335E-07	1.52220E-07
7.73609E-07	8.50306E-08	2.60020E-08	2.02630E-09	2.07274E-09	3.71035E-07
7.30360E-09	1.20040E-07	5.10020E-06	0.0	1.00000E-09	3.20059E-07
2.17046E-06	2.40707E-07	5.10376E-06	1.52296E-06	1.02003E-06	2.96179E-06
2.69146E-10	1.70370E-08	6.56116E-09	1.19103E-06	1.02250E-08	1.06009E-08
7.71400E-09	8.37960E-02	1.46393E-10	6.66666E-11	1.33803E-07	6.67006E-10
7.03701E-10	3.57606E-10	7.00554E-10	7.29403E-07	7.93064E-06	3.47959E-05
1.36200E-06	1.00003E-07	1.40102E-07	2.72709E-07	9.43636E-12	7.30756E-09
6.07516E-07	3.25229E-09	1.39004E-06	2.00599E-07	1.59120E-07	7.60104E-07
8.66040E-08	2.66220E-08	2.85003E-09	2.30034E-09	3.72987E-07	7.31175E-09
1.22057E-07	5.10020E-06	0.0	1.00000E-09	3.27011E-07	2.16753E-06
2.00410E-07	5.11331E-06	1.53636E-06	9.01125E-07	2.96057E-06	2.15299E-10
1.72304E-08	6.66550E-09	1.10794E-06	1.41000E-08	1.00063E-08	7.59421E-09
8.37960E-02	1.17319E-10	6.00760E-11	1.29497E-07	3.70725E-10	7.10651E-10
2.73942E-10	6.65335E-10	7.20264E-07	8.02510E-06	3.07073E-05	1.36200E-06
1.06353E-07	1.45060E-07	2.70750E-07	7.56952E-12	7.02611E-09	6.09666E-07
2.61002E-09	1.60255E-06	1.97651E-07	1.65613E-07	7.05230E-07	8.70651E-08
2.67332E-06	2.06692E-09	1.86393E-09	3.74260E-07	7.31055E-09	1.23007E-07
5.10020E-06	0.0	1.00000E-09	3.30375E-07	2.16517E-06	1.61200E-07
5.12041E-06	1.54657E-06	9.51501E-07	2.95930E-06	1.71950E-10	1.73070E-08
6.76450E-09	1.10403E-06	1.40092E-08	1.03967E-08	7.69253E-09	8.37960E-02
9.40609E-11	5.60702E-11	1.25102E-07	2.92609E-10	6.52545E-10	2.09650E-10
6.32309E-10	7.27230E-07	8.09760E-06	3.50375E-05	1.36200E-06	1.07562E-07
1.06536E-07	2.69175E-07	6.06514E-12	7.65259E-09	6.91350E-07	2.09609E-09
1.61221E-06	1.93220E-07	1.71664E-07	7.09295E-07	8.08715E-08	2.69520E-08
2.06661E-09	1.67066E-09	3.75005E-07	7.31199E-09	1.23756E-07	5.10020E-06
0.0	1.00000E-09	3.32334E-07	2.16329E-06	1.29150E-07	5.12463E-06
1.55450E-06	9.20710E-07	2.95031E-06	1.35616E-10	1.75090E-08	6.00136E-09
1.18238E-06	1.30001E-08	1.03267E-08	7.40037E-09	8.37960E-02	7.56600E-11
5.16916E-11	1.20950E-07	2.28974E-10	5.03129E-10	1.60046E-10	5.99069E-10
7.26367E-07	8.15602E-06	3.53032E-05	1.36200E-06	1.00536E-07	1.07392E-07
2.67099E-07	6.05825E-12	7.47616E-09	6.92740E-07	1.68660E-09	1.02000E-06
1.00137E-07	1.77190E-07	7.92561E-07	8.96600E-08	2.70842E-08	2.05394E-09
1.10954E-09	3.75509E-07	7.29510E-09	1.24380E-07	5.10020E-06	0.0
1.00000E-09	3.33742E-07	2.16100E-06	1.02040E-07	5.11975E-06	1.56123E-06
9.09653E-07	2.95789E-06	1.01409E-10	1.76217E-08	6.09439E-09	1.10054E-06
1.35052E-08	1.02550E-08	7.32601E-09	8.37960E-02	6.31090E-11	6.70227E-11
1.16930E-07	1.77737E-10	5.03309E-10	1.26100E-10	5.57773E-10	7.25530E-07
8.20503E-06	3.55251E-05	1.36200E-06	1.09359E-07	1.40009E-07	2.66795E-07
6.05529E-12	7.50160E-09	6.96080E-07	1.40935E-09	1.42670E-06	1.02323E-07

Table 3. CONTINUED

1.02323E-07	7.99399E-07	9.02701E-04	2.71301E-04	2.41313E-09	9.32420E-10
3.75914E-07	7.22150E-09	1.45051E-07	5.14020E-04	0.0	1.00000E-09
1.30335E-07	2.35300E-04	4.25476E-07	3.79210E-07	2.21420E-04	1.79039E-05
1.95321E-07	8.92020E-10	1.00734E-11	3.44602E-13	1.40467E-04	3.50223E-09
1.03105E-09	3.19767E-13	8.37943E-02	7.40053E-10	1.12262E-10	2.07310E-08
2.79412E-10	2.35303E-13	1.27657E-09	8.15450E-10	1.05358E-07	5.47052E-07
2.32252E-06	1.36200E-04	5.27761E-09	1.94043E-09	5.14905E-08	5.74519E-11
5.71349E-10	5.16799E-08	1.49603E-08	1.31420E-07	1.73795E-09	1.22620E-08
7.96315E-08	3.28935E-09	3.24501E-10	1.40581E-10	1.11157E-08	3.97355E-08
2.09730E-09	9.74472E-09	5.14020E-04	0.0	1.00000E-09	5.13445E-09
2.33290E-04	1.04455E-04	1.38544E-06	1.14347E-07	1.36369E-05	1.17191E-06
2.04792E-09	3.40362E-10	1.56037E-11	1.40532E-06	2.29157E-08	7.27150E-09
2.31324E-09	8.37960E-02	1.55969E-09	2.37744E-10	8.67896E-06	1.30135E-09
7.57776E-10	3.07713E-09	1.48024E-09	3.08434E-07	1.49357E-06	7.39211E-06
1.36200E-04	1.60000E-08	3.39714E-08	1.49084E-07	1.19367E-10	1.79727E-09
1.53812E-07	3.13277E-08	3.28455E-07	1.12995E-08	3.49184E-06	2.16593E-07
1.95533E-08	1.84033E-09	3.84367E-10	2.36564E-08	6.91692E-06	5.96097E-09
3.11037E-08	5.14020E-04	0.0	1.00000E-09	2.87673E-08	2.30932E-04
1.36127E-06	2.56965E-04	2.97424E-07	9.48642E-06	1.84437E-04	2.31227E-09
1.60485E-09	1.17729E-10	1.43265E-06	2.60442E-08	1.35469E-08	6.04435E-09
8.37960E-02	1.57119E-05	1.74818E-10	1.33776E-07	1.73793E-09	1.10511E-09
3.01992E-09	1.70080E-09	4.81360E-07	2.05842E-06	1.21649E-05	1.36200E-04
2.97337E-08	5.26810E-04	2.26113E-07	1.10735E-10	3.08192E-09	2.45932E-07
3.10325E-08	5.59643E-07	3.26362E-08	5.30373E-08	3.53549E-07	2.26344E-08
4.96346E-09	6.76053E-10	2.39530E-06	1.20573E-07	4.21403E-09	5.21733E-08
5.14020E-04	0.0	1.00000E-09	7.44400E-06	2.20542E-06	1.42734E-06
3.50607E-06	5.25467E-07	4.44394E-06	2.31460E-06	2.23403E-09	3.98961E-09
4.06956E-10	1.36139E-06	2.41601E-08	1.56400E-08	9.19759E-09	8.37960E-02
7.39990E-09	1.05807E-10	1.59230E-07	2.13561E-09	1.36306E-09	3.91611E-09
1.59571E-09	6.01060E-07	3.91210E-06	1.66693E-05	1.36200E-04	4.20426E-08
7.26900E-08	2.76416E-07	1.63476E-10	4.23428E-05	3.10078E-07	2.87461E-08
7.57865E-07	6.21161E-08	6.94151E-08	4.66235E-07	3.45729E-08	8.90682E-09
1.07972E-09	2.10913E-07	1.00094E-07	6.41139E-09	6.00153E-08	5.14020E-04
0.0	1.00000E-09	1.29705E-07	2.26346E-06	1.34917E-06	4.12764E-06
7.50660E-07	4.62396E-06	2.60089E-06	1.90863E-09	6.83134E-05	8.96395E-10
1.32565E-06	2.15049E-08	1.56794E-08	1.05044E-08	8.37960E-02	1.15085E-09
1.24062E-10	1.69128E-07	2.20894E-09	1.38324E-09	3.49691E-09	1.41574E-09
6.73306E-07	4.79341E-06	2.04554E-05	1.36200E-04	5.49702E-06	8.95350E-08
2.98966E-07	8.31081E-11	5.14010E-09	3.69429E-07	2.40835E-08	9.14266E-07
9.36952E-08	8.25015E-08	5.51149E-07	4.53492E-08	1.24174E-08	1.48265E-09
1.78422E-08	2.40092E-07	4.61969E-09	8.15851E-08	5.14020E-04	0.0
1.00000E-09	1.40725E-07	2.24403E-06	1.19840E-06	4.50925E-06	9.43270E-07
3.34234E-06	2.77510E-06	1.61603E-09	9.41849E-09	1.48719E-09	1.29607E-06
1.93722E-08	1.47627E-04	1.05396E-08	8.37960E-02	5.20754E-10	1.08888E-10
1.70357E-07	2.67622E-09	1.33366E-09	2.68374E-09	1.24840E-09	7.11054E-07
5.50363E-06	2.35246E-05	1.36200E-04	4.55007E-08	1.32931E-07	3.05556E-07
6.45351E-11	5.83739E-05	4.05101E-07	1.94490E-08	1.03320E-06	1.22637E-07
9.38936E-08	6.12878E-07	5.43882E-08	1.63591E-08	1.82327E-09	1.42975E-08
2.79272E-07	6.80027E-09	9.14110E-08	5.14020E-04	0.0	1.00000E-09
2.21522E-07	1.22043E-04	1.02431E-04	4.73940E-06	1.09461E-06	2.50137E-06
2.06509E-06	1.30611E-09	1.10735E-08	2.08112E-09	1.27222E-06	1.78473E-08
1.37635E-08	1.00973E-08	8.37960E-02	7.26263E-10	9.05356E-11	1.67592E-07
1.84452E-09	1.26301E-09	2.27064E-09	1.15231E-09	7.29024E-07	6.06744E-06
2.59780E-05	1.36200E-04	7.42054E-08	1.13298E-07	3.04275E-07	4.97600E-11
6.28856E-09	4.29447E-07	1.55473E-08	1.12292E-06	1.46555E-07	1.04167E-07
6.57569E-07	6.17140E-08	1.86125E-08	2.09141E-09	1.13108E-08	3.07570E-07
6.98201E-09	9.89042E-08	5.14020E-04	0.0	1.00000E-09	2.51863E-07
2.21531E-04	8.54543E-07	4.88080E-06	1.20813E-06	2.03500E-06	2.91428E-06
1.04295E-09	1.30117E-08	2.61460E-09	1.25322E-06	1.67868E-08	1.29348E-08
9.58197E-09	8.37960E-02	5.72225E-10	9.12527E-11	1.63270E-07	1.58232E-09
1.19008E-09	1.76277E-09	1.04910E-09	7.36644E-07	6.51337E-06	2.79316E-05
1.36200E-04	8.14430E-08	1.21240E-07	2.99920E-07	3.85185E-11	6.61713E-09
4.46409E-07	1.23875E-08	1.19094E-06	1.65019E-07	1.13406E-07	6.90271E-07
6.76132E-08	2.05922E-08	2.29779E-09	8.94106E-09	3.27427E-07	7.04954E-09
1.04807E-07	5.14020E-04	0.0	1.00000E-09	2.73769E-07	2.20467E-06
7.02257E-07	4.97069E-06	1.29142E-06	1.70684E-06	2.93965E-06	8.28037E-10
1.01018E-08	3.86606E-09	1.23815E-06	1.60486E-08	1.23016E-08	9.12857E-09
8.37960E-02	4.51774E-10	6.57678E-11	1.58467E-07	1.32505E-09	1.11960E-09
1.35054E-09	9.66569E-10	7.39178E-07	6.06511E-06	2.94053E-05	1.36200E-04
8.72026E-08	1.27322E-07	2.98849E-07	3.00185E-11	6.84805E-09	4.58470E-07
9.05350E-09	1.24297E-06	1.78402E-07	1.22660E-07	7.10562E-07	7.23463E-08
2.21277E-08	2.45560E-09	7.07163E-09	3.41184E-07	7.12780E-09	1.39271E-07
5.14020E-04	0.0	1.00000E-09	2.89502E-07	2.19610E-04	5.71795E-07
5.02981E-06	1.35211E-06	1.48778E-06	2.95261E-06	6.57940E-10	1.49721E-08
3.43805E-09	1.22620E-06	1.55276E-08	1.18289E-08	8.76186E-09	8.37960E-02
3.57649E-10	8.12530E-11	1.53604E-07	1.09307E-09	1.05267E-09	1.03080E-09
8.99163E-10	7.39358E-07	7.14365E-06	3.07221E-05	1.36200E-04	9.18062E-08
1.31999E-07	2.90060E-07	2.35456E-11	7.01285E-09	4.67249E-07	7.84458E-09
1.28312E-06	1.07363E-07	1.31199E-07	7.32871E-07	7.61417E-08	2.33216E-08
2.57533E-09	5.60527E-09	3.50664E-07	7.18350E-09	1.12690E-07	5.14020E-04
0.0	1.00000E-09	3.00083E-07	2.18921E-04	4.62997E-07	5.06998E-06
1.39640E-06	1.33716E-06	2.95891E-06	5.22610E-10	1.55068E-08	3.73800E-09
1.21672E-06	1.51527E-08	3.14765E-08	8.47230E-09	8.37960E-02	2.03899E-10
7.71922E-11	1.48816E-07	8.90363E-10	9.86134E-10	7.86037E-10	8.42460E-10
7.30537E-07	7.36449E-06	3.17078E-05	1.36200E-04	9.54771E-08	1.35618E-07
2.05896E-07	1.05605E-11	7.13252E-09	4.73706E-07	6.25323E-09	1.31035E-06
1.92731E-07	1.39349E-07	7.46650E-07	7.91767E-08	2.42494E-08	2.66871E-09
4.45332E-09	3.57179E-07	7.22162E-09	1.15314E-07	5.14020E-04	0.0
1.00000E-09	3.09213E-07	2.18368E-04	3.73710E-07	5.09796E-06	1.42896E-06
1.23077E-06	2.96165E-06	4.15701E-10	1.60467E-08	3.97852E-09	1.20918E-06
1.40771E-08	1.12119E-08	8.24355E-09	8.37960E-02	2.25919E-10	7.32688E-11
1.04130E-07	7.18599E-10	9.20719E-10	5.99634E-10	7.93423E-10	7.37366E-07
7.53998E-06	3.20905E-05	1.36200E-04	9.84031E-08	1.38430E-07	2.02412E-07
1.07077E-11	7.22087E-09	4.78636E-07	4.99197E-09	1.33860E-06	1.95190E-07
1.47121E-07	7.57636E-07	8.16023E-08	2.49670E-08	2.72930E-09	3.54603E-09
3.61641E-07	7.24652E-09	1.17335E-07	5.14020E-04	0.0	1.00000E-09
3.15393E-07	2.17924E-04	3.01119E-07	5.11780E-06	1.45311E-06	1.15382E-06
2.96252E-06	3.31200E-10	1.63943E-08	4.17073E-09	1.20319E-06	1.46783E-08
1.10117E-04	8.86065E-09	8.37960E-02	1.40175E-10	6.92928E-11	1.19561E-07

Table 3. CONTINUED

5.75760E-10	8.55048E-10	4.57817E-10	7.49922E-10	7.36144E-07	7.67975E-06
3.31232E-05	1.36200E-04	1.00737E-07	1.00639E-07	2.79553E-07	1.16904E-11
7.20700E-09	4.62367E-07	3.99082E-09	1.35005E-06	1.95350E-07	1.54503E-07
7.66031E-07	8.35431E-08	2.55170E-08	2.77357E-09	2.62918E-09	3.64679E-07
7.28164E-09	1.10896E-07	5.14020E-04	0.0	1.00000E-09	3.20030E-07
2.17548E-08	2.42391E-07	5.13222E-06	1.47120E-06	1.09764E-06	2.98203E-06
2.64268E-10	1.66594E-08	4.32413E-09	1.19040E-06	1.45122E-08	1.08570E-08
7.91179E-09	8.37960E-02	1.43945E-10	4.51557E-11	1.35033E-07	4.58560E-10
7.88764E-10	3.49707E-10	7.10556E-10	7.35015E-07	7.79120E-08	3.30264E-05
1.36200E-04	1.02600E-07	1.02374E-07	2.77231E-07	9.31644E-12	7.33733E-09
4.05244E-07	3.19426E-09	1.37320E-06	1.93727E-07	1.61472E-07	7.72611E-07
8.50938E-08	2.59319E-04	2.80047E-09	2.26112E-09	3.66727E-07	7.26944E-09
1.20109E-07	5.14020E-04	0.0	1.00000E-09	3.23558E-07	2.17283E-06
1.94946E-07	5.14284E-06	1.48489E-06	1.05047E-06	2.96191E-06	2.11010E-10
1.60632E-08	4.04645E-09	1.19459E-06	1.43890E-08	1.07383E-08	7.78087E-09
8.37960E-02	1.15122E-10	6.00024E-11	1.30596E-07	3.63233E-10	7.21004E-10
2.67277E-10	6.74398E-10	7.34016E-07	7.08037E-06	3.40294E-05	1.36200E-04
1.84009E-07	1.02743E-07	2.75155E-07	7.41734E-12	7.37507E-09	4.87402E-07
2.55833E-09	1.30537E-06	1.90710E-07	1.67997E-07	7.77794E-07	8.63332E-08
2.62373E-08	2.81250E-09	1.80083E-09	3.68007E-07	7.27240E-09	1.21056E-07
5.14020E-04	0.0	1.00000E-09	3.26256E-07	2.17355E-06	1.56520E-07
5.15070E-06	1.49535E-06	1.02212E-06	2.96123E-06	1.60199E-10	1.70210E-08
4.54365E-09	1.19154E-06	1.42062E-08	1.04053E-08	7.68294E-09	8.37960E-02
9.20996E-11	5.62160E-11	1.26227E-07	2.86019E-10	6.53926E-10	2.84039E-10
6.40566E-10	7.33160E-07	7.95160E-06	3.03521E-05	1.36200E-04	1.05279E-07
1.44020E-07	2.73644E-07	5.94106E-12	7.40505E-09	4.89241E-07	2.08900E-09
1.39490E-06	1.06628E-07	1.74040E-07	7.01896E-07	8.73210E-08	2.64516E-08
2.01132E-09	1.44739E-09	3.48958E-07	7.26991E-09	1.21801E-07	5.14020E-04
0.0	1.00000E-09	3.28322E-07	2.16073E-06	1.25107E-07	5.15565E-06
1.50347E-06	9.97399E-07	2.96062E-06	1.32304E-10	1.71466E-08	4.61917E-09
1.18915E-06	1.41435E-08	1.05703E-08	7.59168E-09	8.37960E-02	7.39088E-11
5.14664E-11	1.21945E-07	2.23230E-10	5.02806E-10	1.55731E-10	6.06654E-10
7.32423E-07	8.00877E-06	3.46112E-05	1.36200E-04	1.06234E-07	1.05688E-07
2.72626E-07	4.76313E-12	7.43053E-09	4.90671E-07	1.64572E-09	1.40272E-06
1.05713E-07	1.79602E-07	7.85184E-07	8.80947E-08	2.65805E-08	2.79703E-09
1.16160E-09	3.69524E-07	7.25375E-09	1.22420E-07	5.14020E-04	0.0
1.00000E-09	3.29017E-07	2.16729E-06	9.93042E-08	5.15161E-06	1.51233E-06
9.76363E-07	2.96054E-06	9.88771E-11	1.72609E-08	4.67159E-09	1.18736E-06
1.38647E-08	1.05004E-08	7.51130E-09	8.37960E-02	6.15646E-11	4.72619E-11
1.17057E-07	1.72746E-10	5.01818E-10	1.22073E-10	5.60863E-10	7.31700E-07
8.05660E-06	3.40270E-05	1.36200E-04	1.37042E-07	1.46308E-07	2.71560E-07
3.96549E-12	7.45666E-09	4.92068E-07	1.37168E-09	1.40939E-06	1.76087E-07
1.84712E-07	7.86027E-07	8.86530E-08	2.65960E-08	2.77346E-09	9.66638E-10
3.69893E-07	7.10294E-09	1.23079E-07	5.14020E-04	0.0	1.00000E-09
3.30499E-07	2.35344E-06	4.08304E-07	3.59853E-07	2.00013E-08	1.80855E-05
3.77271E-07	8.46962E-13	1.56165E-11	2.71116E-13	1.48371E-06	9.26364E-09
1.60950E-09	2.80689E-10	8.37960E-02	7.12175E-10	1.12115E-10	2.74631E-08
2.57618E-10	2.23025E-10	1.20339E-09	8.11684E-10	1.00297E-07	5.21566E-07
2.21077E-06	1.36200E-04	5.01894E-09	9.50974E-09	4.93739E-08	5.47491E-11
5.43682E-10	4.93050E-08	1.42644E-08	9.67648E-08	1.57133E-09	1.22073E-08
6.82710E-08	3.12510E-09	2.95099E-10	1.38067E-10	1.05861E-08	1.86910E-08
2.86613E-09	9.22456E-09	5.14020E-04	0.0	1.00000E-09	4.64774E-09
2.33439E-04	1.01645E-06	1.33173E-06	1.05630E-07	1.38010E-05	1.12493E-06
1.95470E-09	2.89567E-10	1.26299E-11	1.44789E-06	2.25006E-08	6.87430E-09
2.09896E-09	8.37960E-02	1.49233E-05	2.08573E-10	8.36988E-08	9.35426E-10
7.28609E-10	2.90222E-09	1.67732E-09	2.96428E-07	1.61764E-06	6.86801E-06
1.36200E-04	1.60102E-08	2.95930E-08	1.48093E-07	1.18361E-10	1.71582E-09
1.47407E-07	2.99007E-08	3.14526E-07	1.02970E-08	3.50028E-08	2.07332E-07
1.09664E-08	1.69393E-09	3.69883E-10	2.24369E-08	6.45957E-08	5.92240E-09
2.97035E-08	5.14020E-04	0.0	1.00000E-09	2.63678E-08	2.31179E-06
1.30315E-06	2.49312E-06	2.72110E-07	1.00153E-05	1.78283E-06	2.24274E-09
1.40258E-09	9.77995E-11	1.40669E-06	2.62183E-08	1.26819E-08	5.66278E-09
8.37960E-02	1.51776E-09	1.77363E-10	1.30383E-07	1.64560E-09	1.15705E-09
3.61877E-09	1.70582E-09	4.64392E-07	2.74267E-06	1.16644E-05	1.36200E-04
2.80091E-08	5.05672E-08	2.21571E-07	1.14963E-10	2.95476E-09	2.37459E-07
3.07430E-08	5.34519E-07	2.99366E-08	5.42167E-08	3.40464E-07	2.15483E-08
4.59756E-09	6.40104E-10	2.31286E-08	1.22146E-07	6.19325E-09	5.02250E-08
5.14020E-04	0.0	1.00000E-09	6.91709E-08	2.28087E-04	1.37164E-06
3.43336E-06	4.83903E-07	7.02683E-06	2.25937E-06	2.16127E-09	3.57317E-09
3.46586E-10	1.36700E-06	2.46265E-08	1.55683E-08	8.89047E-09	8.37960E-02
1.36480E-09	1.49207E-10	1.56827E-07	2.04647E-09	1.34632E-09	3.73768E-09
1.60883E-09	5.88410E-07	3.76849E-06	1.60488E-05	1.36200E-04	4.10399E-08
7.00994E-08	2.71365E-07	1.01268E-10	4.08468E-09	3.09160E-07	2.79991E-08
7.33019E-07	5.74475E-08	7.01797E-08	4.51573E-07	3.31051E-08	8.38615E-09
1.02128E-09	2.09375E-08	1.80187E-07	6.37604E-09	6.66399E-08	5.14020E-04
0.0	1.00000E-09	1.21612E-07	2.26774E-04	1.30050E-06	4.07400E-06
6.95898E-07	4.97335E-06	2.56134E-06	1.89448E-09	6.24691E-09	7.78160E-10
1.33227E-06	2.20707E-08	1.58653E-08	1.04193E-08	8.37960E-02	1.13370E-09
1.27503E-10	1.68023E-07	2.13609E-09	1.38062E-09	3.36626E-09	1.45766E-09
6.63645E-07	4.63265E-06	1.97554E-05	1.36200E-04	5.27856E-08	8.66905E-08
2.96389E-07	8.20401E-11	4.99325E-09	3.61271E-07	2.36069E-08	8.88132E-07
8.72197E-08	8.36655E-08	5.36399E-07	4.36908E-08	1.21475E-08	1.41164E-09
1.75016E-08	2.30008E-07	6.5737[illegible]-09	7.92697E-08	5.14020E-04	0.0
1.00000E-09	1.71126E-07	2.24936E-[illegible]	1.15783E-06	4.47760E-06	8.79470E-07
3.64344E-06	2.73860E-06	1.57695E-09	8.75278E-09	1.31645E-09	1.30342E-06
1.99426E-08	1.51015E-08	1.06445E-08	8.37960E-02	9.07628E-10	1.12102E-10
1.70352E-07	2.02073E-09	1.34186E-09	2.79342E-09	1.30719E-09	7.05360E-07
5.33213E-06	2.27708E-05	1.36200E-04	6.30331E-08	1.00009E-07	3.05390E-07
6.40511E-11	5.66988E-09	3.97650E-07	1.91729E-08	1.00698E-06	1.18750E-07
9.50296E-08	5.98694E-07	5.26012E-08	1.53520E-08	1.70781E-09	1.40811E-08
2.68774E-07	6.74741E-09	8.89834E-08	5.14020E-04	0.0	1.00000E-09
2.11529E-07	2.23394E-04	9.90882E-07	4.72670E-06	1.02530E-06	2.79675E-06
2.03882E-06	1.27723E-09	1.07877E-08	1.86673E-09	1.28010E-06	1.03910E-08
1.41629E-08	1.03124E-08	8.37960E-02	7.16984E-10	1.01394E-10	1.68350E-07
1.80249E-09	1.27643E-09	2.21602E-09	1.17851E-09	7.26798E-07	5.88863E-06
2.51846E-05	1.36200E-04	7.16145E-08	1.10389E-07	3.06028E-07	4.94982E-11
6.15355E-09	4.22916E-07	1.53341E-08	1.09702E-06	1.37738E-07	1.06034E-07
6.44100E-07	5.98570E-08	1.79013E-08	2.01530E-09	1.11645E-08	2.97030E-07
6.88535E-09	9.64658E-08	5.14020E-04	0.0	1.00000E-09	2.42097E-07

Table 3. CONTINUED

2.22127E-04	8.27065E-07	4.80246E-06	1.93598E-06	2.25299E-06	2.89465E-06
1.02069E-09	1.23360E-08	2.36063E-09	1.26151E-06	1.72990E-08	1.33489E-08
9.84901E-09	8.37960E-02	5.64766E-10	9.37380E-11	1.64502E-07	1.54927E-09
1.20578E-09	1.71761E-09	1.07390E-09	7.37394E-07	6.32865E-06	2.71054E-05
1.36200E-04	7.86259E-08	1.10381E-07	3.03065E-07	3.83137E-11	6.49580E-09
4.80655E-07	1.21903E-08	1.16542E-06	1.55577E-07	1.15840E-07	6.77451E-07
6.56980E-08	1.98045E-08	2.22194E-09	8.81734E-09	3.17067E-07	6.98960E-07
1.02220E-07	5.14020E-04	0.0	1.00000E-09	2.64481E-07	2.21099E-04
6.79542E-07	4.98264E-08	1.21789E-06	1.89602E-06	2.92560E-06	8.10992E-10
1.34867E-08	2.79832E-09	1.24676E-06	1.65304E-08	1.27113E-08	9.41601E-09
8.37960E-02	4.85314E-10	8.79020E-11	1.59960E-07	1.29903E-09	1.13533E-09
1.31648E-09	9.89474E-10	7.41604E-07	6.67611E-06	2.06315E-05	1.36200E-04
8.42755E-08	1.24520E-07	2.98969E-07	2.98164E-11	6.73743E-09	4.53344E-07
9.65126E-09	-1.21775E-06	1.68550E-07	1.25062E-07	7.02263E-07	7.83787E-08
2.10217E-08	2.37977E-09	6.96529E-09	3.31059E-07	7.04585E-09	1.06635E-07
5.14020E-04	0.0	1.00000E-09	2.88740E-07	2.[illegible]271E-04	5.52980E-07
5.04911E-06	1.27087E-06	1.65526E-06	2.94271E-06	6.43231E-10	1.43389E-08
3.15375E-09	1.23500E-06	1.59035E-08	1.22279E-08	9.85451E-09	8.37960E-02
3.51900E-10	8.30643E-11	1.55240E-07	1.87040E-09	1.06656E-09	1.00416E-09
9.19961E-10	7.43222E-07	6.95072E-06	2.98443E-05	1.36200E-04	8.87953E-08
1.29251E-07	2.94056E-07	2.33370E-11	6.91160E-09	4.62595E-07	7.70223E-09
1.25810E-06	1.77330E-07	1.33810E-07	7.28970E-07	7.41196E-08	2.26134E-08
2.49910E-09	5.51137E-09	3.40773E-07	7.11993E-09	1.10021E-07	5.14020E-04
0.0	1.00000E-09	2.92603E-07	2.19606E-04	4.47209E-07	5.09446E-06
1.32233E-06	1.48837E-06	2.95211E-06	5.10292E-10	1.49733E-08	3.84240E-09
1.22583E-06	1.55075E-08	1.10630E-08	8.76342E-09	8.37960E-02	2.70767E-10
7.87031E-11	1.50503E-07	8.70800E-10	9.98816E-10	7.64730E-10	8.61302E-10
7.43450E-07	7.16013E-06	3.00090E-05	1.36200E-04	9.23996E-08	1.32913E-07
2.91160E-07	1.83600E-11	7.03800E-09	4.69460E-07	6.12700E-09	1.20945E-06
1.02617E-07	1.42137E-07	7.35244E-07	7.71050E-08	2.35361E-08	2.50771E-09
4.37004E-09	3.47497E-07	7.15690E-09	1.12622E-07	5.14020E-04	0.0
1.00000E-09	3.01340E-07	2.19873E-04	3.60485E-07	5.12611E-06	1.35509E-06
1.36978E-06	2.95719E-06	4.05305E-10	1.54497E-08	3.67463E-09	1.31840E-06
1.52952E-08	1.15005E-08	8.53043E-09	8.37960E-02	2.21367E-10	7.44953E-11
1.05816E-07	7.81609E-10	9.31220E-10	5.82380E-10	8.10468E-10	7.43051E-07
7.38061E-06	3.15774E-05	1.36200E-04	9.52714E-08	1.35763E-07	2.88016E-07
1.05076E-11	7.13305E-09	4.74631E-07	4.88201E-09	1.31395E-06	1.05093E-07
1.50052E-07	7.46246E-07	7.94001E-08	2.42471E-08	2.65139E-09	3.47251E-09
3.52137E-07	7.10090E-09	1.14626E-07	5.14020E-04	0.0	1.00000E-09
3.87060E-07	2.18647E-04	2.90027E-07	5.14862E-06	1.37954E-06	1.28352E-06
2.95983E-06	3.22402E-10	1.58100E-08	3.06060E-09	1.21265E-06	1.50752E-08
1.13706E-08	8.30244E-09	8.37960E-02	1.76171E-10	7.02459E-11	1.41193E-07
5.61024E-10	8.63100E-10	4.43770E-10	7.65362E-10	7.42400E-07	7.47774E-06
3.21904E-05	1.36200E-04	9.75603E-08	1.37994E-07	2.05400E-07	1.15035E-11
7.20387E-09	4.78576E-07	3.89494E-09	1.33321E-06	1.85343E-07	1.57547E-07
7.54790E-07	8.13086E-08	2.47897E-08	2.69449E-09	2.76406E-09	3.55324E-07
7.19551E-09	1.16177E-07	5.14020E-04	0.0	1.00000E-09	3.12773E-07
2.18305E-04	2.33082E-07	5.16492E-06	1.39795E-06	1.21960E-06	2.96112E-06
2.56083E-10	1.60867E-08	4.00919E-09	1.20800E-06	1.49060E-08	1.12172E-08
8.18844E-09	8.37960E-02	1.40448E-10	6.58440E-11	1.36633E-07	4.45830E-10
7.94463E-10	3.38319E-10	7.24583E-10	7.41700E-07	7.58696E-06	3.26799E-05
1.36200E-04	9.93859E-08	1.39747E-07	2.83257E-07	9.14594E-12	7.25772E-09
4.81610E-07	3.11108E-09	1.34842E-06	1.83854E-07	1.64598E-07	7.61489E-07
8.29050E-08	2.51976E-08	2.72029E-09	2.20499E-09	3.57497E-07	7.20312E-09
1.17301E-07	5.14020E-04	0.0	1.00000E-09	3.16513E-07	2.18031E-04
1.87128E-07	5.17696E-06	1.41195E-06	1.17169E-06	2.96166E-06	2.04674E-10
1.62989E-08	4.12774E-09	1.20430E-06	1.47757E-08	1.10921E-08	8.05985E-09
8.37960E-02	1.12080E-10	6.12344E-11	1.32131E-07	3.52305E-10	7.25100E-10
2.57903E-10	6.87201E-10	7.41039E-07	7.67404E-06	3.30711E-05	1.36200E-04
1.00843E-07	1.41130E-07	2.81516E-07	7.28366E-12	7.29906E-09	4.83982E-07
2.48640E-09	1.36046E-06	1.81023E-07	1.71177E-07	7.66751E-07	8.41147E-08
2.54964E-08	2.73123E-09	1.76012E-09	3.58959E-07	7.20562E-09	1.10322E-07
5.14020E-04	0.0	1.00000E-09	3.19383E-07	2.17813E-04	1.49949E-07
5.18596E-06	1.42267E-06	1.13518E-06	2.96180E-06	1.62013E-10	1.64630E-08
4.22192E-09	1.20135E-06	1.46671E-08	1.09943E-08	7.95023E-09	8.37960E-02
8.94551E-11	5.64016E-11	1.27691E-07	2.76686E-10	6.54927E-10	1.96369E-10
6.52339E-10	7.40437E-07	7.74351E-06	3.33816E-05	1.36200E-04	1.02006E-07
1.42223E-07	2.80109E-07	5.80420E-12	7.33120E-09	4.85035E-07	1.98678E-09
1.37003E-06	1.77162E-07	1.77254E-07	7.70907E-07	8.50769E-08	2.57050E-08
2.72901E-09	1.40514E-09	3.59926E-07	7.20312E-09	1.19061E-07	5.14020E-04
0.0	1.00000E-09	3.21584E-07	2.17639E-04	1.19576E-07	5.19170E-06
1.43101E-06	1.10696E-06	2.96184E-06	1.27861E-10	1.65937E-08	4.29516E-09
1.19904E-06	1.45419E-08	1.09150E-08	7.85480E-09	8.37960E-02	7.15920E-11
5.14212E-11	1.23335E-07	2.15297E-10	5.81036E-10	1.49438E-10	6.17608E-10
7.39900E-07	7.79913E-06	3.36339E-05	1.36200E-04	1.02930E-07	1.43089E-07
2.78966E-07	4.63972E-12	1.35746E-09	4.87336E-07	1.59147E-09	1.37771E-06
1.72496E-07	1.82800E-07	7.74227E-07	8.58294E-08	2.58300E-08	2.71461E-09
1.12466E-09	3.60553E-07	7.18775E-09	1.19673E-07	5.14020E-04	0.0
1.00000E-09	3.23192E-07	2.17502E-04	9.87237E-08	5.18809E-06	1.43801E-06
1.08370E-06	2.96226E-06	9.52860E-11	1.67109E-08	8.38639E-09	1.19732E-06
1.42484E-08	1.08430E-08	7.77069E-09	8.37960E-02	5.54551E-11	4.70369E-11
1.19166E-07	1.66003E-10	4.99214E-10	1.16803E-10	5.75192E-10	7.39345E-07
7.84550E-06	3.38417E-05	1.36200E-04	1.03721E-07	1.43792E-07	2.77976E-07
3.05000E-12	7.38451E-09	4.88756E-07	1.32249E-09	1.38420E-06	1.67140E-07
1.87898E-07	7.77082E-07	8.63749E-08	2.58476E-08	2.68969E-09	9.33089E-10
3.60903E-07	7.12089E-09	1.20315E-07	5.14020E-04	0.0	1.00000E-09
3.23991E-07	2.35404E-04	3.75439E-07	3.36000E-07	1.72807E-08	1.82130E-05
3.53902E-07	7.83472E-10	1.20400E-11	1.92380E-13	1.40480E-06	8.80847E-09
1.50141E-09	2.33735E-10	8.37960E-02	6.67166E-10	1.11736E-10	2.59041E-08
2.30252E-10	2.06401E-10	1.11236E-09	8.04800E-10	9.42786E-08	4.88586E-07
2.87059E-06	1.36200E-04	4.69467E-09	8.90968E-09	4.64431E-08	5.13473E-11
5.80762E-10	4.63183E-08	1.33701E-08	9.26647E-08	1.36521E-09	1.22075E-08
6.00493E-08	2.91820E-09	2.58871E-10	1.30895E-10	9.91681E-09	1.73860E-08
2.81950E-09	8.55382E-09	5.14020E-04	0.0	1.00000E-09	4.02810E-09
2.33636E-04	9.45890E-07	1.25496E-06	9.16195E-08	1.42451E-05	1.06124E-06
1.81811E-09	2.28171E-10	9.19735E-12	1.45160E-06	2.18806E-08	6.29255E-09
1.81849E-09	8.37960E-02	1.40130E-09	2.09289E-10	7.96142E-08	8.47903E-10
6.87277E-10	2.66984E-09	1.66459E-09	2.80100E-07	1.51756E-06	6.84108E-06
1.36200E-08	1.89684E-08	2.77455E-08	1.36380E-07	1.87561E-10	1.60731E-09

Table 3. CONTINUED

1.39107E-07	2.81586E-08	2.95490E-07	4.99917E-09	3.50532E-08	1.95092E-07
9.01932E-08	1.49336E-09	3.51015E-10	2.10630E-08	5.99251E-08	5.06234E-09
2.70073E-08	5.14020E-04	0.0	1.00000E-09	2.31419E-04	2.31533E-04
1.21632E-06	2.37680E-06	2.37463E-07	1.05351E-05	1.69691E-06	2.10097E-09
1.14039E-09	7.34333E-11	1.41305E-06	2.62243E 00	1.20125E-08	5.08826E-09
8.37960E-02	1.43625E-09	1.00472E-10	1.25594E-07	1.51439E-09	1.11304E-09
3.32726E-09	1.70151E-09	4.44803E-07	2.58132E-06	1.09720E-05	1.36200E-04
2.65754E-08	4.76304E-08	2.12058E-07	1.09125E-10	2.70042E-09	2.25529E-07
2.90820E-08	5.09103E-07	2.63262E-08	5.46336E-08	3.22152E-07	2.00391E-08
4.09382E-09	5.09621E-10	2.10763E-08	1.13295E-07	6.11517E-09	4.75157E-06
5.14020E-04	0.0	1.00000E-09	6.10763E-08	2.29396E-04	1.20380E-06
3.31296E-06	4.25460E-07	7.59354E-06	2.17197E-06	2.03590E-09	2.98850E-09
2.48127E-10	1.37570E-06	2.51131E-08	1.52517E-08	8.33676E-09	8.37960E-02
1.30566E-09	1.53598E-10	1.53177E-07	1.91026E-09	1.31774E-09	3.46203E-09
1.61980E-09	5.67415E-07	3.56123E-06	1.51555E-05	1.36200E-04	3.04542E-08
6.62022E-08	2.63230E-07	9.73092E-11	3.66422E-09	2.95903E-07	2.67527E-08
6.97025E-07	5.08444E-08	7.11127E-08	4.30125E-07	3.09616E-08	7.56031E-09
9.35995E-10	2.00127E-08	1.67670E-07	4.31334E-09	6.35250E-06	5.14020E-04
0.0	1.00000E-09	1.09502E-07	2.27421E-04	1.22023E-06	3.97299E-06
6.16590E-07	5.51262E-06	2.48400E-06	1.79339E-09	5.39304E-09	6.10420E-10
1.34285E-06	2.27361E-08	1.59513E-08	1.01006E-08	8.37960E-02	1.09467E-09
1.32245E-10	1.46173E-07	2.01756E-09	1.37064E-09	3.14005E-09	1.48144E-08
6.44802E-07	4.39400E-06	1.07198E-05	1.36200E-04	4.95650E-08	8.23409E-08
2.91337E-07	7.98198E-11	4.75579E-09	3.40422E-07	2.27426E-08	8.49872E-07
7.77558E-08	8.51559E-06	5.14055E-07	4.11376E-08	1.11140E-08	1.38102E-09
1.60789E-08	2.15150E-07	6.48753E-09	7.59895E-08	5.14020E-04	0.0
1.00000E-09	1.56011E-07	2.25691E-04	1.08846E-06	4.40324E-06	7.84845E-07
4.12476E-06	2.67666E-06	1.49830E-09	7.73380E-09	1.07490E-09	1.31546E-06
2.06346E-08	1.54401E-04	1.06470E-06	8.37960E-02	8.81449E-10	1.16631E-10
1.70152E-07	1.92514E-09	1.34590E-09	2.63334E-09	1.33768E-09	6.93485E-07
5.07230E-06	2.16337E-05	1.36200E-04	5.93149E-08	9.53944E-08	3.03634E-07
6.20084E-11	5.43555E-09	3.45833E-07	1.05639E-08	9.44077E-07	1.02919E-07
9.74520E-08	5.76615E-07	4.97993E-08	1.42075E-08	1.62512E-08	1.34572E-08
2.52609E-07	6.64391E-09	8.54351E-08	5.14020E-04	0.0	1.00000E-09
1.94935E-07	2.20251E-04	9.32501E-07	4.67690E-06	9.20765E-07	3.21691E-06
2.79061E-06	1.21624E-09	9.69903E-09	1.54645E-09	1.29327E-06	1.98566E-08
1.46197E-08	1.05001E-08	8.37960E-02	6.97988E-10	1.05458E-10	1.69371E-07
1.72670E-09	1.20907E-08	2.10056E-09	1.21086E-09	7.19849E-07	5.61361E-06
2.39707E-05	1.36200E-04	6.75201E-08	1.05662E-07	3.07062E-07	4.07280E-11
5.93246E-09	4.12251E-07	1.40761E-08	1.05677E-06	1.24147E-07	1.08535E-07
6.22694E-07	5.60863E-08	1.67069E-08	1.80648E-09	1.00542E-08	2.00416E-07
6.76951E-09	9.27663E-08	5.14020E-04	0.0	1.00000E-09	2.25071E-07
2.23062E-04	7.78679E-07	4.05211E-06	1.02537E-06	2.62003E-06	2.05775E-06
9.72750E-10	1.12326E-08	1.98972E-09	1.27556E-06	1.79226E-08	1.38402E-08
1.01369E-08	8.37960E-02	5.49784E-10	9.72646E-11	1.66322E-07	1.40036E-09
1.22169E-09	1.63311E-09	1.10540E-09	7.33951E-07	6.44204E-06	2.58301E-05
1.36200E-04	7.42407E-08	1.13622E-07	3.06219E-07	3.77322E-11	6.29080E-09
4.31039E-07	1.10316E-08	1.12530E-06	1.40750E-07	1.10757E-07	6.56755E-07
6.25919E-08	1.86647E-08	2.09024E-09	8.57243E-09	3.00403E-07	6.06404E-09
9.84033E-08	5.14020E-04	0.0	1.00000E-09	2.47575E-07	2.22097E-04
6.39584E-07	4.06660E-06	1.10395E-06	2.22045E-06	2.09754E-06	7.72745E-10
1.23934E-08	2.37535E-09	1.26152E-06	1.71131E-08	1.32176E-08	9.75170E-09
8.37960E-02	4.32860E-10	9.08901E-11	1.62260E-07	1.24485E-09	1.15191E-09
1.25316E-09	1.01090E-09	7.41354E-07	6.38021E-06	2.73052E-05	1.36200E-04
7.96037E-08	1.19765E-07	3.03659E-07	2.93219E-11	6.54770E-09	4.48594E-07
9.30600E-09	1.17779E-06	1.52934E-07	1.20332E-07	6.02100E-07	6.71545E-08
2.01030E-08	2.24583E-09	6.76233E-09	3.14540E-07	6.93459E-09	1.02732E-07
5.14020E-04	0.0	1.00000E-09	2.64104E-07	2.21320E-04	5.19959E-07
5.04352E-06	1.16203E-06	1.94665E-06	2.92141E-06	6.12352E-10	1.32646E-08
2.69005E-09	1.25040E-06	1.65307E-08	1.27270E-08	9.41015E-09	8.37960E-02
3.41316E-10	8.55604E-11	1.57000E-07	1.02835E-09	1.80190E-09	9.55712E-10
9.46952E-10	7.45122E-07	6.64714E-06	2.84751E-05	1.36200E-04	8.40377E-08
1.24512E-07	3.00642E-07	2.20947E-11	6.73503E-09	4.54532E-07	7.44392E-09
1.21025E-06	1.61225E-07	1.37377E-07	7.01372E-07	7.07915E-08	2.13580E-08
2.36305E-09	5.33942E-09	3.24460E-07	6.98395E-09	1.06057E-07	5.14020E-04
0.0	1.00000E-09	2.76454E-07	2.20697E-04	4.20060E-07	5.09629E-06
1.20594E-06	1.75845E-06	2.93596E-06	4.85166E-10	1.39195E-08	2.96232E-09
1.24160E-06	1.61055E-08	1.23509E-08	9.12507E-09	8.37960E-02	2.69702E-10
8.07313E-11	1.53170E-07	8.35232E-10	1.01197E-09	7.27086E-10	8.05873E-10
7.46940E-07	6.05812E-06	2.94034E-05	1.36200E-04	8.75118E-08	1.20192E-07
2.97733E-07	1.79606E-11	6.07296E-09	4.61932E-07	5.90030E-09	1.24965E-06
1.66276E-07	1.45984E-07	7.16014E-07	7.36064E-08	2.22650E-08	2.44950E-09
4.22344E-09	3.31415E-07	7.01753E-09	1.08614E-07	5.14020E-04	0.0
1.00000E-09	2.05509E-07	2.20198E-04	3.30127E-07	5.13326E-06	1.23848E-06
1.61646E-06	2.94497E-06	3.84760E-10	1.44146E-08	2.17618E-09	1.23463E-06
1.57898E-08	1.20632E-08	8.09140E-09	8.37960E-02	2.13630E-10	7.60823E-11
1.48514E-07	6.71460E-10	9.41506E-10	5.52033E-10	8.32791E-10	7.47723E-07
7.02519E-06	3.01411E-05	1.36200E-04	9.02797E-08	1.31059E-07	2.95150E-07
1.41495E-11	6.97586E-09	4.67517E-07	4.69556E-09	1.27416E-06	1.60785E-07
1.50050E-07	7.27291E-07	7.59897E-08	2.29602E-08	2.51126E-09	3.34764E-09
3.36264E-07	7.03919E-09	1.10588E-07	5.14020E-04	0.0	1.00000E-09
2.92850E-07	2.19799E-04	2.71610E-07	5.15964E-06	1.26299E-06	1.51540E-06
2.95065E-06	3.05550E-10	1.47917E-08	3.34816E-09	1.22918E-06	1.55515E-08
1.10421E-08	8.69973E-09	8.37960E-02	1.69585E-10	7.14147E-11	1.43856E-07
5.35552E-10	8.78287E-10	4.20427E-10	7.85664E-10	7.47965E-07	7.15776E-06
3.07282E-05	1.36200E-04	9.24847E-08	1.33301E-07	2.92948E-07	1.11870E-11
7.05354E-09	4.71781E-07	3.73708E-09	1.39339E-06	1.69054E-07	1.61687E-07
7.36046E-07	7.78226E-08	2.34886E-08	2.55250E-09	2.65082E-09	3.39638E-07
7.05206E-09	1.12117E-07	5.14020E-04	0.0	1.00000E-09	2.97654E-07
2.19800E-04	2.17907E-07	5.17878E-06	1.28160E-06	1.44014E-06	2.95420E-06
2.42944E-10	1.50809E-08	3.48591E-09	1.22471E-06	1.53680E-08	1.16712E-08
8.54083E-09	8.37960E-02	1.34858E-10	6.66157E-11	1.39224E-07	4.28415E-10
7.90311E-10	3.19812E-10	7.43116E-10	7.47930E-07	7.26312E-06	3.11959E-05
1.36200E-04	9.42418E-08	1.35063E-07	2.91112E-07	8.84914E-12	7.11280E-09
4.75068E-07	2.97776E-09	1.30854E-06	1.67775E-07	1.68835E-07	7.42886E-07
7.92817E-08	2.30839E-08	2.57663E-09	2.11519E-09	3.41973E-07	7.05853E-09
1.13306E-07	5.14020E-04	0.0	1.00000E-09	3.01635E-07	2.19225E-04
1.74611E-07	5.19294E-06	1.29583E-06	1.38330E-06	2.95640E-06	1.93206E-10
1.53030E-08	3.59600E-09	1.22121E-06	1.52267E-08	1.15303E-08	8.40781E-09
8.37960E-02	1.07303E-10	6.16305E-11	1.34630E-07	3.34385E-10	7.25764E-10

Table 3. CONTINUED

2.03186E-13	7.24229E-10	7.67777E-07	7.34695E-06	3.15607E-05	1.36283E-06
5.54623E-08	1.36651E-07	2.69461E-07	7.04306E-12	7.15619E-09	4.77622E-07
2.37387E-09	1.32051E-06	1.65239E-07	9.75449E-07	7.40254E-07	8.04425E-08
2.03721E-08	2.58611E-09	1.64614E-09	3.63574E-07	7.06333E-09	1.10236E-07
5.94020E-04	0.0	1.00000E-09	3.24700E-07	2.19322E-06	1.39636E-07
5.20359E-06	1.30679E-06	1.36301E-06	2.95621E-06	1.53369E-13	1.56767E-06
3.68353E-09	1.27666E-06	1.51163E-06	1.76363E-06	4.29226E-09	8.37960E-02
8.54270E-11	5.64440E-11	1.33304E-07	2.61741E-10	6.52635E-13	1.84624E-13
6.68108E-10	7.67570E-07	7.61364E-06	3.10457E-05	1.36200E-06	9.67580E-08
1.37547E-07	2.48374E-07	5.59507E-12	7.19383E-09	4.79620E-07	1.49151E-09
1.33000E-06	1.63760E-07	1.61559E-07	7.52603E-07	8.11644E-08	2.43723E-08
2.50267E-09	1.34367E-09	3.64450E-07	7.05755E-09	1.14743E-07	5.14023E-08
0.0	1.00000E-09	3.07355E-07	2.10061E-06	1.11519E-07	5.29385E-06
9.39533E-06	1.30653E-06	2.95936E-06	1.23121E-10	1.56112E-08	3.75160E-09
1.21627E-06	1.49824E-09	1.13512E-09	8.19146E-09	8.37960E-02	6.81265E-11
5.81390E-11	1.25615E-07	2.02864E-10	5.76094E-10	1.40312E-10	6.32523E-10
7.67362E-07	7.66686E-06	3.21067E-05	1.36200E-06	9.76490E-08	1.38612E-07
2.07371E-07	4.45509E-12	7.22551E-09	4.91226E-07	1.53980E-09	1.33750E-06
1.57486E-07	1.67090E-07	7.55046E-07	8.23641E-08	2.44322E-08	2.50734E-09
1.06929E-09	3.45365E-07	7.04302E-09	1.15562E-07	5.14020E-04	0.0
1.00000E-09	3.08801E-07	2.10734E-06	8.76251E-08	5.20970E-06	1.32214E-06
1.27914E-06	4.96063E-08	6.92599E-13	3.57336E-08	3.79994E-09	[illegible]
1.47003E-08	1.12764E-08	6.10305E-05	8.37960E-02	5.63245E-11	4.65319E-11
1.21323E-07	1.55643E-13	4.92649E-10	1.09022E-10	5.84063E-13	7.67067E-07
7.51100E-06	3.22987E-05	1.36200E-06	5.41955E-08	1.39115E-07	2.06499E-07
3.68146E-12	7.25090E-09	4.02769E-07	1.24909E-09	1.34603E-06	1.52632E-07
1.92120E-07	7.58714E-07	8.26084E-08	2.45131E-08	2.54207E-09	8.03221E-10
1.45899E-07	6.98323E-09	1.16177E-07	5.14020E-04	0.0	1.00000E-09
3.09753E-07	2.35484E-06	3.36706E-07	3.03074E-07	1.40992E-06	1.03400E-05
3.27724E-07	6.08362E-10	8.70623E-12	1.22033E-13	1.48643E-06	7.95010E-09
9.26044E-09	1.03229E-10	8.37960E-02	6.20467E-10	1.10754E-10	2.43201E-08
1.99776E-10	1.08864E-10	1.01678E-09	7.91176E-10	9.40174E-04	4.56611E-07
1.92620E-06	1.36200E-06	6.35049E-09	8.28525E-09	6.33961E-08	4.78250E-11
4.72153E-10	4.32560E-08	1.26057E-08	8.63952E-08	1.13226E-09	1.21024E-08
5.97101E-08	2.70029E-09	2.19763E-10	1.31165E-10	9.22762E-09	1.60377E-08
2.75625E-09	7.88192E-09	5.14020E-04	0.0	1.00000E-09	3.27706E-09
2.33900E-04	8.45968E-07	1.16122E-06	7.43739E-08	1.06541E-05	9.04393E-07
1.60087E-09	1.66455E-13	5.81776E-12	1.65737E-06	2.02631E-08	5.41610E-09
1.45633E-09	8.37960E-02	1.29666E-09	2.08773E-10	7.52955E-08	7.03395E-10
6.28539E-10	2.39638E-09	1.63197E-09	2.61570E-07	1.40634E-06	5.96686E-06
1.36200E-06	1.36087E-08	2.56969E-08	1.27648E-07	5.96817E-11	1.48370E-09
1.29861E-07	2.60591E-08	2.75367E-07	7.63687E-09	3.49090E-08	1.81537E-07
9.30036E-09	1.25769E-09	3.28250E-10	1.94895E-08	5.46620E-08	5.76273E-09
2.57750E-08	5.14020E-04	0.0	1.00000E-09	1.89376E-08	2.32043E-06
1.00532E-06	2.18549E-06	1.93081E-07	1.11624E-05	9.58513E-06	1.85656E-09
8.04720E-10	4.76314E-11	1.42301E-06	2.50762E-08	1.07003E-08	4.24544E-09
8.37960E-02	1.32810E-09	1.02089E-10	1.20335E-07	1.30673E-09	1.03955E-09
2.90519E-09	1.66767E-09	4.17632E-07	2.38075E-06	1.01485E-05	1.36200E-06
2.43655E-08	4.39455E-08	2.00034E-07	1.01226E-10	2.56287E-09	2.11350E-07
2.68765E-08	4.74412E-07	2.17527E-06	5.67491E-08	3.00332E-07	1.81667E-08
3.05501E-09	5.20859E-10	2.02214E-08	1.02529E-07	6.05619E-09	4.44468E-08
5.14020E-04	0.0	1.00000E-09	5.07295E-08	2.30147E-06	1.14551E-06
3.08467E-06	3.48110E-07	4.31341E-06	2.05103E-06	1.83110E-09	2.29757E-09
8.70063E-10	9.39063E-06	2.45532E-08	1.41190E-08	7.22203E-09	8.37960E-02
1.21515E-09	1.57181E-13	1.49215E-07	1.72570E-09	1.15460E-09	3.07403E-09
1.59796E-09	5.37986E-07	3.30157E-06	1.40391E-05	1.36200E-06	3.51817E-08
6.12586E-08	2.51559E-07	9.14582E-11	3.57591E-09	2.79482E-07	2.49331E-08
6.52490E-07	4.21581E-08	7.16703E-08	4.03205E-07	2.61201E-08	6.44972E-09
8.18170E-10	1.06676E-08	1.51539E-07	6.15569E-09	5.99304E-08	5.14020E-04
0.0	1.00000E-09	9.71036E-08	2.28193E-08	1.05029E-06	3.70181E-06
5.88773E-07	6.22622E-06	2.37271E-06	1.59114E-09	4.27317E-09	4.22683E-13
9.36133E-06	2.24783E-08	1.52244E-08	9.26557E-09	8.37960E-02	1.03182E-09
1.36112E-10	1.64493E-07	1.88822E-09	1.32692E-09	2.81740E-09	1.07358E-09
6.19692E-07	4.08418E-06	1.73802E-05	1.36200E-06	4.53340E-08	7.62961E-08
2.82306E-07	7.58889E-11	4.42887E-09	3.31616E-07	2.13664E-08	7.98991E-07
6.07551E-08	8.62218E-08	4.84819E-07	3.75670E-08	9.59420E-09	1.73446E-09
1.58865E-04	1.90983E-07	6.27044E-09	7.20130E-08	5.14020E-04	0.0
1.00000E-09	1.31689E-07	2.26860E-06	9.73991E-07	4.18635E-06	6.53252E-07
4.78337E-06	2.58092E-06	1.33272E-09	6.30406E-09	7.50682E-10	1.33701E-06
2.08884E-08	1.59407E-08	1.00599E-06	8.37960E-02	8.35828E-10	1.20473E-10
1.70672E-07	1.78151E-09	1.31964E-09	2.37646E-09	1.33963E-09	6.70757E-07
4.72529E-06	2.01243E-05	1.36200E-06	5.42839E-08	8.66283E-08	2.97936E-07
6.82308E-11	5.09707E-09	3.69757E-07	1.75249E-08	9.14041E-07	8.61451E-08
9.90025E-08	5.46706E-07	4.57203E-08	1.24142E-08	1.43326E-09	1.29280E-08
2.29089E-07	6.37951E-09	8.13155E-08	5.14020E-04	0.0	1.00000E-09
1.66380E-07	2.25569E-06	8.35466E-07	4.47853E-06	7.72530E-07	3.80770E-06
2.71200E-06	1.08353E-09	8.08136E-09	1.10724E-09	1.31726E-06	1.89298E-08
1.44142E-08	1.01499E-08	8.37960E-02	6.63358E-10	1.08738E-10	1.71571E-07
1.60759E-09	1.27430E-09	1.90787E-09	1.21788E-09	7.01190E-07	5.23846E-06
2.23282E-05	1.36200E-06	6.10089E-08	9.84109E-08	3.04332E-07	4.69130E-11
5.59891E-09	3.97237E-07	1.40649E-08	1.00262E-06	1.04382E-07	1.30501E-07
5.92851E-07	5.20368E-08	1.67306E-08	1.67159E-09	1.02969E-08	2.56295E-07
6.47005E-09	8.84592E-08	5.14020E-04	0.0	1.00000E-09	1.93930E-07
2.20507E-04	6.98003E-07	4.67062E-06	8.66259E-07	3.14748E-06	2.79421E-06
8.67173E-10	9.52093E-09	1.44859E-09	1.30149E-06	1.77881E-08	1.37420E-08
9.94079E-09	8.37960E-02	5.22263E-10	9.98821E-11	1.69645E-07	1.30926E-09
1.21338E-09	1.08945E-09	1.11434E-09	7.18982E-07	5.64406E-06	2.40402E-05
1.36200E-06	6.80767E-08	1.06042E-07	3.05073E-07	3.63532E-11	5.96875E-09
4.17069E-07	1.11770E-08	1.07047E-06	1.16786E-07	1.24061E-07	6.27219E-07
5.78468E-08	1.65801E-08	1.86170E-09	8.12837E-09	2.75600E-07	6.54010E-09
9.39418E-08	5.14020E-04	0.0	1.00000E-09	2.14968E-07	2.23645E-04
5.73334E-07	6.79880E-06	9.38030E-07	2.69479E-06	2.84628E-06	6.88789E-10
1.06360E-08	1.75172E-09	1.20898E-06	1.69617E-08	1.31591E-08	9.64670E-09
8.37960E-02	4.10367E-10	9.26011E-11	1.66269E-07	1.16580E-09	1.14632E-09
1.19545E-09	1.02791E-09	7.29145E-07	5.96534E-06	2.54672E-05	1.36200E-06
7.31159E-08	1.11957E-07	3.05095E-07	2.82017E-11	6.24030E-09	4.31521E-07
8.84755E-09	1.12254E-06	1.29430E-07	1.30895E-07	6.52973E-07	6.21664E-08
1.88149E-08	7.88760E-09	6.39986E-09	2.99879E-07	6.59709E-09	9.81888E-08

Table 3. CONTINUED

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4.80605E-06	9.92305E-07	2.37050E-06	2.47587E-06	5.05468E-10	1.16866E-08
2.06310E-09	1.27908E-06	1.61617E-06	1.24083E-08	9.15495E-09	8.37960E-02
3.22600E-10	8.69106E-11	1.62163E-07	9.50303E-10	1.37066E-05	8.70365E-10
9.55322E-10	7.15050E-07	4.21709E-06	2.45661E-09	1.36200E-04	7.71606E-06
1.10538E-07	3.03702E-07	2.19563E-11	6.00592E-09	4.42184E-07	4.99725E-09
1.16260E-06	1.36760E-07	1.40124E-07	4.72440E-07	6.55992E-08	1.91260E-06
2.11740E-09	5.03860E-09	2.99355E-07	6.62092E-09	1.01363E-07	5.14020E-04
0.0	1.00000E-09	2.42654E-07	2.22395E-06	3.76372E-07	4.90605E-06
1.03367E-06	2.15303E-06	2.93795E-06	4.31760E-10	1.21383E-08	2.22271E-09
1.27126E-06	1.55710E-09	1.23205E-09	4.10301E-09	8.17463E-02	2.56170E-10
6.95353E-11	1.57651E-07	7.76263E-10	1.30561E-09	6.66956E-10	8.93326E-10
7.38663E-07	6.61709E-06	2.76328E-09	1.36200E-04	8.03300E-08	1.20055E-07
3.31610E-07	1.71664E-11	6.59032E-09	6.50155E-07	5.53721E-09	1.19380E-06
1.41260E-07	9.68075E-07	6.61301E-07	6.83224E-06	1.59785E-08	2.19821E-09
1.97366E-09	3.36360E-07	6.65301E-09	1.33668E-07	5.14020E-04	0.0
1.00000E-09	2.51596E-07	2.21950E-06	3.72381E-07	4.98951E-06	1.06661E-06
1.96191E-06	2.91405E-06	3.61902E-10	1.22366E-08	2.39688E-09	1.26506E-06
1.55930E-08	1.20366E-06	6.66336E-09	8.37960E-02	2.03702E-10	7.61850E-11
1.53062E-07	6.21973E-10	9.32099E-10	5.35113E-10	8.39287E-10	7.60636E-07
6.57667E-06	2.61197E-09	1.36200E-04	6.25663E-09	1.22666E-07	2.99527E-07
1.36775E-11	6.70276E-09	4.56165E-07	6.18758E-09	1.10358E-06	1.61676E-07
1.56982E-07	6.56133E-07	7.06032E-10	2.30315E-08	2.25532E-09	3.11996E-09
3.11128E-07	6.66533E-09	1.05769E-07	5.14020E-04	0.0	1.00000E-09
2.50380E-07	2.21596E-06	2.62579E-07	5.32033E-06	1.08036E-06	1.06806E-06
2.92716E-06	2.71209E-10	1.33596E-08	2.53770E-09	1.26376E-06	1.53652E-08
1.18127E-08	8.70367E-09	8.37960E-02	1.50666E-10	7.12660E-11	1.68311E-07
6.96301E-10	8.59229E-10	3.43614E-10	7.91650E-10	7.61572E-07	6.69936E-06
2.06653E-05	1.36200E-04	6.50135E-08	1.25036E-07	2.97036E-07	1.36193E-11
6.78021E-09	6.63793E-07	3.61956E-09	1.23706E-06	1.63689E-07	1.66627E-07
7.07596E-07	7.21975E-09	2.11260E-06	2.29306E-09	2.08652E-09	3.16036E-07
6.67606E-09	1.07279E-07	5.14020E-04	0.0	1.00000E-09	2.53566E-07
2.21310E-06	1.96322E-07	5.06287E-06	1.10658E-06	1.77722E-06	2.93637E-06
2.15311E-10	1.33393E-06	2.65117E-09	1.25626E-08	1.51557E-08	1.16602E-06
8.54623E-09	8.37960E-02	1.25960E-10	6.60573E-11	1.63556E-07	3.90262E-10
7.86126E-13	2.91297E-10	7.66032E-10	7.62219E-07	6.75786E-06	2.90998E-05
1.36200E-04	8.66656E-08	1.26736E-07	2.96366E-07	6.39207E-12	6.05371E-09
6.66366E-07	2.76656E-09	1.25157E-06	1.62681E-07	1.71736E-07	7.16536E-07
7.35586E-08	2.16967E-08	2.31665E-05	1.37260E-09	3.17301E-07	4.68228E-09
1.08638E-07	5.14020E-04	0.0	1.00000E-09	2.67554E-07	2.21386E-06
1.55633E-07	5.05968E-06	8.12656E-06	1.70031E-06	2.93353E-06	1.70956E-10
1.35362E-08	2.74203E-09	1.25317E-06	1.50051E-08	1.15356E-08	8.61669E-09
8.37960E-02	9.95456E-11	6.07072E-11	1.38602E-07	1.36276E-10	7.09631E-10
2.21023E-10	7.38665E-10	7.62578E-07	6.87625E-06	2.98636E-05	1.36200E-04
8.79666E-08	1.28376E-07	2.95165E-07	6.66204E-12	6.50425E-09	6.67103E-07
2.19898E-09	1.26376E-06	1.40773E-07	1.76202E-07	7.19922E-07	7.66392E-08
2.17662E-08	2.32236E-05	1.56576E-09	3.19028E-07	6.68252E-09	1.39363E-07
5.14020E-04	0.0	1.00000E-09	2.70666E-07	2.20904E-06	1.21987E-07
5.37265E-06	1.33166E-06	1.65606E-06	2.96333E-06	1.15369E-10	1.37126E-06
2.01661E-09	1.25372E-06	1.48916E-08	1.14603E-08	6.33362E-09	8.37960E-02
7.92586E-11	5.51969E-11	1.36081E-07	2.16695E-10	6.34571E-10	1.67326E-10
6.72323E-10	7.62770E-07	6.93862E-06	2.97369E-05	1.36200E-04	8.89771E-08
1.29130E-07	2.94160E-07	5.25667E-12	6.64352E-09	6.69255E-07	1.76606E-09
1.27306E-06	1.37819E-07	1.86250E-07	7.26173E-07	7.54966E-08	2.19680E-08
2.31796E-09	1.26208E-07	3.20226E-07	6.67928E-09	1.10352E-07	5.14020E-04
0.0	1.00000E-09	2.73036E-07	2.20761E-06	9.62761E-08	5.00166E-06
1.13991E-06	1.61691E-06	2.96536E-06	1.05698E-10	1.38512E-08	2.87009E-09
1.20081E-06	1.67651E-08	1.11167E-06	6.20062E-09	8.37960E-02	6.28652E-11
6.95988E-11	1.29626E-07	1.86321E-10	5.57425E-10	1.26355E-10	6.36982E-10
7.62856E-07	6.98778E-06	2.99161E-05	1.36200E-04	8.97987E-08	1.29961E-07
2.93336E-07	4.16612E-12	6.97691E-09	6.70967E-07	1.36673E-09	1.24062E-06
1.36205E-07	1.89626E-07	7.27535E-07	7.61613E-08	2.20601E-08	2.30261E-09
9.85656E-10	3.21052E-07	6.66731E-09	1.10628E-07	5.14020E-04	0.0
1.00000E-09	2.74818E-07	2.20653E-06	7.71085E-08	5.08356E-06	1.16666E-06
1.58201E-06	2.94069E-06	7.63386E-11	1.39700E-08	2.91139E-09	1.24706E-06
1.05216E-08	1.12613E-06	6.11117E-09	8.37960E-02	5.15177E-11	6.06476E-11
1.26926E-07	1.63165E-10	6.72653E-10	9.76929E-11	5.95682E-10	7.62828E-07
7.02860E-06	3.01121E-05	1.36200E-04	9.06786E-08	1.30632E-07	2.92616E-07
3.69856E-12	7.00627E-09	6.72691E-07	1.11685E-09	1.28640E-06	1.30365E-07
1.96676E-07	7.30356E-07	7.66516E-08	2.20877E-08	2.27781E-09	8.06828E-10
3.21649E-07	6.61966E-09	1.11193E-07	5.14020E-04	0.0	1.00000E-09
2.75806E-07	2.35566E-06	2.96265E-07	2.06267E-07	1.17406E-08	1.83325E-05
3.25769E-07	5.06852E-10	7.80967E-12	8.95592E-10	1.66723E-06	6.19101E-09
1.02422E-09	1.56076E-10	8.37960E-02	6.15297E-10	1.08533E-10	2.52867E-06
1.91318E-10	1.67523E-10	1.02870E-09	7.58275E-10	9.04029E-08	6.68008E-07
1.98208E-06	1.36200E-04	4.47220E-09	6.69246E-09	6.66053E-08	6.91768E-11
4.82342E-10	6.66766E-08	1.28056E-08	6.90937E-08	1.00076E-05	1.18622E-08
6.15639E-08	2.75126E-09	2.09302E-10	1.29015E-10	9.50067E-09	1.66606E-08
2.73533E-09	8.27690E-07	5.14020E-04	0.0	1.00000E-05	2.61668E-09
2.36208E-06	7.36138E-07	9.95870E-07	6.10028E-08	1.45723E-05	9.70374E-07
1.25698E-09	1.39569E-10	3.97218E-12	3.46631E-06	1.56320E-08	4.28352E-09
1.18167E-09	8.37960E-02	1.30963E-09	2.32894E-10	7.83019E-08	7.10690E-10
5.67950E-10	2.33704E-09	1.53260E-09	2.66812E-07	1.42832E-06	6.05966E-06
1.36200E-04	1.39197E-08	2.58811E-08	1.29460E-07	1.00472E-10	1.49966E-09
1.12801E-07	2.62972E-08	2.81028E-07	6.39762E-09	1.40404E-08	1.85067E-07
9.25278E-09	1.15256E-09	3.13921E-10	1.96909E-08	5.86861E-08	5.62167E-09
2.68193E-08	5.14020E-04	0.0	1.00000E-09	1.47779E-08	2.32616E-04
9.30176E-07	1.89867E-06	1.57057E-07	1.11164E-05	1.55267E-06	1.44052E-09
6.94793E-10	3.12615E-11	1.84001E-06	1.92366E-08	8.31875E-09	3.36801E-09
8.37960E-02	1.30061E-09	1.74598E-10	1.25333E-07	1.28960E-09	9.42016E-10
2.76217E-09	1.52112E-09	6.15652E-07	2.38831E-06	1.01463E-05	1.36200E-04
2.40622E-08	4.33111E-08	1.99832E-07	9.49257E-11	2.52294E-09	2.33795E-07
2.62766E-08	4.78587E-07	1.80179E-08	5.30519E-08	3.02280E-07	1.76177E-08
3.07942E-09	4.79469E-10	1.98078E-06	9.98461E-08	5.73903E-09	4.56616E-08
5.14020E-04	0.0	1.00000E-09	3.91667E-08	2.31305E-08	9.79280E-07
2.67739E-06	2.83024E-07	8.30886E-06	2.00669E-06	1.39679E-09	1.85752E-09
1.15135E-10	1.61451E-06	1.89018E-08	1.08833E-08	5.69807E-09	8.37960E-02
1.16837E-09	1.08462E-10	1.55780E-07	1.65035E-09	1.18858E-09	2.79117E-09
1.63690E-07	5.28160E-07	1.25980E-06	1.38625E-05	1.36200E-04	3.41248E-08
5.92659E-08	2.48899E-07	8.75336E-11	3.67012E-09	2.60468E-07	2.38283E-06

Table 3. CONTINUED

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1.27735E-07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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2.15556E-05	1.36220E-06	[illegible]	[illegible]	[illegible]	[illegible]
5.33769E-09	3.93570E-07	[illegible]	[illegible]	8.64645E-08	1.35383E-07
5.01966E-07	6.91966E-06	1.27751E-08	1.04649E-09	[illegible]	2.36225E-07
5.75645E-09	8.93026E-08	5.14023E-06	0.0	1.00000E-09	1.69116E-07
3.36178E-06	6.03933E-07	6.09965E-06	7.37616E-07	3.18335E-06	2.75625E-06
[illegible]	7.66893E-09	9.23266E-10	1.36566E-06	1.15737E-08	1.36900E-08
7.75403E-09	8.37960E-02	4.76566E-16	9.00263E-11	1.77563E-07	1.36669E-08
1.12169E-09	1.31593E-09	[illegible]	6.86520E-07	[illegible]	[illegible]
3.36206E-08	6.36860E-08	9.05863E-08	2.95279E-07	3.32600E-11	5.60193E-09
[illegible]	1.01554E-08	1.09936E-06	9.42660E-08	[illegible]	4.11667E-07
5.01110E-08	1.03633E-08	1.69886E-09	7.41009E-09	2.56583E-07	5.78669E-09
9.65807E-08	5.14020E-06	0.0	1.00000E-09	1.65571E-07	2.25635E-06
4.95352E-07	6.22291E-06	7.80356E-07	2.72660E-06	2.81519E-06	5.37868E-13
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8.37960E-02	3.71956E-13	8.63036E-11	1.73768E-07	1.38916E-09	1.35939E-09
1.08033E-09	9.12633E-10	6.91516E-07	5.71668E-06	2.63969E-05	1.36230E-06
6.81960E-08	1.03624E-07	2.93634E-07	2.56025E-11	5.91688E-09	6.25603E-07
7.90690E-09	1.13021E-06	1.06526E-07	1.21630E-07	6.37760E-07	[illegible]
1.55997E-08	1.73125E-09	5.79672E-09	2.69076E-07	[illegible]	9.85656E-08
5.14020E-04	0.0	1.00000E-09	1.78335E-07	2.26836E-06	6.02986E-07
6.33732E-06	8.46638E-07	2.40606E-06	2.85331E-06	6.26181E-10	9.27596E-07
1.28386E-09	3.32799E-06	1.29066E-08	9.92981E-09	7.33536E-09	8.37960E-02
2.90900E-10	7.43136E-11	1.69200E-07	8.07806E-10	6.93726E-10	7.70169E-10
8.80267E-10	6.96959E-07	5.96376E-06	2.53611E-05	1.36200E-06	7.17196E-06
1.07507E-07	2.91276E-07	1.96223E-11	6.12667E-09	4.35813E-07	6.26436E-06
1.13776E-06	1.12666E-07	1.31967E-07	6.55669E-07	6.10902E-08	1.65537E-08
1.82467E-09	4.53653E-03	2.77997E-07	5.83507E-09	1.03571E-07	5.14320E-06
0.0	1.00000E-09	1.87465E-07	2.26155E-06	3.25333E-07	6.36761E-06
4.65178E-07	2.17666E-06	2.87868E-06	3.37356E-10	9.82129E-09	1.62195E-09
1.32188E-06	1.25783E-08	9.65954E-09	7.16757E-09	8.37960E-02	2.24163E-10
7.32350E-11	1.60272E-07	7.11346E-10	9.26255E-10	5.85134E-10	7.93397E-10
6.96699E-07	6.12004E-06	2.61567E-05	1.36200E-06	7.65635E-08	[illegible]
2.88633E-07	1.58282E-11	6.26913E-09	6.63233E-07	4.55235E-09	1.16675E-06
1.16501E-07	1.39787E-07	6.69273E-07	6.35219E-08	1.72855E-08	1.89307E-09
3.56354E-09	2.88365E-07	5.86892E-09	1.33894E-07	5.14320E-06	0.0
1.00000E-09	1.96576E-07	2.23971E-06	2.61560E-07	4.41399E-06	8.91289E-07
2.00996E-08	2.89668E-06	2.67267E-10	1.02610E-07	1.53503E-09	1.31734E-06
3.23366E-08	9.66967E-09	6.98696E-09	8.37960E-02	1.79496E-10	6.86331E-11
1.59176E-07	5.67312E-10	8.57669E-10	6.63956E-10	7.45669E-10	6.57040E-07
6.26068E-06	2.67690E-05	1.36200E-06	7.68376E-08	1.12866E-07	2.86501E-07
1.20630E-11	6.37702E-09	8.48627E-07	3.91331E-09	1.18730E-06	1.18266E-07
1.47118E-07	6.79702E-07	6.58625E-08	1.78631E-08	1.94113E-09	2.80567E-09
2.88854E-07	5.85755E-09	1.05686E-07	5.14023E-06	0.0	1.00000E-09
2.00038E-07	2.23668E-06	2.09734E-07	4.44269E-06	9.16880E-07	1.88635E-06
2.93908E-06	2.11856E-10	1.05650E-08	1.62673E-09	1.31321E-06	1.21517E-08
9.28653E-09	6.85122E-09	8.37960E-02	1.41598E-10	6.37313E-11	1.58017E-07
6.47776E-10	7.87685E-10	3.36766E-10	7.03255E-10	6.97076E-07	6.37134E-06
2.72534E-05	1.36200E-06	7.86418E-08	1.14669E-07	2.64617E-07	9.47212E-12
6.65946E-09	4.53090E-07	3.09350E-07	1.20691E-06	1.18543E-07	1.53964E-07
6.87763E-07	6.69612E-08	3.82636E-08	1.97253E-09	2.21461E-09	2.92050E-07
5.86205E-09	1.07069E-07	5.14020E-06	0.0	1.00000E-09	2.04178E-07
2.23619E-06	1.67877E-07	4.46623E-06	9.31540E-07	1.79350E-06	2.91817E-06
1.68094E-10	1.08159E-08	1.70066E-09	1.31017E-06	1.23130E-08	9.15998E-09
6.73615E-09	8.37960E-02	1.11932E-10	5.89209E-11	1.48861E-07	3.51134E-10
7.17287E-10	2.55342E-10	6.65042E-10	6.96873E-07	6.45901E-06	2.76371E-05
1.36290E-06	8.00765E-08	1.16096E-07	2.48957E-07	7.96388E-12	6.52285E-09
4.56368E-07	2.45082E-09	1.22073E-06	1.17657E-07	1.60313E-07	6.94024E-07
6.81633E-08	1.85756E-08	1.99002E-09	1.75185E-09	2.94309E-07	5.86342E-09
1.08145E-07	5.14020E-06	0.0	1.00000E-09	2.07398E-07	2.23224E-06
1.34118E-07	4.48404E-06	9.44462E-07	1.72321E-06	2.92483E-06	1.33346E-10
1.10107E-08	1.75997E-09	1.30776E-06	1.19370E-08	9.06151E-09	6.63752E-09
8.37960E-02	8.85488E-11	5.40287E-11	1.61740E-07	2.74062E-10	6.46705E-10
1.93373E-10	6.30251E-10	6.96575E-07	6.52839E-06	2.79411E-05	1.36200E-06
8.12163E-08	1.17217E-07	2.81581E-07	5.88585E-12	6.57190E-09	4.58703E-07
1.94226E-09	1.23160E-06	1.15870E-07	1.66149E-07	6.98315E-07	6.91150E-08
1.88011E-08	1.99563E-09	1.38609E-09	2.95896E-07	5.86253E-09	1.08982E-07
5.14020E-06	0.0	1.00000E-09	2.39896E-07	2.23369E-06	1.36784E-07
4.49783E-06	9.54450E-07	1.66946E-06	2.92977E-06	1.05034E-10	1.11620E-08
1.80724E-09	1.30585E-06	1.18237E-08	8.98478E-09	6.55169E-09	8.37960E-02
6.99515E-11	4.89923E-11	1.38676E-07	2.12307E-10	5.76114E-10	1.45969E-10
5.98247E-10	6.96256E-07	6.58320E-06	2.81816E-05	1.36200E-06	1.21197E-08
1.18097E-07	2.80458E-07	4.63959E-12	[illegible]	4.60873E-07	[illegible]
1.24015E-06	1.13393E-07	1.71454E-07	7.02739E-07	6.98662E-08	1.89562E-08
1.99075E-09	1.09536E-09	2.97002E-07	5.85957E-09	1.09636E-07	5.14020E-06
0.0	1.00000E-09	2.11833E-07	2.22947E-06	8.43675E-08	4.50840E-06
9.62226E-07	1.62822E-06	2.93351E-06	8.21272E-11	[illegible]	[illegible]

Table 3. CONTINUED

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6.95951E-07 6.82601E-06 2.03712E-03 1.36260E-06 8.30330E-06 1.70706E-07
2.79368E-07 3.66047E-12 6.63904E-09 6.62619E-07 1.21960E-09 1.20609E-06
5.96377E-07 1.74269E-07 7.05737E-07 7.26349E-09 1.91560E-06 1.97417E-09
8.63165E-10 2.07760E-07 5.05106E-39 1.15117E-07 5.10620E-06 0.0
1.09621E-09 2.13293E-07 2.23533E-06 6.17730E-06 6.51306E-06 9.60615E-07
1.50172E-06 2.93659E-06 6.06963E-11 3.13760E-06 1.07300E-09 1.36127E-06
1.15036E-06 8.07463E-09 6.66716E-09 8.37960E-02 6.61335E-11 3.96079E-11
1.20056E-07 1.22279E-15 6.27663E-15 8.33200E-11 5.36313E-10 6.95663E-07
6.66113E-06 2.05233E-05 1.36406E-26 8.36188E-06 1.95327E-07 2.70703E-07
2.91560E-12 8.66653E-39 6.63720E-27 1.19373E-15 1.23237E-06 1.06917E-07
1.05644E-07 7.60172E-07 7.00032E-08 1.06791E-08 1.95331E-09 6.91631E-10
2.96305E-37 7.62372E-09 1.16036E-37 5.16620E-06 0.0              1.00000E-39
2.36236E-07 2.36162E-06 0.0                 3B    2.01720E-05
0.0               6B    1.69919E-06 0.0                 3B    8.37960E-02
0.0              15B    1.36200E-06 0.0                10B    5.16620E-06
0.0          1.00000E-39 0.0              2.36162E-06 0.0                  3B
2.01720E-05 0.0                 6B    1.69919E-06 0.0                 3B
8.37960E-02 0.0                15B    1.36200E-06 0.0                10B
5.16620E-06 0.0          1.00000E-39 0.0              2.36162E-06
0.0               3B    2.01720E-05 0.0                 6B    1.69919E-06
0.0               3B    8.37960E-02 0.0                15B    1.36200E-06
0.0              10B    5.16620E-06 0.0              1.00000E-39 0.0
2.36162E-06 0.0                 3B    2.01720E-05 0.0                 6B
1.69919E-06 0.0                 3B    8.37960E-02 0.0                15B
1.36200E-06 0.0                10B    5.16620E-06 0.0              1.00000E-39
0.0          2.36162E-06 0.0                 3B    2.01720E-05
0.0               6B    1.69919E-06 0.0                 3B    8.37960E-02
0.0              15B    1.36200E-06 0.0                10B    5.16620E-06
0.0          1.00000E-39 0.0              2.36162E-06 0.0                  3B
2.01720E-05 0.0                 6B    1.69919E-06 0.0                 3B
8.37960E-02 0.0                15B    1.36200E-06 0.0                10B
5.16620E-06 0.0          1.00000E-39 0.0              2.36162E-06
0.0               3B    2.01720E-05 0.0                 6B    1.69919E-06
0.0               3B    8.37960E-02 0.0                15B    1.36200E-06
0.0              10B    5.16620E-06 0.0              1.00000E-39 0.0
2.36162E-06 0.0                 3B    2.01720E-05 0.0                 6B
1.69919E-06 0.0                 3B    8.37960E-02 0.0                15B
1.36200E-06 0.0                10B    5.16620E-06 0.0              1.00000E-39
0.0              10B    1.43630E-03 0.0                30B    1.26333E-03
0.0              15B    8.01300E-02 0.0                66B    7.02600E-02
0.0              33B
39 CAUSES              $CARD B  ASE      $
1D       4      67       0       1       0       1     4:)       3      3B
     1      2B        3      2B
 2D /
    *IE30  SAME AS IE05 PLUS NP-237,LESS XE-135                        *
    *                    HE       CMO-147 I-135       CMICVBLCGBBSIE-135*
    *CS-133CS-134CS-135PM-147PM148MPM-148SM-149SM-151EU-153 U-236*
    *PU-242AM-243     FP2     FP1TH-232 U-233 U-234 U-235NP-239PU-149*
    * KR-83 KR-85RH-103RU-105AG-109XE-131XE-133ND-143ND-145SM-150*
    *SM-152EU-154EU-155PA-233 U-238PU-239PU-240PU-241PU-237*
9.07444E-01 3.25543E-02 1.12421E-07 2.02055E-11 1.14525E 09 1.00641E 08
6.11920E 06 6.96834E 05 1.69183E 07 1.03155E 05 5.82907E 02 1.85560E 00
5.00000E-03
 4D /
    *     HE       CMO-147 I-135       CMICVBLCOBBBSIE-135CS-133CS-134*
    *CS-135PM-147PM148MPM-148SM-149SM-151EU-153 U-236PU-242AM-243*
    *    FP2     FP1TH-232 U-233 U-234 U-235NP-239PM-149 KR-83 KR-85*
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    *0000  0000  0000  0000  0000  0000  0000  0000  0000  0000  *
    *0000  0000  0000  0000  0000  0000  0000  0000  0000  0000  *
    *0000  0000  0000  0000  0000  1119  1262  1264  1265  1266  *
    *1145  *
0.00000E 00 1.20000E 01 1.47000E 02 1.35000E 02 8.00000E 00
0.0              2B    1.35000E 02 1.33000E 02 1.36600E 02 1.35000E 02
1.47000E 02 1.48000E 02      2B    1.49000E 02 1.51000E 02 1.53000E 02
2.36000E 02 2.42000E 02 2.43000E 02 1.16000E 02      2B    2.32000E 02
2.33000E 02 2.34000E 02 2.35000E 02 2.39000E 02 1.49000E 02 8.20000E 01
8.30000E 01 1.03000E 02 1.05000E 02 1.39000E 02 1.31000E 02 1.33000E 02
1.43000E 02 1.45000E 02 1.50000E 02 1.52000E 02 1.54000E 02 1.55000E 02
2.33000E 02 2.38000E 02 2.39000E 02 2.40000E 02 2.41000E 02 2.37000E 02
0.0             17B    3.26000E-11 3.38000E-11 3.39000E-11
0.0              2B    3.10000E-11 3.19000E-11      2B    3.21000E-11
3.27000E-11 0.0             14B    3.19000E-11 3.31000E-11 3.30000E-11
3.36000E-11 3.37000E-11 3.39000E-11 0.0             42B    7.60000E-13
1.03000E-12 8.70000E-13 1.00000E-12 0.0             44B
9.00000E 02     47B    0.0             94B
     5     2B      4     2B      5     3B      4    10B      3     3B
     4     2B      2      1      2      1     2B      4    14B      1
     2      1      2      1      3      0      1      0    17B
     1     3B      0     2B      1     5B      0    14B      1     9B
     0     4B
5D   2.72675E 00 2.20472E 00 2.26202E 00 2.81667E 00 2.81669E 00
1.69928E-04 1.71096E-04 0.0              5.30702E 00 0.0              6.14410E 00
6.46512E 00 4.61560E 00 1.19646E-01 5.68839E 00 4.97637E 00 5.86730E 00
6.05219E 00 5.19120E 00 5.55163E 00 1.68009E-02 5.83656E-02 6.38119E 00
5.51373E 00 5.23215E 00 5.44584E 00 5.93443E 00 2.69747E 00 8.81338E-03
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6.48543E 00 6.49399E 00 5.13952E 00 5.14034E 00 7.24509E 00 7.07715E 00
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Table 3. CONTINUED

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7.87908E 00 7.83105E 00 8.13743E 00 3.78611E 00 1.00052E-02 5.75836E 00
6.54925E 00 2.81468E 00 6.46540E 00 6.39370E 00 0.0         6.53929E 00
6.84805E 00 7.24621E 00 7.24716E 00 7.38300E 00 7.23138E 00 7.76260E 00
8.31911E 00 8.10449E 00 8.03684E 00 8.30054E 00 8.23446E 00 0.0
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1.12309E-01 1.98084E-02 6.89954E-02 1.33771E-01 1.00169E-01 1.45830E-01
1.34672E-01 1.77390E-01 5.42370E-05 1.00052E-02 6.96959E-02 1.61773E-01
2.81468E 00 3.55081E-03 7.43168E-02 0.0         4.56981E-02 4.17935E-02
4.53866E-02 4.67278E-02 4.78093E-01 1.68942E-01 2.38447E-01 9.60310E-02
7.42090E-02 1.17012E-01 1.33562E-01 4.97173E-01 0.0                 17R
3.43251E-01 8.51617E-01 6.58659E-02 0.0                 2R  3.75753E-02
2.01422E 00 9.00457E-01 1.26974E 00 9.99135E-01 0.0                 14R
2.39641E-01 1.50326E-01 1.71910E 00 9.97331E-01 1.44508E 00 9.76313E-01
0.0               17R 2.67375E 00 3.07247E 00 3.30557E 00
0.0                2R 2.38996E 00 2.60555E 00 2.49045E 00 2.57337E 00
2.68862E 00 0.0                14R 2.59917E 00 2.73709E 00 3.05436E 00
3.12018E 00 3.10474E 00 2.96357E 00 0.0                17R  9.67491E-01
9.69033E-01         2R  0.0                  2R  9.64726E-01      2R
9.67491E-01         2R  9.67563E-01 0.0                 14R  9.60562E-01
9.65305E-01 9.66769E-01 9.66450E-01 9.65702E-01 9.64023E-01 0.0
1.63978E-04 1.68523E-04 2.46417E-03 2.46418E-03 0.0                  9R
4.34521E-05 0.0         1.77254E-05 0.0                10R  3.30738E-03
0.0               19R   1.10449E-06 0.0                 2R  4.50605E-06
4.50607E-06 0.0                 9R  4.34521E-05 0.0         3.77250E-05
0.0               10R   4.85918E-06 0.0                27R  3.79669E-04
0.0         3.79669E-04 3.33988E-04 0.0                  2R  3.04659E-03
0.0         5.40800E-04 2.03267E-03 1.56080E-03 0.0                  3R
5.22697E-03 2.34937E-03 7.44109E-04 2.86591E-03 3.20318E-03
0.0                2R   2.06015E-05 1.72929E-04 0.0         2.40303E-04
4.11248E-04 0.0         1.09935E-03      2R   2.96853E-03      2R
4.77579E-04 4.67028E-04 1.05821E-03 4.21759E-03 8.80445E-04 3.56570E-04
6.18094E-03 5.30730E-04
50  4.82290E-01 4.35231E 00 4.35237E 00 3.49753E 00 3.49753E 00
2.06140E-03 2.06140E-03 1.52321E-05 9.26764E 00 2.14095E-01 8.29260E 00
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4.15390E 00 9.49521E-04 0.0                15R  1.21289E-04 2.69034E 00
1.35594E-01 5.10008E 00 2.37119E-02 0.0                 14R  2.81522E 00
3.04800E 00 0.0                 3R  2.50295E 00 2.51197E 00 2.48354E 00
2.51398E 00 0.0                15R  2.32166E 00 2.87625E 00 2.87262E 00
2.93456E 00 2.74368E 00 0.0                17R  3.25084E-02
3.09656E-02         2R  0.0                  2R  3.32735E-02      2R
3.25084E-02         2R  3.24364E-02 0.0                 14R  3.54358E-02
3.46541E-02 3.32113E-02 3.35582E-02 3.42969E-02 3.59889E-02
0.0               47R   1.33889E-05 0.0                 23R
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3.61728E-02 3.61728E-02 3.78285E 01 7.33304E 01 4.84648E 00 1.35521E 01
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7.30751E 03 1.48671E 02 2.60451E 02 2.19646E 02 4.90488E 01 1.67291E 02
4.88853E 01 1.00471E 00 1.14621E 01 8.84712E 00 1.57413E 01 1.02368E 02
2.05401E 01 7.26987E 01 0.0         3.31288E 01 2.67233E 01 5.00069E 00
5.24403E 02 2.22075E 02 1.24670E 02 6.77641E 00 1.07204E 01 4.95280E 01
4.60413E 01 3.45577E 02 9.83011E 01 5.00762E 02 6.17149E 01 4.41639E 01
2.59195E 01 2.53076E 01 1.78970E 01 5.38817E 01 0.0                 23R
6.85055E 01 0.0         3.09190E 01 0.0                16R  2.30618E-08
3.44931E 01 1.71391E-01 8.12202E 01 9.65878E-02 0.0                 23R
2.50290E 00 0.0         2.48200E 00 0.0                16R  2.31952E 00
```

Table 3. CONTINUED

```
2.87331E 00 2.86903E 00 2.93252E 00 2.74003E 00 0.0             41R
6.89751E-06 6.74645E-06 6.45220E-06 6.51945E-06 6.67079E-06 7.01303E-06
0.0              47R   2.10631E-04 0.0                    93R
5D   8.01320E-01 4.78763E 00 4.76718E 00 3.05716E 00 3.09402E 00
4.41400E-01 4.40407E-01 1.15569E 06 1.29440E 01 5.90144E 01 3.83405E 00
1.03748E 02 1.10910E 04 6.60611E 02 3.66346E 04 3.38406E 03 1.72612E 02
1.20940E 01 2.34920E 01 1.14635E 02 4.09294E-01 6.30199E 00 1.56100E 01
2.83610E 02 4.58926E 01 2.00910E 02 3.37797E 01 3.66794E 00 1.90180E 01
8.74590E 01 1.04092E 02 6.60412E 03 4.07675E 01 5.20846E 01 8.36774E 01
1.36010E 02 2.63465E 01 3.78374E 01 9.40403E 01 6.60413E 02 6.16571E 03
5.80025E 01 1.01247E 01 1.33823E 03 7.71939E 02 1.01093E 03 1.29007E 02
7.95305E-01 4.76045E 00 4.75234E 00 3.04463E 00 3.08135E 00 4.42460E-01
4.41404E-01 1.16995E 06 1.29645E 01 5.91590E 01 3.84092E 00 1.03980E 02
1.19201E 04 6.62220E 02 3.70326E 04 3.39400E 03 1.72447E 02 1.20964E 01
2.35096E 01 1.12771E 02 4.90490E-01 6.31494E 00 1.56159E 01 2.03753E 02
8.60113E 01 2.81041E 02 3.38347E 01 3.65573E 00 1.90460E 01 8.76941E 01
1.42903E 02 6.42227E 03 4.08371E 01 5.26100E 01 8.38822E 01 1.37180E 02
2.64049E 01 3.75262E 01 9.50525E 01 6.62220E 02 6.18079E 03 5.72121E 01
1.01256E 01 1.32270E 03 7.65761E 02 1.31816E 03 1.28240E 02 3.07682E-03
1.76995E-03 1.76594E-03 7.99290E-05 7.99286E-05 4.42460E-01 4.41404E-01
1.16995E 06 1.29645E 01 5.91590E 01 3.84052E 00 1.03980E 02 1.19201E 04
6.62220E 02 3.68337E 04 3.38697E 03 1.68047E 02 2.74788E 00 1.45130E 01
1.05427E 02 4.90490E-01 6.31494E 00 3.12540E 00 2.40529E 01 3.78183E 01
4.23914E 01 2.38400E 01 7.85844E-05 1.98660E 01 8.76941E 01 1.42903E 02
6.42227E 03 4.08371E 01 5.26100E 01 8.38822E 01 1.37180E 02 2.64049E 01
3.75262E 01 9.50525E 01 6.62220E 02 6.18079E 03 4.89124E 01 1.22614E 03
4.93313E 02 7.18252E 02 2.63914E 02 1.12074E 02 0.0             23R
2.44406E 02 0.0         2.26559E 02 0.0             16R   2.90904E-09
8.20497E 02 1.38280E-01 7.35333E 02 6.77481E-03 0.0             23R
2.50299E 00 0.0         2.43008E 00 0.0             16R   2.31951E 00
2.87331E 00 2.86981E 00 2.93230E 00 2.73997E 00 0.0             41R
7.00054E-11 1.21590E-09 1.16323E-09 1.17535E-09 1.20263E-09 5.04428E-10
0.0          141R
7D       1    94R
9D   2.96573E 00 2.61631E 00 2.63368E 00 3.44494E 00 3.44497E 00
0.0              3R   6.03125E 00 0.0             6.00464E 00 6.07738E 00
0.0              2R   6.02770E 00 8.52070E 00 6.78213E 00 7.07510E 00
6.88407E 00 6.76514E 00 0.0              2R   7.47196E 00 5.39840E 00
6.66161E 00 6.28711E 00 6.52532E 00 3.62471E 00 0.0             5.68465E 00
6.27273E 00 0.0         5.94394E 00 6.18974E 00 0.0             6.37462E 00
6.35467E 00 7.00446E 00     2R   6.40329E 00 6.85199E 00 6.32670E 00
7.86533E 00 6.16538E 00 6.77949E 00 6.92742E 00 6.51258E 00
7D      2     5R     1     3R     2     1     2     2R
     1     2R     2     4R     1     2R     2     6R     1
     2     2R     1     2     2R     1     2     12R     1     47R
8D   6.74443E-01 1.68335E-01 4.50872E 00 1.93987E-01 4.50880E 00
1.94335E-01 3.51895E 00 1.36204E-01 3.51893E 00 1.36207E-01
0.0              3R   7.91439E 00 2.51713E-01 0.0             7.80050E 00
2.51844E-01 1.61690E 01 1.01022E-01 0.0             2R   1.69459E 01
3.40983E-01 9.74362E 00 3.84983E-01 1.23661E 01 7.57609E-01 1.48220E 01
2.28060E-01 1.88439E 01 1.20749E-01 1.08604E 01 5.96255E-01
0.0              2R   1.37834E 01 2.21066E-01 1.00176E 01 1.53571E-01
1.12245E 01 1.72061E-01 1.08239E 01 1.62243E-01 1.07488E 01 4.38037E-01
3.50211E 00 1.18046E-01 0.0         6.75576E 00 8.36437E-02 7.48625E 00
1.34501E-01 0.0         5.86845E 00 1.60279E-01 5.66333E 00 1.26609E-01
0.0         5.64774E 00 8.96546E-02 2.07503E 01 9.02555E-02 1.18849E 01
1.98400E-01 1.18849E 01 1.98480E-01 5.95743E 00 2.21623E-01 6.99448E 00
2.10441E-01 1.08455E 01 9.37446E-01 1.50495E 01 2.06862E-01 1.18847E 01
1.48244E-01 1.89002E 01 1.42487E-01 1.15353E 01 2.79980E-01 1.27364E 01
2.45749E-01
7D      2     3     4R     1     3R     3     1     3     2R
     1     2R     3     6R     1     2R     3     5R     2     1
     3     2R     1     3     2R     1     3     12R     1     47R
8D   6.75441E-01 5.15095E-02 4.63563E 00 1.24860E-01 2.60333E-07
4.63567E 00 1.24861E-01 2.65608E-07 3.63987E 00 7.33811E-02 8.44071E-08
3.63986E 00 7.33910E-02 9.44082E-05 0.0             3R   1.41043E 01
2.57231E-02 3.79248E-06 0.0         8.16307E 00 2.16947E-02 3.79248E-06
1.17826E 02 2.75715E-02 1.07678E-06 0.0             2R   7.16819E 01
8.31769E-02 3.60999E-05 1.84252E 01 1.89077E-02 7.14781E-06 1.74154E 01
3.88444E-02 5.44716E-05 2.50770E 01 4.63666E-02 6.77888E-08 3.55932E 01
4.91841E-02 6.91682E-09 1.4901E 01 1.72051E-02 1.10480E-05
0.0              2R   1.89799E 01 3.80988E-02 3.51918E-06 1.19018E 01
1.69809E-02 3.50526E-06 3.68007E 01 1.92851E-02 2.76983E-06 1.17515E 01
1.71909E-02 3.02296E-05 1.61769E 01 2.01322E-02 8.87967E-06 3.63111E 00
7.34120E-02 0.0         1.42250E 01 2.72118E-02 4.43700E-07 6.24541E 00
1.99339E-02 1.23856E-06 0.0         2.65145E 01 2.73985E-02 1.81468E-06
3.64686E 02 1.21745E-02 1.45293E-06 0.0         1.14394E 01 1.27305E-02
8.91496E-07 4.36257E 01 3.68567E-02 8.91496E-07 4.17758E 01 1.03540E-01
2.72109E-06 4.56933E 02 1.03540E-01 2.72109E-06 5.27087E 00 1.22815E-02
3.24963E-06 7.10057E 00 1.54864E-02 2.94795E-06 1.12147E 01 1.60449E-02
2.39734E-05 3.45678E 01 1.50448E-02 1.62343E-06 1.28000E 01 2.92805E-02
2.27298E-06 2.79391E 01 1.35910E-02 7.24138E-07 1.21681E 01 1.81021E-02
1.57806E-06 1.55230E 01 2.17584E-02 2.57145E-06
7D      2     4     4R     1     3R     2     1     2     2R
     1     2R     3     2     3     2     3     2     1     2R
     2     3R     4     2     2R     1     2     2R     1
     2     2R     1     2     6R     4     3     3R     2     3
     1     47R
8D   7.92205E-01 4.85801E-02 4.75840E 00 1.18370E-01 0.0
6.45761E-10 4.75023E 00 1.18369E-01 0.0         6.58842E-10 3.84449E 00
7.11542E-02 0.0         7.45468E-11 3.88114E 00 7.11544E-02 0.0
7.45471E-11 0.0         4R   1.79215E-02 0.0             2R
1.74479E-02 0.0         1.15333E-02 0.0             2R   1.90804E 02
2.38985E-02 9.58605E-09 7.10767E 00 8.90258E-03 4.39954E 00 3.87744E-03
1.08308E-07 9.35065E 00 1.17922E-02 8.99663E 00 3.71579E-03 8.29284E-10
7.34468E 00 2.28271E-02 0.0             2R   1.24904E 01 1.64633E-02
1.24940E 01 1.66358E-02 8.99290E 00 1.37668E-02 1.24900E 01 1.79536E-02
1.18391E-08 1.96926E-07 9.99464E 00 1.38251E-02 3.65559E 00 6.94791E-02
0.0              2R   2.34777E-02 0.0             2.16001E-02
0.0              2R   1.72815E-02 0.0             2.73527E-02
0.0              2R   7.86849E-02 0.0             3.46667E-02 0.0
```

Table 3. CONTINUED

```
 1.447348E-02 0.0          4.172218E-02 0.0          1.242348E-02 0.0
 1.622028E-02 6.259428E 00 1.760007E-02 1.703108E-09 4.653308E-11 6.049604E 03
 1.106748E-02 1.160032E-09 8.449152E 03 1.281968E-02 1.577832E-09 6.717338E 01
 1.744458E-02 2.303378E-13 1.391338E 01 1.125968E-02 1.619878E 01 1.803348E-02
 2.065458E-09
STOP
END
DVENTR        NEUTRONICS PROBLEM, 9-2
001
                                                  1.6445       0.94         1.3

                                                      1.0
  1                                       75    3
  1                                                1   1   1   1
003
  7   1   2   2   2
004
  3  100.      1  41.      4  50.      4  45.      1  30.      1 11.
  3  37.       1  33.      3  30.      2  12.      4  80.
  5 160.       1     24.   2     12.   2  30.5556  2  30.5556  2 30.5556
  2  30.5556   2  30.5556  2  30.5556  2  30.5556  2  30.5556  2 30.5556
  2  30.5556   2  30.5556  2  30.5556  2  30.5556  2  30.5556  2 30.5556
  2  30.5556   2  30.5556  2  30.5556  2  12.      4  80.
005
153153153153153153153153153154154
153153153153153153153153153154154
153153153153153153153153153154154
  1   1 19 37 55 73 91109127154154
  2   2 20 38 56 74 92110128154154
  3   3 21 39 57 75 93111129154154
  4   4 22 40 58 76 94112130154154
  5   5 23 41 59 77 95113131154154
  6   6 24 42 60 78 96114132154154
  7   7 25 43 61 79 97115133154154
  8   8 26 44 62 80 98116134154154
  9   9 27 45 63 81 99117135154154
 10  10 28 46 64 82100118136154154
 11  11 29 47 65 83101119137154154
 12  12 30 48 66 84102120138154154
 13  13 31 49 67 85103121139154154
 14  14 32 50 68 86104122140154154
 15  15 33 51 69 87105123141154154
 16  16 34 52 70 88106124142154154
 17  17 35 53 71 89107125143154154
 18  18 36 54 72 90108126144154154
155155155155155155155155155154154
155155155155155155155155155154154
012
  0
  1144   1   1            0.61
145152   1   5            1.0
153153   1   2            1.0
154154   1   3            1.0
155155   1   4            1.0

013
 47
 47
TH-232PA-233 U-233 U-234 U-235 U-236NP-239PU-242AM-243 U-238PU-239PU-240
PU-241     C I-135XE-135PM-147PM-148PM148MPM-149SM-149ND-143   FP1   FP2
    ME KR-82 KR-83RH-103RH-105AG-109XE-131XE-133CS-133CS-134CS-135ND-145
EU-153EU-154EU-155ND-147SM-150SM-151SM-152     OCOBADSBECVELNP-237
020    -1
END
DOTLIN
EXPINS         0 18   0 62   1
      1100.0
                                                   0.4    185030.
                                                                      0.2
               1   1                       -2   0
  3   1   1   0   1   0   1
      145   0   8   0 18   0   1   0       2
PBLINS         0 32   0 24
             350.          40.                          6.
  0.99                                     2.5          2.5       850.


 240.
  350.
  0   0   0             1                                   1   2

END
DOTLIN
PBLINS         0 26   0 24
             350.          40.                          6.
  0.99                                     2.5          2.5       850.


  150.
  0   0   0             0             -1    1           -1

END
DOTLIN
PBLINS         0 12   0 24
             350.          40.                          6.
  0.99                                     2.5          2.5       850.
  0   0  -1             0                               1   0   1   1

END
/*
//
```

— END INPUT DATA STREAM —

Table 3. CONTINUED

— CONDENSED EDIT SUMMARIZES THE CALCULATION —

```
BOLD VENTURE VERS-4 RUN ON THE [illegible], [illegible], DATE=05-26-81, [illegible], [illegible]

INITIALIZATION, REFERENCE - REMAINING I/O=   [illegible], CPU MIN=   [illegible]

NEW TITLE AND CONTROL MODULE DATA
  SAMPLE PROBLEM, TWO DIMENSIONAL [illegible]
100000    0    0    0    0    0    0    0    0 0 0 1 0 0 0
  1  2  2  7 11 20  2 29  2 20
  0       0       0       0       0       0       0       0       0


                        INITIAL I/O FILE MANAGEMENT TABLES
                   FILE NAME SUPPLIED BY
                 --------------------------------                                  TEST
FILE NUMBER        SET    USER-EXIST   (SEP-STACK        VERSION      WRITTEN    IDENTIFICATION
    10           CONTRL                                      1            1     DRVC      05-26-81


MODULES TO BE ACCESSED IN ORDER
    1     2     2     7    11    20     2    29     2    29

READ DATA AND ACCESS MODULE  1    - REMAINING I/O=   6.90, CPU MIN=   9.[illegible]

READ DATA FOR A SPECIAL PROCESSOR - REMAINING I/O=   6.7[illegible], CPU MIN=   9.[illegible]

ACCESS PROCESSOR 'OUTPUT'         - REMAINING I/O=   6.7[illegible], CPU MIN=   9.[illegible]

READ DATA FOR A SPECIAL PROCESSOR - REMAINING I/O=   6.7[illegible], CPU MIN=   9.[illegible]

ACCESS PROCESSOR 'OUTLIN'         - REMAINING I/O=   6.7[illegible], CPU MIN=   9.[illegible]

READ INPUT DATA ONLY (LOOK-AHEAD) - REMAINING I/O=   6.7[illegible], CPU MIN=   9.4[illegible]

ACCESS MODULES  7 11  0  0  0     - REMAINING I/O=   6.7[illegible], CPU MIN=   9.41
     ITERATIONS, CONVERGENCE, SEARCH, PEAK POWER DENSITY, K -   [illegible] -1.[illegible]   0.0          1.6060[illegible] 0[illegible]   0.9575006
     PRIMITIVE CONVERSION RATIO, ALSO FOR CRITICAL [illegible], FUEL CONSUMPTION([illegible]) -   0.57698   0.57995   3.030[illegible] 10
     TIME AFTER [illegible].395 DAYS, ESTIMATED K  0.[illegible], FISSILE INVENTORY 6.[illegible] KG, CONVERSION RATIO(90)    0.58005
     EXPOSURE TIME STEP 1100.000 DAYS,                    TOTAL POWER 1.63[illegible] W(TH)
     ZONE    - PEAK POWER DENSITY 2.[illegible] 01 W(TH)/CC, PATH [illegible] 1.63[illegible] W(TH), FISSILE FEED RATE 1.2776[illegible] 00 KG/DAY
     SUBZONE - PEAK POWER DENSITY 0.0          W(TH)/CC, PATH [illegible] 0.0          W(TH), FISSILE FEED RATE 0.0          KG/DAY

ACCESS MODULES 20  0  0  0  0     - REMAINING I/O=   6.38, CPU MIN=   6.95
     GAS TEMPS, PEAK/MEAN BY ZONE, SUBZONE   922.2  917.9    0.0     0.0 POWER WEIGHTED   732.9    0.0 POWER (MWT)  1656.
     GAS TEMPS, PEAK/MEAN BY ZONE, SUBZONE   922.6  918.1    0.0     0.0 POWER WEIGHTED   732.9    0.0 POWER (MWT)  1656.

ACCESS PROCESSOR 'OUTLIN'         - REMAINING I/O=   6.33, CPU MIN=   6.[illegible]

READ INPUT DATA ONLY (LOOK-AHEAD) - REMAINING I/O=   6.3[illegible], CPU MIN=   6.[illegible]

ACCESS MODULES 20  0  0  0  0     - REMAINING I/O=   6.31, CPU MIN=   6.[illegible]
     GAS TEMPS, PEAK/MEAN BY ZONE, SUBZONE   922.6  918.2    0.0     0.0 POWER WEIGHTED   732.9    0.0 POWER (MWT)  1656.

ACCESS PROCESSOR 'OUTLIN'         - REMAINING I/O=   6.29, CPU MIN=   5.79

ACCESS MODULES 20  0  0  0  0     - REMAINING I/O=   6.27, CPU MIN=   5.79
     GAS TEMPS, PEAK/MEAN BY ZONE, SUBZONE   922.2  917.9    0.0     0.0 POWER WEIGHTED   732.9    0.0 POWER (MWT)  1656.

                        FINAL I/O FILE MANAGEMENT TABLES
                   FILE NAME SUPPLIED BY
                 --------------------------------                                  TEST
FILE NUMBER        SET    USER-EXIST   (SEP-STACK        VERSION      WRITTEN    IDENTIFICATION
    10           CONTRL                                      1            1     DRVC      05-26-81
    11           EXPOSE                                      1            1     DRVC      05-26-81
    12           SNATDN                                      1            1     DRVC      05-26-81
    13           GRUPXS                                      1            1     DRVC      05-26-81
    14           NDXDST                                      1            1     DRVC      05-26-81
    15           ZNDSPR                                      1            1     DRVC      05-26-81
    16           PERTUR                                      1            1     DRVC      05-26-81
    17           RTFLUX                                      1            1     DRVC      05-26-81
    18           PWDINT                                      1            1     DRVC      05-26-81
    19           ZNPOWR                                      1            1     DRVC      05-26-81
    20           GEODST                                      1            1     DRVC      05-26-81
    30           CPRIST                                      1            1     DRVC      05-26-81
    31           TDATAS                                      1            1     DRVC      05-26-81
    32           TUTSRN                                      1            1     DRVC      05-26-81

WRAP-UP NOW COMPLETE. -- DRIVER TO SEEK NEW CASE - REMAINING I/O=   6.20, CPU MIN=   5.61 - TIME=15.59.51
```

Table 3. CONTINUED

[illegible] - [illegible] - APRIL 29, [illegible] - [illegible]

—REGULAR OUTPUT
STARTS WITH INPUT
DATA PROCESSING—

```
CASE TITLE -   SAMPLE PROBLEM, [illegible]

SPACE   140000       0       0       0       0       0       1       6       0       0       0       1

*****STANDARD FILE CARD INPUT*****
0T [illegible] / [illegible] DATA [illegible]                 [illegible]              CARD    1
1D   13020  42  0   1  0  4 1* 10   0  C  3 0 3 12* 0 0 0 0 0 0                              CARD    2
2D  60R U-235, 238, [illegible]                                                              CARD    3
  12D  30 3-5-40                                                                             CARD    4
        60RTH-232PA-233 U-233 U-238 U-235 U-236 [illegible]-240                              CARD    5
        60RPU-[illegible]-241 [illegible]-245                                                CARD    6
        10RUD-103   [illegible]                                                              CARD    7
        60R [illegible]                                                                      CARD    8
        50RUD-105[illegible]-237                                                             CARD    9
3D  0.  1  3  5  7  9 11 14 15 19 21 [illegible]                                             CARD   10
     17 18 40 41  2  8 11 14 15 16 17 18 19 27 30 32 [illegible] 40 /                        CARD   11
4D  2.93E-7  3.81-6  1.4-6 /                                                                 CARD   12
             2.07E-7  2.09E-6  8.2-9  1.89E-6  [illegible]  3.61E-8 /                         CARD   13
  5.36E-5  1.52E-8  [illegible]  [illegible]-10 /                                             CARD   14
5D   .0539   .0096   .0417  .0570  .0451  .0526 /                                            CARD   15
     .0021   .0138   .0028  .0032  .0027  .0026 /                                            CARD   16
     .00965  .0077   .0113  .021   .013   .012  /                                            CARD   17
     .00     .0591   .0431  .060   .064   .056  /                                            CARD   18
  .301  .309  .299  .273  .328  .328 /                                                       CARD   19
  1.137  1.115  1.26  1.826  1.066  1.065 /                                                  CARD   20
 .01  .0069  .0029  .0005  .0017  .0207 /                                                    CARD   21
  .0199 .0118  .00544  .0009  .0029  .011 /                                                  CARD   22
  .0016  .016  .03  .062  .056  .062 /                                                       CARD   23
  .0005  .005  .009  .017  .055  .058 /                                                      CARD   24
  .00055  .0004  .0003  .003  .0155  .031 /                                                  CARD   25
  .017  .0341  .0293  .021  .038  .034 /                                                     CARD   26
  .037  .0589  .0659  .052  .069  .06 /                                                      CARD   27
  .066  .0338  .0399  .039  .031  .038 /                                                     CARD   28
  .00038  .0015  .00169  .0019  .0038  .302 /                                                CARD   29
  .00009  .0003  .00037  .0013  .0016  .031 /                                                CARD   30
  .0302  .0193  .0236  .028  .020  .022 /                                                    CARD   31
  .002  .0035  .3044  .309  .008  .307 /                                                     CARD   32
  .00095  .0022  .00291  .004  .004  .001 /                                                  CARD   33
8D  1  +2  2  +1  3  +2  4  +2  5  +2  6  +2 82 0 /                                          CARD   34
  1  +2  2  +2  -4  +2  -4  +2  -6  +2  -82  0  /                                            CARD   35
  7  +2  8  +1  9  +2  10  +2  11  +2  12  +2  13  0  /                                      CARD   36
  7  +2  8  +2 -10  +2 -11  +2 -12  +2 -13  0  /                                             CARD   37
 7 +5  -82  0 /                                                                              CARD   38
  14  +1  15  +1  33  0 /                                                                    CARD   39
  30 +1  16  +530002  17  +2  19  +1  23  +2 39 +2 40 +2 41 0 /                              CARD   40
  30 +1  16  +470002  18  +2 -19  +1 -20  +2 -39 +2 -40 +2 -41 0 /                           CARD   41
  -41  +2  35  +2  36  +2  37  0 /                                                           CARD   42
  20  +2  25  0  26  0  27  0  28  0  29  0 /                                                CARD   43
  21  0  22  +2  23  0  30 +1  31  +2  32  1  48  0  0 /                                     CARD   44
0T [illegible]              [illegible]05-22-90[illegible]                                   CARD   45
1D  2.726722 04                                                                              CARD   46
     0    155     87      1                                                                  CARD   47
20   2.35209E-04 8.60994E-07 4.11469E-0[illegible] 2.70181E-04 [illegible]                    CARD   48
4.32937E-07 [illegible] [illegible] [illegible] 1.0[illegible]E-06 [illegible]E-09           CARD   49
2.12520E-09 8.09836E-10 8.37960E-02 [illegible]E-13 1.12297E-10 3.13179E-08                  CARD   50
3.26406E-10 2.60050E-10 1.03561E-09 [illegible]E-13 1.[illegible]E-07 [illegible]E-07        CARD   51
2.56124E-06 1.36200E-08 5.92070E-09 1.10039E-08 5.[illegible]E-08 6.31900E-11                CARD   52
6.30130E-10 5.67262E-09 1.65018E-09 1.13959E-07 2.10[illegible]E-09 1.22821E-08              CARD   53
7.87866E-08 3.63935E-09 3.90193E-10 1.46111E-13 1.22590E-08 2.[illegible]E-08                CARD   54
2.95110E-09 1.09283E-08 5.18020E-08 0.0         1.30030E-09 6.30160E-09                      CARD   55
2.33021E-08 1.16252E-06 1.88782E-06 1.39604E-07 1.30620E-05 1.26370E-06                      CARD   56
2.22063E-09 6.53200E-10 2.28880E-11 1.00046E-06 2.32050E-08 7.95848E-09                      CARD   57
2.73640E-09 8.37960E-02 1.60019E-09 2.05609E-10 9.29189E-09 1.13198E-09                      CARD   58
8.13285E-10 3.82530E-09 1.69881E-09 3.32676E-07 1.06580E-06 7.84264E-06                      CARD   59
1.36200E-08 1.83098E-08 2.37210E-09 1.61137E-07 1.29008E-13 1.45880E-09                      CARD   60
1.66301E-07 3.39389E-08 3.56971E-07 1.33920E-09 1.46713E-08 2.35041E-07                      CARD   61
1.27301E-08 2.16756E-09 8.10355E-10 2.58209E-09 7.53922E-09 6.02465E-09                      CARD   62
5.80170E-08 5.18020E-08 0.0         1.00920E-09 3.17150E-08 2.20875E-08                      CARD   63
1.06231E-06 2.79629E-06 3.67296E-07 6.97250E-06 1.09900E-06 2.86033E-09                      CARD   64
2.01030E-09 1.60799E-10 1.39881E-06 2.56579E-08 1.36591E-08 6.70031E-09                      CARD   65
8.37960E-02 1.65577E-09 1.69639E-10 1.35064E-07 1.90200E-09 1.22296E-09                      CARD   66
4.17029E-09 1.69900E-09 5.08000E-07 3.07501E-06 1.30920E-05 1.36200E-08                      CARD   67
3.22146E-08 5.65799E-09 2.39627E-07 1.28573E-10 3.31601E-09 2.61362E-07                      CARD   68
3.35640E-08 5.99900E-07 3.78387E-08 5.25959E-09 3.77623E-07 2.66793E-08                      CARD   69
5.66501E-09 7.07400E-10 2.52609E-09 1.89781E-07 6.[illegible]E-09 5.53508E-08                CARD   70
5.18020E-08 0.0         1.00000E-09 8.50079E-08 2.27933E-08 1.51517E-06                      CARD   71
3.62659E-06 6.01783E-07 5.99880E-06 3.81695E-06 2.33866E-09 4.75207E-09                      CARD   72
5.26026E-10 1.35179E-05 2.32950E-09 1.56028E-09 9.62338E-09 8.37960E-02                      CARD   73
1.08485E-09 1.39776E-10 1.63081E-07 3.27770E-09 1.37999E-09 8.18305E-05                      CARD   74
1.56709E-09 6.27481E-07 4.16406E-06 1.77606E-05 1.36200E-08 4.60356E-08                      CARD   75
7.71925E-08 2.88162E-07 1.06033E-10 8.69936E-09 3.33188E-07 2.97210E-08                      CARD   76
8.01132E-07 7.07061E-08 6.78735E-09 4.91673E-07 3.71687E-08 9.93970E-09                      CARD   77
1.10330E-09 2.22102E-08 2.04360E-07 6.67123E-09 7.26909E-08 5.18020E-08                      CARD   78
0.0         1.09000E-09 1.44073E-07 2.25619E-08 1.41886E-06 4.26091E-06                      CARD   79
4.46261E-07 4.06900E-06 2.68110E-06 2.07860E-09 7.92138E-09 1.16759E-09                      CARD   80
1.31401E-06 2.05035E-09 1.52656E-09 1.95203E-09 8.37960E-02 1.17508E-05                      CARD   81
1.10169E-10 1.70475E-07 2.31120E-09 1.37589E-09 3.66876E-09 1.39369E-09                      CARD   82
6.07066E-07 5.06255E-06 2.16323E-05 1.36200E-08 5.06660E-08 9.41913E-08                      CARD   83
3.01090E-07 8.37309E-11 5.39620E-09 3.42979E-07 2.46768E-08 9.57479E-07                      CARD   84
1.04960E-07 8.02969E-08 4.75133E-07 4.81620E-09 1.39232E-08 1.59976E-09                      CARD   85
1.01027E-08 2.56803E-07 6.69034E-09 3.50712E-09 5.18020E-08 0.0                              CARD   86
1.00000E-09 1.96507E-07 2.23625E-08 1.25191E-06 4.55077E-06 1.05012E-06                      CARD   87
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Table 3. CONTINUED

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2.00965E-06 2.02993E-08 1.65669E-09 1.06793E-08 1.70126E-09 1.28607E-08     CARD   88
1.00669E-08 1.01562E-09 1.02750E-08 8.37967E-02 9.20950E-10 1.03672E-10     CARD   89
1.69083E-07 2.14025E-09 1.31200E-05 2.90595E-09 1.23539E-09 7.17351E-07     CARD   90
5.70070E-06 2.07893E-05 1.36200E-08 6.95227E-08 1.07900E-07 3.00360E-07     CARD   91
6.04101E-11 6.08120E-09 8.17295E-07 1.97514E-09 1.07056E-06 1.35063E-07     CARD   92
9.10050E-08 6.30960E-07 5.72013E-09 7.71523E-09 7.90069E-09 1.00007E-08     CARD   93
2.96002E-07 6.09160E-09 9.53705E-09 5.14020E-04 0.0         1.00000E-09     CARD   94
2.36963E-07 2.21961E-08 1.06581E-06 8.70929E-06 1.20046E-06 2.97659E-64     CARD   95
2.90091E-06 1.33209E-09 1.25130E-08 2.03250E-09 1.20013E-06 1.65097E-08     CARD   96
1.31021E-06 9.69505E-09 8.37960E-02 7.16358E-15 9.06668E-11 1.65902E-07     CARD   97
1.00965E-09 1.23560E-09 2.30121E-09 1.16770E-09 7.20939E-07 6.30072E-06     CARD   98
2.72355E-05 1.36200E-08 7.05706E-09 1.17679E-07 3.00110E-07 6.95130E-11     CARD   99
6.60036E-39 6.30900E-07 1.57001E-09 1.16295E-06 1.40666E-07 1.06052E-07     CARD  100
6.77055E-07 6.09000E-09 5.96772E-09 2.23097E-09 1.16109E-08 3.23017E-07     CARD  101
7.02690E-09 1.03316E-07 5.14020E-04 0.0         1.00000E-09 2.44161E-07     CARD  102
2.20590E-06 8.07900E-07 6.06750E-06 1.32232E-06 1.72309E-06 2.92360E-06     CARD  103
1.06206E-09 1.39995E-08 3.00321E-09 1.20077E-06 1.59960E-08 1.22705E-08     CARD  104
9.13055E-09 8.37963E-02 5.76090E-10 9.30551E-11 1.69022E-07 1.61007E-09     CARD  105
1.16004E-09 1.90507E-09 1.00025E-09 1.33002E-07 6.79713E-06 2.95155E-05     CARD  106
1.36200E-04 8.57907E-08 1.25017E-07 2.93779E-07 3.03639E-11 8.70772E-09     CARD  107
6.50399E-07 1.25327E-08 1.22903E-06 1.79698E-07 1.99901E-07 7.09100E-07     CARD  108
7.05176E-08 2.96219E-08 2.00760E-09 9.93520E-09 3.02967E-07 7.13571E-09     CARD  109
1.00000E-07 5.14020E-04 0.0         1.30900E-09 2.06755E-07 2.19092E-08     CARD  110
7.20700E-07 6.96110E-06 1.00576E-09 1.05222E-06 2.95639E-06 8.60361E-10     CARD  111
1.50705E-08 3.07969E-09 1.22501E-06 1.53102E-08 1.16707E-09 9.66717E-09     CARD  112
8.37960E-02 9.56665E-10 8.25009E-11 1.55996E-07 1.35095E-09 1.09120E-09     CARD  113
1.30267E-09 9.20961E-10 7.32732E-07 1.15222E-06 3.07903E-05 1.36200E-04     CARD  114
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— NOTE PAGES DELETED —

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1.20050E-07 1.222 7E-10 6.27663E-10 6.30200E-11 5.39017E-10 6.52003E-07     CARD 1171
6.66113E-06 2.05232E-05 1.36200E-08 8.38105E-09 1.19333E-07 2.78792E-07     CARD 1172
2.91980E-12 6.66603E-09 8.63729E-07 5.71073E-10 1.25237E-06 1.06917E-07     CARD 1173
1.00400E-07 7.09172E-07 7.08032E-09 1.90791E-09 1.95323E-09 6.91031E-10     CARD 1174
2.98305E-07 5.02312E-39 1.10630E-07 5.14020E-04 0.0         1.00000E-09     CARD 1175
2.14216E-07 2.36162E-04 0.0                  3R    2.01720E-05              CARD 1176
0.0               4R    1.09919E-06 0.0                  3R    8.37960E-02  CARD 1177
0.0              10R    1.36200E-04 0.0                 10R    5.14020E-04  CARD 1178
0.0         1.00000E-09 0.0         2.36162E-04 0.0                  3R     CARD 1179
2.01720E-05 0.0               4R    1.09919E-06 0.0                  3R     CARD 1180
8.37960E-02 0.0              10R    1.36200E-04 0.0                 10R     CARD 1181
5.14020E-04 0.0         1.00000E-09 0.0         2.36162E-04                 CARD 1182
0.0               3R    2.01720E-05 0.0               4R    1.09919E-06     CARD 1183
0.0               3R    8.37960E-02 0.0              10R    1.36200E-04     CARD 1184
0.0              10R    5.14020E-04 0.0         1.00000E-09 0.0             CARD 1185
2.36162E-04 0.0               3R    2.01720E-05 0.0               4R        CARD 1186
1.09919E-06 0.0               3R    8.37960E-02 0.0              10R        CARD 1187
1.36200E-04 0.0              10R    5.14020E-04 0.0         1.00000E-09     CARD 1188
0.0         2.36162E-04 0.0                  3R    2.01720E-05              CARD 1189
0.0               4R    1.09919E-06 0.0                  3R    8.37960E-02  CARD 1190
0.0              10R    1.36200E-04 0.0                 10R    5.14020E-04  CARD 1191
0.0         1.00000E-09 0.0         2.36162E-04 0.0                  3R     CARD 1192
2.01720E-05 0.0               4R    1.09919E-06 0.0                  3R     CARD 1193
8.37960E-02 0.0              10R    1.36200E-04 0.0                 10R     CARD 1194
5.14020E-04 0.0         1.00000E-09 0.0         2.36162E-04                 CARD 1195
0.0               3R    2.01720E-05 0.0               4R    1.09919E-06     CARD 1196
0.0               3R    8.37960E-02 0.0              10R    1.36200E-04     CARD 1197
0.0              10R    5.14020E-04 0.0         1.00000E-09 0.0             CARD 1198
2.36162E-04 0.0               3R    2.01720E-05 0.0               4R        CARD 1199
1.09919E-06 0.0               3R    8.37960E-02 0.0              10R        CARD 1200
1.36200E-04 0.0              10R    5.14020E-04 0.0         1.00000E-09     CARD 1201
0.0              10R    1.60600E-02 0.0                 30R    1.26000E-03  CARD 1202
0.0              15R    8.03000E-02 0.0                 46R    7.02600E-02  CARD 1203
0.0              33R                                                        CARD 1204
8T GROUPS             SOPHL 4  ADE      1                                   CARD 1205
1D       4      87       0       3       0       1     423       0      3R  CARD 1206
     1     28       0     29                                                CARD 1207
 2D /                                                                       CARD 1208
    *XX08  SAME AS XX05 PLUS NP-237,LESS XE-135                        *    CARD 1209
    *                   BR     CRD-107 I-135     OPPCYPLCONBOSXE-135*       CARD 1210
    *CS-133CS-134CS-135PM-147PM148MSM-149SM-149SM-151EU-153 U-236*          CARD 1211
    *PU-242AM-243    PP2    PP1TH-232 U-233 U-234 U-235PU-239PU-149*        CARD 1212
    * KR-82 KR-83RH-103RH-105AG-105XE-131XE-133ND-143ND-145SM-150*          CARD 1213
    *SM-152EU-154EU-155PA-233 U-238PU-239PU-240PU-241NP-237*                CARD 1214
9.67440E-01 3.25503E-02 1.12421E-07 2.02055E-11 1.10525E+09 1.04601E+00     CARD 1215
6.11920E+06 4.90934E+05 1.49103E+07 1.83155E+05 5.82947E+02 1.05549E+00     CARD 1216
5.00000E-03                                                                 CARD 1217
 4D /                                                                       CARD 1218
    *     BR     CRD-107 I-135      OPICYELCCPAOSXE-135CS-133CS-134*        CARD 1219
    *CS-135PM-147PM148MPM-148SM-149SM-151EU-153 U-236PU-242AM-243*          CARD 1220
    *    PP2    PP1TH-232 U-233 U-234 U-235PU-239PU-149 KR-82 KR-83*        CARD 1221
    *RH-103RH-105AG-109XE-131XE-133ND-143ND-145SM-150SM-152EU-154*          CARD 1222
    *EU-155PA-233 U-238PU-239PU-240PU-241NP-2370000506012506012?*           CARD 1223
    *0001650001671111111111125413575500005513005513506114706114000*         CARD 1224
    *611401621493621515631530922360942426952439000000000000902337*          CARD 1225
    *922330922339922359923900800093600203600300500000510505711090*          CARD 1226
    *501310501330601430601450621500621520631540631550001119002262*          CARD 1227
    *00126400126500126600114500000  0000  0000  0000  0000  0000  *         CARD 1228
    *0000   0000  0000  0000  0000  0000  0000  0000  0000  0000  *         CARD 1229
    *0000   0000  0000  0000  0000  0000  0000  0000  0000  0000  *         CARD 1230
    *0000   0000  0000  0000  0000  0000  0000  0000  0000  0000  *         CARD 1231
    *0000   0000  0000  0000  0000  1119  1262  1264  1265  1266  *         CARD 1232
    *1145  *                                                                CARD 1233
8.00000E+00 1.20000E+01 1.47000E+02 1.35000E+02 8.00000E+00                 CARD 1234
0.0               2R    1.35000E+02 1.33000E+02 1.34000E+02 1.35000E+02     CARD 1235
1.47000E+02 1.49000E+02       2R    1.45000E+02 1.51000E+02 1.53000E+02     CARD 1236
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Table 3. CONTINUED

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[illegible]  [illegible]  [illegible]  [illegible]     .0   [illegible]                   CARD 1237
2.330000E+02 2.300000E+02 2.190000E+02 2.190000E+02 1.090000E+02 1.200000E+01         CARD 1238
0.300000E+01 1.090000E+02 1.090000E+02 1.090000E+02 1.770000E+02 1.330000E+02         CARD 1239
1.630000E+02 1.650000E+02 1.500000E+02 1.920000E+02 1.940000E+02 1.130000E+02         CARD 1240
2.330000E+02 2.140000E+02 2.190000E+02 2.090000E+02 2.010000E+02 2.170000E+02         CARD 1241
0.0             17P  3.267000E-11 3.100000E-11 3.190000E-11                           CARD 1242
0.0             2P   3.190000E-11 3.190000E-11     3P   3.210000E-11                  CARD 1243
3.270000E-11 0.0            10P   3.110000E-11 3.190000E-11 3.300000E-11              CARD 1244
3.360000E-11 3.370000E-11 3.390000E-11 0.0            47P   7.400000E-11              CARD 1245
1.030000E-12 0.700000E-13 7.000000E-12 0.0            49P                             CARD 1246
9.000000E+02    07P   0.0            10P                                              CARD 1247
     9     2P      0     2P      5     1P      0    10P      3     3P                 CARD 1248
     0     2P      2      1      2      1     2P      0    10P      1                 CARD 1249
     2      1      2      1      3      0      1      0    11P                        CARD 1250
     1     3P      0     2P      1     5P      0    10P      1     9P                 CARD 1251
     6     0P                                                                         CARD 1252
5D  2.720750E 00 2.300729 00 2.302032 00 2.910470 00 2.090690 00                      CARD 1253
1.099200E-00 1.700960E-00 0.0          7.007030E+03 0.0          6.100150E+00         CARD 1254
6.005120E+00 0.695000E+00 1.990460E-01 2.000700E+09 0.970370E+00 5.067360E+00         CARD 1255
6.052190E+00 5.191200E+00 7.051610E+09 1.000090E-02 7.036500E-02 6.201190E+06         CARD 1256
5.513730E+00 5.232150E+00 5.065000E+00 2.910030E+00 2.697070E+00 0.013300E-03         CARD 1257
5.000020E+00 6.173190E+09 2.070610E+09 0.307670E+00 0.350720E+00 0.0                  CARD 1258
6.005030E+00 6.097000E+00 5.139520E+00 2.100100E+00 7.205090E+00 7.077150E+00         CARD 1259
5.507670E+06 5.566110E+09 5.602050E+00 2.577010E+00 7.600000E+00 5.710910E+00         CARD 1260
2.130110E+00 2.010520E+00 2.020030E+00 1.003670E+03 3.607690E+00 7.030320E-00         CARD 1261
1.901200E-00 0.0          6.300340E+00 0.0          6.270320E+00 0.000050E+00         CARD 1262
5.230030E+00 1.350120E-01 7.370990E+00 7.060030E+09 7.703090E+09 0.600000E+00         CARD 1263
7.930750E+00 0.133210E+00 1.990000E-02 0.095500E-02 7.095750E+00 7.600610E+00         CARD 1264
7.070000E+00 7.031050E+09 0.337030E+00 3.706110E+00 7.000500E-02 5.750360E+00         CARD 1265
6.560290E+00 2.010600E-00 6.065000E+00 0.390730E+00 0.0          0.505290E+00         CARD 1266
6.000050E+00 7.206210E+00 7.207160E+09 3.303000E+00 7.273300E+00 7.762600E+00         CARD 1267
0.310110E+00 0.100690E+00 9.010000E+00 0.990500E+00 9.230060E+00 0.0                  CARD 1268
7.700010E-07 7.760550E-07-1.013390E-10-1.013000E-15 1.930330E-00 1.901200E-00         CARD 1269
0.0          5.372010E-02 0.0          3.070700E-02 2.661500E-01 5.230630E+00         CARD 1270
1.350120E-05 2.607710E-01 6.311160E-01 2.302270E-01 2.300500E-01 0.022900E-02         CARD 1271
1.123090E-01 1.990000E-02 6.099500E-02 1.337710E-01 1.031400E-01 1.050300E-01         CARD 1272
1.306720E-01 1.773900E-01 5.023700E-09 1.000130E-02 6.000000E-02 1.617720E-01         CARD 1273
2.010600E+00 3.550010E-01 7.031600E-02 0.0          0.769910E-02 0.179350E-02         CARD 1274
0.570660E-02 0.672700E-02 0.700930E-01 1.699620E-01 2.306070E-01 9.661190E-02         CARD 1275
7.020000E-02 1.170120E-01 1.335620E-01 0.571730E-01 0.0            17P                CARD 1276
3.032510E-01 0.516170E-01 6.506550E-01 0.0            2P   3.757530E-02              CARD 1277
2.010220E+00 9.000570E-01 1.200700E+00 1.991350E-01 0.0            10P                CARD 1278
2.306010E-01 1.503260E-01 1.719100E+00 5.979310E-01 1.605900E+00 9.763100E-01         CARD 1279
0.0             17P  2.673770E+00 3.372070E+00 3.305770E+00                           CARD 1280
0.0             2P   2.399060E+00 2.405530E+00 2.690050E+00 2.573370E+00              CARD 1281
2.600620E+00 0.0            10P   2.599110E+00 2.777990E+00 3.350260E+00              CARD 1282
3.120100E+00 3.900760E+00 2.963570E+00 0.0            17P   7.670010E-01              CARD 1283
9.690330E-01    2P   0.0            2P   9.667260E-01    2P                           CARD 1284
5.070910E-01    2P   9.675630E-01 0.0            10P   9.685620E-01                   CARD 1285
9.653050E-01 9.667690E-01 9.660500E-01 5.657020E-01 9.600370E-01 0.0                  CARD 1286
1.639700E-00 1.695230E-00 2.060170E-03 2.060100E-31 0.0            9P                 CARD 1287
0.305210E-05 0.0          1.772560E-05 0.0            11P   1.307350E-03              CARD 1288
0.0            10P   1.106090E-06 0.0            2P   0.506050E-06                    CARD 1289
0.506070E-06 0.0            9P   0.305210E-05 0.0          1.772560E-0                CARD 1290
0.0            10P   0.959100E-06 0.0            2P   3.704600E-00                    CARD 1291
0.0          3.796600E-00 3.339000E-00 0.0            2P   2.306590E-03               CARD 1292
0.0          5.000000E-00 2.032670E-03 1.967090E-03 0.0            3P                 CARD 1293
5.226970E-03 2.309370E-03 7.601000E-00 2.965910E-03 7.203190E-03                      CARD 1294
0.0             2P   2.000150E-05 1.720200E-06 0.0          2.603020E-06              CARD 1295
0.112000E-00 0.0          1.099350E-03    2P   2.960530E-03    2P                     CARD 1296
0.775790E-00 0.679200E-00 1.002210E-03 0.217590E-03 9.906050E-06 3.565700E-00         CARD 1297
6.100940E-03 5.397300E-00                                                             CARD 1298
5D  6.022000E-01 0.352310 00 0.352310 00 3.097530 00 3.007530 00                      CARD 1299
2.061400E-03 2.061400E-03 1.523210E-05 1.267600E+00 2.100950E-01 0.792600E+00         CARD 1300
2.203060E+01 6.236150E+02 7.010000E+02 2.161720E+01 1.700010E+01 1.903670E+01         CARD 1301
1.600900E+01 1.031900E+01 1.325500E+01 2.399730E-01 6.959000E-01 1.067370E+01         CARD 1302
```

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1.993370E-02 1.230500E-06 0.0          4.051050E+01 2.159950E-02 1.710000E-00          ARD 1035
3.660060E+02 1.217050E-02 1.052030E-06 0.0          1.103900E+01 1.273050E-02         CARD 1036
5.910960E-07 0.302570E+01 3.605670E-02 0.910960E-07 0.177500E+01 1.035000E-01         CARD 1037
2.721090E-06 0.569330E+02 1.035000E-01 2.721090E-06 5.270070E+00 1.220150E-02         CARD 1038
3.209630E-06 7.100570E+09 1.560600E-02 2.907950E-06 1.127070E+01 1.600090E-02         CARD 1039
2.397300E-06 3.056700E+01 1.500000E-02 1.623030E-06 1.200000E+01 2.920050E-02         CARD 1040
2.272900E-   2.792910E+01 1.359100E-02 7.301300E-07 1.216010E+01 1.010210E-02         CARD 1041
1.570060E-06 1.952300E+01 2.175000E-02 2.571250E-06                                   CARD 1042
7D     2      0     0P      1     3P      2      1      2     3P                      CARD 1043
     1     2P      3      2      3      2      3      2      1     2P                 CARD 1044
     2     3P      0      2     2P      1      2     2P      1                        CARD 1045
     2     2P      1      2     6P      0      3     3P      2      3                 CARD 1046
     1    07P                                                                         CARD 1047
0D  7.922050-01 0.050010E-02 0.750900 00 1.103700E-01 0.0                             CARD 1048
6.057610E-10 0.750230E+00 1.103690E-01 0.0          6.500420E-10 3.000490E+00         CARD 1049
7.119420E-02 0.0          7.050600E-11 7.001100E+00 7.115000E-02 0.0                  CARD 1050
7.050770E-11 0.0             0P   1.792150E-02 0.0            2P                      CARD 1051
1.700790E-02 0.0          1.153330E-02 0.0            2P   1.960000E+02               CARD 1052
2.309050E-02 9.506050E-09 7.107677E+00 0.992500E-03 0.309560E+00 3.077000E-03         CARD 1053
1.063000E-07 9.350650E+00 1.179227E-02 1.996630E+00 3.715797E-03 0.292000E-10         CARD 1054
7.306600E+00 2.202710E-02 0.0            2P   1.249000E+01 1.686330E-02               CARD 1055
1.209000E+01 1.663500E-02 0.992900E+00 1.376600E-02 1.200000E+01 1.792360E-02         CARD 1056
1.103910E-00 1.967260E-07 9.990600E+00 1.302510E-02 3.655570E+00 6.907910E-02         CARD 1057
0.0             2P   2.307770E-02 0.0          2.160010E-02                           CARD 1058
0.0             2P   1.720150E-02 0.0          2.735270E-02                           CARD 1059
0.0             2P   7.069090E-02 0.0          3.066670E-02 0.0                       CARD 1060
1.067340E-02 0.0          2.172210E-02 0.0          1.020300E-02 0.0                  CARD 1061
1.622020E-02 0.709620E+00 1.760067E-02 1.703100E-09 0.050300E-11 0.099000E+00         CARD 1062
1.106260E-02 3.900320E-09 0.609150E+00 1.201960E-02 1.577030E-09 0.737030E+01         CARD 1063
3.704650E-02 2.203370E-10 1.091330E+01 1.125060E-02 1.615070E+01 1.003360E-02         CARD 1064
2.669450E-09                                                                          CARD 1065
STOP                                                                                  CARD 1066
```

—MORE PAGES DELETED—

Table 3. CONTINUED

```
          SUMMARY OF FILES PROCESSED

     FILE NAME    LOGICAL UNIT   VERSION
      REPORT           11            1
      ERATPU           12            1
      GEOPTS           13            0

DATA FILE MANAGEMENT TABLES
LOGICAL UNIT  FILE NAME   VERSION     I/O PORT DATA
      9                      0            1            0
     10       CONTRL         1            1            0
     11       REPORT         1            1            0
     12       ERATPU         1            1            0
     13       GEOPTS         1            1            0
     99                      0            1            0

    TOTAL CPU TIME USED    0.000 MINUTES     TOTAL CLOCK TIME USED    1.309 MINUTES     TOTAL I/O USED     109

NORMAL END OF STANDARD INPUT MODULE


                    DUTLIN - SPECIAL INPUT MODULE - JANUARY 17, 1976 - QUALITY ASSURANCE LEVEL 0
                    ---------------------------------------------------------------------------
```

— NEUTRONICS PROBLEM DESCRIPTION —

```
CASE TITLE -   SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS

SPACE   140000       0      0      0      0      0      1      0      0      0      0      1


INPUT SECTION  1
DXX     0.0           0.0           0.0           1.640000E 09  9.000000E-01  7.000000E 00
UXX     0.0           0.0           0.0           0.0           0.0           0.0
RXX     0.0           0.0           0.0           1.000000E 00  0.0           0.0
IXC       1   0   0   0   0   0   0   4   0   0   0  75   0   0   8   0   0   0   0   0   0   0   0   0
IXX       1   0   0   0   0   0   0   0   0   0   0   0   0   0   1   1   1   1   0   0   0   0   0   0
IXCN      0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
IXEN      0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
IXUN      0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
RXEN    0.0           0.0           0.0           0.0           0.0           0.0
RXXN    0.0           0.0           0.0           0.0           0.0           0.0

DTBIES RECORD ADDED TO FILE CONTRL


INPUT SECTION  3

   7   1   2   2   2   0   0   0   0   0   0   0   0   0   0   0   0   0
GEOMETRY NO.  7   2-D R-Z
BSQ     0.0
ISBD      1
OFDC    0.0           4.692000E-01  4.692000E-01  4.692000E-01  9.999999E 29  9.999999E 29
BBDI    4.692000E-01


INPUT SECTION  4

MEMORY REQUIRED       1084
NSBJ/ISBJ         3  1.0000000D 02     3  8.1000000D 01     4  5.0600000D 01     4  8.5000000D 01     2  1.0000000D 01     3  3.3000000D 01
NSBJ/ISBJ         3  3.7000000D 01     3  3.3000000D 01     3  3.9600000D 01     2  1.2000000D 01     4  9.0000000D 01
NSBI/ISBI         5  1.6000000D 02     3  2.0000000D 01     2  1.2600000D 01     2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01
NSBI/ISBI         2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01
NSBI/ISBI         2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01
NSBI/ISBI         2  3.0555600D 01     2  3.0555600D 01     2  3.0555600D 01     2  1.2000000D 01     4  9.0000000D 01
NSBKD/ISBKD       1  1.0000000D 00
XRESB   0.0             1.0000000D 02  1.0100000D 02  1.9900000D 02  2.4800000D 02  2.9200000D 02  3.1560000D 02  3.5200000D 02
XRESB   3.0500000D 02  4.1500000D 02  4.2700000D 02  5.1500000D 02
YRESB   0.0             1.6400000D 02  1.8000000D 02  2.0000000D 02  2.3055560D 02  2.6111120D 02  2.9166680D 02  3.2222240D 02
YRESB   3.5277800D 02  3.8333360D 02  4.1388920D 02  4.4444480D 02  4.7500040D 02  5.0555600D 02  5.3611160D 02  5.6666720D 02
YRESB   5.9722280D 02  6.2777840D 02  6.5833400D 02  6.8888960D 02  7.1944520D 02  7.5000000D 02  7.6200090D 02  8.5000000D 02
ZRESB   0.0             1.0000000D 00

GEOMETRY NO.   7
J/II       1    0.0       2  57.7350     3  81.6497     4 100.0000     5 115.2992     6 128.7910     7 141.0000     8 157.5151
J/II       9  172.0550   10 186.2015    11 199.0000    12 211.1510    13 222.6398    14 233.5642    15 244.0000    16 257.2910
J/II      17  269.9284   18 282.0000    19 293.4127    20 304.3978    21 315.0000    22 327.7977    23 340.1162    24 352.0000
J/II      25  363.3332   26 374.3238    27 385.0000    28 395.2531    29 405.2469    30 415.0000    31 421.0028    32 427.0000
J/II      33  450.6180   34 473.0507    35 498.0704    36 515.0000
I/TT       1    0.0       2  32.8000     3  65.6000     4  98.4000     5 131.2000     6 164.0000     7 172.9000     8 180.0000
I/TT       9  180.0000   10 196.0000    11 200.0000    12 215.2778    13 230.5556    14 245.8334    15 261.1112    16 276.3890
I/TT      17  291.6668   18 306.9446    19 322.2224    20 337.5002    21 352.7780    22 368.0558    23 383.3336    24 398.6114
I/TT      25  413.8892   26 429.1670    27 444.4448    28 459.7226    29 475.0004    30 490.2782    31 505.5560    32 520.8338
I/TT      33  536.1116   34 551.3894    35 566.6672    36 581.9450    37 597.2228    38 612.5006    39 627.7784    40 643.0562
I/TT      41  658.3340   42 673.6118    43 688.8896    44 704.1670    45 719.4452    46 734.7230    47 750.0000    48 756.0000
I/TT      49  762.0000   50 784.0000    51 806.0000    52 820.0000    53 850.0000
KB/KK      1    0.0       2   1.0000
J/I        1   48.0200    2  70.7107     3  91.2871     4 107.9205     5 122.2373     6 135.0338     7 149.0058     8 165.1505
J/I        9  179.0603   10 192.7070    11 205.1655    12 216.9715    13 228.1676    14 238.0391    15 250.7336    16 263.6050
J/I       17  276.0302   18 287.7629    19 298.9557    20 309.7482    21 321.4625    22 330.0127    23 346.1001    24 357.7119
J/I       25  368.0692   26 379.6992    27 390.1602    28 400.2012    29 410.1520    30 419.0327    31 428.0310    32 439.9690
```

Table 3. CONTINUED

```
J/R        33 461.9686   34 483.8791   35 504.0396
I/R         1  16.0000    2  49.2000    3  82.0000    4 114.0000    5 147.6000    6 169.0000    7 176.0000    8 184.0000
I/R         9 191.0000   10 197.0000   11 207.6389   12 222.9167   13 238.1945   14 253.4722   15 268.7501   16 284.0279
I/R        17 299.3057   18 314.5835   19 329.8613   20 345.1391   21 360.4169   22 375.6947   23 390.9725   24 406.2503
I/R        25 421.5281   26 436.8059   27 452.0837   28 467.3615   29 482.6393   30 497.9171   31 513.1949   32 528.4727
I/R        33 543.7505   34 559.0283   35 574.3061   36 589.5839   37 604.8617   38 620.1395   39 635.4173   40 650.6951
I/R        41 665.9729   42 681.2507   43 696.5285   44 711.8063   45 727.0841   46 742.3619   47 753.0008   48 759.0009
I/R        49 773.0008   50 795.0000   51 817.0000   52 839.0009
KB/R        1   0.5000

MEMORY REQUIRED    3956


INPUT SECTION  5


ZONE INPUT BY REGION

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


INPUT SECTION 12
NSS    0
   1 144    1    1    6.0000000E-01
 145 152    1    5    1.0000000E 00
 153 153    1    2    1.0000000E 00
 154 154    1    3    1.0000000E 00
 155 155    1    4    1.0000000E 00
   0   0    0    0    0.0

REGION VOL SUM    7.0828571D 04  ZONE VOL SUM    7.0828446D 04

MEMORY REQUIRED    5205

INTERFACE FILE GEODST HAS BEEN WRITTEN ON UNIT  14


INPUT SECTION 13
NNS  47

MEMORY REQUIRED   13040

TITLE FROM CROSS SECTION FILE /XIOA  SAME AS XX05 PLUS NP-237,LESS XE-135

NDIS(1)   47 FOR SET  1
TH-232  PA-233   U-233   U-234   U-235   U-236  NP-239  PU-242  AM-243   U-239  PU-239  PU-240
PU-241       C   I-135  XE-135  PM-147  PM-148  PM148M  PM-149  SM-149  ND-143     FP1     FP2
    HE   KR-82   KR-83  RH-103  PD-105  AG-109  XE-131  XE-133  CS-133  CS-134  CS-135  ND-145
EU-153  EU-154  EU-155  ND-147  SM-150  SM-151  SM-152       O  CCWABS  REMVEL  NP-237


INPUT SECTION 20
NOPD  -1 NCYS   0 TIMES  0.0

NO ZNATDN FILE WILL BE WRITTEN - IT SHOULD ALREADY EXIST - THE REST OF SECTION 020 MUST NOT BE PRESENT IN YOUR DATA DECK

INTERFACE FILE NDXSRF HAS BEEN WRITTEN ON UNIT  15

     TOTAL CPU TIME USED    0.004 MINUTES     TOTAL CLOCK TIME USED    0.064 MINUTES     TOTAL I/O USED      19

NORMAL END OF SPECIAL INPUT MODULE DVIOZ9
```

Table 3. CONTINUED

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                    DUTLIN - SPECIAL INPUT MODULE - JANUARY 17, 1979 - QUALITY ASSURANCE LEVEL 0
                    -----------------------------------------------------------------------------


*** UTILITY INPUT *** ADD OR REPLACE RECORDS IN CONTRL FILE
RECORD NAME *EXPINS*  NO. HOLLERITH   0  NO. REAL  18  NO. INTEGER(I6)   0  NO. INTEGER(I3)  62  PRINT OPT.   1
   1.100000D 03   0.0          0.0            0.0            0.0            0.0
   0.0            0.0          0.0            8.000000D-01   1.050000E 05   0.5
   0.0            0.0          0.5            0.0            0.0            2.000000D-01
   0   0   0   0   1   1   0   0   0   0   0   0  -2   0   0   0   0   0   0   0   0   0   0   0
   3   1   1   0   1   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   0   0 145   0   0   0  10   0   1   0   0   0   2   0
RECORD NAME *PDLINS*  NO. HOLLERITH   0  NO. REAL  32  NO. INTEGER(I6)   0  NO. INTEGER(I3)  20  PRINT OPT.   0
RECORD NAME *      *  NO. HOLLERITH   0  NO. REAL   0  NO. INTEGER(I6)   0  NO. INTEGER(I3)   0  PRINT OPT.   0

THE FOLLOWING RECORDS ARE ON CONTRL
*EXPINS*
*PDLINS*
*PROCES*
*DURINS*
*OTHINS*
*      *

     TOTAL CPU TIME USED    0.001 MINUTES     TOTAL CLOCK TIME USED    0.022 MINUTES     TOTAL I/O USED      13

NORMAL END OF SPECIAL INPUT MODULE DUTLIN



                    VENTURE - NEUTRONICS MODULE -VERS 3- JANUARY 1,1981 --- QUALITY ASSURANCE LEVEL 1
                    ---------------------------------------------------------------------------------

RUN TITLE -   SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS


STORAGE REQUIRED FOR CROSS SECTION CHECK     859 WORDS

TITLE OF THE LATEST VERSION CROSS SECTION FILE
          XX08   SAME AS XX05 PLUS NP-237,LESS XE-135

CROSS SECTION CHECK COMPLETED NORMALLY

REFERENCE REAL TIME FROM MASTER INTERFACE FILE =  2.72672E 00 DAYS

SOLUTION BY FINITE-DIFFERENCE DIFFUSION THEORY
EIGENVALUE PROBLEM
GEOMETRY NO.  7   2-D R-Z
NUMBER OF ENERGY GROUPS                                4
NUMBER OF UPSCATTER GROUPS (MAX)                       0
NUMBER OF DOWNSCATTER GROUPS (MAX)                     3
NUMBER OF INTERVALS IN DIMENSION 1 (COLUMNS)          35
NUMBER OF INTERVALS IN DIMENSION 2 (ROWS)             52
NUMBER OF INTERVALS IN DIMENSION 3 (PLANES)            1
NUMBER OF ZONES                                      155
NUMBER OF REGIONS                                    252
NUMBER OF BLACK ABSORBER ZONES                         0
BOUNDARY INDICATORS-     LEFT  1  RIGHT  2
                          TOP  2 BOTTOM  2



                                     MEMORY REQUIREMENTS FOR DATA STORAGE

                                           TOTAL                  A          B          C          D
                                      MINIMUM   MAXIMUM
STORAGE AVAILABLE                      140000
MACRO CALCULATION                       10756
EQUATION CONSTANTS CALCULATION
          CORE CONTAINED OR SPACE STORED  13059     13059
          PLANE STORED                  16659     16659
          ROW STORED                     7690      7690
          MULTI-LEVEL PLANE STORED      10083     10083
INITIAL FLUX
          CORE CONTAINED OR SPACE STORED   6027      6027
          OTHER MODES                    6027      6027
ITERATIVE PROCESS
          CORE CONTAINED                69951                 50950       2911       5892       7369
          SPACE STORED                  26029                 21920       2911       2892          9
        1 PLANES STORED                 33701                 29200       2911       2892          1
        1 PLANE STORED                  33701                 29200       2911       2892          0
       52 ROWS STORED                   20775                 20202       2911       2892          0
        1 ROW STORED                     8893                     0       2911       2892          3
        1 MULTI-LEVEL PLANES STORED     42765                 10920       2911       2892      27352
PERTURBATION CALCULATION                10320

DATA WILL BE STORED FOR ALL GROUPS, ALL SPACE

MEMORY LOCATIONS RESERVED FOR DATA STORAGE---   140000
MAX MEMORY LOCATIONS REQUIRED FOR THIS PROB--    69951
MEMORY LOCATIONS NOT USED-------------------    70049
```

—NEUTRONICS
PROBLEM
SOLUTION—

Table 3. CONTINUED

```
     SPECIAL SCRATCH DATASET REQUIREMENTS
     MAXIMUM PHYSICAL RECORD IS     7200 WORDS

SIZE CONTAINER ARRAYS, CONTROL      34 DATA   70083
FILE 26 DEFAULTS TO CORE - NO.RECS, REC.LNTH, TOT.LNTH, START LOC, CORE LEFT.     8   3640  14560       1  55483
FILE 27 DEFAULTS TO CORE - NO.RECS, REC.LNTH, TOT.LNTH, START LOC, CORE LEFT.     8   3640  14560   14561  40923
FILE 28 DEFAULTS TO CORE - NO.RECS, REC.LNTH, TOT.LNTH, START LOC, CORE LEFT.     8   3640  14560   29121  26353
DIRECT ACCESS FILE 40  REQUIRES     8 RECORDS     7367 WORDS IN LENGTH

D0 PARAMETERS FOLLOW FOR  N1 = 3520  AND  N2 =  32000
N2=  19 N3=  10 N4=   1 N5=   9 N6=  10 N7=   1 N8=   1 N9=   5 F10=   5 N11=   7 N12=   1 N13=   5 N14= 1 N15=10
N16=  19   (NOTE THAT IF THE FLUXES ARE TO BE EXPANDED FROM EXISTING NTFLUX, N10=  19)

REQUIRED DISK STORAGE SPACE FOR FLUX(UNITS 26,27,28) IS     66800 BYTES.
                           FOR CONSTANTS(UNIT 40) IS--    288000 BYTES.
                           FOR CONSTANTS(UNIT 23) IS--     35200 BYTES.
REQUIRED TOTAL DISK STORAGE SPACE IS------------------   6381440 BYTES.

FOR THE ASSIGNED DATA STORAGE, THE REQUIRED REGION SIZE IS APPROXIMATELY  490K BYTES

MAXIMUM STORAGE USED FOR MACROSCOPIC CROSS SECTION CALCULATION   10756 WORDS

THE MAXIMUM AND MINIMUM DIFFUSION COEFFICIENTS ARE  9.206321E 00  8.077442E-01

FINE MESH DESCRIPTION - POINT IS LOCATED AT THE CENTROID OF THE VOLUME ELEMENT
DISTANCE TO POINT - DIMENSION 1 (LEFT TO RIGHT)
    1  48.0208     2  70.7107     3  91.2071     4 107.9205     5 122.2313     6 135.0339     7 149.0858     8 165.1585
    9 179.0803    10 192.7870    11 205.3655    12 216.9715    13 228.1674    14 238.9391    15 250.7326    16 263.6858
   17 276.0302    18 287.7629    19 298.9557    20 309.7482    21 321.0625    22 334.0127    23 346.1081    24 357.7115
   25 368.8692    26 379.6992    27 390.1602    28 400.2812    29 410.1524    30 418.9323    31 428.8318    32 438.9650
   33 461.9686    34 483.6791    35 504.0396
DISTANCE TO POINT - DIMENSION 2 (TOP TO BOTTOM)
    1  16.0000     2  49.2000     3  82.0000     4 114.8000     5 147.6000     6 160.0000     7 176.0000     8 184.0000
    9 191.0000    10 197.0000    11 207.6389    12 222.9167    13 238.1945    14 253.4723    15 268.7501    16 284.0279
   17 299.3057    18 314.5835    19 329.8613    20 345.1391    21 360.4169    22 375.6947    23 390.9725    24 406.2503
   25 421.5281    26 436.8059    27 452.0837    28 467.3615    29 482.6393    30 497.9171    31 513.1949    32 528.4727
   33 543.7505    34 559.0283    35 574.3061    36 589.5839    37 604.8617    38 620.1395    39 635.4173    40 650.6951
   41 665.9729    42 681.2507    43 696.5285    44 711.8063    45 727.0841    46 742.3619    47 753.0000    48 759.0000
   49 773.0000    50 795.0000    51 817.0000    52 839.0000

DETERMINE INITIAL PARAMETERS FOR ITERATIVE PROCEDURE

REFERENCE POINT FOR INITIALIZATION WILL BE AT COLUMN =    26 ROW =    26 PLANE =     1 ZONE =   116
INITIAL OUTER ITERATION EIGENVALUE         0.064000  OPTION  -95
INITIAL OVERRELAXATION COEFFICIENTS MAX.  1.590941  MIN.  1.252676  INNER ITERATIONS MAX.    4 MIN.    4  OPTION    0
MESH POINT SWEEP OPTION    1
OUTER ITERATION LIMIT TO BE USED    75  ESTIMATED    31

MAXIMUM STORAGE USED FOR CALCULATING INITIAL PARAMETERS WAS    8439

INITIAL FLUX IS FXE(J,K)*FY(I)*FZ(KB)

TOTAL CORE REQUIRED FOR DATA STORAGE IS  69903 WORDS
ELAPSED CPU AND CLOCK MINUTES ARE  0.687   1.092


 4 FLUX - EIGENVALUE PROBLEM FOLLOWS
      4 INNERS MIN,  4 INNERS MAX - CHEBYCHEV  BETA ON INNERS
    SIGMA-1 ORDERING
PROCEDURE=0,1,2,3,4-NORMAL,CHEBYSHEV,SEMBI,DEMBI,SEMBIP.   ICVD=0,1-YES,NO INNERS CONVG.   OCVD=0,1-YES,NO OUTERS CONVG.
ITER  PROC  ICVD  OCVD   FLUX CHANGE    MU-MAX  OTHER-MU  SEM-INP   ACCELERATION PARAMETERS   SOURCE       K-USED     K-CALC
  1     0     0     0    7.53066D 01   0.0      0.0      1.00000     0.0        0.0       9.04927E 17  1.0000000  0.9651902
  2     0     0     0    1.04057D 00   3.01800  0.0      1.00000     1.00000    0.0       8.96158E 17  1.0000000  0.9686643
  3     0     1     0    7.46109D-01   0.55466  0.0      1.00000     1.20547    0.0       8.61572E 17  1.0000000  0.9725393
  4     0     1     0    8.19977D-01   1.50093  0.0      1.00000    -2.91125    0.73390   8.40543E 17  1.0000000  0.9757790
  5     0     1     0    5.95693D-01   3.70636  0.0      1.00000    16.78317   12.51758   8.22080E 17  1.0000000  0.9785160
  6     0     1     0    5.12175D-01   0.77807  0.0      1.00000     2.02639    0.36645   8.05625E 17  1.0000000  0.9808700
  7     0     1     0   -4.78039D-01   0.00691  0.0      1.00000     6.59296   -1.68879   7.90875E 17  1.0000000  0.9829873
NEW OVERRELAXATION COEFFICIENTS CALCULATED  1.63729  1.59153  1.50758  1.64809
NEW INNERS CALCULATED    4   4   4   4
  8     0     0     1    2.10051D 00   3.33682  0.0      1.00000    -1.96345    3.55713   7.77902E 17  1.0000000  0.9848707
  9     0     1     1    7.08307D 01  69.13601  0.0      1.00000    -1.05235    3.66581   7.68641E 17  0.9848707  0.9859001
 10     0     1     1    6.01907D 01   1.03665  0.0      1.00000    -1.00875   -1.01052   7.68281E 17  0.9859001  0.9870016
 11     0     1     0    3.99355D 01   0.90530  0.0      1.00000     9.08523   -1.30020   7.68361E 17  0.9870016  0.9870660
     FORCED EXTRAPOLATION LAMBDA         6.92907

  3.03007D 13  3.26227E 13  6.29276D 13  0.0        9.29067D-01  8.01684D-01  9.29176D-01  9.99389D-01  1.65222D-03
 12     4     1     0   -4.10923D-01   0.92937  0.0      1.00000     6.30810    0.0       7.60277E 17  0.9878660  0.9986622
 13     1     1     0    8.10873D 00   0.0      0.0      1.00000     0.66667    0.0       7.67219E 17  0.9939812
 14     1     1     1    3.29891D 00   0.0      0.0      1.00000     1.55319    0.53191   7.71055E 17  1.0000767
 15     1     1     0    5.56586D 00   0.51633  0.51633  1.00000     1.27053    0.36232   7.72029E 17  1.0006791
 16     1     1     1    3.32560D 00   0.73917  2.26030  1.00000     1.19207    0.38979   7.68391E 17  0.9980107
 17     1     1     1    2.69325D 01   0.03210 21.46875  1.00000     1.15720    0.29832   7.66823E 17  0.9955548
 18     1     1     1    8.02155D 00   3.67310  2.37495  1.00000     1.18973    0.29848   7.67512E 17  0.9960589
 19     0     1     1    3.95616D 03   0.0      0.0      1.00000    -1.80072    0.76184   7.69973E 17  0.9990559  0.9976092
 20     1     1     0    3.55050D 00   0.0      0.0      1.00000     0.55335    0.0       7.69128E 17  0.9976002
 21     1     0     0    7.85721D 00   0.0      0.0      1.00000     0.91861    0.17082   7.69021E 17  0.9978799
 22     1     1     1    4.93675D 00   3.09669  3.09669  1.00000     0.91861    0.17082   7.69268E 17  0.9973868
 23     1     1     0    2.59210D 00   0.85262  1.76896  1.00000     0.91861    0.17082   7.69989E 17  0.9978581
 24     1     0     0    3.98902D 00   0.78586  3.58686  1.00000     0.91861    0.17082   7.69085E 17  0.9978260
 25     1     1     0   -4.89323D-01   0.70100  0.60960  1.00000     0.91861    0.17082   7.69195E 17  0.9975199
 26     1     1     1    6.01635D 00   0.72269  4.02565  1.00000     0.91861    0.17082   7.69137E 17  0.9970711
 27     0     1     1    1.63376D 01   0.0      0.0      1.00000    -1.00991    2.35088   7.69168E 17  0.9978986  0.9978877
 28     1     0     0    5.07730D-01   0.0      0.0      1.00000     0.38518    0.0       7.69167E 17  0.9978877
 29     1     0     0   -1.92351D-01   0.0      0.0      1.00000     0.08598    0.07995   7.69170E 17  0.9978919
 30     1     0     0    1.98196D-01   0.57712  0.57712  1.00000     0.08598    0.07995   7.69171E 17  0.9978929
 31     1     0     0    5.39312D-02   0.83190  0.61519  1.00000     0.08598    0.07995   7.69172E 17  0.9978938
 32     1     1     0   -3.52301D-02   0.00003  0.61856  1.00000     0.08598    0.07995   7.69178E 17  0.9978949
 33     1     1     0    2.09105D-02   0.03989  0.70707  1.00000     0.08598    0.07995   7.69178E 17  0.9978952
 34     1     1     0   -1.87895D-02   0.88081  0.73565  1.00000     0.08598    0.07995   7.69176E 17  0.9978963
 35     1     1     0    1.39260D-02   0.83185  0.70897  1.00000     0.08598    0.07995   7.69177E 17  0.9978972
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Table 3. CONTINUED

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36   1   1   0  -9.64471D-03   0.84295  0.67716  1.00000    0.49598   0.07995   7.691772E 17  0.9974979
37   1   1   0   6.98799D-03   0.83740  0.67708  1.00000    0.49598   0.07995   7.691798E 17  0.9974991
38   1   1   0  -4.70002D-03   0.95672  0.68882  1.00000    0.49598   0.07995   7.691702E 17  0.9975003
39   1   1   0   3.13705D-03   0.96315  0.66594  1.00000    0.49598   0.07995   7.691703E 17  0.9974986
40   1   1   0  -2.05036D-03   0.86437  0.66573  0.0        0.49598   0.07995   7.691795E 17  0.9974999
41   3   1   0   7.41695D-02   1.70577  6.49023  0.0       12.32576  -0.52944   7.691792E 17  0.9974991
42   0   0   1  -1.87556D-02   0.0      0.0      1.00000   -2.68901  -1.08590   7.691022E 17  0.9975007  0.9975006
43   1   0   0  -1.98013D-03   0.0      0.0      1.00000    0.49620   0.0       7.691022E 17  0.9975006
44   1   0   0   8.97135D-04   0.0      0.0      1.00000    0.67696   0.12029   7.691022E 17  0.9975007
45   1   0   0   7.44231D-04   0.40460  0.40460  1.00000    0.67696   0.12029   7.691022E 17  0.9975007
46   1   0   0  -6.39936D-04   0.63519  0.05484  1.00000    0.67696   0.12029   7.691022E 17  0.9975007
47   1   0   0   2.44999D-04   0.67091  0.39333  1.00000    0.67696   0.12029   7.691023E 17  0.9975007
48   1   1   0   2.19457D-04   0.72157  0.51757  1.00000    0.67696   0.12029   7.691022E 17  0.9975006
49   1   1   0   1.45153D-04   0.74119  0.48797  1.00000    0.67696   0.12029   7.691022E 17  0.9975006
50   1   1   0   1.71095D-04   0.48697  0.91540  1.00000    0.67696   0.12029   7.691022E 17  0.9975006
51   1   1   0  -1.49213D-04   0.84446  0.06090  1.00000    0.67696   0.12029   7.691022E 17  0.9975006
52   1   1   0   1.26440D-04   0.82198  0.85178  1.00000    0.67696   0.12029   7.691022E 17  0.9975006
53   1   1   0  -1.06833D-04   0.01630  0.02073  1.00000    0.67696   0.12029   7.691022E 17  0.9975006
54   1   1   0   9.10240D-05   0.02147  0.02074  1.00000    0.67696   0.12029   7.691022E 17  0.9975006
55   1   1   0  -7.69020D-05   0.93402  0.04490  1.00000    0.67696   0.12029   7.691028E 17  0.9975006
56   0   1   1  -1.06332D-04   0.0      0.0      1.00000   -1.07990   0.66204   7.691029E 17  0.9975006  0.9975006
57   1   1   0  -1.71956D-05   0.0      0.0      1.00000    0.40620   0.0       7.691023E 17  0.9975006
                                                                                              0.9975006

ESTIMATED ABSOLUTE POINT FLUX RELATIVE ERROR  5.28067D-05

MULTIPLICATION RELIABILITY ESTIMATORS
NEUTRON BALANCE EFFECTIVE-----------------------------------------   0.9975006
BY THE SUM OF THE SQUARES OF THE RESIDUES-------------------------   0.9975006
UPPER AND LOWER BOUNDS ESTIMATES BY MAX REL FLUX CHANGE---------- -   0.9975178   0.9974935
UPPER AND LOWER BOUNDS ESTIMATES OVER ALL SIGNIFICANT POINTS------   0.9975052   0.9974987

NUMBER OF INNER ITERATIONS, OUTER ITERATION ERROR EIGENVALUE, AND OVERRELAXATION COEFFICIENTS     4  7.54157D-01
  1.50936  1.54262  1.53064  1.64409

CPU AND CLOCK MINUTES REQUIRED FOR THIS EIGENVALUE PROBLEM ARE  1.052   6.381
DOPC FILE CLOSING DATA - UNIT, ARRAYS       20      21   43601
DOPC FILE CLOSING DATA - UNIT, ARRAYS       20      16   43601

    LEAKAGE  5.19952E 18  TOTAL LOSSES  1.20988E 20  TOTAL PRODUCTIONS  1.20664E 20  REACTOR POWER(WATTS)  1.600000D 09

PRIMITIVE FISSILE CONVERSION RATIO IS  5.76902D-01, ESTIMATE FOR CRITICAL SYSTEM IS  5.71055D-01
FISSILE DESTRUCTION PER UNIT ENERGY (ATOMS/WATT-SEC) IS  3.03425D 16

BOUNDARY NEUTRON LEAKAGE
GROUP     LEFT          RIGHT             TOP            BOTTOM          FRONT          BACK
 1    0.0          1.91030D 15   1.31851D 17   1.05418D 18   0.0            0.0
 2    0.0          5.27124D 15   2.65685D 17   4.93327D 18   0.0            0.0
 3    0.0          1.19991D 16   3.82365D 17   1.07048D 15   0.0            0.0
 4    0.0          2.55121D 18   1.60263D 18   1.55230D 17   0.0            0.0
SUM   0.0          2.57040E 18   2.30210E 18   1.56980E 17   0.0            0.0

OVERALL NEUTRON BALANCE

      GROUP ABSORPTIONS   N**2 LOSSES    1/V LOSS    OUT-SCATTER   IN-SCATTER   P1 IN-SCATTER    SOURCE     POWER(WATTS)
        1   5.28460E 17   0.0           0.0         1.28126E 20   0.0           0.0          1.24789E 20  5.90350E 06
        2   3.67034E 19   0.0           0.0         1.28383E 20   1.28126E 20   0.0          4.19909E 19  1.69095E 07
        3   2.78673E 19   0.0           0.0         9.65201E 19   1.28383E 20   0.0          1.45009E 13  1.20978E 09
        4   9.22110E 19   0.0           0.0         0.0           9.65201E 19   0.0          2.60425E 09  1.52954E 09
SUM         1.23077E 20   0.0           0.0         3.45029E 20   3.45029E 20   0.0          1.20667E 20  1.67385E 09

ZONE VOLUMES FOLLOW. TOTAL WEIGHT  7.08282E 09
   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06
   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06   1.90844E 06
   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06
   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06   1.89299E 06
   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06
   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06   1.91362E 06
   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06
   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06   1.91871E 06
   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06
   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06   1.89116E 06
   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06
   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06   2.36902E 06
   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06
   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06   2.33465E 06
   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06
   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06   2.30383E 06
   0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0           1.08212E 08
   2.40343E 08   5.41060E 07

ZONE AVERAGE FLUX INTERFACE FILE RTFLUX (VERSION  1) HAS BEEN WRITTEN ON UNIT NUMBER  16

POINT REGULAR FLUX INTERFACE FILE RTFLUX (VERSION  1) HAS BEEN WRITTEN ON UNIT NUMBER  17

GROUP FLUX VALUES AT PLANE  1 ROW 18 COLUMN  1 = POINT AT FIRST GROUP MAXIMUM
   1.15043E 14   1.70503E 14   1.30645E 14   2.17578E 14

MAXIMUM FIRST GROUP FLUXES BY ZONE
   1.00730E 14   1.15003E 14   1.11992E 14   1.00665E 14   8.50500E 13   6.97603E 13   5.65260E 13   4.59960E 13   3.67295E 13
   2.96060E 13   2.39910E 13   1.93089E 13   1.56198E 13   1.26505E 13   1.02594E 13   9.30231E 12   6.70010E 12   5.16091E 12
   9.05251E 13   1.13230E 14   1.10402E 14   9.57680E 13   8.05216E 13   6.98459E 13   5.63075E 13   4.50231E 13   3.65001E 13
   2.90701E 13   2.37623E 13   1.91707E 13   1.54067E 13   1.25327E 13   1.01300E 13   8.19910E 12   6.60660E 12   5.00670E 12
   9.59520E 13   1.11111E 14   1.08737E 14   9.47094E 13   8.39040E 13   6.90636E 13   5.60360E 13   4.51990E 13   3.63040E 13
   2.92012E 13   2.35770E 13   1.90027E 13   1.53309E 13   1.23703E 13   9.99672E 12   8.04019E 12   6.47598E 12   4.90002E 12
   9.25520E 13   1.08072E 14   1.06190E 14   9.69047E 13   8.27032E 13   6.82577E 13   5.50599E 13   4.47259E 13   3.59708E 13
   2.89100E 13   2.32022E 13   1.87001E 13   1.50593E 13   1.21350E 13   9.78130E 12   7.87736E 12   6.31059E 12   4.84070E 12
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Table 3. CONTINUED

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  8.851631E 13  1.081502E 14  1.020803E 14  9.887092E 13  8.100631E 13  6.700677E 13  5.886227E 13  4.370980E 13  3.527768E 13
  2.031111E 13  2.272108E 13  1.820799E 13  1.866787E 13  1.179692E 13  9.888552E 12  7.628207E 12  6.907132E 12  4.670032E 12
  8.357638E 13  9.895987E 13  9.808862E 13  9.077987E 13  7.920258E 13  6.891087E 13  5.290927E 13  4.255692E 13  3.818789E 13
  2.735608E 13  2.591207E 13  1.756172E 13  1.808662E 13  1.130608E 13  9.073252E 12  7.272952E 12  5.551692E 12  4.427629E 12
  7.857978E 13  9.065898E 13  9.809937E 13  8.372267E 13  7.201867E 13  6.018827E 13  4.896257E 13  3.980652E 13  3.155612E 13
  2.522068E 13  2.035192E 13  1.611128E 13  1.289177E 13  1.032142E 13  8.260917E 12  6.579897E 12  5.201112E 12  3.977097E 12
  6.726068E 13  7.790037E 13  7.688312E 13  7.072192E 13  6.074398E 13  5.015087E 13  4.068877E 13  3.259732E 13  2.600782E 13
  2.072558E 13  1.651728E 13  1.317839E 13  1.051882E 13  8.802908E 12  6.709207E 12  5.302252E 12  4.219997E 12  3.170809E 12
  0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0           4.963297E 13
  3.306008E 13  2.180318E 12

THE MAXIMUM POWER DENSITY IS AT PLANE   1, ROW  16,  AND COLUMN   1  AND IS   1.996076070 01  WATTS/CC.

THE MAXIMUM NEUTRON DENSITY IS AT PLANE   1, ROW  17, AND COLUMN   1  AND IS   5.677708420 09  NEUTRONS/CC.

THE MAXIMUM POWER DENSITY (WATTS/CC) IN EACH ZONE IS
  1.625328E 01  1.686077E 01  1.534629E 01  1.310552E 01  1.094012E 01  8.935607E 00  7.220992E 00  5.929972E 00  4.708239E 00
  3.797818E 00  3.066418E 00  2.479908E 00  2.006652E 00  1.625968E 00  1.310072E 00  1.068231E 00  8.691692E-01  7.332082E-01
  1.500738E 01  1.663077E 01  1.522978E 01  1.308162E 01  1.091378E 01  8.920907E 00  7.229157E 00  5.923522E 00  4.701592E 00
  3.709098E 00  3.056572E 00  2.068937E 00  1.595032E 00  1.618128E 00  1.306367E 00  1.056957E 00  9.578732E-01  7.229128E-01
  1.505428E 01  1.630198E 01  1.507882E 01  1.295652E 01  1.008562E 01  8.986067E 00  7.216227E 00  5.920952E 00  4.697652E 00
  3.770068E 00  3.080097E 00  2.051107E 00  1.978218E 00  1.597838E 00  1.290907E 00  1.082592E 00  9.882687E-01  7.101728E-01
  1.600168E 01  1.590937E 01  1.480337E 01  1.278832E 01  1.077682E 01  8.881567E 00  7.166822E 00  5.779092E 00  4.688867E 00
  3.736768E 00  3.005952E 00  2.419512E 00  1.900272E 00  1.570598E 00  1.266327E 00  1.020827E 00  8.281992E-01  6.917138E-01
  1.420932E 01  1.538752E 01  1.481617E 01  1.253517E 01  1.061318E 01  8.726727E 00  7.077707E 00  5.771592E 00  4.590887E 00
  3.676218E 00  2.956872E 00  2.370292E 00  1.905687E 00  1.523358E 00  1.233537E 00  9.817057E-01  7.989692E-01  6.605122E-01
  1.339528E 01  1.659738E 01  1.386167E 01  1.216067E 01  1.025732E 01  8.560207E 00  6.929987E 00  5.677332E 00  4.672082E 00
  3.502298E 00  2.969012E 00  2.290387E 00  1.848897E 00  1.490612E 00  1.198807E 00  9.529907E-01  7.651962E-01  6.379827E-01
  1.230318E 01  1.380592E 01  1.208302E 01  1.136272E 01  9.727612E 00  8.037807E 00  6.519507E 00  5.229692E 00  4.199928E 00
  3.307208E 00  2.673232E 00  2.136507E 00  1.709307E 00  1.368462E 00  1.095322E 00  8.752817E-01  6.983512E-01  5.795732E-01
  1.315038E 01  1.361058E 01  1.256952E 01  1.206892E 01  9.098882E 00  7.389907E 00  5.919657E 00  4.711312E 00  3.703927E 00
  2.973208E 00  2.363097E 00  1.880587E 00  1.488877E 00  1.190872E 00  9.521317E-01  7.561927E-01  5.985532E-01  4.787982E-01
  0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
  0.0           0.0

THE RELATIVE POWER DENSITY TRAVERSE LEFT-TO-RIGHT IS
  1.000000D 00  9.969620D-01  9.939850D-01  9.909608D-01  9.877760D-01  9.802690D-01  9.962580D-01  9.986990D-01  9.787370D-01
  9.601050D-01  9.692190D-01  9.615020D-01  9.533090D-01  9.445060D-01  9.435720D-01  9.290070D-01  9.180250D-01  9.102520D-01
  8.920310D-01  8.781170D-01  8.657560D-01  9.389770D-01  8.107750D-01  7.950920D-01  7.697300D-01  7.888890D-01  7.300930D-01
  7.876100D-01  9.972260D-01  0.0           0.0           0.0           0.0           0.0           0.0

THE RELATIVE POWER DENSITY TRAVERSE TOP-TO-BOTTOM IS
  0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0           0.0
  0.0           8.253330D-01  9.639650D-01  9.399250D-01  1.000000D 00  8.887870D-01  9.197750D-01  7.772790D-01  7.623990D-01
  6.408510D-01  6.168810D-01  5.299660D-01  4.931850D-01  4.291020D-01  3.981900D-01  3.853020D-01  3.155330D-01  2.792820D-01
  2.532520D-01  2.252860D-01  2.037490D-01  1.918670D-01  1.682820D-01  1.876270D-01  1.327210D-01  1.190130D-01  1.073950D-01
  9.603070D-02  8.699160D-02  7.817360D-02  7.968080D-02  6.375630D-02  5.712210D-02  5.189950D-02  4.680980D-02  4.348580D-02
  4.273700D-02  0.0           0.0           0.0           0.0           0.0           0.0

POWER DENSITY INTERFACE FILE PDOUT (VERSION  1) HAS BEEN WRITTEN ON UNIT NUMBER  19

ROUC USE OF CONTAINER ARRAYS, CONTROL       11, MAX DATA   43600

TOTAL CPU MINUTES USED   1.107   TOTAL CLOCK MINUTES USED   7.017   TOTAL I/O USED    205



                    POWDER - EXPOSURE MODULE - PRE-RELEASE VERSION 1G - AUGUST 20, 1979  - QUALITY ASSURANCE LEVEL 0
                    -------------------------------------------------------------------------------------------------


CASE TITLE -    SAMPLE PROBLEM, TWO DIMENSIONAL PPESLP AND THERMAL HYDRAULICS

SIZE CONTAINER ARRAYS, CONTROL        6 DATA        1

TITLE OF THE LATEST VERSION CROSS SECTION FILE
          XS00  SAME AS XS05 PLUS PU-237,LESS XE-135

METHOD OF SOLUTION - EXPLICIT CHAIN

          THE LONGEST EXPLICIT CHAIN IS     16


CONTINUOUS FUELING MODE!

FALSE ZONE NUMBER CONTAINING FEED MATERIAL COMPOSITION FOR ZONE PATHS        185
NUMBER OF ZONE PATHS THROUGH THE REACTOR                                       8
NUMBER OF ZONES ALONG EACH ZONE PATH                                          18
ZONE FEED OPTION                                                               1  ZONE    185 THROUGH ZONE    152

MAXIMUM ARRAY SIZE USED FOR INITIAL PROCESSING IS    2560

STORAGE REQUIRED FOR BASIC DATA IS    2559

         STORAGE SUPPLIED IS    100000
MAXIMUM STORAGE REQUIRED IS     62805
MINIMUM STORAGE REQUIRED IS     13139

 MODNB  =  0 MODPRT = -1

MEMORY ACTUALLY USED WILL BE    62805

NEXT-TO-LATEST VERSION NUFLUX NOT AVAILABLE FOR LINEAR FLUX APPROXIMATION
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— CONTINUOUS
FUELING
EXPOSURE
CALCULATION —

Table 3. CONTINUED

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EXPOSURE TIME STEP STARTS AT   2.7267?0E 00  DAYS

EXPOSURE TIME STEP IS   1.1000000E 01 DAYS (  9.[illegible] 0? SECONDS ) THE NUMBER OF PASSES IS     2

REFERENCE POWER   1.6???E 0? WATTS

                              AVERAGE POWER    1.6?3983E 0? WATTS PER PASS      1
                    MAXIMUM AVERAGE POWER DENSITY    2.6??70?E 01 WATTS/CC IN ZONE          2

         INITIAL REACTION RATES WILL BE MULTIPLIED BY    1.0037?0E 00 FOR THIS PASS              1.0037?7E 00

         REFERENCE POWER LEVEL HAS BEEN ATTAINED

      FEED DENSITIES FOR ZONE PATH    1

TH-232      2.3617?0E-04    U-235      2.0177999E-05   U-238      1.4551?0?E-06        C      9.[illegible]E-02
    SI      1.3619999E-?0        O      5.1031?7?E-06   DECVEL     9.9999998E-19


DISCHARGE DENSITIES FOR ZONE PATH    1 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232      2.9501?0?E-0?  PA-233      1.0311113E-07    U-233      5.0530208E-06    U-234      1.6560?[illegible]E-06
 U-235      7.960592?E-0?   U-236      2.90?6??E-06   NP-239      9.0201068E-1?  PU-24?      1.?33??[illegible]E-0?
AM-243      5.3612?7E-09    U-238      1.1655?[illegible]E-06   PU-239      1.2?0062?E-0?   PU-240      5.?60?2[illegible]E-0?
PU-241      7.02056[illegible]E-0?        C      8.3795968E-02    I-135      6.560092?E-11   XE-135      8.7?0?0?E-11
PD-107      1.1360277E-07  PD-108      1.7010?0E-10  PM148M      4.1463?2?E-10   PM-148      1.2?[illegible]E-?0
SB-109      5.273033E-10   RH-103      7.1010691E-07       FP1      8.5150712E-06       FP2      3.6?9165?E-0?
    SI      1.3619?9?E-04   KR-83      1.1025400E-07    KR-83      1.5173078E-0?   RU-103      2.[illegible]E-0?
RH-105      4.107739E-12   AG-109      7.5?933?E-0?   XE-131      4.9013038E-0?   XE-133      1.066?[illegible]E-0?
CS-133      1.0622998E-06   CS-134      1.92609?E-07   CS-135      1.0193078E-0?   ND-14?      9.?0?7?0?E-0?
EU-153      9.3540512E-0?   EU-154      2.0?30?2?E-0?   EU-155      2.9037558E-0?   ND-14?      1.0?[illegible]E-0?
SM-150      3.0660000E-0?   SM-151      7.2120271E-09   SM-152      1.2096302E-0?        C      5.?0?[illegible]E-0?
DECVEL      9.999999?E-10   NP-237      3.0216?1?E-0?


      FEED DENSITIES FOR ZONE PATH    2

TH-232      2.361626E-04    U-235      2.01??5?E-05    U-238      1.0551?0?E-06        .      9.?7?5?6?E-02
    SI      1.3619999E-04        O      5.1601?7?E-06   DECVEL     9.999999?E-19


DISCHARGE DENSITIES FOR ZONE PATH    2 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232      2.152?69?E-04  PA-233      1.0129732E-07    U-233      5.0697007E-04    U-234      1.6316?0?E-06
 U-235      8.2093?0?E-0?   U-236      2.9513058E-06   NP-239      9.2?96007E-1?   PU-242      1.?[illegible]E-0?
AM-243      5.2556902E-09    U-238      1.1600921E-06   PU-239      1.3033008E-0?   PU-240      9.96?2?[illegible]E-0?
PU-241      7.10198?1E-0?        C      8.3795902E-02    I-135      6.0031018E-11   XE-135      4.7??2?7?E-11
PD-107      1.100072E-07   PD-108      1.7150?0?E-10  PM148M      4.7372628E-10   PM-148      1.2?[illegible]E-?9
SB-109      5.300?052E-10   RH-103      7.1?3??7?E-07       FP1      8.0?0000?E-06       FP2      3.?6??[illegible]E-0?
    SI      1.361999?E-04   KR-83      1.1315298E-07    KR-83      1.5890108E-07   RU-103      2.[illegible]E-0?
RH-105      4.129?152E-12   AG-109      7.5?3?10?E-09   XE-131      4.9700?0?E-0?   XE-133      1.003096?E-0?
CS-133      1.3503158E-06   CS-134      1.0062259E-07   CS-135      1.02?600?E-0?   ND-14?      8.??100??E-07
EU-153      9.270?30?E-0?   EU-154      2.7052098E-09   EU-155      2.9165068E-0?   ND-14?      1.0?[illegible]E-0?
SM-150      3.0?9?95E-07   SM-151      7.2153008E-09   SM-152      1.2002067E-0?        C      5.?0?[illegible]E-0?
DECVEL      9.999990E-1?   NP-237      3.0065699E-07


      FEED DENSITIES FOR ZONE PATH    3

TH-232      2.3616201E-04    U-235      2.0177199?E-05   U-238      1.0551?0?E-06        C      9.[illegible]E-02
    SI      1.3619998E-04        O      5.1031?7?E-06   DECVEL     9.9599998E-19


DISCHARGE DENSITIES FOR ZONE PATH    3 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232      2.1560?72E-04  PA-233      9.8512658E-08    U-233      5.098707?E-04    U-234      1.5[illegible]E-06
 U-235      8.5033??E-07   U-236      2.9?05?0?E-06   NP-239      9.1036798E-1?   PU-242      1.?[illegible]E-0?
AM-243      5.1016012E-09    U-238      1.1736078E-06   PU-239      1.3225058E-0?   PU-240      ?.?1200?E-09
PU-241      7.22203?7E-0?        C      8.3795968E-02    I-135      6.3203308E-11   XE-135      8.6?02??E-11
PD-107      1.1067858E-0?  PD-108      1.6767208-1?  PM148M      4.7209298E-10   PM-148      1.2329858E-10
SB-109      5.3030108E-10   RH-103      7.2213098E-07       FP1      6.3000531E-06       FP2      3.6?50???E-0?
    SI      1.361999?E-04   KR-83      1.1153700-07    KR-83      1.0097337E-0?   RU-103      2.6303??[illegible]E-0?
RH-105      4.0529658E-12   AG-109      7.5076558E-09   XE-131      4.9423700E-0?   XE-133      1.012?2?0?E-09
CS-133      1.0020658E-06   CS-134      1.0526199E-07   CS-135      1.0009?0?E-07   ND-14?      8.6??230?E-0?
EU-153      9.1696221E-08   EU-154      2.7509268E-09   EU-155      2.0772378E-0?   ND-14?      9.?2??60?E-?9
SM-150      3.7090507E-07   SM-151      7.191765?E-09   SM-152      1.2660318E-07        C      5.100[illegible]E-0?
DECVEL      ?.[illegible]E-1?  NP-237      3.3?02??E-07


      FEED DENSITIES FOR ZONE PATH    4

TH-232      2.3617209E-04    U-235      2.0177998E-05   U-238      1.0551008E-06        C      8.[illegible]9?0E-02
    SI      1.3619992E-04        O      5.1031?7?E-06   DECVEL     9.9599998E-19
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Table 3. CONTINUED

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DISCHARGE DENSITIES FOR ZONE PATH   4 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232     2.162526E-04  PA-233   9.597865E-09  U-233    5.129050E-06  U-234      1.500872E-06
 U-235     9.215050E-07  U-236    2.952250E-06  NP-239   8.053862E-11  PU-242     1.759660E-08
AM-243     4.872702E-09  U-238    1.193753E-06  PU-239   1.351057E-08  PU-240     1.036777E-08
PU-241     7.005049E-09       C   8.379596E-02  I-135    6.150087E-11  XE-135     8.679556E-11
PM-147     1.155056E-07  PM-148   1.635551E-10  PM148M   4.767386E-10  PM-149     1.900733E-10
SM-149     5.410263E-10  ND-143   7.297095E-07     FP1   8.107550E-06     FP2     3.502203E-05
    HE     1.361999E-08  KR-82    1.091628E-07  KR-83    1.401775E-07  RH-103     2.603689E-07
RH-105     3.952999E-12  AG-109   7.595129E-09  XE-131   4.963263E-07  XE-133     1.277574E-09
CS-133     1.028999E-06  CS-134   1.780709E-07  CS-135   1.873000E-07  ND-145     7.900410E-07
EU-153     9.009976E-09  EU-154   2.783976E-09  EU-155   2.819380E-09  ND-147     9.680300E-10
SM-150     3.739397E-07  SM-151   7.155803E-09  SM-152   1.206299E-07       O     5.180197E-04
DECVEL     9.999999E-10  NP-237   3.307635E-07


     FEED DENSITIES FOR ZONE PATH   5

TH-232     2.361620E-04   U-235   2.011199E-05  U-238    1.495100E-06       C     8.379596E-02
    HE     1.361999E-08       O   5.180197E-04  DECVEL   9.999999E-10


DISCHARGE DENSITIES FOR ZONE PATH   5 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232     2.170525E-04  PA-233   9.039611E-09  U-233    5.169600E-06  U-234      1.077208E-06
 U-235     1.021805E-06  U-236    2.961081E-06  NP-239   8.510907E-11  PU-242     1.705365E-08
AM-243     4.539209E-09  U-238    1.191036E-06  PU-239   1.390032E-08  PU-240     1.070786E-08
PU-241     7.660777E-09       C   8.379596E-02  I-135    5.522270E-11  XE-135     4.652925E-11
PM-147     1.168750E-07  PM-148   1.553590E-10  PM148M   4.670726E-10  PM-149     1.136200E-10
SM-149     5.500121E-10  ND-143   7.364150E-07     FP1   7.977117E-06     FP2     3.442133E-05
    HE     1.361999E-08  KR-82    1.051761E-07  KR-83    1.055952E-07  RH-103     2.750100E-07
RH-105     3.827297E-12  AG-109   7.836771E-09  XE-131   4.912296E-07  XE-133     1.310700E-09
CS-133     1.399610E-06  CS-134   1.697509E-07  CS-135   1.905112E-07  ND-145     7.897762E-07
EU-153     8.770712E-09  EU-154   2.529520E-09  EU-155   2.730300E-09  ND-147     9.297251E-10
SM-150     3.650699E-07  SM-151   7.096325E-09  SM-152   1.210195E-07       O     5.180197E-04
DECVEL     9.999999E-10  NP-237   3.290950E-07


     FEED DENSITIES FOR ZONE PATH   6

TH-232     2.361620E-04   U-235   2.011199E-05  U-238    1.495100E-06       C     8.379596E-02
    HE     1.361999E-08       O   5.180197E-04  DECVEL   9.999999E-10


DISCHARGE DENSITIES FOR ZONE PATH   6 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232     2.183131E-04  PA-233   8.339260E-09  U-233    5.190593E-06  U-234      1.255107E-06
 U-235     1.203327E-06  U-236    2.962067E-06  NP-239   7.950516E-11  PU-242     1.680127E-08
AM-243     3.900837E-09  U-238    1.209703E-06  PU-239   1.035340E-08  PU-240     1.112505E-08
PU-241     7.902130E-09       C   8.379596E-02  I-135    5.508500E-11  XE-135     8.590269E-11
PM-147     1.109972E-07  PM-148   1.055655E-10  PM148M   8.613312E-10  PM-149     1.057812E-10
SM-149     5.668170E-10  ND-143   7.052013E-07     FP1   7.633762E-06     FP2     3.285590E-05
    HE     1.361999E-08  KR-82    1.003976E-07  KR-83    1.409585E-07  RH-103     2.837760E-07
RH-105     3.662037E-12  AG-109   7.319229E-09  XE-131   4.855460E-07  XE-133     1.200695E-09
CS-133     1.359560E-06  CS-134   1.551017E-07  CS-135   1.906943E-07  ND-145     7.650904E-07
EU-153     8.400787E-09  EU-154   2.095268E-09  EU-155   2.560007E-09  ND-147     9.795607E-10
SM-150     3.501615E-07  SM-151   6.963290E-09  SM-152   1.176626E-07             5.180197E-04
DECVEL     9.999999E-10  NP-237   3.165796E-07


     FEED DENSITIES FOR ZONE PATH   7

TH-232     2.361620E-04   U-235   2.011199E-05  U-238    1.495100E-06       C     8.379596E-02
    HE     1.361999E-08       O   5.180197E-04  DECVEL   9.999999E-10


DISCHARGE DENSITIES FOR ZONE PATH   7 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232     2.202619E-04  PA-233   7.322050E-09  U-233    5.071270E-06  U-234      1.179110E-06
 U-235     1.079934E-06  U-236    2.950935E-06  NP-239   6.950210E-11  PU-242     1.633911E-08
AM-243     3.065753E-09  U-238    1.282176E-06  PU-239   1.017256E-08  PU-240     1.109727E-08
PU-241     7.965671E-09       C   8.379596E-02  I-135    5.065359E-11  XE-135     8.299372E-11
PM-147     1.225168E-07  PM-148   1.305339E-10  PM148M   4.032601E-10  PM-149     9.600779E-11
SM-149     5.697000E-10  ND-143   7.811041E-07     FP1   7.109701E-06     FP2     3.056609E-05
    HE     1.361999E-08  KR-82    9.203905E-08  KR-83    1.320797E-07  RH-103     2.098816E-07
RH-105     3.339020E-12  AG-109   7.073780E-09  XE-131   4.150718E-07  XE-133     1.119320E-09
CS-133     1.303039E-06  CS-134   1.320081E-07  CS-135   1.966715E-07  ND-145     7.209067E-07
EU-153     7.006926E-09  EU-154   2.253030E-09  EU-155   2.320610E-09  ND-147     7.927299E-10
SM-150     3.362100E-07  SM-151   6.604130E-09  SM-152   1.127106E-07       O     5.180197E-04
DECVEL     9.999999E-10  NP-237   2.807366E-07
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Table 3. CONTINUED

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     FEED DENSITIES FOR ZONE PATH   8

TH-232     2.361620E-04   U-235     2.017190E-05   U-238     1.099190E-06        C      9.2?????E-02
    HE     1.361999E-04       O     5.303197E-04  RECYCL     9.999999E-10

DISCHARGE DENSITIES FOR ZONE PATH   8 EXPOSURE TIME FOR EACH ZONE IN PATH    61.1111 DAYS

TH-232     2.220930E-04  PA-233     6.235710E-06   U-233     4.569047E-06   U-234     9.?????E-07
 U-235     1.401309E-06   U-236     2.985903E-06  NP-239     5.350605E-11  PU-242     1.17????E-0?
AM-243     1.979175E-09   U-238     1.290009E-06  PU-239     1.123620E-09  PU-240     8.??????E-09
PU-241     6.107207E-09       C     8.379596E-02   I-135     6.203399E-11  XE-135     3.791130E-11
PM-147     1.261513E-07  PM-148     1.127786E-10  PM148M     4.009042E-10  PM-149     7.??????E-11
SM-149     5.120399E-10  RH-103     6.929025E-07     FP1     6.770651E-0?     FP2     2.0?????E-0?
    HE     1.361999E-04   KR-82     9.525791E-09   KR-83     1.209621E-07  RU-103     2.7?1627E-07
RU-105     2.790516E-12  AG-109     6.737913E-09  XE-131     4.670043E-07  XE-133     9.35????E-10
CS-133     1.260706E-06  CS-134     1.091103E-07  CS-135     1.020050E-07  ND-145     7.15????E-07
EU-153     7.226561E-08  EU-154     1.950029E-09  EU-155     1.952000E-09  ND-147     6.6?????E-10
SM-150     3.027000E-07  SM-151     5.019732E-09  SM-152     1.121213E-07       C     5.1?????E-08
RECYCL     9.999999E-10  NP-237     2.106593E-07

                AVERAGE POWER    1.637773E 09 WATTS PER PASS     2
REACTOR AVERAGE POWER DENSITY    2.66????E 01 WATTS/CC IN ZONE            2


    FEED AND DISCHARGE RATES (KILOGRAMS PER DAY) BY ABSOLUTE NUCLIDE

                      MOVING ZONES                  STATIONARY ZONES
NO.  NAME          FEED          DISCHARGE      FEED            DISCHARGE
  1     HE      1.060340E-01   1.960390E-01   0.0             0.0
  2      C      2.710152E 02   2.710152E 02   4.615632E 02    4.615632E 02
  3 PM-147      0.0            3.550520E-05   0.0             0.0
  4  I-135      0.0            2.000550E-06   0.0             0.0
  5      O      1.900300E 00   1.900300E 00   0.0             0.0
  6 RECYCL      0.0            0.0            0.0             0.0
  7 COOLNT      0.0            0.0            0.0             0.0
  8 XE-135      0.0            1.601200E-06   0.0             0.0
  9 CS-133      0.0            4.950930E-02   0.0             0.0
 10 CS-134      0.0            5.000000E-03   0.0             0.0
 11 CS-135      0.0            6.038200E-03   0.0             0.0
 12 PM-147      0.0            4.601530E-03   0.0             0.0
 13 PM148M      0.0            1.020700E-05   0.0             0.0
 14 PM-148      0.0            6.016490E-06   0.0             0.0
 15 SM-149      0.0            2.176100E-05   0.0             0.0
 16 SM-151      0.0            2.790090E-04   0.0             0.0
 17 EU-153      0.0            3.532500E-03   0.0             0.0
 18  U-236      0.0            1.079300E-01   0.0             0.0
 19 PU-242      0.0            1.050790E-03   0.0             0.0
 20 AM-243      0.0            2.730400E-04   0.0             0.0
 21    FP2      0.0            1.056290E 00   0.0             0.0
 22    FP1      0.0            2.066520E-01   0.0             0.0
 23 TH-232      1.476639E 01   1.361599E 01   0.0             0.0
 24  U-233      0.0            3.150100E-01   0.0             0.0
 25  U-234      0.0            4.094359E-02   0.0             0.0
 26  U-235      1.277630E 00   6.900910E-02   0.0             0.0
 27 NP-239      0.0            5.201769E-06   0.0             0.0
 28 PM-149      0.0            4.400720E-06   0.0             0.0
 29  KR-82      0.0            2.279570E-03   0.0             0.0
 30  KR-83      0.0            3.171210E-03   0.0             0.0
 31 RH-103      0.0            7.560260E-03   0.0             0.0
 32 RU-105      0.0            1.040400E-07   0.0             0.0
 33 AG-109      0.0            2.151660E-04   0.0             0.0
 34 XE-131      0.0            1.720500E-02   0.0             0.0
 35 XE-133      0.0            4.567000E-05   0.0             0.0
 36 RU-103      0.0            2.790510E-02   0.0             0.0
 37 ND-145      0.0            3.026600E-02   0.0             0.0
 38 SM-150      0.0            1.039910E-02   0.0             0.0
 39 SM-152      0.0            4.957270E-03   0.0             0.0
 40 EU-154      0.0            1.000000E-03   0.0             0.0
 41 EU-155      0.0            1.095630E-04   0.0             0.0
 42 PA-233      0.0            5.076900E-03   0.0             0.0
 43  U-238      9.616600E-02   7.703359E-02   0.0             0.0
 44 PU-239      0.0            8.572970E-04   0.0             0.0
 45 PU-240      0.0            6.630700E-04   0.0             0.0
 46 PU-241      0.0            4.760060E-04   0.0             0.0
 47 NP-237      0.0            1.975490E-02   0.0             0.0

   FISSILE      1.277630E 00   3.921100E-01   0.0             0.0


POWER (WATTS) FOR EACH ZONE PATH
    1)   2.075006E 08      2)   2.039130E 08      3)   2.032752E 08      4)   1.996?0?E 08      5)   1.910197E 08
    6)   2.201095E 08      7)   2.052760E 08      8)   1.949985E 08

TOTAL POWER (WATTS) FOR ZONE PATHS    1.637703E 09

ACTINIDE FEED RATE (KILOGRAMS PER DAY) FOR EACH ZONE PATH
    1)   1.063209E 00      2)   1.040120E 00      3)   1.060269E 00      4)   1.0?3227E 00      5)   1.046339E 00
    6)   2.312070E 00      7)   2.279319E 00      8)   2.209235E 00

TOTAL ACTINIDE FEED RATE (KILOGRAMS PER DAY) FOR ZONE PATHS    1.613059E 01

EXPOSURE (MEGAWATT-DAYS PER KILOGRAM) FOR EACH ZONE PATH
    1)   1.193087E 02      2)   1.103357E 02      3)   1.080039E 02      4)   1.065003E 02      5)   1.030596E 02
    6)   9.962610E 01      7)   9.101725E 01      8)   8.669503E 01

TOTAL EXPOSURE (MEGAWATT-DAYS PER KILOGRAM) FOR ZONE PATHS    1.0?0697E 02
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Table 3. CONTINUED

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                 INVENTORY AND REACTION RATES BY ABSOLUTE NUCLIDE

NO.  NAME    INVENTORY    ABSORPTION   FISSION      PRODUCTION   CAPTURE
               (KG)                                                 (N,G)
 1       HE  1.61516E 02  7.00478E-05  0.0          0.0          6.79554E-05
 2        C  8.05403E 05  4.37259E-02  0.0          0.0          4.29217E-02
 3   ND-147  3.03655E-01  4.11406E-09  0.0          0.0          3.97727E-09
 4    I-135  2.29279E-02  1.03798E-10  0.0          0.0          1.19120E-11
 5        O  1.21912E 03  7.65610E-05  0.0          0.0          6.96234E-06
 6   RECVEL  0.0          7.40612E-08  0.0          0.0          7.40612E-08
 7   CONABS  0.0          3.51639E-02  0.0          0.0          3.51639E-02
 8   XE-135  3.05967E-03  2.26053E-02  0.0          0.0          2.26053E-02
 9   CS-133  4.16785E 01  5.03562E-03  0.0          0.0          5.03561E-03
10   CS-134  5.12529E 00  9.88059E-04  0.0          0.0          9.08859E-04
11   CS-135  4.77520E 00  8.89270E-05  0.0          0.0          8.09253E-05
12   PM-147  6.00391E 00  5.49227E-03  0.0          0.0          5.49226E-03
13   PM148M  4.05418E-02  2.36100E-03  0.0          0.0          2.36100E-03
14   PM-148  4.45460E-02  9.12024E-04  0.0          0.0          9.12024E-04
15   SM-149  4.42780E-02  7.25039E-03  0.0          0.0          7.25039E-03
16   SM-151  2.92709E-01  3.57807E-03  0.0          0.0          3.57807E-03
17   EU-153  2.73132E 00  1.99136E-03  0.0          0.0          1.90136E-03
18    U-236  1.78510E 02  8.29598E-03  4.00045E-05  1.07176E-04  8.25565E-03
19   PU-242  7.69275E-01  9.11269E-05  3.09625E-07  9.48202E-07  9.08167E-05
20   AM-243  1.71204E-01  3.00204E-05  4.33113E-08  1.03140E-07  2.99771E-05
21      FP2  8.57235E 02  3.21304E-03  0.0          0.0          3.21304E-03
22      FP1  1.99533E 02  4.34291E-03  0.0          0.0          4.34291E-03
23   TH-232  1.53571E 04  2.67409E-01  4.68599E-04  1.11490E-03  2.67055E-01
24    U-233  2.87115E 02  1.80912E-01  1.62567E-01  4.06941E-01  1.83405E-02
25    U-234  6.07758E 01  9.19537E-03  3.20930E-05  4.73592E-05  9.16304E-03
26    U-235  2.96721E 02  2.88675E-01  2.36935E-01  5.76168E-01  5.16892E-02
27   NP-239  6.27052E-02  1.26719E-05  7.98629E-09  2.14536E-07  1.25910E-05
28   PM-149  6.49254E-02  4.71600E-10  0.0          0.0          2.97787E-11
29    KR-82  1.76966E 00  2.95195E-04  0.0          0.0          2.95195E-04
30    KR-83  2.61990E 00  1.39300E-03  0.0          0.0          1.39300E-03
31   RH-103  7.97070E 00  5.93784E-03  0.0          0.0          5.93784E-03
32   RH-105  1.29548E-03  7.09606E-05  0.0          0.0          7.09606E-05
33   AG-109  1.05240E-01  9.70945E-05  0.0          0.0          9.70945E-05
34   XE-131  1.53260E 01  5.52995E-03  0.0          0.0          5.52995E-03
35   XE-132  4.71126E-01  2.54665E-04  0.0          0.0          2.54665E-04
36   ND-143  2.71691E 01  1.35419E-02  0.0          0.0          1.35419E-02
37   ND-145  2.62103E 01  3.00746E-03  0.0          0.0          3.00746E-03
38   SM-150  1.22439E 01  2.02181E-03  0.0          0.0          2.02181E-03
39   SM-152  4.20979E 00  2.03577E-03  0.0          0.0          2.03577E-03
40   EU-154  8.03800E-01  1.51607E-03  0.0          0.0          1.51681E-03
41   EU-155  8.95501E-02  1.57963E-03  0.0          0.0          1.57963E-03
42   PA-233  4.33290E 01  1.12151E-02  1.23923E-05  3.22095E-05  1.12027E-02
43    U-238  9.08676E 01  4.24562E-03  1.10385E-05  3.12916E-05  4.23387E-03
44   PU-239  1.16923E 00  4.00500E-03  2.41796E-03  7.17752E-03  1.58711E-03
45   PU-240  7.89425E-01  1.37247E-03  1.10307E-06  3.42630E-06  1.37233E-03
46   PU-241  5.35775E-01  1.24983E-03  9.23961E-04  2.70048E-03  3.25871E-04
47   NP-237  1.56948E 01  3.80605E-03  9.54494E-06  2.79508E-05  3.79691E-03
             -----------  -----------  -----------  -----------  -----------
     TOTALS  8.28771E 05  9.60380E-01  4.03589E-01  9.98406E-01  5.55891E-01
OTHER LOSS RATE           3.96125E-02
TOTAL LOSS RATE           1.00000E 00
SYSTEM LOSS RATE(N/SEC)   1.29225E 20
RELATIVE FLUX LEVEL       1.00377E 00




              SUMMARY TABLES FOR EXPOSURE ENDING AT TIME    2.836720E 04  DAYS
              FOR CASE            SAMPLE PROBLEM, TWO DIMENSIONAL SIMPLE AND THERMAL HYDRAULICS


              AVERAGE NEUTRON LOSSES BY NUCLIDE CLASS AND ZONE CLASS - SYSTEM LOSS RATE   1.292059E 20   N/SEC

ZONE CLASS  FISSILE     FERTILE      C. ACTINIDE  FISSION PROD STRUCTURAL
   ID.         1           2            3            4            5
    1       0.4861107   0.2828239    0.3122281    0.1005723    0.0257078
    5       0.0         0.0          0.0          0.0          0.0
    2       0.0         0.0          0.0          0.0          0.0369896
    3       0.0         0.0          0.0          0.0          0.0156536
    4       0.0         0.0          0.0          0.0          0.0007061
            ----------  ----------   ----------   ----------   ----------
       SUM  0.4861107   0.2828239    0.3122281    0.1005723    0.0790511



ZONE CLASS   ABSORPTION            EFFECTIVE CONVERSION RATIO                POWER (WATTS)
   ID.         LOSSES                     REACTION RATE
    1         0.9070397                      0.57980                      1.637773E 09
    5         0.0                            0.0                          0.0
    2         0.0369896                      0.0                          0.0
    3         0.0156536                      0.0                          0.0
    4         0.0007061                      0.0                          0.0
              ----------                 -----------                   -------------
   OVERALL    0.9603819                      0.57980                      1.637773E 09
OTHER LOSSES  0.0396181
              ----------
TOTAL LOSSES  1.0000000

EFFECTIVE CONVERSION RATIO FROM MASS BALANCE      0.58045
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Table 3. CONTINUED

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                                   FISSILE INVENTORY IS   6.2807991E 02 KG

     FISSILE CONSUMPTION PER UNIT ENERGY GENERATION IS   1.0915451E-10 KG/WATT-SEC
                             FISSILE CONSUMPTION RATE IS   2.4420451E-05 KG/SEC

INTERFACE FILE ZNATOM VERSION  1 (OLD) HAS BEEN WRITTEN ON UNIT  12  WITH DENSITIES AT TIME   2.9187201E 04  DAYS
     DENSITIES WRITTEN = X2 + F*(X1 - X2)
          WHERE X2 = END OF EXPOSURE DENSITIES, X1 = START OF EXPOSURE DENSITIES, AND F =    0.2000

POWER COMPUTED FROM POWER DENSITY   1.6177702E 09

INTERFACE FILE ZNPOWD VERSION  1 (NEW) HAS BEEN WRITTEN ON UNIT  19

INTERFACE FILE ZNATDN VERSION  1 (NEW) HAS BEEN WRITTEN ON UNIT  20

CONTINUOUS FUELING EXPOSURE INFORMATION

INTERFACE FILE CPHIST VERSION  1 (NEW) HAS BEEN WRITTEN ON UNIT  30


        SUMMARY OF CALCULATION

     EXPLICIT CHAIN - EXPOSURE
      SIGNIFICANCE EVENTS ENCOUNTERED                    666


     MAX ARRAY SIZE USED     62003 WORDS - FOR ZONE CALCULATION


     MAX ARRAY SIZE USED     62003 WORDS

     TOTAL CPU TIME USED     0.118 MINUTES     TOTAL CLOCK TIME USED     1.527 MINUTES     TOTAL I/O USED      40
  NORMAL END OF EXPOSURE MODULE

       --PEBBLE--THERMAL HYDRAULICS CODE, ORNL VERSION 3.0, FEBRUARY, 1981 -- QA LEVEL C
       ------------------------------------------------------------------------------------

  SAMPLE PROBLEM, TWO DIMENSIONAL PROFILE BED THERMAL HYDRAULICS


---- INTEGAL CONTROL VARIABLES ----
IDNFL (0-FLOW DOWN, 1-FLOW UP)                  0
ERGUN/US PRESSURE DROP AND FILM COEFF           0
IFLUX (-1/0,1/2- FLUENCE 0/ CPHIST/ ZNPOWD)     0
IPOWER  (-1/0,1/2- TOTAL/FIRST/SECOND BANDS)    0
MEMORY AVAILABLE IF .NE. 0 (WORDS)              0
HEAT CONDUCTION THERMAL CONDUCTIVITY            0
DEBUG EDIT LEVEL                                0
EDIT LEVEL OPTION                               1
HEAT REMOVAL OPTIONS                            0
FUEL ELEMENT GEOMETRY, 0- SPHERE, 1- CYL        0

   0   0   0   0   0   0   0   0   0   1   2   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0


---- FLOATING CONTROL VARIABLES ----
VOID FRACTION                              0.0
INLET TEMPERATURE (C)                      0.35000D 03
INLET PRESSURE (ATM)                       0.40000D 02
MASS FLOW RATE (KG/S)                      0.0
CHARACTERISTIC HYDRAULIC DIAMETER (CM)     0.60000D 01
REFERENCE FLUENCE                          0.0
RECOVERABLE ENERGY FRACTION                0.99000D 00
SPECIFIED POWER LEVEL                      0.0
DIAMETER OF CELL FOR HEAT REMOVAL (CM)     0.0
FUEL RADIUS OF ZONE MATERIAL (CM)          0.25000D 01
FUEL RADIUS OF SUBZONE MATERIAL (CM)       0.25000D 01
OUTLET TEMPERATURE (C)                     0.85000D 03
FLUENCE MULTIPLIER                         0.0
THERMAL CONDUCTIVITY MULTIPLIER            0.0
CONVERGENCE CRITERIA                       0.0
                          MAXIMUM CPU TIME IN SECONDS        0.20000E 03

  0.0          0.0          0.0          0.0          0.0
  0.0          0.0          0.0          0.0          2.40000D 02  0.0          0.0          0.0          0.0          0.0
  3.50000D 02

MAXIMUM MEMORY REQUIREMENT --   69359 WORDS, MEMORY AVAILABLE --   160000 WORDS

POWER OF ZNPOWD -  0.1630E 10 DOES NOT MATCH PRDINT-  0.1640E 10

TIME OF ZNPOWD-  0.2037E 05 DOES NOT MATCH PRDINT-  0.0

DATA UNIT NUMBERS, GEOMETRY, EXPOSURE, ZONE AND POINT  POWER DENSITY   18  30  19  10

PROBLEM MESH (RZ)         1     20     11     46          0.0        415.00       200.00       750.00

THE ENDS OF THE VARIABLY DIMENSIONED DATA BLOCKS        5815       6901      31829      63271
   DATA ARRAY STORAGE REQUIREMENT    63271

NOMINAL VOID FRACTION, MAXIMUM AND MINIMUM 0.40000 0.42000 0.40000

        MAXIMUM POWER DENSITY (W/CC)   LOCATION -  RADIUS / DEPTH FROM TOP (M)
        -------------------------------------------------------------------------
             16.061                          0.333 /    0.450
```

— FIRST ACCESS
THERMAL HYDRAULICS
CODE "PEBBLE" —

Table 3. CONTINUED

WATTS/CC SOURCE BY MESHPOINT

—HEAT SOURCE—

RADIAL	0.0	0.0803	0.1606	0.2410	0.2739	0.3068	0.3398	0.3727	0.4056	0.4426	0.4795	0.5066	0.5337
AXIAL													
0.0	13.916	13.878	13.828	13.770	13.699	13.638	13.576	13.495	13.387	13.273	13.170	13.066	12.935
0.0278	15.084	15.046	14.989	14.943	14.868	14.803	14.743	14.663	14.553	14.437	14.340	14.225	14.089
0.0556	15.789	15.754	15.701	15.659	15.590	15.529	15.492	15.435	15.331	15.220	15.106	15.059	14.928
0.0833	16.093	16.061	16.013	15.975	15.912	15.856	15.844	15.910	15.713	15.608	15.561	15.504	15.378
0.1111	15.889	15.861	15.818	15.783	15.727	15.676	15.679	15.562	15.573	15.475	15.449	15.413	15.291
0.1389	15.132	15.103	15.070	15.041	14.992	14.947	14.567	14.967	14.888	14.801	14.790	14.706	14.673
0.1667	14.226	14.204	14.173	14.147	14.105	14.066	14.093	14.101	14.032	13.955	13.959	13.965	13.963
0.1944	12.980	12.962	12.936	12.913	12.880	12.847	12.880	12.896	12.837	12.771	12.796	12.805	12.716
0.2222	11.897	11.882	11.860	11.842	11.813	11.785	11.818	11.936	11.785	11.728	11.747	11.770	11.692
0.2500	10.667	10.655	10.636	10.622	10.599	10.575	10.607	10.626	10.543	10.535	10.556	10.582	10.518
0.2778	9.665	9.654	9.639	9.627	9.607	9.587	9.617	9.638	9.598	9.556	9.577	9.601	9.542
0.3056	8.625	8.617	8.608	8.598	8.577	8.561	8.587	8.602	8.572	8.537	8.556	8.578	8.527
0.3333	7.775	7.768	7.757	7.749	7.734	7.721	7.743	7.757	7.730	7.700	7.716	7.736	7.691
0.3611	6.940	6.938	6.925	6.918	6.906	6.894	6.913	6.925	6.902	6.875	6.899	6.906	6.864
0.3889	6.242	6.237	6.229	6.223	6.212	6.202	6.218	6.228	6.208	6.188	6.196	6.210	6.175
0.4167	5.580	5.575	5.568	5.563	5.554	5.545	5.558	5.566	5.548	5.528	5.537	5.549	5.517
0.4444	5.014	5.010	5.004	4.999	4.991	4.983	4.995	5.001	4.985	4.966	4.978	4.983	4.955
0.4722	4.489	4.486	4.480	4.476	4.469	4.461	4.471	4.478	4.461	4.444	4.450	4.457	4.432
0.5000	4.038	4.031	4.026	4.022	4.015	4.009	4.016	4.020	4.007	3.992	3.996	4.001	3.978
0.5278	3.617	3.614	3.609	3.606	3.599	3.593	3.608	3.602	3.590	3.576	3.579	3.583	3.562
0.5556	3.251	3.248	3.244	3.241	3.235	3.229	3.234	3.236	3.225	3.212	3.218	3.217	3.198
0.5833	2.918	2.916	2.912	2.909	2.903	2.898	2.902	2.903	2.893	2.881	2.882	2.883	2.866
0.6111	2.624	2.622	2.618	2.615	2.610	2.605	2.609	2.609	2.600	2.588	2.589	2.590	2.574
0.6389	2.358	2.356	2.353	2.350	2.345	2.340	2.343	2.343	2.338	2.324	2.324	2.323	2.309
0.6667	2.122	2.120	2.117	2.114	2.109	2.105	2.107	2.107	2.098	2.089	2.089	2.088	2.074
0.6944	1.909	1.907	1.903	1.901	1.896	1.892	1.894	1.893	1.885	1.878	1.876	1.874	1.862
0.7222	1.718	1.716	1.713	1.711	1.707	1.703	1.704	1.703	1.696	1.687	1.686	1.685	1.673
0.7500	1.546	1.544	1.542	1.539	1.535	1.532	1.532	1.531	1.524	1.516	1.515	1.513	1.503
0.7778	1.392	1.391	1.388	1.386	1.382	1.378	1.379	1.377	1.371	1.364	1.362	1.360	1.350
0.8056	1.253	1.251	1.249	1.247	1.243	1.240	1.240	1.239	1.232	1.226	1.224	1.222	1.213
0.8333	1.128	1.127	1.124	1.122	1.119	1.116	1.116	1.114	1.108	1.102	1.101	1.098	1.090
0.8611	1.016	1.014	1.012	1.010	1.007	1.004	1.003	1.002	0.997	0.991	0.989	0.987	0.979
0.8889	0.916	0.914	0.912	0.910	0.907	0.904	0.904	0.902	0.897	0.892	0.889	0.888	0.880
0.9167	0.829	0.828	0.826	0.824	0.821	0.818	0.818	0.816	0.812	0.806	0.805	0.802	0.795
0.9444	0.762	0.760	0.758	0.757	0.754	0.751	0.751	0.748	0.745	0.740	0.739	0.735	0.729
0.9722	0.727	0.725	0.723	0.722	0.719	0.716	0.716	0.714	0.709	0.705	0.703	0.700	0.694
1.0000	0.720	0.719	0.717	0.715	0.712	0.710	0.709	0.707	0.703	0.698	0.696	0.693	0.687

WATTS/CC SOURCE BY MESHPOINT

RADIAL	0.5608	0.5896	0.6185	0.6490	0.6795	0.7060	0.7325	0.7590	0.7855	0.8185	0.8482	0.8747	0.9012
AXIAL													
0.0	12.799	12.665	12.506	12.301	12.120	11.922	11.701	11.485	11.252	10.976	10.751	10.552	10.405
0.0278	13.947	13.785	13.636	13.415	13.218	12.989	12.750	12.502	12.277	11.967	11.611	11.343	11.128
0.0556	14.782	14.667	14.510	14.288	14.107	13.901	13.626	13.344	13.097	12.700	12.373	12.052	11.786
0.0833	15.238	15.153	15.021	14.799	14.644	14.463	14.178	13.954	13.696	13.288	12.970	12.576	12.236
0.1111	15.150	15.104	15.008	14.779	14.653	14.522	14.211	14.029	13.779	13.130	13.014	12.698	12.316
0.1389	14.551	14.529	14.461	14.246	14.155	14.002	13.760	13.624	13.415	12.972	12.698	12.417	12.034
0.1667	13.752	13.740	13.700	13.530	13.434	13.347	13.001	12.979	12.803	12.378	12.134	11.891	11.528
0.1944	12.610	12.633	12.604	12.425	12.385	12.327	12.083	12.020	11.803	11.480	11.287	11.080	10.781
0.2222	11.605	11.626	11.600	11.486	11.419	11.376	11.153	11.110	10.896	10.632	10.457	10.285	9.960
0.2500	10.439	10.466	10.456	10.318	10.300	10.272	10.073	10.059	9.961	9.626	9.447	9.305	9.055
0.2778	9.476	9.503	9.496	9.370	9.340	9.339	9.160	9.105	9.064	8.772	8.642	8.516	8.258
0.3056	8.470	8.495	8.491	8.300	8.375	8.359	8.200	8.192	8.120	7.965	7.751	7.602	7.489
0.3333	7.681	7.663	7.659	7.561	7.556	7.542	7.400	7.383	7.336	7.100	6.996	6.896	6.688
0.3611	6.822	6.841	6.837	6.750	6.746	6.733	6.667	6.601	6.550	6.390	6.287	6.156	5.971
0.3889	6.136	6.152	6.147	6.069	6.065	6.052	5.939	5.932	5.885	5.698	5.611	5.527	5.362
0.4167	5.482	5.495	5.489	5.428	5.414	5.401	5.381	5.292	5.280	5.083	5.003	4.925	4.778
0.4444	4.928	4.938	4.920	4.865	4.859	4.846	4.756	4.746	4.705	4.557	4.482	4.418	4.279
0.4722	4.403	4.411	4.400	4.349	4.341	4.327	4.287	4.236	4.199	4.065	3.996	3.929	3.812
0.5000	3.953	3.950	3.951	3.901	3.893	3.879	3.807	3.795	3.759	3.640	3.577	3.518	3.410
0.5278	3.539	3.543	3.535	3.489	3.481	3.467	3.402	3.390	3.356	3.250	3.191	3.132	3.040
0.5556	3.176	3.179	3.171	3.130	3.121	3.100	3.049	3.036	3.005	2.909	2.855	2.801	2.710
0.5833	2.847	2.844	2.840	2.802	2.792	2.780	2.727	2.718	2.695	2.600	2.569	2.499	2.428
0.6111	2.556	2.556	2.540	2.518	2.505	2.492	2.445	2.432	2.404	2.327	2.281	2.235	2.160
0.6389	2.293	2.292	2.288	2.253	2.244	2.232	2.180	2.176	2.150	2.081	2.039	1.985	1.936
0.6667	2.059	2.058	2.050	2.022	2.013	2.001	1.962	1.950	1.926	1.868	1.828	1.785	1.732
0.6944	1.848	1.846	1.839	1.813	1.805	1.793	1.754	1.746	1.724	1.669	1.631	1.595	1.547
0.7222	1.660	1.658	1.651	1.628	1.619	1.608	1.576	1.565	1.545	1.498	1.461	1.420	1.384
0.7500	1.491	1.489	1.482	1.468	1.452	1.442	1.413	1.402	1.382	1.337	1.307	1.276	1.237
0.7778	1.339	1.337	1.330	1.313	1.303	1.293	1.267	1.257	1.239	1.198	1.179	1.142	1.107
0.8056	1.203	1.200	1.198	1.176	1.160	1.159	1.135	1.125	1.109	1.072	1.046	1.021	0.999
0.8333	1.080	1.078	1.072	1.055	1.048	1.039	1.017	1.008	0.993	0.959	0.936	0.912	0.883
0.8611	0.970	0.967	0.962	0.946	0.940	0.931	0.911	0.903	0.890	0.859	0.836	0.815	0.788
0.8889	0.872	0.870	0.860	0.850	0.844	0.834	0.818	0.809	0.796	0.764	0.740	0.728	0.703
0.9167	0.798	0.795	0.788	0.767	0.761	0.753	0.736	0.728	0.716	0.690	0.671	0.652	0.630
0.9444	0.722	0.719	0.714	0.702	0.694	0.689	0.673	0.665	0.643	0.629	0.611	0.593	0.570
0.9722	0.687	0.684	0.679	0.667	0.661	0.654	0.639	0.631	0.619	0.595	0.577	0.559	0.535
1.0000	0.680	0.677	0.672	0.660	0.654	0.647	0.632	0.624	0.612	0.588	0.579	0.550	0.526

WATTS/CC SOURCE BY MESHPOINT

RADIAL	0.9277	0.9518	0.9759	1.0000
AXIAL				
0.0	10.360	10.505	11.103	11.630
0.0278	11.031	11.200	11.893	12.399
0.0556	11.541	11.629	12.329	12.852
0.0833	11.929	11.933	12.503	13.070
0.1111	11.971	11.901	12.485	12.937
0.1389	11.648	11.513	12.019	12.417
0.1667	11.114	10.933	11.371	11.715
0.1944	10.126	10.108	10.476	10.771
0.2222	9.555	9.319	9.630	9.598
0.2500	8.659	8.408	8.667	8.890
0.2778	7.976	7.625	7.785	7.927
0.3056	7.053	6.806	6.889	7.142

Table 3. CONTINUED

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0.3333        6.357   6.120   6.276   6.407
0.3611        5.666   5.480   5.571   5.682
0.3889        5.082   4.871   4.983   5.079
0.4167        4.522   4.328   4.421   4.533
0.4444        4.046   3.865   3.949   4.019
0.4722        3.601   3.435   3.505   3.567
0.5000        3.219   3.067   3.128   3.182
0.5278        2.867   2.728   2.781   2.827
0.5556        2.562   2.426   2.482   2.522
0.5833        2.288   2.170   2.209   2.245
0.6111        2.041   1.938   1.972   2.003
0.6389        1.821   1.729   1.758   1.785
0.6667        1.629   1.548   1.570   1.598
0.6944        1.458   1.378   1.401   1.422
0.7222        1.307   1.232   1.251   1.270
0.7500        1.162   1.100   1.117   1.133
0.7778        1.039   0.983   0.997   1.012
0.8056        0.928   0.877   0.889   0.902
0.8333        0.829   0.782   0.793   0.804
0.8611        0.738   0.697   0.706   0.715
0.8889        0.658   0.620   0.627   0.635
0.9167        0.588   0.553   0.557   0.563
0.9444        0.531   0.497   0.498   0.502
0.9722        0.495   0.459   0.458   0.456
1.0000        0.485   0.446   0.437   0.435

GUESS DEL P (ATM)   6.2771D-01 AT DENSITY  1.9851D 00 VOLUME  2.9758D 08, MASS FLOW (KG/SEC)    6.3779D 02 POWER  1.6560D 09

MAXIMUM INITIALIZED BULK FLUID AND PEBBLE TEMPERATURES (K)     1204.82    1299.34 APPARENT PRESSURE DROP (ATM)    0.6719

   INITIALIZATION OF PROBLEM COMPLETE, START ITERATION  .....  CONVERGENCE DATA FOLLOWS


 PROCESSOR TIME (SEC) AT START OF ITERATION       0.93 --COEFFICIENTS   1.3332  0.7090  1.0030  1.8532 MAX IT    170

ITERATION, MAXIMUM CHANGE (PSI, BULK TEMP, SURF TEMP, PRESSURE),  BETA(T), PRESSURE DROP, REL HEAT BALANCE,  RHO(5)
    1  -0.002901   0.000413  -0.004783  -0.001178  1.1516  0.6731  -0.000073  0.0048  0.0921  0.1049  0.0438  0.3135
    2   0.001477   0.006403  -0.004478   0.000560  1.1516  0.6718   0.000017  0.5083  0.8643  1.0288  0.8009  0.3048
    3   0.001354   0.000890   0.001677   0.000262  1.3032  0.6722  -0.000077  0.9172  0.8039  2.1239  0.5412  1.1098
    4   0.001263   0.000808   0.000985   0.000103  1.3032  0.6723  -0.000173  0.9336  0.8898  0.9765  0.6638  1.1038
    5   0.001030   0.001976   0.001958   0.000068  1.3032  0.6728  -0.000186  0.8225  0.8932  2.2880  0.7616  1.1582
    6   0.000911   0.001660   0.001648  -0.000029  1.3032  0.6725  -0.000200  0.9781  0.9477  1.0096  0.9280  1.1825
    7   0.000821   0.001522   0.001507  -0.000025  1.3032  0.6727  -0.000199  0.9023  0.9572  0.9556  0.8923  0.9672
    8   0.000756   0.001367   0.001352  -0.000022  1.3032  0.6728  -0.000199  0.9212  0.9679  0.9557  0.9492  0.9591
    9   0.000703   0.001231   0.001219  -0.000020  1.3032  0.6729  -0.000202  0.9292  0.9683  0.9652  0.9467  0.9683
   10   0.000642   0.001112   0.001101  -0.000019  1.3032  0.6730  -0.000213  0.9185  0.9689  0.9712  0.9555  0.9688
   11   0.000609   0.001009   0.001000  -0.000017  1.3032  0.6731  -0.000238  0.9493  0.9700  0.9773  0.9583  0.9719
   12   0.000577   0.000919   0.000911   0.000016  1.3032  0.6732  -0.000264  0.9464  0.9709  0.9815  0.9611  0.9789
   13   0.000542   0.000839   0.000832   0.000015  1.3032  0.6733  -0.000305  0.9404  0.9719  0.9858  0.9633  0.9778
   14   0.000522   0.000769   0.000762   0.000014  1.3032  0.6734  -0.000356  0.9639  0.9726  0.9898  0.9652  0.9796
   15   0.000506   0.000706   0.000700  -0.000013  1.3032  0.6735  -0.000419  0.9606  0.9735  0.9937  0.9669  0.9811
   16   0.000488   0.000676   0.000661  -0.000012  1.3032  0.6735  -0.000498  0.9659  0.9743  0.9906  0.9679  0.9821
   17   0.000473   0.000647   0.000632  -0.000012  1.3032  0.6736  -0.000582  0.9693  0.9748  0.9906  0.9686  0.9826
   18   0.000460   0.000613   0.000602  -0.000013  1.3032  0.6737  -0.000688  0.9723  0.9756  0.9910  0.9692  0.9830
   19   0.000452   0.000597   0.000586  -0.000026  1.3032  0.6737  -0.000800  0.9821  0.9761  0.9997  0.9377  0.9833
   20   0.000439   0.000577   0.000566   0.000023  1.3032  0.6738  -0.000931  0.9733  0.9766  0.9910  0.9495  0.9836
   21   0.000430   0.000552   0.000541  -0.000021  1.3032  0.6739  -0.001090  0.9786  0.9772  0.9993  0.9704  0.9838
   22   0.000422   0.000537   0.000525  -0.000020  1.3032  0.6739  -0.001246  0.9822  0.9778  0.9906  0.9735  0.9839
   23   0.000414   0.000523   0.000514  -0.000018  1.3032  0.6740  -0.001431  0.9811  0.9781  0.9896  0.9735  0.9840
   24   0.000406   0.000504   0.000496  -0.000017  1.3032  0.6741  -0.001626  0.9905  0.9788  0.9895  0.9734  0.9839
   25   0.000400   0.000491   0.000488  -0.000016  1.3032  0.6741  -0.001862  0.9953  0.9789  0.9895  0.9734  0.9839
   26   0.000394   0.000480   0.000478  -0.000016  1.3032  0.6742  -0.002132  0.9851  0.9792  0.9878  0.9734  0.9837
   27   0.000389   0.000466   0.000460  -0.000015  1.3032  0.6742  -0.002385  0.9876  0.9797  0.9869  0.9734  0.9828
   28   0.000384   0.000458   0.000449   0.000014  1.3037  0.6742  -0.002682  0.9889  0.9800  0.9859  0.9735  0.9831
   29   0.000380   0.000446   0.000441  -0.000014  1.3032  0.6743  -0.003003  0.9896  0.9803  0.9845  0.9736  0.9827

EXTRAPOLATION OF SELECTED ITERATE DATA WITH EIGENVALUE  0.98268 FACTORS     89.81     53.29     36.79 LEVEL    0
   30   0.001355   0.002966   0.002913  -0.000000  1.3532  0.6756  -0.022090  3.5707  0.8006  2.6685  0.6138  1.1097
   31   0.000938   0.002792   0.002768  -0.000008  1.3532  0.6755  -0.023856  0.6928  1.0513  0.9510  0.9527  1.1195
   32   0.000538   0.002622   0.002601  -0.000007  1.3532  0.6754  -0.025518  0.5736  0.9882  0.9389  0.9216  0.9806
   33   0.000360   0.002559   0.002540  -0.000007  1.3532  0.6754  -0.027015  0.6695  0.9718  0.9288  0.9183  0.9573
   34   0.000307   0.002430   0.002411  -0.000006  1.3532  0.6753  -0.028287  0.8526  0.9756  0.9321  0.9189  0.9533
   35   0.000277   0.002346   0.002331  -0.000005  1.3532  0.6752  -0.029282  0.9086  0.9758  0.9357  0.9198  0.9585
   36   0.000251   0.002256   0.002202  -0.000005  1.3532  0.6751  [illegible]  0.9055  0.9765  0.9363  0.9179  0.9558
   37   0.000235   0.002156   0.002188  -0.000004  1.3532  0.6751  -0.030296  0.9388  0.9788  0.9391  0.9173  0.9561
   38   0.000220   0.002096   0.002086  -0.000004  1.3532  0.6751  -0.030288  0.9395  0.9730  0.9450  0.9169  0.9577
   39   0.000205   0.001987   0.001978  -0.000004  1.3532  0.6750  -0.029939  0.9329  0.9705  0.9475  0.9168  0.9589
   40   0.000200   0.001952   0.001948  -0.000003  1.3532  0.6750  -0.029295  0.9759  0.9682  0.9517  0.9191  0.9598
   41   0.000190   0.001873   0.001965  -0.000003  1.3532  0.6750  -0.028379  0.9877  0.9663  0.9545  0.9195  0.9602
   42   0.000193   0.001800   0.001933  -0.000003  1.3532  0.6750  -0.027282  0.9756  0.9638  0.9522  0.9217  0.9592
   43   0.000189   0.001771   0.001765  -0.000003  1.3532  0.6750  -0.025961  0.9911  0.9615  0.9503  0.9260  0.9569
   44   0.000189   0.001664   0.001658  -0.000003  1.3532  0.6751  -0.024583  0.9978  0.9603  0.9433  0.9289  0.9536
   45   0.000187   0.001523   0.001519  -0.000002  1.3532  0.6751  -0.023168  0.9891  0.9583  0.9389  0.9325  0.9488
   46   0.000184   0.001358   0.001393  -0.000002  1.3532  0.6751  -0.021752  0.9976  0.9559  0.9295  0.9351  0.9485
   47   0.000184   0.001178   0.001171  -0.000002  1.3532  0.6752  -0.020388  0.9997  0.9550  0.9287  0.9375  0.9412
   48   0.000183   0.000982   0.000975  -0.000002  1.3532  0.6752  -0.019186  0.9981  0.9546  0.9213  0.9397  0.9387
   49   0.000182   0.000879   0.000975  -0.000002  1.3532  0.6753  -0.017928  0.9928  0.9581  0.9202  0.9423  0.9378
   50   0.000182   0.000833   0.000938  -0.000002  1.3532  0.6753  -0.016868  1.0006  0.9539  0.9293  0.9428  0.9370
   51   0.000181   0.000788   0.000777  -0.000001  1.3532  0.6753  -0.015938  0.9959  0.9581  0.9225  0.9426  0.9376
   52   0.000198   0.000838   0.000830  -0.000001  1.4032  0.6754  -0.015088  1.0927  1.0139  1.0229  0.9425  0.9778
   53   0.000206   0.000801   0.000798  -0.000001  1.4032  0.6754  -0.018289  1.0802  1.0098  0.9816  0.9427  0.9982
   54   0.000207   0.000751   0.000748  -0.000001  1.4032  0.6754  -0.012675  1.0087  0.9688  0.9331  0.9435  0.9593
   55   0.000206   0.000694   0.000692  -0.000001  1.4032  0.6755  -0.013196  0.9979  0.9581  0.9739  0.9428  0.9461
   56   0.000205   0.000636   0.000638  -0.000001  1.4032  0.6755  -0.012867  0.9980  0.9880  0.9381  0.9425  0.9462
   57   0.000206   0.000577   0.000575  -0.000001  1.4032  0.6755  -0.012519  1.0053  0.9577  0.9393  0.9433  0.9452
   58   0.000209   0.000526   0.000528  -0.000001  1.4032  0.6755  -0.012303  1.0129  0.9565  0.9277  0.9439  0.9429
   59   0.000205   0.000488   0.000482  -0.000001  1.3681  0.6755  -0.012146  0.9838  0.9181  0.9248  0.9456  0.9395
   60   0.000205  -0.000443  -0.000482   0.000001  1.7681  0.6755  -0.012038  1.0001  0.9221  0.9215  0.9480  0.9204
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Table 3. CONTINUED

```
61   0.000211  -0.000434  -0.000432   0.000001  1.3681  0.6756  -0.011957  1.0241  0.9533  0.9148  0.9510  0.9290
62   0.000216  -0.000424  -0.000423   0.000001  1.3681  0.6756  -0.011904  1.0239  0.9559  0.9169  0.9532  0.9357
63   0.000220  -0.000404  -0.000403   0.000000  1.3681  0.6756  -0.011868  1.0190  0.9548  0.9140  0.9556  0.9350
64   0.000222  -0.000380  -0.000379   0.000000  1.3681  0.6756  -0.011845  1.0087  0.9518  0.9125  0.9577  0.9330
65   0.000222  -0.000355  -0.000354   0.000000  1.3681  0.6756  -0.011830  1.0011  0.9490  0.9113  0.9604  0.9310
66   0.000216  -0.000329  -0.000328  -0.000001  1.3339  0.6756  -0.011920  0.9697  0.9075  0.9105  0.9624  0.9198
67   0.000202  -0.000301  -0.000301  -0.000001  1.3339  0.6756  -0.011813  0.9351  0.9181  0.9109  0.9653  0.9115
68   0.000196  -0.000275  -0.000274  -0.000001  1.3339  0.6756  -0.011807  0.9735  0.9869  0.9098  0.9676  0.9218
69   0.000193  -0.000249  -0.000248  -0.000001  1.3339  0.6756  -0.011803  0.9934  0.9891  0.9093  0.9705  0.9298
70   0.000189  -0.000225  -0.000224  -0.000001  1.3339  0.6756  -0.011799  0.9809  0.9876  0.9094  0.9732  0.9286
71   0.000184  -0.000202  -0.000202  -0.000001  1.3339  0.6756  -0.011795  0.9719  0.9859  0.9099  0.9760  0.9280
72   0.000177  -0.000181  -0.000181  -0.000001  1.3339  0.6756  -0.011791  0.9686  0.9848  0.9105  0.9786  0.9275
73   0.000171  -0.000162  -0.000162  -0.000001  1.3339  0.6757  -0.011787  0.9620  0.9833  0.9113  0.9841  0.9272
74   0.000163  -0.000145  -0.000145  -0.000001  1.3339  0.6757  -0.011783  0.9571  0.9828  0.9122  0.9847  0.9272
75   0.000156  -0.000130  -0.000130  -0.000001  1.3339  0.6757  -0.011779  0.9531  0.9817  0.9135  0.9845  0.9273
76   0.000148  -0.000116  -0.000116  -0.000001  1.3339  0.6757  -0.011775  0.9526  0.9810  0.9149  0.9881  0.9276
77   0.000140  -0.000104  -0.000104  -0.000001  1.3339  0.6757  -0.011771  0.9478  0.9805  0.9162  0.9883  0.9280
78   0.000133  -0.000093  -0.000093  -0.000001  1.3339  0.6757  -0.011767  0.9460  0.9800  0.9180  0.9879  0.9286
79   0.000125  -0.000084  -0.000083  -0.000001  1.3339  0.6757  -0.011763  0.9434  0.9399  0.9195  0.9883  0.9293
80   0.000118  -0.000075  -0.000075  -0.000001  1.3339  0.6757  -0.011759  0.9409  0.9396  0.9217  0.9885  0.9301
81   0.000111  -0.000069  -0.000067  -0.000001  1.3339  0.6757  -0.011755  0.9389  0.9394  0.9236  0.9886  0.9311
82   0.000104  -0.000061  -0.000061  -0.000001  1.3339  0.6757  -0.011752  0.9380  0.9396  0.9257  0.9885  0.9321
83   0.000097  -0.000055  -0.000055  -0.000001  1.3339  0.6757  -0.011749  0.9388  0.9397  0.9279  0.9884  0.9332

EXTRAPOLATION OF SELECTED ITERATE ES 1 WITH EIGENVALUE  0.91985 FACTORS    15.57   12.67   85.83 LEVEL   0
   84  -0.000026  -0.000019   0.000038   0.000006  1.3510  0.6760  -0.011710  0.2663  0.2909  0.8537  1.4698  0.6271

 PROCESSOR TIME (SEC) FOR     84 ITERATIONS     56.29 --COEFFICIENTS   1.3510  0.8796  1.0030  1.0171

ESTIMATED FRACTIONAL ABSOLUTE ERROR   3.98145D-04 RELATIVE CHANGE IN THE PRESSURE DROP   0.00008
```

— THE ABOVE DISPLAYS THE ITERATIVE PROGRESS TO A STATE OF ACCEPTABLE CONVERGENCE —

```
  SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS


THERMAL HYDRAULIC DATA ARRAYS SAVED FOR RECOVERY ON UNIT   31  ←— SPECIAL ACTION

  TEMPERATURES ARBITRARILY ADJUSTED TO ELIMINATE THE HEAT BALANCE ERROR

BED RADIUS AND HEIGHT (M)                            4.1500    5.5000
THERMAL POWER (MW)                                  1656.01
COOLANT MASS FLOW RATE (KG/S)                       637.787
INLET AVERAGE REYNOLDS NUMBER                        21296.
INLET COOLANT TEMPERATURE (K)                         623.0
MEAN OUTLET COOLANT TEMPERATURE (K)                  1123.0
PEAK OUTLET COOLANT TEMPERATURE (K)                  1187.0  AT RADIAL LOCATION (M)      0.0
MAX AND MIN PEBBLE SURFACE TEMPERATURES (K)          1191.5     692.9
INLET PRESSURE (ATM)                                 40.000
OUTLET PRESSURE (ATM)                                39.324
PRESSURE DROP (ATM)                                  0.67600
ERRORS IN FLOW AND HEAT BALANCE (PERCENT)            -0.000     -1.171
   APPROXIMATE AXIAL PRESSURE CHANGE ACROSS CORE AT H/3 AND 2H/3 (ATM), --NO GRAVITY  -0.67356  -0.67367

MAXIMUM RADIAL COMPONENT OF THE RELATIVE MASS FLOW RATE (ABSOLUTE)       0.00508

APPARENT EXTREME PRESSURE DROP (ATM)  0.67600

                      RELATIVE MASS FLOW RATE, G
                      ------------------------------
   RADIAL  0.0      0.0803  0.1606  0.2410  0.2729  0.3069  0.3398  0.3707  0.4096  0.4446  0.4795  0.5066  0.5337
 AXIAL    ----------------------------------------------------------------------------------------------------------
 0.0       0.9788  0.9792  0.9798  0.9807  0.9812  0.9819  0.9825  0.9834  0.9844  0.9855  0.9867  0.9878  0.9891
 0.0278    0.9785  0.9789  0.9795  0.9804  0.9809  0.9816  0.9823  0.9831  0.9841  0.9853  0.9865  0.9876  0.9889
 0.0556    0.9783  0.9788  0.9793  0.9802  0.9808  0.9814  0.9820  0.9828  0.9839  0.9850  0.9862  0.9873  0.9886
 0.0833    0.9780  0.9785  0.9790  0.9799  0.9805  0.9811  0.9817  0.9826  0.9835  0.9846  0.9857  0.9867  0.9880
 0.1111    0.9776  0.9781  0.9787  0.9795  0.9801  0.9807  0.9812  0.9819  0.9830  0.9841  0.9851  0.9861  0.9874
 0.1389    0.9772  0.9777  0.9783  0.9791  0.9797  0.9803  0.9808  0.9814  0.9824  0.9836  0.9845  0.9854  0.9867
 0.1667    0.9768  0.9773  0.9779  0.9787  0.9793  0.9799  0.9803  0.9809  0.9819  0.9830  0.9839  0.9847  0.9861
 0.1944    0.9764  0.9769  0.9775  0.9783  0.9788  0.9794  0.9798  0.9803  0.9813  0.9825  0.9832  0.9841  0.9855
 0.2222    0.9759  0.9765  0.9770  0.9778  0.9784  0.9790  0.9793  0.9799  0.9809  0.9819  0.9827  0.9835  0.9849
 0.2500    0.9755  0.9760  0.9766  0.9774  0.9780  0.9785  0.9788  0.9793  0.9803  0.9814  0.9822  0.9829  0.9843
 0.2778    0.9751  0.9756  0.9762  0.9770  0.9776  0.9781  0.9783  0.9788  0.9798  0.9808  0.9817  0.9824  0.9838
 0.3056    0.9747  0.9752  0.9758  0.9766  0.9771  0.9777  0.9779  0.9784  0.9794  0.9804  0.9812  0.9820  0.9834
 0.3333    0.9743  0.9748  0.9754  0.9762  0.9767  0.9773  0.9775  0.9780  0.9790  0.9800  0.9809  0.9816  0.9829
 0.3611    0.9739  0.9744  0.9750  0.9758  0.9764  0.9769  0.9771  0.9776  0.9786  0.9796  0.9805  0.9812  0.9826
 0.3889    0.9735  0.9741  0.9747  0.9754  0.9760  0.9765  0.9767  0.9772  0.9782  0.9793  0.9803  0.9808  0.9822
 0.4167    0.9732  0.9737  0.9743  0.9751  0.9756  0.9762  0.9764  0.9769  0.9778  0.9790  0.9797  0.9805  0.9819
 0.4444    0.9729  0.9734  0.9740  0.9748  0.9753  0.9758  0.9761  0.9765  0.9775  0.9786  0.9794  0.9802  0.9816
 0.4722    0.9726  0.9731  0.9737  0.9745  0.9750  0.9755  0.9758  0.9762  0.9772  0.9783  0.9791  0.9799  0.9813
 0.5000    0.9723  0.9728  0.9734  0.9742  0.9747  0.9752  0.9755  0.9760  0.9769  0.9780  0.9789  0.9797  0.9811
 0.5278    0.9720  0.9725  0.9731  0.9739  0.9744  0.9749  0.9752  0.9757  0.9767  0.9777  0.9786  0.9795  0.9808
 0.5556    0.9717  0.9723  0.9728  0.9737  0.9742  0.9747  0.9750  0.9755  0.9764  0.9775  0.9784  0.9793  0.9806
 0.5833    0.9715  0.9720  0.9726  0.9734  0.9739  0.9744  0.9747  0.9752  0.9762  0.9772  0.9782  0.9791  0.9804
 0.6111    0.9713  0.9718  0.9724  0.9732  0.9737  0.9742  0.9745  0.9751  0.9760  0.9770  0.9780  0.9789  0.9802
 0.6389    0.9711  0.9716  0.9722  0.9730  0.9735  0.9740  0.9743  0.9749  0.9759  0.9768  0.9778  0.9787  0.9801
 0.6667    0.9709  0.9714  0.9720  0.9728  0.9733  0.9738  0.9741  0.9747  0.9756  0.9767  0.9776  0.9786  0.9799
 0.6944    0.9707  0.9712  0.9718  0.9726  0.9731  0.9736  0.9740  0.9745  0.9755  0.9765  0.9775  0.9785  0.9798
 0.7222    0.9705  0.9710  0.9716  0.9725  0.9730  0.9734  0.9738  0.9744  0.9753  0.9764  0.9774  0.9783  0.9797
```

Table 3. CONTINUED

0.7500	0.9704	0.9709	0.9715	0.9723	0.9729	0.9733	0.9737	0.9743	0.9752	0.9762	0.9772	0.9782	0.9796
0.7778	0.9702	0.9708	0.9714	0.9722	0.9727	0.9732	0.9736	0.9741	0.9751	0.9761	0.9771	0.9781	0.9795
0.8056	0.9701	0.9706	0.9713	0.9721	0.9726	0.9731	0.9735	0.9741	0.9750	0.9760	0.9770	0.9780	0.9794
0.8333	0.9700	0.9705	0.9712	0.9720	0.9725	0.9729	0.9734	0.9740	0.9749	0.9759	0.9770	0.9780	0.9793
0.8611	0.9699	0.9705	0.9711	0.9719	0.9724	0.9729	0.9733	0.9739	0.9748	0.9758	0.9769	0.9779	0.9792
0.8889	0.9699	0.9704	0.9710	0.9718	0.9723	0.9728	0.9732	0.9738	0.9747	0.9757	0.9768	0.9778	0.9791
0.9167	0.9698	0.9703	0.9710	0.9718	0.9723	0.9727	0.9732	0.9738	0.9746	0.9757	0.9767	0.9778	0.9791
0.9444	0.9698	0.9703	0.9709	0.9717	0.9722	0.9727	0.9731	0.9737	0.9746	0.9756	0.9767	0.9777	0.9791
0.9722	0.9697	0.9703	0.9709	0.9717	0.9722	0.9726	0.9731	0.9737	0.9746	0.9756	0.9767	0.9777	0.9790
1.0000	0.9697	0.9702	0.9709	0.9717	0.9722	0.9726	0.9731	0.9737	0.9746	0.9756	0.9767	0.9777	0.9790

RELATIVE MASS FLOW RATE, G

RADIAL AXIAL	0.5600	0.5830	0.6105	0.6490	0.6795	0.7060	0.7325	0.7590	0.7880	0.8185	0.8482	0.8747	0.9012
0.0	0.9904	0.9919	0.9937	0.9957	0.9979	1.0000	1.0023	1.0046	1.0078	1.0102	1.0130	1.0152	1.0170
0.0278	0.9903	0.9919	0.9936	0.9957	0.9979	1.0000	1.0023	1.0047	1.0075	1.0104	1.0131	1.0154	1.0172
0.0556	0.9900	0.9916	0.9932	0.9953	0.9975	0.9996	1.0020	1.0044	1.0073	1.0104	1.0134	1.0159	1.0181
0.0833	0.9895	0.9908	0.9926	0.9947	0.9969	0.9990	1.0015	1.0040	1.0071	1.0105	1.0138	1.0167	1.0193
0.1111	0.9889	0.9902	0.9919	0.9940	0.9962	0.9984	1.0010	1.0036	1.0068	1.0105	1.0142	1.0174	1.0205
0.1389	0.9882	0.9894	0.9912	0.9933	0.9955	0.9977	1.0005	1.0031	1.0065	1.0106	1.0146	1.0181	1.0216
0.1667	0.9876	0.9888	0.9905	0.9927	0.9948	0.9971	1.0000	1.0027	1.0063	1.0107	1.0149	1.0187	1.0226
0.1944	0.9869	0.9881	0.9898	0.9921	0.9943	0.9966	0.9995	1.0024	1.0061	1.0107	1.0153	1.0192	1.0235
0.2222	0.9864	0.9875	0.9892	0.9915	0.9937	0.9961	0.9991	1.0020	1.0059	1.0108	1.0156	1.0197	1.0243
0.2500	0.9858	0.9870	0.9887	0.9910	0.9933	0.9957	0.9988	1.0018	1.0058	1.0109	1.0159	1.0202	1.0250
0.2778	0.9853	0.9865	0.9882	0.9906	0.9929	0.9953	0.9985	1.0015	1.0056	1.0109	1.0161	1.0206	1.0256
0.3056	0.9849	0.9861	0.9878	0.9902	0.9925	0.9950	0.9982	1.0013	1.0056	1.0110	1.0163	1.0210	1.0262
0.3333	0.9845	0.9857	0.9874	0.9898	0.9922	0.9948	0.9980	1.0012	1.0055	1.0111	1.0165	1.0213	1.0267
0.3611	0.9841	0.9853	0.9871	0.9895	0.9920	0.9945	0.9978	1.0011	1.0055	1.0111	1.0167	1.0217	1.0272
0.3889	0.9837	0.9850	0.9868	0.9892	0.9917	0.9943	0.9976	1.0010	1.0055	1.0112	1.0169	1.0220	1.0276
0.4167	0.9834	0.9847	0.9865	0.9890	0.9915	0.9942	0.9975	1.0009	1.0055	1.0113	1.0171	1.0223	1.0280
0.4444	0.9831	0.9844	0.9863	0.9888	0.9913	0.9940	0.9974	1.0008	1.0055	1.0114	1.0173	1.0226	1.0284
0.4722	0.9828	0.9842	0.9861	0.9886	0.9912	0.9939	0.9973	1.0008	1.0056	1.0114	1.0175	1.0229	1.0287
0.5000	0.9826	0.9839	0.9859	0.9884	0.9910	0.9938	0.9972	1.0008	1.0056	1.0115	1.0176	1.0231	1.0290
0.5278	0.9823	0.9837	0.9857	0.9882	0.9909	0.9937	0.9971	1.0008	1.0057	1.0116	1.0178	1.0234	1.0292
0.5556	0.9821	0.9836	0.9855	0.9881	0.9908	0.9936	0.9971	1.0008	1.0057	1.0117	1.0179	1.0236	1.0295
0.5833	0.9819	0.9834	0.9854	0.9879	0.9907	0.9936	0.9970	1.0008	1.0058	1.0118	1.0181	1.0238	1.0297
0.6111	0.9818	0.9832	0.9853	0.9879	0.9906	0.9935	0.9970	1.0008	1.0058	1.0119	1.0182	1.0240	1.0299
0.6389	0.9816	0.9831	0.9851	0.9877	0.9905	0.9935	0.9970	1.0008	1.0059	1.0120	1.0184	1.0242	1.0301
0.6667	0.9814	0.9830	0.9850	0.9876	0.9905	0.9934	0.9970	1.0008	1.0060	1.0120	1.0185	1.0243	1.0302
0.6944	0.9813	0.9829	0.9850	0.9875	0.9904	0.9934	0.9969	1.0009	1.0060	1.0121	1.0186	1.0245	1.0304
0.7222	0.9812	0.9828	0.9849	0.9875	0.9904	0.9934	0.9969	1.0009	1.0061	1.0122	1.0187	1.0246	1.0305
0.7500	0.9811	0.9827	0.9848	0.9874	0.9903	0.9934	0.9969	1.0009	1.0062	1.0122	1.0188	1.0247	1.0306
0.7778	0.9810	0.9826	0.9847	0.9873	0.9903	0.9934	0.9969	1.0010	1.0062	1.0124	1.0189	1.0249	1.0307
0.8056	0.9809	0.9825	0.9847	0.9873	0.9903	0.9933	0.9969	1.0010	1.0063	1.0125	1.0190	1.0250	1.0308
0.8333	0.9808	0.9824	0.9846	0.9872	0.9903	0.9933	0.9970	1.0010	1.0064	1.0125	1.0191	1.0251	1.0308
0.8611	0.9807	0.9824	0.9846	0.9872	0.9902	0.9933	0.9970	1.0011	1.0064	1.0126	1.0192	1.0251	1.0309
0.8889	0.9807	0.9823	0.9845	0.9872	0.9902	0.9933	0.9970	1.0011	1.0065	1.0126	1.0192	1.0252	1.0309
0.9167	0.9806	0.9823	0.9845	0.9871	0.9902	0.9933	0.9970	1.0011	1.0065	1.0127	1.0193	1.0252	1.0309
0.9444	0.9806	0.9822	0.9844	0.9871	0.9902	0.9933	0.9970	1.0011	1.0066	1.0127	1.0193	1.0253	1.0310
0.9722	0.9805	0.9822	0.9844	0.9871	0.9901	0.9933	0.9970	1.0012	1.0066	1.0128	1.0194	1.0253	1.0310
1.0000	0.9805	0.9822	0.9844	0.9871	0.9902	0.9933	0.9970	1.0012	1.0066	1.0128	1.0194	1.0253	1.0310

RELATIVE MASS FLOW RATE, G

RADIAL AXIAL	0.9277	0.9510	0.9759	1.0000
0.0	1.0179	1.0170	1.0144	1.0127
0.0278	1.0181	1.0173	1.0146	1.0130
0.0556	1.0193	1.0183	1.0149	1.0129
0.0833	1.0209	1.0197	1.0157	1.0132
0.1111	1.0225	1.0214	1.0169	1.0141
0.1389	1.0241	1.0231	1.0184	1.0154
0.1667	1.0255	1.0247	1.0200	1.0169
0.1944	1.0268	1.0263	1.0216	1.0185
0.2222	1.0279	1.0277	1.0232	1.0201
0.2500	1.0290	1.0289	1.0246	1.0217
0.2778	1.0298	1.0301	1.0260	1.0232
0.3056	1.0306	1.0311	1.0273	1.0246
0.3333	1.0313	1.0320	1.0285	1.0260
0.3611	1.0319	1.0329	1.0296	1.0272
0.3889	1.0325	1.0336	1.0306	1.0283
0.4167	1.0329	1.0342	1.0315	1.0294
0.4444	1.0334	1.0347	1.0323	1.0304
0.4722	1.0337	1.0352	1.0331	1.0313
0.5000	1.0340	1.0357	1.0338	1.0321
0.5278	1.0343	1.0360	1.0344	1.0329
0.5556	1.0345	1.0364	1.0349	1.0336
0.5833	1.0348	1.0367	1.0354	1.0342
0.6111	1.0349	1.0369	1.0359	1.0348
0.6389	1.0351	1.0371	1.0363	1.0353
0.6667	1.0352	1.0373	1.0366	1.0358
0.6944	1.0353	1.0375	1.0370	1.0362
0.7222	1.0354	1.0376	1.0373	1.0366
0.7500	1.0355	1.0377	1.0375	1.0369
0.7778	1.0355	1.0378	1.0378	1.0373
0.8056	1.0356	1.0379	1.0380	1.0376
0.8333	1.0356	1.0380	1.0382	1.0378
0.8611	1.0356	1.0380	1.0383	1.0381
0.8889	1.0356	1.0380	1.0385	1.0383
0.9167	1.0356	1.0381	1.0386	1.0385
0.9444	1.0356	1.0381	1.0387	1.0386
0.9722	1.0356	1.0381	1.0388	1.0388
1.0000	1.0356	1.0381	1.0389	1.0389

Table 3. CONTINUED

AXIAL COMPONENT OF RELATIVE MASS FLOW RATE, GZ

RADIAL AXIAL	0.0	0.0803	0.1606	0.2410	0.2739	0.3068	0.3399	0.3727	0.4096	0.4466	0.4795	0.5066	0.5337
0.0	0.9788	0.9792	0.9798	0.9807	0.9812	0.9819	0.9825	0.9834	0.9844	0.9855	0.9867	0.9878	0.9891
0.0278	0.9785	0.9789	0.9795	0.9804	0.9809	0.9816	0.9823	0.9831	0.9841	0.9853	0.9865	0.9876	0.9889
0.0556	0.9783	0.9788	0.9793	0.9802	0.9808	0.9814	0.9820	0.9828	0.9839	0.9850	0.9862	0.9873	0.9886
0.0833	0.9780	0.9785	0.9790	0.9799	0.9805	0.9811	0.9817	0.9824	0.9835	0.9846	0.9857	0.9867	0.9880
0.1111	0.9776	0.9781	0.9787	0.9795	0.9801	0.9807	0.9812	0.9819	0.9830	0.9841	0.9851	0.9860	0.9874
0.1389	0.9772	0.9777	0.9783	0.9791	0.9797	0.9803	0.9808	0.9814	0.9824	0.9836	0.9845	0.9854	0.9867
0.1667	0.9768	0.9773	0.9779	0.9787	0.9793	0.9799	0.9803	0.9808	0.9819	0.9830	0.9839	0.9847	0.9861
0.1944	0.9764	0.9769	0.9775	0.9783	0.9788	0.9794	0.9799	0.9803	0.9813	0.9825	0.9832	0.9841	0.9854
0.2222	0.9759	0.9765	0.9770	0.9778	0.9784	0.9790	0.9793	0.9798	0.9808	0.9819	0.9827	0.9835	0.9849
0.2500	0.9755	0.9760	0.9766	0.9774	0.9780	0.9785	0.9788	0.9792	0.9802	0.9814	0.9821	0.9829	0.9843
0.2778	0.9751	0.9756	0.9762	0.9770	0.9776	0.9781	0.9783	0.9788	0.9798	0.9808	0.9817	0.9824	0.9838
0.3056	0.9747	0.9752	0.9758	0.9766	0.9771	0.9777	0.9779	0.9784	0.9794	0.9805	0.9812	0.9820	0.9834
0.3333	0.9743	0.9748	0.9754	0.9762	0.9767	0.9773	0.9775	0.9779	0.9790	0.9800	0.9809	0.9816	0.9829
0.3611	0.9739	0.9744	0.9750	0.9759	0.9764	0.9769	0.9771	0.9776	0.9786	0.9796	0.9804	0.9812	0.9826
0.3889	0.9735	0.9741	0.9747	0.9754	0.9760	0.9765	0.9767	0.9772	0.9782	0.9793	0.9800	0.9808	0.9822
0.4167	0.9732	0.9737	0.9743	0.9751	0.9756	0.9762	0.9764	0.9769	0.9778	0.9789	0.9797	0.9805	0.9819
0.4444	0.9729	0.9734	0.9740	0.9748	0.9753	0.9758	0.9761	0.9765	0.9775	0.9786	0.9794	0.9802	0.9816
0.4722	0.9726	0.9731	0.9737	0.9745	0.9750	0.9755	0.9758	0.9762	0.9772	0.9782	0.9791	0.9799	0.9813
0.5000	0.9723	0.9728	0.9734	0.9742	0.9747	0.9752	0.9755	0.9760	0.9769	0.9780	0.9788	0.9797	0.9811
0.5278	0.9720	0.9725	0.9731	0.9739	0.9744	0.9749	0.9752	0.9757	0.9767	0.9777	0.9786	0.9795	0.9808
0.5556	0.9717	0.9723	0.9728	0.9737	0.9742	0.9747	0.9750	0.9755	0.9764	0.9775	0.9784	0.9793	0.9806
0.5833	0.9715	0.9720	0.9726	0.9734	0.9739	0.9744	0.9747	0.9753	0.9762	0.9772	0.9782	0.9791	0.9804
0.6111	0.9713	0.9718	0.9724	0.9732	0.9737	0.9742	0.9745	0.9751	0.9760	0.9770	0.9780	0.9789	0.9802
0.6389	0.9711	0.9716	0.9722	0.9730	0.9735	0.9740	0.9743	0.9749	0.9758	0.9768	0.9778	0.9787	0.9801
0.6667	0.9709	0.9714	0.9720	0.9728	0.9733	0.9738	0.9741	0.9747	0.9756	0.9767	0.9776	0.9786	0.9799
0.6944	0.9707	0.9712	0.9718	0.9726	0.9731	0.9736	0.9740	0.9745	0.9755	0.9765	0.9775	0.9785	0.9798
0.7222	0.9705	0.9710	0.9716	0.9725	0.9730	0.9734	0.9738	0.9744	0.9753	0.9764	0.9774	0.9783	0.9797
0.7500	0.9704	0.9709	0.9715	0.9723	0.9728	0.9733	0.9737	0.9743	0.9752	0.9762	0.9772	0.9782	0.9796
0.7778	0.9702	0.9708	0.9714	0.9722	0.9727	0.9732	0.9736	0.9741	0.9751	0.9761	0.9771	0.9781	0.9795
0.8056	0.9701	0.9706	0.9713	0.9721	0.9726	0.9731	0.9735	0.9741	0.9750	0.9760	0.9770	0.9780	0.9794
0.8333	0.9700	0.9705	0.9712	0.9720	0.9725	0.9729	0.9734	0.9740	0.9749	0.9759	0.9770	0.9780	0.9793
0.8611	0.9699	0.9705	0.9711	0.9719	0.9724	0.9729	0.9733	0.9739	0.9748	0.9758	0.9769	0.9779	0.9792
0.8889	0.9699	0.9704	0.9710	0.9718	0.9723	0.9728	0.9732	0.9738	0.9747	0.9757	0.9769	0.9778	0.9791
0.9167	0.9698	0.9703	0.9710	0.9718	0.9722	0.9727	0.9732	0.9738	0.9746	0.9757	0.9767	0.9778	0.9791
0.9444	0.9698	0.9703	0.9709	0.9717	0.9722	0.9727	0.9731	0.9737	0.9746	0.9756	0.9767	0.9777	0.9791
0.9722	0.9697	0.9703	0.9709	0.9717	0.9722	0.9726	0.9731	0.9737	0.9746	0.9756	0.9767	0.9777	0.9790
1.0000	0.9697	0.9702	0.9709	0.9717	0.9722	0.9726	0.9731	0.9737	0.9746	0.9756	0.9767	0.9777	0.9790

AXIAL COMPONENT OF RELATIVE MASS FLOW RATE, GZ

RADIAL AXIAL	0.5608	0.5883	0.6185	0.6490	0.6795	0.7060	0.7325	0.7590	0.7888	0.8185	0.8482	0.8787	0.9012
0.0	0.9904	0.9919	0.9937	0.9957	0.9979	1.0000	1.0023	1.0046	1.0074	1.0102	1.0130	1.0152	1.0170
0.0278	0.9903	0.9919	0.9936	0.9957	0.9979	1.0000	1.0023	1.0047	1.0075	1.0104	1.0131	1.0158	1.0172
0.0556	0.9900	0.9918	0.9932	0.9953	0.9975	0.9996	1.0020	1.0044	1.0073	1.0104	1.0134	1.0159	1.0181
0.0833	0.9895	0.9908	0.9926	0.9947	0.9969	0.9990	1.0015	1.0040	1.0071	1.0105	1.0138	1.0166	1.0193
0.1111	0.9888	0.9901	0.9919	0.9940	0.9962	0.9984	1.0010	1.0036	1.0068	1.0105	1.0142	1.0174	1.0205
0.1389	0.9882	0.9894	0.9911	0.9933	0.9955	0.9977	1.0004	1.0031	1.0065	1.0106	1.0146	1.0181	1.0216
0.1667	0.9875	0.9887	0.9904	0.9927	0.9948	0.9971	1.0000	1.0027	1.0062	1.0107	1.0149	1.0187	1.0226
0.1944	0.9869	0.9881	0.9898	0.9921	0.9943	0.9966	0.9995	1.0023	1.0060	1.0107	1.0153	1.0192	1.0235
0.2222	0.9864	0.9875	0.9892	0.9915	0.9937	0.9961	0.9991	1.0020	1.0059	1.0108	1.0155	1.0197	1.0243
0.2500	0.9858	0.9870	0.9887	0.9910	0.9933	0.9957	0.9988	1.0018	1.0057	1.0109	1.0159	1.0202	1.0250
0.2778	0.9853	0.9865	0.9882	0.9906	0.9929	0.9953	0.9985	1.0015	1.0056	1.0109	1.0161	1.0206	1.0256
0.3056	0.9849	0.9861	0.9878	0.9902	0.9925	0.9950	0.9982	1.0013	1.0056	1.0110	1.0163	1.0210	1.0262
0.3333	0.9844	0.9856	0.9874	0.9898	0.9922	0.9948	0.9980	1.0012	1.0055	1.0111	1.0165	1.0213	1.0267
0.3611	0.9841	0.9853	0.9871	0.9895	0.9920	0.9945	0.9978	1.0011	1.0055	1.0111	1.0167	1.0217	1.0272
0.3889	0.9837	0.9850	0.9868	0.9892	0.9917	0.9943	0.9976	1.0010	1.0055	1.0112	1.0169	1.0220	1.0276
0.4167	0.9833	0.9847	0.9865	0.9890	0.9915	0.9942	0.9975	1.0009	1.0055	1.0113	1.0171	1.0223	1.0280
0.4444	0.9831	0.9844	0.9863	0.9888	0.9913	0.9940	0.9974	1.0008	1.0055	1.0114	1.0173	1.0226	1.0284
0.4722	0.9828	0.9842	0.9861	0.9885	0.9912	0.9939	0.9973	1.0008	1.0056	1.0114	1.0175	1.0229	1.0287
0.5000	0.9826	0.9839	0.9859	0.9884	0.9910	0.9938	0.9972	1.0008	1.0056	1.0115	1.0176	1.0231	1.0290
0.5278	0.9823	0.9837	0.9857	0.9882	0.9909	0.9937	0.9971	1.0008	1.0056	1.0116	1.0178	1.0234	1.0292
0.5556	0.9821	0.9836	0.9855	0.9881	0.9908	0.9936	0.9971	1.0008	1.0057	1.0117	1.0179	1.0236	1.0295
0.5833	0.9819	0.9834	0.9854	0.9879	0.9907	0.9936	0.9970	1.0008	1.0058	1.0118	1.0181	1.0238	1.0297
0.6111	0.9818	0.9832	0.9853	0.9878	0.9906	0.9935	0.9970	1.0008	1.0058	1.0119	1.0182	1.0240	1.0299
0.6389	0.9816	0.9831	0.9851	0.9877	0.9905	0.9935	0.9970	1.0008	1.0059	1.0120	1.0184	1.0242	1.0301
0.6667	0.9814	0.9830	0.9850	0.9876	0.9905	0.9934	0.9970	1.0008	1.0060	1.0121	1.0185	1.0243	1.0302
0.6944	0.9813	0.9829	0.9850	0.9875	0.9904	0.9934	0.9969	1.0009	1.0060	1.0121	1.0186	1.0245	1.0304
0.7222	0.9812	0.9828	0.9849	0.9875	0.9904	0.9934	0.9969	1.0009	1.0061	1.0122	1.0187	1.0246	1.0305
0.7500	0.9811	0.9827	0.9848	0.9874	0.9903	0.9934	0.9969	1.0009	1.0062	1.0122	1.0189	1.0247	1.0306
0.7778	0.9810	0.9826	0.9847	0.9873	0.9903	0.9934	0.9969	1.0010	1.0062	1.0124	1.0189	1.0249	1.0307
0.8056	0.9809	0.9825	0.9847	0.9873	0.9903	0.9933	0.9969	1.0010	1.0063	1.0125	1.0190	1.0250	1.0308
0.8333	0.9808	0.9824	0.9846	0.9872	0.9903	0.9933	0.9970	1.0010	1.0064	1.0125	1.0191	1.0251	1.0308
0.8611	0.9807	0.9824	0.9846	0.9872	0.9902	0.9933	0.9970	1.0011	1.0064	1.0126	1.0192	1.0251	1.0309
0.8889	0.9807	0.9823	0.9845	0.9872	0.9902	0.9933	0.9970	1.0011	1.0065	1.0126	1.0192	1.0252	1.0309
0.9167	0.9806	0.9823	0.9845	0.9871	0.9902	0.9933	0.9970	1.0011	1.0065	1.0127	1.0193	1.0252	1.0309
0.9444	0.9806	0.9822	0.9844	0.9871	0.9902	0.9933	0.9970	1.0011	1.0066	1.0127	1.0193	1.0253	1.0310
0.9722	0.9805	0.9822	0.9844	0.9871	0.9901	0.9933	0.9970	1.0012	1.0066	1.0128	1.0194	1.0253	1.0316
1.0000	0.9805	0.9822	0.9844	0.9871	0.9902	0.9933	0.9970	1.0012	1.0066	1.0128	1.0194	1.0253	1.0310

AXIAL COMPONENT OF RELATIVE MASS FLOW RATE, GZ

RADIAL AXIAL	0.9277	0.9518	0.9759	1.0000
0.0	1.0179	1.0170	1.0144	1.0127
0.0278	1.0181	1.0173	1.0146	1.0130
0.0556	1.0193	1.0183	1.0149	1.0128
0.0833	1.0209	1.0197	1.0157	1.0132
0.1111	1.0225	1.0214	1.0169	1.0141
0.1389	1.0241	1.0231	1.0184	1.0155
0.1667	1.0255	1.0247	1.0200	1.0169
0.1944	1.0268	1.0263	1.0216	1.0185
0.2222	1.0279	1.0277	1.0232	1.0201
0.2500	1.0289	1.0289	1.0246	1.0217
0.2778	1.0298	1.0301	1.0260	1.0232
0.3056	1.0306	1.0311	1.0273	1.02[illegible]

Table 3. CONTINUED

0.3333	1.0313	1.0320	1.0285	1.0260
0.3611	1.0319	1.0328	1.0296	1.0272
0.3889	1.0325	1.0336	1.0306	1.0283
0.4167	1.0329	1.0342	1.0315	1.0294
0.4444	1.0334	1.0347	1.0323	1.0304
0.4722	1.0337	1.0352	1.0331	1.0313
0.5000	1.0340	1.0357	1.0338	1.0321
0.5278	1.0343	1.0360	1.0344	1.0329
0.5556	1.0345	1.0364	1.0349	1.0336
0.5833	1.0348	1.0367	1.0354	1.0342
0.6111	1.0349	1.0369	1.0359	1.0348
0.6389	1.0351	1.0371	1.0363	1.0353
0.6667	1.0352	1.0373	1.0366	1.0358
0.6944	1.0353	1.0375	1.0370	1.0362
0.7222	1.0354	1.0376	1.0373	1.0366
0.7500	1.0355	1.0377	1.0375	1.0369
0.7778	1.0355	1.0378	1.0378	1.0373
0.8056	1.0356	1.0379	1.0380	1.0376
0.8333	1.0356	1.0380	1.0382	1.0378
0.8611	1.0356	1.0380	1.0383	1.0381
0.8889	1.0356	1.0380	1.0385	1.0383
0.9167	1.0356	1.0381	1.0386	1.0385
0.9444	1.0356	1.0381	1.0387	1.0386
0.9722	1.0356	1.0381	1.0388	1.0388
1.0000	1.0356	1.0381	1.0389	1.0389

RELATIVE COOLANT PRESSURE, P

RADIAL	0.0	0.0803	0.1606	0.2410	0.2739	0.3068	0.3398	0.3747	0.4096	0.4446	0.4795	0.5056	0.5337
AXIAL													
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.0278	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
0.0556	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994
0.0833	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990
0.1111	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987
0.1389	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983
0.1667	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979
0.1944	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975
0.2222	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971
0.2500	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9966	0.9966	0.9966
0.2778	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962
0.3056	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958
0.3333	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953
0.3611	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948
0.3889	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944
0.4167	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939
0.4444	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934
0.4722	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929
0.5000	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924
0.5278	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919
0.5556	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914
0.5833	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909
0.6111	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904
0.6389	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899
0.6667	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894
0.6944	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889
0.7222	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884	0.9884
0.7500	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878
0.7778	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873
0.8056	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868
0.8333	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863
0.8611	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857
0.8889	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852
0.9167	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847
0.9444	0.9841	0.9841	0.9841	0.9841	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842
0.9722	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836
1.0000	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831

RELATIVE COOLANT PRESSURE, P

RADIAL	0.5608	0.5880	0.6185	0.6490	0.6795	0.7060	0.7325	0.7590	0.7898	0.8185	0.8482	0.8767	0.9012
AXIAL													
0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.0278	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997
0.0556	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994
0.0833	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990
0.1111	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987
0.1389	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983	0.9983
0.1667	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979
0.1944	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975	0.9975
0.2222	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971	0.9971
0.2500	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966	0.9966
0.2778	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962	0.9962
0.3056	0.9958	0.9958	0.9958	0.9958	0.9958	0.9958	0.9957	0.9957	0.9957	0.9957	0.9957	0.9957	0.9957
0.3333	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953	0.9953
0.3611	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948	0.9948
0.3889	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9944	0.9943	0.9943	0.9943	0.9943
0.4167	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939	0.9939
0.4444	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934	0.9934
0.4722	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929	0.9929
0.5000	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924	0.9924
0.5278	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919	0.9919
0.5556	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914	0.9914
0.5833	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909	0.9909
0.6111	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904	0.9904
0.6389	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899	0.9899
0.6667	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894	0.9894
0.6944	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889	0.9889

Table 3. CONTINUED

0.7222	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883	0.9883
0.7500	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878	0.9878
0.7778	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873	0.9873
0.8056	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868	0.9868
0.8333	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863	0.9863
0.8611	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857	0.9857
0.8889	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852	0.9852
0.9167	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847	0.9847
0.9444	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842	0.9842
0.9722	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836	0.9836
1.0000	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831	0.9831

RELATIVE COOLANT PRESSURE, P

RADIAL AXIAL	0.9277	0.9518	0.9759	1.0000
0.0	1.0000	1.0000	1.0000	1.0000
0.0278	0.9997	0.9997	0.9997	0.9997
0.0556	0.9994	0.9994	0.9994	0.9994
0.0833	0.9990	0.9990	0.9990	0.9990
0.1111	0.9987	0.9986	0.9986	0.9986
0.1389	0.9983	0.9983	0.9983	0.9983
0.1667	0.9979	0.9979	0.9979	0.9979
0.1944	0.9975	0.9975	0.9975	0.9975
0.2222	0.9971	0.9971	0.9971	0.9971
0.2500	0.9966	0.9966	0.9966	0.9966
0.2778	0.9962	0.9962	0.9962	0.9962
0.3056	0.9957	0.9957	0.9957	0.9957
0.3333	0.9953	0.9953	0.9953	0.9953
0.3611	0.9948	0.9948	0.9948	0.9948
0.3889	0.9943	0.9943	0.9943	0.9943
0.4167	0.9939	0.9939	0.9939	0.9939
0.4444	0.9934	0.9934	0.9934	0.9934
0.4722	0.9929	0.9929	0.9929	0.9929
0.5000	0.9924	0.9924	0.9924	0.9924
0.5278	0.9919	0.9919	0.9919	0.9919
0.5556	0.9914	0.9914	0.9914	0.9914
0.5833	0.9909	0.9909	0.9909	0.9909
0.6111	0.9904	0.9904	0.9904	0.9904
0.6389	0.9899	0.9899	0.9899	0.9899
0.6667	0.9894	0.9894	0.9894	0.9894
0.6944	0.9889	0.9889	0.9889	0.9889
0.7222	0.9883	0.9883	0.9883	0.9883
0.7500	0.9878	0.9878	0.9878	0.9878
0.7778	0.9873	0.9873	0.9873	0.9873
0.8056	0.9868	0.9868	0.9868	0.9868
0.8333	0.9863	0.9863	0.9863	0.9863
0.8611	0.9857	0.9857	0.9857	0.9857
0.8889	0.9852	0.9852	0.9852	0.9852
0.9167	0.9847	0.9847	0.9847	0.9847
0.9444	0.9842	0.9842	0.9842	0.9842
0.9722	0.9836	0.9836	0.9836	0.9836
1.0000	0.9831	0.9831	0.9831	0.9831

COOLANT BULK TEMPERATURE, TB (K)

RADIAL AXIAL	0.0	0.0803	0.1606	0.2410	0.2739	0.3068	0.3398	0.3727	0.4056	0.4386	0.4715	0.5066	0.5337
0.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0
0.0278	660.2	660.1	659.9	659.8	659.6	659.4	659.2	659.0	658.7	658.4	658.1	657.8	657.4
0.0556	699.6	699.3	699.0	698.7	698.3	697.9	697.6	697.2	696.8	696.4	695.8	694.8	694.1
0.0833	740.0	739.6	739.2	738.7	738.1	737.6	737.2	736.6	735.8	734.9	734.1	733.3	732.1
0.1111	780.3	779.8	779.2	778.7	777.9	777.3	776.8	776.1	775.0	773.9	772.9	771.9	770.5
0.1389	819.2	818.7	818.0	817.3	816.4	815.6	815.1	814.0	813.1	811.6	810.6	809.3	807.8
0.1667	855.9	855.3	854.5	853.7	852.7	851.8	851.4	850.6	849.1	847.8	846.3	845.2	843.2
0.1944	889.9	889.3	888.6	887.8	886.8	885.8	885.0	884.2	882.5	880.7	879.5	878.3	876.1
0.2222	921.0	920.3	919.3	918.3	917.2	916.1	915.7	914.9	913.1	911.1	910.0	909.7	906.3
0.2500	949.1	948.4	947.8	946.1	945.1	944.0	943.6	942.8	940.9	939.8	937.6	936.3	933.8
0.2778	974.6	973.8	972.7	971.5	970.3	969.2	968.8	968.0	966.0	963.8	962.6	961.3	959.7
0.3056	997.8	996.6	995.5	994.2	993.0	991.8	991.5	990.7	989.6	987.8	986.1	983.8	981.1
0.3333	1017.9	1017.1	1015.9	1014.6	1013.4	1012.2	1011.8	1011.0	1009.9	1007.6	1006.3	1004.0	1001.2
0.3611	1036.4	1035.5	1034.3	1033.0	1031.7	1030.5	1030.1	1029.3	1027.2	1024.9	1023.5	1022.1	1019.3
0.3889	1052.9	1052.0	1050.8	1049.4	1048.1	1046.9	1046.5	1045.7	1043.6	1041.2	1039.9	1038.3	1035.5
0.4167	1067.8	1066.9	1065.6	1064.2	1062.9	1061.7	1061.3	1060.4	1058.3	1055.9	1054.8	1052.9	1050.0
0.4444	1081.1	1080.2	1078.9	1077.4	1076.1	1075.0	1074.5	1073.6	1071.8	1069.1	1067.6	1066.0	1063.1
0.4722	1093.1	1092.1	1090.9	1089.3	1088.0	1086.9	1086.4	1085.5	1083.3	1080.9	1079.3	1077.7	1074.8
0.5000	1103.8	1102.9	1101.6	1100.0	1098.7	1097.6	1097.1	1096.1	1093.9	1091.5	1089.9	1088.2	1085.3
0.5278	1113.5	1112.5	1111.2	1109.6	1108.3	1107.2	1106.7	1105.7	1103.5	1101.1	1099.8	1097.7	1094.8
0.5556	1122.2	1121.2	1119.9	1118.3	1117.0	1115.8	1115.3	1114.3	1112.1	1109.7	1108.5	1106.1	1103.2
0.5833	1130.0	1129.1	1127.7	1126.1	1124.8	1123.6	1123.0	1122.0	1119.8	1117.8	1115.6	1113.8	1110.9
0.6111	1137.1	1136.1	1134.8	1133.1	1131.8	1130.7	1130.0	1128.9	1126.8	1124.8	1122.5	1120.6	1117.7
0.6389	1143.4	1142.4	1141.1	1139.8	1138.	1137.0	1136.3	1135.2	1133.5	1130.6	1128.7	1126.8	1123.9
0.6667	1149.1	1148.2	1146.8	1145.1	1143.8	1142.7	1142.0	1140.9	1138.7	1136.3	1134.3	1132.3	1129.4
0.6944	1154.3	1153.3	1152.0	1150.2	1149.0	1147.8	1147.1	1145.9	1143.8	1141.8	1139.8	1137.3	1134.8
0.7222	1159.0	1158.0	1156.6	1154.8	1153.6	1152.5	1151.7	1150.9	1148.8	1146.0	1143.9	1141.8	1138.9
0.7500	1163.2	1162.2	1160.8	1159.3	1157.8	1156.7	1155.9	1154.6	1152.5	1150.1	1148.0	1145.9	1143.0
0.7778	1167.0	1166.0	1164.6	1162.9	1161.6	1160.4	1159.6	1158.3	1156.2	1153.9	1151.7	1149.5	1146.6
0.8056	1170.4	1169.4	1168.0	1166.2	1165.0	1163.9	1163.0	1161.7	1159.6	1157.2	1155.0	1152.8	1149.9
0.8333	1173.5	1172.5	1171.2	1169.3	1168.1	1167.0	1166.1	1164.9	1162.7	1160.3	1158.0	1155.8	1152.9
0.8611	1176.3	1175.3	1173.9	1172.1	1170.9	1169.8	1168.8	1167.5	1165.4	1163.0	1160.7	1158.5	1155.6
0.8889	1178.9	1177.9	1176.5	1174.6	1173.4	1172.3	1171.3	1170.5	1167.9	1165.5	1163.2	1160.9	1158.0
0.9167	1181.2	1180.2	1178.8	1176.9	1175.7	1174.6	1173.6	1172.2	1170.2	1167.9	1165.8	1163.1	1160.2
0.9444	1183.3	1182.3	1180.9	1179.0	1177.8	1176.7	1175.7	1174.3	1172.2	1169.9	1167.5	1165.2	1162.2
0.9722	1185.3	1184.3	1182.9	1181.0	1179.8	1178.7	1177.6	1176.2	1174.1	1171.9	1169.4	1167.0	1164.1
1.0000	1187.0	1186.0	1184.6	1182.6	1181.4	1180.3	1179.3	1177.9	1175.9	1173.8	1171.3	1169.6	1165.7

Table 3. CONTINUED

COOLANT BULK TEMPERATURE, TB (K)

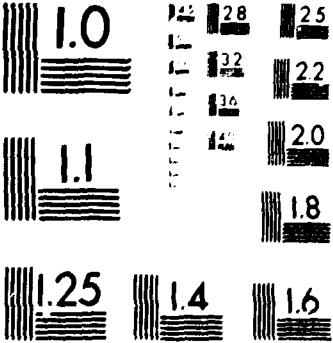
RADIAL AXIAL	0.5609	0.5880	0.6185	0.6490	0.6795	0.7060	0.7325	0.7590	0.7855	0.8120	0.8492	0.8707	0.9012
0.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0	623.0
0.0278	657.0	656.6	656.1	655.5	655.0	654.4	653.7	653.0	652.0	651.5	650.9	650.2	649.7
0.0556	693.3	692.5	691.6	690.4	689.2	688.1	686.7	685.4	683.9	682.1	680.5	679.1	677.9
0.0833	731.0	729.9	728.6	726.8	725.1	723.0	721.3	719.2	717.0	714.9	711.6	709.3	707.3
0.1111	768.9	767.6	765.9	763.5	761.5	759.2	756.4	753.8	750.7	746.7	743.3	740.1	737.1
0.1389	805.9	804.4	802.4	799.5	797.0	794.6	790.9	787.9	783.9	779.9	776.5	770.6	766.7
0.1667	841.0	839.4	837.2	833.8	831.0	828.0	823.8	820.2	815.6	809.7	804.6	799.4	795.1
0.1944	873.7	872.0	869.6	865.8	862.7	859.4	854.7	850.9	845.9	838.7	832.9	827.5	821.9
0.2222	903.7	902.0	899.4	895.2	891.9	888.3	883.2	879.0	873.8	865.6	859.5	853.1	846.7
0.2500	931.1	929.2	926.5	922.1	918.5	914.8	909.3	905.7	899.7	892.2	883.8	876.6	869.5
0.2778	955.8	953.9	951.0	946.0	942.7	938.7	932.9	929.1	921.7	912.6	904.9	897.9	890.3
0.3056	978.1	976.1	973.1	969.3	964.4	960.2	954.2	949.1	942.8	932.8	920.6	917.2	909.1
0.3333	998.2	996.1	993.0	988.0	984.0	979.6	973.8	968.1	961.9	951.0	942.3	938.6	926.0
0.3611	1016.2	1014.0	1010.8	1005.9	1001.5	997.0	990.6	985.1	977.7	967.3	958.3	950.1	941.1
0.3889	1032.4	1030.1	1026.8	1021.7	1017.3	1012.6	1006.1	1000.3	992.7	982.0	972.5	964.1	950.7
0.4167	1046.9	1044.5	1041.1	1035.9	1031.4	1026.6	1019.9	1014.0	1006.1	995.1	985.3	976.6	966.9
0.4444	1059.9	1057.5	1054.0	1048.7	1044.0	1039.1	1032.3	1026.2	1018.0	1006.9	994.8	987.7	977.9
0.4722	1071.6	1069.1	1065.5	1060.2	1055.4	1050.3	1043.5	1037.2	1028.7	1017.0	1007.0	997.7	987.6
0.5000	1082.1	1079.5	1075.8	1070.5	1065.5	1060.3	1053.4	1046.9	1038.3	1026.8	1016.2	1006.6	996.4
0.5278	1091.5	1088.8	1085.1	1079.7	1074.6	1069.3	1062.4	1055.7	1046.9	1035.3	1024.4	1014.6	1004.2
0.5556	1100.0	1097.2	1093.4	1088.0	1082.8	1077.4	1070.4	1063.6	1054.5	1042.8	1031.7	1021.7	1011.2
0.5833	1107.6	1104.9	1100.9	1095.4	1090.1	1084.6	1077.6	1070.6	1061.4	1049.6	1038.3	1028.1	1017.5
0.6111	1114.5	1111.5	1107.5	1102.1	1096.7	1091.0	1084.0	1076.9	1067.5	1055.7	1044.2	1033.8	1023.2
0.6389	1120.6	1117.6	1113.6	1108.1	1102.6	1096.9	1089.8	1082.5	1073.0	1061.1	1049.4	1038.9	1028.3
0.6667	1126.2	1123.1	1119.0	1113.5	1107.9	1102.1	1094.9	1087.6	1077.9	1066.0	1054.2	1043.6	1032.9
0.6944	1131.1	1128.0	1123.9	1118.3	1112.6	1106.8	1099.6	1092.1	1082.3	1070.4	1058.4	1047.7	1037.0
0.7222	1135.6	1132.5	1128.2	1122.7	1116.9	1111.0	1103.8	1096.2	1086.3	1074.3	1062.2	1051.4	1040.7
0.7500	1139.7	1136.5	1132.1	1126.6	1120.8	1114.7	1107.5	1099.8	1089.8	1077.8	1065.7	1054.8	1044.1
0.7778	1143.3	1140.1	1135.7	1130.2	1124.2	1118.1	1110.9	1103.1	1093.0	1081.0	1068.7	1057.8	1047.1
0.8056	1146.6	1143.3	1138.9	1133.3	1127.3	1121.2	1113.9	1106.0	1095.8	1083.8	1071.5	1060.5	1049.8
0.8333	1149.6	1146.2	1141.8	1136.2	1130.1	1123.9	1116.6	1108.7	1098.4	1086.4	1074.0	1063.0	1052.2
0.8611	1152.3	1148.9	1144.4	1138.8	1132.7	1126.4	1119.1	1111.1	1100.7	1088.7	1076.2	1065.2	1054.5
0.8889	1154.7	1151.3	1146.7	1141.1	1134.9	1128.6	1121.3	1113.2	1102.8	1090.7	1078.3	1067.2	1056.4
0.9167	1156.9	1153.4	1148.9	1143.2	1137.0	1130.7	1123.2	1115.1	1104.7	1092.6	1080.1	1069.0	1058.0
0.9444	1158.9	1155.4	1150.8	1145.2	1138.9	1132.5	1125.1	1116.9	1106.4	1094.3	1081.8	1070.6	1060.1
0.9722	1160.8	1157.2	1152.6	1146.9	1140.6	1134.2	1126.7	1118.5	1107.9	1095.8	1083.3	1072.2	1061.7
1.0000	1162.4	1158.8	1154.1	1148.5	1142.1	1135.6	1128.2	1119.9	1109.2	1097.1	1084.6	1073.5	1063.0

COOLANT BULK TEMPERATURE, TB (K)

RADIAL AXIAL	0.9277	0.9518	0.9759	1.0000
0.0	623.0	623.0	623.0	623.0
0.0278	649.5	649.9	651.5	652.6
0.0556	677.3	678.2	681.2	683.5
0.0833	706.1	707.2	711.6	714.9
0.1111	735.0	736.5	741.9	746.2
0.1389	760.1	765.2	771.4	776.8
0.1667	791.7	792.6	799.4	805.0
0.1944	817.7	818.8	825.5	831.0
0.2222	841.8	842.1	849.4	855.6
0.2500	863.9	863.9	871.1	877.8
0.2778	884.0	883.6	890.7	897.0
0.3056	902.2	901.8	908.3	914.5
0.3333	918.6	917.5	924.0	930.1
0.3611	933.4	931.9	938.1	943.9
0.3889	946.6	944.9	950.6	954.3
0.4167	958.7	956.5	961.8	967.2
0.4444	969.2	966.9	971.8	976.7
0.4722	978.8	976.2	980.7	985.5
0.5000	987.4	984.6	988.7	993.2
0.5278	995.2	992.2	995.9	1000.0
0.5556	1002.1	999.0	1002.2	1006.1
0.5833	1009.4	1005.1	1007.9	1011.5
0.6111	1014.6	1010.6	1013.1	1016.3
0.6389	1019.1	1015.4	1017.7	1021.6
0.6667	1023.7	1020.1	1021.8	1024.5
0.6944	1027.9	1024.1	1025.5	1028.9
0.7222	1031.6	1027.9	1028.9	1031.1
0.7500	1035.0	1031.1	1031.9	1033.9
0.7778	1038.1	1034.1	1034.7	1036.4
0.8056	1040.9	1036.4	1037.1	1038.6
0.8333	1043.5	1039.3	1039.4	1040.7
0.8611	1045.8	1041.6	1041.4	1042.5
0.8889	1047.9	1043.6	1043.2	1044.1
0.9167	1049.6	1045.5	1044.9	1045.6
0.9444	1051.6	1047.2	1046.4	1047.0
0.9722	1053.2	1048.7	1047.8	1048.2
1.0000	1054.5	1050.0	1048.9	1049.2

PEBBLE AVERAGE SURFACE TEMPERATURE, TS (K)

RADIAL AXIAL	0.0	0.0803	0.1606	0.2410	0.2739	0.3068	0.3398	0.3727	0.4056	0.4386	0.4795	0.5066	0.5337
0.0	719.3	719.0	718.5	718.2	717.6	717.1	716.7	716.1	715.3	714.4	713.7	712.9	711.9
0.0278	759.4	759.0	758.4	757.9	757.2	756.5	755.9	755.1	753.9	752.0	751.0	750.6	749.3
0.0556	804.0	803.5	802.8	802.1	801.2	800.4	799.7	798.4	797.4	796.0	794.4	793.4	791.7
0.0833	846.7	846.2	845.3	844.6	843.5	842.6	842.0	841.1	839.5	837.7	836.5	835.2	831.1
0.1111	886.4	885.7	884.8	883.9	882.4	881.7	881.2	880.4	879.6	878.6	875.4	873.1	871.0
0.1389	921.3	920.6	919.6	918.6	917.4	916.2	915.8	914.9	913.1	911.9	909.4	908.5	906.0
0.1667	951.8	951.1	950.0	949.0	947.7	946.5	946.2	945.8	943.4	941.1	940.3	938.0	936.1
0.1944	978.3	977.5	976.6	975.2	973.9	972.7	972.4	971.7	969.6	967.2	966.1	965.0	962.1
0.2222	1001.3	1000.5	999.4	998.2	996.8	995.6	995.4	994.7	992.5	990.1	988.9	987.9	986.9
0.2500	1021.7	1020.8	1019.7	1019.0	1017.1	1015.8	1015.6	1014.9	1012.7	1010.2	1009.1	1008.0	1005.0



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

Table 3. CONTINUED

0.2778	1039.6	1038.0	1037.6	1036.3	1034.9	1033.6	1033.5	1032.0	1030.7	1029.9	1028.9	1025.7	1022.7
0.3056	1055.0	1054.9	1053.7	1052.3	1050.9	1049.7	1049.5	1047.9	1046.9	1044.9	1042.9	1041.6	1038.9
0.3333	1070.1	1069.2	1068.0	1066.6	1065.2	1063.9	1063.7	1063.3	1062.7	1059.7	1057.3	1055.7	1052.6
0.3611	1083.0	1082.1	1080.9	1079.0	1078.1	1076.9	1076.6	1075.9	1073.9	1071.0	1069.7	1068.0	1065.3
0.3889	1094.6	1093.7	1092.6	1091.0	1089.4	1088.3	1088.0	1087.3	1085.9	1082.0	1081.1	1079.7	1076.6
0.4167	1105.1	1104.1	1102.9	1101.0	1100.0	1098.0	1098.6	1097.6	1095.3	1092.9	1091.6	1089.9	1086.0
0.4444	1114.5	1113.5	1112.2	1110.7	1109.3	1109.1	1107.7	1106.9	1104.6	1102.7	1100.6	1099.1	1094.0
0.4722	1123.0	1122.0	1120.7	1119.1	1117.7	1116.6	1114.1	1113.2	1111.0	1109.4	1108.9	1107.3	1104.2
0.5000	1130.6	1129.6	1128.3	1126.7	1125.3	1124.2	1123.7	1122.9	1121.5	1120.0	1118.0	1116.7	1111.7
0.5278	1137.5	1136.5	1135.2	1133.6	1132.2	1131.0	1130.5	1129.5	1127.3	1126.9	1122.1	1121.0	1119.3
0.5556	1143.7	1142.9	1141.8	1139.7	1138.4	1137.2	1136.7	1135.7	1133.0	1130.9	1129.2	1127.0	1124.0
0.5833	1149.3	1148.3	1147.0	1145.3	1143.9	1142.0	1142.2	1141.2	1140.0	1139.5	1136.7	1132.0	1129.0
0.6111	1156.0	1155.0	1152.5	1153.3	1149.0	1147.9	1147.2	1148.2	1142.9	1141.9	1139.6	1137.7	1136.7
0.6389	1159.0	1158.0	1156.6	1155.9	1153.6	1152.0	1151.0	1150.6	1149.8	1146.0	1144.1	1142.1	1139.1
0.6667	1163.1	1162.1	1160.0	1159.9	1157.7	1154.6	1155.9	1154.7	1152.5	1150.0	1148.1	1146.1	1143.7
0.6944	1166.9	1165.9	1164.5	1162.7	1161.0	1160.3	1159.6	1159.0	1156.2	1153.7	1151.7	1149.7	1146.7
0.7222	1170.3	1169.3	1167.9	1166.1	1164.0	1163.7	1162.9	1161.7	1155.5	1157.1	1155.0	1152.9	1149.0
0.7500	1173.0	1172.0	1171.0	1169.2	1167.9	1166.7	1165.9	1164.7	1162.4	1160.1	1158.3	1155.0	1152.0
0.7778	1176.1	1175.1	1173.7	1171.9	1170.7	1169.5	1168.1	1167.4	1165.2	1162.9	1160.6	1158.7	1155.5
0.8056	1178.7	1177.7	1176.3	1174.0	1173.2	1172.0	1171.1	1169.9	1167.7	1165.3	1163.1	1160.9	1157.9
0.8333	1180.9	1179.9	1178.5	1176.7	1175.4	1174.3	1173.4	1172.1	1169.9	1167.9	1165.2	1163.0	1160.0
0.8611	1183.0	1182.0	1180.6	1178.7	1177.5	1176.3	1175.4	1174.1	1171.9	1169.5	1167.2	1165.0	1162.0
0.8889	1184.9	1183.9	1182.5	1180.6	1179.0	1178.2	1177.3	1175.9	1173.0	1171.0	1169.5	1166.7	1163.9
0.9167	1186.6	1185.6	1184.2	1182.3	1181.1	1179.9	1179.0	1177.6	1175.5	1172.9	1170.7	1168.6	1165.6
0.9444	1188.3	1187.3	1185.8	1183.9	1182.7	1181.6	1180.6	1179.2	1177.1	1174.7	1172.3	1169.9	1167.0
0.9722	1189.9	1188.9	1187.5	1185.6	1184.3	1183.2	1182.2	1180.8	1178.7	1176.2	1173.9	1171.5	1168.5
1.0000	1191.5	1190.6	1189.0	1187.1	1185.9	1184.7	1183.7	1182.3	1180.2	1177.8	1175.3	1172.9	1170.0

PEBBLE AVERAGE SURFACE TEMPERATURE, TS (K)

RADIAL AXIAL	0.5600	0.5800	0.6105	0.6490	0.6795	0.7060	0.7325	0.7590	0.7856	0.8100	0.8402	0.8767	0.9072
0.0	710.9	709.9	708.7	707.2	705.8	704.3	702.7	701.1	699.8	697.8	696.7	696.3	693.2
0.0278	747.9	746.5	744.0	742.6	740.7	738.6	736.3	733.9	731.0	728.0	725.9	723.5	721.7
0.0556	789.9	788.2	786.1	781.3	780.9	779.1	774.9	771.8	768.1	764.8	760.2	756.7	753.7
0.0833	831.0	829.2	826.9	823.0	820.6	817.5	813.0	808.0	804.5	800.7	796.9	790.0	786.0
0.1111	869.3	867.5	865.0	861.0	857.9	854.5	849.7	845.7	840.7	833.7	828.9	822.6	817.9
0.1389	901.2	901.0	898.0	894.0	891.3	887.5	883.1	877.0	872.0	866.3	857.4	851.9	845.0
0.1667	933.1	931.0	928.7	923.9	920.5	916.4	910.0	904.0	898.5	891.6	886.5	878.1	870.7
0.1944	959.3	957.3	954.6	949.5	944.0	942.1	935.7	931.2	924.5	919.3	907.0	901.0	892.9
0.2222	981.7	980.0	977.2	971.9	969.3	963.3	957.7	952.9	946.5	938.2	929.3	921.1	912.5
0.2500	1001.7	999.9	997.1	991.7	987.9	983.0	976.9	972.1	965.0	958.6	946.2	938.7	929.6
0.2778	1019.1	1017.5	1014.6	1009.1	1005.2	1001.0	993.9	989.4	984.4	978.0	962.1	954.2	944.7
0.3056	1035.2	1033.3	1030.2	1024.6	1020.6	1016.1	1009.1	1003.9	996.7	987.2	975.1	967.9	958.1
0.3333	1049.2	1047.2	1044.1	1039.5	1034.3	1029.4	1022.6	1017.2	1009.1	999.9	988.5	980.0	970.0
0.3611	1061.9	1059.0	1056.6	1053.9	1046.6	1042.0	1036.7	1029.1	1021.3	1009.0	998.6	990.0	980.6
0.3889	1073.2	1071.0	1067.7	1062.0	1057.6	1052.4	1045.6	1039.4	1031.6	1019.4	1009.5	1000.6	989.9
0.4167	1083.0	1081.1	1077.1	1072.0	1067.6	1062.5	1055.1	1049.1	1040.9	1028.7	1019.3	1009.0	998.0
0.4444	1092.6	1090.2	1086.7	1081.0	1076.2	1071.4	1063.0	1057.5	1049.0	1036.9	1027.2	1016.6	1005.9
0.4722	1100.9	1098.0	1094.7	1089.3	1084.1	1079.9	1071.6	1064.1	1056.0	1044.2	1033.3	1023.4	1012.6
0.5000	1108.4	1105.7	1102.0	1096.3	1091.2	1085.4	1078.5	1071.9	1063.0	1050.7	1039.6	1029.6	1019.6
0.5278	1115.0	1112.3	1108.5	1102.9	1097.6	1092.2	1084.4	1078.9	1068.9	1056.6	1045.3	1035.0	1024.1
0.5556	1121.0	1118.2	1114.3	1109.6	1103.3	1097.9	1090.8	1083.5	1074.2	1061.9	1050.0	1040.0	1028.9
0.5833	1126.4	1123.6	1119.6	1113.9	1108.5	1102.9	1095.5	1089.0	1079.0	1066.6	1054.9	1044.4	1033.3
0.6111	1131.3	1129.0	1124.3	1118.6	1113.1	1107.6	1100.0	1092.8	1083.2	1070.9	1058.9	1049.3	1037.3
0.6389	1135.7	1132.7	1129.6	1122.9	1117.3	1111.5	1104.1	1096.8	1087.0	1074.7	1062.7	1051.9	1040.7
0.6667	1139.7	1136.6	1132.6	1126.0	1121.1	1115.2	1107.6	1100.3	1090.5	1079.1	1066.3	1055.1	1044.1
0.6944	1143.3	1140.2	1135.9	1130.2	1124.5	1118.5	1111.1	1103.5	1093.6	1081.2	1069.3	1059.1	1047.0
0.7222	1146.5	1143.3	1139.0	1133.4	1127.5	1121.5	1114.1	1106.4	1096.3	1084.0	1071.7	1060.7	1049.7
0.7500	1149.5	1146.2	1141.9	1136.2	1130.3	1124.2	1116.7	1109.0	1098.8	1086.5	1074.1	1063.6	1052.1
0.7778	1152.1	1148.8	1144.6	1138.7	1132.7	1126.6	1119.1	1111.3	1101.1	1088.9	1076.3	1065.2	1054.2
0.8056	1154.5	1151.2	1146.7	1141.0	1135.0	1128.8	1121.3	1113.4	1103.1	1090.8	1078.3	1067.1	1056.2
0.8333	1156.7	1153.3	1148.8	1143.1	1137.0	1130.7	1123.3	1115.2	1104.9	1092.6	1080.1	1068.9	1058.0
0.8611	1158.6	1155.2	1150.7	1145.0	1138.8	1132.5	1125.0	1116.9	1106.5	1094.2	1081.7	1070.4	1059.6
0.8889	1160.4	1156.9	1152.4	1146.7	1140.4	1134.1	1126.6	1118.4	1108.0	1095.7	1083.1	1071.9	1061.1
0.9167	1162.1	1158.5	1153.9	1148.2	1141.9	1135.6	1128.0	1119.8	1109.3	1097.0	1084.6	1073.2	1062.5
0.9444	1163.6	1160.1	1155.4	1149.7	1143.4	1136.9	1129.4	1121.1	1110.6	1098.3	1085.7	1074.4	1063.8
0.9722	1165.2	1161.6	1156.9	1151.2	1144.8	1138.3	1130.8	1122.5	1111.8	1099.6	1086.9	1075.1	1065.1
1.0000	1166.6	1163.0	1158.3	1152.5	1146.1	1139.6	1132.1	1123.7	1113.0	1100.8	1088.1	1076.8	1066.2

PEBBLE AVERAGE SURFACE TEMPERATURE, TS (K)

RADIAL AXIAL	0.9277	0.9510	0.9759	1.0000
0.0	692.9	698.2	699.6	701.7
0.0278	721.0	722.7	728.7	733.1
0.0556	752.1	753.9	761.6	767.3
0.0833	783.3	788.7	793.6	800.3
0.1111	813.2	818.2	823.7	831.1
0.1389	840.5	844.1	850.0	858.5
0.1667	864.0	868.7	876.6	882.6
0.1944	884.1	889.5	895.3	903.3
0.2222	904.9	903.8	913.7	921.2
0.2500	921.4	919.9	929.9	936.7
0.2778	934.0	930.0	942.6	953.2
0.3056	949.0	946.6	950.0	962.0
0.3333	960.5	957.0	965.4	972.6
0.3611	970.0	967.4	976.9	981.5
0.3889	980.0	976.9	983.0	989.6
0.4167	989.3	985.0	990.9	996.4
0.4444	995.7	992.2	997.7	1001.2
0.4722	1002.4	998.8	1003.7	1009.9
0.5000	1008.6	1004.7	1009.1	1013.9
0.5278	1013.9	1010.0	1016.0	1019.4
0.5556	1018.0	1014.4	1019.4	1022.5
0.5833	1023.3	1019.2	1022.3	1026.1
0.6111	1027.3	1023.2	1025.9	1029.3
0.6389	1031.0	1026.8	1029.1	1032.2

Table 3. CONTINUED

```
0.6667     1036.2  1030.1  1032.0  1030.0
0.6944     1037.3  1033.1  1036.4  1017.1
0.7222     1040.1  1039.9  1037.6  1033.1
0.7500     1042.0  1039.2  1039.1  1031.2
0.7778     1044.9  1040.5  1041.1  1042.9
0.8056     1046.9  1042.5  1042.9  1038.6
0.8333     1048.8  1044.4  1044.5  1045.9
0.8611     1050.6  1046.1  1046.0  1047.1
0.8889     1052.2  1047.6  1047.2  1049.2
0.9167     1053.6  1049.1  1048.5  1049.3
0.9444     1055.0  1050.0  1049.6  1053.2
0.9722     1056.3  1051.7  1050.7  1051.1
1.0000     1057.5  1052.9  1051.6  1051.9

PEBBLE THERMAL CONDUCTIVITY DATA WILL BE SAVED
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← SPECIAL ACTION

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SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS
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—NOW A REPRESENTAVE PEBBLE IS TREATED FOR AVERAGE ZONE CONDITIONS—

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ZONES     155 SUBZONES      0 INTERVALS, AXIAL, RADIAL      37     30

ZONE AND SUBZONE TEMPERATURES (DEGREES C) FOR MASS FLOW RATE (KG/SEC)   6.37790 02 SUBZONE POWER (KW-TH)   1650.

ZONE  (CONDUCTIVITY AND F(EXPOSURE)), FLUID       SURFACE      SHELL        MEAT  CENTER TEMPERATURES,  DT/DR (DEG/CM)
---------------------------------------------------------------------------------------------------------------------
  1      0.0983  0.2559792E 21     307.2        485.7        490.6        550.7       604.9       -67.3
  2      0.3393  0.9990592E 21     465.5        570.8        591.2        678.0       757.9      -107.4
  3      0.2062  0.2060662E 22     501.0        600.1        647.1        757.7       867.9      -110.1
  4      0.2030  0.3391058E 22     613.4        701.0        721.9        793.7       898.3      -106.0
  5      0.2804  0.5570028E 22     672.3        748.5        761.9        830.1       897.4       -89.1
  6      0.2790  0.5960012E 22     720.4        770.6        792.7        847.9       902.3       -72.2
  7      0.2823  0.6277228E 22     759.2        805.9        816.9        860.7       904.0       -57.1
  8      0.2841  0.6533008E 22     790.6        827.8        836.6        871.8       906.4       -45.2
  9      0.2856  0.6730172E 22     815.4        845.7        852.7        880.3       908.1       -36.0
 10      0.2869  0.6905201E 22     836.2        860.2        865.7        887.8       910.1       -28.7
 11      0.2880  0.7039158E 22     852.7        872.0        876.4        894.1       912.0       -23.9
 12      0.2890  0.7147268E 22     866.1        881.6        885.2        899.4       913.4       -18.5
 13      0.2898  0.7230402E 22     877.0        889.5        892.4        903.8       915.4       -16.0
 14      0.2905  0.7305358E 22     885.8        896.0        898.3        907.5       916.9       -12.0
 15      0.2910  0.7362598E 22     893.1        901.3        903.1        910.6       918.2        -9.7
 16      0.2915  0.7400932E 22     899.0        905.6        907.1        913.1       919.3        -7.9
 17      0.2919  0.7446298E 22     903.8        909.2        910.4        915.3       920.2        -6.4
 18      0.2922  0.7470972E 22     907.9        912.5        913.5        917.4       922.2        -5.6
 19      0.4979  0.2400128E 21     396.2        482.0        494.4        560.9       597.3       -65.2
 20      0.3411  0.9700602E 21     462.6        565.5        585.8        666.8       749.9      -105.2
 21      0.2964  0.2005028E 22     539.3        639.7        661.8        751.0       840.1      -116.7
 22      0.2836  0.3277662E 22     608.5        695.4        716.2        797.5       877.0      -106.2
 23      0.2799  0.5170308E 22     666.9        738.9        756.1        824.2       891.9       -89.0
 24      0.2791  0.5566158E 22     718.7        772.7        786.8        842.0       896.3       -72.2
 25      0.2816  0.5801058E 22     753.8        799.8        810.9        856.7       899.9       -57.1
 26      0.2833  0.6136038E 22     786.5        821.7        830.4        865.2       899.9       -45.3
 27      0.2848  0.6382228E 22     809.6        839.4        846.3        874.9       901.7       -36.0
 28      0.2860  0.6507508E 22     829.9        853.7        859.3        881.3       903.4       -28.7
 29      0.2871  0.6600782E 22     846.2        865.4        869.8        887.9       905.3       -23.0
 30      0.2880  0.6740191E 22     859.5        874.9        878.4        892.8       907.0       -18.8
 31      0.2888  0.6830092E 22     870.2        882.6        885.5        896.9       908.5       -14.8
 32      0.2894  0.6900052E 22     879.9        889.0        891.3        900.4       909.9       -11.9
 33      0.2899  0.6961572E 22     886.1        894.2        896.0        903.4       911.0        -9.6
 34      0.2904  0.9605128E 22     891.9        899.4        899.9        905.9       912.6        -7.7
 35      0.2905  0.9601951E 22     896.6        902.0        903.2        908.0       913.0        -6.3
 36      0.2907  0.9710108E 22     900.6        905.1        906.2        910.4       914.8        -5.4
 37      0.5025  0.2002308E 21     384.9        477.4        489.3        537.9       590.9       -62.5
 38      0.3035  0.9301618E 21     459.1        550.2        570.9        657.7       737.9      -102.2
 39      0.2973  0.1927008E 22     538.1        631.7        652.9        741.9       829.6      -110.6
 40      0.2835  0.3129228E 22     602.2        690.0        700.5        789.1       869.7      -105.2
 41      0.2792  0.8755598E 22     659.4        731.0        748.3        816.1       882.7       -88.5
 42      0.2782  0.9100308E 22     707.1        760.7        770.8        833.9       889.1       -72.0
 43      0.2806  0.5053908E 22     745.4        791.6        802.6        846.3       889.7       -57.0
 44      0.2822  0.5707178E 22     776.3        813.2        821.9        856.6       891.7       -45.4
 45      0.2836  0.5911078E 22     801.1        830.6        837.6        865.3       892.9       -35.9
 46      0.2847  0.6075078E 22     821.1        844.7        850.3        872.3       894.8       -28.6
 47      0.2857  0.6207018E 22     837.2        854.3        860.6        878.2       896.9       -22.9
 48      0.2866  0.1249308E 23     850.3        865.5        869.0        883.9       897.4       -18.3
 49      0.2865  0.1257068E 23     863.0        873.1        875.9        887.2       899.7       -14.7
 50      0.2872  0.1260772E 23     869.4        879.2        881.5        890.6       899.9       -11.8
 51      0.2877  0.1270308E 23     876.3        884.2        886.1        893.5       900.9        -9.5
 52      0.2881  0.1270032E 23     882.0        888.4        889.9        895.8       901.9        -7.6
 53      0.2465  0.1274608E 23     [illegible]  [illegible]  665.1        667.4       662.1        -0.2
 54      0.2889  0.1281218E 23     890.5        895.0        896.0        900.2       904.8        -5.0
 55      0.5003  0.2297068E 21     393.4        471.9        483.2        529.2       576.9       -59.8
 56      0.3469  0.8991028E 21     450.7        551.2        570.2        645.9       722.6       -99.1
 57      0.2984  0.1827118E 22     527.0        622.8        644.0        725.7       815.1      -111.6
 58      0.2838  0.2937618E 22     593.8        677.9        698.1        777.8       855.9      -103.5
 59      0.2789  0.8297208E 22     650.4        720.4        737.6        800.7       870.7       -87.6
 60      0.2771  0.8242578E 22     696.9        753.7        767.6        822.3       876.2       -71.8
 61      0.2770  0.8952108E 22     730.5        780.1        791.1        [illegible] 877.9       -56.6
 62      0.2780  0.8802158E 22     764.8        801.2        809.9        848.4       879.5       -44.9
 63      0.2807  0.9003318E 22     799.2        818.3        825.2        852.6       880.2       -35.9
 64      0.2819  0.9160928E 22     809.9        832.0        837.5        859.8       881.8       -29.8
 65      0.2826  0.9290708E 22     820.5        843.2        847.5        865.9       882.7       -22.6
 66      0.2838  0.9399108E 22     837.2        852.2        855.7        869.6       883.4       -19.1
 67      0.2842  0.9403058E 22     847.5        859.5        862.3        873.5       884.4       -14.5
 68      0.2848  0.9550658E 22     855.8        865.5        867.7        876.7       885.9       -11.9
 69      0.2853  0.9605098E 22     862.6        870.3        872.1        879.8       886.7        -9.8
 70      0.2857  0.9640908E 22     868.0        874.3        875.7        881.5       887.5        -7.5
 71      0.2860  0.9690028E 22     872.5        877.6        878.7        883.8       890.2        -6.1
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Table 3. CONTINUED

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 72   0.2843  0.9710982E 22   876.2   880.5   881.5   895.6   909.8    -5.3
 73   0.5156  0.2173598E 21   381.6   465.6   476.2   519.8   568.2   -55.7
 74   0.3516  0.9386808E 21   449.8   541.3   559.6   631.3   708.0   -73.8
 75   0.3001  0.1703108E 22   519.1   610.6   631.4   723.8   796.2  -107.2
 76   0.2835  0.2705329E 22   583.2   664.9   684.5   761.7   828.1  -100.7
 77   0.2778  0.3829468E 22   639.1   706.5   723.3   789.9   858.0   -85.9
 78   0.2759  0.5098327E 22   693.4   739.0   752.7   806.6   859.7   -70.4
 79   0.2753  0.5707098E 22   720.0   768.6   775.5   818.5   861.4   -55.9
 80   0.2769  0.5951717E 22   749.5   785.2   793.8   828.0   862.3   -40.7
 81   0.2782  0.6108835E 22   773.2   801.6   808.5   835.7   863.0   -35.4
 82   0.2792  0.6306108E 22   792.2   818.9   820.3   842.0   863.9   -29.2
 83   0.2801  0.6432628E 22   807.4   825.6   829.9   847.2   864.6   -22.5
 84   0.2809  0.6534139E 22   819.7   830.2   837.7   851.5   865.8   -17.9
 85   0.2815  0.9496808E 22   829.6   841.2   844.0   855.0   866.2   -10.3
 86   0.2815  0.9552308E 22   837.5   846.9   849.1   857.9   866.9   -11.5
 87   0.2819  0.9698098E 22   844.0   851.5   853.2   860.3   867.5    -9.2
 88   0.2823  0.9487218E 22   849.2   855.2   856.6   862.3   868.1    -7.4
 89   0.2826  0.9681008E 22   853.4   858.3   859.4   864.0   868.6    -5.2
 90   0.2829  0.9706798E 22   856.9   861.0   862.0   866.0   870.0    -5.1
 91   0.5260  0.2015158E 21   379.4   458.0   467.8   507.5   548.6   -51.3
 92   0.3507  0.7620208E 21   482.6   528.9   545.8   611.8   678.8   -85.6
 93   0.3035  0.1536861E 22   537.9   598.1   613.6   690.9   769.2  -100.4
 94   0.2843  0.2800097E 22   568.8   646.0   664.6   738.1   811.1   -95.9
 95   0.2772  0.3296739E 22   620.5   685.9   702.0   765.8   829.1   -82.7
 96   0.2748  0.4228843E 22   663.6   716.9   730.2   782.5   834.1   -68.2
 97   0.2732  0.5852638E 22   698.5   741.8   752.1   794.3   836.0   -55.1
 98   0.2728  0.1035718E 23   726.6   760.9   769.3   802.9   836.3   -43.6
 99   0.2729  0.1058508E 23   749.2   776.8   783.1   809.7   836.8   -30.5
100   0.2737  0.1069558E 23   767.2   788.9   794.2   815.3   836.6   -27.8
101   0.2745  0.1081598E 23   781.6   799.0   803.2   820.0   837.0   -21.8
102   0.2752  0.1091288E 23   793.2   807.1   810.4   823.8   837.4   -17.4
103   0.2759  0.1098968E 23   802.5   813.6   816.3   827.0   837.8   -13.9
104   0.2763  0.1105168E 23   810.0   818.9   821.0   829.6   838.3   -11.1
105   0.2767  0.1110128E 23   816.1   823.2   824.9   831.7   838.7    -8.9
106   0.2770  0.1114108E 23   820.9   826.6   828.0   833.5   839.0    -7.1
107   0.2773  0.1117278E 23   824.9   829.5   830.6   835.0   839.4    -5.7
108   0.2775  0.1119688E 23   828.1   832.0   832.9   836.7   840.6    -4.9
109   0.5401  0.1817798E 21   377.4   450.4   459.7   495.7   533.9   -46.6
110   0.3701  0.6725401E 21   435.6   515.1   529.8   598.6   668.4   -76.3
111   0.3103  0.1327228E 22   495.5   578.9   592.5   662.4   732.5   -90.8
112   0.2975  0.2029008E 22   551.3   623.1   640.2   707.9   775.2   -89.1
113   0.2781  0.2698298E 22   599.5   660.3   675.3   738.4   793.0   -77.0
114   0.2738  0.3310708E 22   639.6   689.2   701.7   750.8   799.4   -68.0
115   0.2718  0.3880758E 22   672.1   712.0   722.1   761.8   801.3   -51.9
116   0.2707  0.4841128E 22   698.3   730.1   738.2   770.0   801.7   -41.6
117   0.2702  0.5026518E 22   719.3   744.9   750.9   776.3   801.5   -33.0
118   0.2699  0.5729398E 22   736.1   756.2   761.2   781.3   801.5   -26.2
119   0.2697  0.6818698E 22   749.6   765.6   769.6   785.5   801.6   -20.8
120   0.2697  0.6905168E 22   760.5   775.2   776.8   789.1   801.9   -16.5
121   0.2701  0.6974298E 22   769.3   779.8   781.5   792.1   802.3   -13.1
122   0.2706  0.1020268E 23   776.4   784.5   786.5   794.6   802.8   -10.5
123   0.2705  0.1024688E 23   782.2   788.7   790.3   796.7   803.3    -8.3
124   0.2709  0.1028218E 23   786.9   792.1   793.4   798.5   803.7    -6.6
125   0.2711  0.1031018E 23   790.8   795.0   796.0   800.1   804.3    -5.3
126   0.2718  0.1033128E 23   794.1   797.5   798.4   801.9   805.4    -4.5
127   0.5659  0.1879978E 21   370.2   453.9   462.7   498.1   538.9   -45.7
128   0.3993  0.5318378E 21   436.9   516.9   530.2   598.1   639.9   -69.9
129   0.3337  0.1012958E 22   495.7   573.4   589.3   651.5   718.4   -81.0
130   0.3055  0.1498738E 22   549.4   618.3   633.4   693.2   753.0   -77.8
131   0.2919  0.1921508E 22   595.1   652.6   665.7   717.7   769.5   -67.7
132   0.2848  0.2280708E 22   632.7   679.0   689.9   732.9   775.7   -56.0
133   0.2807  0.2598708E 22   662.9   699.8   708.6   743.4   778.0   -45.3
134   0.2782  0.2833998E 22   687.2   716.3   723.4   751.2   779.0   -36.3
135   0.2766  0.3050868E 22   706.5   729.6   735.2   757.4   779.5   -28.9
136   0.2755  0.3234018E 22   722.1   740.3   744.8   762.8   780.0   -23.0
137   0.2748  0.3403998E 22   730.5   749.0   752.5   766.6   780.6   -19.3
138   0.2742  0.3589828E 22   740.6   756.1   758.9   770.1   781.3   -14.6
139   0.2739  0.3679398E 22   752.8   761.9   764.2   773.1   782.0   -11.6
140   0.2736  0.3790558E 22   759.4   766.7   768.5   775.6   782.7    -9.3
141   0.2734  0.3896508E 22   764.9   770.6   772.1   777.7   783.4    -7.4
142   0.2732  0.3985098E 22   769.3   773.9   775.0   779.9   784.1    -5.9
143   0.2731  0.4065728E 22   773.0   776.6   777.5   781.1   784.6    -4.6
144   0.2731  0.4145178E 22   776.6   778.9   779.7   782.6   785.5    -3.9
145   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
146   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
147   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
148   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.6
149   0.0     0.0             859.9   850.0   850.0   850.0   850.0     0.0
150   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
151   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
152   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
153   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
154   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0
155   0.0     0.0             850.0   850.0   850.0   850.0   850.0     0.0

DISTRIBUTION FRACTIONS OF    144 HEAT TEMPERATURES IN TWENTY FRACTILES OVER THE RANGE (C)    390.0    917.9
 0.0       0.0       0.0       0.0       0.0     0.02778 0.02083 0.00694 0.01389 0.01389
0.02083 0.02083 0.03472 0.04167 0.09722 0.15278 0.10417 0.14583 0.15972 0.13889

ZONE AVERAGE TEMP AND T**2, THEN SUBSECUT      791.82    798.31      0.0       0.0

    MAX TEMPS, PEAK/MEAN BY ZONE, SOIZONE   922.2  917.8    0.0    0.0 POWER WEIGHTED    732.9     0.0 POWER (MWT)  1654.

AVERAGE AND PEAK TEMPERATURE SLOPE AT PEBBLE HEAT/SHELL INTERFACE (DEG/CM)       -81.9    -118.1

CORRELATION FAILURE COUNT        1051         0

FILE -GETEMP- WRITTEN, UNIT AND VERSION        32        1
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Table 3. CONTINUED

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 96   0.2885  0.4162298E 22   663.6   704.7   731.7   788.8   846.5   -75.6
 97   0.2874  0.5132088E 22   699.5   737.8   753.2   820.0   866.1   -61.0
 98   0.2870  0.6520085E 22   726.6   760.9   770.3   807.8   848.8   -48.8
 99   0.2869  0.6712368E 22   749.2   776.8   783.9   813.8   842.9   -38.3
100   0.2875  0.6862965E 22   767.2   788.9   794.8   818.2   841.8   -30.8
101   0.2880  0.6993331E 22   781.6   799.9   803.6   822.2   843.1   -24.2
102   0.2885  0.7079742E 22   793.2   807.3   810.8   825.7   840.7   -19.1
103   0.2889  0.7157018E 22   802.4   813.6   816.6   828.5   840.5   -15.8
104   0.2892  0.1000061E 23   813.4   818.9   821.3   830.8   839.8   -12.8
105   0.2893  0.1005508E 23   816.1   823.2   827.1   832.7   840.8    -9.9
106   0.2895  0.1009568E 23   820.9   826.6   828.1   834.2   840.8    -7.9
107   0.2897  0.1052733E 23   828.9   829.5   830.7   835.6   840.4    -6.3
108   0.2899  0.1055189E 23   829.1   832.0   833.8   837.3   841.6    -5.5
109   0.0889  0.1931165E 21   377.8   450.9   460.6   520.9   582.7   -51.8
110   0.3334  0.6797919E 21   435.6   515.1   531.8   596.7   663.2   -98.7
111   0.2801  0.1302892E 22   485.5   574.9   590.5   679.9   789.6  -108.9
112   0.2599  0.2048922E 22   551.3   623.1   642.1   717.9   781.6   -97.7
113   0.2517  0.2708157E 22   599.5   660.3   677.0   742.5   807.2   -85.8
114   0.2879  0.3299158E 22   639.6   689.3   703.1   757.8   811.9   -70.9
115   0.2860  0.3801768E 22   672.1   712.0   723.2   767.3   810.9   -57.5
116   0.2850  0.4270598E 22   699.3   728.1   739.1   778.8   809.3   -46.1
117   0.2848  0.4718998E 22   719.3   744.5   751.6   779.8   807.7   -36.8
118   0.2841  0.5167772E 22   736.1   756.2   761.8   788.1   806.8   -29.1
119   0.2839  0.5676228E 22   749.6   765.6   770.8   787.7   805.5   -23.1
120   0.2838  0.6307932E 22   760.5   773.2   776.7   790.9   805.0   -18.3
121   0.2837  0.7287822E 22   769.3   779.8   782.2   793.5   804.8   -14.6
122   0.2837  0.7382708E 22   776.8   784.5   786.8   795.7   804.9   -11.6
123   0.2840  0.1025252E 23   782.2   788.7   790.5   797.6   804.9    -9.3
124   0.2839  0.1028788E 23   786.9   792.1   793.5   799.2   804.9    -7.8
125   0.2842  0.1031508E 23   790.9   794.0   796.1   800.7   805.3    -5.9
126   0.2843  0.1033898E 23   790.1   797.5   798.5   802.8   806.7    -5.0
127   0.5078  0.1898068E 21   379.2   451.9   463.6   503.1   588.0   -80.9
128   0.3595  0.5359522E 21   436.9   516.8   537.7   597.6   672.7   -77.6
129   0.3040  0.1021603E 22   495.7   573.8   590.8   660.0   729.8   -89.9
130   0.2759  0.1508508E 22   539.8   619.3   634.0   701.8   767.6   -86.2
131   0.2639  0.1925838E 22   595.1   652.6   667.2   728.9   782.9   -75.1
132   0.2576  0.2273878E 22   632.7   679.0   691.1   739.9   786.1   -62.7
133   0.2539  0.2559008E 22   662.9   699.8   709.6   748.2   786.8   -50.3
134   0.2516  0.2793668E 22   687.2   716.3   724.2   755.0   785.7   -40.2
135   0.2501  0.2991948E 22   706.5   729.6   735.8   760.8   785.9   -32.1
136   0.2491  0.3161272E 22   722.1   740.3   745.3   764.9   786.2   -25.5
137   0.2483  0.3307508E 22   738.5   749.0   752.9   768.9   788.0   -20.2
138   0.2478  0.3835208E 22   748.5   756.1   759.2   777.6   788.0   -16.2
139   0.2475  0.3587182E 22   752.8   761.5   764.4   778.3   788.2   -12.9
140   0.2472  0.3685369E 22   759.8   766.7   768.7   776.6   788.5   -10.7
141   0.2470  0.3731292E 22   764.9   770.6   772.2   779.5   788.9    -8.2
142   0.2469  0.3805668E 22   769.3   773.9   775.2   780.2   785.2    -6.5
143   0.2468  0.3870848E 22   773.0   776.6   777.8   781.8   785.5    -5.3
144   0.2467  0.3936988E 22   776.5   778.9   779.8   783.0   786.3    -4.2
145   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
146   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
147   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
148   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
149   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
150   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
151   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
152   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
153   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
154   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0
155   0.0     0.0             850.0   850.0   577.0   577.0   577.0     0.0

DISTRIBUTION FRACTIONS OF   144 HEAT TEMPERATURES IN TWENTY FRACTILES OVER THE RANGE (C)   390.0   918.4
 0.0     0.0     0.0     0.0     0.0     0.02083 0.02083 0.01389 0.01389 0.00694
 0.02083 0.02778 0.02083 0.03472 0.11111 0.13889 0.11111 0.14583 0.16667 0.14583

ZONE AVERAGE TEMP AND TOP2, THEN SUBZONE      798.20    802.50      0.0       0.0

     MAX TEMPS, PEAK/MEAN BY ZONE, SUBZONE   923.2  918.4     0.0     0.0 POWER WEIGHTED   788.2    0.0 POWER (MWT)   1650.

AVERAGE AND PEAK TEMPERATURE SLOPE AT PEBBLE HEAT/SHELL INTERFACE (DEG/CM)      -86.5    -139.9

CORRELATION FAILURE COUNT        908         0

TEMPERATURES RECALCULATED FOR THE PEAK ZONE SURFACE TEMPERATURES (ASSUMED WORST CASE, DISCREET INTEGRALS)  <— NOTE

 ZONE  (CONDUCTIVITY AND F(EXPOSURE)), FLUID      SURFACE      SHELL       HEAT  CENTER TEMPERATURES,  DT/DR (DEG/CM)
------------------------------------------------------------------------------------------------------------------
   1       0.4983  0.2568367E 21       406.9       508.4       521.2       573.8       627.5       -67.3
   2       0.3822  0.1001899E 22       496.9       593.1       613.6       695.6       778.8      -106.3
   3       0.2997  0.2089689E 22       568.1       662.0       685.7       774.7       868.3      -116.6
   4       0.2871  0.3297318E 22       631.9       716.2       736.8       817.6       897.2      -105.5
   5       0.2935  0.4967968E 22       699.3       757.0       774.2       841.7       909.0       -89.1
   6       0.2825  0.5356688E 22       730.1       789.3       803.2       857.9       911.7       -71.8
   7       0.2887  0.5677858E 22       771.9       815.1       824.1       865.5       912.5       -56.6
   8       0.2861  0.5929298E 22       800.7       836.1       848.8       879.3       913.7       -44.9
   9       0.2874  0.6135808E 22       820.7       852.0       860.0       887.5       915.0       -35.8
  10       0.2885  0.6301879E 22       848.1       866.9       872.8       894.8       916.5       -28.6
  11       0.2895  0.6435388E 22       859.8       878.1       882.5       900.1       917.8       -22.9
  12       0.2903  0.6583898E 22       872.5       887.3       890.9       905.0       919.8       -18.8
  13       0.2910  0.6639978E 22       882.9       894.8       897.7       909.1       920.7       -14.8
  14       0.2916  0.1023288E 23       891.3       901.9       903.3       912.5       921.8       -11.9
  15       0.2915  0.1029968E 23       898.2       906.0       907.9       915.7       922.8        -9.6
  16       0.2920  0.1031608E 23       903.7       910.2       911.7       917.7       923.8        -7.8
  17       0.2924  0.1037335E 23       908.5       913.7       914.9       919.4       924.8        -6.3
  18       0.2927  0.1040208E 23       912.4       916.9       918.0       922.1       926.5        -5.5
  19       0.4978  0.2803378E 21       405.3       498.4       516.8       567.7       619.6       -65.2
  20       0.3839  0.9778108E 21       481.7       588.1       608.2       688.5       770.0      -108.1
  21       0.3007  0.1990928E 22       559.9       657.6       680.0       768.8       856.6      -115.2
  22       0.2869  0.3183188E 22       626.9       710.8       731.0       811.8       890.7      -104.9
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Table 3. CONTINUED

TEMPERATURES RECALCULATED FOR THE THERMAL CONDUCTIVITY MULTIPLIED BY 0.9 ← NOTE

ZONE	(CONDUCTIVITY AND	DIFFUSIVITY),	FLUID	SURFACE	SHELL	[illegible]	[illegible] TEMPERATURES,	DT/DR (DEG/CM)
1	0.4436	0.2590301E 21	397.2	495.7	509.0	558.5	619.4	-78.9
2	0.3057	0.7019165E 22	465.5	570.8	592.5	685.8	778.6	-119.1
3	0.2679	0.2106692E 22	543.8	648.1	669.5	773.1	849.7	-120.5
4	0.2571	0.3808803E 22	613.4	701.0	720.2	814.9	891.7	-118.8
5	0.2542	0.5402572E 22	672.3	744.5	763.9	857.3	903.7	-94.9
6	0.2536	0.5872162E 22	720.4	770.6	795.2	875.8	915.7	-89.0
7	0.2556	0.6100972E 22	759.2	805.9	818.2	866.6	918.5	-63.3
8	0.2569	0.6444002E 22	790.6	827.4	837.6	876.9	918.4	-50.2
9	0.2580	0.6650928E 22	815.9	845.7	853.4	888.7	918.8	-39.8
10	0.2590	0.6816992E 22	836.2	860.2	864.4	898.9	915.5	-31.9
11	0.2598	0.6950902E 22	852.7	872.0	876.9	896.6	916.8	-25.5
12	0.2604	0.7059019E 22	866.1	881.6	885.6	901.8	917.8	-20.5
13	0.2612	0.7186397E 22	877.0	888.5	892.7	903.8	918.3	-16.5
14	0.2617	0.7217107E 22	885.8	896.0	898.5	908.8	919.2	-13.2
15	0.2622	0.7278385E 22	893.1	901.7	903.3	911.6	920.0	-10.7
16	0.2626	0.7320489E 22	899.2	905.6	907.3	914.0	920.9	-9.7
17	0.2629	0.1167038E 23	903.8	909.2	910.6	916.0	921.6	-7.1
18	0.2628	0.1164302E 23	907.9	912.5	913.7	918.4	923.2	-6.2
19	0.4469	0.2517602E 21	396.2	482.0	495.8	552.0	619.7	-72.5
20	0.3073	0.9052778E 21	462.6	565.5	580.0	678.0	769.2	116.8
21	0.2682	0.2088727E 22	539.3	638.7	663.9	763.2	841.8	-129.8
22	0.2569	0.3311728E 22	609.5	695.4	718.4	809.6	887.1	-117.8
23	0.2537	0.5120531E 22	665.9	738.7	759.1	832.8	907.2	-99.6
24	0.2530	0.5517177E 22	718.7	772.7	799.3	869.5	904.8	-80.0
25	0.2549	0.5813308E 22	753.8	799.8	812.1	865.6	899.6	-63.7
26	0.2561	0.6099061E 22	798.5	829.7	831.4	870.9	909.3	-50.2
27	0.2572	0.6293882E 22	809.4	839.4	847.1	877.4	908.9	-39.9
28	0.2581	0.6450808E 22	829.9	857.7	859.9	884.8	909.0	-31.5
29	0.2590	0.6592008E 22	846.2	865.4	870.3	888.9	909.7	-25.5
30	0.2597	0.6699422E 22	859.5	876.9	878.8	898.6	910.5	-20.8
31	0.2603	0.6796139E 22	870.2	882.6	885.8	899.5	911.3	-16.8
32	0.2608	0.1080632E 23	879.9	889.0	891.5	901.7	912.1	-13.2
33	0.2607	0.1086299E 23	886.1	894.2	896.2	904.8	912.8	-10.7
34	0.2611	0.1090878E 23	891.9	899.4	900.1	906.7	913.8	-8.6
35	0.2614	0.1094455E 23	896.6	902.0	903.3	908.7	914.2	-7.0
36	0.2617	0.1097777E 23	900.6	905.1	906.3	911.5	915.8	-6.1
37	0.4510	0.2808538E 21	398.9	477.8	490.6	548.5	608.5	-69.6
38	0.3095	0.9481582E 21	459.1	559.2	581.1	668.5	757.2	-133.8
39	0.2689	0.1468172E 22	538.1	631.7	656.4	763.9	851.0	-121.1
40	0.2567	0.3179508E 22	633.2	688.0	710.8	800.0	897.9	-116.6
41	0.2533	0.4736782E 22	659.8	731.0	750.2	829.3	898.8	-90.1
42	0.2522	0.5[illegible]19558E 22	707.1	760.7	780.3	847.3	901.1	-79.9
43	0.2540	0.1033548E 23	745.8	791.6	803.9	852.3	900.2	-63.2
44	0.2539	0.1058878E 23	776.1	813.2	822.9	861.8	899.7	-50.1
45	0.2551	0.1079265E 23	801.1	830.4	838.1	868.9	899.6	-39.8
46	0.2561	0.1095668E 23	821.1	844.7	850.9	875.3	899.9	-31.7
47	0.2569	0.1110859E 23	837.2	856.2	861.1	880.6	900.3	-25.8
48	0.2576	0.1119872E 23	850.1	865.5	869.4	885.1	900.9	-20.3
49	0.2582	0.1129089E 23	860.5	873.1	876.2	889.8	901.6	-16.7
50	0.2587	0.1138488E 23	869.4	878.3	881.8	892.9	902.2	-13.1
51	0.2592	0.1140515E 23	876.3	884.7	886.3	894.5	902.9	-10.5
52	0.2595	0.1145018E 23	882.0	888.4	890.1	896.6	903.7	-8.5
53	0.2598	0.1148627E 23	886.7	891.9	893.2	898.5	903.9	-6.9
54	0.2601	0.1151387E 23	890.5	895.0	896.1	902.8	905.5	-6.0
55	0.4563	0.2320539E 21	383.8	471.9	484.5	535.7	589.8	-66.0
56	0.3125	0.9015915E 21	458.7	551.1	572.1	676.3	741.5	-109.0
57	0.2697	0.1859815E 22	527.8	622.8	646.4	781.5	836.1	-123.8
58	0.2566	0.2882807E 22	593.9	677.9	700.3	788.2	878.7	-118.7
59	0.2524	0.4298492E 22	650.8	720.5	735.5	813.7	886.6	-97.1
60	0.2512	0.6815618E 22	695.7	757.7	769.2	825.7	889.1	-79.2
61	0.2510	0.7125108E 22	718.5	780.1	792.3	840.8	889.1	-62.8
62	0.2523	0.7375198E 22	758.9	801.2	810.9	849.2	897.8	-49.8
63	0.2538	0.7576359E 22	799.2	818.3	825.9	856.8	896.9	-39.6
64	0.2543	0.7737955E 22	815.8	832.0	838.1	862.8	896.9	-31.5
65	0.2550	0.7867782E 22	828.5	843.2	848.0	867.8	897.0	-25.1
66	0.2557	0.7972189E 22	837.2	852.2	856.1	871.6	897.3	-20.1
67	0.2563	0.8056098E 22	847.5	859.9	862.6	874.1	897.7	-16.1
68	0.2567	0.8123698E 22	855.9	865.9	868.0	878.0	898.1	-13.0
69	0.2571	0.8178132E 22	862.6	870.3	872.3	880.8	898.5	-10.8
70	0.2578	0.8221908E 22	868.9	874.3	875.9	882.8	898.9	-8.8
71	0.2577	0.8257967E 22	872.5	877.6	878.9	888.1	899.8	-6.8
72	0.2579	0.8293992E 22	876.2	880.5	881.6	886.2	900.8	-5.9
73	0.4629	0.2198157E 21	381.6	465.6	477.8	529.5	575.3	-62.0
74	0.3167	0.8858239E 21	449.8	547.7	561.6	681.2	721.9	-103.2
75	0.2712	0.1731973E 22	519.1	610.6	633.7	725.1	836.3	-119.0
76	0.2567	0.2783219E 22	553.2	668.9	686.7	772.2	856.6	-111.6
77	0.2516	0.3832358E 22	614.6	700.5	745.1	798.0	849.0	-95.2
78	0.2499	0.5195268E 22	683.8	739.0	754.2	813.9	872.5	-78.0
79	0.2496	0.5499037E 22	720.0	760.6	776.1	828.6	871.9	-62.5
80	0.2505	0.8901138E 22	749.5	785.2	798.7	832.7	870.5	-49.5
81	0.2505	0.9097778E 22	773.2	801.6	809.2	839.8	869.6	-39.3
82	0.2513	0.9255528E 22	792.2	818.9	820.9	844.9	869.1	-31.3
83	0.2521	0.9392088E 22	807.9	825.6	830.8	849.6	868.9	-24.9
84	0.2527	0.9483558E 22	819.7	838.2	838.1	853.0	868.9	-19.9
85	0.2532	0.9565068E 22	829.6	841.2	844.3	856.5	869.0	-15.9
86	0.2536	0.9630568E 22	837.5	846.9	849.3	859.2	869.1	-12.7
87	0.2539	0.9683198E 22	844.0	851.5	853.4	861.3	869.3	-10.2
88	0.2542	0.9725468E 22	849.2	855.2	856.8	863.1	869.5	-8.2
89	0.2545	0.9759268E 22	853.0	858.3	859.5	864.6	869.9	-6.6
90	0.2547	0.9785008E 22	856.9	861.0	862.1	866.5	871.0	-5.7
91	0.4722	0.2032308E 21	379.8	458.0	468.8	511.0	558.8	-57.3
92	0.3231	0.7718278E 21	442.6	528.9	547.2	620.5	698.9	-95.1
93	0.2781	0.1550698E 22	507.9	598.1	615.8	705.8	787.0	-111.8
94	0.2573	0.2870228E 22	564.4	646.0	666.7	748.2	829.8	-106.3
95	0.2510	0.3297519E 22	620.5	685.9	703.8	778.0	843.7	-91.7

Table 3. CONTINUED

23	0.2839	0.8798419E 22	692.9	749.2	760.0	839.7	841.0	-87.5
24	0.2849	0.8997857E 22	729.2	783.2	797.2	859.8	845.4	-71.8
25	0.2859	0.9413162E 22	760.9	808.9	819.9	863.3	856.0	-56.6
26	0.2853	0.9640718E 22	787.8	829.4	830.0	872.9	887.0	-48.9
27	0.2865	0.9873529E 22	810.2	846.8	853.0	880.9	895.5	-35.9
28	0.2874	0.9510888E 22	827.5	860.9	865.0	887.6	899.7	-28.5
29	0.2885	0.1203099E 23	851.0	872.2	875.0	891.2	911.8	-22.8
30	0.2888	0.1211822E 23	865.6	880.2	885.0	897.8	912.2	-19.3
31	0.2891	0.1222898E 23	875.9	887.6	890.5	901.8	913.7	-14.7
32	0.2897	0.1228898E 23	880.1	893.7	895.9	905.1	914.8	-11.9
33	0.2902	0.1233968E 23	890.9	898.6	900.0	907.8	915.1	-9.6
34	0.2907	0.1239739E 23	894.0	902.4	904.1	910.7	916.2	-7.7
35	0.2909	0.1243827E 23	900.9	906.1	907.3	912.1	917.8	-6.1
36	0.2911	0.1246285E 23	903.7	909.2	910.3	916.5	918.9	-5.5
37	0.5023	0.2006301E 21	493.5	499.6	511.6	560.0	570.7	-62.5
38	0.3863	0.9383068E 21	500.3	582.3	601.0	679.8	759.9	-101.1
39	0.3000	0.1917998E 22	558.9	651.3	673.2	760.2	848.9	-113.2
40	0.2860	0.3855228E 22	621.1	700.0	720.2	803.8	882.5	-103.9
41	0.2828	0.4832108E 22	676.5	748.8	761.5	828.5	898.8	-87.5
42	0.2812	0.8733708E 22	721.5	776.3	790.2	844.7	898.3	-71.2
43	0.2818	0.9087258E 22	757.9	801.7	812.7	856.0	899.1	-56.5
44	0.2826	0.9300528E 22	787.2	822.2	830.9	868.8	899.8	-44.9
45	0.2840	0.9500481E 22	810.9	838.8	845.7	873.1	900.7	-35.7
46	0.2852	0.9640481E 22	829.8	852.3	857.0	879.0	901.7	-29.8
47	0.2862	0.9800361E 22	845.1	863.2	867.6	885.1	902.8	-22.7
48	0.2870	0.9990608E 22	857.5	872.1	875.0	889.6	903.8	-14.2
49	0.2877	0.9992228E 22	867.6	879.3	882.1	893.8	900.8	-10.6
50	0.2883	0.1006138E 23	875.9	885.2	887.5	898.5	903.4	-11.7
51	0.2889	0.1011788E 23	882.8	890.0	891.8	899.1	906.6	-9.5
52	0.2892	0.1016208E 23	887.0	894.0	895.8	901.3	907.1	-7.6
53	0.2895	0.1019018E 23	892.3	897.2	898.5	903.3	905.1	-6.2
54	0.2898	0.1022578E 23	896.0	900.4	901.6	905.6	908.9	-5.8
55	0.5001	0.2300497E 21	491.2	493.8	500.7	550.7	598.8	-59.8
56	0.3896	0.8836338E 21	475.8	578.1	592.0	667.8	783.9	-97.2
57	0.3019	0.1821528E 22	547.4	642.1	663.5	788.1	832.7	-110.2
58	0.2967	0.2893108E 22	612.7	698.2	714.1	792.5	869.9	-102.2
59	0.2816	0.4897648E 22	667.1	738.3	751.2	817.5	882.9	-86.6
60	0.2801	0.6025218E 22	711.6	765.7	779.5	833.6	884.9	-70.7
61	0.2797	0.6338738E 22	747.8	790.8	801.7	848.9	887.7	-56.1
62	0.2812	0.6508788E 22	776.3	810.9	819.5	853.8	888.9	-44.6
63	0.2825	0.6785988E 22	799.5	827.2	834.0	861.3	898.7	-35.8
64	0.2835	0.6987558E 22	819.1	840.3	845.7	867.5	889.8	-29.2
65	0.2844	0.7077788E 22	833.2	850.5	855.3	872.6	890.2	-22.5
66	0.2852	0.7191738E 22	845.3	858.6	863.0	876.9	891.8	-18.0
67	0.2858	0.7265698E 22	855.1	866.6	869.8	880.5	891.8	-14.5
68	0.2863	0.7333788E 22	861.1	872.3	874.5	883.9	892.6	-11.6
69	0.2869	0.738[illegible]28E 22	869.5	877.0	878.0	886.0	893.7	-9.3
70	0.2872	0.7831548E 22	874.8	880.8	882.2	888.9	893.9	-7.5
71	0.2875	0.1093108E 23	879.1	888.0	885.1	889.8	898.6	-6.1
72	0.2878	0.1095708E 23	882.7	886.9	887.9	892.8	896.9	-5.3
73	0.5153	0.2176579E 21	390.7	496.6	497.2	540.8	589.7	-55.8
74	0.3581	0.8396818E 21	469.3	560.4	582.3	653.8	725.4	-92.1
75	0.3036	0.1702308E 22	539.6	637.0	651.5	732.9	818.8	-105.9
76	0.2869	0.2671598E 22	592.6	682.2	701.5	777.8	853.1	-89.8
77	0.2810	0.3703678E 22	655.6	721.5	738.0	803.1	867.2	-84.9
78	0.2788	0.4968878E 22	699.5	752.2	765.0	819.1	871.7	-69.6
79	0.2782	0.6683698E 22	738.1	776.7	797.5	838.8	872.8	-56.1
80	0.2781	0.8888318E 22	762.2	796.3	808.0	838.9	872.8	-44.8
81	0.2793	0.9001958E 22	788.8	812.0	818.0	849.9	872.9	-35.2
82	0.2803	0.9242708E 22	803.0	828.7	838.1	851.6	873.3	-28.0
83	0.2812	0.9369228E 22	817.6	838.9	839.3	856.8	873.7	-22.3
84	0.2819	0.9870738E 22	829.3	843.2	846.7	860.8	878.2	-17.8
85	0.2825	0.9552208E 22	838.9	850.0	852.7	863.7	878.9	-14.2
86	0.2830	0.9617738E 22	846.0	855.8	857.6	866.8	875.1	-11.8
87	0.2834	0.9670378E 22	852.6	859.8	861.6	868.6	875.9	-9.1
88	0.2839	0.9712648E 22	857.6	863.8	864.0	879.5	876.7	-7.2
89	0.2841	0.9748488E 22	861.7	866.4	867.6	872.9	876.5	-5.9
90	0.2843	0.9772998E 22	865.1	869.2	870.2	878.1	878.2	-5.1
91	0.5252	0.2017638E 21	355.7	470.8	448.1	527.9	669.9	-51.3
92	0.3612	0.7696268E 21	462.2	552.8	568.7	638.2	735.7	-88.9
93	0.3067	0.1583008E 22	529.9	614.2	635.5	711.8	798.2	-89.2
94	0.2878	0.2398458E 22	599.2	665.9	684.3	746.9	820.9	-88.6
95	0.2886	0.3248578E 22	640.3	700.1	720.0	782.6	840.5	-81.7
96	0.2776	0.4122638E 22	693.1	722.8	744.9	790.6	848.5	-67.2
97	0.2764	0.5150468E 22	715.9	747.3	767.9	805.6	840.9	-58.8
98	0.2759	0.6987038E 22	743.0	776.1	788.5	817.6	850.7	-43.1
99	0.2757	0.7095358E 22	768.7	791.1	797.7	828.8	850.8	-30.2
100	0.2766	0.7289058E 22	792.1	803.1	808.8	829.7	850.8	-27.1
101	0.2770	0.7346298E 22	796.0	812.9	817.0	832.6	850.4	-21.7
102	0.2780	0.7862738E 22	807.2	820.6	823.9	837.2	850.6	-17.3
103	0.2785	0.7500658E 22	816.2	826.4	826.5	840.2	850.4	-13.5
104	0.2790	0.7601958E 22	823.8	832.0	834.1	842.6	851.2	-11.0
105	0.2793	0.7651628E 22	829.2	836.1	837.0	844.4	851.5	-8.9
106	0.2796	0.1228027E 23	833.9	838.8	840.0	846.2	851.7	-7.0
107	0.2796	0.1231598E 23	837.7	842.2	843.2	847.6	852.1	-5.7
108	0.2798	0.1238008E 23	840.9	848.7	845.6	849.0	853.2	-4.9
109	0.5390	0.1819608E 21	392.1	468.6	477.5	543.4	550.7	-46.6
110	0.3728	0.6779355E 21	453.1	535.9	550.5	609.0	648.8	-75.9
111	0.3132	0.1333078E 22	510.8	595.1	612.5	691.6	751.1	-89.8
112	0.2906	0.2029679E 22	570.1	631.5	650.8	725.3	792.8	-87.1
113	0.2812	0.2698108E 22	617.6	677.3	692.1	750.5	798.8	-76.1
114	0.2769	0.3275489E 22	656.4	708.1	717.8	765.9	810.0	-63.3
115	0.2767	0.3918808E 22	699.3	727.1	737.0	775.8	815.8	-51.3
116	0.2736	0.8327138E 22	713.4	740.5	752.5	788.0	815.1	-41.1
117	0.2730	0.8837018E 22	733.9	750.8	764.7	789.9	818.9	-32.9
118	0.2726	0.5398598E 22	750.9	769.4	778.6	798.4	818.5	-26.9
119	0.2728	0.6075968E 22	761.0	778.6	782.6	798.8	818.3	-20.6
120	0.2723	0.7135458E 22	773.5	785.9	789.1	801.7	818.8	-16.8
121	0.2723	0.7208578E 22	791.9	791.8	798.3	808.8	818.5	-13.0

Table 3. CONTINUED

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 122      0.2727  0.1118798E 23     898.7     896.6     898.6     906.6     914.7     -10.8
 123      0.2728  0.1119236E 23     898.2     900.5     902.1     908.5     915.0      -8.3
 124      0.2729  0.1119589E 23     899.7     903.7     905.0     910.1     915.3      -6.6
 125      0.2731  0.1119869E 23     902.3     906.4     907.4     911.5     915.6      -5.3
 126      0.2733  0.1120090E 23     905.3     908.9     909.7     913.2     916.7      -4.5
 127      0.5633  0.1881177E 21     394.2     478.7     483.5     515.0     555.9     -45.9
 128      0.8016  0.5341865E 21     455.7     529.2     552.5     606.1     650.9     -69.8
 129      0.3368  0.1012595E 22     515.1     583.6     609.1     678.8     733.2     -80.1
 130      0.3089  0.1483081E 22     567.5     625.7     650.2     709.3     769.5     -76.9
 131      0.2952  0.1993555E 22     611.1     666.6     679.6     731.0     782.2     -66.9
 132      0.2879  0.2230962E 22     646.3     690.7     701.4     744.0     786.3     -55.4
 133      0.2836  0.2505555E 22     678.3     709.4     718.1     752.5     786.9     -44.9
 134      0.2810  0.2770282E 22     696.8     720.2     731.1     758.7     786.2     -35.9
 135      0.2792  0.2916088E 22     714.9     735.9     741.5     763.0     785.8     -28.6
 136      0.2780  0.3071238E 22     729.0     745.3     749.7     767.2     788.7     -22.8
 137      0.2771  0.3201972E 22     739.2     752.9     756.4     770.3     788.3     -18.1
 138      0.2765  0.3312812E 22     748.2     758.0     761.8     772.9     788.0     -14.5
 139      0.2761  0.3407352E 22     755.4     764.0     766.2     775.1     788.0     -11.5
 140      0.2759  0.3499972E 22     761.6     768.5     770.3     777.4     788.4      -9.2
 141      0.2755  0.3592882E 22     767.1     772.7     774.1     779.7     785.8      -7.3
 142      0.2753  0.3673252E 22     771.7     776.1     777.2     781.7     786.2      -5.8
 143      0.2752  0.3748982E 22     775.5     779.0     779.9     783.4     787.9      -4.6
 144      0.2750  0.3818235E 22     778.6     781.6     782.3     785.2     788.1      -3.9
 145      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 146      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 147      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 148      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 149      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 150      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 151      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 152      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 153      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 154      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0
 155      0.0     0.0               850.0     350.0     304.0     304.0     304.0       0.0

DISTRIBUTION FRACTIONS OF    144 HEAT TEMPERATURES IN TWENTY FRACTILES OVER THE RANGE (C)    350.0    922.3
 0.0      0.0      0.0      0.0      0.0      0.11389 0.01389 0.02778 0.00694 0.01389
 0.00694 0.03472 0.02083 0.04167 0.10417 0.11111 0.11806 0.15278 0.18750 0.14583

ZONE AVERAGE TEMP AND TMAX, THEN SUBZONE      805.10     809.15      0.0       0.0

     MAX TEMPS, PEAK/MEAN BY ZONE, SUBZONE   926.6   922.3     0.0     0.0 POWER WEIGHTED   788.3    0.0 POWER (MWT)  1650.

AVERAGE AND PEAK TEMPERATURE SLOPE AT PEBBLE HEAT/SHELL INTERFACE (DEG/CM)      [illegible]    -116.6

CORRELATION FAILURE COUNT       955        0


 CASE RECALCULATED WITH NEW COOLANT TEMPERATURES (C)    350.0   850.0 AND POWER  1.656013D 09   ← NOTE

MASS FLOW RATE  (KG/SEC)   0.6378D 03 SCHED  0.1656D 10

MAXIMUM INITIALIZED BULK FLUID AND PEBBLE TEMPERATURES (K)    1126.97   1191.44 APPARENT PRESSURE DROP (ATM)   0.6698

   INITIALIZATION OF PROBLEM COMPLETE, START ITERATION .....  CONVERGENCE DATA FOLLOWS

 PROCESSOR TIME (SEC) AT START OF ITERATION      50.36 --COEFFICIENTS   1.3510  0.7796  1.0090  1.4171 MAX IT   170

ITERATION, MAXIMUM CHANGE (PSI, BULK TEMP, SURF TEMP, PRESSURE), BETA(1), PRESSURE DROP, DEL HEAT BALANCE,  SUM(5)
    1   0.000113  -0.005052  -0.005335  -0.000057  1.1755  0.6704  -0.000070  0.0007  0.0032  0.0465  0.0040  0.1102
    2  -0.000064  -0.000083  -0.000118   0.000022  1.1755  0.6704  -0.000137  0.5687  0.6055  0.9783  0.5932  0.0967
    3  -0.000050  -0.000096  -0.000115   0.000011  1.3510  0.6705  -0.000276  0.7790  0.7572  2.1987  0.6680  0.9966
    4  -0.000041  -0.000084  -0.000099   0.000007  1.3510  0.6706  -0.000409  0.9292  0.8359  1.0111  0.8260  1.0992
    5  -0.000024  -0.000221  -0.000215  -0.000006  1.3510  0.6707  -0.000722  0.5759  0.7708  2.4134  0.9110  1.1213
    6  -0.000019  -0.000205  -0.000194  -0.000005  1.3510  0.6708  -0.001064  0.9027  0.8058  1.1115  0.9392  1.1376
    7  -0.000016  -0.000197  -0.000183  -0.000005  1.3510  0.6708  -0.001402  0.8372  0.7996  0.9709  0.9448  0.9129
    8  -0.000014  -0.000189  -0.000178  -0.000004  1.3510  0.6709  -0.001729  0.9684  0.9506  0.9677  0.9544  0.8939
    9  -0.000013  -0.000183  -0.000173  -0.000004  1.3510  0.6710  -0.002075  0.9370  0.9849  0.9647  0.9566  0.9060
   10  -0.000011  -0.000179  -0.000170  -0.000004  1.3510  0.6710  -0.002412  0.8963  0.9077  0.9657  0.9578  0.9194
   11  -0.000011  -0.000175  -0.000168  -0.000003  1.3510  0.6711  -0.002749  0.9353  0.9193  0.9645  0.9584  0.9379
   12  -0.000010  -0.000172  -0.000167  -0.000003  1.3510  0.6711  -0.003088  0.5393  0.9382  0.9632  0.9598  0.9451
   13  -0.000009  -0.000170  -0.000166  -0.000003  1.3510  0.6711  -0.003429  0.5819  0.9430  0.9619  0.9605  0.9505
   14  -0.000009  -0.000168  -0.000164  -0.000003  1.3510  0.6712  -0.003776  0.9589  0.9499  0.9603  0.9614  0.9535
   15  -0.000009  -0.000167  -0.000163  -0.000003  1.3510  0.6712  -0.004092  0.9689  0.9508  0.9587  0.9622  0.9557
   16  -0.000008  -0.000165  -0.000163  -0.000003  1.3510  0.6712  -0.004429  0.9692  0.9635  0.9569  0.9630  0.9595
   17  -0.000008  -0.000164  -0.000162  -0.000003  1.3510  0.6713  -0.004765  0.9582  0.9660  0.9550  0.9641  0.9603

EXTRAPOLATION OF SELECTED ITERATE DATA WITH EIGENVALUE  0.96359 FACTORS      0.0       0.0     26.47 LEVEL    2
   18  -0.000008  -0.000163  -0.000161  -0.000003  1.3510  0.6722  -0.005101  0.9587  0.9947  0.9529  0.9081  0.9675
   19  -0.000008  -0.000162  -0.000161  -0.000003  1.3510  0.6721  -0.005437  0.9872  1.0316  0.9596  0.9757  0.9933
   20  -0.000007  -0.000162  -0.000161  -0.000002  1.3510  0.6722  -0.005773  0.9592  1.0092  0.9809  0.9121  0.9851
   21  -0.000007  -0.000161  -0.000160  -0.000002  1.3510  0.6722  -0.006110  0.9664  1.0097  0.9852  0.9297  0.9773
   22  -0.000007  -0.000161  -0.000160  -0.000002  1.3510  0.6722  -0.006446  0.9629  1.0073  0.9829  0.9312  0.9753
   23  -0.000006  -0.000160  -0.000160  -0.000001  1.3510  0.6722  -0.006782  0.9521  1.0075  0.9384  0.9344  0.9732
   24  -0.000006  -0.000160  -0.000159  -0.000001  1.3510  0.6722  -0.007118  0.9952  1.0069  0.9344  0.9364  0.9712
   25  -0.000006  -0.000160  -0.000159  -0.000001  1.3510  0.6722  -0.007453  0.9759  1.0069  0.9299  0.9385  0.9689
   26  -0.000006  -0.000159  -0.000159  -0.000001  1.3510  0.6722  -0.007789  0.9537  1.0067  0.9247  0.9406  0.9661
   27  -0.000006  -0.000159  -0.000158  -0.000001  1.3510  0.6722  -0.008121  0.9909  1.0066  0.9189  0.9424  0.9639
   28  -0.000006  -0.000157  -0.000157  -0.000001  1.3510  0.6722  -0.008450  0.9663  1.0057  0.9123  0.9445  0.9596
   29  -0.000006  -0.000156  -0.000155  -0.000001  1.3510  0.6722  -0.008770  0.9894  1.0050  0.9051  0.9467  0.9557
   30  -0.000006  -0.000153  -0.000153  -0.000001  1.3510  0.6722  -0.009090  1.0139  1.0084  0.8973  0.9488  0.9516
   31  -0.000006  -0.000150  -0.000149  -0.000001  1.3510  0.6722  -0.009396  1.0282  1.0037  0.8899  0.9512  0.9469
   32  -0.000006  -0.000145  -0.000144  -0.000001  1.3510  0.6722  -0.009696  1.0229  1.0039  0.8801  0.9545  0.9421
   33  -0.000006  -0.000138  -0.000138  -0.000001  1.3510  0.6722  -0.009963  1.0191  1.0036  0.8713  0.9573  0.9368
   34  -0.000006  -0.000130  -0.000130  -0.000001  1.3510  0.6722  -0.010213  1.0211  1.0003  0.8619  0.9587  0.9312
   35  -0.000006  -0.000121  -0.000121  -0.000001  1.3510  0.6722  -0.010444  1.0365  0.9986  0.8527  0.9600  0.9256
   36  -0.000007  -0.000111  -0.000110  -0.000001  1.3510  0.6722  -0.010653  1.0399  0.9969  0.8439  0.9611  0.9200
```

Table 3. CONTINUED

```
EXTRAPOLATION OF SELECTED ITERATE DATA WITH EIGENVALUE  0.96053 FACTORS     0.0      0.0     28.78 LEVEL   2
   37  -0.000006  -0.000100  -0.000106  -0.000001  1.3510  0.6722  -0.019825  1.1801  1.0023  0.8352  0.6257  0.9761
   38  -0.000030  -0.000089  -0.000085  -0.000001  1.3510  0.6722  -0.010986  1.0717  0.9985  0.8273  1.1828  0.9119
   39  -0.000009  -0.000078  -0.000078  -0.000001  1.3510  0.6723  -0.011133  1.0205  0.9921  0.8299  0.8561  0.9858
   40  -0.000009  -0.000067  -0.000067  -0.000001  1.3510  0.6723  -0.011250  0.9957  0.9998  0.8135  0.9288  0.8846
   41  -0.000009  -0.000057  -0.000057  -0.000000  1.3510  0.6723  -0.011387  1.0103  0.9977  0.8895  0.9965  0.9958
   42  -0.000009  -0.000048  -0.000048  -0.000000  1.3510  0.6723  -0.011427  0.9922  0.9858  0.8046  0.9293  0.9921

 PROCESSOR TIME (SEC) FOR     42 ITERATIONS      86.02 --COEFFICIENTS   1.3510  0.8796  1.0010  1.0900

ESTIMATED FRACTIONAL ABSOLUTE ERROR   1.935789-03 RELATIVE CHANGE IN THE PRESSURE DROP   0.00001


  SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS


  TEMPERATURES ARBITRARILY ADJUSTED TO ELIMINATE THE HEAT BALANCE ERROR

BED RADIUS AND HEIGHT (M)                           4.1509    5.5000
THERMAL POWER (MW)                                 1656.01
COOLANT MASS FLOW RATE (KG/S)                      637.787
INLET AVERAGE REYNOLDS NUMBER                      21296.
INLET COOLANT TEMPERATURE (K)                       623.0
MEAN OUTLET COOLANT TEMPERATURE (K)                1123.0
PEAK OUTLET COOLANT TEMPERATURE (K)                1187.2  AT RADIAL LOCATION (M)       0.0
MAX AND MIN PEBBLE SURFACE TEMPERATURES (K)        1191.7     692.9
INLET PRESSURE (ATM)                               40.000
OUTLET PRESSURE (ATM)                              39.328
PRESSURE DROP (ATM)                                 0.67230
ERRORS IN FLOW AND HEAT BALANCE (PERCENT)          -0.000     -1.143
   APPROXIMATE AXIAL PRESSURE CHANGE ACROSS CORE AT R/3 AND 2R/3 (ATM), --NO GRAVITY  -0.67359  -0.67369

MAXIMUM RADIAL COMPONENT OF THE RELATIVE MASS FLOW RATE (ABSOLUTE)      0.00603.

APPARENT EXTERNAL PRESSURE DROP (ATM) 0.67233

                  RELATIVE MASS FLOW RATE, G
                  --------------------------

   RADIAL  0.0       0.0803 0.1606 0.2410 0.2739 0.3068 0.3398 0.3727 0.4056 0.4446 0.4795 0.5066 0.5337
  AXIAL   ---------------------------------------------------------------------------------------------
  0.0        0.9783  0.9787  0.9793  0.9802  0.9808  0.9814  0.9821  0.9830  0.9840  0.9852  0.9864  0.9875  0.9889
  0.0278     0.9783  0.9787  0.9793  0.9802  0.9808  0.9813  0.9821  0.9830  0.9840  0.9852  0.9864  0.9875  0.9889
  0.0556     0.9781  0.9785  0.9791  0.9800  0.9806  0.9812  0.9819  0.9827  0.9838  0.9849  0.9861  0.9872  0.9885
  0.0833     0.9778  0.9783  0.9788  0.9797  0.9803  0.9810  0.9815  0.9823  0.9834  0.9845  0.9856  0.9866  0.9880
  0.1111     0.9774  0.9779  0.9785  0.9793  0.9799  0.9806  0.9811  0.9818  0.9829  0.9840  0.9850  0.9860  0.9874
  0.1389     0.9770  0.9775  0.9781  0.9789  0.9795  0.9802  0.9806  0.9813  0.9823  0.9835  0.9844  0.9853  0.9867
  0.1667     0.9766  0.9771  0.9777  0.9785  0.9791  0.9797  0.9801  0.9807  0.9818  0.9829  0.9838  0.9846  0.9860
  0.1944     0.9762  0.9767  0.9773  0.9781  0.9787  0.9793  0.9796  0.9802  0.9812  0.9824  0.9832  0.9840  0.9854
  0.2222     0.9757  0.9763  0.9768  0.9776  0.9782  0.9788  0.9791  0.9796  0.9807  0.9818  0.9826  0.9834  0.9848
  0.2500     0.9753  0.9758  0.9764  0.9772  0.9778  0.9784  0.9787  0.9792  0.9802  0.9813  0.9821  0.9829  0.9843
  0.2778     0.9749  0.9754  0.9760  0.9768  0.9774  0.9780  0.9782  0.9787  0.9797  0.9809  0.9816  0.9824  0.9838
  0.3056     0.9745  0.9750  0.9756  0.9764  0.9770  0.9775  0.9779  0.9783  0.9792  0.9804  0.9812  0.9819  0.9833
  0.3333     0.9741  0.9746  0.9752  0.9760  0.9766  0.9771  0.9774  0.9779  0.9789  0.9800  0.9807  0.9815  0.9829
  0.3611     0.9737  0.9743  0.9749  0.9757  0.9762  0.9768  0.9770  0.9775  0.9785  0.9796  0.9804  0.9811  0.9825
  0.3889     0.9734  0.9739  0.9745  0.9753  0.9759  0.9764  0.9766  0.9771  0.9781  0.9792  0.9800  0.9808  0.9822
  0.4167     0.9731  0.9736  0.9742  0.9750  0.9755  0.9761  0.9763  0.9768  0.9778  0.9789  0.9797  0.9805  0.9819
  0.4444     0.9727  0.9733  0.9739  0.9747  0.9752  0.9757  0.9760  0.9765  0.9775  0.9786  0.9794  0.9802  0.9816
  0.4722     0.9724  0.9730  0.9736  0.9744  0.9749  0.9754  0.9757  0.9762  0.9772  0.9783  0.9791  0.9800  0.9813
  0.5000     0.9722  0.9727  0.9733  0.9741  0.9746  0.9751  0.9754  0.9759  0.9769  0.9780  0.9788  0.9797  0.9811
  0.5278     0.9719  0.9724  0.9730  0.9739  0.9744  0.9749  0.9752  0.9757  0.9767  0.9777  0.9786  0.9795  0.9809
  0.5556     0.9716  0.9722  0.9728  0.9736  0.9741  0.9746  0.9749  0.9755  0.9764  0.9775  0.9784  0.9793  0.9807
  0.5833     0.9714  0.9719  0.9725  0.9734  0.9739  0.9744  0.9747  0.9752  0.9762  0.9772  0.9782  0.9791  0.9805
  0.6111     0.9712  0.9717  0.9723  0.9732  0.9737  0.9742  0.9745  0.9751  0.9760  0.9771  0.9780  0.9790  0.9803
  0.6389     0.9710  0.9715  0.9721  0.9730  0.9735  0.9740  0.9743  0.9749  0.9758  0.9769  0.9779  0.9788  0.9802
  0.6667     0.9708  0.9713  0.9719  0.9728  0.9733  0.9738  0.9741  0.9747  0.9757  0.9767  0.9777  0.9787  0.9800
  0.6944     0.9706  0.9711  0.9717  0.9726  0.9731  0.9736  0.9740  0.9746  0.9755  0.9766  0.9776  0.9785  0.9799
  0.7222     0.9705  0.9710  0.9716  0.9724  0.9729  0.9734  0.9738  0.9744  0.9754  0.9764  0.9774  0.9784  0.9798
  0.7500     0.9703  0.9708  0.9714  0.9723  0.9728  0.9733  0.9737  0.9743  0.9752  0.9763  0.9773  0.9783  0.9797
  0.7778     0.9702  0.9707  0.9713  0.9722  0.9727  0.9731  0.9736  0.9742  0.9751  0.9762  0.9772  0.9782  0.9796
  0.8056     0.9700  0.9706  0.9712  0.9721  0.9725  0.9730  0.9734  0.9741  0.9750  0.9761  0.9771  0.9782  0.9795
  0.8333     0.9699  0.9705  0.9711  0.9719  0.9724  0.9729  0.9733  0.9740  0.9749  0.9760  0.9771  0.9781  0.9794
  0.8611     0.9699  0.9704  0.9710  0.9719  0.9723  0.9728  0.9733  0.9739  0.9748  0.9759  0.9770  0.9780  0.9794
  0.8889     0.9698  0.9703  0.9709  0.9718  0.9723  0.9727  0.9732  0.9738  0.9748  0.9759  0.9769  0.9780  0.9793
  0.9167     0.9697  0.9702  0.9709  0.9717  0.9722  0.9727  0.9731  0.9738  0.9747  0.9757  0.9769  0.9779  0.9793
  0.9444     0.9697  0.9702  0.9708  0.9717  0.9721  0.9726  0.9731  0.9737  0.9746  0.9757  0.9769  0.9779  0.9792



 103      0.2785   0.751781E 22       816.0       826.7       829.4       840.0       850.7       -13.8
 104      0.2789   0.757976E 22       823.2       831.8       832.9       842.8       851.0       -11.0
 105      0.2793   0.762983E 22       829.0       835.9       837.6       844.4       851.3        -8.8
 106      0.2796   0.115956E 23       833.7       839.2       840.6       845.0       851.5        -7.0
 107      0.2796   0.116273E 23       837.5       842.0       843.1       847.8       851.9        -5.7
 108      0.2798   0.116510E 23       840.7       844.5       845.5       849.2       853.1        -4.9
 109      0.5390   0.101959E 21       392.1       468.5       477.8       513.5       550.9       -86.6
 110      0.3724   0.677017E 21       453.0       535.4       550.5       608.5       669.4       -75.9
 111      0.3132   0.133299E 22       518.3       595.0       612.8       681.5       751.0       -89.8
 112      0.2906   0.202845E 22       570.0       641.4       658.4       725.2       791.9       -87.1
 113      0.2812   0.268367E 22       617.5       677.2       692.0       750.4       808.4       -76.1
 114      0.2769   0.327454E 22       656.6       705.0       717.3       765.9       813.9       -63.3
 115      0.2747   0.381276E 22       688.1       727.0       736.9       776.3       815.3       -51.3
 116      0.2736   0.432830E 22       713.8       744.8       752.4       783.9       815.2       -41.1
 117      0.2730   0.483302E 22       733.7       758.3       764.6       789.7       814.8       -32.8
 118      0.2726   0.538605E 22       749.9       769.5       774.5       794.4       814.4       -26.0
 119      0.2724   0.605966E 22       762.9       778.5       782.4       799.3       814.2       -20.6
 120      0.2723   0.709370E 22       773.3       785.8       788.9       801.5       814.2       -16.8
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↑ SEVERAL PAGES DELETED

Table 3. CONTINUED

```
121    0.2723  0.716290E 22    781.7    791.7    794.2    898.2    910.8   -13.0
122    0.2726  0.106763E 23    788.5    796.9    798.5    906.5    918.6   -10.8
123    0.2726  0.107205E 23    794.0    800.4    802.0    899.0    910.9    -8.3
124    0.2729  0.107554E 23    798.5    803.6    804.8    879.9    915.1    -6.6
125    0.2731  0.107830E 23    802.2    806.3    807.3    911.3    915.5    -5.3
126    0.2733  0.109050E 23    805.3    808.8    809.6    913.1    915.6    -4.5
127    0.5633  0.148177E 21    394.2    478.7    483.5    519.0    555.9   -45.9
128    0.4016  0.534130E 21    455.6    539.2    552.5    664.1    690.4   -69.8
129    0.3368  0.101254E 22    515.0    593.6    609.1    670.8    733.1   -80.1
130    0.3087  0.148368E 22    567.4    635.2    650.1    709.2    769.4   -76.9
131    0.2952  0.189331E 22    611.0    666.6    679.5    730.9    782.1   -66.9
132    0.2879  0.223050E 22    644.2    690.6    701.3    743.9    786.2   -55.4
133    0.2836  0.250099E 22    674.1    709.3    718.0    752.4    786.7   -44.9
134    0.2809  0.272952E 22    694.3    724.0    731.0    759.6    786.8   -35.9
135    0.2792  0.291510E 22    713.9    735.8    741.3    763.3    785.7   -28.6
136    0.2780  0.307003E 22    727.9    745.2    749.6    767.1    784.6   -22.9
137    0.2771  0.320051E 22    739.1    752.8    756.3    770.2    784.1   -18.1
138    0.2765  0.331121E 22    748.0    758.9    761.7    772.8    783.9   -14.5
139    0.2761  0.340560E 22    755.2    763.9    766.1    774.9    783.8   -11.5
140    0.2757  0.348819E 22    761.4    769.4    770.2    777.2    784.1    -9.2
141    0.2755  0.359093E 22    767.0    772.5    773.9    779.4    785.2    -7.3
142    0.2753  0.367262E 22    771.6    776.0    777.1    781.6    786.4    -5.8
143    0.2751  0.374619E 22    775.4    778.9    779.8    783.4    786.9    -4.6
144    0.2750  0.382237E 22    778.6    781.6    782.3    785.2    788.1    -3.8
145    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
146    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
147    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
148    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
149    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
150    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
151    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
152    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
153    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
154    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0
155    0.0     0.0             350.0    350.0    300.0    300.0    300.0     0.0

DISTRIBUTION FRACTIONS OF    144 HEAT TEMPERATURES IN TWENTY FRACTILES OVER THE RANGE (C)    350.0    922.5
 0.0      0.0      0.0      0.0      0.0      0.01389 0.01389 0.02778 0.00694 0.01389
 0.00694 0.03472 0.02083 0.04167 0.10417 0.11111 0.11806 0.15278 0.18750 0.14583

ZONE AVERAGE TEMP AND TMP2, THEN SOURCES      805.0     809.11      0.0       0.0

     MAX TEMPS, PEAK/MEAN BY ZONE, SUBZONE   926.9   922.5    0.0     0.0 POWER WEIGHTED    789.2    0.0 POWER (MWT)   1650.

AVERAGE AND PEAK TEMPERATURE SLOPE AT PEBBLE HEAT/SHELL INTERFACE (DEG/CM)       -41.6     -116.6

CORRELATION FAILURE COUNT         955         0

TOTAL CPU TIME IS    1.658 MINUTES AND TOTAL CLOCK TIME IS    9.923 MINUTES FOR PEBBLE CODE EXECUTION


                    UTILIN - SPECIAL INPUT MODULE - JANUARY 17, 1979 - QUALITY ASSURANCE LEVEL 0
                    ---------------------------------------------------------------------------
```

—NEW THERMAL HYDRAULICS
INSTRUCTIONS SUPPLIED—

```
*** UTILITY INPUT *** ADD OR REPLACE RECORDS IN CONTROL FILE
RECORD NAME *PBLINS*  NO. HOLLERITH   0  NO. REAL  26  NO. INTEGER(I6)   0  NO. INTEGER(I3)  20  PRINT OPT.   0
RECORD NAME *       *  NO. HOLLERITH   0  NO. REAL   0  NO. INTEGER(I6)   0  NO. INTEGER(I3)   0  PRINT OPT.   0

THE FOLLOWING RECORDS ARE ON CONTROL
*PBLINS*
*ZEPINS*
*PROINS*
*DVEINS*
*DTEINS*
*      *

     TOTAL CPU TIME USED    0.001 MINUTES     TOTAL CLOCK TIME USED    0.029 MINUTES     TOTAL I/O USED      13

NORMAL END OF SPECIAL INPUT MODULE UTILIN


          --PEBBLE--THERMAL HYDRAULICS CODE, ORNL VERSION 3.0, FEBRUARY, 1981 -- QA LEVEL 0
          ------------------------------------------------------------------------------

 SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS


---- INTEGER CONTROL VARIABLES ----
IDEPL (0=FLOW DOWN, 1=FLOW UP)                 0
ERGUN/US PRESSURE DROP AND FILM COEFF          0
IFLUE (-1/0,1/2- FLUENCE 0/ CTHIST/ EXPORT)    0
IPRNGE  (-1/0,1/2- TOTAL/FIRST/SECOND RANGE)   0
MEMORY AVAILABLE IF .NE. 0 (WORDS)             0
HEAT CONDUCTION THERMAL CONDUCTIVITY           0
DEBUG EDIT LEVEL                               0
EDIT LEVEL OPTION                              0
HEAT REMOVAL OPTIONS                           0
FUEL ELEMENT GEOMETRY, 0- SPHERE, 1- CYL       0

   0   0  -1   0   1   0   0   0   0  -1   0   0   3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
```

Table 3. CONTINUED

```
---- FLOATING CONTROL VARIABLES ----
VOID FRACTION                                  0.0
INLET TEMPERATURE (C)                          0.3500D 03
INLET PRESSURE (ATM)                           0.4000D 02
MASS FLOW RATE (KG/S)                          0.0
CHARACTERISTIC HYDRAULIC DIAMETER (CM)         0.6000D 01
REFERENCE FLUENCE                              0.0
RECOVERABLE ENERGY FRACTION                    0.9900D 00
SPECIFIED POWER LEVEL                          0.0
DIAMETER OF CELL FOR HEAT REMOVAL (CM)         0.0
FUEL RADIUS OF ZONE MATERIAL (CM)              0.2500D 01
FUEL RADIUS OF SUBZONE MATERIAL (CM)           0.2500D 01
OUTLET TEMPERATURE (C)                         0.8500D 03
FLUENCE MULTIPLIER                             0.0
THERMAL CONDUCTIVITY MULTIPLIER                0.0
CONVERGENCE CRITERIA                           0.0
                               MAXIMUM CPU TIME IN SECONDS        0.1500E 03

  0.0           0.0           0.0           0.0          0.0
  0.0           0.0           0.0           0.0          1.50000D 03

MAXIMUM MEMORY REQUIREMENT --   69359 WORDS, MEMORY AVAILABLE --   160000 WORDS

POWER OF EXPOND -  0.1639E 10 DOES NOT MATCH PBDIF-  0.1490E 10

TIME OF EXPOND-  0.2837E 05 DOES NOT MATCH PBDIF-  0.0

DATA UNIT NUMBERS, GEOMETRY, EXPOSURE, ZONE AND POINT  POWER DENSITY   18  20  19  19

PROBLEM MESH (RZ)        1     29     11     46       0.0       415.00      290.99      750.90

THE ENDS OF THE VARIABLY DIMENSIONED DATA BLOCKS       5815      6901      31529      43271

   DATA ARRAY STORAGE REQUIREMENT   43271

NOMINAL VOID FRACTION, MAXIMUM AND MINIMUM 0.40000 0.40000 0.40000

         MAXIMUM POWER DENSITY (W/CC)   LOCATION -  RADIUS / DEPTH FROM TOP (M)
         ------------------------------------------------------------------------
              16.061                          0.333 /    0.458


GULS DEL P (ATM)   6.2711D-01 AT DENSITY  1.9851D 00 VOLUME  2.9758D 00, MASS FLOW (KG/SEC)   6.2779D 02 POWER  1.6540D 09

MAXIMUM INITIALIZED BULK FLUID AND PEBBLE TEMPERATURES (K)     1204.02    1209.34 APPARENT PRESSURE DROP (ATM)   0.6719

   INITIALIZATION OF PROBLEM COMPLETED, START ITERATION  .....  CONVERGENCE DATA FOLLOWS

 PROCESSOR TIME (SEC) AT START OF ITERATION       0.82 --COEFFICIENTS   1.3032  0.2822  1.9930  1.8532 MAX IT   170

ITERATION, MAXIMUM CHANGE (PSI, BULK TEMP, SURF TEMP, PRESSURE),  BETA(I), PRESSURE DROP, DEL HEAT BALANCE,  RHO(S)
   1   -0.002684   0.000648   0.000917   0.001246  1.1516  0.6725  -0.000337  0.0940  0.0999  0.1322  0.0678  0.3382
   2   -0.001639   0.000502  -0.003736   0.000651  1.1516  0.6723  -0.000087  0.6099  0.7397  1.0130  0.7818  0.3185
   3    0.001235   0.001259   0.001729   0.000887  1.3032  0.6724  -0.000186  0.7527  0.9059  2.2049  0.7023  1.1053
   4    0.001085   0.000972   0.001331   0.000320  1.3032  0.6725  -0.000199  0.8795  0.9219  0.9500  0.7860  1.1198
   5    0.000967   0.002785   0.002724   0.000228  1.3032  0.6725  -0.000213  0.8917  0.9615  2.5532  0.8090  1.1460
   6    0.000831   0.001931   0.001858   0.000166  1.3032  0.6726  -0.000194  0.9909  0.9357  0.9278  0.8263  1.1753
   7    0.000782   0.001678   0.001616   0.000113  1.3032  0.6727  -0.000288  0.9085  0.9709  0.9493  0.8262  0.9861
   8    0.000718   0.001448   0.001838   0.000073  1.3032  0.6728  -0.000305  0.9135  0.9692  0.9512  0.8527  0.9606
   9    0.000655   0.001300   0.001258   0.000053  1.3032  0.6729  -0.000393  0.9177  0.9737  0.9596  0.8912  0.9631
  10    0.000608   0.001178   0.001162   0.000041  1.3032  0.6730  -0.000496  0.9295  0.9759  0.9456  0.9053  0.9685
  11    0.000589   0.001108   0.001071   0.000031  1.3032  0.6730  -0.000613  0.9682  0.9753  0.9709  0.9094  0.9717
  12    0.000566   0.001051   0.001013  -0.000028  1.3032  0.6731  -0.000757  0.9607  0.9768  0.9737  0.9172  0.9739
  13    0.000539   0.001006   0.000971  -0.000022  1.3032  0.6732  -0.000916  0.9537  0.9772  0.9766  0.9276  0.9753
  14    0.000518   0.000960   0.000938  -0.000021  1.3032  0.6732  -0.001102  0.9600  0.9777  0.9763  0.9349  0.9768
  15    0.000496   0.000917   0.000891  -0.000019  1.3032  0.6733  -0.001317  0.9599  0.9790  0.9776  0.9409  0.9775
  16    0.000480   0.000895   0.000860  -0.000018  1.3032  0.6734  -0.001562  0.9600  0.9789  0.9779  0.9465  0.9782
  17    0.000467   0.000856   0.000832  -0.000017  1.3032  0.6735  -0.001869  0.9738  0.9797  0.9772  0.9509  0.9783

EXTRAPOLATION OF SELECTED ITERATE DATA WITH EIGENVALUE  0.97930 FACTORS    46.77    42.56    18.50 LEVEL   0
  18    0.001195   0.006738   0.006766   0.000040  1.3532  0.6745  -0.016356  2.5571  1.1392  5.5079  1.2928  1.5650
  19    0.001023   0.006289   0.006187   0.000032  1.3532  0.6744  -0.019878  0.9579  0.9509  0.9380  0.8660  1.0980
  20    0.000903   0.005808   0.005719   0.000027  1.3532  0.6743  -0.020078  0.9222  0.9019  0.9805  0.8785  0.9066
  21    0.000882   0.005817   0.005367   0.000023  1.3532  0.6743  -0.023118  0.9358  0.9277  0.9388  0.8920  0.9268
  22    0.000869   0.005078   0.005015   0.000019  1.3532  0.6742  -0.025895  0.9085  0.9238  0.9299  0.9037  0.9310
  23    0.000861   0.004777   0.004727  -0.000015  1.3532  0.6741  -0.027878  0.9927  0.9095  0.9821  0.9115  0.9362
  24    0.000838   0.004509   0.004466  -0.000014  1.3532  0.6740  -0.029357  0.9692  0.9550  0.9377  0.9151  0.9400
  25    0.000003   0.004268   0.004229  -0.000013  1.3532  0.6740  -0.030989  0.9632  0.9615  0.9375  0.9190  0.9400
  26   -0.000022   0.004043   0.004012  -0.000012  1.3532  0.6739  -0.031967  1.0285  0.9669  0.9292  0.9281  0.9486
  27   -0.000066   0.003849   0.003818  -0.000011  1.3532  0.6738  -0.032583  1.0521  0.9661  0.9315  0.9299  0.9402
  28   -0.000008   0.003658   0.003631  -0.000010  1.3193  0.6738  -0.032613  0.9326  0.9331  0.9310  0.9365  0.9327
  29   -0.000011   0.003495   0.003465  -0.000010  1.3193  0.6738  -0.032069  1.0902  0.9731  0.9399  0.9401  0.9360
  30   -0.000601   0.003331   0.003318  -0.000010  1.3193  0.6738  -0.030959  0.9399  0.9683  0.9355  0.9435  0.9535
  31    0.000511   0.003171   0.003157  -0.000009  1.3193  0.6738  -0.029260  0.7503  0.9685  0.9299  0.9477  0.9517
  32    0.000470   0.003092   0.003075  -0.000009  1.3193  0.6739  -0.027100  0.9199  0.9596  0.9391  0.9538  0.9502
  33    0.000432   0.002897   0.002887  -0.000009  1.3193  0.6740  -0.024508  0.9196  0.9579  0.9373  0.9550  0.9402
  34    0.000396   0.002737   0.002728  -0.000009  1.3193  0.6740  -0.021671  0.9173  0.9560  0.9269  0.9560  0.9463
  35    0.000393   0.002487   0.002480  -0.000008  1.3193  0.6741  -0.018677  0.9920  0.9505  0.9078  0.9601  0.9359
  36    0.000398   0.002308   0.002301  -0.000009  1.3193  0.6742  -0.015735  1.0136  0.9528  0.8978  0.9597  0.9277
  37    0.000346   0.002125   0.002118  -0.000007  1.2868  0.6743  -0.012901  0.9899  0.8898  0.8853  0.9616  0.9059
  38    0.000323   0.001853   0.001986  -0.000007  1.2868  0.6745  -0.010076  0.9328  0.9627  0.8830  0.9619  0.9045
  39    0.000260   0.001611   0.001608  -0.000007  1.2868  0.6746  -0.009392  0.8965  0.9666  0.8779  0.9617  0.9215
  40    0.000289  -0.001472  -0.001461  -0.000006  1.2868  0.6746  -0.006795  0.9533  0.9659  0.8926  0.9633  0.9209
  41    0.000238  -0.001428  -0.001418  -0.000006  1.2868  0.6747  -0.005667  0.9570  0.9632  0.8871  0.9646  0.9260
  42    0.000228  -0.001395  -0.001375  -0.000005  1.2868  0.6748  -0.005031  0.9607  0.9699  0.8986  0.9632  0.9267
  43    0.000220  -0.001330  -0.001330  -0.000005  1.2868  0.6749  -0.004491  0.9652  0.9597  0.8993  0.9512  0.9299
  44    0.000213  -0.001297  -0.001290  -0.000005  1.2868  0.6749  -0.004080  0.9691  0.9592  0.9170  0.9592  0.9331
  45    0.000207  -0.001252  -0.001248  -0.000004  1.2868  0.6749  -0.003329  0.9728  0.9575  0.9237  0.9577  0.9300
```

Table 3. CONTINUED

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  46   0.000202 -0.001225 -0.001215 -0.000034  1.2864  0.6750  -0.005910  0.9707  0.9579  0.9235  0.9567  0.9403
  47   0.000198 -0.001220 -0.001210 -0.000004  1.2864  0.6750  -0.006579  0.5799  0.9576  0.9095  0.9569  0.9366
  48   0.000193 -0.001212 -0.001207 -0.000002  1.2864  0.6750  -0.007262  0.9709  0.9571  0.9073  0.9569  0.9323
  49   0.000190 -0.001179 -0.001175 -0.000003  1.2864  0.6750  -0.007994  0.5988  0.9558  0.8963  0.9574  0.9286
  50   0.000187 -0.001089 -0.001084 -0.000002  1.2864  0.6750  -0.008886  0.5912  0.9586  0.8995  0.9571  0.9260
  51   0.000185 -0.000976 -0.000973 -0.000002  1.2864  0.6750  -0.009957  0.9977  0.9521  0.8931  0.9572  0.9248
  52   0.000182 -0.000870 -0.000867 -0.000003  1.2864  0.6750  -0.009332  0.5987  0.9509  0.9013  0.9568  0.9240
  53   0.000179 -0.000785 -0.000783 -0.000002  1.2864  0.6750  -0.009595  0.5878  0.9500  0.8966  0.9570  0.9283
  54   0.000178 -0.000616 -0.000614 -0.000002  1.2864  0.6750  -0.009777  0.9908  0.9879  0.9096  0.9571  0.9255


EXTRAPOLATION OF SELECTED ITERATE DATA WITH EIGENVALUE  0.92374 FACTOR,    16.74     6.06   22.39 LEVEL    0
    55   0.000537  0.000807  0.000796  0.000001  1.3028  0.6753  -0.010397  3.0285  0.7515  0.7981  0.8800  0.8467
    56   0.000462 -0.001097 -0.001091 -0.000001  1.3028  0.6753  -0.010166  0.9603  0.9087  0.8592  0.9549  0.8012
    57   0.000381  0.001083  0.001075  0.000001  1.3028  0.6753  -0.009958  0.5281  0.8809  0.8815  0.8824  0.9359
    58   0.000468 -0.001394 -0.001385  0.000001  1.3028  0.6754  -0.009797  1.2301  0.9558  0.9029  0.8895  0.8595
    59   0.000347  0.001837  0.001826  0.000001  1.3028  0.6754  -0.009617  0.7819  0.8667  0.8713  0.9058  0.9739
    60   0.000493 -0.001782 -0.001770  0.000001  1.3028  0.6754  -0.009797  1.8222  0.8790  0.9616  0.9756  0.9915
    61   0.000348  0.001891  0.001878 -0.000001  1.3028  0.6754  -0.009577  0.6983  0.8873  0.9057  0.9346  0.9082
    62   0.000540 -0.001852 -0.001848  0.000000  1.3028  0.6758  -0.009706  1.5671  0.9810  0.7626  0.9850  0.8560
    63   0.000353  0.001312  0.001303 -0.000001  1.3028  0.6754  -0.009627  0.6551  0.9006  0.8873  0.9633  0.9584
    64   0.000387 -0.001061 -0.001055  0.000000  1.3028  0.6754  -0.009720  1.0988  0.9019  0.9453  0.9715  0.9110
    65   0.000265  0.000721  0.000715  0.000000  1.3028  0.6754  -0.009691  0.8967  0.9226  0.8962  0.9822  0.9163
    66   0.000248 -0.000618 -0.000613  0.000000  1.3028  0.6754  -0.009729  0.9200  0.9353  0.9467  0.9821  0.9245
    67   0.000175  0.000389  0.000386  0.000000  1.3028  0.6754  -0.009727  0.7174  0.9439  0.8984  0.9854  0.9308
    68   0.000160 -0.000361 -0.000359  0.000000  1.3028  0.6754  -0.009749  0.9112  0.9832  0.9467  0.9832  0 9323
    69   0.000121  0.000204  0.000202  0.000000  1.3028  0.6754  -0.009736  0.7566  0.9872  0.9029  0.9853  0.9343
    70   0.000110 -0.000216 -0.000214  0.000000  1.3028  0.6754  -0.009747  0.5097  0.9872  0.9459  0.9839  0.9356
    71   0.000088  0.000103  0.000102  0.000000  1.3028  0.6754  -0.009739  0.8021  0.9898  0.9112  0.9852  0.9383
    72   0.000081 -0.000131 -0.000130  0.000000  1.3028  0.6754  -0.009742  0.5175  0.9897  0.9485  0.9845  0.9387
    73   0.000069 -0.000056 -0.000056  0.000000  1.3028  0.6754  -0.009735  0.9895  0.9517  0.9191  0.9852  0.9408
    74   0.000068 -0.000080 -0.000080  0.000000  1.3028  0.6754  -0.009735  0.9262  0.9517  0.9822  0.9846  0.9406
    75   0.000056 -0.000082 -0.000082  0.000000  1.3028  0.6754  -0.009710  0.8875  0.9529  0.9219  0.9850  0.9417

EXTRAPOLATION OF SELECTED ITERATE DATA WITH EIGENVALUE  0.94077 FACTORS    15.72     7.94    3.0  LEVEL    0
    76  -0.000197 -0.000618 -0.000613  0.000000  1.3028  0.6754  -0.009720  3.4987  0.8368  1.0399  1.0140  0.7988
    77  -0.000113  0.000877  0.000874  0.000000  1.3028  0.6754  -0.009692  0.5783  0.8677  0.9173  0.9869  0.7783
    78   0.000065 -0.000335 -0.000333  0.000000  1.3028  0.6754  -0.009707  0.5724  0.9032  0.8857  0.9785  0.8922
    79  -0.000052  0.000275  0.000273  0.000000  1.3028  0.6756  -0.009690  0.8968  0.9196  0.9136  0.9819  0.9058
    80   0.000033 -0.000180 -0.000175  0.000000  1.3028  0.6754  -0.009696  0.6317  0.9399  0.8755  0.9802  0.9096
    81  -0.000020  0.000160  0.000159  0.000000  1.3028  0.6754  -0.009695  0.8395  0.9874  0.9196  0.9817  0.9142
    82   0.000018 -0.000096 -0.000095  0.000000  1.3028  0.6754  -0.009687  0.6326  0.9882  0.8671  0.9813  0.9163
    83  -0.000014  0.000092  0.000092  0.000000  1.3028  0.6755  -0.009691  0.7968  0.9561  0.9082  0.9827  0.9182
    84   0.000010 -0.000050 -0.000050  0.000000  1.3028  0.6755  -0.009692  0.7379  0.9571  0.8639  0.9828  0.9195
    85   0.000008  0.000054  0.000053  0.000000  1.3028  0.6755  -0.009689  0.7726  0.9618  0.8997  0.9834  0.9195
    86   0.000007  0.000030  0.000030  0.000000  1.3028  0.6755  -0.009687  0.8537  0.9617  0.9598  0.9839  0.9219

 PROCESSOR TIME (SEC) FOR     86 ITERATIONS      56.96 --COEFFICIENTS   1.3028  0.2798  1.9999  1.5767

ESTIMATED FRACTIONAL ABSOLUTE ERROR   3.39728D-04 RELATIVE CHANGE IN THE PRESSURE DROP   0.00000


  SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS



  TEMPERATURES ARBITRARILY ADJUSTED TO ELIMINATE THE HEAT BALANCE ERROR

BED RADIUS AND HEIGHT (M)                          4.1500   5.5000
THERMAL POWER (MW)                                1656.01
COOLANT MASS FLOW RATE (KG/S)                     637.787
INLET AVERAGE REYNOLDS NUMBER                      21296.
INLET COOLANT TEMPERATURE (K)                       623.0
MEAN OUTLET COOLANT TEMPERATURE (K)                1123.0
PEAK OUTLET COOLANT TEMPERATURE (K)                1187.5  AT RADIAL LOCATION (M)      0.0
MAX AND MIN PEBBLE SURFACE TEMPERATURES (K)        1192.0     692.9
INLET PRESSURE (ATM)                               40.000
OUTLET PRESSURE (ATM)                              39.325
PRESSURE DROP (ATM)                                 0.67585
ERRORS IN FLOW AND HEAT BALANCE (PERCENT)          0.0       -0.968
   APPROXIMATE AXIAL PRESSURE CHANGE ACROSS CORE AT H/3 AND 2H/3 (ATM), --NO GRAVITY   -0.67797  -0.67826

MAXIMUM RADIAL COMPONENT OF THE RELATIVE MASS FLOW RATE (ABSOLUTE)     0.00598

APPARENT EXTREME PRESSURE DROP (ATM) 0.67585

             AXIAL COMPONENT OF RELATIVE MASS FLOW RATE, GZ
             -----------------------------------------------
    RADIAL  0.0      0.0803  0.1606  0.2410  0.2739  0.3068  0.3398  0.3727  0.4096  0.4446  0.4795  0.5066  0.5337
  AXIAL     ----------------------------------------------------------------------------------------------------------
  0.0        0.9781  0.9785  0.9791  0.9800  0.9806  0.9812  0.9819  0.9829  0.9839  0.9850  0.9863  0.9874  0.9887
  0.0278     0.9781  0.9785  0.9791  0.9800  0.9806  0.9812  0.9819  0.9829  0.9839  0.9850  0.9863  0.9874  0.9887
  0.0556     0.9779  0.9784  0.9789  0.9798  0.9804  0.9811  0.9817  0.9825  0.9836  0.9848  0.9859  0.9870  0.9884
  0.0833     0.9776  0.9781  0.9787  0.9795  0.9801  0.9808  0.9814  0.9821  0.9832  0.9844  0.9855  0.9865  0.9879
  0.1111     0.9772  0.9777  0.9783  0.9792  0.9798  0.9804  0.9809  0.9816  0.9827  0.9839  0.9849  0.9858  0.9872
  0.1389     0.9768  0.9773  0.9779  0.9787  0.9794  0.9800  0.9804  0.9811  0.9822  0.9833  0.9843  0.9852  0.9866
  0.1667     0.9764  0.9769  0.9775  0.9783  0.9789  0.9796  0.9799  0.9805  0.9816  0.9828  0.9836  0.9845  0.9859
  0.1944     0.9759  0.9765  0.9770  0.9779  0.9785  0.9791  0.9794  0.9800  0.9811  0.9822  0.9831  0.9839  0.9853
  0.2222     0.9755  0.9760  0.9766  0.9774  0.9780  0.9786  0.9789  0.9795  0.9806  0.9817  0.9825  0.9833  0.9847
  0.2500     0.9751  0.9756  0.9762  0.9770  0.9776  0.9782  0.9785  0.9790  0.9801  0.9812  0.9820  0.9828  0.9842
  0.2778     0.9746  0.9752  0.9758  0.9766  0.9772  0.9778  0.9780  0.9785  0.9796  0.9807  0.9815  0.9823  0.9837
  0.3056     0.9742  0.9748  0.9754  0.9762  0.9768  0.9773  0.9776  0.9781  0.9791  0.9803  0.9810  0.9818  0.9832
  0.3333     0.9738  0.9744  0.9750  0.9758  0.9764  0.9769  0.9772  0.9777  0.9787  0.9798  0.9806  0.9814  0.9828
  0.3611     0.9735  0.9740  0.9746  0.9754  0.9760  0.9765  0.9768  0.9773  0.9783  0.9794  0.9802  0.9810  0.9824
  0.3889     0.9731  0.9736  0.9742  0.9751  0.9756  0.9762  0.9764  0.9769  0.9779  0.9790  0.9799  0.9807  0.9821
  0.4167     0.9728  0.9733  0.9739  0.9747  0.9751  0.9758  0.9761  0.9765  0.9776  0.9787  0.9795  0.9804  0.9819
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Table 3. CONTINUED

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0.4444     0.9724  0.9730  0.9736  0.9744  0.9750  0.9755  0.9758  0.9763  0.9773  0.9784  0.9792  0.9801  0.9815
0.4722     0.9721  0.9727  0.9733  0.9741  0.9747  0.9752  0.9755  0.9760  0.9770  0.9781  0.9789  0.9799  0.9812
0.5000     0.9718  0.9724  0.9730  0.9738  0.9744  0.9749  0.9752  0.9757  0.9767  0.9778  0.9787  0.9796  0.9810
0.5278     0.9716  0.9721  0.9727  0.9736  0.9741  0.9746  0.9749  0.9755  0.9764  0.9775  0.9784  0.9794  0.9807
0.5556     0.9713  0.9718  0.9725  0.9733  0.9739  0.9743  0.9747  0.9752  0.9762  0.9773  0.9782  0.9792  0.9805
0.5833     0.9711  0.9716  0.9722  0.9731  0.9736  0.9741  0.9745  0.9750  0.9760  0.9771  0.9780  0.9790  0.9803
0.6111     0.9709  0.9714  0.9720  0.9729  0.9734  0.9739  0.9742  0.9748  0.9758  0.9769  0.9778  0.9788  0.9802
0.6389     0.9706  0.9712  0.9718  0.9727  0.9732  0.9737  0.9740  0.9746  0.9756  0.9767  0.9777  0.9786  0.9800
0.6667     0.9705  0.9710  0.9716  0.9725  0.9730  0.9735  0.9739  0.9745  0.9754  0.9765  0.9775  0.9785  0.9799
0.6944     0.9703  0.9708  0.9714  0.9723  0.9728  0.9733  0.9737  0.9743  0.9753  0.9764  0.9774  0.9784  0.9798
0.7222     0.9701  0.9706  0.9713  0.9721  0.9726  0.9731  0.9736  0.9742  0.9751  0.9762  0.9773  0.9783  0.9796
0.7500     0.9700  0.9705  0.9711  0.9720  0.9725  0.9730  0.9734  0.9740  0.9750  0.9761  0.9771  0.9782  0.9795
0.7778     0.9698  0.9703  0.9710  0.9719  0.9724  0.9729  0.9733  0.9739  0.9749  0.9760  0.9770  0.9781  0.9795
0.8056     0.9697  0.9702  0.9709  0.9717  0.9722  0.9727  0.9732  0.9738  0.9748  0.9759  0.9770  0.9780  0.9794
0.8333     0.9696  0.9701  0.9707  0.9716  0.9721  0.9726  0.9731  0.9737  0.9747  0.9758  0.9769  0.9779  0.9793
0.8611     0.9695  0.9700  0.9707  0.9715  0.9720  0.9725  0.9730  0.9737  0.9746  0.9757  0.9768  0.9779  0.9793
0.8889     0.9694  0.9699  0.9706  0.9715  0.9720  0.9725  0.9729  0.9736  0.9745  0.9756  0.9768  0.9778  0.9792
0.9167     0.9693  0.9699  0.9705  0.9714  0.9719  0.9724  0.9729  0.9735  0.9745  0.9755  0.9767  0.9778  0.9792
0.9444     0.9693  0.9699  0.9705  0.9713  0.9719  0.9723  0.9728  0.9735  0.9744  0.9755  0.9767  0.9778  0.9791


  103     0.2785  0.7343135E 22        816.3        826.5        829.1        835.8        850.5        -15.8
  104     0.2789  0.7455108E 22        823.5        831.6        833.7        842.2        850.8        -11.0
  105     0.2793  0.7504778E 22        829.2        835.7        837.4        844.2        851.1         -8.8
  106     0.2796  0.7940308E 22        833.8        839.0        840.8        845.8        851.3         -7.0
  107     0.2796  0.7972008E 22        837.5        841.7        842.8        847.2        851.6         -5.7
  108     0.2798  0.7996188E 22        840.6        844.5        845.4        849.2        853.0         -4.9
  109     0.5300  0.1019878E 21        392.2        471.2        480.1        516.2        553.6        -46.6
  110     0.3728  0.6760038E 21        453.7        537.6        552.2        610.5        669.9        -75.7
  111     0.3136  0.1325698E 22        515.5        594.8        612.2        681.2        750.6        -89.7
  112     0.2908  0.2011548E 22        571.3        646.1        657.0        723.8        790.8        -87.0
  113     0.2813  0.2658898E 22        618.7        675.6        690.4        748.8        806.7        -76.1
  114     0.2768  0.3246478E 22        657.6        703.6        715.9        764.4        812.5        -63.3
  115     0.2746  0.3786338E 22        699.0        725.7        735.7        775.1        814.1        -51.3
  116     0.2735  0.4304078E 22        714.2        743.4        751.4        783.0        814.3        -41.1
  117     0.2728  0.4823738E 22        730.3        757.6        763.9        789.0        814.0        -32.8
  118     0.2725  0.5398538E 22        750.4        768.9        773.9        793.8        813.8        -26.0
  119     0.2723  0.6108358E 22        763.3        778.0        782.0        797.8        813.7        -20.6
  120     0.2722  0.7232268E 22        773.8        785.8        788.5        801.1        813.8        -16.8
  121     0.2721  0.7301388E 22        781.9        791.3        793.0        803.9        814.9        -13.0
  122     0.2725  0.7356668E 22        788.6        796.1        798.1        806.1        814.3        -10.4
  123     0.2729  0.1049188E 23        794.1        800.1        801.6        808.0        814.5         -8.2
  124     0.2728  0.1052718E 23        798.5        803.2        804.5        809.6        814.4         -6.6
  125     0.2731  0.1055518E 23        802.0        805.9        806.9        811.0        815.7         -5.3
  126     0.2733  0.1057638E 23        805.1        808.5        809.4        812.8        816.8         -4.5
  127     0.5630  0.1481988E 21        394.5        477.0        485.7        521.3        558.2        -45.9
  128     0.4019  0.5331438E 21        456.5        540.2        553.5        607.1        661.7        -69.8
  129     0.3371  0.1007988E 22        515.3        593.0        608.5        670.1        732.4        -80.0
  130     0.3090  0.1474978E 22        560.8        633.7        648.6        707.7        766.9        -76.9
  131     0.2953  0.1882928E 22        612.3        665.0        677.9        729.3        780.5        -66.9
  132     0.2879  0.2220918E 22        647.3        689.2        699.9        742.5        788.8        -55.8
  133     0.2836  0.2497678E 22        675.1        708.2        716.9        751.3        785.6        -44.9
  134     0.2809  0.2725128E 22        697.1        723.2        730.1        757.7        785.2        -35.9
  135     0.2791  0.2913558E 22        713.5        735.1        740.7        762.6        784.6        -28.6
  136     0.2779  0.3070968E 22        728.4        744.6        749.1        766.6        784.0        -22.8
  137     0.2770  0.3203398E 22        739.4        752.3        755.8        769.8        783.7        -18.1
  138     0.2764  0.3315838E 22        748.2        759.5        761.3        772.4        783.5        -14.5
  139     0.2760  0.3410578E 22        755.3        763.5        765.7        774.6        783.4        -11.5
  140     0.2756  0.3498968E 22        761.5        768.1        769.8        776.9        784.0         -9.2
  141     0.2754  0.3590808E 22        767.0        772.2        773.6        779.3        784.9         -7.3
  142     0.2752  0.3679368E 22        771.5        775.7        776.8        781.3        785.9         -5.8
  143     0.2750  0.3751858E 22        775.3        778.6        779.5        783.0        786.6         -4.6
  144     0.2749  0.3832128E 22        778.4        781.3        782.0        785.0        787.9         -3.8
  145     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  146     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  147     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  148     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  149     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  150     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  151     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  152     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  153     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  154     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0
  155     0.0     0.0                  850.0        350.0        304.0        304.0        304.0          0.0

DISTRIBUTION FRACTIONS OF    144 HEAT TEMPERATURES IN TWENTY FRACTILES OVER THE RANGE (C)    350.0    922.9
 0.0     0.0     0.0     0.0     0.0     0.01389 0.01389 0.02778 0.00694 0.01389
 0.00694 0.03472 0.02083 0.04167 0.11111 0.11111 0.11806 0.15278 0.18056 0.14583

ZONE AVERAGE TEMP AND T**2, THEN SUBZONE     804.78     808.79      0.0       0.0

     MAX TEMPS, PEAK/NEAR BY ZONE, SUBZONE   927.2  922.8    0.0    0.0 POWER WEIGHTED   789.1    0.0 POWER (MWT)  1650.

AVERAGE AND PEAK TEMPERATURE SLOPE AT PEBBLE HEAT/SHELL INTERFACE (DEG/CM)      -81.5    -116.4

CORRELATION FAILURE COUNT       984        0


TOTAL CPU TIME IS   0.971 MINUTES AND TOTAL CLOCK TIME IS    6.513 MINUTES FOR PEBBLE CORE EXECUTION
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SEVERAL PAGES DELETED

Table 3. CONTINUED

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DUTLIB - SPECIAL INPUT MODULE - JANUARY 17, 1979 - QUALITY ASSURANCE LEVEL C
------------------------------------------------------------------------------
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— NEW THERMAL
HYDRAULICS INSTRUCTIONS —

```
*** UTILITY INPUT *** ADD OR REPLACE RECORDS IN CONTRL FILE
RECORD NAME *FULIBS*  NO. HOLLERITH  0  NO. REAL  12  NO. INTEGER(I6)  0  NO. INTEGER(I3)  30  PRINT OPT.  0
RECORD NAME *      *  NO. HOLLERITH  0  NO. REAL   3  NO. INTEGER(I6)  0  NO. INTEGER(I3)   6  PRINT OPT.  0

THE FOLLOWING RECORDS ARE ON CONTRL
*FULIBS*
*EXPIBS*
*FMEIBS*
*DUTIBS*
*DTHIBS*
*      *

     TOTAL CPU TIME USED    0.001 MINUTES     TOTAL CLOCK TIME USED    0.020 MINUTES     TOTAL I/O USED      13

NORMAL END OF SPECIAL INPUT MODULE UTILIB


         --PEBBLE--THERMAL HYDRAULICS CODE, ORNL VERSION 3.0, FEBRUARY, 1981 -- QA LEVEL 9
         ---------------------------------------------------------------------------------

  SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS


---- INTEGER CONTROL VARIABLES ----
IDEVL (0=FLOW DOWN, 1=FLOW UP)                  0
GERMAN/US PRESSURE DROP AND FILM COEFF          0
IFLUE (-1/0,1/2- FLUENCE 0/ FIRST/ REPORT)     -1
IPOWR  (-1/0,1/2- TOTAL/FIRST/SECOND PASS)      0
MEMORY AVAILABLE IF .NE. 0 (WORDS)              0
HEAT CONDUCTION THERMAL CONDUCTIVITY            0
DEBUG EDIT LEVEL                                0
EDIT LEVEL OPTION                               0
HEAT REMOVAL OPTIONS                            0
FUEL ELEMENT GEOMETRY, 0- SPHERE, 1- CYL        0

   0   0   0   0   0   0   0   0   0   1   0   1   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0


---- FLOATING CONTROL VARIABLES ----
VOID FRACTION                             0.0
INLET TEMPERATURE (C)                     0.35000D 03
INLET PRESSURE (ATM)                      0.40000D 02
MASS FLOW RATE (KG/S)                     0.0
CHARACTERISTIC HYDRAULIC DIAMETER (CM)    0.60000D 01
REFERENCE FLUENCE                         0.0
RECOVERABLE ENERGY FRACTION               0.99000D 00
SPECIFIED POWER LEVEL                     0.0
DIAMETER OF CELL FOR HEAT REMOVAL (CM)    0.0
FUEL RADIUS OF ZONE MATERIAL (CM)         0.25000D 01
FUEL RADIUS OF SUPPORT MATERIAL (CM)      0.25000D 01
OUTLET TEMPERATURE (C)                    0.85000D 03
FLUENCE MULTIPLIER                        1.0
THERMAL CONDUCTIVITY MULTIPLIER           1.0
CONVERGENCE CRITERIA                      0.0
                             MAXIMUM CPU TIME IN SECONDS         0.1200E 02

MAXIMUM MEMORY REQUIREMENT --    69359 WORDS, MEMORY AVAILABLE --    160000 WORDS

POWER OF EXPOND -  0.1630E 10 DOES NOT MATCH PEDIT-  0.1640E 10

TIME OF EXPOND-  0.2837E 05 DOES NOT MATCH PEDIT-  0.0

DATA UNIT NUMBERS, GEOMETRY, EXPOSURE, ZONE AND POINT  POWER DENSITY   10   9  13  19

PROBLEM SIZE (DT)        1      29      11      46        0.0        815.00        200.00        750.30

THE ENDS OF THE VARIABLY DIMENSIONED DATA BLOCKS        5815        6981       77429       83277

   DATA ARRAY STORAGE REQUIREMENT    63271

NOMINAL VOID FRACTION, MAXIMUM AND MINIMUM 0.40000 0.40000 0.40000

         MAXIMUM POWER DENSITY (W/CC)    LOCATION -  RADIUS / DEPTH FROM TOP (M)
         ------------------------------------------------------------------------
               16.061                          0.337 /    0.450

ERGUN DEL P (ATM)   6.2711D-01 AT DENSITY  1.9851D 00 VOLUME  2.9150D 00, MASS FLOW (KG/SEC)   6.2770D 02 POWER  1.6560D 09
```

Table 3. CONTINUED

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THERMAL HYDRAULIC DATA APPEARS RECOVERED FROM UNIT  39

MAXIMUM INITIALIZED BULK FLUID AND PEBBLE TEMPERATURES (K)     1181.12   1185.61 APPARENT PRESSURE DROP (ATM)   0.6760

   INITIALIZATION OF PROBLEM COMPLETE, START ITERATION  .....  CONVERGENCE DATA FOLLOWS

 PROCESSOR TIME (SEC) AT START OF ITERATION       0.29 --COEFFICIENTS   1.3510  0.8796  1.0000  1.0171 MAX IT   170

ITERATION, MAXIMUM CHANGE (PSI, BULK TEMP, SURF TEMP, PRESSURE),  BETA(S), PRESSURE DROP, REL HEAT BALANCE,  RHO(S)
    1  -0.000019   0.000008  -0.050500   0.000065  1.1755  0.6760  -0.011708  0.0000  0.0005  0.0013  0.0002  0.0279
    2  -0.000013   0.000008   0.000008   0.000008  1.1755  0.6760  -0.011708  0.6938  0.9000  0.9764  0.9605  0.0263
    3  -0.000015   0.000006   0.000008   0.000008  1.3510  0.6760  -0.011708  1.0992  1.1700  2.2099  0.9818  1.9971
    4  -0.000015   0.000006   0.000006   0.000003  1.3510  0.6759  -0.011707  1.0020  1.0056  0.9730  0.9357  1.2064
    5  -0.000015   0.000016   0.000016   0.000033  1.3510  0.6759  -0.011707  0.9999  0.9005  2.3776  0.9337  1.2023

 PROCESSOR TIME (SEC) FOR     5 ITERATIONS       3.62 --COEFFICIENTS   1.3510  0.8796  1.0000  1.0171

ESTIMATED FRACTIONAL ABSOLUTE ERROR   6.591060-04 RELATIVE CHANGE IN THE PRESSURE DROP  -0.90002
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← SPECIAL ACTION

```
 SAMPLE PROBLEM, TWO DIMENSIONAL PEBBLE BED THERMAL HYDRAULICS


 TEMPERATURES ARBITRARILY ADJUSTED TO ELIMINATE THE HEAT BALANCE ERROR

BED RADIUS AND HEIGHT (M)                          4.1500   5.5000
THERMAL POWER (MW)                                1656.01
COOLANT MASS FLOW RATE (KG/S)                     637.707
INLET AVERAGE REYNOLDS NUMBER                     21296.
INLET COOLANT TEMPERATURE (K)                      623.0
MEAN OUTLET COOLANT TEMPERATURE (K)               1127.0
PEAK OUTLET COOLANT TEMPERATURE (K)               1187.0  AT RADIAL LOCATION (M)      0.0
MAX AND MIN PEBBLE SURFACE TEMPERATURES (K)       1191.5     652.9
INLET PRESSURE (ATM)                               40.000
OUTLET PRESSURE (ATM)                              39.320
PRESSURE DROP (ATM)                                 0.67593
ERRORS IN FLOW AND HEAT BALANCE (PERCENT)          -0.000    -1.171
   APPROXIMATE AXIAL PRESSURE CHANGE ACROSS CORE AT H/3 AND 2H/3 (ATM), --NO GRAVITY  -0.67356  -0.67370

MAXIMUM RADIAL COMPONENT OF THE RELATIVE MASS FLOW RATE (ABSOLUTE)      0.90600

APPARENT EXTERNAL PRESSURE DROP (ATM) 0.67593

            AXIAL COMPONENT OF RELATIVE MASS FLOW RATE, G2
            ---------------------------------------------
   RADIAL  0.0     0.0803  0.1606  0.2410  0.2739  0.3060  0.3390  0.3707  0.4096  0.4446  0.4795  0.5066  0.5337
 AXIAL     ------------------------------------------------------------------------------------------------------
 0.0        0.9788  0.9789  0.9798  0.9803  0.9809  0.9816  0.9822  0.9831  0.9841  0.9851  0.9865  0.9876  0.9889
 0.0278     0.9788  0.9789  0.9798  0.9803  0.9809  0.9816  0.9822  0.9831  0.9841  0.9852  0.9865  0.9876  0.9889
 0.0556     0.9782  0.9787  0.9793  0.9801  0.9807  0.9814  0.9820  0.9828  0.9839  0.9850  0.9862  0.9872  0.9886
 0.0833     0.9779  0.9784  0.9790  0.9799  0.9804  0.9811  0.9816  0.9824  0.9835  0.9846  0.9857  0.9867  0.9880
 0.1111     0.9776  0.9781  0.9787  0.9795  0.9801  0.9807  0.9812  0.9819  0.9830  0.9841  0.9851  0.9860  0.9874
 0.1389     0.9772  0.9777  0.9783  0.9791  0.9797  0.9803  0.9807  0.9814  0.9824  0.9835  0.9846  0.9854  0.9867
 0.1667     0.9768  0.9773  0.9778  0.9786  0.9792  0.9798  0.9802  0.9809  0.9819  0.9830  0.9838  0.9847  0.9861
 0.1944     0.9763  0.9769  0.9774  0.9782  0.9788  0.9794  0.9797  0.9803  0.9813  0.9824  0.9832  0.9840  0.9854
 0.2222     0.9759  0.9764  0.9770  0.9778  0.9784  0.9789  0.9792  0.9797  0.9808  0.9819  0.9827  0.9835  0.9849
 0.2500     0.9755  0.9760  0.9766  0.9774  0.9779  0.9785  0.9788  0.9792  0.9803  0.9814  0.9821  0.9829  0.9843
 0.2778     0.9750  0.9756  0.9761  0.9769  0.9775  0.9781  0.9783  0.9788  0.9798  0.9809  0.9817  0.9824  0.9838
 0.3056     0.9746  0.9752  0.9757  0.9765  0.9771  0.9776  0.9779  0.9783  0.9794  0.9804  0.9812  0.9820  0.9834
 0.3333     0.9742  0.9748  0.9754  0.9761  0.9767  0.9772  0.9775  0.9779  0.9789  0.9800  0.9808  0.9815  0.9829
 0.3611     0.9739  0.9744  0.9750  0.9758  0.9763  0.9768  0.9771  0.9775  0.9785  0.9796  0.9804  0.9812  0.9826
 0.3889     0.9735  0.9740  0.9746  0.9754  0.9760  0.9764  0.9767  0.9772  0.9782  0.9793  0.9800  0.9808  0.9822
 0.4167     0.9732  0.9737  0.9743  0.9751  0.9756  0.9761  0.9764  0.9768  0.9778  0.9789  0.9797  0.9805  0.9819
 0.4444     0.9728  0.9734  0.9740  0.9747  0.9753  0.9758  0.9761  0.9765  0.9775  0.9786  0.9794  0.9802  0.9816
 0.4722     0.9725  0.9731  0.9736  0.9745  0.9750  0.9755  0.9757  0.9762  0.9772  0.9782  0.9791  0.9799  0.9813
 0.5000     0.9722  0.9728  0.9734  0.9742  0.9747  0.9752  0.9755  0.9760  0.9769  0.9780  0.9788  0.9797  0.9811
 0.5278     0.9720  0.9725  0.9731  0.9739  0.9744  0.9749  0.9752  0.9757  0.9767  0.9777  0.9786  0.9795  0.9808
 0.5556     0.9717  0.9722  0.9728  0.9736  0.9742  0.9746  0.9749  0.9755  0.9766  0.9774  0.9784  0.9793  0.9806
 0.5833     0.9715  0.9720  0.9726  0.9734  0.9739  0.9744  0.9747  0.9752  0.9762  0.9773  0.9782  0.9791  0.9804
 0.6111     0.9712  0.9717  0.9724  0.9732  0.9737  0.9742  0.9745  0.9750  0.9760  0.9770  0.9780  0.9789  0.9803
 0.6389     0.9710  0.9715  0.9721  0.9730  0.9735  0.9740  0.9743  0.9749  0.9758  0.9768  0.9779  0.9788  0.9801
 0.6667     0.9708  0.9713  0.9720  0.9728  0.9733  0.9738  0.9741  0.9747  0.9756  0.9767  0.9777  0.9786  0.9800
 0.6944     0.9706  0.9712  0.9718  0.9726  0.9731  0.9736  0.9740  0.9745  0.9755  0.9764  0.9775  0.9785  0.9798
 0.7222     0.9705  0.9710  0.9716  0.9725  0.9729  0.9734  0.9738  0.9744  0.9753  0.9764  0.9774  0.9784  0.9797
 0.7500     0.9703  0.9709  0.9715  0.9723  0.9728  0.9733  0.9737  0.9743  0.9752  0.9762  0.9773  0.9783  0.9796
 0.7778     0.9702  0.9707  0.9713  0.9722  0.9727  0.9731  0.9735  0.9741  0.9751  0.9761  0.9772  0.9782  0.9795
 0.8056     0.9701  0.9706  0.9712  0.9721  0.9725  0.9730  0.9734  0.9740  0.9749  0.9760  0.9771  0.9781  0.9794
 0.8333     0.9700  0.9705  0.9711  0.9720  0.9724  0.9729  0.9733  0.9739  0.9749  0.9759  0.9770  0.9780  0.9793
 0.8611     0.9699  0.9704  0.9710  0.9719  0.9723  0.9729  0.9733  0.9739  0.9748  0.9758  0.9769  0.9779  0.9793
 0.8889     0.9698  0.9703  0.9710  0.9718  0.9723  0.9727  0.9732  0.9738  0.9747  0.9757  0.9769  0.9779  0.9792
 0.9167     0.9698  0.9703  0.9709  0.9718  0.9722  0.9727  0.9731  0.9737  0.9746  0.9757  0.9768  0.9778  0.9791
 0.9444     0.9697  0.9702  0.9709  0.9717  0.9722  0.9726  0.9731  0.9737  0.9746  0.9756  0.9767  0.9778  0.9791


 0.8056     1046.9  1042.5  1042.9  1044.4
 0.8333     1048.9  1044.4  1044.5  1045.8
 0.8611     1050.6  1046.1  1046.0  1047.1
 0.8889     1052.2  1047.7  1047.3  1048.2
 0.9167     1053.6  1049.1  1048.5  1049.3
 0.9444     1055.9  1050.4  1049.6  1050.2
 0.9722     1056.3  1051.7  1050.7  1051.1
 1.0000     1057.5  1052.8  1051.6  1051.9
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↑ SEVERAL PAGES DELETED

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PEBBLE THERMAL CONDUCTIVITY DATA WILL BE RECOVERED
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← SPECIAL ACTION

Table 3. CONTINUED

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103   [illegible] [illegible]  22     [illegible] [illegible] [illegible] [illegible] [illegible]  [illegible]
104   0.2790  0.7601958E 22     823.4   832.0   834.1   882.4   891.2   -11.0
105   0.2793  0.7651628E 22     829.2   830.1   837.8   884.4   893.4    -9.8
106   0.2796  0.1102278E 23     831.9   839.0   840.7   888.2   851.7    -7.0
107   0.2796  0.1231159E 23     837.7   842.1   843.2   867.6   842.0    -5.7
108   0.2790  0.1230008E 23     863.0   866.7   865.6   869.4   843.2    -8.9
109   0.5390  0.1819559E 21     392.1   448.4   477.9   511.8   449.4   -46.6
110   0.3720  0.6770308E 21     453.1   438.9   550.5   669.0   660.8   -79.8
111   0.3132  0.1311052E 22     510.4   595.1   612.5   691.8   759.4   -89.8
112   0.2906  0.2020638E 22     570.1   681.5   650.4   727.3   791.4   -87.1
113   0.2852  0.2680078E 22     617.4   677.3   692.1   750.5   808.8   -76.1
114   0.2769  0.3275118E 22     654.6   705.1   717.4   764.9   810.6   -43.7
115   0.2767  0.3810378E 22     688.2   727.5   737.0   776.8   845.8   -51.3
116   0.2736  0.4326018E 22     711.5   748.5   752.5   788.0   874.1   -41.1
117   0.2730  0.4837208E 22     733.9   758.8   760.7   799.9   878.9   -32.0
118   0.2726  0.5391808E 22     750.0   769.6   774.4   798.4   878.4   -26.0
119   0.2724  0.6070508E 22     761.3   778.6   782.6   798.0   878.1   -20.4
120   0.2721  0.7132408E 22     771.5   789.3   789.1   807.7   878.8   -19.6
121   0.2723  0.7208578E 22     781.9   791.9   794.3   808.8   878.5   -13.0
122   0.2727  0.1172508E 23     788.7   794.6   798.6   806.6   878.7   -10.8
123   0.2726  0.1192168E 23     790.2   808.5   802.1   809.5   845.6    -8.1
124   0.2729  0.1195098E 23     799.7   803.7   807.0   810.7   819.2    -6.6
125   0.2731  0.1190698E 23     832.1   806.8   807.2   811.5   815.4    -5.1
126   0.2733  0.1200008E 23     835.1   809.8   809.7   811.2   816.7    -4.7
127   0.5633  0.1041767E 21     398.2   478.7   483.5   555.0   555.4   -65.4
128   0.4416  0.5361019E 21     455.7   539.2   552.5   605.1   660.8   -69.8
129   0.3360  0.1812597E 22     515.1   593.6   609.1   670.8   733.2   -80.1
130   0.3080  0.1803782E 22     567.5   635.1   650.1   709.1   749.4   -70.4
131   0.2952  0.1893518E 22     611.1   666.5   679.8   737.0   782.7   -48.7
132   0.2879  0.2730908E 22     646.2   690.7   701.8   764.0   788.1   -45.8
133   0.2836  0.2505878E 22     670.2   709.8   710.1   752.8   798.8   -48.9
134   0.2810  0.2730198E 22     656.8   728.2   731.1   788.7   796.2   -35.9
135   0.2792  0.2935598E 22     710.0   735.8   761.5   763.8   788.1   -28.6
136   0.2780  0.3071138E 22     729.0   785.3   769.7   767.2   798.7   -22.8
137   0.2771  0.3281958E 22     739.2   782.9   756.8   770.4   798.2   -18.1
138   0.2765  0.3312768E 22     749.2   759.0   761.0   772.8   798.4   -18.4
139   0.2761  0.3407308E 22     755.8   768.0   768.2   775.1   798.8   -11.5
140   0.2758  0.3489958E 22     761.6   768.5   770.3   777.8   798.8    -9.2
141   0.2755  0.3592878E 22     767.1   772.7   774.1   776.7   798.6    -7.3
142   0.2753  0.3673398E 22     771.7   776.1   777.2   785.7   786.7    -5.8
143   0.2752  0.3705308E 22     775.5   779.0   779.9   783.8   787.0    -8.4
144   0.2750  0.3810928E 22     778.4   781.6   782.3   784.2   789.1    -1.8
145   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
146   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
147   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
148   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
149   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
150   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
151   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
152   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
153   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
154   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0
155   0.0     0.0               850.0   850.0   850.0   850.0   850.0     0.0

DISTRIBUTION FRACTIONS OF    144 HEAT TEMPERATURES IN TWENTY FRACTILES OVER THE RANGE (F)    750.0    922.1
 0.0     0.0     0.0     0.0     0.0     0.01389 0.01389 0.02778 0.00694 0.01389
 0.00694 0.03472 0.02083 0.04167 0.10417 0.11111 0.11806 0.15278 0.18750 0.14583

ZONE AVERAGE TEMP AND T**2, THEN SUBZONE      805.10     809.15       0.0        0.0

     MAX TEMPS, PEAK/HEAD BY ZONE, SUBZONE   926.7  922.1     0.0     0.0 POWER WEIGHTED    788.2     0.0 POWER (MWT)   1654.

AVERAGE AND PEAK TEMPERATURE SLOPE AT PEBBLE HEAT/SHELL INTERFACE (DEG/CM)       -87.6     -194.6

CORRELATION FAILURE COUNT       456         0
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