LA--10317-MS

DE85 010326

TRANSPA: A Code for Transient Thermal Analysis of a Single Fuel Pin

F. Coyne Prenger

Los Alamos Los Alamos National Laboratory
Los Alamos,New Mexico 87545

TRANSPA: A CODE FOR TRANSIENT THERMAL ANALYSIS OF A SINGLE FUEL PIN

by

F. Coyne Prenger

ABSTRACT

An analytical model (TRANSPA) for the transient thermal analysis of a single uranium carbide fuel pin was developed. This model uses thermal boundary conditions obtained from COBRA-WC output and calculates the transient thermal response of a single fuel pin to changes in internal power generation, coolant flowrate, or fuel pin physical configuration. The model uses the MITAS finite difference thermal analyzer. MITAS provides the means to input separate conductance models through the use of a user subroutine input capability. The model is a lumped-mass representation of the fuel pin using 26 nodes and 42 conductors. Run time for each transient analysis is approximately one minute of central processor time on the NOS operating system.

I. INTRODUCTION

The Transient Single Pin Analysis (TRANSPA) model uses the finite difference thermal analyzer code MITAS[1] as its basis. MITAS uses a lumped-mass thermal network and can accept user written subroutines describing physical processes of interest. In addition MITAS contains an extensive library of subroutines that includes network solutions for both transient and steady state analyses.

TRANSPA is a thermal model of a single uranium-plutonium LMFBR carbide fuel pin located within a fuel pin assembly. Its primary purpose is to provide cladding temperature histories for selected transient events such as transient overpowers, loss of coolant simulations, or control rod transients. These cladding temperatures are used as input to the SPECKEL and ABAQUS[2] code that is used to assess fuel performance. Boundary conditions for TRANSPA are obtained from the results of a complete assembly analysis of the fuel pin bundle. At present these results are obtained using the COBRA-WC[3] thermal-hydraulics code. The procedure is to determine the steady state temperatures and flow distribution of the complete pin bundle using COBRA-WC. From these results the hot fuel pin is identified. The transient response of the hot pin or other selected pin is then analyzed using TRANSPA with flowrate and inlet temperature obtained from the COBRA-WC analysis. A description of the TRANSPA model follows.

II. MODEL DESCRIPTION

TRANSPA is a network thermal model of a single fuel pin. Boundary conditions are coolant flowrate and inlet temperature. The heat source is uniform internal heat generation that is specified by the pin location and time in the reactor. A description of the thermal network is given followed by discussion of the special subroutines, the input power profile and the network solution characteristics.

A. Thermal Network

The thermal network comprises 26 nodes and 42 conductors. The fuel pin is divided into five axial stations each of length 18.3 cm. Each axial segment is divided into 4 radial segments representing the fuel centerline, the fuel surface, the clad inner surface and the clad outer surface. In addition an inlet and outlet fluid node is specified for each segment. The heat generation is simulated by a source term for the fuel centerline at each segment and the heat sink is a specified coolant inlet temperature at the bottom of the fuel pin. Both radiation and conduction are used to calculate the radial heat transfer across the fuel-cladding gap. Axial conduction in the fuel and cladding is also included. The convective heat transfer coefficient is used to calculate a heat transfer effectiveness that is used to calculate thermal couplings between the coolant and the fuel cladding. The thermal network is shown in Fig. 1.

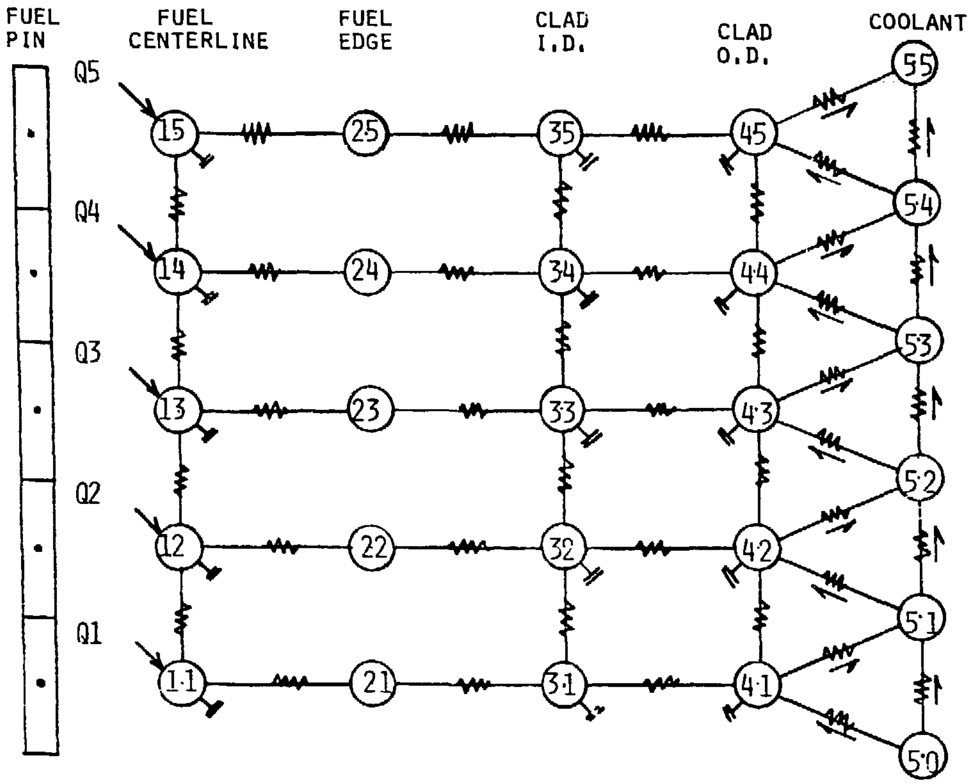

Fig. 1. Thermal network.

The thermal time constant of the model is small requiring small transient time steps. Also abrupt physical changes in the configuration lead to numerical instability in the model. These characteristics are discussed in a separate section. User subroutines required for the thermal network are discussed next.

B. Subroutines

User written subroutines can be easily incorporated into the MITAS code. Three subroutines are required for the TRANSPA model. The first subroutine calculates the gap conductance between the fuel and cladding. The gap conductance is a function of the interface pressure between the fuel and cladding. The subroutine uses initial conditions from either SPECKLE III or LIFE-4C code and then calculates changing interface pressure based on temperature dependent coefficients of thermal expansion and moduli of elasticity. The routine cannot currently handle plasticity. The interface pressure is then used to approximate the gap conductance based on a curve fit generated with data predicted by the LIFE-4C code.

The second subroutine calculates the convective heat transfer coefficient of the coolant. This subroutine uses empirical data that is a function of the Reynolds and Prandtl numbers.[3] The convective coefficient is then used to calculate a heat exchanger effectiveness that is used to specify the thermal couplings.

The final subroutine calculates the fuel conductivity as a function of temperature and porosity.[4] Each of the subroutines represents a separate thermal conductance model based on either empirical data or results from a separate analysis. The structure of the MITAS code facilitates the parameterization of the TRANSPA model through the use of these user supplied subroutines.

C. Power Profiles

The heat source term is imposed on the fuel centerline nodes of each segment. The heat source is a function of the fuel irradiation history and the pin location within the bundle and the bundle's location within the reactor. A nominal power profile is input and multiplying factors are used to define heat loads for a particular pin within the pin bundle. In addition an axial distribution of power is also imposed on the fuel pin. A transient power profile is created using a time dependent multiplying factor that is input in tabular form. A sample profile corresponding to a normal scram is shown in Fig. 2. The transient coolant flowrate is specified in a similar manner.

D. Execution Characteristics

Because the thermal time constant is only 0.02 s the time step for the transient solution must also be small. An implicit, forward-backward differencing scheme is used for the thermal network solution. Because the solution is implicit there is no upper bound on the time step, however, if the time step greatly exceeds the thermal time constant, errors in the resulting calculation may become significant. The small thermal time constant results from large thermal couplings combined with low heat capacity within the model. The modeling of liquid metal coolants flowing at high Reynolds numbers around small diameter fuel pins with large internal heat generation leads to numerical instabilities in the solution. Especially significant are changes

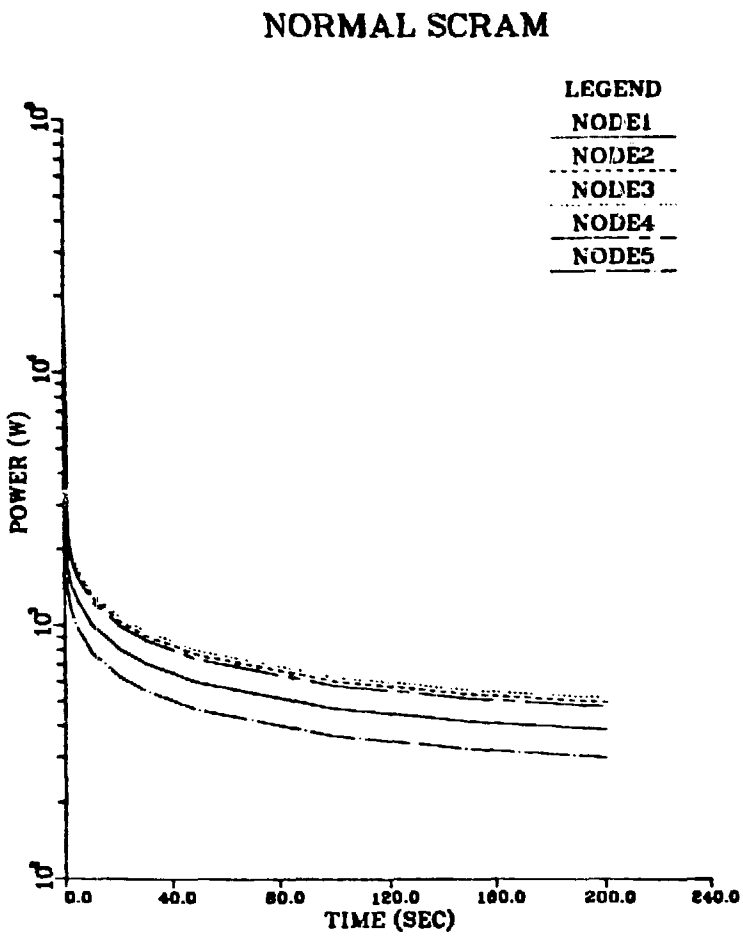

Fig. 2. Power profile for normal scram.

in the configuration that result in significant changes in the thermal couplings. Since the thermal conductance of the fuel and fuel-clad gap is strongly temperature dependent, numerical damping of these parameters must be utilized or severe temperature oscillations will occur. Because the use of these damping factors is largely empirical, sensitivity studies to determine their effect on the final results were conducted. In all cases the extent of the required damping had little influence on the final results.

This brief description of the model is intended to serve as an introduction to TRANSPA. Some of its special features and some of the difficulties encountered during its development were outlined. The following section contains a description of the output. The Appendix contains a listing of the program.

TABLE I

TWELVE TRANSIENT EVENTS

Event	Initial Condition
1. Normal scram	Full power
2. Rod drop	Full power
3. 0.5 ¢/s, 100% flow to 460 MW, primary trip	Full power
4. 3.4 ¢/s, 100% flow to 486 MW, primary trip	Full power
5. Continuous flow reduction, primary trip	93% power and flow
6. 0.5 ¢/s, 100% flow to 500 MW, secondary trip	Full power
7. 3.4 ¢/s, 100% flow to 526 MW, secondary trip	Full power
8. 25 ¢/s, 100% flow to 500 MW, primary trip	Full power
9. 25 ¢/s, 100% flow to 528 MW, secondary trip	Full power
10. Total loss electric power	Full power
11. Continuous flow reduction, secondary trip	93% power and flow
12. Primary pump seizure	Full power

III. OUTPUT AND RESULTS

TRANSPA is used to evaluate the transient thermal response of a single fuel pin to the twelve events shown in Table I. For each event a transient power profile and coolant flowrate are specified. For each case a steady state solution is obtained that serves as the initial condition for the transient. The model then calculates the transient response of the fuel centerline, the outside clad, and the fluid outlet temperatures. These temperatures are saved on a separate file and plotted using a separate program. Examples of the output are shown in Figs. 3, 4, and 5. Each figure contains five curves corresponding to each of the five axial nodes in TRANSPA.

The model is set up to analyze all of the twelve transient events in a single run. Logic to accomplish this is contained in the MITAS execution

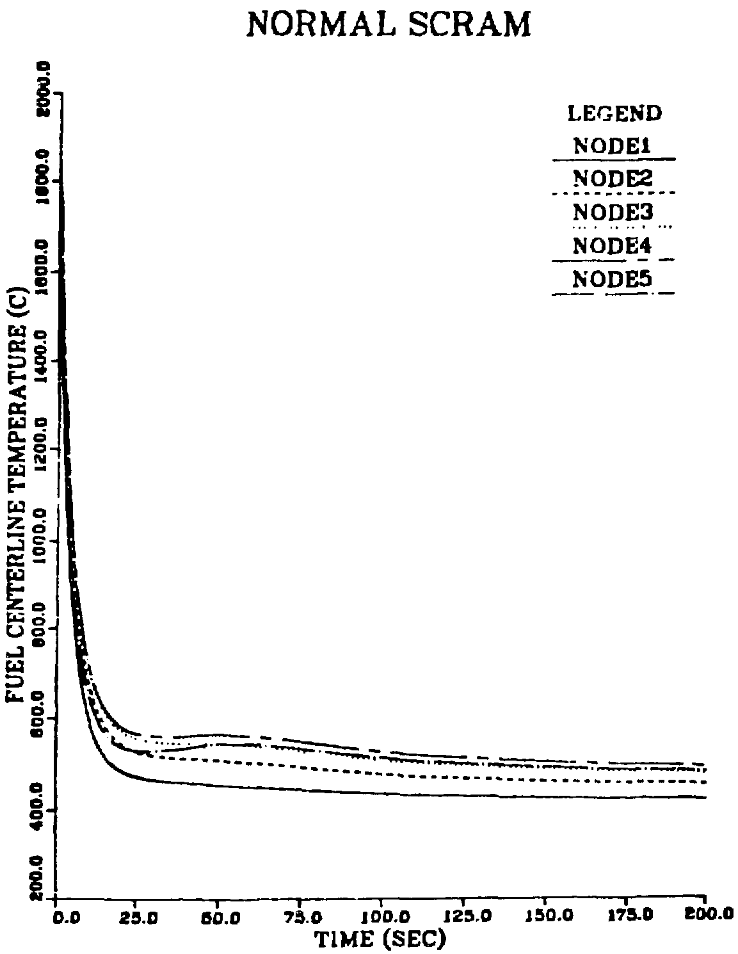

Fig. 3. Fuel centerline temperature for normal scram.

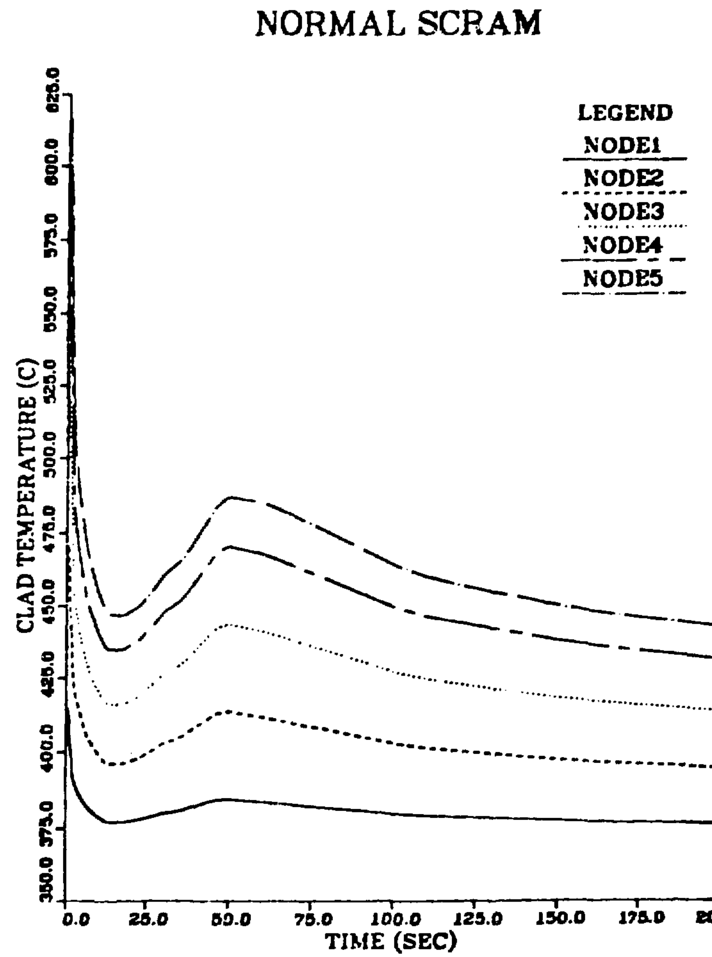

Fig. 4. Clad temperature for normal scram.

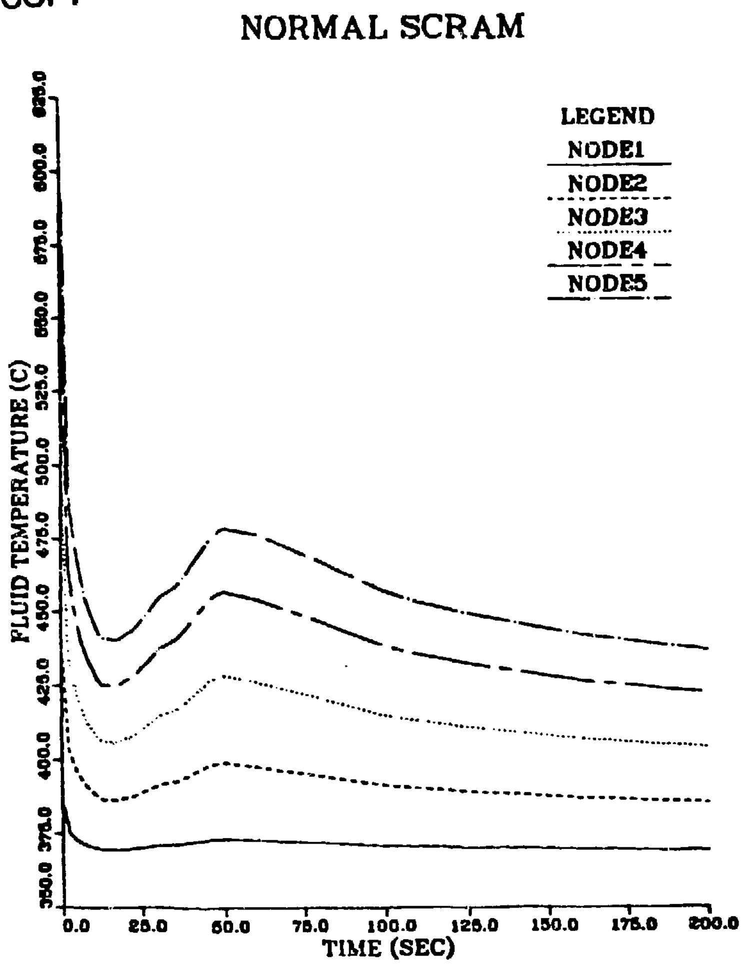

Fig. 5. Coolant temperature for normal scram.

routine. In addition two steady state at 93% power and coolant flow rate conditions are analyzed. The solution time step is varied during each calculation depending on the rate of change of the power profile or coolant flowrate. Execution time for the twelve transient cases requires approximately ten minutes of central processing time on the NOS system.

V. REFERENCES

1. G. M. Holmstead, R. E. Kannady, Jr., R. J. Connor, and E. Shirley, "Martin Marietta Interactive Thermal Analysis System, MITAS-II," User's Manual, May 1976.

2. <u>ABAQUS Computer Program Manuals</u> (Hibbitt, Karlsson & Sorensen, Inc., Providence, Rhode Island, 1981), Vol. 1-4.

3. E. P. Coomes, E. V. Khan, T. C. George, R. L. Cheatham, and D. R. Rector, "User's Manual, COBRA-WC: A Version of COBRA for Single Phase and Single and Multiassembly Thermal-Hydraulic Transient Analysis," Pacific Northwest Laboratories report PNL-3259, 1979.

4. T. L. George and K. L. Peddicord, "SPECKLE III: A Computer Code for Calculating the Behavior of Sphere Pac Fuel Pins," Oregon State University Rept. OSU-EIR-64, December 1982.

APPENDIX

MITAS II INPUT DATA FOR TRANSPA MODEL

```
DATE 84/09/24.TIME 17.16.04.  MARTIN MARIETTA THERMAL ANALYZER SYSTEM

    START OF INPUT DECK PROCESSING

INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.        CARD NO.

                         BCD 3TITLE DATA                                                    A.      1          1
                         BCD 9TRANSPA: TRANSIENT SINGLE PIN ANALYSIS                        A.      2          2
                         BCD 9CARBIDE FUELS PROGRAM                                         A.      3          3
                         BCD 9LANL MAY 1984                                                 A.      4          4
                         BCD 95 AXIAL NODES W/ AXIAL CONDUCTION                             A.      5          5
                         BCD 9AC3 CONFIGURATION, PIN 10 (MAX TEMP)                          A.      6          6
                         BCD 9THERMAL CONDUCTIVITY IS CURVEFIT FR SPECKLE POROSITY=0.23     A.      7          7
                         BCD 9INCLUDES GAP CONDUCTANCE MODEL                                A.      8          8
                         BCD 9UNITS ARE G-CM-S-DEG C-W                                      A.      9          9
                         END                                                                A.     10         10
```

```
DATE 84/09/24.TIME 17.16.04.  MARTIN MARIETTA THERMAL ANALYZER SYSTEM

    TRANSPA: TRANSIENT SINGLE PIN ANALYSIS              CARBIDE FUELS PROGRAM                             LANL MAY 198

INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.       CARD NO.

                          BCD 3NODE DATA                                                           A.    11          11
                          GEN 11, 5, 1, 1500.0,1.0$ FUEL CENTERLINE                                A.    12          12
                             +++++        11,   .15000E+04,   .10000E+01
                             +++++        12,   .15000E+04,   .10000E+01
                             +++++        13,   .15000E+04,   .10000E+01
                             +++++        14,   .15000E+04,   .10000E+01
                             +++++        15,   .15000E+04,   .10000E+01
                          GEN 21, 5, 1, 593.0,-1.$ FUEL OD                                         A.    13          13
                             +++++        21,   .59300E+03,  -.10000E+01
                             +++++        22,   .59300E+03,  -.10000E+01
                             +++++        23,   .59300E+03,  -.10000E+01
                             +++++        24,   .59300E+03,  -.10000E+01
                             +++++        25,   .59300E+03,  -.10000E+01
                          GEN 31, 5, 1, 593.0,1.0$ CLAD ID                                         A.    14          14
                             +++++        31,   .59300E+03,   .10000E+01
                             +++++        32,   .59300E+03,   .10000E+01
                             +++++        33,   .59300E+03,   .10000E+01
                             +++++        34,   .59300E+03,   .10000E+01
                             +++++        35,   .59300E+03,   .10000E+01
                          GEN 41, 5, 1, 593.0,1.0$ CLAD OD                                         A.    15          15
                             +++++        41,   .59300E+03,   .10000E+01
                             +++++        42,   .59300E+03,   .10000E+01
                             +++++        43,   .59300E+03,   .10000E+01
                             +++++        44,   .59300E+03,   .10000E+01
                             +++++        45,   .59300E+03,   .10000E+01
                          GEN 51, 5, 1, 375.0,-1.$ FLUID(COOLANT)                                  A.    16          16
                             +++++        51,   .37500E+03,  -.10000E+01
                             +++++        52,   .37500E+03,  -.10000E+01
                             +++++        53,   .37500E+03,  -.10000E+01
                             +++++        54,   .37500E+03,  -.10000E+01
                             +++++        55,   .37500E+03,  -.10000E+01
                            -50, 362.0, 0.0$ COOLANT INLET                                         A.    17          17
                          END                                                                      A.    18          18
RFL TO 116127B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
                                                 NODE SUMMARY

THERE ARE   15 DIFFUSION NODES,   10 ARITHMETIC NODES,    0 HEATER NODES, AND    1 BOUNDARY NODES
FOR A TOTAL OF   26 NODES IN THE NETWORK

                                               NODE DIRECTORY
                                                INPUT/INTERNAL

                                                DIFFUSION NODES
   11=     1 $    12=     2 $    13=     3 $    14=     4 $    15=     5 $    31=     6 $    32=     7 $    33=     8 $    34=     9
   35=    10 $    41=    11 $    42=    12 $    43=    13 $    44=    14 $    45=    15 $

                                                ARITHMETIC NODES
   21=    16 $    22=    17 $    23=    18 $    24=    19 $    25=    20 $    51=    21 $    52=    22 $    53=    23 $    54=    24
   55=    25 $

                                                 HEATER NODES
                                                   ++NONE++
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.      CARD NO.

                        BCD 3CONDUCTOR DATA                                          A.   19       19
RFL TO 000000B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
                        GEN 41,5,1,-50,1,41,1, 1.0$ FLUID COUPLING                   A.   20       20
                           +++++        41,    -50,     41,    .10000E+01
                           +++++        42,    -51,     42,    .10000E+01
                           +++++        43,    -52,     43,    .10000E+01
                           +++++        44,    -53,     44,    .10000E+01
                           +++++        45,    -54,     45,    .10000E+01
                        GEN 51,5,1,-50,1,51,1, 1.0                                   A.   21       21
                           +++++        51,    -50,     51,    .10000E+01
                           +++++        52,    -51,     52,    .10000E+01
                           +++++        53,    -52,     53,    .10000E+01
                           +++++        54,    -53,     54,    .10000E+01
                           +++++        55,    -54,     55,    .10000E+01
                        GEN 61,5,1,-41,1,51,1, 1.0                                   A.   22       22
                           +++++        61,    -41,     51,    .10000E+01
                           +++++        62,    -42,     52,    .10000E+01
                           +++++        63,    -43,     53,    .10000E+01
                           +++++        64,    -44,     54,    .10000E+01
                           +++++        65,    -45,     55,    .10000E+01
                        GEN 11,5,1,11,1,21,1, 1.0$ RADIAL CONDUCTION                 A.   23       23
                           +++++        11,     11,     21,    .10000E+01
                           +++++        12,     12,     22,    .10000E+01
                           +++++        13,     13,     23,    .10000E+01
                           +++++        14,     14,     24,    .10000E+01
                           +++++        15,     15,     25,    .10000E+01
                        GEN 21,5,1,21,1,31,1, 1.0                                    A.   24       24
                           +++++        21,     21,     31,    .10000E+01
                           +++++        22,     22,     32,    .10000E+01
                           +++++        23,     23,     33,    .10000E+01
                           +++++        24,     24,     34,    .10000E+01
                           +++++        25,     25,     35,    .10000E+01
                        GEN 31,5,1,31,1,41,1, 1.0                                    A.   25       25
                           +++++        31,     31,     41,    .10000E+01
                           +++++        32,     32,     42,    .10000E+01
                           +++++        33,     33,     43,    .10000E+01
                           +++++        34,     34,     44,    .10000E+01
                           +++++        35,     35,     45,    .10000E+01
                        GEN111,4,1,11,1,12,1, 1.0$ AXIAL CONDUCTION                  A.   26       26
                           +++++       111,     11,     12,    .10000E+01
                           +++++       112,     12,     13,    .10000E+01
                           +++++       113,     13,     14,    .10000E+01
                           +++++       114,     14,     15,    .10000E+01
                        GEN131,4,1,31,1,32,1, 1.0                                    A.   27       27
                           +++++       131,     31,     32,    .10000E+01
                           +++++       132,     32,     33,    .10000E+01
                           +++++       133,     33,     34,    .10000E+01
                           +++++       134,     34,     35,    .10000E+01
                        GEN141,4,1,41,1,42,1, 1.0                                    A.   28       28
                           +++++       141,     41,     42,    .10000E+01
                           +++++       142,     42,     43,    .10000E+01
                           +++++       143,     43,     44,    .10000E+01
                           +++++       144,     44,     45,    .10000E+01
```

```
TRANSPA: TRANSIENT SINGLE PIN ANALYSIS                 CARBIDE FUELS PROGRAM                                          LANL MAY 198
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.           CARD NO.
                         END                                                                               A.    29                29
RFL TO 116135B REQUESTED. OLD FL=200000B ,NEW FL=200000B.

                                                   CONDUCTOR SUMMARY

THERE ARE   42 LINEAR CONDUCTORS AND    0 NON-LINEAR CONDUCTORS , FOR A TOTAL OF   42 CONDUCTORS IN THIS NETWORK

                                                  CONDUCTOR DIRECTORY
                                                    INPUT=INTERNAL

    41=    1 $    42=    2 $    43=    3 $    44=    4 $    45=    5 $    51=    6 $    52=    7 $    53=    8 $    54=    9
    55=   10 $    61=   11 $    62=   12 $    63=   13 $    64=   14 $    65=   15 $    11=   16 $    12=   17 $    13=   18
    14=   19 $    15=   20 $    21=   21 $    22=   22 $    23=   23 $    24=   24 $    25=   25 $    31=   26 $    32=   27
    33=   28 $    34=   29 $    35=   30 $   111=   31 $   112=   32 $   113=   33 $   114=   34 $   131=   35 $   132=   36
   133=   37 $   134=   38 $   141=   39 $   142=   40 $   143=   41 $   144=   42 $
RFL TO 116150B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
RFL TO 116043B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
```

```
INPUT CARD COL.12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.        CARD NO.

                    BCD 3CONSTANTS DATA                                              A.     30          30
                       1,0.23    $ POROSITY OF FUEL                                  A.     31          31
                       2,0.24    $ CLAD CONDUCTIVITY - AXIAL ONLY (W/CM-C)           A.     32          32
                       3,13.51   $ DENSITY FUEL (G/CM**3)                            A.     33          33
                       4,7.64    $ DENSITY CLAD (G/CM**3)                            A.     34          34
                       5,0.250   $ CP FUEL (W-S/G-K)                                 A.     35          35
                       6,0.505   $ CP CLAD (W-S/G-K)                                 A.     36          36
                       7,1.04    $ RADIAL POWER FACTOR                               A.     37          37
                       8,14.0E6$ INITIAL INTERFACE PRESSURE                          A.     38          38
                       9,228.4   $ COOLANT FLOWRATE (G/S)                            A.     39          39
                       11,0.838 $ FUEL OD (CM)                                       A.     40          40
                       12,0.838 $ CLAD ID (CM)                                       A.     41          41
                       13,0.940 $ CLAD OD (CM)                                       A.     42          42
                       14,18.27 $ NODE LENGTH (CM)                                   A.     43          43
                       15,1321.6$ NOMINAL POWER DENSITY (W/CM**3)                    A.     44          44
                       16,1.26   $ CP COOLANT (W-S/G-K)                              A.     45          45
                       17,0.536 $ HYDRAULIC DIA OF CHANNEL                           A.     46          46
                       18,0.1974$ FLOW AREA OF CHANNEL                               A.     47          47
                       21,0.0    $ FUEL VOLUME (CM**3)                               A.     48          48
                       22,0.0    $ CLAD VOLUME (CM**3)                               A.     49          49
                       23,0.0    $ FUEL AXIAL CONDUCTANCE (W/K)                      A.     50          50
                       24,0.0    $ 0.5*CLAD AXIAL CONDUCTANCE (W/K)                  A.     51          51
                       25,0.0    $ FUEL RADIAL CONDUCTANCE (W/K)                     A.     52          52
                       26,0.0    $ CLAD RADIAL CONDUCTANCE (W/K)                     A.     53          53
                       27,0.0    $ CAPACITANCE OF FUEL (W-S/K)                       A.     54          54
                       28,0.0    $ CAPACITANCE OF CLAD (W-S/K)                       A.     55          55
                       29,0.0    $ FUEL SURFACE AREA (CM**2)                         A.     56          56
                       30,0.0    $ TRANSIENT HEAT FLUX NORMALIZED (W/CM**3)          A.     57          57
                       31,0.0    $ TRANSIENT FLOWRATE (G/S)                          A.     58          58
                       32,0.0    $ FLOWRATE*CP COOLANT                               A.     59          59
                       41,0.0$ CLAD-FUEL INTERFACE PRESSURE NODE 1                   A.     60          60
                       42,0.0$ CLAD-FUEL INTERFACE PRESSURE NODE 2                   A.     61          61
                       43,0.0$ CLAD-FUEL INTERFACE PRESSURE NODE 3                   A.     62          62
                       44,0.0$ CLAD-FUEL INTERFACE PRESSURE NODE 4                   A.     63          63
                       45,0.0$ CLAD-FUEL INTERFACE PRESSURE NODE 5                   A.     64          64
                       51,0.903 $ RELATIVE POWER NODE 1                              A.     65          65
                       52,1.159 $ RELATIVE POWER NODE 2                              A.     66          66
                       53,1.203 $ RELATIVE POWER NODE 3                              A.     67          67
                       54,1.114 $ RELATIVE POWER NODE 4                              A.     68          68
                       55,0.7C2 $ RELATIVE POWER NODE 5                              A.     69          69
                       60,0.4802     $ 0 TH COEFFICIENT FUEL CONDUCTIVITY (W/CM-K)   A.     70          70
                       61,-1.367E-3 $ 1 ST COEFFICIENT FUEL CONDUCTIVITY (W/CM-K)    A.     71          71
                       62,1.607E-6   $ 2 ND COEFFICIENT (T**2)                       A.     72          72
                       63,-8.379E-10$ 3 RD COEFFICIENT (T**3)                        A.     73          73
                       64,1.643E-13 $ 4 TH COEFFICIENT (T**4)                        A.     74          74
                       68,0.115 $ 0 TH COEFFICIENT CLAD CONDUCTIVITY (W/CM-C)        A.     75          75
                       69,1.30E-4 $ 1 ST COEFFICIENT (T)                             A.     76          76
                       71,0.0$ FUEL-CLADDING GAP CONDUCTANCE                         A.     77          77
                       72,0.0$                                                       A.     78          78
                       73,0.0$                                                       A.     79          79
                       74,0.0$                                                       A.     80          80
                       75,0.0$                                                       A.     81          81
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.        CARD NO.

                  90,0.95 $ GAP CONDUCTANCE DAMPING FACTOR                        A.    82     82
                  92,CGAP$ LABEL                                                  A.    83     83
                  93,IPRESS$ LABEL                                                A.    84     84
                  94,0.750 $ FUEL TEMPERATURE WEIGHT FACTOR FOR K                 A.    85     85
                  95,0.70   $ FUEL CONDUCTANCE DAMPING FACTOR                     A.    86     86
                  96,5.669E-12$ STEPHAN BOLTZMANN CONSTANT                        A.    87     87
                  97,CNST$ LABEL                                                  A.    88     88
                  98,EFF $ LABEL                                                  A.    89     89
                  99,3.14159$                                                     A.    90     90
                  111,1500.0$ SS FUEL C/L TEMP                                    A.    91     91
                  112,1500.0$                                                     A.    92     92
                  113,1500.0$                                                     A.    93     93
                  114,1500.0$                                                     A.    94     94
                  115,1500.0$                                                     A.    95     95
                  121,593.0$ SS FUEL EDGE TEMP                                    A.    96     96
                  122,593.0$                                                      A.    97     97
                  123,593.0$                                                      A.    98     98
                  124,593.0$                                                      A.    99     99
                  125,593.0$                                                      A.   100    100
                  131,593.0$ SS CLAD OD TEMP                                      A.   101    101
                  132,593.0$                                                      A.   102    102
                  133,593.0$                                                      A.   103    103
                  134,593.0$                                                      A.   104    104
                  135,593.0$                                                      A.   105    105
                  141,593.0$ SS CLAD OD TEMP                                      A.   106    106
                  142,593.0$                                                      A.   107    107
                  143,593.0$                                                      A.   108    108
                  144,593.0$                                                      A.   109    109
                  145,593.0$                                                      A.   110    110
                  155,375.0$ SS COOLANT OUTLET TEMP                               A.   111    111
                  ITEST,0  $ TRANSIENT FLAG (1=TRANSIENT)                         A.   112    112
                  NTEST,0  $ NUMBER OF TIME STEPS IN TRANSIENT                    A.   113    113
                  SBCNST = 1.0$                                                   A.   114    114
                  ABSZRO = -273.0$                                                A.   115    115
                  DRLXCA = 0.005$                                                 A.   116    116
                  ARLXCA = 0.005$                                                 A.   117    117
                  EBALSA = 500.0$                                                 A.   118    118
                  EBALNA = 100.0$                                                 A.   119    119
                  NDSTOR = 200$                                                   A.   120    120
                  ITERMX = 200$                                                   A.   121    121
                  EXTLIM = 100.0$                                                 A.   122    122
                  ITERXT = 5$                                                     A.   123    123
                  END                                                             A.   124    124
RFL TO 116374B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
```

CONSTANTS DIRECTORY

INPUT=INTERNAL

```
  1=   1 $    2=   2 $    3=   3 $    4=   4 $    5=   5 $    6=   6 $    7=   7 $    8=   8 $    9=   9
 11=  10 $   12=  11 $   13=  12 $   14=  13 $   15=  14 $   16=  15 $   17=  16 $   18=  17 $   21=  18
 22=  19 $   23=  20 $   24=  21 $   25=  22 $   26=  23 $   27=  24 $   28=  25 $   29=  26 $   30=  27
 31=  28 $   32=  29 $   41=  30 $   42=  31 $   43=  32 $   44=  33 $   45=  34 $   51=  35 $   52=  36
```

```
 53=  37 $   54=  38 $   55=  39 $   60=  40 $   61=  41 $   62=  42 $   63=  43 $   64=  44 $   68=  45
 69=  46 $   71=  47 $   72=  48 $   73=  49 $   74=  50 $   75=  51 $   90=  52 $   92=  53 $   93=  54
 94=  55 $   95=  56 $   96=  57 $   97=  58 $   98=  59 $   99=  60 $  111=  61 $  112=  62 $  113=  63
114=  64 $  115=  65 $  121=  66 $  122=  67 $  123=  68 $  124=  69 $  125=  70 $  131=  71 $  132=  72
133=  73 $  134=  74 $  135=  75 $  141=  76 $  142=  77 $  143=  78 $  144=  79 $  145=  80 $  155=  81
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.     CARD NO.

          BCD 3ARRAY DATA                                                                  A.   125       125
              2$ TIMEND ARRAY FOR TRANSIENTS                                               A.   126       126
              200.0,200.0,50.0,12.0,600.0,50.0,12.0,12.0,12.0                              A.   127       127
              200.0,600.0,200.0,END$                                                       A.   128       128
              8.SPACE,5,END$ COMPUTED HEAT GENERATION EACH NODE                            A.   129       129
              40,SPACE,150,END$                                                            A.   130       130
              41,SPACE,150,END$                                                            A.   131       131
              42,SPACE,150,END$                                                            A.   132       132
              43,SPACE,150,END$                                                            A.   133       133
              44,SPACE,150,END$                                                            A.   134       134
              45,SPACE,150,END$                                                            A.   135       135
              51,SPACE,150,END$                                                            A.   136       136
              52,SPACE,150,END$                                                            A.   137       137
              53,SPACE,150,END$                                                            A.   138       138
              54,SPACE,150,END$                                                            A.   139       139
              55,SPACE,150,END$                                                            A.   140       140
              61,SPACE,150,END$                                                            A.   141       141
              62,SPACE,150,END$                                                            A.   142       142
              63,SPACE,150,END$                                                            A.   143       143
              64,SPACE,150,END$                                                            A.   144       144
              65,SPACE,150,END$                                                            A.   145       145
              66,SPACE,150,END$                                                            A.   146       146
              71,SPACE,150,END$                                                            A.   147       147
              72,SPACE,150,END$                                                            A.   148       148
              73,SPACE,150,END$                                                            A.   149       149
              74,SPACE,150,END$                                                            A.   150       150
              75,SPACE,150,END$                                                            A.   151       151
              101$ NORMAL SCRAM - POWER                                                    A.   152       152
                    0.0,   1.0000,     1.0,   0.1400,      2.0,   0.1220                   A.   153       153
                    3.0,   0.1120,     4.0,   0.1050,      5.0,   0.0989                   A.   154       154
                   10.1,   0.0800,    20.1,   0.0645,     30.0,   0.0566                   A.   155       155
                   50.1,   0.0474,   100.0,   0.0374,    150.1,   0.0333                   A.   156       156
                  200.1,   0.0310, END$                                                    A.   157       157
              201$ NORMAL SCRAM - FLOW                                                     A.   158       158
                  0.000,   1.0000,   1.000,   0.8923,    2.000,   0.7713                   A.   159       159
                  3.016,   0.6778,   4.047,   0.6015,    5.053,   0.5413                   A.   160       160
                  6.010,   0.4938,   7.036,   0.4511,    8.069,   0.4146                   A.   161       161
                  8.999,   0.3863,   9.998,   0.3596,   15.047,   0.2648                   A.   162       162
                 19.998,   0.2084,  25.095,   0.1695,   30.059,   0.1425                   A.   163       163
                 35.110,   0.1293,  40.025,   0.1123,   45.099,   .09833                   A.   164       164
                 50.071,   .09294,  55.049,   .09269,   60.026,   .09275                   A.   165       165
                 74.952,   .09255,  99.991,   .09308,  150.103,   .09434                   A.   166       166
                200.029,   .09546, END$                                                    A.   167       167
              102$ ROD DROP - POWER                                                        A.   168       168
                    0.0,   1.0000,    18.3,   0.7620,     18.5,   0.7590                   A.   169       169
                   19.3,   0.1400,    20.3,   0.1220,     21.3,   0.1120                   A.   170       170
                   22.3,   0.1050,    23.3,   0.0989,     30.4,   0.0755                   A.   171       171
                   50.4,   0.0553,   100.3,   0.0399,    148.4,   0.0346                   A.   172       172
                  198.5,   0.0317, END$                                                    A.   173       173
              202$ ROD DROP - FLOW                                                         A.   174       174
                  0.000,   1.0000                                                          A.   175       175
                 18.300,   1.0000,  19.300,   0.8923,   20.300,   0.7713                   A.   176       176
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.   CARD NO.
                    21.316,   0.6778,   22.347,   0.6015,   23.353,   0.5413          A.   177     177
                    24.310,   0.4938,   25.336,   0.4511,   26.369,   0.4146          A.   178     178
                    27.299,   0.3863,   28.298,   0.3596,   33.347,   0.2648          A.   179     179
                    38.298,   0.2084,   43.395,   0.1695,   48.359,   0.1425          A.   180     180
                    53.410,   0.1293,   58.325,   0.1123,   63.399,   .09833          A.   181     181
                    68.371,   .09294,   73.349,   .09269,   78.326,   .09275          A.   182     182
                    93.252,   .09255,  118.291,   .09308,  168.403,   .09434          A.   183     183
                   218.329,   .09546, END$                                          A.   184     184
                  103$ 0.5C/S, PRIMARY TRIP                                         A.   185     185
                       0.0,   1.0000,      5.0,   1.0250,     10.0,   1.0512          A.   186     186
                      15.0,   1.0798,     20.0,   1.1105,     26.0,   1.1500          A.   187     187
                      27.0,   0.1378,     30.0,   0.0960,     35.0,   0.0912          A.   188     188
                      40.3,   0.0855,     41.0,   0.0850,     45.0,   0.0828          A.   189     189
                      50.0,   0.0822, END$                                          A.   190     190
                  203,0.0,1.0,50.0,1.0,END$                                         A.   191     191
                  104$ 3.4C/S, PRIMARY TRIP                                         A.   192     192
                       0.0,   1.0000,      1.0,   1.0355,      2.0,   1.0722          A.   193     193
                       3.0,   1.1105,      4.0,   1.1495,      5.0,   1.1898          A.   194     194
                       5.6,   1.2150,     5.61,   0.5245,     5.68,   0.3932          A.   195     195
                       6.0,   0.1812,      7.0,   0.1290,      7.8,   0.1200          A.   196     196
                       8.0,   0.1182,      8.4,   0.1150,      9.0,   0.1105          A.   197     197
                      10.0,   0.1050,     12.0,   0.0968, END$                      A.   198     198
                  204,0.0,1.0,12.0,1.0,END$                                         A.   199     199
                  105$ CONTINUOUS FLOW REDUCTION, PRIMARY TRIP  - POWER             A.   200     200
                      0.00,   1.0000,     1.02,   0.9988,     1.98,   0.9923          A.   201     201
                      3.00,   0.9816,     4.08,   0.9676,     5.04,   0.9534          A.   202     202
                      6.06,   0.9392,     7.02,   0.9255,     8.04,   0.9123          A.   203     203
                      9.00,   0.8997,    10.02,   0.8877,    11.10,   0.8752          A.   204     204
                     12.06,   0.8643,    13.08,   0.8538,    13.98,   0.1805          A.   205     205
                     15.00,   0.1037,    16.02,   0.0954,    16.98,   0.0901          A.   206     206
                     18.06,   0.0856,    19.08,   0.0822,    20.04,   0.0793          A.   207     207
                     21.06,   0.0768,    22.02,   0.0747,    23.04,   0.0728          A.   208     208
                     24.00,   0.0712,    25.02,   0.0694,    25.98,   0.0679          A.   209     209
                     27.06,   0.0663,    28.08,   0.0651,    29.10,   0.0639          A.   210     210
                     30.06,   0.0629,    31.08,   0.0619,    32.04,   0.0609          A.   211     211
                     33.06,   0.0601,    34.02,   0.0593,    35.04,   0.0585          A.   212     212
                     36.00,   0.0578,    37.02,   0.0571,    38.04,   0.0565          A.   213     213
                     39.00,   0.0559,    40.02,   0.0553,    41.10,   0.0547          A.   214     214
                     42.06,   0.0541,    43.08,   0.0536,    44.10,   0.0531          A.   215     215
                     45.06,   0.0527,    46.08,   0.0522,    47.04,   0.0518          A.   216     216
                     48.06,   0.0513,    49.02,   0.0509,    50.04,   0.0505          A.   217     217
                     51.06,   0.0502,    52.02,   0.0498,    53.04,   0.0494          A.   218     218
                     54.00,   0.0491,    55.02,   0.0488,    55.98,   0.0484          A.   219     219
                     57.00,   0.0481,    58.08,   0.0478,    59.10,   0.0475          A.   220     220
                     60.06,   0.0472,    75.06,   0.0437,    90.00,   0.0411          A.   221     221
                    105.00,   0.0393,   120.06,   0.0378,   135.00,   0.0366          A.   222     222
                    150.06,   0.0356,   165.06,   0.0347,   180.00,   0.0340          A.   223     223
                    195.00,   0.0334,   210.06,   0.0328,   225.00,   0.0323          A.   224     224
                    240.06,   0.0318,   255.00,   0.0314,   270.06,   0.0310          A.   225     225
                    285.06,   0.0306,   300.06,   0.0302,   315.06,   0.0299          A.   226     226
                    330.06,   0.0296,   345.06,   0.0293,   360.06,   0.0291          A.   227     227
                    375.00,   0.0288,   390.00,   0.0286,   405.06,   0.0283          A.   228     228
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.     CARD NO.

              420.12,   0.0281,   435.06,   0.0279,   450.06,   0.0277                  A.  229        229
              465.00,   0.0275,   480.06,   0.0273,   495.06,   0.0271                  A.  230        230
              510.00,   0.0270,   525.06,   0.0268,   540.00,   0.0266                  A.  231        231
              555.12,   0.0265,   570.06,   0.0263,   585.06,   0.0262                  A.  232        232
              600.00,   0.0260, END$                                                    A.  233        233
           205$ CONTINUOUS FLOW REDUCTION, PRIMARY TRIP - FLOW                          A.  234        234
                0.00,   1.0000,     1.02,   0.9818,     1.98,   0.9416                  A.  235        235
                3.00,   0.8994,     4.08,   0.8577,     5.04,   0.8213                  A.  236        236
                6.06,   0.7883,     7.02,   0.7584,     8.04,   0.7312                  A.  237        237
                9.00,   0.7065,    10.02,   0.6839,    11.10,   0.6612                  A.  238        238
               12.06,   0.6423,    13.08,   0.6242,    13.98,   0.6023                  A.  239        239
               15.00,   0.5489,    16.02,   0.4993,    16.98,   0.4585                  A.  240        240
               18.06,   0.4188,    19.08,   0.3868,    20.04,   0.3587                  A.  241        241
               21.06,   0.3340,    22.02,   0.3121,    23.04,   0.2926                  A.  242        242
               24.00,   0.2751,    25.02,   0.2594,    25.98,   0.2452                  A.  243        243
               27.06,   0.2311,    28.08,   0.2195,    29.10,   0.2089                  A.  244        244
               30.06,   0.1991,    31.08,   0.1901,    32.04,   0.1818                  A.  245        245
               33.06,   0.1742,    34.02,   0.1671,    35.04,   0.1605                  A.  246        246
               36.00,   0.1543,    37.02,   0.1485,    38.04,   0.1430                  A.  247        247
               39.00,   0.1378,    40.02,   0.1328,    41.10,   0.1276                  A.  248        248
               42.06,   0.1232,    43.08,   0.1190,    44.10,   0.1151                  A.  249        249
               45.06,   0.1113,    46.08,   0.1078,    47.04,   0.1055                  A.  250        250
               48.06,   0.1043,    49.02,   0.1037,    50.04,   0.1033                  A.  251        251
               51.06,   0.1030,    52.02,   0.1029,    53.04,   0.1027                  A.  252        252
               54.00,   0.1027,    55.02,   0.1026                                      A.  253        253
               60.06,   0.1026,    75.06,   0.1033,    90.00,   0.1029                  A.  254        254
              105.00,   0.1031,   120.06,   0.1034,   135.00,   0.1040                  A.  255        255
              150.06,   0.1045,   165.06,   0.1048,   180.00,   0.1050                  A.  256        256
              195.00,   0.1053,   210.06,   0.1058,   225.00,   0.1063                  A.  257        257
              240.06,   0.1070,   255.00,   0.1075,   270.06,   0.1080                  A.  258        258
              285.06,   0.1084,   300.06,   0.1087,   315.06,   0.1089                  A.  259        259
              330.06,   0.1091,   345.06,   0.1093,   360.06,   0.1096                  A.  260        260
              375.00,   0.1097,   390.00,   0.1099,   405.06,   0.1100                  A.  261        261
              420.12,   0.1101,   435.06,   0.1101,   450.06,   0.1102                  A.  262        262
              540.00,   0.1102                                                          A.  263        263
              555.12,   0.1101,   570.06,   0.1101,   585.06,   0.1100                  A.  264        264
              600.00,   0.1099, END$                                                    A.  265        265
           106$ 0.5C/S, SECONDARY TRIP                                                  A.  266        266
                 0.0,   1.0000,      5.0,   1.0250,     10.0,   1.0512                  A.  267        267
                15.0,   1.0798,     20.0,   1.1105,     26.0,   1.1500                  A.  268        268
                27.0,   1.1560,     30.0,   1.1770,     35.0,   1.2140                  A.  269        269
                40.3,   1.2500,     41.0,   0.1465,     45.0,   0.0970                  A.  270        270
                50.0,   0.0908, END$                                                    A.  271        271
           206,0.0,1.0,50.0,1.0,END$                                                    A.  272        272
           107$ 3.4C/S, SECONDARY TRIP                                                  A.  273        273
                 0.0,   1.0000,      1.0,   1.0355,      2.0,   1.0722                  A.  274        274
                 3.0,   1.1105,      4.0,   1.1495,      5.0,   1.1898                  A.  275        275
                 5.6,   1.2150,      6.0,   1.2322,      7.0,   1.2768                  A.  276        276
                 7.3,   1.3138,    7.816,   0.8838,    7.962,   0.7690                  A.  277        277
                 8.0,   0.6898,      8.4,   0.2708,      9.0,   0.2062                  A.  278        278
                10.0,   0.1845,     12.0,   0.1595, END$                                A.  279        279
           207,0.0,1.0,12.0,1.0,END$                                                    A.  280        280
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.   CARD NO.

 111$ CONTINUOUS FLOW REDUCTION, SECONDARY TRIP  - POWER                A.  281    281
   0.00,   1.0000,    1.02,   0.9997,    1.98,   0.9974                 A.  282    282
   3.00,   0.9932,    4.08,   0.9869,    4.98,   0.9803                 A.  283    283
   6.00,   0.9722,    7.02,   0.9636,    8.04,   0.9547                 A.  284    284
   9.06,   0.9458,   10.04,   0.9378,   11.04,   0.9290                 A.  285    285
  12.06,   0.9204,   13.08,   0.9117,   14.10,   0.9031                 A.  286    286
  15.00,   0.8953,   16.02,   0.8868,   17.04,   0.8783                 A.  287    287
  18.06,   0.8700,   19.08,   0.8621,   19.98,   0.1190                 A.  288    288
  21.00,   0.0991,   22.02,   0.0921,   23.10,   0.0872                 A.  289    289
  24.00,   0.0837,   25.02,   0.0804,   26.04,   0.0776                 A.  290    290
  27.06,   0.0753,   28.08,   0.0732,   29.04,   0.0716                 A.  291    291
  24.00,   0.0837,   25.02,   0.0804,   26.04,   0.0776                 A.  292    292
  27.06,   0.0753,   28.08,   0.0732,   29.04,   0.0716                 A.  293    293
  30.06,   0.0699,   31.08,   0.0682,   32.10,   0.0667                 A.  294    294
  33.00,   0.0655,   34.02,   0.0642,   35.04,   0.0631                 A.  295    295
  36.06,   0.0620,   37.02,   0.0612,   38.04,   0.0603                 A.  296    296
  39.06,   0.0594,   40.08,   0.0586,   41.04,   0.0579                 A.  297    297
  42.06,   0.0572,   43.08,   0.0565,   44.10,   0.0559                 A.  298    298
  45.00,   0.0553,   46.02,   0.0548,   47.04,   0.0542                 A.  299    299
  48.12,   0.0537,   49.02,   0.0532,   50.04,   0.0527                 A.  300    300
  51.06,   0.0523,   52.02,   0.0518,   53.04,   0.0514                 A.  301    301
  54.06,   0.0510,   55.08,   0.0506,   55.98,   0.0502                 A.  302    302
  57.00,   0.0498,   58.08,   0.0495,   59.10,   0.0491                 A.  303    303
  60.00,   0.0488,   75.00,   0.0448,   90.00,   0.0419                 A.  304    304
 105.12,   0.0398,  120.12,   0.0382,  135.00,   0.0370                 A.  305    305
 150.06,   0.0359,  165.00,   0.0350,  180.06,   0.0342                 A.  306    306
 195.06,   0.0336,  210.06,   0.0330,  225.06,   0.0324                 A.  307    307
 240.06,   0.0320,  255.06,   0.0315,  270.00,   0.0311                 A.  308    308
 285.06,   0.0307,  300.06,   0.0304,  315.06,   0.0300                 A.  309    309
 330.06,   0.0297,  345.06,   0.0294,  360.06,   0.0292                 A.  310    310
 375.06,   0.0289,  390.06,   0.0286,  405.06,   0.0284                 A.  311    311
 420.00,   0.0282,  435.00,   0.0280,  450.00,   0.0278                 A.  312    312
 465.12,   0.0276,  480.12,   0.0274,  495.00,   0.0272                 A.  313    313
 510.00,   0.0270,  525.00,   0.0268,  540.00,   0.0267                 A.  314    314
 555.06,   0.0265,  570.06,   0.0264,  585.06,   0.0262                 A.  315    315
 600.00,   0.0261, END$                                                 A.  316    316
 211$ CONTINUOUS FLOW REDUCTION, SECONDARY TRIP  - FLOW                 A.  317    317
   0.00,   1.0000,    1.02,   0.9870,    1.98,   0.9549                 A.  318    318
   3.00,   0.9188,    4.08,   0.8813,    4.98,   0.8501                 A.  319    319
   6.00,   0.8180,    7.02,   0.7884,    8.04,   0.7613                 A.  320    320
   9.06,   0.7364,   10.04,   0.7158,   11.04,   0.6946                 A.  321    321
  12.06,   0.6744,   13.08,   0.6550,   14.10,   0.6365                 A.  322    322
  15.00,   0.6207,   16.02,   0.6042,   17.04,   0.5886                 A.  323    323
  18.06,   0.5748,   19.08,   0.5632,   19.98,   0.5342                 A.  324    324
  21.00,   0.4898,   22.02,   0.4499,   23.10,   0.4156                 A.  325    325
  24.00,   0.3878,   25.02,   0.3603,   26.04,   0.3359                 A.  326    326
  27.06,   0.3143,   28.08,   0.2949,   29.04,   0.2792                 A.  327    327
  30.06,   0.2634,   31.08,   0.2492,   32.10,   0.2362                 A.  328    328
  33.00,   0.2255,   34.02,   0.2146,   35.04,   0.2046                 A.  329    329
  36.06,   0.1954,   37.02,   0.1877,   38.04,   0.1798                 A.  330    330
  39.06,   0.1724,   40.08,   0.1656,   41.04,   0.1599                 A.  331    331
  42.06,   0.1539,   43.08,   0.1482,   44.10,   0.1428                 A.  332    332
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.      CARD NO.
                  45.00,    0.1382,     46.02,    0.1322,     47.04,    0.1286          A.  333         333
                  48.12,    0.1241,     49.02,    0.1206,     50.04,    0.1164          A.  334         334
                  51.06,    0.1138,     52.02,    0.1125,     53.04,    0.1117          A.  335         335
                  54.06,    0.1113,     55.08,    0.1109,     55.98,    0.1107          A.  336         336
                  57.00,    0.1106,     58.08,    0.1105,     59.10,    0.1104          A.  337         337
                  60.00,    0.1103,     75.00,    0.1108,     90.00,    0.1107          A.  338         338
                 105.12,    0.1106,    120.12,    0.1107,    135.00,    0.1110          A.  339         339
                 150.06,    0.1116,    165.00,    0.1120,    180.06,    0.1124          A.  340         340
                 195.06,    0.1126,    210.06,    0.1130,    225.06,    0.1135          A.  341         341
                 240.06,    0.1140,    255.06,    0.1146,    270.00,    0.1152          A.  342         342
                 285.06,    0.1156,    300.06,    0.1160,    315.06,    0.1163          A.  343         343
                 330.06,    0.1166,    345.06,    0.1168,    360.00,    0.1170          A.  344         344
                 375.06,    0.1177,    390.06,    0.1174,    405.06,    0.1175          A.  345         345
                 420.00,    0.1177,    435.00,    0.1178,    450.00,    0.1178          A.  346         346
                 465.12,    0.1179,    540.00,    0.1179                                A.  347         347
                 555.06,    0.1178,    570.06,    0.1178,    585.06,    0.1178          A.  348         348
                 600.00,    0.1177, END$                                                A.  349         349
             108$ 25C/S, PRIMARY TRIP                                                   A.  350         350
                  0.000,    1.0000,     0.200,    1.0495,     0.400,    1.1098          A.  351         351
                  0.600,    1.1745,     0.800,    1.2465,     0.810,    0.7618          A.  352         352
                  0.855,    0.5953,     0.900,    0.4420,     1.000,    0.3110          A.  353         353
                  1.200,    0.1913,     1.400,    0.1478,     1.600,    0.1343          A.  354         354
                  2.000,    0.1273,     3.000,    0.1158,     5.000,    0.1023          A.  355         355
                  8.000,    .09325,    12.000,    .08325, END$                          A.  356         356
             208,0.0,1.0,12.0,1.0,END$                                                  A.  357         357
             109$ 25C/S, SECONDARY TRIP                                                 A.  358         358
                  0.000,    1.0000,     0.200,    1.0495,     0.400,    1.1098          A.  359         359
                  0.600,    1.1745,     0.800,    1.2465,     1.000,    1.3190          A.  360         360
                  1.016,    0.9968,     1.1095,   0.9233                                A.  361         361
                  1.200,    0.8000,     1.400,    0.5018,     1.600,    0.3020          A.  362         362
                  2.000,    0.2050,     3.000,    0.1805,     5.000,    0.1545          A.  363         363
                  8.000,    0.1325,    12.000,    0.1155, END$                          A.  364         364
             209,0.0,1.0,12.0,1.0,END$                                                  A.  355         365
             110$ TOTAL LOSS ELECTRIC POWER, - POWER                                    A.  366         366
                    0.0,    1.0000,       1.0,    0.1400,       2.0,    0.1220          A.  367         367
                    3.0,    0.1120,       4.0,    0.1050,       5.0,    0.0989          A.  368         368
                   10.1,    0.0800,      20.1,    0.0645,      30.0,    0.0566          A.  369         369
                   50.1,    0.0474,     100.0,    0.0374,     150.1,    0.0333          A.  370         370
                  200.1,    0.0310, END$                                                A.  371         371
             210$ TOTAL LOSS ELECTRIC POWER, - FLOW                                     A.  372         372
                  0.000,    1.0000,     2.000,    0.7452,     4.093,    0.5813          A.  373         373
                  6.045,    0.4782,     8.026,    0.3999,    10.119,    0.3370          A.  374         374
                 14.081,    0.2550,    20.152,    0.1809,    24.014,    0.1507          A.  375         375
                 30.143,    0.1166,    40.144,    .08051,    50.158,    .05880          A.  376         376
                 60.061,    .04532,    70.185,    .03564,    80.128,    .02961          A.  377         377
                 90.075,    .02743,   100.021,    .02741,   150.134,    .02966          A.  378         378
                200.056,    .02919, END$                                                A.  379         379
             112$ PRIMARY PUMP SEIZURE, - POWER                                         A.  380         380
                  0.000,    1.0000,     1.000,    0.2758,     2.000,    0.1216          A.  381         381
                  3.001,    0.1114                                                      A.  382         382
                  4.001,    0.1042,     5.014,    .09829,     6.041,    .09328          A.  383         383
                  7.061,    .08910,     8.025,    .08571,     9.025,    .08267          A.  384         384
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.      CARD NO.

               10.058,    .07995,    15.095,    .07049,    20.027,    .06452          A.   385        385
               25.134,    .05998,    29.978,    .05659,    35.006,    .05370          A.   386        386
               40.001,    .05129,    50.123,    .04738,   100.073,    .03742          A.   387        387
              150.077,    .03328,   200.128,    .03095,END$                           A.   388        388
         212$ PRIMARY PUMP SEIZURE, - FLOW                                            A.   389        389
                0.000,    1.0000,     1.000,    0.8244,     2.000,    0.7490          A.   390        390
                3.001,    0.6510                                                      A.   391        391
                4.001,    0.5766,     5.014,    0.5153,     6.041,    0.4647          A.   392        392
                7.061,    0.4230,     8.025,    0.3897,     9.025,    0.3600          A.   393        393
               10.058,    0.3336,    15.095,    0.2437,    20.027,    0.1911          A.   394        394
               25.134,    0.1551,    29.978,    0.1307,    35.006,    0.1118          A.   395        395
               40.001,    .09723,    50.123,    .08238,   100.073,    .08203          A.   396        396
              150.077,    .08312,   200.128,    .08410,END$                           A.   397        397
        END                                                                           A.   398        398
RFL TO 116231B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
```

ARRAY DIRECTORY

INPUT NO.	STARTING LOCATION	INTERNAL NO.	NO. OF ELEMENTS
2	1	1	13
8	14	2	6
40	20	3	151
41	171	4	151
42	322	5	151
43	473	6	151
44	624	7	151
45	775	8	151
51	926	9	151
52	1077	10	151
53	1228	11	151
54	1379	12	151
55	1530	13	151
61	1681	14	151
62	1832	15	151
63	1983	16	151
64	2134	17	151
65	2285	18	151
66	2436	19	151
71	2587	20	151
72	2738	21	151
73	2889	22	151
74	3040	23	151
75	3191	24	151
101	3342	25	27
201	3369	26	51
102	3420	27	27
202	3447	28	53
103	3500	29	27
203	3527	30	5
104	3532	31	35
204	3567	32	5
105	3572	33	195

TRANSPA: TRANSIENT SINGLE PIN ANALYSIS CARBIDE FUELS PROGRAM

205	3767	34	177
106	3944	35	27
206	3971	36	5
107	3976	37	35
207	4011	38	5
111	4016	39	207
211	4223	40	187
108	4410	41	35
208	4445	42	5
109	4450	43	33
209	4483	44	5
110	4488	45	27
210	4515	46	39
112	4554	47	43
212	4597	48	43

RFL TO 127130B REQUESTED. OLD FL=200000B ,NEW FL=200000B.

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.     CARD NO.

RFL TO 116376B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
                  BCD 3EXECUTION                                                    A.   399
              C   DERIVED QUANTITIES                                                A.   400
                  R21 = R99*R11*R11*R14/4.0                                         A.   401
                  R22 = R99*(R13*R13-R12*R12)*R14/4.00                              A.   402
                  R27 = R3*R5*R21*(1.0-R1)                                          A.   403
                  R28 = R4*R6*R22                                                   A.   404
                  STFSQS(R27,5,C11)                                                 A.   405
                  STFSQS(R28/2.,5,C31)                                              A.   406
                  STFSQS(R28/2.,5,C41)                                              A.   407
              C   AXIAL CONDUCTION                                                  A.   408
                  R24 = R2*R99*(R13*R13-R12*R12)/8.0/R14                            A.   409
                  STFSQS(R24,4,G131)                                                A.   410
                  STFSQS(R24,4,G141)                                                A.   411
              F   DO 100 ITEST=2,2                                                  A.   412
                  MTEST = 0                                                         A.   413
                  ITERMX = 500                                                      A.   414
                  JTEST = 0                                                         A.   415
                  TIMEN = 0.0                                                       A.   416
                  TIMEND = 0.0                                                      A.   417
                  TIMEO = 0.0                                                       A.   418
                  STDSTL                                                            A.   419
                  PRINTA(K97,R21,12,21)                                             A.   420
                  WRITE(6,210) ITEST                                                A.   421
                  TIMEND = A2+ITEST                                                 A.   422
                  TSTEPI = .05                                                      A.   423
                  TSTEPO = 0.2                                                      A.   424
                  ITERMX = 100                                                      A.   425
                  JTEST = 1                                                         A.   426
                  NTEST = 0                                                         A.   427
                  FWDBCK                                                            A.   428
                  WRITE(6,200) NTEST                                                A.   429
                  WRITE(6,201) (A40+I,A41+I,A42+I,A43+I,A44+I,A45+I,A71+I,A72+I.    A.   430
                * A73+I,A74+I,A75+I,A51+I,A52+I,A53+I,A54+I,A55+I,A61+I,A62+I,      A.   431
                * A63+I,A64+I,A65+I,A66+I,I=1,NTEST)                                A.   432
                  PUNCH 200, NTEST                                                  A.   433
                  PUNCH 201, (A40+I,A41+I,A42+I,A43+I,A44+I,A45+I,A71+I,A72+I,      A.   434
                * A73+I,A74+I,A75+I,A51+I,A52+I,A53+I,A54+I,A55+I,A61+I,A62+I,      A.   435
                * A63+I,A64+I,A65+I,A66+I,I=1,NTEST)                                A.   436
              F 200 FORMAT(I4)                                                      A.   437
              F 201 FORMAT(X,*TIME = *,F6.2,* (S)*/5X,*POWER (W)     *,1X,5F8.1     A.   438
              F   * /5X,*T FUEL CL (C)*,1X,5F8.1/5X,*T CLAD (C)    *,1X,5F8.1       A.   439
              F   * /5X,*T COOLANT (C)*,1X,5F8.1/5X,*T OUTLET (C) *,1X,F8.1)        A.   440
              F 210 FORMAT(/X,20H********************/                              A.   441
              F   *X,*TRANSIENT CASE *,I2/                                          A.   442
              F   *X,20H********************)                                       A.   443
                100 CONTINUE                                                        A.   444
                  END                                                               A.   445
```

```
      BCD 3VARIABLES1
      IF(TIMEN.LE.5.0) GO TO 10
      TSTEPI = 0.05
      TSTEPO = 0.5
       IF(TIMEN.LE.10.0) GO TO 10
       TSTEPO = 1.0
      IF(TIMEN.LE.50.0) GO TO 10
      TSTEPI = 0.5
      TSTEPO = 10.0
   10 CONTINUE
C       CONDUCTION\IN\FUEL
       TFUEL1 = R94*T11 + (1.0-R94)*T21
       TFUEL2 = R94*T12 + (1.0-R94)*T22
       TFUEL3 = R94*T13 + (1.0-R94)*T23
       TFUEL4 = R94*T14 + (1.0-R94)*T24
       TFUEL5 = R94*T15 + (1.0-R94)*T25
       CFUEL(TFUEL1,R14,R11,R1,R60,R61,R62,R63,R64,GFUEL1,G111)
       CFUEL(TFUEL2,R14,R11,R1,R60,R61,R62,R63,R64,GFUEL2,G112)
       CFUEL(TFUEL3,R14,R11,R1,R60,R61,R62,R63,R64,GFUEL3,G113)
       CFUEL(TFUEL4,R14,R 1,R1,R60,R61,R62,R63,R64,GFUEL4,G113)
       CFUEL(TFUEL5,R14,R11,R1,R60,R61,R62,R63,R64,GFUEL5,G114)
       DF = 1.0
       IF(JTEST.EQ.0) DF = R95
       G11 = DF*GFUEL1 + (1.0-DF)*G11
       G12 = DF*GFUEL2 + (1.0-DF)*G12
       G13 = DF*GFUEL3 + (1.0-DF)*G13
       G14 = DF*GFUEL4 + (1.0-DF)*G14
       G15 = DF*GFUEL5 + (1.0-DF)*G15
C      RADIAL CONDUCTION IN CLAD
       CLAD = 2.0*R99*R14/ALOG(R13/R12)
       G31 = (R68 + R69*(T31+T41)/2.)*CLAD
       G32 = (R68 + R69*(T32+T42)/2.)*CLAD
       G33 = (R68 + R69*(T33+T43)/2.)*CLAD
       G34 = (R68 + R69*(T34+T44)/2.)*CLAD
       G35 = (R68 + R69*(T35+T45)/2.)*CLAD
C      FUEL/CLAD GAP CONDUCTANCE
       IF(JTEST.GT.0) GO TO 30
       R111 = T11
       R112 = T12
       R113 = T13
       R114 = T14
       R115 = T15
       R121 = T21
       R122 = T22
       R123 = T23
       R124 = T24
       R125 = T25
       R131 = T31
       R132 = T32
       R133 = T33
       R134 = T34
       R135 = T35
```

```
      R141 = T41
      R142 = T42
      R143 = T43
      R144 = T44
      R145 = T45
      R155 = T55
   30 HGAP(1,T11,T21,R111,R121,T31,T41,R131,R141,T55,R155,R11,R13,
     * R12,R8,R1,R41,R71)
      HGAP(1,T12,T22,R112,R122,T32,T42,R132,R142,T55,R155,R11,R13,
     * R12,R8,R1,R42,R72)
      HGAP(1,T13,T23,R113,R123,T33,T43,R133,R143,T55,R155,R11,R13,
     * R12,R8,P1,R43,R73)
      HGAP(1,T14,T24,R114,R124,T34,T44,R134,R144,T55,R155,R11,R13,
     * R12,R8,R1,R44,R74)
      HGAP(1,T15,T25,R115,R125,T35,T45,R135,R145,T55,R155,R11,R13,
     * R12,R8,R1,R45,R75)
      R29 = R99*R11*R14
      G21 = (1.0-R90)*G21 + R90*R29*R71
      G22 = (1.0-R90)*G22 + R90*R29*R72
      G23 = (1.0-R90)*G23 + R90*R29*R73
      G24   (1.0-R90)*G24 + R90*R29*R74
      G25 = (1.0-R90)*G25 + R90*R29*R75
C     COOLANT FLOWRATE AND POWER
      GO TO (11,12,13,14,15,16,17,18,19,20,21,22),ITEST
   11 D1D1WM(TIMEN,A101,R15,R30)
      D1D1WM(TIMEN,A201,R9,R31)
      GO TO 99
   12 D1D1WM(TIMEN,A102,R15,R30)
      D1D1WM(TIMEN,A202,R9,R31)
      GO TO 99
   13 D1D1WM(TIMEN,A103,R15,R30)
      D1D1WM(TIMEN,A203,R9,R31)
      GO TO 99
   14 D1D1WM(TIMEN,A104,R15,R30)
      D1D1WM(TIMEN,A204,R9,R31)
      GO TO 99
   15 D1D1WM(TIMEN,A105,R15,R30)
      D1D1WM(TIMEN,A205,R9,R31)
      R30 = 0.93*R30
      R31 = 0.93*R31
      GO TO 99
   16 D1D1WM(TIMEN,A106,R15,R30)
      D1D1WM(TIMEN,A206,R9,R31)
      GO TO 99
   17 D1D1WM(TIMEN,A107,R15,R30)
      D1D1WM(TIMEN,A207,R9,R31)
      GO TO 99
   18 D1D1WM(TIMEN,A108,R15,R30)
      D1D1WM(TIMEN,A208,R9,R31)
      GO TO 99
   19 D1D1WM(TIMEN,A109,R15,R30)
      D1D1WM(TIMEN,A209,R9,R31)
```

```
                                                                                                   CARD NO.
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678.8 EDIT NO.
                                                                                                      550
             GO TO 99                                                              A.   550           551
         20  D1D1WM(TIMEN,A110,R15,R30)                                            A.   551           552
             D1D1WM(TIMEN,A210,R9,R31)                                             A.   552           553
             GO TO 99                                                              A.   553           554
         21  D1D1WM(TIMEN,A111,R15,R30)                                            A.   554           555
             D1D1WM(TIMEN,A211,R9,R31)                                             A.   555           556
             R30 = 0.93*R30                                                        A.   556           557
             R31 = 0.93*R31                                                        A.   557           558
             GO TO 99                                                              A.   558           559
         22  D1D1WM(TIMEN,A112,R15,R30)                                            A.   559           560
             D1D1WM(TIMEN,A212,R9,R31)                                             A.   560           561
             GO TO 99                                                              A.   561           562
         99  CONTINUE                                                              A.   562           563
             R32 = R31*R16                                                         A.   563           564
      C      HEAT GENERATION IN PIN                                                A.   564           565
             Q11 = R7*R30*R21*R51                                                  A.   565           566
             Q12 = R7*R30*R21*R52                                                  A.   566           567
             Q13 = R7*R30*R21*R53                                                  A.   567           568
             Q14 = R7*R30*R21*R54                                                  A.   568           569
             Q15 = R7*R30*R21*R55                                                  A.   569           570
             A8+1 = Q11                                                            A.   570           571
             A8+2 = Q12                                                            A.   571           572
             A8+3 = Q13                                                            A.   572           573
             A8+4 = Q14                                                            A.   573           574
             A8+5 = Q15                                                            A.   574           575
      C      FLUID NETWORK                                                         A.   575           576
             FILM(T50,T51,R32,R17,R18,R13,R14,G41,G61,G51)                         A.   576           577
             FILM(T51,T52,R32,R17,R18,R13,R14,G42,G62,G52)                         A.   577           578
             FILM(T52,T53,R32,R17,R18,R13,R14,G43,G63,G53)                         A.   578           579
             FILM(T53,T54,R32,R17,R18,R13,R14,G44,G64,G54)                         A.   579           580
             FILM(T54,T55,R32,R17,R18,R13,R14,G45,G65,G55)                         A.   580           581
             END                                                                   A.   581
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.   CARD NO.
              BCD 3OUTPUT CALLS                                                          A.   582      582
              IF(JTEST.EQ.O.OR.TIMEN.EQ.O.O) GO TO 10                                    A.   583      583
              MTEST = MTEST + 1                                                          A.   584      584
              IF(MTEST.LE.4) GO TO 20                                                    A.   585      585
              MTEST = O                                                                  A.   586      586
       10     TPRINT                                                                     A.   587      587
              PRINTA(K97,R30,2,30)                                                       A.   588      588
              PRINTA(K93,R41,5,1)                                                        A.   589      589
              PRINTA(K92,R71,5,1)                                                        A.   590      590
              WRITE(6,11)                                                                A.   591      591
       20     CONTINUE                                                                   A.   592      592
     F 11     FORMAT(* TIME*,12X,* HEAT GENERATION (W)*,13X,*  CLAD TEMPERATURE          A.   593      593
     F      1 (C)*/8X,*Q1*,7X,*Q2*,7X,*Q3*,7X,*Q4*,7X,*Q5*,5X,*T1*,4X,*T2*,             A.   594      594
     F      2 4X,*T3*,4X,*T4*,4X,*T5*)                                                   A.   595      595
              WRITE(6,12)TIMEN,(A8+I,I=1,5),T41,T42,T43,T44,T45                          A.   596      596
     F 12     FORMAT(1X,F5.1,5E9.3,5F6.1)                                                A.   597      597
              IF(JTEST.EQ.O) RETURN                                                      A.   598      598
              NTEST = NTEST + 1                                                          A.   599      599
              A40+NTEST = TIMEN                                                          A.   600      600
              A41+NTEST = A8+1                                                           A.   601      601
              A42+NTEST = A8+2                                                           A.   602      602
              A43+NTEST = A8+3                                                           A.   603      603
              A44+NTEST = A8+4                                                           A.   604      604
              A45+NTEST = A8+5                                                           A.   605      605
              A51+NTEST = T41                                                            A.   606      606
              A52+NTEST = T42                                                            A.   607      607
              A53+NTEST = T43                                                            A.   608      608
              A54+NTEST = T44                                                            A.   609      609
              A55+NTEST = T45                                                            A.   610      610
              A61+NTEST = (T50+T51)/2.                                                   A.   611      611
              A62+NTEST = (T51+T52)/2.                                                   A.   612      612
              A63+NTEST = (T52+T53)/2.                                                   A.   613      613
              A64+NTEST = (T53+T54)/2.                                                   A.   614      614
              A65+NTEST = (T54+T55)/2.                                                   A.   615      615
              A66+NTEST = T55                                                            A.   616      616
              A71+NTEST = T11                                                            A.   617      617
              A72+NTEST = T12                                                            A.   618      618
              A73+NTEST = T13                                                            A.   619      619
              A74+NTEST = T14                                                            A.   620      620
              A75+NTEST = T15                                                            A.   621      621
              END                                                                        A.   622      622
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.       CARD NO.

                BCD 3SUBROUTINES                                                                 A.   623         623
F               SUBROUTINE HGAP(IFLAG,TFI,TFO,TFSSI,TFSSO,TCI,TCO,TCSSI,TCSSO,                  A.   624         624
F             $ TFLO,TFLOSS,DFUEL,DCLADO,DCLADI,PNOT,PORE,PINTF,GGAP)                           A.   625         625
C                                                                                                A.   626         626
C               THIS SUBROUTINE COMPUTES THE GAP CONDUCTANCE BETWEEN CLADDING AND               A.   627         627
C               FUEL FOR BOTH SPHERE-PAC AND PELLET FUEL PINS.                                   A.   628         628
C               AN "ADAPTED" ROSS/STOUTE METHOD IS USED                                          A.   629         629
C               WHERE THE DEPENDENCE OF CONDUCTANCE ON INTERFACE PRESSURE IS A                   A.   630         630
C               CURVE FIT BASED ON LIFE-4C COMPUTATIONS.                                         A.   631         631
C                                                                                                A.   632         632
C               CONSTANTS FOR D9 CLADDING                                                        A.   633         633
C                                                                                                A.   634         634
F               DATA AEC,BEC/2.01E+05,-79.29/                                                    A.   635         635
F               DATA AGC,BGC/7.86E+04,-38.41/                                                    A.   636         636
F               DATA AAC,BAC/15.E-06,4.E-09/                                                     A.   637         637
C                                                                                                A.   638         638
C               CONSTANTS FOR CARBIDE FUEL                                                       A.   639         639
C                                                                                                A.   640         640
F               DATA AAF,BAF/9.,1E-06,1.4E-09/                                                   A.   641         641
C                                                                                                A.   642         642
C               DATA FOR PLENUM IC'S                                                             A.   643         643
C                                                                                                A.   644         644
F               DATA PPNOT,TPNOT/330000.,871./                                                   A.   645         645
C                                                                                                A.   646         646
C               CALCULATE ELASTIC CONSTANTS                                                      A.   647         647
C                                                                                                A.   648         648
F               TCLAD=0.5*(TCI+TCO)                                                              A.   649         649
F               ECLAD=(AEC+BEC*TCLAD)*1.E+6                                                      A.   650         650
F               GCLAD=(AGC+BGC*TCLAD)*1.E+6                                                      A.   651         651
F               ALPHC=AAC+BAC*TCLAD                                                              A.   652         652
F               GNUC=(ECLAD/(2.*GCLAD))-1.                                                       A.   653         653
C                                                                                                A.   654         654
F               TFUEL=0.5*(TFI+TFO)                                                              A.   655         655
F               EFUEL=2.02*(1.-1.54*PORE)*(1.-0.92E-04*(TFUEL-25.))*1.E+11                       A.   656         656
F               GFUEL=0.78*(1.-1.54*PORE)*(1.-0.92E-04*(TFUEL-25.))/(1.-0.44E-04*               A.   657         657
F             $ (TFUEL-25.))*1.E+11                                                              A.   658         658
F               ALPHF=AAF+BAF*TFUEL                                                              A.   659         659
F               GNUF=(EFUEL/(2.*GFUEL))-1.                                                       A.   660         660
C                                                                                                A.   661         661
C               CALCULATE CHANGE IN PLENUM PRESSURE                                              A.   662         662
C                                                                                                A.   663         663
F               DELPP=PPNOT*((TFLO+273.)/TPNOT-1.0)                                              A.   664         664
C                                                                                                A.   665         665
C               CALCULATE INTERFERANCE BASED ON NEW TEMPERATURES                                 A.   666         666
C               AND PLENUM PRESSURES                                                             A.   667         667
C                                                                                                A.   668         668
F               TICLAD=0.5*(TCSSI+TCSSO)                                                         A.   669         669
F               TIFUEL=0.5*(TFSSI+TFSSO)                                                         A.   670         670
F               RCI=(DCLADI/2.)/100.                                                             A.   671         671
F               RCO=(DCLADO/2.)/100.                                                             A.   672         672
F               THIKCL=RCO-RCI                                                                   A.   673         673
F               RF=(DFUEL/2.)/100.                                                               A.   674         674
```

```
INPUT CARD COL. = 12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 2345678 8 EDIT NO.     CARD NO.
F       DELTA=((1.+GNUF)*ALPHF*RF*(TFUEL-TIFUEL)-ALPHC*RCI*(TCLAD-TICLAD)
F     $ )-DELPP*(RCI*RCI/(2.*ECLAD*THIKCL))
C
C       CALCULATE INTERFACE PRESSURE BASED ON NEW DELTA
C
F       DENOM=RCI*(1./EFUEL+(RCO*RCO+RCI*RCI)/(ECLAD*(RCO*RCO-RCI*RCI))
F     $ -GNUF/EFUEL+GNUC/ECLAD)
F       PINTF=DELTA/DENOM+PNOT
C
C       CALCULATE GAP CONDUCTANCE
C
F       IF(PINTF.LE.O.O) PINTF=0.0
F       GGAP=1.005+5.218*((PINTF*1.E-06)/18.63)**1.15
C
F       RETURN
F       END
F       SUBROUTINE FILM(TF1,TF2,MCP,DCHAN,ACHAN,DCLAD,LEN,G1,G2,G3)
F       REAL MCP,LEN
F       PI = 3.14159
F       ASURF = PI*DCLAD*LEN
F        TFM = (TF1+TF2)/2.0
F        COND = 0.9291 + TFM*(1.1723E-7*TFM-5.8064E-4)
F       PECLET = MCP/2.*DCHAN/ACHAN/COND
F       HTC = COND/DCHAN*(0.012*PECLET**.86+4.386)
F       UA = HTC*ASURF
F       IF(UA/MCP.GT.1.0E3) GO TO 10
F       EFF = 1.0-EXP(-UA/MCP)
F       G1 = EFF*MCP
F       G2 = G1
F       G3 = (1.0-EFF)*MCP
F       RETURN
F 10    G1 = MCP
F       G2 = G1
F       G3 = 1.0E-3
F       RETURN
F       END
F       SUBROUTINE CFUEL(TFUEL,LEN,DFUEL,PORO,CO,C1,C2,C3,C4,
      * CONDR,CONDA)
C       THIS SUBROUTINE CALCULATES FUEL CONDUCTANCE, AXIAL AND RADIAL,
C       AS A FUNCTION OF TEMPERATURE UNITS ARE W/CM-K FOR T IN KELVINS
F       REAL LEN,KFUEL
F       TFUEL = TFUEL + 273.15
F       KFUEL = (CO + TFUEL*(C1 + TFUEL*(C2 +TFUEL*(C3 + TFUEL*C4))))
F       IF(KFUEL.GT.0.15) KFUEL = 0.15
F       CONDR = 4.0*KFUEL*3.14159*LEN
F       CONDA = KFUEL*3.14159*DFUEL*DFUEL/4.0/LEN
F       RETURN
        END
        BCD 3END OF DATA
RFL TO 127050B REQUESTED. OLD FL=200000B ,NEW FL=200000B.
```

THE INITIAL DATA VALUES AND FORTRAN PROGRAMS (AFTER EDITS) HAVE BEEN WRITTEN ON THE PROBLEM RESTART FILE -RSTRTO- AS PROBLEM-ST0000-.

CORE REQUIREMENTS FOR MITAS COMPILATION PHASE

NODE BLOCK..	0116127 OCTAL
CONDUCTOR BLOCK...	0116147 OCTAL
CONSTANTS BLOCK...	0116374 OCTAL
ARRAY BLOCK...	0127130 OCTAL
VARIABLE CAP. AND/OR COND. ARRAY CONSTRUCTION............	0000000 OCTAL
OPERATIONS BLOCK INTERPRETATION.........................	0116376 OCTAL
FILE SETUP..	0127050 OCTAL
PARAMETRIC AND/OR RESTART...............................	0000000 OCTAL
MINIMUM CORE REQUIRED FOR MITAS COMPILER.................	0127200 OCTAL

CP TIME CONSUMED IN MITAS COMPILATION PHASE

EDIT PROCESSING................................		.567 SEC
NODE BLOCK.....................................	.229	
CONDUCTOR BLOCK................................	.306	
CONSTANT BLOCK.................................	.322	
ARRAY BLOCK....................................	1.170	
VARIABLE CAP. AND/OR CONO......................	.052	
TOTAL TIME FOR DATA BLOCKS.....................		2.115 SEC
TOTAL TIME FOR OPERATIONS BLOCK................		1.681 SEC
TOTAL TIME FOR FILE SETUP......................		0.000 SEC
TOTAL TIME FOR PARAMETRIC AND/OR RESTART.......		0.000 SEC

TOTAL CP TIME FOR MITAS COMPILATION PHASE......		4.847 SEC

+++++ NORMAL TERMINATION OF MITAS COMPILER +++++